



Domestic Solar Panel Production: Room for Growth

— The growing need for a strategic government response given the future role of solar PV —

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◀Summary▶

- ◆ As countries work to decarbonize, the role of solar photovoltaic (PV) power is growing around the world. The technology is expected to become a key source of electricity going forward. However, most solar panels are currently manufactured in China, leaving many countries heavily dependent on Chinese products. Energy security risks are likely to grow as solar PV generation expands; in particular, risks stemming from China potentially imposing solar panel export restrictions. This has made it increasingly necessary for countries to strengthen domestic solar panel manufacturing capacity.
- ◆ There have been various moves to strengthen domestic panel manufacturing in different countries so far. While the results have varied, the U.S. has seen domestic production rise significantly. The Inflation Reduction Act (IRA), implemented under the Biden administration, facilitated substantial industrial support and contributed directly to this growth. While clear results are yet to be seen in Australia and Europe, government initiatives aimed at expanding domestic production are picking up speed.
- ◆ Though this kind of large-scale industrial support has historically been considered taboo, there has recently been much talk of the “China Shock 2.0”. This refers to how China’s competitive edge in manufacturing has shifted from low-cost production to a new stage characterized by advanced technology driving competitiveness. In response, an increasing number of countries are adopting what can be called “China-style” industrial policy to support their solar manufacturing industries. This trend is expected to continue spreading. Indeed, one major element of U.S. success has been the growing output of solar panel manufacturers that have received funding from Chinese firms. Accepting investment from technologically advanced Chinese firms may therefore be an important ingredient in an effective industrial policy.

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- ◆ Japan too urgently needs a strategic, state-led approach toward solar panels. If the country rapidly expands support for next-generation perovskite solar cells and manages to increase domestic manufacturing of panels focused on these, it will substantially reduce risks to its energy security going forward.

- This is a English version of “太陽光パネル国内製造とその拡大の可能性～太陽光発電の将来の重要性を考え、国家主導の戦略的対応が必要に～” in Research Focus (The original version is available at <https://www.jri.co.jp/MediaLibrary/file/report/researchfocus/pdf/16206.pdf>)

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1. Introduction

As societies decarbonize, solar photovoltaic (PV) power's potential as a major renewable energy source has made it increasingly important. Countries all over the world, including Japan, have already installed many solar panels and solar PV accounts for a portion of their electricity supplies. Going forward, solar PV's share of the global electricity mix is expected to rise significantly.

However, most of the panels required for solar PV generation (often called photovoltaic modules) are manufactured in China. The current situation where many countries possess little capacity to produce solar panels domestically, despite their increasing importance, poses a significant risk to future energy security.

This paper: 2) examines the issue of dependence on solar panels made in China and 3) reviews policies supporting solar panel manufacturing in major advanced economies and analyzes their outcomes. It then 4) investigates what sorts of policies countries around the globe have implemented to counter China's solar panel industry. Based on this, 5) it examines the current state of manufacturing in Japan and future challenges.

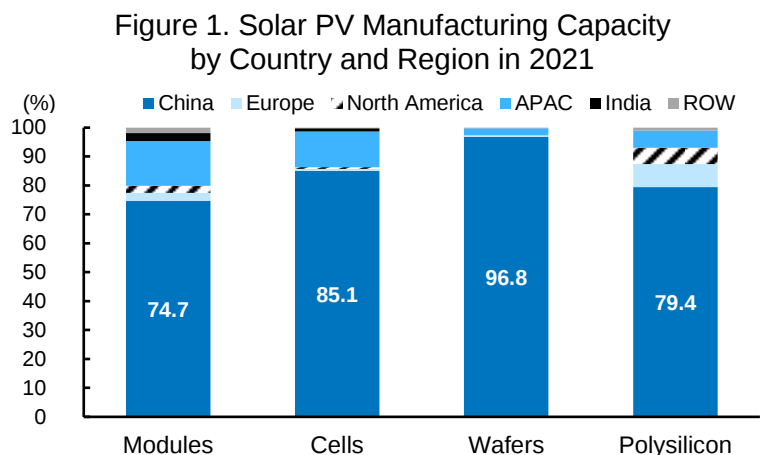
2. Problems Caused by Overreliance on Solar Panels Made in China

China now produces by far the largest share of solar panels in the world. It is also the biggest producer of the components needed to make solar panels, such as solar cells, wafers and polysilicon (Figure 1).

Problems such as cyberattacks from China via solar panels have drawn attention in recent years⁴. Some parts of the media⁵ have pointed to the possibility of cyberattacks in the recent large-scale blackouts in Spain and Portugal, highlighting the risks of Chinese products (We note that this is a misleading article; see Appendix 1 for details). Addressing these risks is certainly important and it will be crucial going forward to consider developing new laws, including regulations around the control and oversight of infrastructure systems.

However, this paper does not deal with such cybersecurity risks. This is a problem requiring increased vigilance across all types of infrastructure, not just solar power systems. The focus here is on the medium- to long-term economic security risks posed by China potentially getting a near monopoly on solar panel production. This would undermine other countries' ability to generate solar power independently.

The scale of solar PV generation in many countries is expected to expand in the future (Figure 2). If this happens, China could impose prolonged solar panel export restrictions, posing a serious energy security threat.

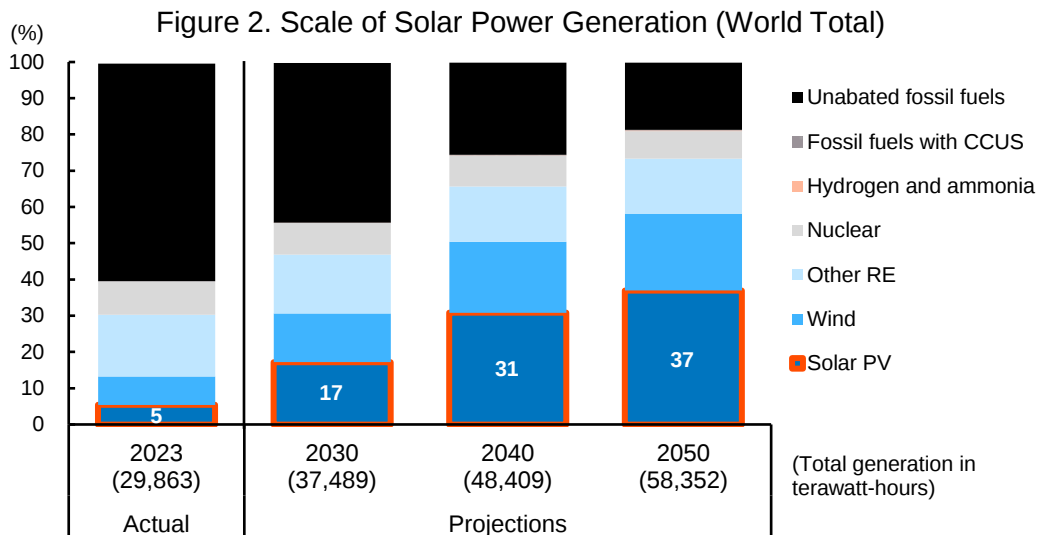


Source: JRI based on IEA

Note: APAC = Asia-Pacific region excluding India. ROW = rest of world.

