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Delivering the energy transition

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Key takeaways

- To deliver the energy transition and make progress toward global climate targets, civilization needs to build a new energy infrastructure from electricity generation, transmission/distribution, and storage to consumption.
- However, common obstacles to achieving such goals include: 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) the cost inflation and low returns.
- Overall, while these bottlenecks and constraints can be overcome, it will require a concerted and collective effort by governments, companies, and consumers to deliver the energy transition and make real progress toward ambitious climate targets.

New energy infrastructure – the foundation 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. Meanwhile, the war in Ukraine has ratcheted up the sense of urgency, adding energy security as another dimension to green technology investment. This has led to a raft of ambitious energy targets. But what might hinder progress? And are the targets too ambitious in light of the obstacles?

To start with, permitting needs to accelerate. BofA Global Research believes 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 the MIFTs (metals important for future technologies) and polysilicon, a high-purity form of silicon that is a key raw material in the solar photovoltaic (PV) supply chain. This is a concern in many countries that are looking to make their supply chains more autonomous. Furthermore, there is also an impending shortage of skilled linemen and trades, which, along with the rapid increases in capital spending and supply chain bottlenecks, add to cost inflation.

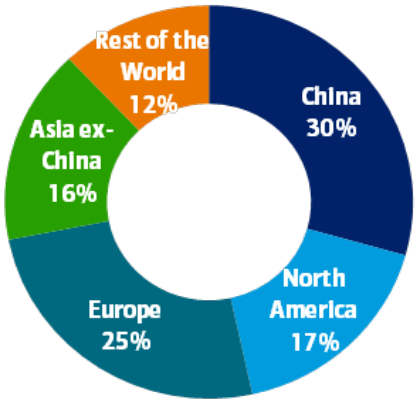
System integration is also critical for successful delivery of the energy transition. System integration usually revolves around aligning electricity generation with the power consumption infrastructure and creation of bi-directional flow of energy between the grid and users. With bi-directional energy flow, electricity generation could be powered through locally installed renewables and maintain a stable grid. For example, some states allow for excess energy produced through solar panels to be sold back to the utility companies. To ensure stability, energy storage, through technologies like batteries or hydrogen, will play a critical role.

Headwinds to energy transitions in a nutshell: China

Looking at the regional spending breakdown, developed economies in Europe and North America accounted for the lion's share of clean energy investment in 2022 (Exhibit 1). China topped the leaderboard, accounting for nearly a third of global green energy spending. While capacity additions in solar and wind in China have exceeded those in coal in recent years, the country could serve as a case study for some of the issues that crop up when decarbonizing the economy.

Specifically, in 2Q22 and 1Q23 some Chinese regions experienced severe power shortages caused by a sharp drop in rainfall and wind speed. This led to an increased reliance on coal, which reinforces the idea that while energy transition is one focus, energy security also matters. According to the China Electricity Council, China will likely add 70GW (gigawatt) of new coal-fired power capacity in 2023, which BofA Global Research expects to be followed by 60GW and 45GW of new additions in 2024 and 2025, respectively. At the same time, coal-fired power units are increasingly being converted to operate at lower utilization 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, BofA Global Research suggests that the pace should pick up over 2023-25 as prices of wind turbines and polysilicon drop with rising supply.

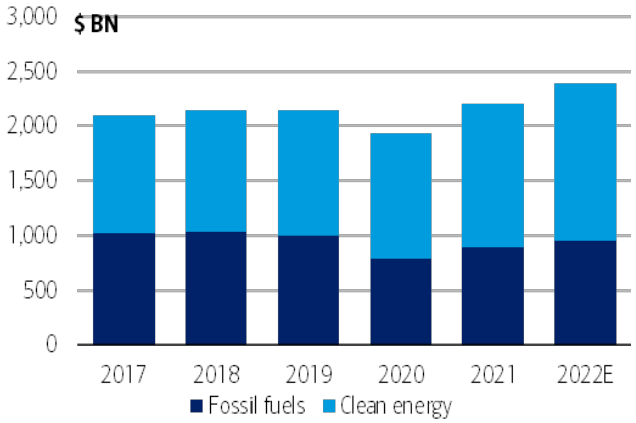
Exhibit 1: Clean energy investment (2022E), by country/region
Developed markets in Europe and North America account for 42% of clean energy investment; China is the single biggest investor



