

- Race to the top on clean energy –
- The US and EU response to China's dominance



Report prepared by Kaya Partners for the Inevitable Policy Response

January 2023

**Kaya** 

## Policy analysis by Kaya, Foreword by IPR

*This short paper by Brian Hensley and Asta Lappetelainen at [Kaya](#), a specialist climate policy consultancy, has been commissioned by the Inevitable Policy Response ([IPR](#)). It examines the alignment of climate objectives with economic and industrial needs as a new catalyst for climate action, and the race to the top emerging between China, the EU and the US. The views in this report do not necessarily reflect the views of the IPR research consortium.*

*IPR is a climate transition forecasting consortium commissioned by the Principles for Responsible Investment (PRI) whose aim is to prepare investors for the portfolio risks and opportunities associated with accelerating policy responses to climate change. [The key outputs of IPR consist of the Forecast Policy Scenario \(FPS\) and the 1.5°C Required Policy Scenario \(RPS\)](#). Both the FPS and the RPS are intentionally designed to be long-term, running out to 2050 and beyond. Both scenarios assumed emissions rose slightly out to 2025/6 when published last October 2021.*

PRI commissioned the Inevitable Policy Response in 2018 to advance the industry’s knowledge of climate transition risk, and to support investors’ efforts to incorporate climate risk into their portfolio assessments.



This report is funded in part by the Gordon and Betty Moore Foundation through The Finance Hub, which was created to advance sustainable finance.



A research partnership led by Energy Transition Advisers and Vivid Economics undertakes the initiative’s policy research and scenario modelling and includes Kaya, 2Dii, Carbon Tracker Initiative, Climate Bonds Initiative and Planet Tracker.

The consortium was given the mandate to bring leading analytic tools and an independent perspective to assess the drivers of likely policy action, and the implications on the market.

Leading financial institutions joined the IPR in 2021 as Strategic Partners including BlackRock, Fitch Ratings, Nuveen, BNP Paribas Asset Management, Temasek, Quinbrook Infrastructure Partners and Goldman Sachs Asset Management.

## IPR Foreword

This paper, written by Kaya for IPR, offers the most up-to-date understanding of the political context for the clean energy acceleration globally. A new catalyst for more renewables involves a likely chain reaction of industrial policies for green industries in western countries as evidenced in the EU Green Deal Industrial Plan.

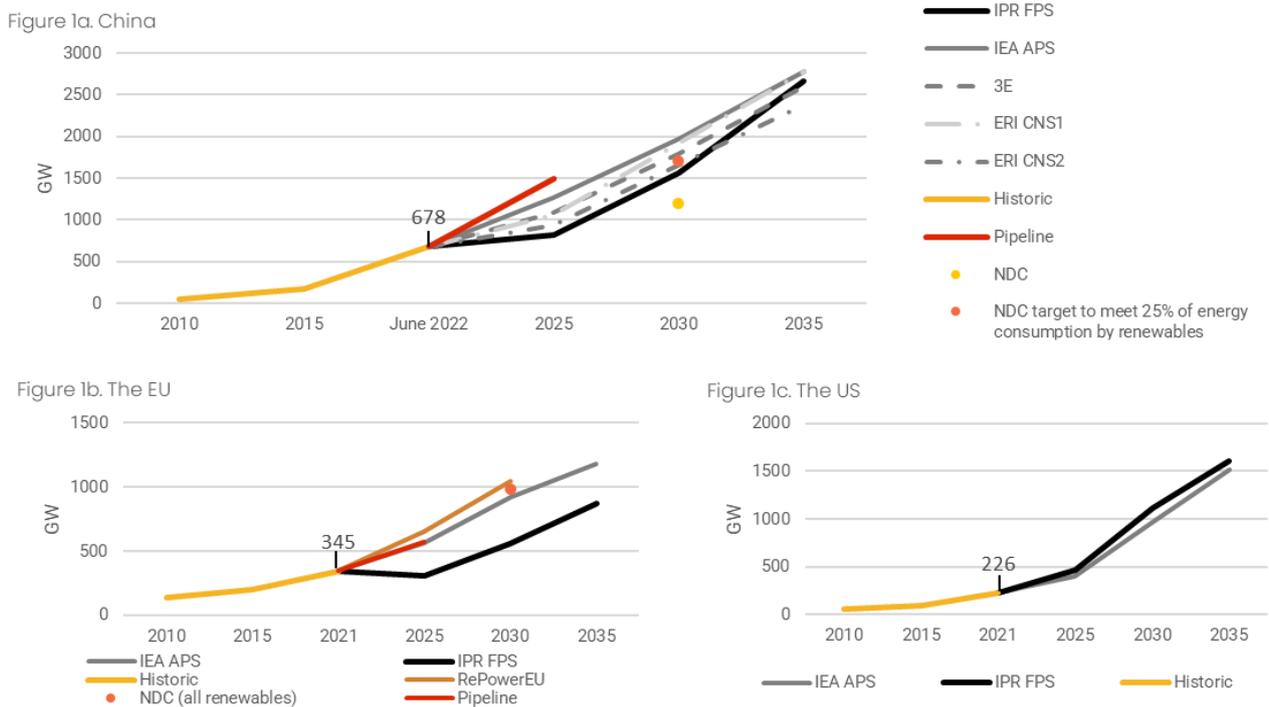
This analysis paves the way for an upgrade to clean energy in our *Forecast Policy Scenario* in the medium term, as discussed in the latest Q4 2022 [Quarterly Forecast Tracker](#). There will be challenges for investment around the interaction of demand and supply responses. So long as demand leads or keeps up with supply, then the outcome will be positive.

Mark Fulton, Project Director, Inevitable Policy Response

## Executive Summary

- ❖ The scene is set for major countries - in addition to China - to build clean energy capacity at scale. The EU and US are primed to race to the top of clean technology, much of which is now manufactured by China. To do this, the US is using industrial policy with protectionist elements. The EU is likely to follow with its own subsidy playbook.
- ❖ An instigator of this moment is China’s dominance in multiple areas of renewable manufacturing and critical raw material (CRM) refining. Current western policy responses to this situation reveal the tension between being unable to live *without* China if energy transition goals are to be met and being unable to completely live *with* China when it comes to survival of domestic industries.
- ❖ A primary rationale for America’s new industrial policy is not commonly appreciated; the Biden Administration views it as a means to it protect democracy in America. The industrial strategy involves incentivising global companies to locate manufacturing of clean energy in the US, exploiting the huge job creation potential of the industry.
- ❖ Seen from this standpoint, the US administration is unlikely to backslide on its industrial and trade agenda. The US expects and welcomes the prospect that the Inflation Reduction Act (IRA) will elicit a chain reaction of similar subsidies among its allies. This policy is likely to stick even in a post-Biden world.
- ❖ The EU must now contend with unabashed subsidy regimes from two of its primary global trading partners in clean energy, China, and the US. Current EU tools are not fit for purpose; the bloc has some ammunition to use for business support, but comprehensive action is constrained by unique factors and much of the support is being directed to cushioning business and individuals from high energy prices.
- ❖ Within the context of a Green Deal Industrial Plan, the EU Commission is developing a plan to respond to the IRA, including a Net-Zero Industry ACT. They will be considering many of the ideas laid out in this paper. We do not rule out that new common debt may be eventually used, possible via the new European Sovereignty Fund.
- ❖ How did we get here? China has spent more on industrial policy support than any other nation. This has created a production void in other countries while also dramatically reducing the cost of clean technologies. We look at a history of climate-related industrial policy in China and assess the ranges of dominance in solar, CRM processing, offshore wind, electric vehicles, and hydrogen electrolyzers.
- ❖ Due to the limited time and enormous scale of the energy transition, it is not realistic to cut China from clean energy supply chains. But it is possible to increase the number of complementary supply chains designed around national security imperatives. This offers new trade and investment opportunities.
- ❖ There are implications for the climate from this moment. Unilateral country subsidies and the pursuit of new multi-national trade agreements will become more pronounced. This heralds a further divergence from a WTO system which has dominated global relations since the mid-90s but adds a functional path for decarbonisation alongside the UNFCCC and Paris Agreement process.
- ❖ Such a dramatic use of industrial policy by the west does entail risks including that a subsidy race leads to overt trade protectionism and export restrictions. This would have negative consequences for the transition.

Figure 1 Renewable capacity needs accelerating simultaneously in China, EU, and US



**Notes:** In this figure we show the historical and projected buildout of solar and wind capacity under different scenarios. The scenarios are IPR FPS = IPR Forecast Policy Scenario; IEA APS = IEA Announced Policy Scenario for all geographies and 3E = Institute of Energy, Environment and Economy, Tsinghua University and ERI = China’s Energy Transformation Outlook for China<sup>1</sup>. Figure 1 reflects that capacity additions are expected to accelerate in all geographies simultaneously.

**Source:** Kaya Advisory

<sup>1</sup> All geographies: IPR (2021) Available at: [Link](#) and IEA (2022) World Energy Outlook. Available at: [Link](#) Specific to China 3E, Institute of Energy, Environment and Economy, Tsinghua University. and China Energy Transformation Program. (2022) China Energy Transformation Outlook. Available at: [Link](#)

## Contents

	IPR Foreword .....	3
1	Introduction.....	7
2	How did we get here? – China’s lead in climate manufacturing exposed .....	10
3	The West awakens.....	16
4	Diversifying supply chains – multilateral action cooperation on clean energy .....	23
5	China’s climate goals and policies to meet them .....	25
	Appendix 1 – Solar PV industry history .....	28
	Appendix 2 – Wind industry history.....	29
	Appendix 3 – Data on wind turbine market concentration, CRM bottlenecks, global mining .....	30
	Disclaimer.....	32

## List of figures

Figure 1	Renewable capacity needs accelerating simultaneously in China, EU, and US.....	5
Figure 2	Industrial policy spending in selected economies and subsidy type, % of GDP.....	10
Figure 3	China becomes the low-cost machine of decarbonisation through its policy choices. ....	11
Figure 4	Degrees of Chinese dominances in selected green sectors.....	11
Figure 5	China manufactures the majority of global solar capacity, both for domestic use and export .....	12
Figure 6a	Global wind turbine production include on-and-offshore.....	12
Figure 7b	Lithium-ion battery manufacturing capacity by region .....	14
Figure 8	Electrolyser manufacturing capacity .....	14
Figure 9a	Refining capacity .....	15
Figure 10	EU funding and select member state aid .....	20
Figure 11	EU imports of solar cells from China .....	21
Figure 12	Final agreement on EU heavy industry free allowance phase out, slower at start but sees a steeper and sooner end .....	22
Figure 13	Cumulative emissions under two scenarios and the 1.5 degree carbon budget.....	26
Figure 14	Possible emissions pathways for China .....	26
Figure 15	Power generation from solar (TWh).....	28
Figure 16	Power generation from wind.....	29
Figure 17	Top offshore wind supplier by installed capacity in 2021.....	30
Figure 18	Top onshore wind supplier by installed capacity in 2021.....	30
Figure 19	Mining and refining of selected minerals by country .....	31

# 1 Introduction

**Climate objectives are taking centre stage along with economic and industrial needs.** This is a catalyst for climate action, resulting in an acceleration of planned clean energy construction beyond even what leading climate scenarios have been forecasting (Figure 1).

