Metals Strategist

Delivering the energy transition: where are the bottlenecks and constraints?

This is a redaction of an 87-page report published on March 31, 2023.

New energy infrastructure – the foundations of transition

To deliver the energy transition, the world economy needs to move away from thermal fuels into green electrons. Climate targets are ambitious, and geopolitics have amplified the desire for energy security and independence. But what might hamper progress? Common obstacles are: 1) slow permitting, 2) supply chains not receiving the attention they deserve, 3) shortages of skilled linemen and trades, 4) the need for system integration and 5) cost inflation and low returns. Overall, while these obstacles can be overcome, it will require a concerted effort by governments, companies and consumers.

US IRA & EU Green Industrial Plan: supply chain break-up

The US Inflation Reduction Act and the EU Green Industrial Plan both target energy security and transition. Industry perceives US policies as more attractive given the focus on mass deployment, causing apprehension among policymakers in Europe. But while there are nuances, both policies are looking to onshore and rebuild domestic capabilities. This could disrupt established supply chains – an issue for China especially, given its dominance. Permitting is also a focus as slow approvals are holding back progress.

Stable supply of raw materials is critical for green targets

We identify 22 metals important for future technologies (MIFT) like EVs and renewables. The scarcity of these commodities could become a constraint on the road to Net Zero, with all metal markets set to flip into deficit by 2030E. To address this, many governments have compiled Critical Raw Material lists, with accompanying strategies that seek to 1) ensure reliable and resilient supply, and 2) foster exploration, production and innovation. Commodity shortfalls will likely lead to rising price volatility. Furthermore, many green technologies are capex-intensive, so financial risk management is critical, given returns for renewable projects can be low.

Solar supply chain is run by China: wind more diversified

China dominates the solar photovoltaic (PV) supply chain. While the US and Europe are looking to reduce their dependence, incentives are needed to offset their 30-40% higher manufacturing costs. The supply chain for wind is more diverse. Three of the top-five wind turbine manufacturers are in Europe and the US. The integration of a significant share of variable renewables into power grids requires a transformation of existing networks. Energy storage, through technologies like batteries or hydrogen, is also vital.

Consumption: **EV batteries could be 'sold out' by 2026/27**

Electric vehicle (EV) penetration needs to hit 100% by 2050 to reach Net Zero. Batteries are key and OEMs have taken different approaches, either producing themselves or outsourcing. All in, our updated EV battery supply-demand model suggests global supply will likely be "sold out" in 2026-27, with global operating rates reaching above 85%.

19 April 2023

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Executive summary: The big 5 pinch points

The planet is warming and efforts to tackle climate change are ongoing. Meanwhile, the war in Ukraine has ratcheted up the sense of urgency, adding energy security and independence as another dimension to green technology investment. This has led to a raft of ambitious energy targets, but will it be plain sailing to achieve them? It looks unlikely and we explore the main obstacles that need to be overcome – albeit none is insurmountable.

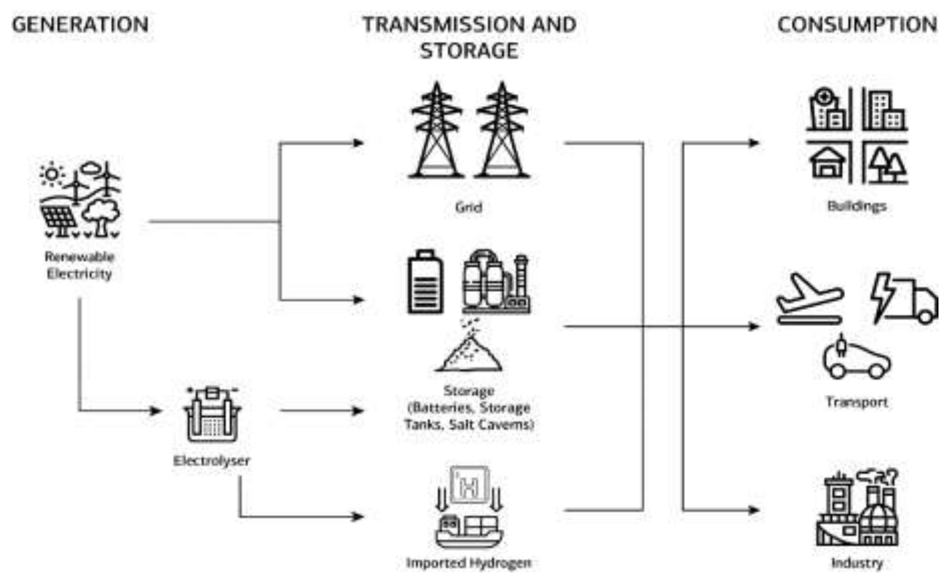
To start with, permitting needs to accelerate. We also believe that supply chains of raw materials and green technologies for electricity generation, storage and transmission have not received the attention they deserve. In particular, China dominates many aspects of green technologies, including MIFTs (metals important for future technologies) or polysilicon. This is a concern in many countries that are looking to make their supply chains more autonomous. Furthermore, there is an impending shortage of skilled linemen and trades. This, along with rapid increases in capital spending and supply chain bottlenecks in materials/components, adds to cost inflation, which ultimately impacts returns.

System integration is also critical, a topic we discuss in the section entitled, 'Importance of electricity transmission/distribution and energy storage'.

Building a new energy infrastructure

Exhibit 1 shows that a new, green energy infrastructure, free of fossil fuels, needs to start with electrifying power generation, then transmitting and storing this energy, before it is finally consumed.