⁴ For instance, the Nikkei newspaper published an article on August 18, 2024, titled "Solar Power Becomes Hotbed for Cyberattacks: Illegal Money Transfers via IoT" (<https://www.nikkei.com/article/DGXZQOUC254VD0V20C24A7000000/>).

⁵ "China-made solar parts under scrutiny after Spain-Portugal power cut", Nikkei Asia, May 17, 2025. <https://asia.nikkei.com/business/energy/china-made-solar-parts-under-scrutiny-after-spain-portugal-power-cut>



Source: JRI based on the IEA's *World Energy Outlook 2024*

Note: Other RE = Other renewables. The projections here are from the IEA's Stated Policies Scenario (STEPS), which takes into account policies currently in place or announced by governments

3. Support for the Solar Panel Industry in Major Advanced Economies

Many advanced economies have already launched initiatives to expand domestic solar panel production, with mixed results.

(1) United States

The United States has implemented several federal measures to promote domestic solar panel adoption over the last two decades (Figure 3). It has only strengthened support for increasing domestic solar panel manufacturing in recent years.

i) Overview of policies implemented

The Investment Tax Credit (ITC) for solar PV generation was first implemented in 2006 and has since been expanded and extended. The 30% credit given to businesses and individuals that install solar energy systems has catalyzed private investment in solar panels.

More substantial industrial support in the U.S. began after the COVID-19 pandemic. In 2022, the 1950 Defense Production Act (DPA) was invoked to allocate federal funds to solar panel manufacturing. The Inflation Reduction Act (IRA) was then introduced by the Biden administration in August 2022 (Figure 4). It included two federal income tax credits relevant for solar manufacturers. The first is the Advanced

Figure 3. US Support for the Solar Panel Industry

Date	Measure	Type	Description
Jan 2006	Investment Tax Credit (ITC)	Legislative policy; Tax expenditure	30% tax credit for solar installation
Feb 2011	SunShot Initiative	R&D initiative; Direct spending	Aimed to reduce solar energy costs by 75% by 2020
Nov 2021	Bipartisan Infrastructure Law (BIL)	Legislative policy; Direct spending	Expanded funding for solar research
June 2022	1950 Defense Production Act (DPA) invoked	Executive initiative	Authorized funds to expand manufacturing
Aug 2022	Inflation Reduction Act (IRA)	Legislative policy; Direct spending	Extended ITC and offers grants for solar projects

Source: JRI based on various media reports

Manufacturing Production Tax Credit (45X MPTC), which gives firms a tax reduction based on the number of units produced domestically and sold. The other is the expansion of the Advanced Energy Project Investment Tax Credit (48C ITC), which is applicable to investments in advanced energy projects such as solar panel manufacturing.

ii) Policy effects and outcomes

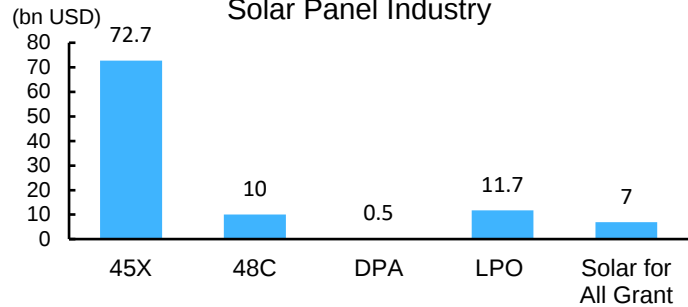
The United States's supply of solar panels is import-dependent. While imports from China are small compared to those from other countries, the solar panel supply in the U.S. remains highly dependent on China because of a significant volume of imports via third-country routes, mainly Southeast Asia (Appendix 2). However, in recent years and particularly since the IRA was passed, solar panel production in the U.S. has risen steadily and dependence on China has fallen (Figure 5).

The background to these achievements includes: a) the unprecedented scale of industrial policy (supply-side strengthening measures), and b) the decision not to exclude China-affiliated companies.

The IRA strongly engaged with the industrial sector, incorporating industrial support not only through the 2006 ITC solar panel installation support (on the demand side) and other R&D assistance, but also in the form of subsidies for production expansion. The amount of solar panels manufactured in the U.S. has increased since 2023, suggesting that the industrial support measures have functioned adequately (Figure 6).

Another noteworthy point is the conspicuous expansion of production by firms with capital ties to Chinese corporations. First Solar, which prides itself on state-of-the-art thin film technology, has

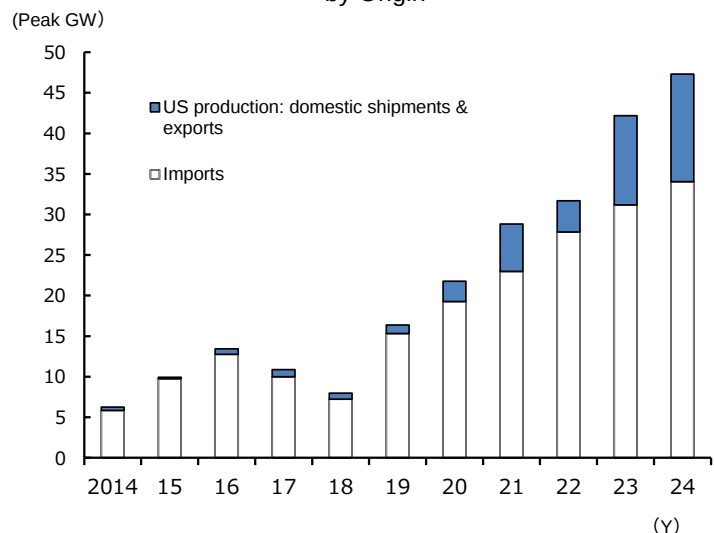
Figure 4. Main IRA Support Measures Related to Solar Panel Industry



Source: JRI based on US Department of Energy, EPA and US Congress data

Note: 45X: 45X Advanced Manufacturing Production Credit, 48C: 48C Advanced Energy Project Credit, DPA: Defense Production Act, LPO: Loan Programs Office.

