Institute for Public Policy Research

RESILIENT BY DESIGN

BUILDING SECURE CLEAN ENERGY SUPPLY CHAINS

Simone Gasperin, Pranesh Narayanan and **Sofie Pultz**

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SUMMARY

The UK must become more resilient to succeed in a more turbulent world. Supply chains – the networks of people and businesses we rely on to make and move the goods we need – are strained by the recent rise of trade wars and armed conflicts. These disruptions push up costs, hurting UK households and businesses. The answer is resilience which, in this context, refers to the capacity of supply chains to withstand and quickly adapt to disruptions. Businesses on their own are not well-placed to face the risks of a more geopolitically fraught era. Policy can shape supply chains and help build resilience. Policy action should be tailored to the characteristics of each supply chain, and the UK's position within them. Moreover, with limited fiscal and institutional bandwidth, action should be based on national economic priorities.

Resilient clean energy supply chains are critical for the UK and should be prioritised. Energy is crucial for economic growth and rising living standards. The UK is a net energy importer with dwindling oil and gas reserves. Clean energy technologies can insulate the economy from volatile global oil and gas markets. These technologies are also crucial for climate progress and provide an opportunity to develop new industries. In this report we analyse the UK's resilience in two finished products: electric batteries and solar panels. We also consider steel and critical minerals as essential input materials for crucial clean energy technologies. Our analysis focusses on the risks of supply chain disruptions and their potential impact on the UK's industrial base and jobs, as well as on energy security and net zero objectives.

The government needs to take a more proactive and strategic approach to building resilient clean energy supply chains. China is a single point of failure for so many supply chains underpinning the UK economy. A broad industrial and international policy toolkit needs to be deployed to ensure that productive capacity is more geographically spread out, including in the UK where it is possible.

The table below summarises our recommendations for the four supply chains focussed on by this report, based on the insights drawn from our analysis.

We also make the following cross-cutting recommendations:

- The government should set out a clear position on Chinese investment and involvement within priority supply chains to provide clarity and certainty for businesses.
- The UK should form focussed international partnerships with limited numbers of countries on a supply chain by supply chain basis.
- Agencies could be set up under the banner of the recently established Global Clean Power Alliance (GCPA) to drive investment, demand creation and stockpiling initiatives that could bolster resilience in clean energy supply chains. This would allow members to pool resources for a more cost-effective resilience drive.

TABLE S1: IPPR'S ANALYSIS AND POLICY RECOMMENDATIONS ON THE RESILIENCE OF SELECTED CLEAN ENERGY SUPPLY CHAINS

	Risk of disruption	Impact of disruption	Policy actions
Battery	**High** Concentration is high in China, especially in anodes, cathodes and other materials, which are increasingly targeted in trade disputes. Full import dependency on those unavoidable components would put domestic battery cell production – and ultimately the manufacturing of electric vehicles – at risk.	**High** The domestic automotive industry will be severely affected by the penetration of foreign-made electric vehicles in the UK market without a secure and competitive supply chain for battery cells.	**Onshoring:** building domestic productive capacity in battery cells and – in the long term – components through joint ventures with leading Asian producers, with support from public financing institutions (such as the NWF). **International partnerships:** offtake agreements with South American countries from the 'Lithium Triangle' to build productive capacity in battery components and establish trade relationships. **Science and innovation partnerships:** financing and technical support to build manufacturing capacity in battery components with countries from the 'Lithium Triangle'.
Solar PV	**Low** Concentration is extremely high in China, with massive and growing import dependency. However, manufacturing overcapacity and the commoditisation of solar panels means they can be transported and deployed easily wherever they are demanded.	**Moderate** The government's 2030 Clean Power Plan relies on tripling installed solar capacity. Severe disruptions would prolong a costly reliance on imported natural gas for electricity generation. This would reduce energy security and slow the decarbonisation of electricity generation.	**Virtual stockpiling:** establishing coordinated actions with partner countries to stockpile solar panels. **Investment partnership:** supporting partner countries with existing capabilities (eg Malaysia, India and Vietnam) to build manufacturing capacity, through preferential financing and offtake agreements. **Transnational industrial policy:** cooperating with neighbouring countries to build manufacturing capacity in the region, sharing financing costs and facilitating the creation of 'European champions'.
Steelmaking	**Moderate** The UK has steelmaking capacity and most steel imports come from friendly neighbouring countries. But international competition and the costs involved in decarbonising the industry are threatening the viability of domestic steelmakers.	**High** Steel production capacity is now below annual demand, making the UK structurally dependent on imports. Losing the capacity to produce 'virgin steel' could put key steel-consuming industries (such as automotive) at risk of temporary shutdowns.	**Keepshoring:** maintaining UK steelmaking capacity and capabilities while supporting lower energy prices (for instance via GB Energy) and financing projects for steel decarbonisation. **International partnerships:** establishing 'green iron corridors' with resource- and energy-rich countries, to preserve the capacity of producing (near-zero emissions) virgin steel with electric arc furnaces. **Open plurilateral agreements:** creating markets for green steel through agreements on common standards and regulations, building on existing initiatives such as alignment with the EU carbon border adjustment mechanism (CBAM).
Critical minerals	**High** Critical minerals refining is more concentrated than mining, with China dominating in almost all of them. China has a recent history of introducing export controls on particularly scarce critical minerals.	**Moderate** Disruptions to the supply of refined critical minerals could compromise the UK's ability to build domestic specialisation in clean energy technologies where it has the greatest potential (eg batteries, heat pumps and wind turbines).	**Investment partnerships:** financing of investment in refining capacity outside China through offtake agreements that can ensure stability of demand for critical minerals. **Science and innovation partnerships:** providing technical assistance and vocational upskilling to countries with high availability of critical minerals; financing collaborations on research to develop clean energy technologies using more abundant mineral resources.

Source: Authors' analysis

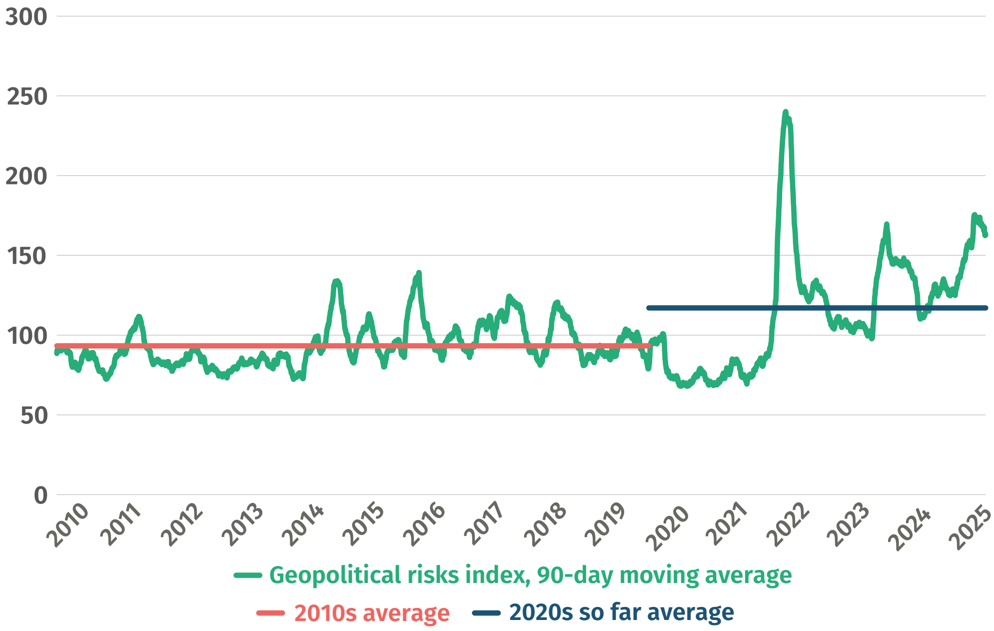
1.
WHY IS RESILIENCE OF CLEAN ENERGY SUPPLY CHAINS IMPORTANT?

1.1 A MORE TURBULENT GLOBAL ECONOMY IS MAKING DAILY LIFE HARDER IN THE UK

The world is getting more dangerous. The 2020s are proving far riskier than the 2010s – geopolitical tensions have escalated significantly, driven by Russia's invasion of Ukraine and, more recently, conflicts spreading across the Middle East.