**China’s current and future position is important to understand. It’s dominance of renewable energy inputs and manufacturing has led to cheaper technology but has also benefited Chinese industry at the expense of the west.** The EU and US, hereafter ‘the West’, have awakened to their inadequate position in clean technology manufacturing and raw material processing, a situation which hampers climate goals, threatens the economy, and even presents societal risks.

**Going forward, this is an intolerable risk for the West given the simultaneously accelerating energy and climate goals globally.** Figure 1 graphs the historical and projected buildout of solar and wind capacity under different scenarios, including the Inevitable Policy Response’s (IPR) own ‘Forecast Policy Scenario’. Note the Q4 2022 Quarterly Forecast Tracker from IPR signals that the renewable energy forecasts on EU and China will show a more accelerated buildout in the next update (last calculated in 2021).

**China is already huge in renewables but will require even more capacity in the future.** China’s existing capacity (678 GW) is greater than the combined capacity of the EU and US (571 GW). China’s pipeline for future buildout, calculated from the provincial level, represents more than a doubling again in just three years.

**The West’s needs are accelerating as well.** Already, the EU policy path for renewables in the *REPowerEU* plan is faster than the market had projected. The US has 132GW of renewables under development compared with its 226 GW currently.<sup>2</sup>

**The direction of travel for the US involves increased competition with China, usage of industrial policy of renewed scale, scope and design, and use of trade agreements to build new supply chains.** The US is compelling other nations into its orbit with the EU particularly exposed in the crosswinds.

**Kaya Advisory views the US Inflation Reduction Act (IRA) as marking the beginning of this new era.** The IRA’s importance lies not in that it uses industrial policy for clean energy - that has been done by Germany and China for example (Appendix 1 and 2).

**What makes the IRA and associated legislation unique in the Western world is scale, scope, (selectively inclusive) protectionism, and alignment with trade agreements.** The trade agreements are designed to rebuild supply chains which exclude competitor countries like China.

**It is not realistic to suddenly cut China from renewable energy supply chains given its dominance, but it is possible to increase the number of complementary supply chains amongst nations with similar interests.** The success of this strategy will depend on how fast production and supply chains which exclude, or limit China can be achieved. This offers investment opportunities for private actors.

**The US fully expects and welcomes the prospect that the IRA will elicit a chain reaction of similar subsidies among its friends.** This is a win for the climate, given the resources that would be unleashed to help industry scale up clean energy.

<sup>2</sup> American Clean Power (2022) NEW REPORT: Clean Energy Industry Poised to Capitalize on IRA Passage, but Lingering Policy Issues Lead to Slowest Quarter In 3 Years. Available at: [link](#)

**Clean energy = manufacturing jobs in conservative America = preservation of US democracy.** ‘Jan 6<sup>th</sup>’, when Trump supporters stormed the US Capital, proved a pivotal moment for the Biden administration. It also influenced the construction of the Biden climate agenda. Events on this date exemplified a level of dissatisfaction among conservative Americans which could be manipulated to threaten the democratic underpinning of the US system of government. The prospect that the energy transition could simultaneously create abundant middle-class jobs in disaffected regions *and* serve to meet decarbonisation goals was in the forefront of minds in the creation of the IRA.

**The EU is caught in the crosswinds of China and US industrial policy, something that the EU will address in 2023.** Industrial support and policies do exist, but much of the funding ammunition is being used to cushion against high energy prices. EU policies and funding do not compete with the IRA, which is a long-term federal plan with open-ended funding specifically targeting clean energy. The fact remains that the EU is structurally constrained in a way that the US and China are not, for example due to common budget restrictions and competition laws designed to facilitate a common playing field within the bloc.

**The EU now recognizes the existing Green Deal is not enough and has come out of the gate firing, introducing a Green Deal Industrial Plan, a Net-Zero Industry Act and a new European Sovereignty Facility.** New common debt borrowing may still be required.

**More broadly, we expect US and EU actions to spark further unilateral country subsidies for clean energy as well as additional bilateral and multi-lateral trade agreements.** This heralds a more pronounced divergence from the WTO system which has dominated global economic relations since the mid-90s. The US has already shunned the WTO by and large. One of the reasons for this is that China became the central source of clean energy technologies under WTO’s watch. If the WTO refuses to level the playing field to reflect national interests, then the US will forge its own path and force others to adapt.

**The last two decades, since the turn of the century, have witnessed an acceleration of industrial policy support from China for clean energy, far in excess of other nations.** How dominant China is depends on the technology. On the whole, China dominates the solar and critical raw materials (CRM) refining industry, is on course to dominate offshore wind and electric vehicles (EVs) and is competing feverishly on technologies of the future like hydrogen electrolyzers. A beneficial impact of Chinese buildout of renewables has been mass production of clean energy technologies at a low cost.

**The result of all this? The world may eventually be less reliant on one actor – China – to provide the bulk of clean energy products but it also raises the all-important question for investors of potential over, or under, capacity down the road.** The IEA estimates that “...China alone would be able to supply the entire global market for solar PV modules in 2030, one-third of the global market for electrolyzers, and 90% of the world’s EV batteries”, but this comes with the caveat “If all announced projects to expand manufacturing capacities were to materialise and all countries implement their announced climate pledges”.<sup>3</sup> That is a huge ‘if’ to say the least, and it is technology-dependent in any case.

The IEA report goes on to highlight the “*importance of clear and credible deployment targets from governments to limit demand uncertainty and guide investment decisions*” which is exactly what the Inevitable Policy Response (IPR) is designed to analyse. Understanding policy direction when it comes to investing in the transition is utterly essential.

**Risks: It should be noted some, such as the Economist, fear that the result of this could end up in an all-out trade war.**<sup>4</sup> A key determinant for this to be avoided is that demand and supply of clean energy is correctly balanced at global level.

<sup>3</sup> IEA (2023) Energy Technology Perspectives 2023. Available at: [link](#)

<sup>4</sup> The Economist (2023) The destructive new logic that threatens globalisation. Available at: [link](#)

**These are the topics of this paper prepared by Kaya Partners for IPR.** In it, we remind ourselves how we got here by examining a short history of industrial policy actions related to climate in China.

We evidence the varying degrees of control that China possesses in clean technologies and materials including solar, wind, EVs, hydrogen, and CRM.

We offer thoughts on US, multilateral, and EU policy response on clean energy.

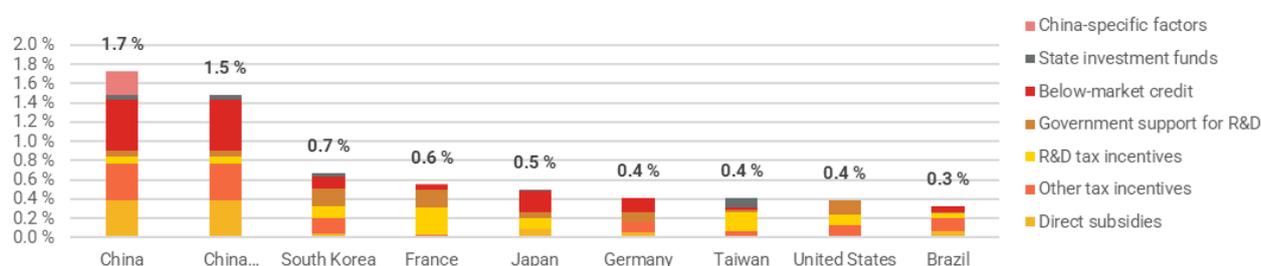
And finally, we look at China’s own climate goals and how they relate and impact the ambitions of the US and EU.

## 2 How did we get here? – China’s lead in climate manufacturing exposed

**China has outspent the world when it comes to supporting its industry.** In 2019, its industrial policy expenditure of 1.73% of GDP was 2.5 times the next largest country, South Korea, over 3 times that of France, and over 4 times both Germany and the US (Figure 2).<sup>5</sup>

Even so, 1.73% is a conservative estimate according to research by the Center for Strategic and International Studies (CSIS). Climate-related sectors including automobiles, energy, and technology all feature prominently in this aggregate number.

Figure 2 Industrial policy spending in selected economies and subsidy type, % of GDP



Source: Center for Strategic and International Studies

**When it comes to clean energy investment, China is in a league of its own.** When accounting for public and private investment, BNEF estimates that in 2021 China was the largest low carbon technology investor in the world at \$266 billion which equals 35% of global expenditure.<sup>6</sup> These figures are up from the \$135 billion and 27% respectively in 2020.

The 2021 numbers are more than double and 5x the next two spenders, the US and Germany at \$114 billion and \$47 billion respectively.

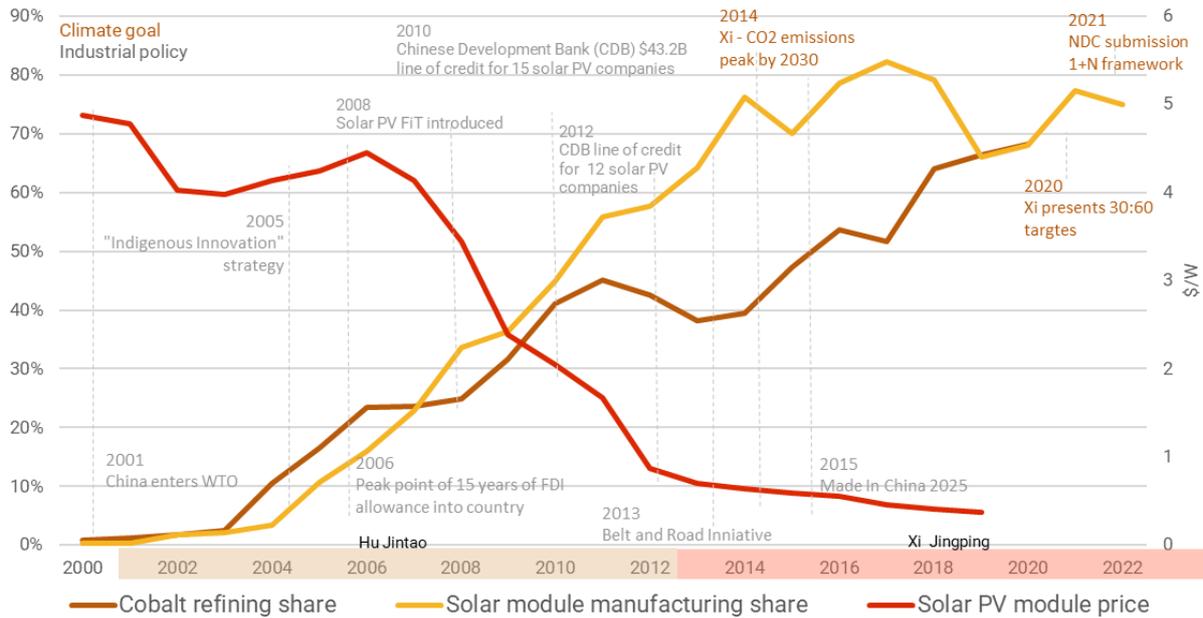
**Climate-related materials and manufacturing features prominently in Chinese industrial policy design.** We can see in Figure 3 that China’s global share of solar manufacturing and cobalt refining rose from non-existent to around 2/3rds presently (cobalt is an essential but limited mineral needed for batteries).