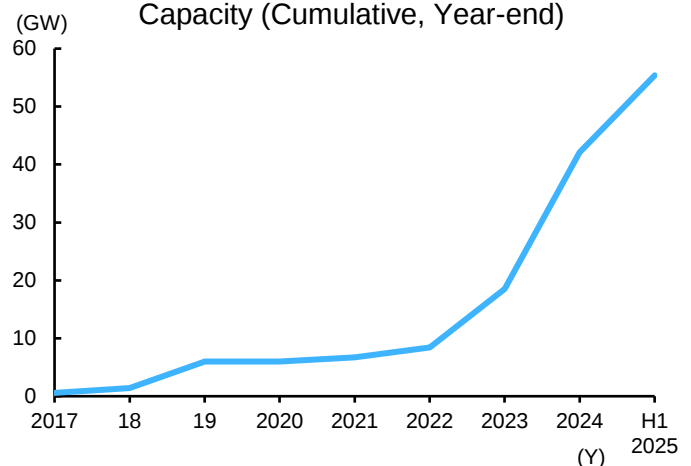
Figure 5. US Solar Modules shipments by Origin



Source: JRI based on US EIA

Note: Data for 2023 and 2024 are estimated from monthly statistics.

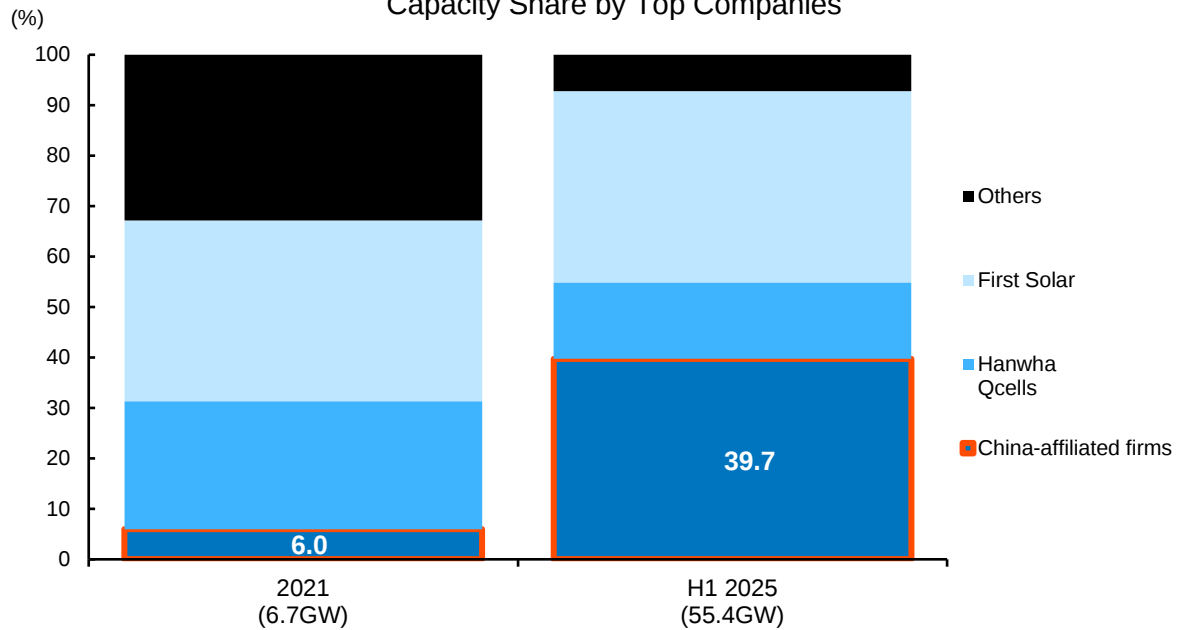
Figure 6. U.S. Solar PV Module Manufacturing Capacity (Cumulative, Year-end)



Source: JRI based on IRENA and SEIA

dominated American solar module manufacturing for the greater part of two decades. However, almost all the other successful makers have capital ties with Chinese corporations (Figure 7). Illuminate USA, with the powerful backing of Chinese solar panel manufacturing giant LONGi, produced 2 gigawatts worth of modules in its first full year of production alone (Brause [2025]). Kurt Wagner, Illuminate USA’s chief financial officer, says that the partnership with LONGi gives the U.S. the opportunity to “really catch up on the technology”⁶. This underscores the current reality that U.S. solar panel manufacturers are compelled to rely on Chinese companies which hold overwhelming technological advantages.

Figure 7. US Domestic PV Module Production Capacity Share by Top Companies



Source: JRI based on various sources

Note: "China-affiliated firms" refers to T1 Energy, Canadian Solar, Illuminate USA, Jinko Solar, Boviet Solar, Runergy and Hounen Solar. "Others" includes smaller American firms with no or unknown affiliation to China. Some companies included in 2025 were not active in 2021.

⁶ “Chinese-backed solar factory stirs suspicions in rural Ohio”, Financial Times, February 13, 2024.
<https://www.ft.com/content/38e29526-d4ef-4ab8-92c0-6eb2e3aba157>

(2) Australia

Despite solar power being a major source of Australian power, it remains a challenge to procure solar panels domestically without imports at present.

i) Overview of policies implemented

The Australian government has emphasized environmental policy and expanded support for solar panel adoption since 2009 (Figure 8). In 2024, the Australian government began efforts to scale up production through the “Future Made in Australia” plan, which includes the initiative known as the Solar Sunshot Program. This aims to boost Australia’s photovoltaic manufacturing to capture global market share, create jobs and reduce import-dependence.

ii) Policy effects and outcomes

As of 2024, 99% of Australia’s solar modules are imported, with 97% of these coming from China. According to projections from the Australian Renewable Energy Agency [2024], the country will need 15GW of annual solar PV deployment by 2030 and 50GW by 2040 to decarbonize its economy and become a clean energy superpower. As part of Solar Sunshot, Australia’s only solar module manufacturer, Tindo Solar, has received a \$34.5 million-dollar federal grant. While this will help expand production to some extent, unresolved issues remain, including regulatory bottlenecks, grid connection delays and rising deployment costs. Coupled with a lack of current manufacturing infrastructure, the country will struggle to reach the levels of deployment required through domestic production alone.