Source: International Energy Agency

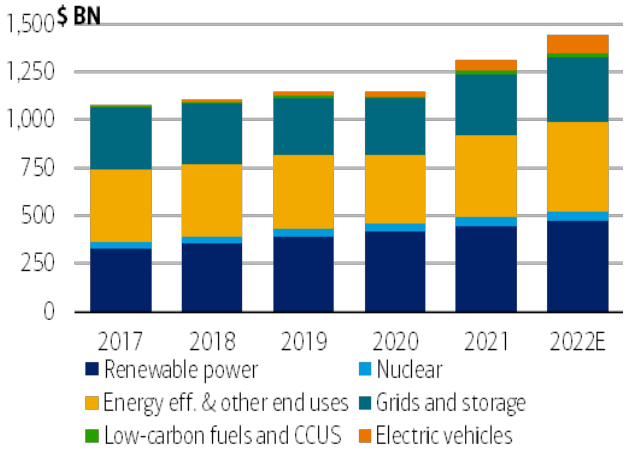
However, there are caveats to assumptions of ever-decreasing costs, and the global community's push towards Net Zero is not all positive. The International Energy Agency (IEA) estimates that investment in the energy sector will increase by 8% to $2.3 trillion in 2022 (Exhibit 2), with investment in green 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 decarbonization of the global economy.

Exhibit 2: Global energy investment
Investments in the energy sector are set to increase by 8% in 2022



Source: International Energy Agency

Exhibit 3: Global clean energy investment
Global spending in clean energy is picking up after years of flat investments

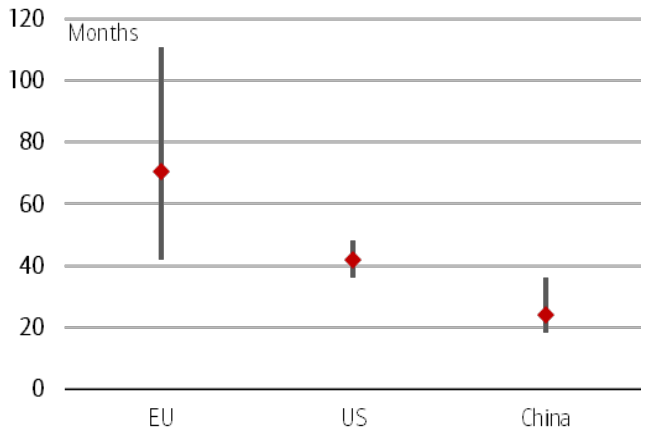


Source: International Energy Agency

Slow permitting holding back progress

Energy security has added a new dimension to an initial focus on the energy transition. While acknowledging that reducing reliance on fossil fuels is important, governments are increasingly keen to accelerate the speed at which green technologies are implemented. According to the World Wind Energy Association, Europe's planning and permitting times are lagging behind those in the US and China (Exhibit 4), though the European Union (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 4: Minimum, maximum and average wind farm planning times
Planning times differ markedly between Europe, the US and China



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

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, BofA Global Research notes 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 its first wind farm – with the whole project taking 10-12 years to complete.