Concurrently, manufacturing at massive scale led to a 90% fall in the price of solar, most of which occurred after China took subsidy leadership from Germany after the global financial crisis of 2008-09. This forced dozens of companies in the US and EU out of business, unable to compete with Chinese pricing and scale. By 2017, the last major German solar producer declared bankruptcy, priced out by imports from China.

<sup>5</sup> DiPippo et al. (2022) Red Ink Estimating Chinese Industrial Policy Spending in Comparative Perspective. Center for Strategic and International Studies. Available at: [link](#)

<sup>6</sup> BNEF (2022) China Is the Growth Engine of World’s Low-Carbon Spending. Available at: [link](#)

Figure 3 China becomes the low-cost machine of decarbonisation through its policy choices.



Source: CREA, US Geological Survey, Lazard, IEA, Statista, Earth Policy Institute and China as an innovation nation by Zhou et al

This industrial strategy for clean technology has led to the current environment whereby Chinese companies dominate the global solar and CRM refining markets. Chinese companies also have a growing grip on the offshore wind and EV/battery markets and are very strong in certain types of hydrogen electrolyzers. Figure 4 shows this dominance continuum along with other sectors.

Figure 4 Degrees of Chinese dominances in selected green sectors



Source: Kaya Advisory

Figure 5 shows that as solar module production in China has exploded, so too has the amount exported abroad. In 2022, 35% of solar panels were exported. Planned investments would triple production capacity by 2025.<sup>7</sup>

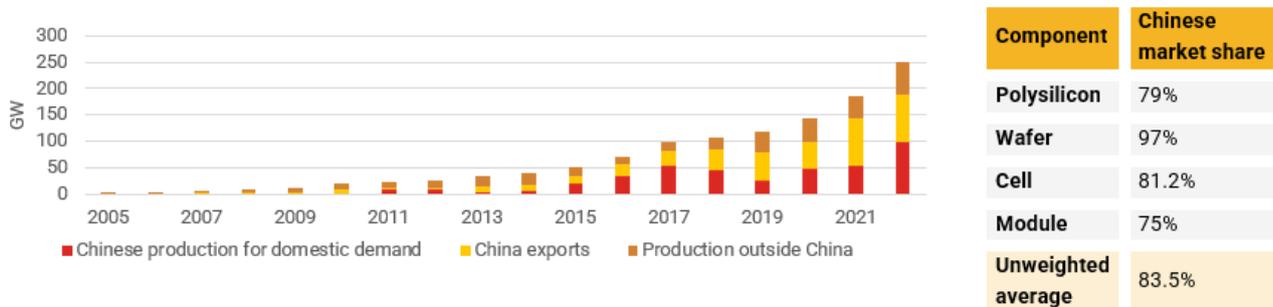
Investors should rightly take heed of forecasts that involve China theoretically being able to supply all solar panels required for global decarbonisation in line with a 1.5°C target.<sup>8</sup>

<sup>7</sup> CREA.

<sup>8</sup> IEA Net Zero Scenario, 650GW/annum during 2030-2035 after which the annual capacity additions are predicted to decline.

Our assertion is that other countries will not allow this. Incentive structures, legislation, and trade agreements feeding into new supply chains are being constructed now which will ensure more global participation in this market (more below).

Figure 5 China manufactures the majority of global solar capacity, both for domestic use and export

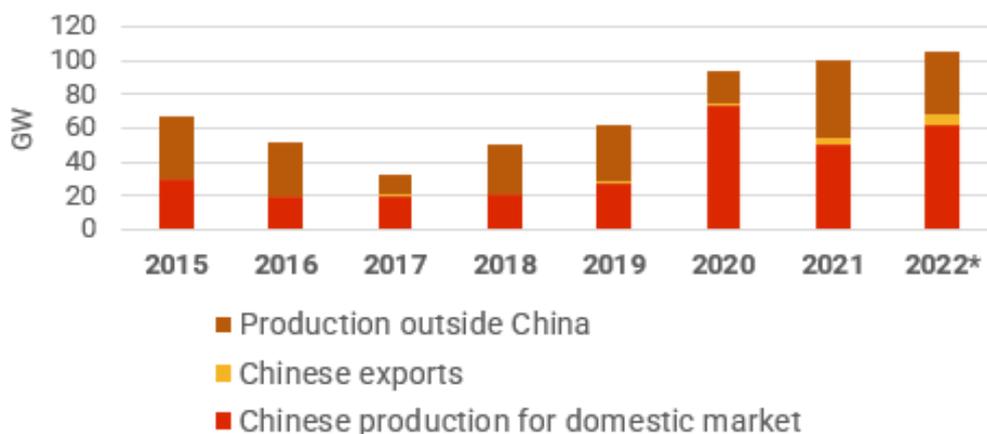


Note: 2022 figure is an estimate by CREA  
 Source: CREA, Earth Policy Institute, and IEA<sup>9</sup>

Chinese mass production of offshore wind turbines has given domestic manufacturers a significant cost advantage but it’s a more domestic market than solar (for the moment). Figure 6a shows that less than 10% of Chinese turbines are exported currently.

But with Chinese wind turbines costing less than half of the global average (Figure 6b), it would not surprise us to see Chinese wind companies expand aggressively abroad to capture market share with margins to spare. This is starting already: over 3 GW was exported in 2021, up from less than 1 GW in 2018. Chinese wind turbine producer MingYang has plans to build a manufacturing facility in the UK.

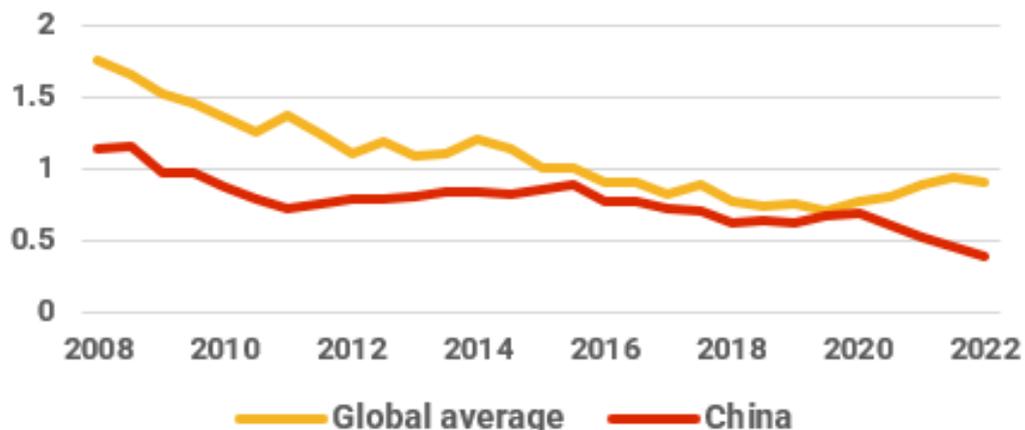
Figure 6a Global wind turbine production include on-and-offshore



Note: 2022 figure is an estimate by CREA  
 Source: BNEF; CREA and IEEFA

<sup>9</sup> The division of Chinese production between exports and production for domestic demand for 2011-2015 assumes that 100% of Chinese installation that year are from Chinese production that year.

Figure 6b Offshore wind turbine price (\$/MW)



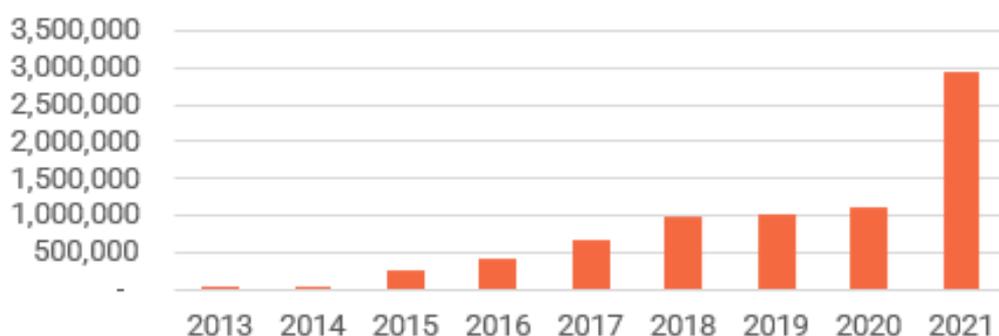
Note: 2022 figure is an estimate by CREA  
 Source: BNEF, CREA and IEEFA

The global *onshore* wind turbine market, in comparison, is more fragmented. More companies operate with smaller market shares and higher geographical dispersion (Appendix 3a). Notably, it is the offshore market that is expected to see the bulk of future growth.<sup>10</sup>

**China is on course to dominate EV production globally, something that would be a major coup against established auto industries in the US and EU.** China is already leading in EV domestic offtake (Figure 7a), battery manufacturing and recycling of batteries.

EVs and battery storage are highly dependent on CRM, accounting for half the mineral demand growth from clean energy technologies. China already dominates global battery production (Figure 7b).

Figure 7a EV production in China

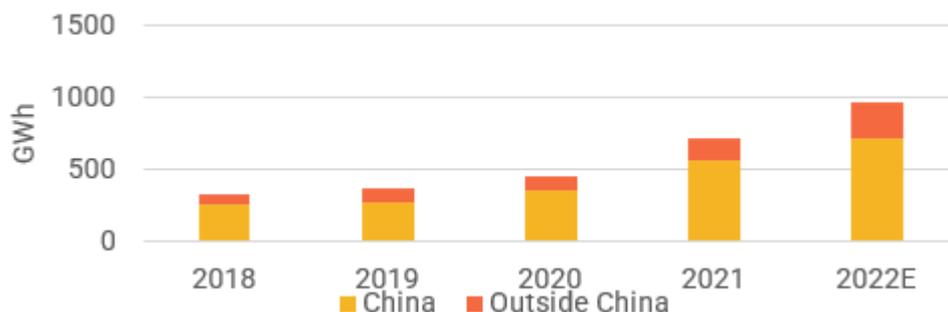


Source: Statista and S&P Global Market Intelligence<sup>11</sup>

<sup>10</sup> Office of Energy Efficiency and Renewable Energy (2021). Top Trends in Offshore Wind Available at: [link](#)

<sup>11</sup> Statista (2022) Annual production volume of new energy vehicles in China from 2013 to 2021, by type. Available at: [link](#) and Yu A. and Sumangil M. (2021) Top electric vehicle markets dominate lithium-ion battery capacity growth. Available at: [link](#)

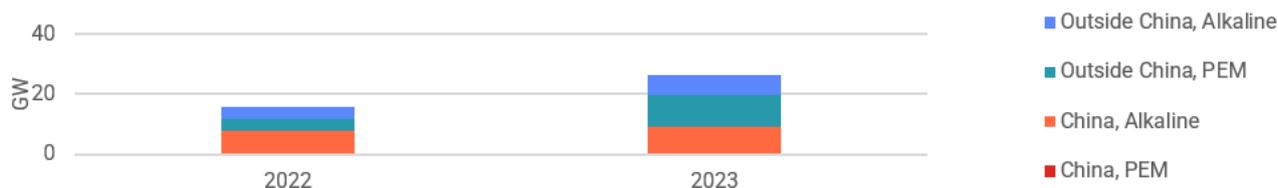
Figure 7b Lithium-ion battery manufacturing capacity by region



Source: Statista and S&P Global Market Intelligence<sup>12</sup>

From a technology perspective, China is strong in a type of electrolyzers, alkaline, which is a mature technology that can be mass produced at a lower cost in China than in the West (Figure 8).<sup>13</sup> China does not dominate in polymer electrolyte membrane (PEM) technology which is more efficient when dealing with variable renewable electricity but needs more R&D to be commercially viable.