(3) European Union

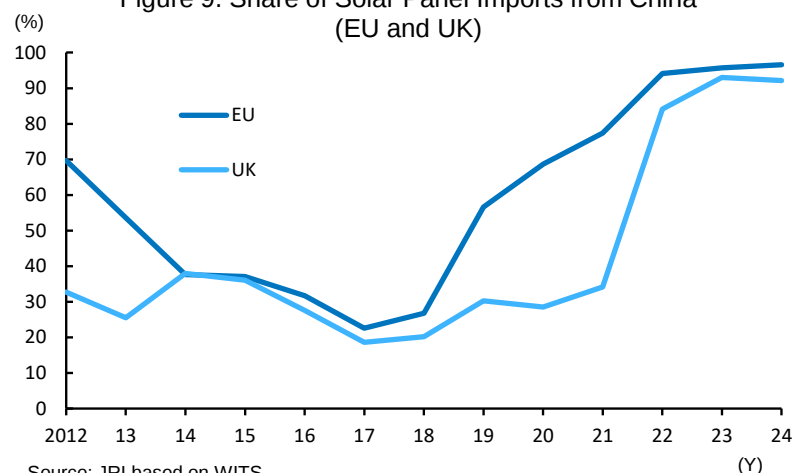
While EU countries have actively encouraged and invested in solar panel deployment, the support for domestic manufacturing has remained small and the bloc has become increasingly dependent on

Figure 8. Australian Support for the Solar Panel Industry

Date	Measure	Description
June 2009	Solar Credits	Multiplied the number of Renewable Energy Certificates (RECs) that small solar PV systems could earn for generating electricity
Aug 2009	Mandatory Renewable Energy Target (MRET) expanded	Required electricity retailers to purchase RECs and surrender them to the Clean Energy Regulator every year
July 2012	Australian Renewable Energy Agency (ARENA) established	Funds projects involving R&D or deployment of renewable energy
Aug 2012	Clean Energy Finance Corporation (CEFC) established	Provides finance for renewable energy
Jan 2023	Capacity Investment Scheme (CIS)	Underwrites revenue for renewable projects
Aug 2024	Solar Sunshot Program	A\$1bn (US\$650m) package to support domestic solar PV manufacturing

Source: JRI based on various media reports

Figure 9. Share of Solar Panel Imports from China (EU and UK)



Source: JRI based on WITS

Note: 2012-2021 uses HS code 854140, 2021-2024 uses HS code 854143. Differences may cause minor inconsistencies when comparing across years.

Chinese imports. As for the UK, the country is similarly dependent and has no plan to reshore solar panel manufacturing at all.

i) Overview of policies implemented

Europe was a powerhouse of solar module production in the 2000s, particularly Germany with its ‘Solar Valley’ business park. But in the 2010s, key players across the EU scaled down production as they were unable to compete with Chinese firms. Nowadays, the EU’s share of global solar panel manufacturing is negligible, and it is heavily reliant on imports from outside the bloc. In 2024, 97% of these came from China (Figure 9).

In response, the EU Solar PV Industry Alliance (ESIA) was launched in 2022. It brings together industry stakeholders, policymakers and experts and aims to promote solar panel manufacturing. At the time of launch, ESIA and the European Commission set a goal of boosting production capacity to 30GW by 2025 (European Solar PV Industry Alliance [2022]).

The European Commission launched the Green Deal Industrial Plan (GDIP) in February 2023. A key pillar of the GDIP was the Net-Zero Industry Act (NZIA), adopted in 2024. This introduced a benchmark for domestically produced net-zero technology to meet 40% of the EU’s annual deployment needs by 2030 and a target of 30GW of manufacturing capacity at each stage of the solar PV value chain by 2030.

The EU has also deployed several financial instruments to support solar panel manufacturing (Figures 10 and 11). The most significant support has come from the Innovation Fund. This gives grants for clean tech

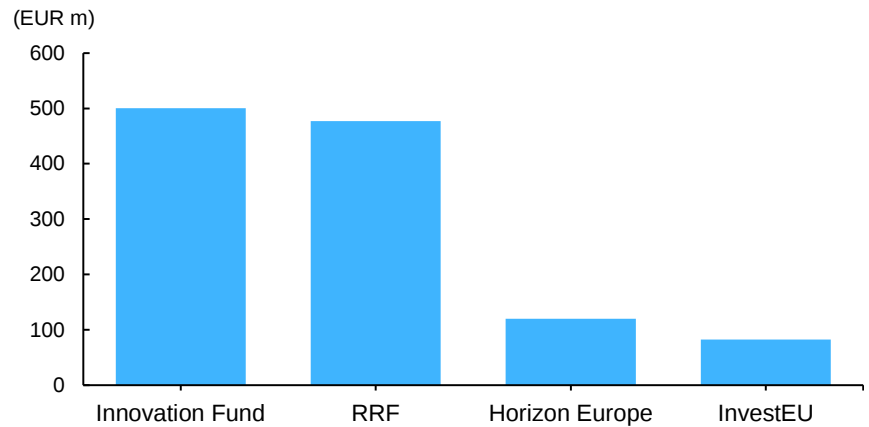
Figure 10. Key EU Funding Programs and Support for Solar PV Manufacturing

Program	Average Yearly Budget	Operating period	Description	Solar PV manufacturing support
Innovation Fund	€4bn	2020-2030	Support for the late-stage development and manufacturing of clean tech	€500.1m of grants (first four rounds of calls, 2020-2023)
Recovery and Resilience Facility	€130bn	2021-2026	Pool of money borrowed by the EU Commission to help states recover from the pandemic	€477m of loans and grants
Horizon Europe	€15.9bn	2021-2027	One of the largest R&D programmes in the world - focus on innovation	€120m of grants (2021-October 2024)
InvestEU	€4.4bn	2021-2027	Aims to trigger at least €372bn in private investment over 2021-2027. InvestEU funds are mostly managed by the European Investment Bank.	€82.5m of InvestEU-backed loans for two projects in 2023 and 2024
Cohesion Policy	€65.3bn	2021-2027	Investments aimed at reducing disparities between member states	Data unavailable

Source: JRI based on various media reports

development and manufacturing based on a system of annual project calls. It uses revenue from the EU Emissions Trading System and has a budget of €40 billion to invest between 2020 and 2030. Another key instrument has been the Recovery and Resilience Facility (RRF), a pool of €723.8 billion to help members recover from the pandemic. Members had to submit Recovery and Resilience Plans outlining how they would use the money and make the investments by the end of 2026.