FIGURE 1.1: GEOPOLITICAL TENSIONS ARE BECOMING A 'NEW NORMAL' IN THE 2020S

Level of geopolitical risk according to the geopolitical risk index (GPR)



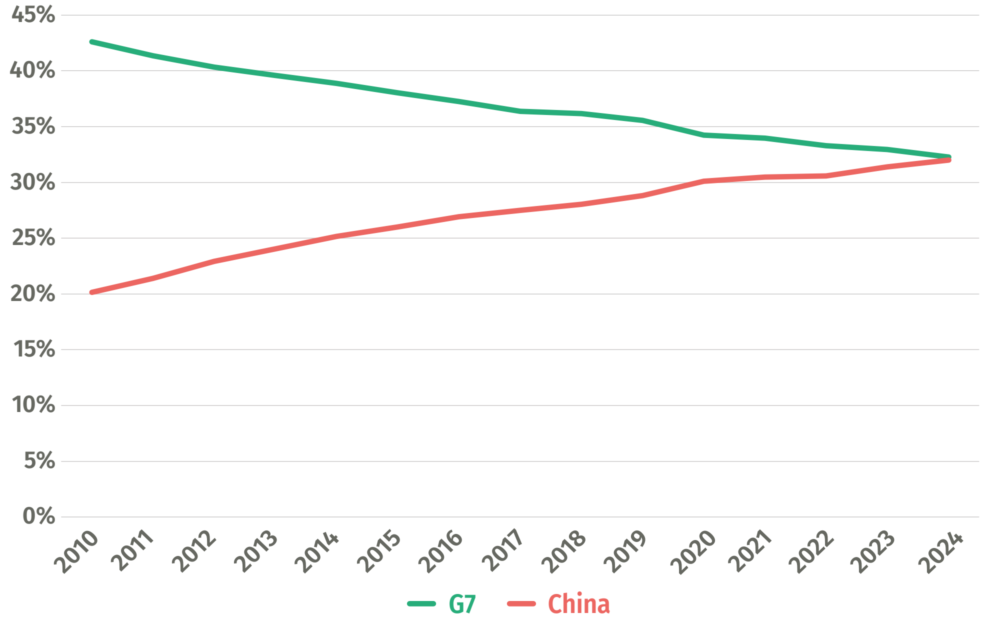
Source: IPPR analysis of Caldara and Iacoviello (2025)

Note: The GPR measures geopolitical risk through text-based analysis of articles from leading English-language newspapers on a daily basis.

The rise of active conflicts has coincided with an increase in economic rivalry and fragmenting trade relationships. The backdrop to this is China's booming manufacturing capacity, shown in figure 1.2 below. The relationship between the West and China has increasingly been at odds with concerns around domestic industries and jobs, as well as national security. The US adopted a more adversarial approach to China under the first Trump administration, a stance that President Biden maintained. This has now boiled over into a campaign of economic coercion against allies and opponents, with the second Trump administration deploying tariffs to push other countries into trade and policy concessions that favour the president's political agenda. An international rules-based order, built to foster cooperation over conflict, is looking less likely every day (Morris and Chappell 2025).

FIGURE 1.2: CHINA IS SET TO OVERTAKE THE G7 IN MANUFACTURING CAPACITY

Evolution of global shares in Manufacturing Value Added (MVA) over time between G7 and China



Source: IPPR analysis of UNIDO National Accounts Database

These tensions are having a significant and ongoing impact on day-to-day life in the UK. The war in Ukraine led to a spike in energy prices, causing a domestic cost of living crisis. Tensions in the Middle East, alongside Trump's trade war, have driven up costs associated with global shipping (KPMG 2025; Anghel 2025). This hits the wallets of British people and the profits of British businesses. It also impacts economic confidence – concerns about geopolitical conflicts make people more likely to save more and consume less as they become pessimistic about their future financial situation (Coibon et al 2025).

Policymakers are finding this world challenging to navigate. It is increasingly difficult for the government to improve living standards in Britain when so much of the pressure comes from abroad. The economy therefore needs greater resilience to these international risks and shocks, as recognised by the current chancellor of the exchequer last year. In her 2024 Mais lecture, Rachel Reeves said: "There is no viable growth strategy today which does not rest upon resilience."

In this paper, we define 'resilience' as the capacity to adapt quickly and bounce back from global shocks. The concept of resilience is especially relevant to supply chains, which are the networks of people, organisations and infrastructure that transform raw materials and other resources into end-use products.

With the world's second-largest goods trade deficit, the UK typically occupies the role of buyer within global supply chains. Given the size of its population and industrial base, Britain usually accounts for small shares of global demand and global production. This makes the UK economy a price taker in most of the goods it imports and means British household finances are disproportionately vulnerable to global shocks (Greene 2025). In a world where the risk of disruptions is growing, and the cost of living is biting, supply chain resilience must be a priority.

Private players tend to underinvest in resilience broadly, and in supply chain resilience specifically, because disruptions are hard to predict and preparing for them is costly (Caponi, Du and Stiglitz 2024). Supply chain resilience must therefore be central to policymaking. In practice, this means taking steps to minimise the likelihood of disruptions and ensure that supply chains can quickly adapt and respond in the face of unavoidable shocks when they occur.

1.2 RESILIENT CLEAN ENERGY SUPPLY CHAINS ARE ESSENTIAL FOR THE UK'S FUTURE

Growth cannot be achieved without secure and affordable energy. Energy prices play an outsized role in driving inflation across the wider economy (Weber et al 2023). As a fundamental input of production, energy costs are key to the competitiveness of the UK economy. The government's ambitions on AI and defence are also dependent on secure energy sources – AI requires power-hungry data centres, while militaries require energy for transport, housing and modern weapons systems (McBride et al 2025; DSTL 2024).

Historically, the primary source of energy has come from burning fossil fuels, and energy affordability has relied on secure and reliable access to oil, gas and coal. This suited the UK when it was essentially self-sufficient on coal, while enjoying the status of net energy exporter through North Sea oil and gas production. Today, the UK is a net energy importer. The North Sea has become far less productive as a matter of geology – it is an ageing basin that is becoming ever more expensive to extract from (Khan and Jones 2024). Therefore, the UK will always be a price taker in global fossil fuel markets.

Luckily, clean energy technologies[1] make it possible to reduce dependence on imported energy molecules in favour of British electrons. Deploying renewable generation capacity alongside electrified heating and transport solutions, such as heat pumps and electric vehicles (EVs), is the way towards energy security (IRENA 2024). Clean energy supply chains also provide growth opportunities for the domestic UK economy, featuring heavily in the 2025 Modern Industrial Strategy (where clean energy is one of the eight 'growth sectors'). Finally, these supply chains are essential for making progress towards net zero and the UK's climate contributions.

While the UK can house some parts of the supply chain at home, we will be reliant on imports across many others. Secure and resilient clean energy supply chains will therefore be essential to achieving energy security, growth and net zero. However, institutional and fiscal constraints mean that the state's capacity to build resilient supply chains is limited – the government needs to be strategic and proactive about where intervention is necessary and how to intervene effectively.

1 In this report, clean energy technologies refer to the suite of products that can be used to produce renewable or low-carbon energy, alongside products that can replace fossil fuel usage within the economy, such as electrified heating and electrified transport.

1.3 UNDERSTANDING THE RISKS OF DISRUPTION AND THEIR IMPACTS ON THE UK

There are two key questions involved in assessing the case for intervention from an economic resilience perspective. First, which supply chains are most exposed to disruption? Second, how would those disruptions affect the UK? Answering them requires a clear framework to identify where the case for policy intervention is strongest and how it should be tailored.

Our analysis of resilience in the UK's clean energy supply chains follows two core considerations.

1. Risk of disruptions: the extent to which the supply chain could experience shocks. This will be assessed through the factors identified in table 1.1.

TABLE 1.1: FACTORS FOR ASSESSING THE RISK OF DISRUPTIONS WITHIN A SUPPLY CHAIN

Risk factors		Description	Risks are higher when
Concentration		The concentration of production capacity within certain countries and across major segments of the supply chain.	Production is highly concentrated in one country.
Import dependency		The degree and diversification of imports from a country's perspective.	The UK relies on imports, and a large share of these imports come from one country.
Other factors	**Market characteristics and trends**	How demand patterns can influence the availability of goods and their price volatility.	Demand is likely to grow, and prices are sensitive to short-term demand fluctuations.
	Technological specifications and trajectories	How potential different technologies behind the products or the materials can offer alternatives for differentiation.	Technological trajectories increase barriers to access.
	Substitutability	Whether a product, component or material can be replaced by another substitute without compromising efficiency or costs.	Few practicable alternatives exist.
	Lead times to scale up capacity	Whether expanding or installing domestic manufacturing capacity is feasible within a reasonable time.	Lead times are longer.
	Other countries' policies	The extent to which other countries' policies are restricting or increasing access to a particular product, component or material.	Other countries implement discriminatory policies.

Source: Authors' analysis

2. Potential impact of disruptions: the extent to which the UK's economic or policy priorities are adversely impacted in the event of a supply chain shock. This will be assessed qualitatively through factors identified in table 1.2. Quantitative assessments of the potential impact of disruptions begin with an estimate of the gap between the UK's domestic capacity within a given supply chain and its expected demand requirements. We refer to these estimates as 'dependency ratios' and provide a detailed methodological explanation for each supply chain in the appendix. We then provide quantitative impact assessments for supply chain disruptions for factors identified in table 1.2, where they are relevant.

TABLE 1.2: FACTORS FOR ASSESSING THE POTENTIAL IMPACT OF DISRUPTIONS WITHIN A SUPPLY CHAIN

Impacted factors	Description
Industrial base and jobs	The extent to which disruptions to a particular supply chain can affect significant areas of the economy in terms of industrial production and jobs.
Energy security	The extent to which disruptions to a particular supply chain can affect energy supply into the UK and increase dependency or costs for households and businesses.
Net zero objectives	The extent to which disruptions to a particular supply chain can affect government decarbonisation plans for transport, energy generation, industrial processes and residential heating.

Source: Authors' analysis

The rest of the report is structured as follows.