Figure 8 Electrolyser manufacturing capacity



Source: BNEF<sup>14</sup>

**China has a strong grip on CRM and critical green technology components.** Other notable bottle neck is in the most efficient permanent magnets used in wind turbines. China dominates both the manufacturing and mining of key minerals. For CRM bottleneck by technology see Appendix 3b.

**China dominates global CRM refining, an industry the west has traditionally been happy to outsource to China given its environmental impact.** Figure 9a shows the increase in refining for copper and cobalt.

China also controls actual mining for most of the world’s ‘rare earths and lithium but still has to import most unrefined minerals (Figure 9b).

China recognises its reliance on imports and the government published strategy to limit this dependency in January 2023.<sup>15</sup>

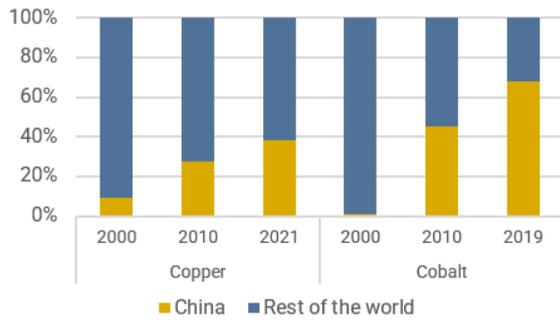
<sup>12</sup> Statista (2022) Annual production volume of new energy vehicles in China from 2013 to 2021, by type. Available at: [link](#) and Yu A. and Sumangil M. (2021) Top electric vehicle markets dominate lithium-ion battery capacity growth. Available at: [link](#)

<sup>13</sup> Alkaline electrolyser uses an alkaline electrolyte solution to separate hydrogen atoms from oxygen. Polymer electrolyte membrane (PEM) electrolysis uses a solid polymer member to conduct the electrolysis of water.

<sup>14</sup> BNEF (2022) A Breakneck Growth Pivot Nears for Green Hydrogen. Available at: [link](#)

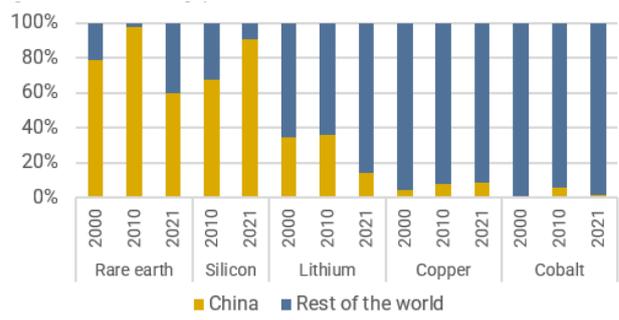
<sup>15</sup> People.cn (2023) 权威访谈·“强信心·抓落实” | 激发要素活力·释放发展潜力——访自然资源部部长王广华 Available at: [link](#)

Figure 9a Refining capacity



Source: US Geological Survey, IEA

Figure 9b Mining production



Source: US Geological Survey, IEA

## 3 The West awakens

### 3.1 The US

*“... the bill I’m about to sign is not just about today, it’s about tomorrow. It’s about delivering progress and prosperity to American families. It’s about showing the American people that democracy still works...”<sup>16</sup>*

*- President Biden at signing of H.R. 5376, The Inflation Reduction Act, August 2022*

These comments, near the beginning of President Biden’s speech upon signing of the IRA, reveal a primary motive for its construction: to preserve democracy in America. Such was the impact of January 6<sup>th</sup>, 2021, upon Democrats that addressing the root cause of dissatisfaction amongst conservative segments of the population became a lodestone mission. Measures to address this target suppression of inflation and creation of jobs for the middle class in disaffected (conservative) regions.

Clean energy, already one of the fastest growing job segments in the country, is seen as an area that could be turbo charged via industrial policy.<sup>17</sup> Between now and 2030, 8 million new jobs will be created globally in clean energy manufacturing.<sup>18</sup> President Biden wants as many of these as he can get to be in the US. Pundits are catching on to this theme: “President Joe Biden is working to create a manufacturing revival — even helping to put factory jobs in Republican territory under the belief it can restore faith in U.S. democracy”.<sup>19</sup>

The *Inflation Reduction Act*, together with the *Infrastructure and Investment Jobs Act* and *CHIPS and Science Act*, now form an American industrial policy with two sectors at the core: clean energy and digital technology.

For climate alone, the amount of public money on offer to private industry is ~\$1 trillion over 10 years. The total cost may eventually be much greater given the unfunded nature of the tax incentives. Kaya has [extensively covered](#) this subject in an October 2022 report for IPR *The US discovers its climate policy: A holistic assessment & implications*.

US industrial policy action differs from other western regimes in its scale, scope, protectionist elements and alignment with trade agreements.

**Scale:** open-ended subsidies and tax credits to *global* firms (meeting certain requirements) to manufacture in the domestic US and then export. If ‘successful’, the ultimate cost of the plan could be in the trillions.

**Scope:** tax credits evolve to be technology ‘agnostic’, encompassing a range of nascent industries from carbon capture and storage (CCS) to hydrogen and biofuels.

<sup>16</sup> The White House (2022) Remarks by President Biden at Signing of H.R. 5376, The Inflation Reduction Act of 2022. Available at: [link](#)

<sup>17</sup> E2 (2022) Clean Jobs America 2022. Available at: <https://e2.org/wp-content/uploads/2022/08/E2-FS-2022-Clean-Jobs-America.pdf>

<sup>18</sup> IEA (2023) Energy Technology Perspectives 2023. Available at: [link](#)

<sup>19</sup> US News (2022) Can Biden Save Democracy One US Factory Job at a Time? Available at: [link](#)

**Protectionism:** domestic content requirements for EVs and batteries, or requirements that these components come from countries in a ‘free trade agreement’ with the US. These measures are designed to create jobs in the US rather than specifically support US firms. Content from ‘friendly’ countries can also qualify. So, it can be argued this is a form of *selectively inclusive protectionism*. Bearing this out, the Director of the National Economic Council (NEC) Brian Deese, stated on October, 2022<sup>20</sup> that the target beneficiary of America’s new industrial strategy is not America’s firms but rather its citizens:

*“[the US industrial strategy is designed] in a way that picks only one winner: the productivity, opportunity, and standard of living of the American people.”*

**Trade alignment to build supply chains with friendly neighbours:** is evidenced by clarification of free trade agreements in White House ‘white papers’.<sup>21</sup> These papers spell out how countries and private actors – not just American - can benefit from US support and the prospect of new supply chains being built.

**The US administration is prepared for pushback from trading partners:** The EU and South Korea have already complained that domestic content requirements for EVs violate WTO rules.<sup>22</sup> Jake Sullivan, the head of the National Security Council (NSC), delivered his answer to this criticism in a conversation with the Carnegie Endowment.<sup>23</sup> Paraphrasing, he said that clean energy will create a positive spill over around the world and that developing a new clean energy innovation cycle helps everyone, everywhere.

In the same speech, Mr Sullivan goes on to describe **three key themes for the Biden Administration in the second half of his presidency:**

1. Closer cooperation between the NSC and the NEC, to work together to join the two narratives of foreign and domestic policy. Key new industries to be built (in clean energy) to support the American middle class.
2. Supply chains. Building strong, resilient, and diversified supply chains to supply what the US needs to grow and avoid coercion from adversaries.
3. Set rules of the road for creating broader, inclusive growth around the world. The Indo-Pacific Economic Framework for Prosperity (IPEF), the G7 Partnership for Global Infrastructure and Investment are examples of this. (Kaya anticipates Multilateral Development Bank (MDB) reform could, finally, also feature as a robust new framework for climate capital).

**Anti-China views have bipartisan support in Congress, indicating America’s slightly protectionist trade and industrial policy agenda has staying power beyond Biden.** It is also the case that this industrial policy is legislated and would require bipartisan support to overturn.

**The Biden administration is undeterred by exhortations that a subsidy race will have no winners.** Director Deese continued in his speech:

*“Some have raised a valid concern that countries may keep one-upping each other on ever-larger industrial subsidies, reducing their efficiency. But the investments we’re making will pay enormous global dividends in expanding supply, speeding adoption, and driving down costs”.*<sup>24</sup>

---

<sup>20</sup> The White House (2022) Remarks on Executing a Modern American Industrial Strategy by NEC Director Brian Deese. Available at: [link](#)

<sup>21</sup> US Department of the treasury (2022) Anticipated Direction of Forthcoming Proposed Guidance on Critical Mineral and Battery Component Value Calculations for the New Clean Vehicle Credit. Available at: [link](#)

<sup>22</sup> Chalmers J. and Jin H. (2022) EU, South Korea say U.S. plan for EV tax breaks may breach WTO rules. Available at: <https://www.reuters.com/business/autos-transportation/eu-says-us-plan-ev-tax-breaks-discriminatory-may-breach-wto-rules-2022-08-11/>

<sup>23</sup> Carnegie Endowment (2022) A Conversation with National Security Adviser Jake Sullivan Available at: [link](#)

<sup>24</sup> The White House (2022) Remarks on Executing a Modern American Industrial Strategy by NEC Director Brian Deese. Available at: [link](#)

Director Deese also delivered a message to other nations that they, too, are welcome to adopt their own preferential strategies as long as the efforts are targeted in specific sectors - notably climate - and in areas where there is little present threat of overcapacity:

*“...for industries like semiconductors and clean energy, we’re nowhere near the global saturation point of needed investments. We should welcome actions by most countries if they’re structured fairly and scaled appropriately.”<sup>25</sup>*

**A near-term caveat to this seemingly unassailable march of industrial policy enactment is a real threat of a government shutdown in 2023.** This is a possibility given that ultra-conservative elements in the Republican wing have exacted powerful concessions from Kevin McCarthy, the new Speaker of the House. Three members of the House Freedom Caucus now sit on the Rules Committee and could compel Speaker McCarthy to keep the debt ceiling issue from coming to the floor or include spending cut provisions.<sup>26</sup>

Since the ensuing shutdown of government would result in a potential credit downgrade of US government debt and kill spending for *all* programs (not just the IRA), we think this situation will be resolved similar to previous occasions.

**In sum, the IRA’s construction gives it staying power and is likely to initiate a chain reaction whereby nations are encouraged to ramp up climate-related industry, ambition, and subsidies. The key for investment markets is that this does not end up in oversupply and a full trade war.**

The US is using another prong in its strategy to rebuild supply chains which exclude China, namely legislation aimed to prevent products made in Xinjiang or with forced labour to enter the US.<sup>27</sup> Xinjiang produces about 45% of the world's supply of the key component, polysilicon, for solar panels.

**Addressing security of CRM supplies is a top 5, if not top 3 issue, of the US administration.** Such is the need over the next decades for CRM, and such is China’s dominance of the sector, that US policy action is likely to step up multiple gears. Some reporting of these measures focuses on what *should* be done, including streamlining of permitting processes, use of the Defence Production Act, and regulating markets.