Figure 11. EU Support for Solar PV Manufacturing



Source: JRI based on various media reports

Note: "RRF" = Recovery and Resilience Facility. Data for each program covers a slightly different time period, which may cause variations. "Invest EU" only covers EIB loans backed by InvestEU.

ii) Policy effects and outcomes

EU solar PV manufacturing capacity increased to 8GW at the end of 2023 (Figure 12). The TANGO (iTaliAN pv Giga factOry) project, led by Italian firm Enel Green Power, is targeting further growth. It aims to expand cell and module production at the 3SUN factory in Catania, Sicily, from 200MW per year in 2022 to 3GW, making it Europe's first solar PV gigafactory.

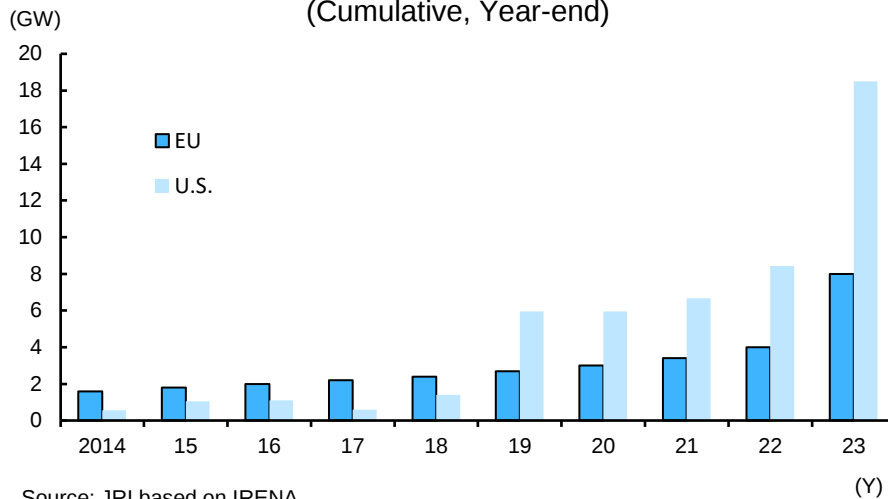
However, when Enel Green Power signed the agreement for Innovation Fund funding for the project, the firm set July 2024 as its target for 3GW annual production but, in 2024, it pushed this back to the end of 2025⁷.

The European Commission has also published a report on boosting competitiveness titled "The future of European competitiveness" (commonly known as the Draghi Report). It expresses concern that current decarbonization policies may inadvertently hinder domestic industrial development within the region and recommends accelerating industrial support (European Commission [2024]). Measures taken based on these proposals may further intensify support for solar panel manufacturing.

⁷ "Italy's Enel pushes back solar panel output goal, document shows," Reuters, May 24, 2024.

<https://www.reuters.com/sustainability/climate-energy/italys-enel-pushes-back-solar-panel-output-goal-document-shows-2024-05-23/>

Figure 12. EU Solar P.V. Module Manufacturing Capacity
(Cumulative, Year-end)



(4) United Kingdom

The UK's Clean Power 2030 Action Plan, released in December 2024, set a target of 45-47GW of solar panel capacity by 2030. The government also published its Solar Roadmap in June this year, outlining various actions it will take to deploy more modules (Department for Energy Security and Net Zero [2024]). But this push will further increase import dependence on China – 92% of solar panels imported in 2024 were made in China (Figure 9).

The Solar Roadmap does not aim to aggressively expand domestic production, but instead suggests examining support for firms that make ‘balance of system’ components – all the components of a PV system except the panel itself, such as wiring and steel brackets – as well as encouraging technological innovation such as perovskite solar cell development.

The British startup Oxford PV unveiled in 2024 a module that uses advanced perovskite cells and has 26.9% efficiency, a world-record (Oxford PV [2025a]). While the firm's R&D is performed in the UK, its only production site is in Germany. It also signed an agreement to massively scale up perovskite-based panel production in August this year, but its partner, Trina Solar, will manufacture the panels in China (Oxford PV [2025b]).

4. The China Shock 2.0 and a Counterstrategy

We have now reviewed the policies of various countries and identified initiatives to expand domestic solar panel production. The U.S. IRA, enacted in 2022 under the Biden administration, has had the most notable success in boosting production. While large-scale state-led support has not yet begun in Europe, there is growing momentum to ramp up policy efforts based on the Draghi Report.

Such moves, which can be called “China-style” industrial policy, appear to follow China's lead and have traditionally been considered taboo. Yet Autor and Hanson [2025], who describe the crisis facing U.S. manufacturing as the “China Shock 2.0”, endorse such policies in response (Appendix 3). Many countries that face intense industrial competition from China, including Japan, must consider strategic responses. This makes it understandable that policy support, including industrial subsidies, is being actively expanded.

Notably, the countermeasures they propose in response to the China Shock 2.0 extend beyond state-led

investment support. They also argue for multilateral agreements and efforts to attract investment from China (Figure 13). As mentioned previously, much of the increase in U.S. domestic production was driven by solar panel manufacturers that had received capital investment from Chinese firms. It is important to recognize that the IRA was partly effective due to the U.S. accepting investments from technologically advanced Chinese companies. Because it implemented Autor and Hanson's first and second proposals, the IRA can be credited with contributing to expanded domestic manufacturing. However, as is widely known, the U.S. effectively abandoned Autor and Hanson's third proposal following the inauguration of the Trump administration. This significantly undermined the IRA's intended effect.

There have also been reports about ongoing discussions in Europe about requiring technology and know-how transfers as a condition for accepting investment from Chinese companies⁸. This suggests that policymakers are acknowledging the difficulty of enhancing industrial competitiveness without accepting Chinese investment and are now seeking a more pragmatic approach. It is also likely that many countries will consider establishing regulatory frameworks to promote such investment while appropriately managing the national security risks associated with investment by Chinese firms. Large-scale perovskite cell production in China, which the UK's Oxford PV has announced, is a development to be minimized as much as possible. Many countries are expected to prioritize securing domestic production capacity regardless of company nationality.