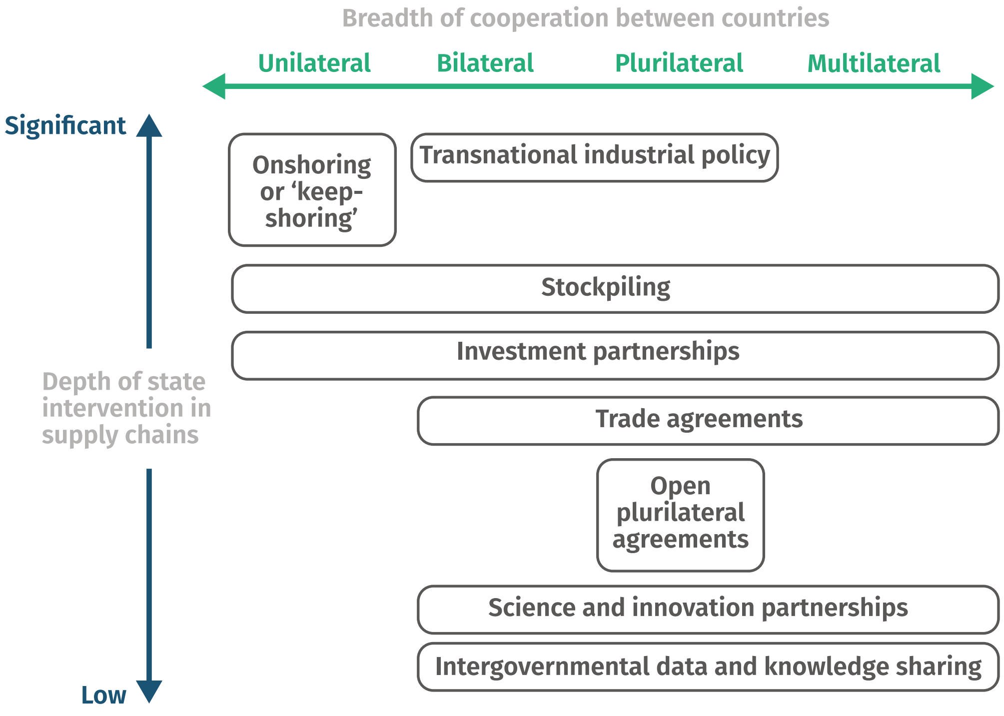
- **Chapter 2** sets out the strategies and policy tools governments can use to enhance supply chain resilience.
- **Chapters 3–6** apply the framework from chapter 2 to four strategically chosen supply chains.
  - **Batteries** (chapter 3), a cornerstone of electric mobility and energy storage, where the UK is building cell manufacturing capacity but remains heavily reliant on imported components.
  - **Solar PV** (chapter 4), the fastest growing source of renewable power globally, where UK deployment ambitions rest almost entirely on imports from highly concentrated global supply chains.
  - **Steel** (chapter 5), a foundational industry and critical input for clean energy infrastructure, where domestic capacity has shrunk below demand, and future competitiveness hinges on decarbonisation.
  - **Critical minerals** (chapter 6), essential inputs into multiple technologies, where the UK is fully import-dependent and exposed to geopolitical and market risks.
- **Chapter 7** draws together cross-cutting themes for building resilient clean energy supply chains, including through international partnerships with selected countries.

2.
HOW CAN THE GOVERNMENT BUILD RESILIENT CLEAN ENERGY SUPPLY CHAINS?

2.1 A BROAD SET OF TOOLS SHOULD BE DEPLOYED TOGETHER TO BUILD RESILIENCE

Supply chain resilience has not been a major feature of economic policy for the past few decades, and the modern iteration of this agenda only emerged following the Covid-19 pandemic. As such, there is a small but growing set of initiatives in this space. Part of the answer came through the 2025 Modern Industrial Strategy (DBT 2025a), which sets out a plan for driving growth in strategic and future-facing domestic industries. The 2025 Trade Strategy (DBT 2025b) dedicates an entire chapter to 'secure and resilient trade', acknowledging the UK's exposure to global shocks and setting out a plan to build supply chain resilience centred on a new 'Supply Chain Centre' within the Department for Business and Trade. But to deliver on this agenda, the government needs to deploy a broader set of tools than it has to date. Figure 2.1 maps these options along two dimensions: the **depth of state intervention** (from enabling to market-shaping) and the **breadth of cooperation** (from unilateral action to broad international coalitions).

FIGURE 2.1: A TAXONOMY FOR POLICY ACTIONS THAT CAN BE USED TO STRENGTHEN SUPPLY CHAIN RESILIENCE



Source: Authors' analysis

Resilience can be built through developing or defending domestic production capacity, increasing buffer stocks or building alternative suppliers abroad (sometimes referred to as '**friendshoring**' or '**nearshoring**'). On the domestic front, there is a limited set of products where supply can be '**onshored**', given the UK's relatively small domestic market and productive capacity relative to the global economy. The Modern Industrial Strategy has committed to onshoring a range of production in clean energy technologies, including batteries, heat pumps and parts of the wind energy supply chain. We use the term '**keepshoring**' to refer to interventions used to support 'foundational industries' and thereby defend ourselves from global economic risks.

Internationally, alternative capacity could be built through **investment partnerships**, where the UK and allies provide finance and support to countries with strong potential to develop new production centres for supply chains that are currently concentrated. This could include mechanisms to create demand through procurement or brokering advanced market commitments between prospective factories and existing customers.

Through **transnational industrial policy**, countries could partner up and combine several policy tools (co-investment, demand creation and alignment of standards) to achieve greater economies of scale across borders than they could have with domestic industrial policy.

Countries could also work together to develop substitutes for goods through **science and innovation partnerships** – this could be joint R&D spending programmes, innovation partnerships between research organisations and businesses across partner countries to exploit knowledge spillovers, or direct collaboration between national research labs.

Open plurilateral agreements (OPAs) are initiatives used to create common standards and regulations. Membership is optional and can be left open for any countries that wish to join even after the agreement is signed. They are especially useful for aligning regulations and standards, and their open nature allows for a more collaborative approach than free trade agreements. OPAs can be used to drive innovation in production processes to achieve more sustainable and labour-friendly supply chains. They can also be used to create larger markets by aligning product standards across multiple economies.

Finally, **stockpiling** is a useful strategy for improving resilience in homogenous, storage-friendly products with high strategic value. This could be carried out unilaterally but would be more effective if done with international partners so that costs could be pooled. There are traditional stockpiling initiatives with centralised national or international stockpiles, or 'virtual stockpiles' where governments take out options contracts with producers and logistics companies to provide a certain quantity of the product when pre-specified risks emerge (eg export bans or natural disasters).

Variants of all these tools have been deployed in the context of resilience, and appendix A.3 provides several examples of such tools in practice deployed at various levels of international cooperation. In the following chapters, we recommend deploying combinations of these tools, based on an analysis of each of our four supply chains.

2.2 THE CURRENT APPROACH TO SUPPLY CHAIN RESILIENCE IS FALLING SHORT

The problem, however, is that the UK has underused the breadth and depth of its available tools. Instead, consecutive governments have relied narrowly on encouraging transparency and frictionless trade. Following the UK's exit from the EU, several trade agreements have emerged which include some provisions on supply chain transparency reporting. The government has also signed several Memoranda of Understanding (MoUs) with countries that signal intent to collaborate on resilience but have little real-world impact. The UK's approach has especially fallen short in three areas:

- **The focus on transparency and frictionless trade does not address the realities of supply chain concentration.** As the analysis in later chapters will show, the core issue in many clean energy supply chains is overwhelming concentrations of production capacity – typically, China. The tools deployed to date do not address this reality. We can encourage businesses to source responsibly and have transparent supply chains through trade regulations. We can minimise the cost of switching suppliers when needed. We can sign MoUs signalling intent to work more closely with partners. But none of this addresses the core problem – if there is only one country to physically source goods from, companies in the UK will not be able to source alternatives during a disruption.
- **The scope of action on supply chain resilience has been too narrow.** Critical minerals have received the lion's share of policy attention in this space, with most of the focus on mining and comparatively less on refining. However, several other supply chains are highly concentrated in China – solar and batteries are both dominated by highly advanced and competitive Chinese producers. There cannot be progress on resilient clean energy supply chains without focussing on the broader concentration of manufacturing capacity for these products.
- **Our approach to working with crucial partner countries, especially emerging economies, is flawed.** Many emerging economies increasingly turn to non-Western partners who offer more pragmatic, less ideologically driven forms of cooperation that better align with their own domestic priorities (Chappell, Pultz and Srinivasa Desikan 2025). Brexit has also diminished our attractiveness to potential partners in advanced economies, as collaboration with the UK alone offers less economic upside than partnerships with the larger, more integrated EU single market. These two trends have weakened the UK's geopolitical and economic position and made it harder to build the kinds of international cooperation and investment relationships essential to long-term supply chain resilience. Without a more strategic and intentional international approach, the UK risks falling behind in an increasingly competitive global landscape.

3. THE BATTERY SUPPLY CHAIN

3.1 THE PIVOTAL ROLE OF THE BATTERY SUPPLY CHAIN AND ITS STRUCTURE

Batteries are the centrepiece of electric mobility. Electric vehicles (EVs) account for 75 per cent of global battery demand (IEA 2025d). Since 2015, the average cost per KWh of batteries has fallen by over 75 per cent (BloombergNEF 2024),[2] making EVs increasingly competitive with traditional cars. In China last year, 65 per cent of EV sales were less expensive than conventional equivalents (IEA 2025a). Batteries are also key to energy storage technologies – representing 10–15 per cent of overall battery deployment globally (IEA 2024a). Finally, batteries have an important role stretching beyond clean energy supply chains into other sectors, as a central component for frontier defence technologies, portable electronics and data centres.