Kaya views all of these as reasonable and potentially likely directions.<sup>28</sup>

**Kaya watches for the US administration to go even deeper to address bottlenecks in CRM.** Possible avenues of policy assistance include:

- guaranteeing offtake agreements for miners
- establishing a ‘Strategic Mineral Reserve’ similar to the petroleum reserve established in 1975 and/or
- setting prices on specific minerals to de-risk cash flows
- using the Development Finance Corporation (DFC) and other entities to provide finance for mining
- writing of statutes to deal with problematic ‘minority rights’ issues for investors
- enhancing trade agreements

---

<sup>25</sup> ibid

<sup>26</sup> Armstrong R. (2023) The debt ceiling is scarier this time. Financial Times. Available at: [link](#)

<sup>27</sup> BBC (2021) China uses Uyghur forced labour to make solar panels, says report. Available at: [link](#)

<sup>28</sup> Bazilian M. and Brew G. (2023) The Missing Minerals: To Shift to Clean Energy, America Must Rethink Supply Chains. Foreign Affairs. Available at: [link](#)

## 3.2 The EU

*“We need to give our answer, our European IRA”<sup>29</sup>*

- EU Commission President Ursula von der Leyen at the European Council meeting, December 2022

The EU has been fighting a rear-guard action against the economic volatility caused by the Russia-Ukraine War and high energy prices. While it has moved to reduce reliance on Russian energy and subsidised both industry and individuals against crippling energy prices, it has not positioned itself to defend against the threat of the IRA.

As a result, industry in Europe is at more risk than ever of leaking to the US given the higher cost of energy in the bloc and the enormous subsidies on offer by the IRA.

The EU needs a response to compete with unabashed subsidy regimes from both of its primary trading partners, the US and China, but its tools are not fit for purpose. For one, existing fiscal capacity is limited and mostly controlled by member states. Open-ended tax incentives at bloc level are not on the table because, at its heart, there can be ‘no IRA without the IRS’ (the IRS is the US federal tax collector).

That is to say that the US can deliver tax packages at the federal level without constraint whereas the EU as a whole cannot. Also, competition policy is crafted in the EU to establish a level playing field and preserve the EU single market. Supporting corporate actors in some states rather than others runs counter to this founding principle.<sup>30</sup>

### How is the EU responding?

The European Green Deal offers the largest pool of funding for climate and green industry, €1 trillion between 2021-2030.<sup>31</sup> €503bn was originally dedicated from the EU budget under various funds, the rest must come from private investors. A proposal has also been put forward to re-allocate €210bn of unused funds from the Recovery and Resilience Fund (created for Covid19 recovery) to the green transition.

The Important Projects of Common European Interest (IPCEI) program is expanding. IPCEIs provide cross-border innovation and infrastructure funding for projects such as semiconductors and hydrogen. In 2022, the first two of four IPCEIs for hydrogen were approved, freeing up nearly 11bn EUR. Between 2007 and 2021, just 3 IPCEI projects were approved in total.

Figure 10 shows funding from EU level and select member states. These numbers are evolving and causing tension within the bloc.<sup>32</sup>

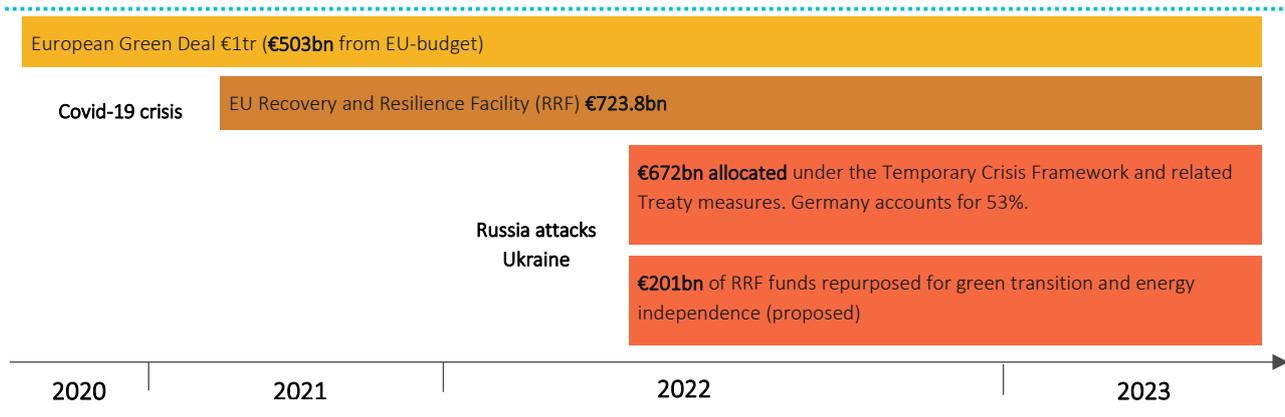
<sup>29</sup> European Commission (2022) Speech by President von der Leyen at the European Parliament Plenary on the preparation of the European Council meeting of 15 December 2022. Available at: [link](#)

<sup>30</sup> This trade category includes diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices (including photovoltaic cells, whether or not assembled in modules or made up into panels); light-emitting diodes

<sup>31</sup> The European Green Deal was introduced to help the reduction of GHG emissions by 55% compared to 1990 by 2030 and to reach net-zero by 2050

<sup>32</sup> Lynch S. and Von Der Burchard H. (2022) Scholz’s ‘Germany First’ energy plan fires Franco-Italian revolt in Brussels. Available at: [link](#)

Figure 10 EU funding and select member state aid <sup>33</sup>



Source: Kaya Advisory

In addition to funding, the EU has adopted softer measures to deal with the energy crisis. These include a ‘Temporary Crisis Framework’ (TCF) allowing member states to use full flexibility of EU state aid rules and equally temporary policies to accelerate permitting. Member states are chipping in; Germany is rolling out its ‘Easter Package’ to accelerate construction of renewables.

2023 will mark the moment the EU must get serious on using industrial policy as a major tool to promote European clean energy. Subsidies to industry will feature more systematically, which brings up an intriguing interaction with the EU’s principal mechanism to reach its own climate goals, the Carbon Border Adjustment Mechanism (CBAM). See Box 1.

Systematic support for clean energy will be required because ad hoc measures designed to cushion industry and households from energy price shocks are not comparable to the IRA. The IRA legislates a clear, long term roadmap for open-ended financial support and does so specifically for clean energy and from the federal level.

The chain reaction is starting. In her December speech, Commission President von der Leyen agreed, calling for (i) adjusting of state aid rules, (ii) boosting of EU public investment for the energy transition, (iii) stepping up of the renewable deployment, and (iv) working together with the US administration. EU competition chief Margrethe Vestager called for a new state aid framework to prevent EU businesses from “moving investments to the US”.<sup>34</sup>

A new Net-Zero Industry Act (NZIA), announced on Jan 17<sup>th</sup>, 2023, in Davos is a significant step towards systematically addressing the IRA. The stated intent initially is “... to simplify and fast-track permitting for new clean tech production sites...”, with an “aim...to focus investment on strategic projects along the entire supply chain.”<sup>35</sup> This means more vertical integration. The Commission sees particular threats from the US and China on batteries, solar, and CRM but is less threatened in hydrogen, wind, and electricity generation.

The NZIA falls under a broader umbrella of the Green Deal Industrial Plan which finally recognizes industry needs to be supported rather than regulated and taxed.

<sup>33</sup> Sgaravatti G. (2022) National fiscal policy responses to the energy crisis. Bruegel. Available at: [link](#)

<sup>34</sup> Stolton S. (2023) Vestager proposes ‘urgent’ state aid reforms to keep business in EU. PoliticoPro. Available at: [link](#)

<sup>35</sup> Stolton S. (2023) Von der Leyen announces Net-Zero Industry Act to compete with US subsidy spree. PoliticoPro. Available at: [link](#)

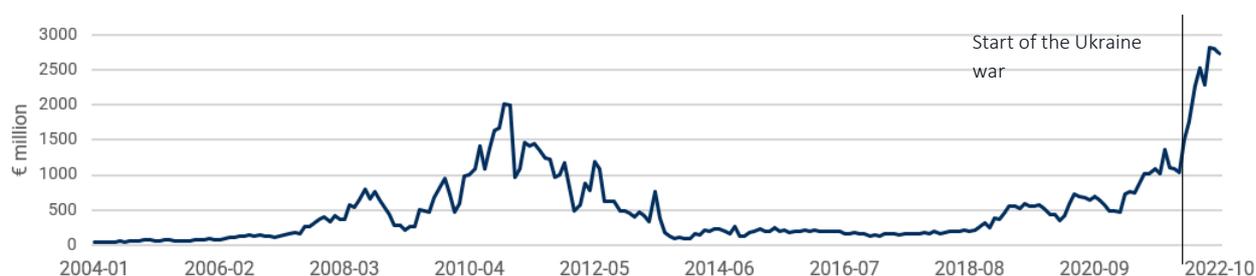
**Kaya forecasts the use of new, common debt to support clean energy and the transition.** A new European Sovereignty Fund is being established as the possible vehicle for this. More substantial movement on this likely later in 2023 under the Spanish Presidency of the Council as opposed to the first half of the year when the (traditionally frugal) Swedish are at the helm. This view is given tailwind by Internal Market Commissioner Thierry Breton visiting European capitals campaigning for:

*“...a coordinated response both with horizontal legislation that responds to the U.S. Inflation Reduction Act, a bit like we did with the Chips Act — but this time for a European IRA...”<sup>36</sup>*

**Influential member states are listening.** The French have announced a new bill to support green industries in reaction to the IRA. Le Maire, the French Economy Minister, stated that these measures are additional to the German and French agenda to adopt “a European Inflation Reduction Act”.<sup>37</sup>

**The EU has a robust relationship with China when it comes to clean energy. Its dependence on solar imports from China is well known.** Figure 11 reveals an explosion in solar cell imports from China since the start of the Russia-Ukraine War.

Figure 11 EU imports of solar cells from China



Source: Eurostat (2022)<sup>38</sup>

The EU’s relationship with China is also complicated and in the process of being tested given Beijing’s association with Putin in the aftermath of Russia’s attack on Ukraine. Germany has written white papers which detail a new and potentially more cautious stance toward China. This has elicited a sharp response from Beijing saying such a change “...smells suspiciously of a Cold War mentality.”<sup>39</sup>

#### Box 1 EU CBAM

The EU is attempting to address its own potential trade protectionism related to the CBAM. The CBAM would impose a tariff on imported goods based on a carbon price. Currently, EU industry is being compensated with ‘free allowances’ so it is not disadvantaged by paying the carbon price at present but these allowances are scheduled to be phased out.

On paper, the CBAM is the solution for establishing a fair level playing field while ensuring EU heavy industry also becomes greener.

In reality it entails so many hurdles, such as bureaucratic challenges and risks of retaliation from trade partners, that the policy may require heavy amendment.