Exhibit 1: Green energy infrastructure
The global community needs to build a new energy infrastructure, electrifying generation, transmission/storage and consumption



Source: BofA Global Research

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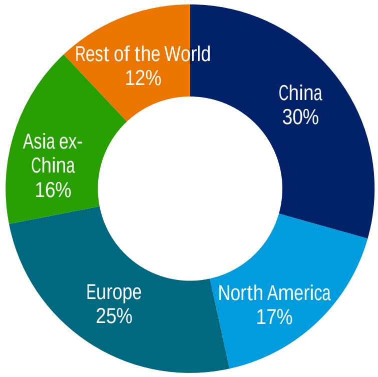
Looking at the regional spending breakdown, countries globally are tackling climate change. Indeed, developed economies in Europe and North America accounted for the lion's share of clean energy investment in 2022 (Exhibit 2). Of course, this is heavily influenced by the fact that they are also the biggest emitters.

Exhibit 2: Clean energy investment (2022E), by country/region
DMs in Europe and North America account for 42% of clean energy investment; China is the single biggest investor



Source: IEA, BofA Global Research

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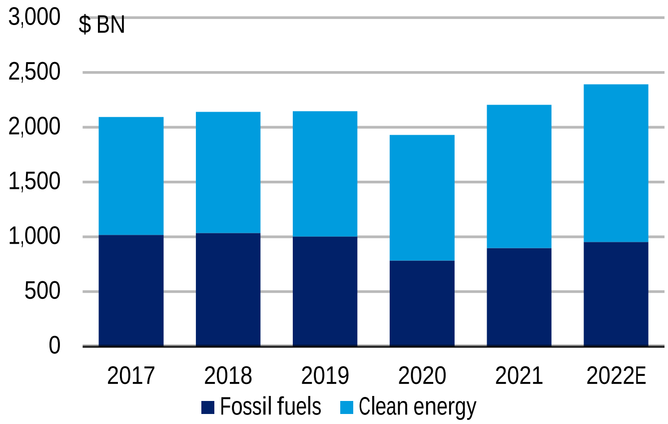
Headwinds to energy transitions in a nutshell: China

By individual country, China accounted for nearly a third of global clean energy spending in 2022. Yet the country could also serve as a case study for some of the issues that crop up when decarbonising the economy. Digging a bit deeper, capacity additions in solar and wind have exceeded those in coal in recent years. That said, following a sharp drop in rainfall and wind speed, China endured severe power shortages in 2Q22 and 1Q23 in some regions. In response, the government approved more coal-fired power capacity to stabilise power supply, reinforcing the idea that while energy transition is one focus, energy security also matters. According to the China Electricity Council, China will likely add 70GW of new coal-fired power capacity in 2023, which we expect to be followed by 60GW and 45GW of new addition in 2024-25. At the same time, coal-fired power units are increasingly being converted to operate at lower utilisation rates so they can back up variable solar and wind units, highlighting the importance of system integration.

While the addition of renewable energy capacity has already accelerated, the pace should pick up over 2023-25 as prices of wind turbines and polysilicon drop with rising supply.

Yet, there are caveats to assumptions of ever-decreasing costs. Indeed, the global community's push towards Net Zero is not all hunky-dory. The IEA estimates that investment in the energy sector will increase by 8% to US$2.3tn in 2022, with investment in green power accounting for almost three-quarters of total growth in capex. At first glance, this sounds encouraging. However, it turns out that nearly 50% of the increase in capex is due to cost inflation, highlighting one in a series of obstacles that can impede the decarbonisation of the global economy.

Exhibit 3: Global energy investment
Investments in the energy sector are set to increase by 8% in 2022



Source: IEA, BofA Global Research

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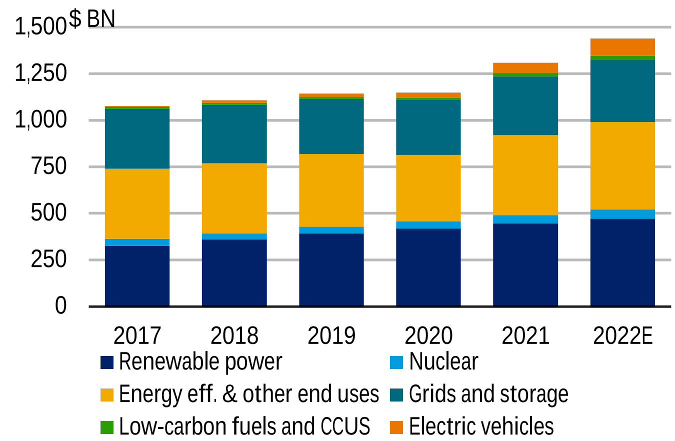
Exhibit 4: Global clean energy investment
Global spending in clean energy is picking up after years of flat investments



Source: IEA, BofA Global Research

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1. Slow permitting holding back progress

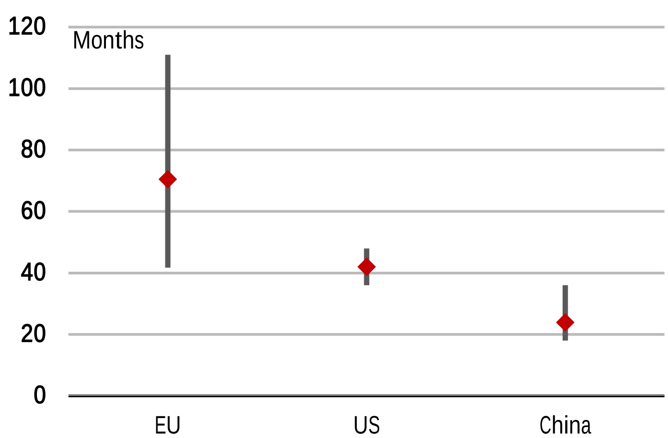
Europe has a lengthy planning and permitting process

EU says renewables **are of "overriding public interest"**

Energy security has added a new dimension to an initial focus on the energy transition. While acknowledging that reducing our reliance on fossil fuels is important, governments are increasingly keen to accelerate the speed at which green technologies are implemented. Exhibit 5 and Exhibit 6 pick up on this, outlining that Europe's planning and permitting times are lagging behind those in the US and China[1].