Table 3.1 shows the battery supply chain, distinguishing between the two prevalent technologies – lithium-ion phosphate (LFP) and nickel manganese cobalt (NMC). Battery cells that are stacked into the final battery product have two major components – anodes and cathodes. They represent more than 60 per cent of the total cost of a battery cell (Argonne National Laboratory 2024). Anodes, but especially cathodes, in turn depend on the cost of minerals. The production costs of anodes — and especially cathodes — depend heavily on mineral costs, which constitute approximately 80 per cent of the total (IEA 2024e).

TABLE 3.1: THE BATTERY SUPPLY CHAIN

Technologies	Resource extraction	Mineral refining	Manufacturing components		Manufactured product	
LFP and NMC	Silicon Graphite ore Lithium ore	Refined silicon Graphite Lithium	Anodes	Battery cells	Battery packs	EVs, storage systems
NMC	Lithium ore Nickel ore Cobalt ore Manganese Copper ore	Lithium Nickel-sulphate Cobalt-sulphate Manganese sulphate Copper	Cathodes			
LFP	Lithium ore Phosphate Graphite ore Manganese Copper ore	Lithium Phosphoric acid Graphite Manganese-sulphate Copper	Cathodes			

Source: Authors' analysis of IEA (2023, 2025b)

Note: This chapter focusses on the highlighted areas in the table.

2 This is the volume-weighted average lithium-ion battery pack and cell price for batteries used in passenger cars, buses, commercial vehicles and stationary storage.

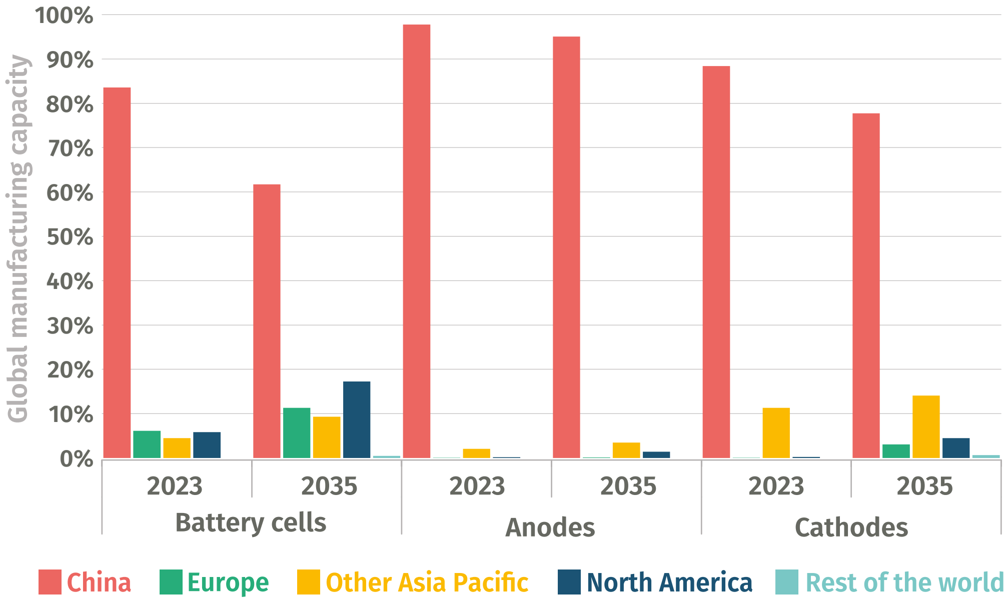
This chapter concentrates on the manufactured components – cathodes, anodes and battery cells – while leaving the discussion on critical minerals to Chapter 6.

3.2 RISK OF DISRUPTIONS IN THE BATTERY SUPPLY CHAIN FROM THE UK PERSPECTIVE

3.2.1 Concentration of production capacity in the battery supply chain at the global level

FIGURE 3.1: CHINA DOMINATES THE ENTIRE BATTERY SUPPLY CHAIN WITH ITS LEADERSHIP PRESERVED IN BATTERY COMPONENTS

Global share of manufacturing capacity in the battery supply chain in 2023 and projections for 2035



Source: Authors' analysis of figures made available by the IEA

Notes: Projections to 2035 are based on the IEA's STEPS scenario. US figures are likely overestimates of future capacity, given the recent scaling back of tax credit incentives for the EV supply chain.

Global battery cell manufacturing capacity reached 3.3TWh in 2024 (IEA 2025a), with about 84 per cent located in China (Greitmeier et al 2025), which holds an even stronger dominance in the supply chain for LFP batteries (IEA 2025b). Chinese-based producers hold a near-global monopoly in anode and cathode manufacturing. They also account for 80 per cent of global battery recycling capacity.[3]

Other major manufacturing nations[4] are located in Asia, particularly in Japan and South Korea,[5] which also has capacity in making anodes and cathodes. The US has some residual manufacturing capacity in NMC battery cells, followed by Europe.[6] However, nearly all of Europe's battery cell manufacturing capacity is owned by

3 In 2024, China established a new state-owned company, China Resources Recycling Group, which specialises in resource recycling, including electric batteries (China Daily 2024).

4 Virtually all battery supply chain capacity outside China is based on the NMC technology.

5 While battery cell manufacturing capacity in South Korea remains fairly small, a key role is played by its leading companies – namely LG, SK Innovation and Samsung – which invested largely abroad (in Europe and the US in particular).

6 Currently, Hungary and Poland are the largest producing countries in Europe, with 58GWh and 86GWh capacity respectively, though Germany and France will soon take over as their announced projects become operational (IPCEI Batteries 2024).

producers headquartered in Asia – 86 per cent in South Korea and 8 per cent in China. Furthermore, Europe and North America have virtually no manufacturing capacity in anodes and cathodes (Battery-News 2025a).[7]

In 10 years, battery cell assembly and cathode production are expected to become only slightly less concentrated globally (figure 3.1), while China is set to retain its dominant share in both anode manufacturing and battery recycling capacity (IEA 2024b).

3.2.2 UK import dependency in the battery supply chain

While China is the top import source for batteries, it currently accounts for one third of UK battery cell imports. In absolute terms, the value of imports for battery components is low, reflecting the UK's marginal production of battery cells. Here, Japan appears to be the top supplier country, providing more than half of the UK's imports for cathodes and anodes (table 3.2).[8] China's global dominance of the battery supply chain is not reflected in UK battery cell imports because of historic links to battery suppliers based in Europe. These form the bulk of non-Chinese battery imports to the UK, the US and other Asian countries.

TABLE 3.2: ANALYSIS OF IMPORTS AND DEPENDENCIES IN THE BATTERY SUPPLY CHAIN

	Value of total imports	Top supplier	Residual supply index[9]
Anodes	£154,880,279	Japan	47.1
Cathodes	£160,898,422	Japan	44.7
Cells	£2,980,808,023	China	65.9

Source: Authors' analysis of HMRC (2024)

Note: Average values for the period 2022–2024. Methodological details, including the choice of product codes, are included in the appendix.

3.2.3 Other factors influencing resilience in the battery supply chain

1. **Market characteristics and trends**

   The global EV market is set to grow sharply, pushing battery demand from 1TWh in 2024 to around 6TWh in 2035 (IEA 2024a).[10] As European carmakers move to EV production, Europe's share of global demand is expected to almost double by 2030 (IEA 2025a), further increasing reliance on imported battery cells and components.

2. **Technological specifications and trajectories**

   Due to their lower price and improved efficiency, LFP batteries are becoming the prevalent and most competitive technology. In 2024, LFP batteries used in EVs have reached nearly half of global sales, up from less than 10 per cent in 2020 (IEA 2025a). With the EU and the US specialising in NMC batteries, the unmatched competitiveness of LFP technology will further favour

7 Early in March 2025, the Chinese leader in LFP anode manufacturer Putailai withdrew its intention to build an anode factory in Sweden, which was planned to generate enough battery capacity of approximately 100GWh (Battery-News 2025b).

8 However, there are significant limitations to findings for cathodes and anodes since trade product codes are too broad to precisely capture these goods.

9 The residual supply index is a measure of supply chain dependency. It shows the proportion of imports left after the top import source country is removed. Higher numbers show low levels of dependency while lower numbers highlight higher levels of dependency.

10 Under the IEA's STEPS scenario.

Chinese battery producers.[11] At the same time, solid-state and sodium-ion batteries remain, respectively, limited in application and far from commercial viability (especially with the current price of lithium), making technological diversification unrealistic in the near future.

3. **Substitutability**

   There are no significant substitutes for batteries and associated components for applications in clean vehicles and stationary storage systems. Battery-powered vehicles face limited competition from other technologies, such as fuel cells vehicles. Especially in short-time storage (below 10 hours), electro-chemical storage systems are proving far superior to any other electricity storage technology (eg thermal, electro-mechanical, pumped hydro), due to their efficiency and universal applicability (IRENA 2017).

4. **Lead times to scale up capacity**

   While retrofitting a traditional ICE plant for EV production can take less than two years, constructing a battery cell gigafactory requires more time. Establishing production for anodes and cathodes typically takes between two and five years, although this is influenced by uncertainty about commercial viability.