<sup>36</sup> Hanock E. (2023) Fair Play: Breton’s industrial policy push – State aid pushback – Labor shortages. PoliticoPro. Available at: [link](#)

<sup>37</sup> Caulcutt C. (2023) France’s Le Maire announces package to boost reshoring of green industries. PoliticoPro. Available at: [link](#)

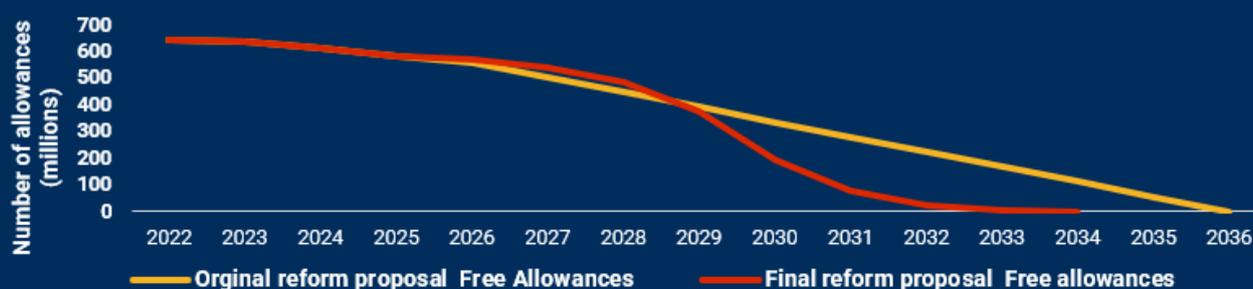
<sup>38</sup> Includes: Diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices (including photovoltaic cells, whether or not assembled in modules or made up into panels). Eurostat (2022) Available at: [link](#)

<sup>39</sup> Heide D. and Sigmund T. (2023) Chinas Botschafter in Berlin Wu Ken: „Mentalität des Kalten Krieges“. Handelsblatt. Available at: [link](#)

This is because the phase out of free allowances to EU industry, which remains the prerequisite for the CBAM introduction, would increase the already substantial threat of large segments of European industry leaking to the US. It continues to be our view that the CBAM will never be *fully* implemented as currently envisaged.

The final agreement on CBAM, in December 2022, introduced a number of safeguards which leave room for the phase out of free allowances to occur more slowly at the start. This reflects the reality of EU industry already being financially threatened by both high energy prices and the IRA. Rather than phasing out free allowances in a linear trajectory of 10% per year, only 2.5% and 5% respectively will be removed in 2026 and 2027 when the changes come into effect – albeit then with a significantly speedier phaseout from 2029 (Figure 12). This extra “window of time” provides enough leeway for the Commission and co-legislators to re-assess the situation again in 2025 before the changes are supposed to kick in, with a stocktaking exercise already mandated in 2025 to assess the situation.

Figure 12 Final agreement on EU heavy industry free allowance phase out, slower at start but sees a steeper and sooner end



Source: EU (2022)<sup>40</sup>

The CBAM will remain a powerful negotiation tool for the bloc when it comes to facilitating decarbonisation of ‘hard-to-abate’ sectors in other countries.

When it comes to CRM, the EU must also urgently address its needs but in a way that does not leave it exposed to geopolitical shifts. Commission President Ursula von der Leyen has announced the intent to identify strategic projects all along the supply chain – from extraction to recycling - to “avoid becoming dependent again, as [the EU] did with oil and gas.” The EU is only seeking to meet up to 30% of the bloc’s critical mineral demand with domestic production and recycling. The concept of ‘smart mining’ will feature more.

A large part of the EU CRM strategy will target imports. Some agreements will be purely offtake agreements, such as the EU-Chile trade agreement that allows the EU undistorted access to Chile’s lithium, copper, and other mineral deposits. Others, such as those initiated at COP27 with Namibia and Kazakhstan, will hinge on the EU providing funds and technology to build up mining operations. Recent discoveries of rare earths in Sweden are also encouraging.<sup>41</sup>

<sup>40</sup> European Parliament (2022) Climate change: Deal on a more ambitious Emissions Trading System (ETS). Available at: [link](#) and European Commission (2022) ETS Market Stability Reserve to reduce auction volume by over 347 million allowances between September 2022 and August 2023 (update) Available at: [link](#)

<sup>41</sup> Zimmermann A. (2023) Mining firm: Europe’s largest, rare earths deposit found in Sweden. PoliticoPro. Available at: [link](#)

## 4 Diversifying supply chains – multilateral action cooperation on clean energy

*“...carbon intensity should be a factor in trade agreements, and I think that intersection, that tool, will become increasingly relevant as we go forward...”*

*US National Security Advisor Jake Sullivan, Council on Foreign Relations, December 2021*

The west is engaged in a plethora of bi - and multilateral initiatives which specifically exclude China and serve as vehicles for cooperation on supply chains of climate-relevant materials and decarbonisation.

The Minerals Security Partnership (MSP) was established in June 2022 to build CRM supply chains outside of Chinese influence. The MSP has 11 members: Australia (Box 2), Canada, Finland, France, Germany, Japan, the Republic of Korea, Sweden, the United Kingdom, the United States, and the European Commission. It is intended to support the build out of robust, responsible critical mineral supply chains and ensure mutual economic benefit among partner countries. The MSP aims explicitly to boost investment for strategic critical mineral projects that adhere to the high ESG standards, something China does not offer.

### Box 2 Australia – important to both Chinese and ex-Chinese CRM supply chains

According to government analysis, Australia is “well placed to be a leading supplier of critical minerals and crucial rare earths elements”.<sup>42</sup> Australia’s Critical Minerals Strategy 2022 outlines funding under the Modern Manufacturing Initiative (MMI) to ramp up lithium, cobalt, and rare earth refining capacity to ease bottlenecks where China dominates. Australia has some of the largest deposits of CRM and lithium and is so well positioned for increased refining.<sup>43</sup> It is already the world’s largest exporter of lithium. For mining and refining data by country see Appendix 3b.

Australia will play a key role in new CRM supply chains. The US has moved to reassure its friends that they can also benefit from parts of the IRA. It’s recently issued ‘white paper’ clarifies that Australia is in a free trade agreement with the US and its CRMs used EV batteries are eligible for the tax rebates under the IRA.<sup>44</sup>

China is massive importer of Australian CRM as well. China bought 90% of Australia’s lithium production in 2022<sup>45</sup> and Chinese Tianqi Lithium and Australian IGO announced a \$1.4 bn joint venture for lithium production in 2020.<sup>46</sup>

Climate finance, in the sense of directing funding from developed to developing markets, has a new China ‘free’ vehicle called the Just Energy Transition Partnership (JETP). JETP’s are multinational decarbonisation vehicles designed to deliver a just transition. There are three JETP’s so far, South Africa, Indonesia, and Vietnam. Although two of these have been announced at COP venues (South African and Indonesia), we note these multi-national initiatives are occurring independent from the UNFCCC process.

<sup>42</sup> Department of Industry, Science, Energy and Resources. (2021) Outlook for selected critical minerals in Australia: 2021. Available at: [link](#)

<sup>43</sup> Department of Industry, Science, Energy and Resources. (2022) 2022 Critical minerals strategy. Available at: [link](#)

<sup>44</sup> US Department of Treasury (2022) Anticipated Direction of Forthcoming Proposed Guidance on Critical Mineral and Battery Component Value Calculations for the New Clean Vehicle Credit. Available at: [link](#)

<sup>45</sup>Wong K. (2023) China-Australia lithium tie-up highlights symbiotic bond, ‘mutual respect’ amid green energy drive. Available at: [link](#)

<sup>46</sup> ibid

The conceptualisation of ‘climate clubs’, as championed by Olaf Scholz, Chancellor of Germany, continue.<sup>47</sup> These clubs are also outside of the UNFCCC process and are being designed by G7 countries, away from China. It is not that China is not welcome, but the rules are being made with its existing dominance in mind.

Chancellor Scholz said the aim of these clubs is to contribute to raising climate action globally by facilitating a near zero emission industrial production transition.<sup>48</sup> We have [written on this topic before](#) in a May 2002 report for IPR *Global Carbon Pricing: Assessing the potential of the EU CBAM and Climate Clubs*.

**A bilateral precursor to this club can be seen in the EU-US steel and aluminium agreement which is designed to facilitate trade in this hard-to-abate sector around carbon content.** It is also designed to prevent ‘dirty steel’ from China and other locations.<sup>49</sup> This vehicle sets a precedent for the alignment of carbon intensity with trade. Jake Sullivan made this clear:

*“a tool that becomes increasingly important is the U.S. and the EU reached agreement to negotiate the first ever sector-based agreement on carbon relating to steel, which accounts for 10 percent of emissions, and the **basic idea being that carbon intensity should be a factor in trade agreements, and I think that intersection, that tool, will become increasingly relevant as we go forward** and should have an impact on those countries that are still calculating whether they’re prepared to put forward a nationally-determined contribution that meets the needs that the planet faces.”<sup>50</sup>*

---

<sup>47</sup> Kurmayer N. (2022) Green industry: G7 sets out terms for global ‘climate club’. Euractiv. Available at: [link](#)

<sup>48</sup> ibid

<sup>49</sup> Lawder D. (2022) U.S. floats new steel, aluminum tariffs based on carbon emissions. Reuters. Available at: [link](#)

<sup>50</sup> Council on Foreign Relation (2021) A conversation with Jake Sullivan. Available at: [link](#)

## 5 China’s climate goals and policies to meet them

Much excellent work has been written on China’s climate progress and the purpose of this section is not to exhaustively analyse such a complicated issue. Instead, we make a few points we view as interesting and relevant.

In October 2021, just before COP26, China announced enhanced climate pledges. These pledges included four quantitative targets (see footnotes) as well as new overarching goals of peaking CO<sub>2</sub> emissions by 2030 and achieving net zero emissions of greenhouse gases by 2060.<sup>51</sup>

At the same time, 2021 marked a new high for China CO<sub>2</sub> emissions, 11.9 Gt CO<sub>2</sub> (12.8 Gt CO<sub>2e</sub>).<sup>52</sup> A recent update on China’s Nationally Determined Contribution (NDC) targets points to decarbonisation progress in *some areas* such as clean energy investments, electrification, building sector emissions, and EV sales.<sup>53</sup> But this progress is overridden by unabated demand growth for energy.

Problematically, China is still expanding its coal capacity. In 2021, China added 25GW of coal power to the grid and started the construction of 33 GW of new coal power. Permitting stalled for new coal power during 2021 but in the first 6 weeks of 2022, 7.3 GW worth of new permits were approved.<sup>54</sup> **Ultimately, solutions to decarbonise the Chinese coal fleet – up to 12% of global emissions and larger the US itself – are key to the climate transition.**

But this might not be as disastrous after a first glance. China is adding capacity due to the power outages during the coal crisis of 2021. Power is needed for the build out of renewables. China has deep pockets as well so new coal plants can potentially be ‘designed’ stranded assets and considered a ‘transition cost’.

Ultimately, it’s a trade-off between costs and security and climate goals. Additional coal is also part of bringing different interest groups in alignment which runs contrary to the general perception that everything happens only with an administrative order.

On the whole, estimates for ‘when China peaks’ are being delayed. Moreover, confusion around the path of emissions create lingering uncertainty around the global target of 1.5°C temperature rise in the Paris Agreement (Box 3). Indeed, China’s position in the Paris Agreement is that it will strive for 2°C rather than 1.5°C.

Negative Emissions Technologies (NETS) and CCS may well have to play an important role as discussed by IPR in several publications.