Exhibit 5: Minimum, maximum and average wind farm planning times

Planning times differ markedly between Europe, the US and China



Note: The installation and erection of a wind farm needs to follow a longer planning process which includes a formal permitting process
Source: World Wind Energy Association, BofA Global Research

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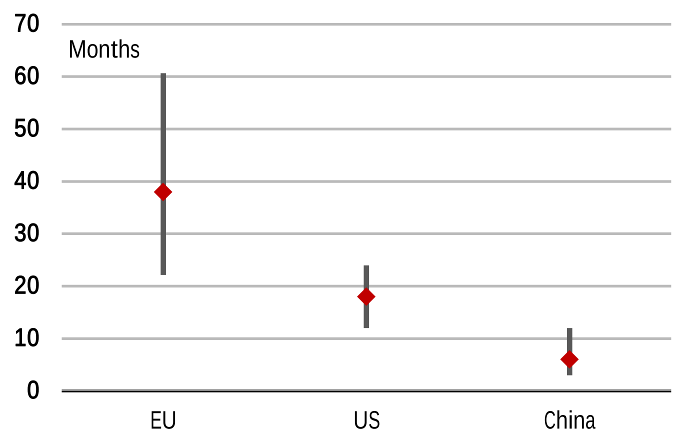
Exhibit 6: Minimum, maximum and average wind farm permitting times
Europe takes the longest to sign off on renewables projects



Note: The installation and erection of a wind farm needs to follow a longer planning process which includes a formal permitting process
Source: World Wind Energy Association, BofA Global Research

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[1] World Wind Energy Association: Measuring Performance of Permitting Processes: The Wind Power Planning and Permitting Index WPPPI

Local authorities have been given more power, but local opposition is an issue

Local opposition a headwind to onshore wind farms

Commenting specifically on wind power, our colleague Ben Heelan, Head of the Developed EMEA Aerospace & Defence research team, has noted a general trend towards decentralising the responsibility for permitting and approving new onshore wind farms away from central government to local authorities in recent years. Yet, while this should normally speed up the permitting process, opposition from local communities has led to significant delays.

Four European countries (UK, France, Sweden and Germany) accounted for around 40% to 50% of onshore wind installations in 2021.

Offshore wind dominates government renewable ambitions

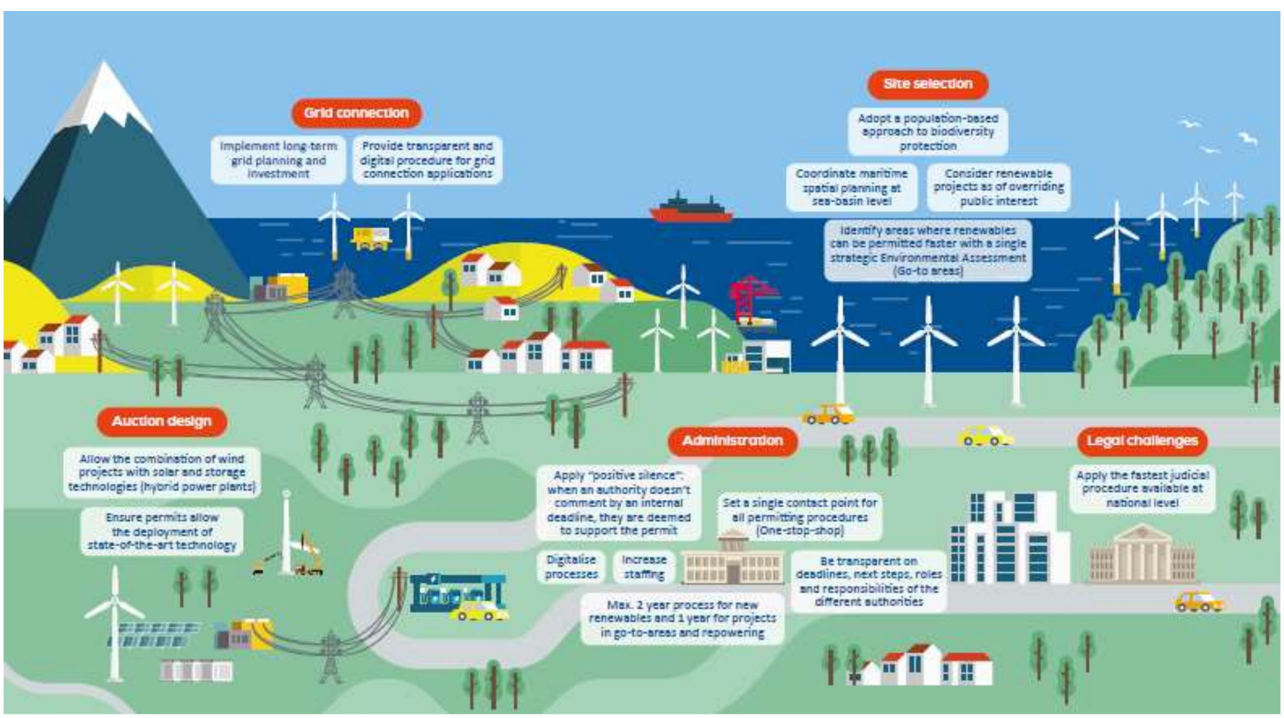
While onshore wind farms are important, there is also an immense focus on offshore wind farms. Against this backdrop, we note that permitting offshore wind farms is still a challenge. It takes four years for planning permission in the UK, two years in Germany, and France has only just completed the first wind farm, with the whole project taking 10-12 years to complete.