5. **Other countries' policies**

   Competition in the battery supply chain is increasingly affected by protectionist industrial and trade policies across the globe. The Inflation Reduction Act (IRA), introduced in 2022 and recently scaled back, aimed to onshore the entire EV supply chain in the US to protect the domestic market from import competition. Similarly, on 15 July China's Ministry of Commerce introduced restrictions on the transfer of battery manufacturing technologies, particularly on LFP batteries and components (MOFCOM 2025a). Further export controls on cathodes and anodes materials were added on 9 October (MOFCOM 2025b). This would make it more difficult for Chinese producers in the battery supply chain to establish overseas factories (Bradsher 2025).

3.3 IMPACT OF BATTERY SUPPLY CHAIN DISRUPTIONS FOR THE UK

3.3.1 The UK's production capacity in the battery supply chain

The UK is currently a marginal player in the global battery supply chain. The only active domestic manufacturer of battery cells is AESC in Sunderland with production capacity close to 2GWh. This is expected to reach around 17GWh through AESC investment in a second gigafactory near the original. Agratas – a subsidiary of the Tata Group – is planning to build a 40GWh assembly factory in Somerset by 2026. In recent years, proposals have been made for a third gigafactory site in Coventry, with a potential annual capacity of 60GWh.

No production is currently in place for anodes and cathodes, though the company Altilium plans to build a facility that could produce enough cathode materials to meet 20 per cent of expected UK demand by 2030 (Altilium 2025).

3.3.2 Dependency ratio in the UK's battery supply chain

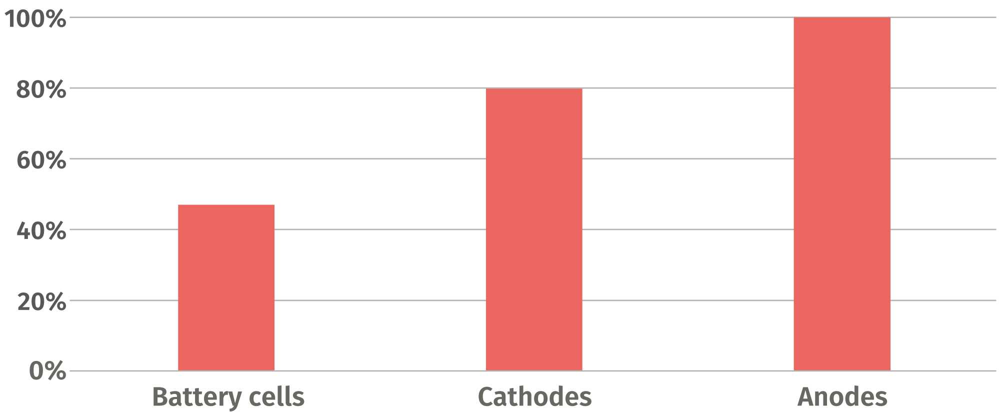
The Faraday Institute projects UK battery demand in 2030 of 108GWh. With the two major gigafactories already under construction, 53 per cent of projected demand for battery cells could be met by domestic production by 2030 (see figure 3.2).

11 Chinese companies have reached low cost and high efficiency in battery production through economies of scale and modularity in the product, enabled by the vertical integration of main industry players (Campbell et al 2023) – notably CATL and BYD, accounting for 37.9 and 17.2 per cent of global market share in EV usage (SNE Research 2025).

However, vulnerabilities remain through the earlier stages of the supply chain. If Altilium succeeds in hitting its targeted production of recycled cathode materials, the UK would still need to source 80 per cent of its cathodes from abroad. Given there are no planned production facilities for anodes, the UK will fully depend on imports.

FIGURE 3.2: IMPORT DEPENDENCY IS SET TO BE VERY HIGH FOR BATTERY COMPONENTS IN 2030

Expected dependency ratios by battery supply chain segment



Source: Authors' analysis of Faraday Institution (2024) and Altilium (2025)

Note: A negative dependency ratio indicates self-sufficiency – domestic production capacity is higher than domestic demand.

Under our import dependency estimates, a severe, year-long disruption to the UK's top supplier of battery components from 2030 could lose out on 583,000 units of EV production and put up to 90,000 jobs at risk.

TABLE 3.3: ESTIMATED IMPACTS OF A DISRUPTION TO BATTERY COMPONENT SUPPLIES IN 2030

	Units
Lost EV production	583,017
	Number of jobs at risk
EV assembly	67,219
Gigafactory	8,186
Battery supply chain	14,734

Source: Authors' analysis of Faraday Institution (2024)

Note: See appendix for more details of the methodology.

3.3.3 Impact of battery supply chain disruptions on national policy priorities

As estimated in the previous section, disruptions in the battery supply chain will affect the competitiveness and growth potential of the automotive industry, but it will have serious implications for other manufacturing sectors. Moreover, discontinuity in battery supply will impact the power system, with severe consequences for energy security and net zero objectives. Table 3.4 details the impact of disruptions to the battery supply chain on major UK policy priorities.

TABLE 3.4: THE IMPACT OF DISRUPTIONS IN THE BATTERY SUPPLY CHAIN IS SIGNIFICANT ON ALL MAJOR POLICY PRIORITIES BUT PARTICULARLY ON ECONOMIC COMPETITIVENESS

Impact	Degree of impact	Description
Industrial base and jobs	★★★★★	If the UK is unable to manufacture cost-competitive battery cells for its automotive industry, foreign players – most likely Chinese – will take over a booming EV market, posing serious threats to domestic carmakers and their suppliers. For instance, BYD increased its UK market share from 0.42% to 3.6% between September 2024 and September 2025 (SMMT 2025). Disruptions could also affect the production of cutting-edge products in the rail, aerospace and defence industries.
Energy security	★★★★	The UK aims to achieve 23–27GW of installed battery storage capacity by 2030 (up from current 4.5GW) to sustain a future renewable-dominated electricity system (DESZN 2024). Without enough storage capacity in the electricity grid, a more renewable-based power system would suffer from shortages and potential blackouts (SolarPower Europe 2025).
Net zero objectives	★★	As the transport sector is the greatest source of emissions in the UK, a faster transition towards EVs is central for reducing air pollution and national net zero objectives. As mentioned, batteries are also critical in a renewable-based power sector that requires electricity to be stored and dispatched.

Source: Authors' analysis

Note: The degree of impact is measured with stars from low (one star) to high (five stars).

3.4 POLICY ACTIONS TO INCREASE THE RESILIENCE OF THE BATTERY SUPPLY CHAIN

The UK government's existing work to support the establishment of efficient gigafactories for battery cells assembly is important, but in the medium-to-longer term it should also ensure that cost-competitive essential components are secured – through a combination of secure imports and domestic investment.

TABLE 3.5: POLICY ACTIONS ON THE BATTERY SUPPLY CHAIN

Timeline	Policy action	Description
Short term (within two years)	Onshoring	**Securing battery cell manufacturing through foreign investment by main industry players from Asia** The UK should leverage its available financing instruments – chiefly the National Wealth Fund (NWF) – to support the establishment of battery manufacturing capacity. This should seek to deliver foreign direct investment by specialised Asian players with the appropriate productive and technological capabilities. Thanks to their vertical integration and established commercial relationships with specialised suppliers, these companies are also well positioned to secure essential battery components and minimise supply chain disruption risks. Investment agreements could take the form of joint ventures between UK domestic carmakers and foreign battery manufacturers – similar to the recent partnership between Stellantis and CATL in Zaragoza, Spain. The NWF could support initial capital costs by providing equity financing – building on its experience with the AESC project in Sunderland – and serve as a stable, long-term minority shareholder in new business initiatives.
Medium term (within two to five years)	Investment partnerships	**Friendshoring battery component manufacturing** To further strengthen the resilience of the battery supply chain, policymakers should promote diversification of supply in battery components (anodes and cathodes). This would require both demand creation and upfront investment in manufacturing capacity outside China. To stimulate demand, UK Export Finance (UKEF) or a new multilateral agency could broker offtake agreements between domestic battery cell manufacturers and cathode or anode manufacturing projects in countries outside China. Concessional financing or equity investment would also be required for these projects. Key partner countries could be South American 'Lithium Triangle' countries (Argentina, Bolivia and Chile) or mineral-rich emerging economies in Africa or Asia such as South Africa or Indonesia.
Medium-to-long term (within five to 10 years)	Onshoring	**Securing battery component manufacturing through foreign investment by main industry players from Asia** To further strengthen the resilience of the battery supply chain, policymakers should promote foreign direct investment in battery component production (such as anodes and cathodes). This will require fostering collaboration – through conditional public financing support from the NWF or other entities – between specialised foreign component manufacturers and domestic battery cell producers, who will need reliable sources of anodes and cathodes for their assembly operations. The NWF could also help cover initial capital costs by providing equity financing, thereby becoming a stable, long-term minority shareholder in new business initiatives.

Source: Authors' analysis

4.
THE SOLAR PV SUPPLY CHAIN

4.1 THE CENTRALITY OF THE SOLAR PV SUPPLY CHAIN AND ITS STRUCTURE

In 2024, 553GW of capacity was installed globally, 61.7 per cent of which was in China (IEA 2025c). By 2029, solar PV is expected to become the world's largest source of renewable electricity generation (IEA 2024c).

Solar PV manufacturing is dominated by the monocrystalline silicon (c-Si) technology[12] that accounts for 98 per cent of global production, with cadmium telluride (CdTe) thin-film technology taking the remaining share (Fraunhofer 2025).