Figure 13. Four Policy Proposals for the United States in Response to the China Shock 2.0

(1) Strengthening International Coordination The United States, the EU, Japan and other countries should share their concerns over trade with China and pursue cooperation through free trade agreements and multilateral frameworks. Actively attracting Chinese investment, including the establishment of production facilities in the U.S., can contribute to enhancing domestic industrial competitiveness.
(2) Expanding State-Led Investment "China Style" The government should select strategically vital sectors—such as drones, advanced semiconductors, nuclear fusion, quantum technology, and biotechnology—and make large-scale, state-led investments. The U.S. government should manage public venture funds to support emerging industries.
(3) Ensuring Policy Continuity and Long-Term Investment The U.S. must choose battles it can win (e.g., semiconductors) and those it cannot afford to lose (e.g., rare earths), and sustain long-term investments in these sectors.
(4) Preventing the Social Impact of Job Losses

Source: JRI, based on David Autor and Gordon Hanson, "We Warned About the First China Shock. The Next One Will Be Worse," *New York Times* (July 14, 2025)

5. Current Status and Challenges Facing Japan's Solar Panel Industry

Details regarding the policies implemented in Japan to date, along with their effects and outcomes, are outlined by the Agency for Natural Resources and Energy [2024]. According to these materials, Japan's policies share similarities with those in Europe, fundamentally prioritizing the expansion of solar power introduction and adoption. Notably, the Feed-in Tariff (FIT) system introduced in 2012 requires power companies to purchase electricity generated by solar power at a fixed price set by the government. This system made it possible to

⁸ "EU floats conditions such as tech transfers for China investments", Reuters, October 15, 2025.
<https://www.reuters.com/world/china/eu-floats-conditions-such-tech-transfers-china-investments-2025-10-14/>

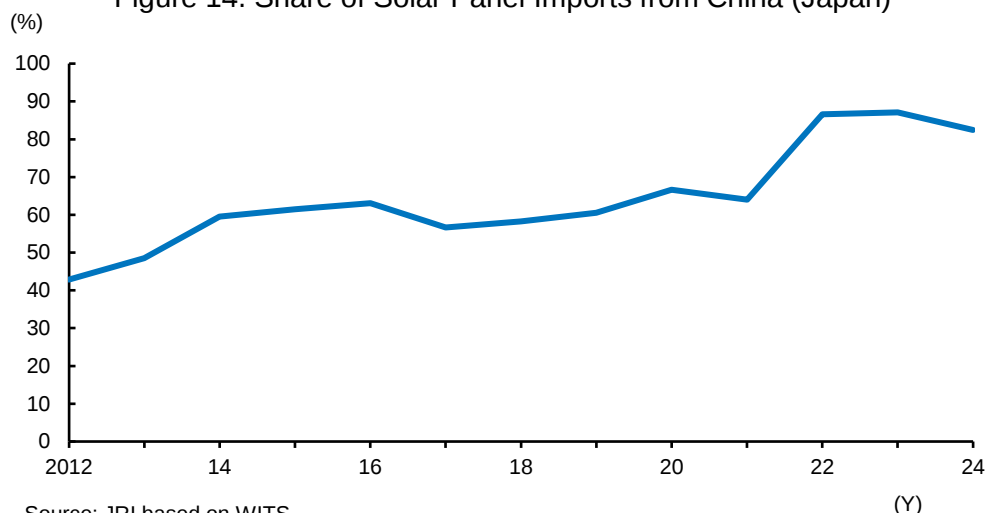
recoup installation costs and became key in supporting the rapid spread of solar PV in Japan. It can be said to have effectively achieved its goal of expanding adoption during the early stages of renewable energy introduction and thereby driving down costs.

Conversely, support for panel manufacturing was virtually nonexistent. While Japan's share of global production peaked at 50.4% in 2004, it subsequently plummeted, leaving the country with almost no share today. China's share of Japan's solar panel imports reached 87% in 2023, with domestic manufacturing in Japan now negligible (Figure 14). The Agency for Natural Resources and Energy explains: “While Japan provided support for technology development (by NEDO) and adoption (by FIT), the mass production capabilities of domestic companies were established within China. The domestic market was also flooded with Chinese panels, eroding Japan's technological advantage in manufacturing.”

In response, the Agency for Natural Resources and Energy has identified “support for establishing mass production systems” for solar PV generation equipment as a necessary measure. In recent years, it has been focusing its support on next-generation perovskite cells. As they are lightweight and flexible enough to be installed on curved surfaces such as walls, they are considered suitable for places where existing solar panels cannot be installed, such as factory roofs and building walls with low load-bearing capacity. One of the support measures, the Green Innovation (GI) Fund project “Development of Next-Generation Solar Cells,” has a budget of 37.8 billion yen over seven years from FY2024 to FY2030 (NEDO [2025]).

Establishing mass perovskite cell production would help significantly reduce energy security risks and make the supply chain for solar PV generation equipment more resilient. This is because iodine is the most important raw material for producing the cells and Japan was the world's second largest iodine producer in 2023. However, there are also concerns about focusing solely on perovskite cells (Zissler [2024]). Given persistent issues such as cost and the difficulty of extending the cells’ service life, conventional solar panels are likely to remain necessary for the time being.

Figure 14. Share of Solar Panel Imports from China (Japan)



Source: JRI based on WITS

Note: 2012-2021 uses HS code 854140, 2021-2024 uses HS code 854143. Differences may cause minor inconsistencies when comparing across years.

6. Conclusion

Most of the panels required for solar PV generation are manufactured in China. This has led to a situation where many other countries, including Japan, must depend on it. It will be difficult to resolve this problem in the near term. Even in the U.S., where manufacturing expanded due to the IRA, the Trump administration has downplayed decarbonization and announced successive withdrawals of support. The large-scale, tax-cutting One Big Beautiful Bill, signed by the President on July 4, 2025, included significant cuts to solar power incentives and restrictions on the Energy Tax Credit (SEIA [2025]). As a result, there are no longer any major advanced countries adequately addressing their problematic dependence on Chinese solar panels.

While discussion about solar panels is spreading in Japan, few of these debates directly confront the issue of economic security. Concerns about problems like cyberattacks from China via solar panels, as discussed in Appendix 1, have been raised in the media. There are equally arguments that regulations over the control and oversight of infrastructure systems are needed. But this is not a problem limited to solar panels. If policies based on this debate rush to exclude all Chinese imports, they would become entirely economically irrational. Forcing households and businesses to procure and use high-cost panels would impose an unnecessary burden, potentially leading to industrial decline and exacerbating the problem.

The crucial task is to envision a long-term industrial structure and determine the appropriate scale for the solar panel industry. Neglecting necessary industrial policy heightens the risk that China will maintain its near monopoly over solar panel manufacturing, potentially leading to Japan losing its independence in solar PV generation. While recycling has also gained importance in recent years, it will be difficult for Japan to make progress on this given its lack of solar panel manufacturing facilities.