Similar to the dynamics in onshore wind, governments are looking to reduce planning permit times in light of energy security issues and COP26/27. The UK wants to shorten the process for offshore wind to just one year. Germany amended its "Offshore Wind Energy Act" in April 2022, aimed at speeding up tendering procedures as well as planning and approval processes. Although France and Sweden are a little further behind in the offshore wind cycle, they will also have to cut planning times to meet their 2030 goals.

EU's plans to accelerate permitting revolve around a range of issues

The EU acknowledges that fast deployment of renewables can help mitigate the energy crisis. With this in mind, and given how reliant Europe has been on Russia's fossil fuels, the EU has been working on a confluence of measures aimed at reducing permit times.

Exhibit 7: WindEurope – how to simplify permitting
Industry has a range of proposals to accelerate the renewables build-out, ranging from site selection to grid connection



Source: WindEurope

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US: Permitting Action Plan to speed up infra projects

In the US, the Biden Administration has been pushing the Bipartisan Infrastructure Law to deliver projects on time and on budget[2]. Embedded in the initiative is a new Permitting Action Plan to strengthen and accelerate Federal permitting and environmental reviews.

The Action Plan outlines the Administration's strategy for ensuring that Federal environmental reviews and permitting processes are effective, efficient and transparent, guided by science to promote positive environmental and community outcomes, and shaped by early and meaningful public engagement. More concretely, the Permitting Action Plan is built on five key elements:

- Accelerating permitting through early cross-agency coordination: Early coordination and effective communication across Federal agencies should help move forward infrastructure projects efficiently and on-time.
- Establishing clear timeline goals and tracking key project information: Communities and project proponents should receive information about the schedules, key milestones and deadlines, and public comment opportunities for the environmental review and permitting of major projects.
- Engaging in early and meaningful outreach with states, tribal nations, territories, and local communities: Proactive, early and ongoing engagement with the public, including disadvantaged, underserved, or overburdened communities, and state, tribal, local, and territorial partners, is seen as fundamental to delivering timely projects that serve the needs and priorities of communities across the country.
- Improving agency responsiveness, technical assistance, and support: Providing responsive technical assistance and support helps project sponsors, permit applicants, affected communities, tribal communities and other stakeholders to navigate the environmental review and permitting process effectively and efficiently.
- Using agency resources and environmental reviews to improve impact: Timely, informative environmental reviews should help deliver positive environmental and community impact, but this requires sufficient levels of skilled agency staff and effective use of budgetary resources.

[2] White House; Fact sheet permitting action plan

2. Raw material supply chains stretched

22 MIFTs are critical for the energy transition

Shifting towards supply chains and looking upstream, mined raw materials are critical for the energy transition. Exhibit 8 highlights that beyond the much-discussed base metals, along with lithium and cobalt, a host of other resources are of strategic importance.

Exhibit 8: Applications helping to decarbonise the economy, along with the commodities required
The energy transition will not happen without metals; most exchange traded metals are in deficit by 2030

	Generation		Storage, transmission/ distribution		Consumption				Net Zero scenario	
Commodity	Wind	Solar photovoltaic	Energy storage	Power infrastructure	Electric vehicles	Electric motors	Carbon capture and storage	Electrification of economy	Supply constrained in 2030	Deficit, of supply in 2030
Exchange-traded										
Aluminium	X	X	X	X	X	X	X	X	Yes	30%
Copper	X	X		X	X	X	X	X	Yes	17%
Nickel	X	X	X		X		X	X	Yes	46%
Zinc	X	X						X	No	
Lead	X	X						X	No	
Silver		X			X			X	Yes	125%
Platinum			X		X			X	Yes	35%
Steel	X	X		X	X			X	No	
Cobalt	X		X		X		X	X	Yes	45%
Lithium	X				X			X	Yes	65%
Non exchange-traded										
Cadmium		X						X		
Chromium	X						X	X		
Gallium		X						X		
Graphite	X				X			X		
Indium		X					X	X		
Iridium			X		X			X		
Manganese	X		X		X		X	X		
Molybdenum	X	X					X	X		
Rare Earths Elements	X				X	X		X		
Silicon	X	X			X			X		
Tellurium		X						X		
Uranium								X		

Source: World Bank, The Growing Role of Minerals and Metals for a Low Carbon Future, CRU, Woodmac, company reports, BofA Global Research

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Resource constraints mean emissions target misses – we need to pay more attention

Beyond a brief dip at the height of the COVID pandemic, emissions have continued to increase, as more oil, gas and coal is burned. As such, efforts to achieve Net Zero are insufficient. Furthermore, we believe the degree of emission reduction achievable with the current resource endowment is still not getting the attention it deserves.

What are the implications? Missing Net Zero targets simply means continuing along the trend of global warming, with the current resource endowment, the world is unlikely to be able to limit global warming to 1.5°C; instead, we are more likely headed towards a 1.8-1.9°C temperature rise. Importantly, CO2 emission increases in 2021 and 2022 have added around 0.1°C to the terminal temperature in 2050E.

Metals demand is set to increase sharply

Exhibit 9 converts those targets into metals demand, highlighting the remarkable CAGRs of up to 80% out to 2030E.