The production of solar panels has four major steps (table 4.1 in light blue). It all originates in silicon being refined and subsequently turned into solar-grade polysilicon, which is then crystallised into monocrystalline silicon ingots. From there, silicon ingots are sliced into wafers and transformed into solar cells with varying methods. Solar cells are finally assembled into PV modules, with the use of other input materials made of aluminium (for the module frame), silver (for electronic contacts), copper and glass (for the module cover).

TABLE 4.1: THE SOLAR PV SUPPLY CHAIN

	Resource production	Material production	Manufacturing components		Final products	
Main solar PV supply chain	Silicon	Polysilicon	Wafers	Cells	PV modules	
Other production inputs	Aluminium Copper Silver Glass	Solar manufacturing equipment				
Components for solar power plants						Inverter Mounting equipment Balance of system

Source: Authors' analysis of IEA (2022) and SolarPower Europe (2024a)

Note: This chapter focusses mostly on the highlighted areas in the table.

The final process of module assembly – roughly identical across regions – accounts for approximately 40–50 per cent of total manufacturing costs. Cost differentials

12 The use of perovskite, still in its infant development, does not substitute crystalline silicon.

between China and Europe appear in other stages of production (cells, wafers and polysilicon), where variations in energy costs and depreciation rates create competitive disparities (IEA 2022).

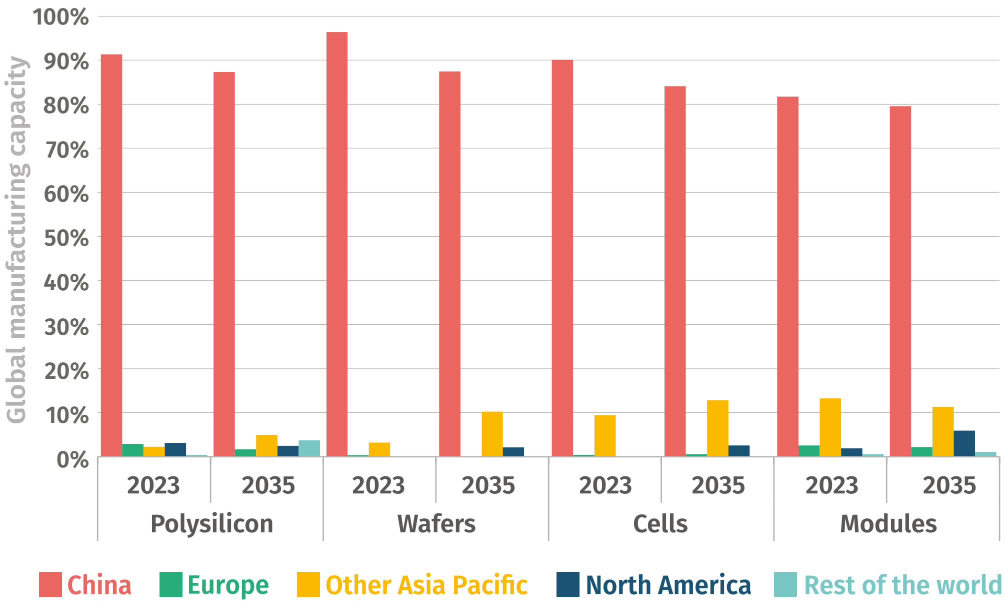
Solar panel production relies on specialised equipment for each manufacturing step, with the machinery used to turn wafers into cells being the most valuable type of equipment in the supply chain (IEA 2022).

4.2 RISK OF DISRUPTIONS IN THE SOLAR PV SUPPLY CHAIN FROM THE UK PERSPECTIVE

4.2.1 Concentration of production capacity in the solar PV supply chain at the global level

FIGURE 4.1: THE SOLAR PV SUPPLY CHAIN IS DOMINATED BY CHINA AND IS EXPECTED TO REMAIN SO FOR THE NEXT DECADE, WITH ONLY MARGINAL GROWTH FROM OTHER ASIA-PACIFIC COUNTRIES

Concentration of solar PV supply chain production capacity and 2035 projections



Source: IPPR's analysis of IEA figures made available to the authors

Note: 2035 projections are based on STEPS scenario.

Global production capacity for solar modules reached 1,155GW in 2023 (IEA 2024a), with slightly lower capacities for cells (1,135GW), and progressively lower levels for wafers (902GW) and polysilicon (855GW). However, nearly all of this is concentrated in China, which accounts globally for 81.8 per cent of module manufacturing, for 90.1 per cent of cell manufacturing and for a staggering 96.3 per cent and 91.3 per cent of wafer and polysilicon production respectively (see figure 4.1).[13] China has also captured nearly three quarters of global manufacturing capacity for solar inverters (SolarPower Europe 2024b). In solar manufacturing equipment

13 China moved from accounting for less than 30 per cent of the world's polysilicon production in 2010 to reaching over 80 per cent by 2021 (IEA 2022).

too – a segment once dominated by Europe – Chinese producers now hold global leadership.[14]

The remaining share of manufacturing capacity in modules and cells is mostly located across Asia-Pacific countries such as India, Vietnam and Malaysia. Canada and the US have a marginal production capacity in polysilicon and modules, which was expected to increase by 2035 (together with wafer and cell manufacturing) as a result of the IRA, prior to its recent revision.

Europe remains a distant third (Fraunhofer 2025). Production is below targets set out in the EU Net Zero Industry Act in every segment of the supply chain aside from solar inverters and polysilicon. Germany and Spain represent 21 per cent of global manufacturing capacity of inverters (SolarPower Europe 2024b). In polysilicon production, a single company — Wacker, based in Germany — remains the only significant producer outside China, with 26.1GW of capacity. Wafer production capacity is virtually absent. Until 2023, cell manufacturing capacity has been lower than 2GW, with the only two major players being Meyer Burger in Germany and 3SUN in Italy, both struggling to maintain their planned expansive investments in the current market. Module assembly is more dispersed into dozens of smaller companies, accounting for approximately 14GW of production capacity.

4.2.2 UK import dependency in the solar PV supply chain

China is the origin of over 55 per cent of UK imports in solar PV modules and this figure has grown over the past few years. This level does not fully reflect China’s dominance of the solar supply chain because relatively low levels of demand for solar panels in the UK could be satisfied by smaller scale producers in Europe. But it is notable that as demand has increased, so have imports from China. Current alternative suppliers include Germany and the US, while South-East Asian countries such as Vietnam and Malaysia could also emerge as potential sources of imports as they expand their manufacturing capacity across the solar PV supply chain (Yeh and Woods 2023). China is also the main import source for cells. Other import dependencies in wafers and polysilicon are less relevant for the UK at present, as its manufacturing capacity is currently limited to some relatively small module assembly activities.

TABLE 4.2: ANALYSIS OF IMPORTS AND DEPENDENCIES IN THE SOLAR PV SUPPLY CHAIN

	Total import value	Top supplier	Residual supply index[15]
Polysilicon	£19,985,574	Japan	21.9
Wafers	£100,441,862	USA	66.9
Cells	£67,187,532	China	66.9
Modules	£692,385,546	China	44.3

Source: Authors’ analysis of HMRC (2024)

Note: Average values for the period 2022–2024. Methodological details, including the choice of product codes, are included in the appendix.

14 Until 2008, leading companies in solar PV manufacturing equipment – accounting for 90 per cent of global revenues in 2008 – were located primarily in Germany, US, Japan and Switzerland. By the end of the 2010s, the top 10 producers were all Chinese, representing a global market share close to 50 per cent (IEA 2022).

15 The residual supply index is a measure of supply chain dependency. It shows the proportion of imports left after the top import source country is removed. Higher numbers show low levels of dependency, while lower numbers highlight higher levels of dependency.

4.2.3 Other factors influencing resilience in the solar PV supply chain

1. **Market characteristics and trends**

   Annual demand for solar PV is set to increase globally by around 50 per cent between now and 2035 (IEA 2024). Global overcapacity and excess supply can accommodate expected demand increases, but low prices and narrow margins will sustain the dominance of Chinese producers – themselves consolidating into fewer players – while discouraging new entrants from outside China.

2. **Technological specifications and trajectories**

   Alternative technologies are not yet commercially available. Emerging options – notably perovskite and heterojunction solar cells – offer higher technical efficiency but remain less competitive. Established alternatives, such as cadmium telluride (CdTe) thin-film, still occupy a small market niche because of their significantly lower efficiency and narrower range of applications.

   Established producers retain a built-in advantage, given the highly commoditised nature of dominant crystalline-silicon solar modules, which demand large-scale manufacturing capacity and economies of scale driven by process innovation rather than product specialisation.

3. **Substitutability**

   Wind is the main substitute for solar PV when it comes to renewable power generation. Nevertheless, solar has a lower levelised cost of electricity (LCOE) and can exploit a complementary energy source (ie sunshine) when the wind does not blow (IEA 2024d).

4. **Lead times to scale up capacity**

   Lead times vary across the solar supply chain, with longer periods required for upstream segments. In the EU and US, establishing a module or cell factory typically takes 6–18 months, increasing to 12–24 months for wafer production and 20–40 months for polysilicon. However, the primary challenge in establishing solar PV manufacturing facilities lies in cost competitiveness[16] rather than lead times.

5. **Other countries' policies**

   Chinese restrictions on solar panel exports pose a relatively minor threat at present but bans on equipment and mineral components could significantly affect non-Chinese producers. More serious are potential restrictions on solar PV manufacturing equipment, as well as the export controls on cadmium telluride introduced by China's Ministry of Commerce on 4 February, which affect thin-film solar PV producers – particularly in the US (Shaw 2025).