Raw material supply chains stretched

A stable supply of raw materials is critical in reaching green targets. The Metals and Mining team at BofA Global Research have identified 22 MIFTs that are critical for energy transition. 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 ~2030. 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, BofA Global Research believes that the degree of emission reduction achievable with the current resource endowment is still not getting the attention it deserves. (Exhibit 5)

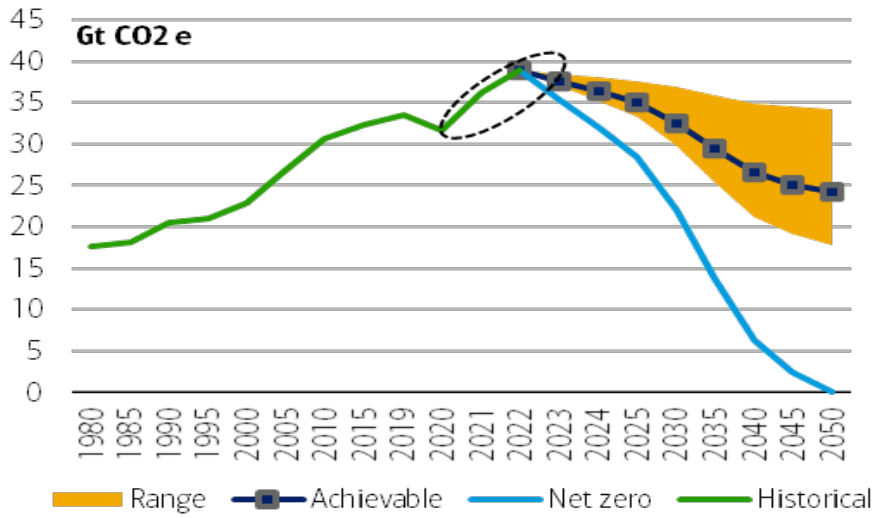
Exhibit 5: Metals demand under IEA Net Zero 2050
Metals demand CAGR (Compound Annual Growth Rate) could hit 78%

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: International Energy Agency

What are the implications? Missing Net Zero targets 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, as mentioned in our Executing on Net Zero Q&A, CO2 emission increases in 2021 and 2022 have added around 0.1°C to the terminal temperature in 2050E.

Exhibit 6: Emission profiles out to 2050, based on resource availability and including Net Zero
With the current resource endowment, the world may fall short of Net Zero by 2050



Source: International Energy Agency, National Aeronautics and Space Administration (NASA)

Notwithstanding a global push towards achieving Net Zero, resource constraints are perhaps one of the biggest obstacles to tackling climate change. The IEA's holistic Net Zero 2050 scenario comprises concrete targets in electricity generation, transmission/distribution, storage and consumption that need to be achieved to hit Net Zero by 2050 (Exhibit 6).

China stands out as the largest producer of many critical resources. This came about by many factors including China's reliance on energy imports, most notably being a dominant oil importer. Concerns over this, along with a strong push to tackle emissions, means the authorities have invested heavily over the past two decades in materials that are required in "future" technologies, including EVs (electric vehicles) and renewables.

Metals production is often dominated by China, causing apprehension in many developed markets. Linked to that, any use of batteries and critical minerals from China, Russia, Iran and North Korea will make a vehicle ineligible for the tax credit under the guidelines of the US Inflation Reduction Act (see also: Inflation Reduction Act: A long game). Meanwhile, the EU wants to build a domestic supply chain, aiming to source domestically at least 10% of the EU's annual consumption for extraction, at least 40% of the EU's annual consumption for processing and at least 15% of the EU's annual consumption for recycling.

As concerns over energy security are increasingly linked to the energy transition push, it is not surprising that policymakers outside of China are paying greater attention to the availability of critical minerals. Europe's dependence on Russian gas and the sudden halt of deliveries has focused governments' attention on ridding themselves of their resource dependence. 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.

Many green technologies are capex-intensive, so financial risk management is critical, given returns for renewable projects can be low. To ensure critical raw materials are available, they also have to be produced and to facilitate that, governments are focusing on different measures:

- **Financing**: Countries may use direct funding to support the development of domestic supplies through mechanisms, such as grants, preferential loans or loan guarantees. These financial incentives can be administered to pre-existing or new extraction projects.
- **Tax incentives:** Countries may use favorable tax schemes to incentivize domestic production. They may also allow tax deductions for specific types of investment.
- **Geological surveys**: Countries may develop geological survey data on existing mineral reserves and make data available both domestically and abroad. Geological data can be made directly accessible to the public, or governments can offer public funding for exploration and surveying activities.