Exhibit 9: Metals demand under IEA Net Zero 2050
Metals demand CAGR could hit 78%

Demand	2020	2030	2050	2020-2030 CAGR	2030-2050 CAGR
Aluminium (t)	12,082,085	23,686,985	24,817,435	7%	0%
Copper (t)	5,062,873	9,977,971	12,371,644	7%	1%
Nickel (t)	89,857	2,610,194	4,364,530	40%	3%
Zinc (t)	1,118,741	2,853,222	2,843,224	10%	0%
Lithium (t)	101,877	3,592,713	9,455,934	43%	5%
Platinum (oz)	9,406	2,951,605	6,960,081	78%	4%
Cobalt (t)	28,258	358,645	599,694	29%	3%
Silver (t)	4,775	8,554	10,477	6%	1%

Source: IEA, BofA Global Research

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3. Electricity generation: solar and wind

Solar energy: China dominates the supply chain

Looking further downstream, the supply chain set-up also matters when it comes to green technologies. This has been reflected in a recent draft published by China's MOC and Ministry of Science and Technology, which is soliciting public comments on whether to add manufacturing IP, used to produce advanced solar wafers, to the list of technologies on which there is a prohibition on exports. This would inhibit overseas expansion of China's PV producers, which dominate the industry.

Crystalline silicon panels are mainstream

There are different technologies for solar panels. Crystalline silicon (c-Si) panels remain the mainstay with a market share of 95%, followed by thin-film technologies, which include Cadmium Tellurium (CdTe), copper indium gallium diselinide (CIGS) and amorphous silicon (a-Si). This classification matters because each technology adopts different raw materials. For instance, the mainstream c-Si panels feature silicon and silver as core materials, while CdTe have more "exotic" ones such as germanium and tellurium.

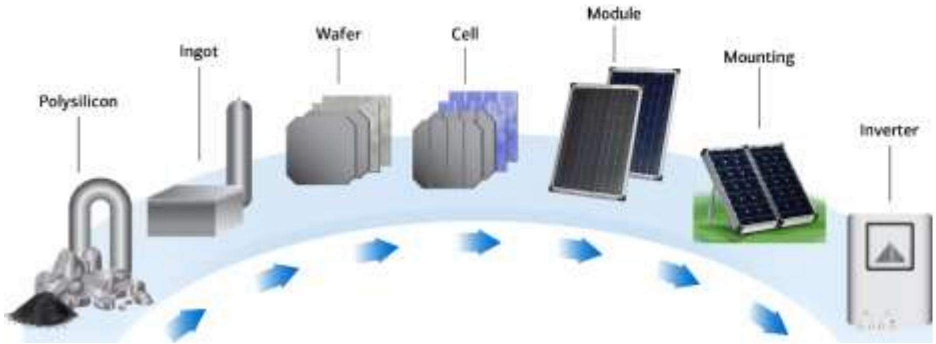
How is the solar PV supply chain set up?

The first step to make crystalline silicone solar panels consist of polysilicon refining. Monocrystalline silicon wafers are made up of one crystal structure, while polycrystalline silicon are made up of different crystals. While monocrystallines are cut from a single source of silicon, polycrystalline cells are a blend of multiple silicon sources. Indeed, polycrystalline cells are manufactured by pouring molten silicon into moulds, with the wafers then cut; the process is more difficult with monocrystalline cells. Monocrystalline panels are more efficient because the electrons move more freely to generate electricity, although polycrystalline cells are less expensive to manufacture. The maximum theoretical efficiency level for a silicon solar cell is about 32%. The best panels for commercial use have efficiencies around 18% to 22%.

The thin silicon wafers are then used to make solar cells, which are connected, sandwiched between glass and plastic sheets, and framed to make PV modules. Then, they are mounted on racking structures and connected to the grid using an inverter.

Exhibit 10: Solar PV supply chain

The solar PV supply chain is made up of multiple stages: polysilicon is critical on the way to model assembly, mounting and connection.



Source: BofA Global Research

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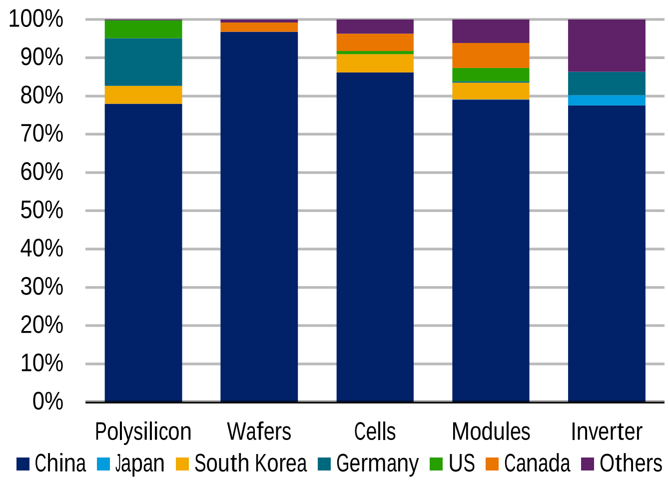
China dominates all stages of the solar PV value chain

Taking a closer look into the c-Si supply chain, concentration is extremely high. Indeed, China's market share along the supply chain exceeds 70%, reaching 97% in the case of wafer production (Exhibit 11). As such, Western economies are highly dependent on Chinese manufacturers to achieve their climate goals. Even looking at individual PV producers, the level of concentration has risen significantly over the past few years, with the top-10 firms controlling more than 70% of the market (Exhibit 12).