Government-led investment support for perovskite cells is already underway in the country. Strategic responses, like those proposed in response to the China Shock 2.0, are also progressing steadily. But it will be necessary to develop legal frameworks that guarantee policy continuity to ensure that these long-term policy support measures are not affected by administration changes or policy shifts. It will also be important to secure some production of conventional solar panels and develop regulatory mechanisms that promote Chinese investment while appropriately managing national security risks.

It should be noted that this discussion has primarily focused on solar PV modules. There are also considerable obstacles to significantly expanding domestic production of items further upstream of the supply chain, such as solar cells, wafers and polysilicon. Doing so will involve many stages where it will be essential to collaborate with developing countries that are cost-competitive in areas such as critical mineral mining and refining. Strengthening multilateral cooperation will be a must.

Appendix 1: The Cybersecurity Problem with Solar Power Systems

Apart from solar panels themselves, PV inverters have become a source of concern. Inverters turn the DC current produced by solar panels into the AC current transmitted by power grids and used by wider society. In recent years, inverters have become part of the IoT and many require internet connections for software updates. As a result, they could theoretically be manipulated remotely by the manufacturers, including malign updates designed to shut them off.

With China dominating inverter production (Chopra [2023]), many countries that are rolling out Chinese

panels are using Chinese inverters with them. If a conflict were to break out, Chinese firms, under government orders, could remotely shut off inverters in unfriendly countries. This would be disastrous at a large scale as it would cause cascading failures across power grids.

Awareness of this vulnerability has spread in recent years. Some countries, such as Lithuania, have taken action including effectively banning Chinese remote access. Some media outlets further spread alarm this year in quoting anonymous U.S. officials who claimed to have found rogue communication devices that could act as inverter kill switches (Mcfarlane [2025]).

The Iberian Blackout this year particularly put inverters in the spotlight in Japan as many suspected Chinese sabotage as the cause. The blackout swept Spain and Portugal at 12:33 p.m. Central European Standard Time on April 28 (Figure 15). Flights were grounded and trains stopped, trapping thousands of passengers. The grid operators later performed a ‘black start’ to return power to the grid, and power was gradually returned over the rest of the 28th and 29th. The following day, the Spanish government had a meeting and formed a commission to investigate the issue.

The commission’s findings, released on June 17, were that poor voltage control caused a cascading failure across the system. No evidence of a cyber-attack was found and no link with solar panels drawn. A day later, Red Eléctrica, Spain’s national grid operator, published its own report. While it differed from the government report in its timeline of the incident and who was to blame, it also attributed no blame to Chinese technology.

Figure 15. Iberian Blackout Timeline

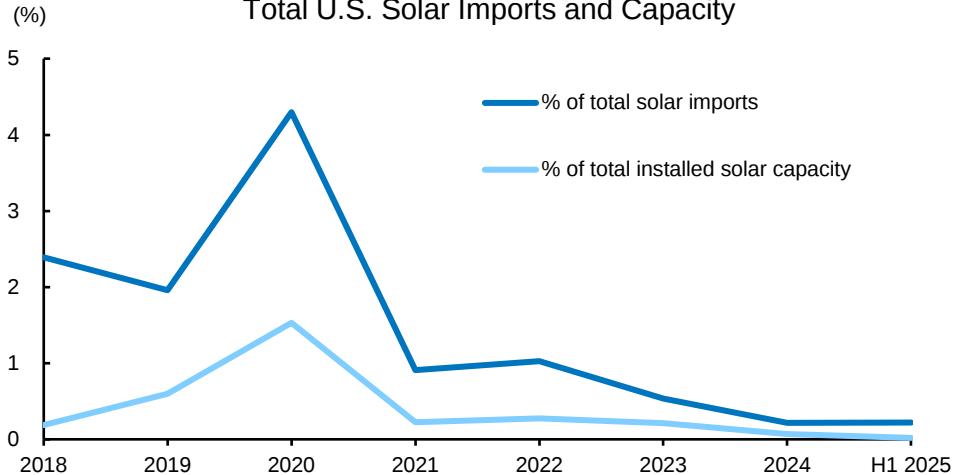
April 28	At 12:33 p.m. CEST, a blackout sweeps Spain and Portugal.
	Power is gradually restored throughout the rest of the day.
April 29	By 6:00 a.m., 99.5% of power is restored.
	Spanish Prime Minister Pedro Sánchez convenes an extraordinary meeting of the National Security Council.
	PM Sánchez announces the creation of a commission to investigate the causes of the blackout.
June 17	The Spanish government commission publishes its findings.
June 18	Grid operator Red Eléctrica publishes its report on the causes of the blackout.

Source: JRI based on various media reports

Appendix 2: U.S. Dependence on Chinese Solar Panels and Transshipped Imports from Third Countries

Looking at US solar panel imports, dependence on China is not obvious. China accounted for over 30% of imports by value in 2014 but this had dropped to just over 20% by 2016. Since 2018, less than 5% of total solar imports have come directly from China, and besides a slight increase in 2020, Chinese imports have continuously fallen (Figure 16). This is largely due to anti-dumping and countervailing duties applied to major Chinese solar companies in 2012, as well as the Section 201 safeguard tariffs of 2018.

Figure 16. Imports from China as a Share of Total U.S. Solar Imports and Capacity



Source: JRI based on USITC and IRENA
 Note: Includes HTS codes 854143, 8541406015, 8541406035.
 Values based on kW capacity.

(Y)

However, it is widely held that Chinese firms have increased

transshipped exports and their dominance in the American market is still at play. In 2022, the US Department of Commerce investigated Chinese circumvention of the anti-dumping and countervailing duties, where its manufacturers set up operations in the Southeast Asian countries of Malaysia, Vietnam, Thailand, and Cambodia (Figure 17). It was determined that circumvention was occurring at several companies in all four countries. With these four countries accounting for over 70% of US solar panel imports, American solar dependence on China is greater than it seems (Figure 18).