4.3 IMPACT OF SOLAR PV SUPPLY CHAIN DISRUPTIONS FOR THE UK

4.3.1 The UK's production capacity in the solar PV chain

The UK has virtually no production in the solar PV supply chain, apart from some minimal manufacturing capacity in module assembly of 25MW[17] and 2MW, operated respectively by the company GB-Sol and UKSOL (Sinovoltaics 2025).

4.3.2 Dependency ratio in the UK's solar PV supply chain

The UK dependency in cells, wafers and polysilicon is 100 per cent and set to remain so. In module assembly, we have estimated that the UK capacity will be able to cover only 0.5 per cent of the UK's forecasted demand[18] for solar panels

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16 Energy costs are extremely relevant – especially in the production of polysilicon, which absorbs 40 per cent of total energy consumed to manufacture solar PV modules (IEA 2022).

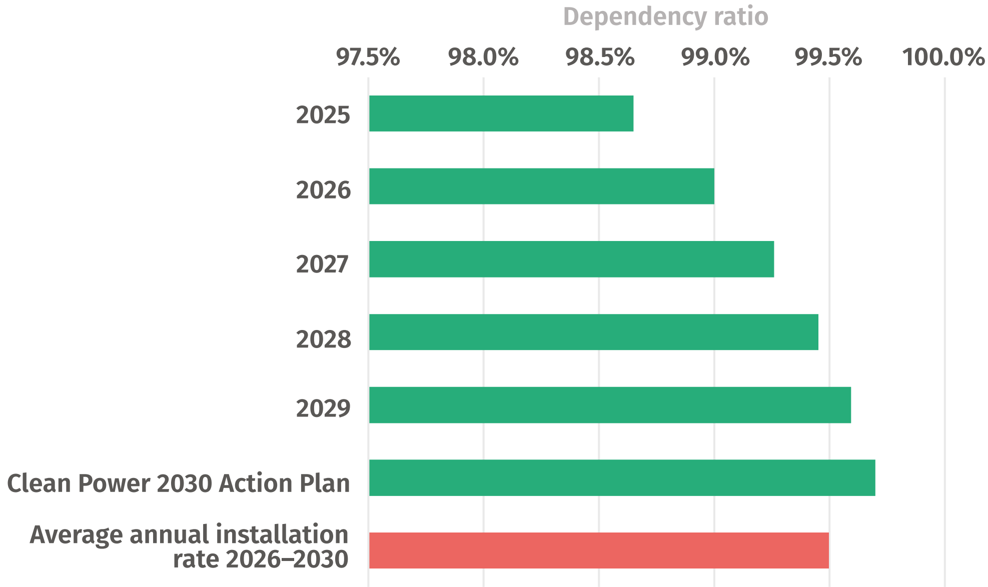
17 Figure from the company's website.

18 Based on the government's plan for solar power installation by 2030 (DESNZ 2024).

by 2030 – meaning that the dependency ratio will be on average 99.5 per cent over the next five years (figure 4.2).

FIGURE 4.2: THE UK'S DEPENDENCE ON SOLAR MODULE IMPORTS IS ALREADY HIGH AND LIKELY TO GROW WITH THE INCREASED DEPLOYMENT OF SOLAR POWER

Dependency ratio for solar PV modules 2026–2030



Source: Authors' analysis of DESNZ (2024, 2025) and SINOVOLTAICS (2025)

Note: See appendix for more details on the methodology.

We further estimated the maximum potential cost of supply chain disruption to solar power deployment in the UK. We assumed that missing solar installation targets – based on the government's plan (DESNZ 2024) – would require compensating with an equivalent amount of natural gas consumption to generate the corresponding amount of expected electricity.

As reported in table 4.4, the full disruption of solar panel imports over the period 2026–2030 could add £1.6 billion per year to total national energy spending due to additional natural gas purchases that would be avoided if the solar PV capacity is installed. Under partial disruption of solar panel imports from China – based on current import dependency – the same figure would be £875 million.

TABLE 4.4: SCENARIOS OF SOLAR PV SUPPLY CHAIN DISRUPTIONS IMPACTING THE UK'S SOLAR DEPLOYMENT PLANS WITH ESTIMATED COSTS

	Scenarios	
	Full disruption	Partial disruption from China
Solar power installed capacity at risk (2026–2030)	26.7GW	14.7GW
Annual solar power generation at risk (from 2030)	26,666GWh	14,740GWh
Corresponding annual volume of natural gas needed to compensate disruption (from 2030)	2.7 billion m^3	1.5 billion m^3
Annual cost of natural gas needed to compensate electricity generation through solar panels (from 2030)	£1,583 million	£875 million

Source: Authors' analysis of DESNZ (2024) and Ofgem (2025)

Note: The 'full disruption' scenario assumes the UK being entirely cut off from foreign supply; the 'partial disruption' scenario is based on the risk of losing access to China's share of solar panel imports (currently 55 per cent). See appendix for more details on the methodology.

4.3.3 Impact of solar PV supply chain disruptions on national policy priorities

Potential disruptions could seriously undermine not only energy security – as outlined in section 4.3.2 – but also the decarbonisation of the power sector.

TABLE 4.3: THE IMPACT OF DISRUPTIONS IN THE SOLAR PV SUPPLY CHAIN IS SIGNIFICANT FOR ENERGY SECURITY AND NET ZERO POLICY OBJECTIVES

Policy	Degree of impact	Description
Industrial base and jobs	★	The solar PV supply chain does not constitute a direct competitive threat to existing economic activities. Nor will its establishment represent a major impulse to growth and job creations – most of the job opportunities are found in deployment and maintenance rather than manufacturing.
Energy security	★★★★	Disruptions in the solar PV supply chain due to low levels of security and resilience can reduce the UK's energy security by making it more reliant on fossil fuel imports, notably natural gas deployed in thermal power plant. Based on NESO's 'New Dispatch' scenario, by 2030 solar power is expected to increase its annual production by 31TWh compared to 2023, while electricity made from natural gas is forecast to fall by 70TWh in the same period.
Net zero objectives	★★★	Disruptions in the solar PV supply chain due to low levels of security and resilience can severely affect the government's plans to decarbonise the power sector. The government set a target of 47GW of solar power capacity to be installed by 2030, up from 16.6GW at the end of 2024.

Source: Authors' analysis

Note: The degree of impact is measured with stars from low (one star) to high (five stars).

4.4 POLICY ACTIONS TO INCREASE THE RESILIENCE OF THE SOLAR PV SUPPLY CHAIN

Ensuring resilience in the solar supply chain means securing the availability of solar panels for the UK while reducing its growing dependence on Chinese imports. Table 4.5 lists the specific policy actions that could be undertaken.

As a priority, the government could pursue international partnerships with similar countries to coordinate a virtual stockpiling mechanism and establish shared strategic reserves of solar panels.

However, building buffer stocks of solar panels can only overcome temporary disruptions. Over the medium term, greater resilience in the solar PV supply chain can only be achieved by diversifying the UK's inflows of solar modules.

This could be done by supporting friendshoring in countries that are developing solar PV manufacturing capacity through investment partnerships. But it should be noted that the manufacturing capacity in those countries is likely to be built by Chinese-owned companies, thus not eliminating geopolitical dependency risks.

Ultimately, reducing dependency risks in the solar supply chain requires establishing some degree of autonomous manufacturing capacity, both domestically and in neighbouring, allied countries. This would involve cooperating with regional partners in Europe to create 'transnational champions' capable of producing solar panels to meet part of the region's demand, even if this initially proves uncompetitive.[19] The associated costs would not be prohibitive, given Europe's relatively modest demand, the lower capital intensity of the solar PV supply chain (particularly if efforts focus on cell and module production), and the potential to share the financial burden across several countries.

19 Airbus, the world-leading manufacturer of commercial aircraft, took 20 years to achieve an operating profit (Warner 2019). Similarly, Rolls-Royce reported its first pre-tax profit in 1985, following the 1971 nationalisation that rescued it from bankruptcy and supported the development of the successful RB211 engine (Pourvand 2013).