Exhibit 11: Solar PV supply chain components, market share by country

China dominates the entire solar PV value chain, with a market share of up to 97%



Source: BNEF, BofA Global Research

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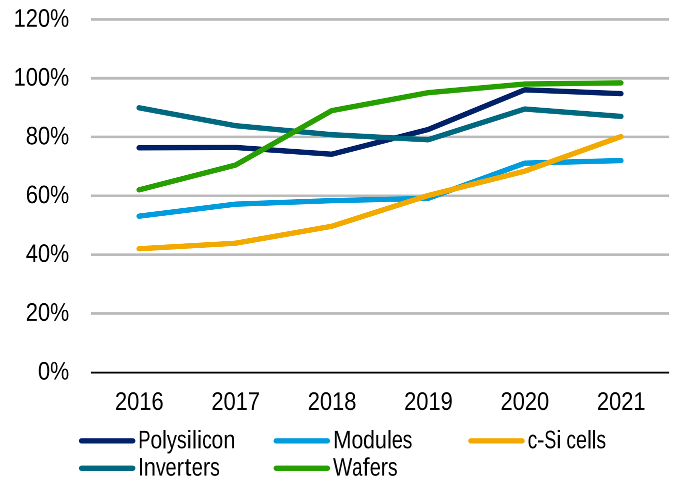
Exhibit 12: Market share of top 10 firms of solar PV components

The top 10 solar PV component manufacturers control more than 70% of the market



Source: BNEF, BofA Global Research

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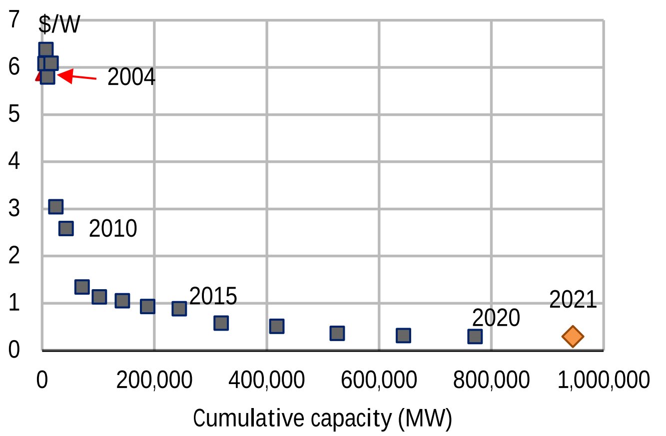
Chinese economies of scale helped bring down solar PV prices

Why has China been so successful and why would it protect its solar industry? Its success has largely been driven by its ability to develop economies of scale and displace potential competitors. This is shown in Exhibit 13, which highlights that an increase in the production of c-Si solar panels was accompanied by a decline in module prices. Heavily influenced by that, a once-promising solar industry in Germany has withered.

Exhibit 13: Crystalline silicon photovoltaic experience curve, 2004-202
Chinese c-Si module prices



Source: BNEF, BofA Global Research

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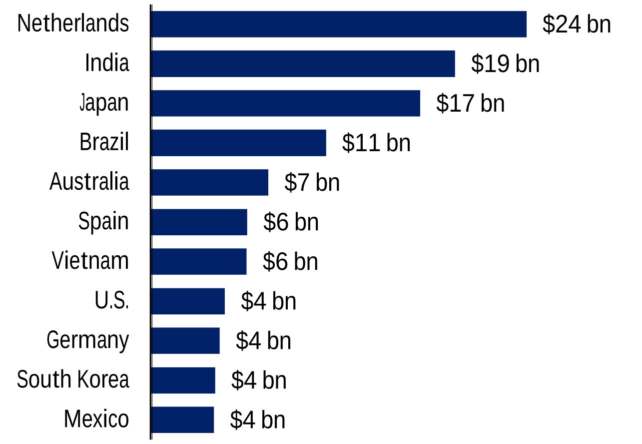
Exhibit 14: China solar PV exports, $ value from Jan 2015 – Nov 2022
China turned the solar PV market into a multibillion industry



Source: BNEF, BofA Global Research

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Exhibit 14 shows how entrenched China's solar industry is in the global economy. The solar PV market has turned into a multibillion-dollar industry for the Asian country, topping US$160bn within eight years. Hence, it is not surprising that the government would want to protect this.

The US **Department of Energy's view on the solar supply chain**

In its recently published supply chain assessment (see here), the US Department of Energy outlined that the US is the second-largest PV market, representing about 10-15% of global PV demand. PV cells made from crystalline silicon dominate installations, with an 84% market share; cadmium telluride (CdTe) thin films represent 16% of the US market. Most PV modules installed in the US are imported. While many components can be sourced outside of China, the Department of Energy confirms that about 97% of the world's production of silicon wafers occurs in China.

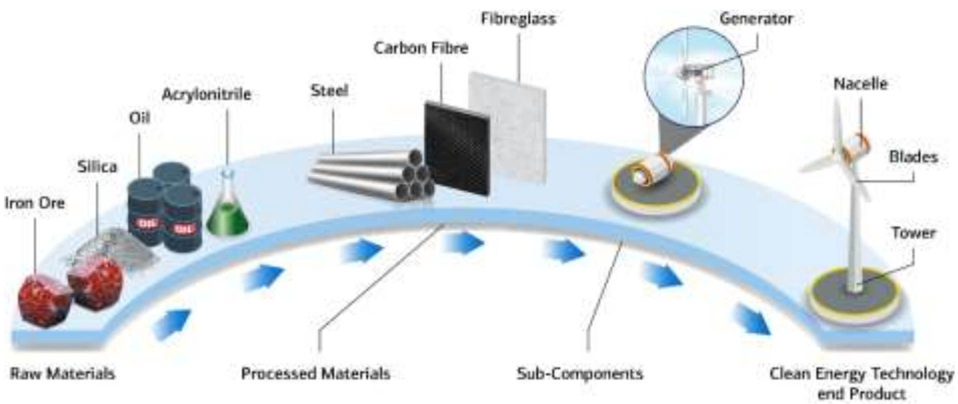
The report also confirmed that developing a US-based photovoltaic (PV) manufacturing base could mitigate global supply chain challenges – noting, however, that growth needs to be accompanied by incentives that offset the around 30-40% higher cost of manufacturing in the US.