---

<sup>51</sup> 1) to lower CO<sub>2</sub> emissions per unit of GDP by over 65% from the 2005 level; 2) to increase the share of non-fossil fuels in primary energy consumption to around 25%; and 3) to bring total installed capacity of wind and solar power to over 1200 gigawatts. Additionally, the “1+N” framework was established in 2021 which provides a strategy for the 2060 broad emissions goal (the “1”) and numerous specific goals for the achievement of peak emissions by 2030 (the “N”). Some draft plans under the N+1 framework have suggested peaking before the national 2030 target in their sector. However, in all the final publication all sectors align with the national target of peaking in 2030. Source: [link](#)

<sup>52</sup> IEA (2022) Global energy review. Available at: [link](#)

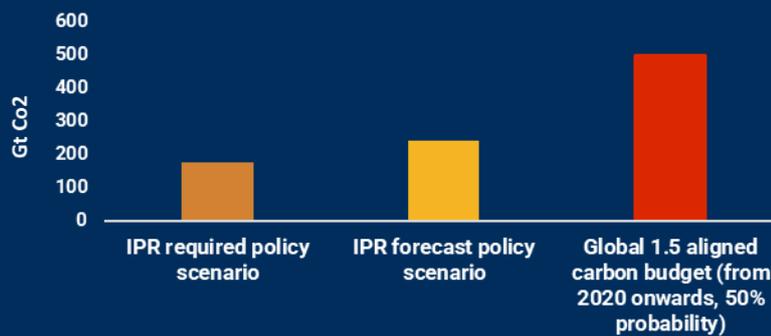
<sup>53</sup> CREA (2022) China’s Climate Transition: Outlook 2022 Available at: [link](#)

<sup>54</sup> Myllyvirta L. (2022) BRIEFING: Most coal power plants since 2016 entered construction in China in 2021, investment in coal-based steelmaking accelerated. Available at: [link](#)

**Box 3 China’s cumulative emissions**

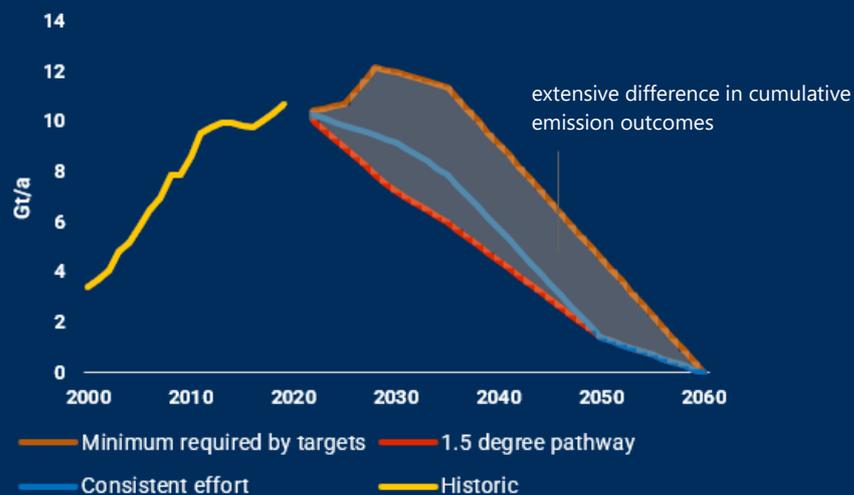
Whether China’s climate targets are 1.5°C aligned depends on the emissions pathway and methodologies used e.g., definition of countries’ ‘fair share’.<sup>55</sup> Such is the flexibility in Chinese pathways under different scenarios, it could simultaneously meet the 30:60 pledge but still wipe out a significant proportion of the remaining global carbon budget for 1.5°C temperature rise by the end of the century (Figure 13). China offers no clarity on how much it will emit before, during, and after the eventual peak. Figure 14 sets this amount next to the emissions necessary for 1.5°C and the remaining carbon budget.

Figure 13 Cumulative emissions under two scenarios and the 1.5 degree carbon budget



Source: IPR and IPCC<sup>56</sup>

Figure 14 Possible emissions pathways for China



Source: CREA<sup>57</sup>

<sup>55</sup> Gabbatiss J. & Tandon A. (2021) In-depth Q&A: What is ‘climate justice’?. Carbon Brief. Available at: [link](#)

<sup>56</sup> IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

<sup>57</sup> Minimum required by targets, 1.5 degree pathway, consistent effort are decarbonisation pathways created by CREA which all align with China’s 30:60 targets. Source: CREA (2022) China’s Climate Transition: Outlook 2022 Available at [link](#)

**The power market reform is the single most important thing China can do, and is doing, to reduce dependence on fossil fuels in the medium to long-term.** This reform would incentivise provinces to share renewable power *between* each other rather than build redundant infrastructure. This would be accomplished through the provision of mid- and long-term contracts initially and spot market trading eventually.

Currently, pilots of power purchase agreements (PPA) are in place which allow corporates to directly participate in green power trading across provinces. If successful, this reform would lead to a reduction in renewable energy ‘curtailment’ whereby wind and solar energy is produced but not used. The reform process started in 2015 and is estimated to have a basic form in place by 2030.

**Clean energy is a bright spot for China’s climate ambitions.** It has already installed twice the amount of solar and wind capacity as the EU and the US combined but its needs are greater still (Figure 1).

**Chinese companies install renewables not only to meet targets but also because it is profitable.** In 2021, power tariffs were allowed to rise by 20% in response to high coal prices. These high coal prices were making coal power plants unprofitable to run and contributing to electricity shortages. This price increase boosted the profitability of renewables substantially given they sell at the same price as coal but have lower running costs.

The demand for renewable electricity is also becoming more entrenched. Provinces have to meet renewable energy consumption targets. Large electricity consumers are also exempted from electricity rationing if they contract green electricity through long-term contracts.

**In contrast to other nations, China is experiencing problems of growth in EV sales being *too fast*.** Limited EV infrastructure, lack of CRM inputs, and grid connectivity are all constraining issues. The Ministry of Industry and Information Technology is actively trying to manage down the domestic demand for EVs to allow domestic manufacturing to catch up.

**Interest in hydrogen has risen as a result of the policy prioritisation: hydrogen was singled out as one of the six industries of focused advancement in the 14<sup>th</sup> FYP and 11 provinces list hydrogen as a priority in their individual 14<sup>th</sup> FYPs.** On the off-take side, in contrast to the EU and the US where hydrogen is aimed at hard-to-abate sectors like steel, the Chinese strategy for hydrogen has transport as a focal point.<sup>58</sup> Also, *Made in China 2025* mentions hydrogen as one of the key technologies for new energy vehicles.

**Currently, China produces roughly a quarter of the world’s current hydrogen (33Mt/a), and it is mostly brown.**<sup>59</sup> Going forward, China aims to produce 100,000-200,000 tonnes of green hydrogen annually by 2025. Electrolyser capacity is growing fast and is expected to increase fivefold during 2022.<sup>60</sup>

<sup>58</sup> Sandalow D. et al. (2022) Guide to Chinese Climate Policy 2022. Oxford Energy Institute. Available at: [link](#)

<sup>59</sup> Brown hydrogen refers to hydrogen produced using coal without CCS.

<sup>60</sup> Bloomberg (2021) China’s Solar Giants Make a Bid to Dominate Hydrogen Power. Available at: [link](#)

## Appendix 1 – Solar PV industry history

### 1970-1990’s – US and Japan

1970’s oil crisis: the US invests in R&D and implements Investment Tax Credits to diversify energy supply. In the 1980’s: Reagan prioritises lower energy prices. R&D funding is cut and PURPA credits stop in 1985. Lacking policy support, the US industry stagnates. Late 1990’s: subsidies for residential installations make Japan the world leader in production and installations.

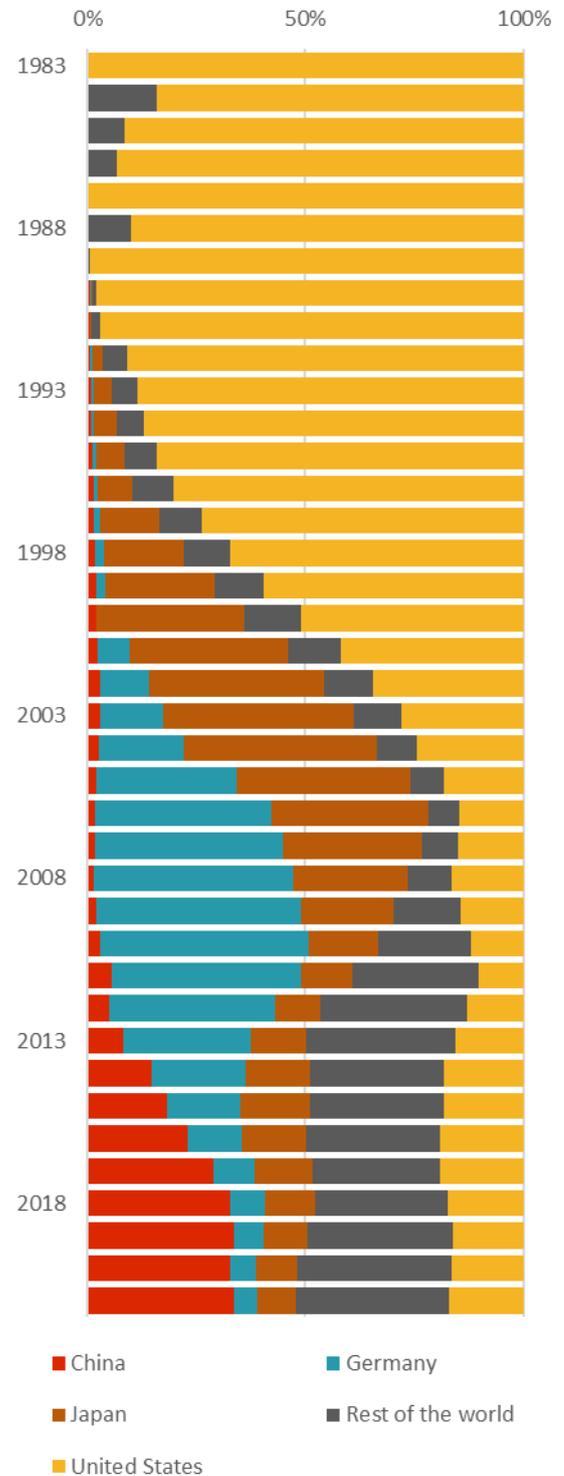
### 2000’s – Japan, Germany, China

In Japan, production declines when the installation subsidies end in 2004. Germany implements a feed-in tariff in 2000 and German industry booms. The Chinese solar industry is born as an export sector to supply Germany demand. First solar panels are exported in 2004. When demand in Europe diminishes due to the 2008 financial crisis, the Chinese government disperses cheap capital to support the industry. Several manufacturers raise western capital through IPOs. In the same year China surpassed Japan and became the largest producer in the world. Global demand picks up around COP15 in 2009. China starts to invest in polysilicon production previously controlled by German, US, and Japanese firms.

### 2010’s – China

Decreasing electricity prices and a decision to lower the feed-in tariffs by the German government in 2013 lead to the bust of the German solar PV industry. In the beginning of the decade manufacturers are making losses. The China Development Bank gives substantial lines of “patient-capital” credit skewing the global competition. Chinese domestic demand grows with the adoption of a feed-in tariff and fixes the electricity prices for solar in 2011. China becomes a world leader in silicon production and companies invest in vertical expansion. Capacity targets are set in 2013. Large scale production in China lead to innovations in production processes and an increase in efficiencies. Ultimately lowering solar panel costs. Solar module prices decrease 81% between 2010-2019.