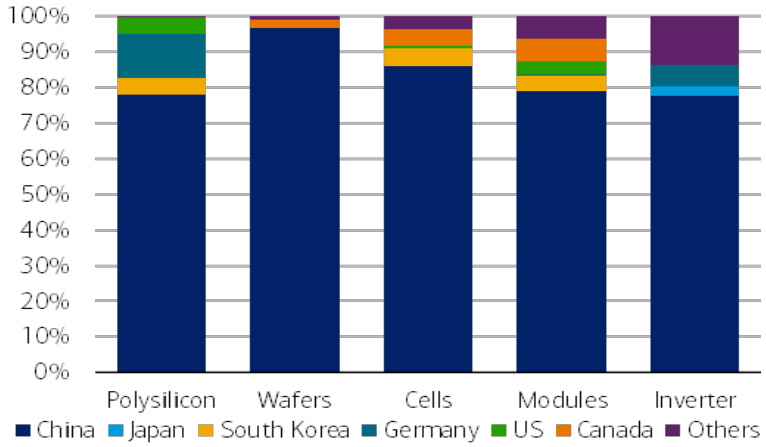
- **Recycling support**: Policies that target development of a secondary-material supply market with adequate processing capability may include research and development funding, regulations to require or increase collection rates, and other support measures for new recycling facilities.

- **Innovation funding**: Measures designed to accelerate technological progress and innovation, generally through funding and information-sharing initiatives, may include direct funding through grants or subsidies for research, development, demonstration and deployment.

Solar supply chain is run by China; wind is more diversified

The supply chain set-up also matters when it comes to green technologies. As mentioned earlier, China dominates the solar photovoltaic (PV) supply chain (Exhibit 7). And while the US and Europe are looking to reduce their dependence, incentives are needed to offset their 30-40% higher manufacturing costs. 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. The solar PV market has turned into a multibillion-dollar industry for China, topping US $160 billion within eight years.

Exhibit 7: 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

While China dominates the solar market, wind energy tends to be more diversified. Indeed, three of the top five wind turbine manufacturers are in Europe and the US. However, Chinese wind turbine producers, which hold a 57% market share, operate almost entirely in their domestic market.

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

As governments have expanded their subsidy programs to boost EV penetration rates, competition among OEMs (original equipment manufacturers) has intensified. Globally, EV production increased by 74% or 3.5 million units to 8.1million units in 2022. The BofA Global Research autos team expects an EV penetration rate of 42% in 2030, taking production to 41.6 million units, implying that competition between auto manufacturers will remain intense.

Global EV battery to hit "sold out" situation by 2026-27E

EV penetration needs to hit 100% by 2050 in order to reach Net Zero. BofA Global Research expects the global operating rates of EV battery manufacturing to rise to about 66%/93% by 2025/30, 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. They also expect further announcements of major EV battery manufacturer capacity addition plans (including joint ventures with up/downstream partners in EV battery value chains), mainly in North America, to benefit from IRA (Inflation Reduction Act) tax credits in the next few decades.

Highlighting the risk to the supply chain, BofA's Electric Vehicle (EV) Battery Thematic Research team 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. The team expects the supply shortage to intensify further in 2027-30, driven by a continued rise in EV penetration globally.

Headwinds remain for the energy transition, but obstacles can be overcome

Overall, civilization can overcome the obstacles in driving an energy transition, but it will require a concerted and collective effort by governments, companies and consumers. Climate targets are ambitious, and geopolitics have amplified the desire for energy

security and independence, but progress can be achieved with a focus on achieving the following: 1) shorter permitting timelines, 2) improving supply chains for raw materials needed for green technologies, 3) training the next generation of skilled labor in the manufacturing of renewable technologies, 4) driving the cost of renewables lower, potentially leading to greater adoption rates, and 5) integrating a bi-directional flow of energy between the grid and users, while developing better storage capacities.

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