Wind energy: Europe and US take a large slice of market

How is the wind turbine supply chain set up?

Several parts are needed to convert wind energy into electrical energy. The wind power supply chain begins with procurement of raw materials (e.g. iron ore, silica sand, acrylonitrile), which are processed to make the turbine's components. Turbines consist of a rotor blade, a nacelle (which houses the generator), a tower, and electrical equipment.

Exhibit 15: Wind turbine supply chain
Raw materials such as iron ore and silica sand are processed to make the components; these components are then assembled to make a wind turbine



Source: BofA Global Research

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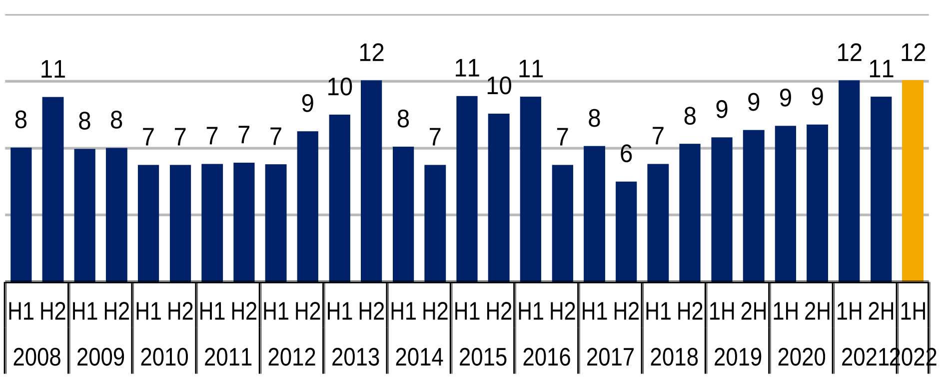
Lead times for wind turbines have been increasing for the past five years

Despite governments racing towards cleaner energy, lead times for wind turbines increased in 2022, highlighting how important a resilient supply chain is. The median lead time for wind turbine contracts signed in 1H22 was about 12 months, almost three months longer than in 2H20. Supply chain bottlenecks in the last couple of years caused logistical delays for turbine manufacturers, in addition to the increase in shipping costs.

Exhibit 16: Lead for wind turbines time by signing date (median)
Lead times have increased, highlighting tightness through the supply chain



Source: BNEF, BofA Global Research

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The US **Department of Energy's view on the wind supply chain**

Commenting on wind energy, the US Department of Energy notes[3] that development of the offshore wind supply chain needs to be accelerated, including offshore wind towers, blades, nacelles, and substructures. To achieve this, offshore infrastructure needs support, including ports and vessels.

At the same time, the land-based wind supply chain needs to be maintained, given the domestic content in land-based wind turbine blades has declined in recent years. Current blades, towers, and nacelles are becoming too large to efficiently transport over existing road and rail networks, and moving components is further challenged by varied state and local transport permit requirements. Making components more modular, along with

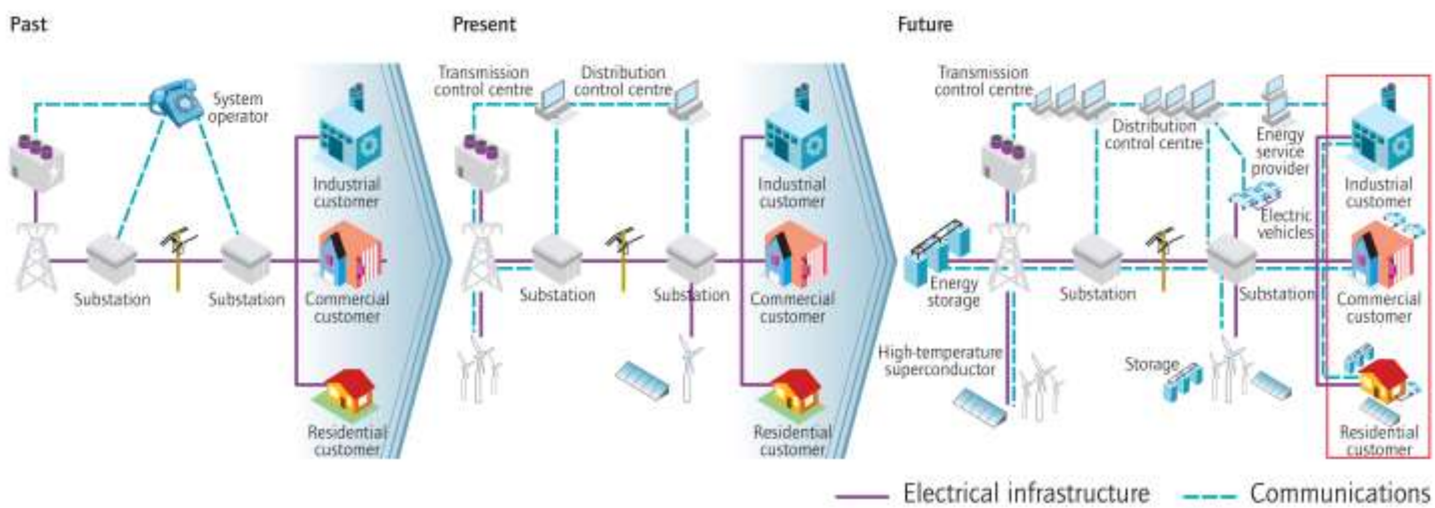
[3] Wind Supply Chain Fact Sheet Final.pdf (energy.gov)

policy and regulatory solutions, could reduce the challenges presented by overland transport. Supply chain competitiveness through R&D has to be a focus, including blade manufacturing automation, additive manufacturing of large castings and forgings, and modularization and onsite manufacturing of large components such as blades and towers. The DoE also highlights the need to expand training programs to support the wind workforce, along with help to find and train workers with a wide range of specialized skills for building and maintaining wind energy facilities.