Figure 15 Power generation from solar (TWh)



Source: Kaya Advisory

## Appendix 2 – Wind industry history

### 1970s – 1990s Denmark, US, Germany & Spain

The modern wind industry is born from the oil crisis. Denmark and US invest in R&D. California offers the most substantial subsidies and becomes a major export market for Danish wind companies. In 1985, subsidies expire. Simultaneously, in Denmark wind and gas are selected over nuclear to become future energy sources. The Danish government sets capacity targets, provides grants, and ensures interconnection and the purchase of power. Lower oil prices stagnate the sector in the US. In Europe feed-in tariff catalyst industry development in Denmark, Germany, and Spain.

### 2000s – Denmark, Germany, US & China

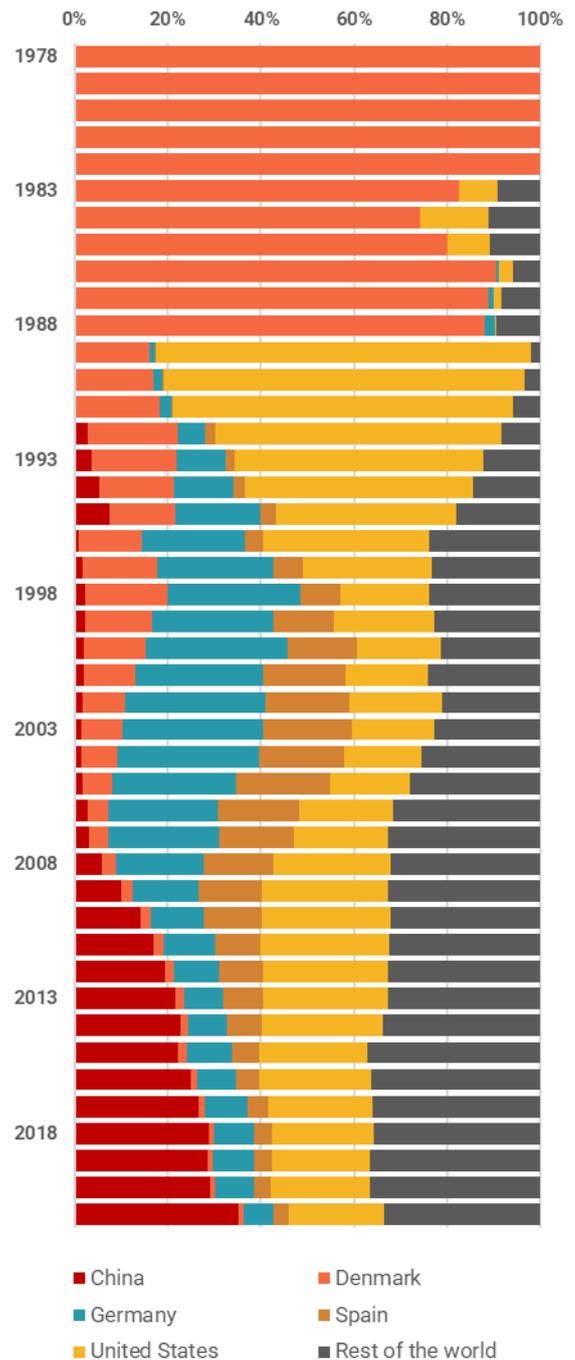
The European industry dominates the market and installation speed grows. The German government updates in feed-in-tariff policy to reflect the industry learning curve in 2002. The Danish industry is strong despite lack of domestic policy support in 2002-2008. The US grows steadily with several cycles of production and investment tax credits (PTC and ITC). In China, the 10<sup>th</sup> FYP introduced the mandatory market share of renewables concept. Local content requirements were set in 2005. Also, in 2005 wind power generation projects and equipment manufactures received a special tax status to promote development. In 2006, the Renewable Energy Law (REL) catalyses the industry in China. It was followed by clear capacity targets in 2007. In 2008, China started to direct tax revenue back to R&D. In 2009 power pricing from wind was standardised and a feed-in tariff set. The local content requirement was removed by the request of the US. However, foreign firms selling to the Chinese market had already established local manufacturing facilities. Moreover, at this point 90% of the Chinese market was controlled by Chinese manufactures.

### 2010s – Denmark, Germany, US & China

Onshore wind becomes the cheapest source of electricity and offshore wind is developed in Europe. China adopts a feed-in tariff for offshore wind in 2014. China becomes the biggest market

in the world by cumulative installation in 2016. EU renewable targets and PTC extension in US support the Western manufactures, but profits start declining in 2016.

Figure 16 Power generation from wind

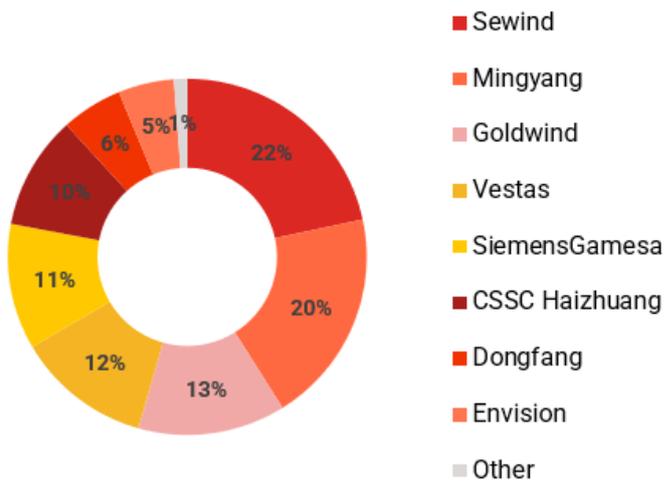


Source: Kaya Advisory

## Appendix 3 – Data on wind turbine market concentration, CRM bottlenecks, global mining

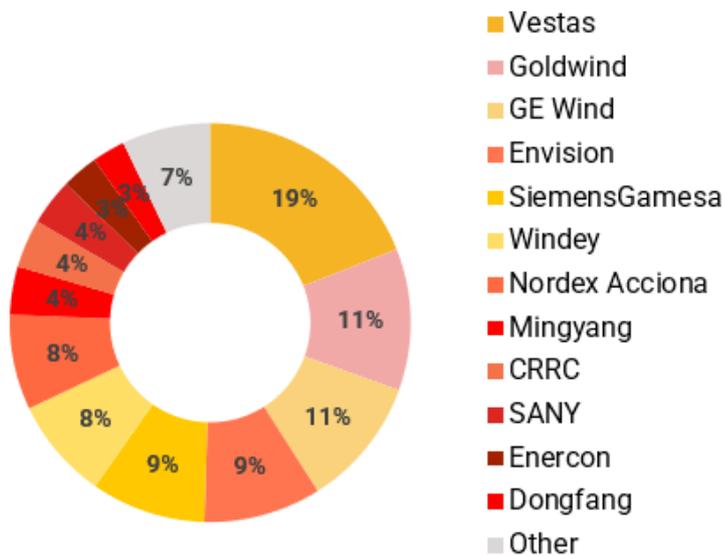
### Appendix 3a – wind turbines

Figure 17 Top offshore wind supplier by installed capacity in 2021



Source: Global Wind Council

Figure 18 Top onshore wind supplier by installed capacity in 2021



Source: Global Wind Council

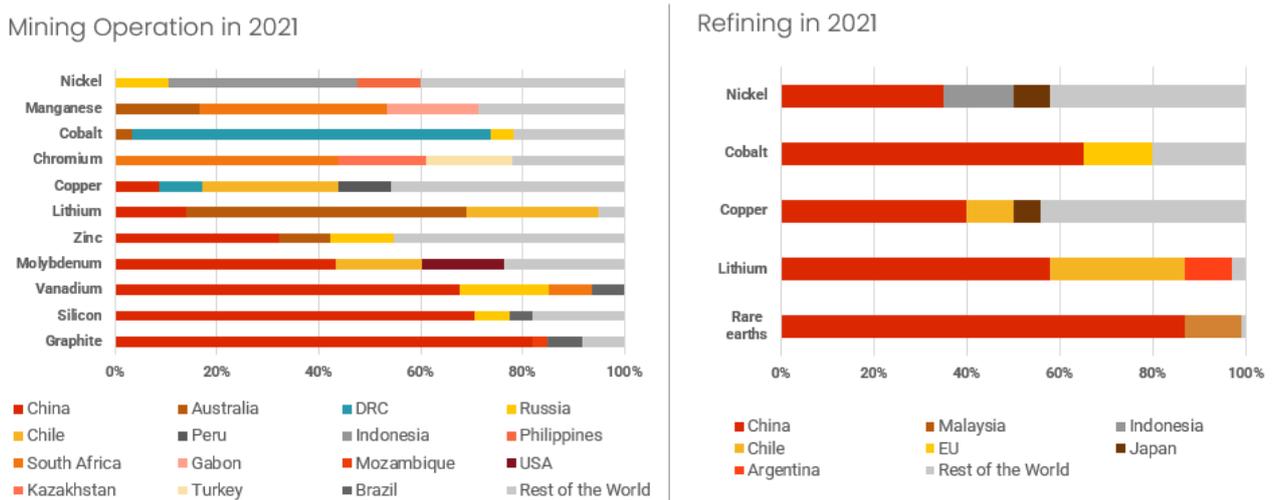
## Appendix 3b – CRM

Table 1 Potential CRM bottle necks by technology

Technology	CRM bottlenecks
Solar PV	Fluorinated polymers, silver and polysilicon. Polysilicon has received the most attention and the production is increasing. <sup>61</sup>
Wind	Minerals used in the most efficient permanent magnets: neodymium, praseodymium and dysprosium. China dominates mineral processing and manufacturing. <sup>62</sup>
Electric vehicles	Lithium, graphite, nickel, and cobalt used to produce batteries.
Hydrogen electrolyser	Iridium for PEM electrolysers. Current mining volumes are low, and profitability is poor. South Africa dominates mining (85%). <sup>63</sup>

Source: Kaya Advisory

Figure 19 Mining and refining of selected minerals by country



Source: US Geological Survey, IEA

<sup>61</sup> Thunder Said Energy

<sup>62</sup> European Commission (2020) Critical Raw Materials for Strategic Technologies and Sectors in the EU. Available at: [link](#) and US Department of Energy (2022) Rare Earth Permanent Magnets. Available at: [link](#)

<sup>63</sup> Collins L. (2022) Could a critical raw materials shortage derail forecast massive green hydrogen growth? Available at: [link](#)

## Disclaimer

*This research note has been prepared and issued by Kaya Advisory Ltd (‘Kaya’) in accordance with its contract with the intended recipient to whom it is addressed. All intellectual property subsisting in the note is the property of Kaya or its third-party licensors unless otherwise agreed by us in writing. The note is private and confidential and is intended solely for the person(s) to whom it is addressed. Redistribution and dissemination of its contents are prohibited. You must obtain our prior written consent before quoting this research note. To the fullest extent permitted by law, Kaya shall have no liability whatsoever (including, without limitation, in negligence or otherwise) for any decision taken based on information contained in this research note. This research note does not constitute investment research and should not be treated or relied on as such.*