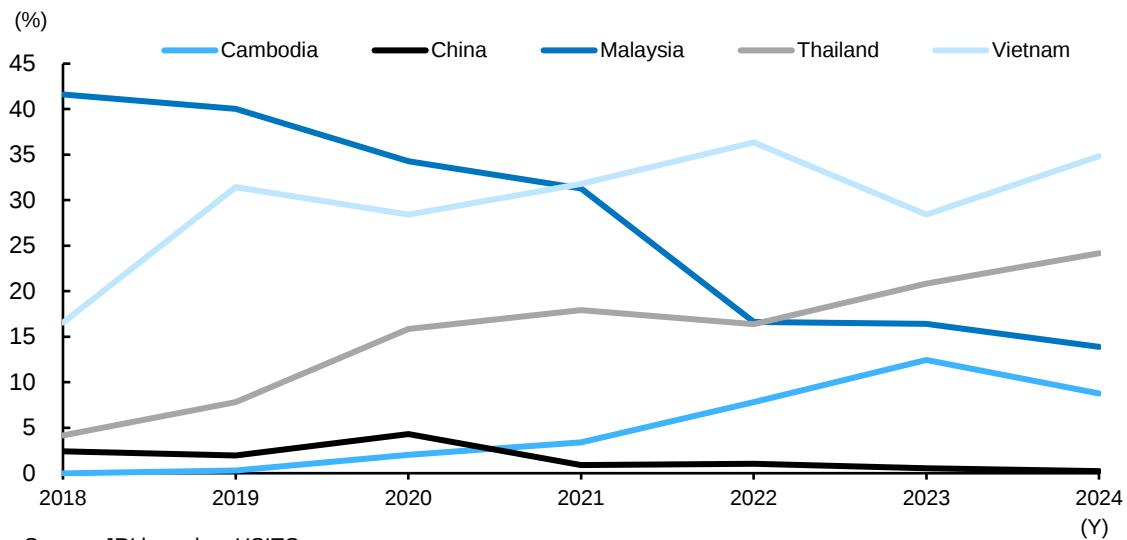
Figure 17. US Department of Commerce Investigation Findings

Applicable AD/CVD Rates	Country	China-Affiliated Company	Company Circumvention Finding	Country-Wide Circumvention Finding	Subsequent Solar Panel Tariff Rate
CVD: Up to 15%	Cambodia	BYD Hong Kong	Yes	Yes	3,521%
		New East Solar	Yes		
	Malaysia	Hanwha Qcells	No	Yes	34.4%
		Jinko Solar	No		
AD: Up to 238%	Thailand	Canadian Solar	Yes	Yes	375.2%
		Trina Solar	Yes		
	Vietnam	Boviet Solar	No	Yes	395.9%
		Vina Solar	Yes		

Source: JRI based on CNBC and DOC

Note: CVD = Countervailing duty; AD = Antidumping duty. While some companies were not circumventing, the DOC found that certain non-cooperative companies in all four countries were engaged in circumvention. Thus, country-wide circumvention was issued.

Figure 18. Imports from Various Countries as Share of Total U.S. Solar Imports



Source: JRI based on USITC

Note: Includes HTS codes 854143, 8541406015, 8541406035. Values based on kW capacity.

Appendix 3: The China Shock 2.0 and Recommended Strategic Responses

In a New York Times piece from July 14, 2025, titled “We Warned About the First China Shock. The Next One Will Be Worse” (Autor and Hanson [2025]), American economists David Autor and Gordon Hanson coined the phrase the “China Shock 2.0”. Autor, Dorn and Hanson first introduced the concept of the “China Syndrome” in a 2013 paper (Autor, Dorn and Hanson [2013]). Autor and Hanson later expanded on what they called the “China Shock 1.0” in a 2016 paper (Autor and Hanson [2016]). This refers to the surge of low-cost Chinese imports into the U.S. market during the 1990s and 2000s, which contributed to American manufacturing decline and a significant loss of employment.

The MAGA movement, which has driven the recent shift toward protectionism in the United States, points to the decline of manufacturing in the Rust Belt – the industrial region stretching from the East Coast to the Midwest – as a key consequence of trade liberalization. The findings of these studies provide strong empirical support for that perspective.

It was once expected that China's role in U.S. economic disruption would diminish as its supply of low-wage labor reached its limits. In fact, labor-intensive industries have already begun relocating to other emerging economies such as Vietnam. But in recent years, China has started to gain leadership in a wide range of high-tech sectors where the United States has traditionally held a competitive edge. These include aviation, AI, telecommunications, microprocessors, robotics, nuclear and fusion power, quantum computing, biotechnology, pharmaceuticals, solar, and batteries.

According to research by the Australian Strategic Policy Institute (ASPI [2024]), the U.S. led in only 7 of 64 key technological fields between 2019 and 2023 (down from 60 fields between 2003 and 2007), while China

led in 57 (up from just 3 in the earlier period). China is seeing rapid growth in industries that not only generate high value-added, high-wage employment, but also have significant implications for geopolitics and military power. In other words, the impact on the U.S. from China's economic expansion has shifted from manufacturing decline and job losses caused by low-cost imports – the China Shock 1.0 – to a broader set of economic, security, and geopolitical risks – the China Shock 2.0.

During the 1990s and 2000s, China's manufacturing sector grew with support from multinational corporations. However, China's current growth model is characterized by the government leading industrial investment and developing an ecosystem that supports innovation. While Professor Autor and his colleagues previously shared the skepticism towards government intervention and industrial policy common among economists, they now reject this view and argue that the U.S. needs to compete by adopting industrial policies similar to China's. Although the Trump administration has implemented aggressive tariff increases to protect domestic industry, they argue that tariffs alone are insufficient to make the United States an attractive hub for advanced manufacturing, particularly in high-tech sectors. They then propose the four following strategies as an alternative.

First, they suggest strengthening international cooperation. This comes in two parts. The first is that the U.S. should co-operate with partners that face the same problem, such as the EU and Japan. Rather than impose tariffs, it should conclude trade deals for instance. The second component is proactively attracting investment from Chinese firms. While some criticize the idea of welcoming a strategic competitor like China, the authors argue that a blanket exclusion of Chinese firms could weaken domestic industrial competitiveness. They advocate for accepting Chinese firms to facilitate technological catch-up, except for in areas that pose clear national security risks.

Second, they call for more active government-led investment. They argue that the government should assume risk and invest – particularly in critical technologies – to foster the emergence of new industries as China has. They point to the U.S. government's pandemic-era Operation Warp Speed, which rapidly accelerated vaccine development, as an example. They also recommend the establishment of an independent strategic investment authority which would be similar in stature to the Federal Reserve but focused on innovation rather than interest rates.

Third, they highlight the importance of policy continuity. Key international and environmental policies initiated under the Biden administration were reversed under Trump. They argue that it is problematic that key policies cannot be implemented continuously and long-term investment in semiconductors and rare earths must be protected from such disruptions.

Finally, they emphasize the importance of mitigating the ripple effects of job losses. In addition to China-related factors, structural changes in industry – such as advances in AI development – and the labor market shifts they entail represent constant risks that are difficult to avoid. Since job losses can undermine not only economic but also political stability, a well-developed labor market safety net is essential. They recommend that government-led industrial development play a role in supporting that net.

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