4. Transmission/distribution & storage: upgrades are needed

System integration is critical for successful delivery of the energy transition. System integration usually revolves around aligning electricity generation with the power consumption infrastructure, so transmission/distribution and energy storage are important. Indeed, power networks in most developed nations have been built over many decades, which means that they may not be able to cope with a step-up in loads. Similarly, intermittency, i.e. differences between when electricity is generated and consumed, is a particular issue with renewables, so energy storage is becoming more important.

Exhibit 17: Evolution of energy system
Compared to the past, electricity grids are becoming more complex. In the future, different components need to communicate and interact to make the system work



Source: IEA (2011), Technology Roadmap - Smart Grids, IEA, Paris https://www.iea.org/reports/technology-roadmap-smart-grids, License: CC BY 4.0

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As such, electrifying the economy through the installation of renewables also has implications for the grid:

- Transmission/distribution: The grid needs to be able to handle more and, given the intermittency issues with renewables, also more variable electricity.
- Energy storage: Renewables and the variable power they produce need to be integrated into the grid. Building back-up power and boosting energy storage are possible solutions.

Transmission and distribution

The integration of a significant share of variable renewables into power grids also requires a substantial transformation of the existing networks, as IRENA notes[4], in order to:

- allow for a bi-directional flow of energy to maintain a stable grid as more distributed generation is installed: power will flow top-down (i.e. from generators to users), but also bottom-up, when end-users contribute to electricity supply for instance through locally installed renewables;

- introduce technologies to ensure grid operation is stable. Power generation from renewables is variable given intermittency issues; this also means that back-up power and energy storage will need to be incorporated to manage differences between electricity supply and demand;

- establish electricity demand and grid management mechanisms aimed at reducing peak loads and improving grid flexibility, responsiveness and security of supply in order to deal with increased systemic variability;

- improve the interconnection of grids at the regional, national and international level to increase grid balancing capabilities, reliability and stability.

The increased importance of wind farms and solar power plants means that the power system needs to be able to address dislocations, such as congestion of transmission lines and voltage instability. These can be facilitated by the upgrading of existing or the addition of new transmission lines, the addition of compensation devices to provide grid support, and operational adjustments to provide the reserves required

Energy storage: important to tackle intermittency issues

Energy storage is another important part of grids that rely heavily on renewables, helping to tackle intermittency issues, i.e., balance differences between electricity consumption and variable renewable power generation. Yet, there is uncertainty on how energy storage will ultimately shape up and how much is required.

[4] IRENA: Renewable Energy Integration in Power Grids, Technology Brief

5. Electricity consumption, EVs: fuelling up while going at maximum speed

Globally, EV production increased by 74% or 3.5m units to 8.1M units in 2022. Our autos team expects an EV penetration rate of 42% in 2030, taking production to 41.6M units, implying that competition between auto manufacturers will remain intense.

Supply chains are important and evolving

Asian companies dominate EV battery production

Looking further upstream, Joon-Ho Lee, APAC coordinator of Electric Vehicle (EV) Battery Thematic Research, notes that the top-six players in battery manufacturing are expected to represent close to 60% of global manufacturing capacity in 2030. By country, Korean and Chinese companies are forecast to represent 36% and 24% of total capacity, respectively.

Investment in battery production powers ahead

Given a global focus on electric vehicles, it is not surprising that manufacturers have announced plans to invest billions of dollars into building new battery production plants and expanding capacity at existing plants.

- unlike commoditized cells and modules, the design of battery packs is the differentiating factor among auto makers as it helps determine the performance of the EV;
- auto OEMs have deeper end-product knowledge, enabling them to design the battery packs in the most product-suitable way;
- transporting battery packs from the supplier to the OEM factory is expensive due to the size and weight of the packs.

Tightness in labour market also an issue for OEMs

Incidentally, car manufacturers also faced challenges in sourcing labour last year. Particularly in the US, labour demand outpaced labour supply.

According to our US Economics team, “the labor market remains stronger than normal, even as the overall economy clips into a growth recession”. Similarly, in Europe, labour costs are expected to remain a headwind for OEMs in 2023, potentially burdening earnings. For example, our European autos team expects labour costs in Germany to increase by c5% as of June 2023 and by a further 3.3% in May 2024.

Global **EV battery to hit “sold out” situation by 2026**-27E

We are not investing enough

Highlighting the risk to the supply chain, Joon Ho Lee, APAC coordinator of Electric Vehicle (EV) Battery Thematic Research, notes that the EV battery supply-demand model suggests the global EV battery supply will likely hit a “sold-out” situation in 2026-27, with global operating rates rising above 85% then. We expect the supply shortage to intensify further in 2027-30, driven by a continued rise in EV penetration globally.

Indeed, we forecast the global operating rates of EV battery manufacturing to rise to, based on announced capacity expansion plans so far, implying another round of substantial capex cycles will likely kick in over the next 2-3 years. We also expect further announcements of major EV battery manufacturer capacity addition plans (including JVs with up/downstream partners in EV battery value chains), mainly in North America, to benefit from IRA tax credits in the next few decades.

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