TABLE 4.5: POLICY ACTIONS ON THE SOLAR PV SUPPLY CHAIN

Timeline	Policy action	Description
Short term (within two years)	Coordinated virtual stockpiling	**Virtual stockpiling of solar panels to secure a buffer stock** The UK and its partners could pool financial resources to develop a virtual stockpiling mechanism, delivered by an agency created under the Global Clean Power Alliance (GCPA), to ensure that all members have access to supplies of solar panels. The virtual stockpile would be delivered through options contracts taken out with distributors and wholesalers across member countries. The UK and its GCPA partners could commit to holding a share of annual solar deployment targets in such contracts, supporting one another in cases of disruptions. Beyond existing GCPA members, countries such as Vietnam, India and Malaysia should be encouraged to join as emerging alternative suppliers in the solar supply chain – this could give their industries a boost in demand.
Medium term (within five years)	Investment partnerships	**Supporting friendshoring in countries building solar PV manufacturing capacity** The UK has recently signed a trade agreement with India, and has free trade arrangements in place with Vietnam and Malaysia through the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). These countries have also seen increasing investment and capacity in the solar supply chain. These three countries are eligible for Overseas Development Assistance (ODA). The UK can use its own development bank (British International Investments) and advocate for multilateral development banks like the World Bank to drive further investment in solar manufacturing capacity in these countries. This should be with the aim of delivering concessional finance or equity investment in solar projects within these countries. This provides a more competitive capital cost structure for producers in countries where there is an emerging but still early-stage solar manufacturing industry, to help them compete commercially with more established Chinese players.
Medium-to-long term (within five to 10 years)	Transnational industrial policy	**The UK engaging with neighbouring countries to build an integrated European solar PV manufacturing supply chain** The European Commission already supports the solar PV supply chain under the Net Zero Industry Act and the funding made available through the EU Innovation Fund. But the EU's policy approach currently lacks coordination to address the main challenges (eg energy costs, economies of scale). The UK could promote and join a transnational industrial policy initiative on solar PV with the EU, like it does already with Horizon, or with some military initiatives (eg the Eurofighter consortium). This could take inspiration from the historical 'Airbus model', in which participating countries pooled resources, shared technological capabilities, and distributed manufacturing activities across borders (based on areas of specialisation) to develop a competitive commercial aircraft. In the case of solar PV supply chain, the partnership should aim at creating new capacity and specialisation. One country might specialise in polysilicon, another in wafer and cell manufacturing, and several others in the easier module assembly. Particularly in module manufacturing, some strategic mergers of relatively small and scattered producers could help reach a more competitive scale. Reasonable public financing would be needed to support relatively modest capital expenditure costs, compared to other clean energy supply chains. This could include equity instruments implying partial public ownership. For instance, Europe's leading solar manufacturer – 3SUN – has been created as a subsidiary of Enel, Italy's state-owned main electric company. Operating costs may also require temporary support, which could be provided through public procurement for government installations and the creation of a protected regional (ie European) market, based on social and environmental standards.

Source: Authors' analysis

5. STEELMAKING

5.1 THE RELEVANCE OF STEELMAKING FOR CLEAN ENERGY MANUFACTURING AND ITS MAIN PROCESSES

In this chapter we focus on the growing importance of steel as an essential material input for clean energy manufacturing and infrastructure IEA (2024a). In fact, steel accounts for over 60 per cent of all material costs incurred to produce a typical wind turbine, as well as around 20 per cent of total material costs for heat pumps (IEA 2024e). Moreover, global demand for steel applications in wind manufacturing and EVs is expected to increase three-fold under a net zero scenario by 2030 (IEA 2024a).

Steel is currently produced via two different methods (table 5.1). One transforms iron ore into pig iron in blast furnaces to achieve 'virgin' steel products.[20] The other process recycles scrap material by melting it in electric arc furnaces. The first process, though currently the most emission-intensive, remains essential for producing flat products with superior ductility and surface quality, which are vital for key manufacturing industries such as automotive.

TABLE 5.1: MAIN STEELMAKING PROCESSES

Production processes	Input raw material	Ironmaking	Steelmaking	Semi-finished Products	Hot-rolled products	Finishing operations
Primary steelmaking	Coal Limestone Iron ore	Pig iron from blast furnace	Basic oxygen furnace Electric arc furnace	Blooms Billets Slabs	*Long products* Rails Structural shapes Welded tubes Seamless tubes Wire rods Bars Rebar *Flat products* Coils Plate	Cold rolling Metal coating Painting
	Iron ore	Sponge iron from DRI process	Electric arc furnace			
Secondary steelmaking	Scrap ferrous material	[None]	Electric arc furnace			

Source: Authors' analysis of Worldsteel (2025a)

20 Virgin steel can also be produced with electric arc furnaces, when iron ore is 'reduced' into a sponge-like form through the direct reduced iron (DRI) process – which can be powered by coal, gas or hydrogen.

5.2 RISK OF DISRUPTIONS IN STEELMAKING FROM THE UK PERSPECTIVE

5.2.1 Concentration of steel productive capacity at the global level

Steelmaking is one of the world's most widespread economic activities, with more than 90 countries producing crude steel in varying quantities. China is the world's dominant steelmaking nation, representing over 46 per cent of global productive capacity.

TABLE 5.2: GLOBAL STEEL PRODUCTION CAPACITY

Country or region	2010		2020		2024		2027 (estimated)	
	Mt	Global share	Mt	Global share	Mt	Global share	Mt	Global share
China	1057.9	48.5%	1147.9	47.3%	1141.5	46.2%	1188.8	45.1%
EU	227.8	10.5%	205.6	8.5%	205.7	8.3%	206.8	7.8%
India	84.4	3.9%	142.3	5.9%	179.5	7.3%	209.9	8.0%
US	117.9	5.4%	113.6	4.7%	119.3	4.8%	127.8	4.8%
Japan	132	6.1%	128.5	5.3%	117	4.7%	117.7	4.5%
Russia	77.7	3.6%	88.8	3.7%	90.8	3.7%	95.0	3.6%
South Korea	76	3.5%	81.6	3.4%	81.6	3.3%	85.1	3.2%
Iran	22.5	1.0%	50.3	2.1%	59.2	2.4%	72.6	2.8%
Turkey	42.7	2.0%	53.4	2.2%	59	2.4%	68.7	2.6%
Brazil	44.6	2.0%	50.9	2.1%	50.9	2.1%	50.9	1.9%
Mexico	20.3	0.9%	27.7	1.1%	27.7	1.1%	27.7	1.1%
Canada	18.6	0.9%	16.2	0.7%	16.3	0.7%	19.8	0.8%
UK	18.7	0.9%	12.1	0.5%	7.3	0.3%	10.3	0.4%
Rest of the world	238.4	10.9%	305.5	12,6%	316.3	12.8%	356.2	13.5%
World	2179.5	100.0%	2424.4	100.0%	2472.1	100.0%	2637.3	100.0%

Source: Authors' analysis of OECD (2024, 2025)

Some clear trends have emerged over recent decades (table 5.2): Europe and Japan have reduced their steelmaking capacity in both absolute and relative terms, whereas India, South Korea, Iran, Russia and Turkey have expanded theirs. In comparison, the US, Canada, Brazil and Mexico have generally kept capacity stable, with some modest growth.

5.2.2 UK import dependency on steel

As UK exports of steel in volume halved in the last decade,[21] the share of home deliveries out of total production increased from approximately one-third in 2014 to around 60 per cent in 2024 (UK Steel 2025a). British steelmakers are therefore increasingly producing for the domestic market.

At the same time, the UK's dependence on foreign steel imports has increased as demand for steel products declined less sharply than domestic production (see

21 The trade balance in value went from being slightly positive in 2014 to becoming negative by around £3 billion in 2024 (UK Steel 2025a).

section 5.3). The share of UK demand met by imports rose from around 64 per cent in 2014 to 69 per cent last year (UK Steel 2024a; 2025).

Nevertheless, despite this growing dependency, the UK's origins of steel imports remain diversified and are primarily sourced from neighbouring European countries. Import diversification has also improved over the past decade: in 2014, the top three and top ten suppliers accounted for 35 and 79 per cent of total imports respectively, compared with 28 and 70 per cent today (see table 5.3).

Finally, the UK's steel imports are now less dependent on countries considered higher geopolitical risks. For example, China fell from being the second largest source of steel imports in 2014 to the eleventh in 2024. Similarly, Russia, which ranked ninth in 2014, now has virtually no steel trade with the UK.

TABLE 5.3: UK FOREIGN DEPENDENCY ON STEEL IS WORSENING BUT IMPORT DIVERSIFICATION IS IMPROVING

	2014	2024
Demand met by imports	64.4%	69.1%
Top 3 (Residual supply index)[22]	0.65	0.72
Top 10 (Residual supply index)	0.21	0.30
Largest import sources (in order)	Germany, China, Spain, Netherlands' Belgium, France, Turkey, Italy, Russia, Sweden	Spain, Germany, Turkey, Netherlands, France, India, Belgium, South Korea, Portugal

Source: Author's analysis of Worldsteel (2015, 2025b) and on figures made available by UK Steel

5.2.3 Other factors influencing resilience in steelmaking

1. **Market characteristics and trends**

   The global steelmaking industry is suffering from overcapacity, particularly severe in Europe (OECD 2024). Moreover, China's net exports in volume are close to Europe's[23] total crude steel output (Worldsteel 2024), although direct steel imports from China remain modest. Low demand and cheaper imports are putting downward pressure on global steel prices, threatening the competitive survival of Europe's steelmaking production capacity and specialisation.

2. **Technological specifications and trajectories**

   Transitioning to secondary steelmaking can make productions more economically sustainable and potentially more resilient as it reduces reliance on imported iron and coke and deploys abundant scrap material instead. The UK is a major producer of scrap and the world's second largest exporter (UK Steel 2023). The introduction of direct reduced iron (DRI) processes could also secure the integrated production of virgin steel. Both approaches would significantly reduce emissions, but their viability in a highly competitive market will depend on electricity costs – where the UK currently faces a disadvantage.

22 The residual supply index is a measure of supply chain dependency. It shows the proportion of imports left after the top import source country is removed. Higher numbers show low levels of dependency, while lower numbers highlight higher levels of dependency.

23 The EU plus the UK.

3. **Substitutability**

   Steel is an irreplaceable input material in most infrastructure and manufacturing products, including in clean energy equipment.

4. **Lead times to scale up capacity**

   Lead times are not a significant concern in steelmaking, particularly in the context of European overcapacity. More critical are the long-term impacts that plant closures could have on production capacity and specialisation. In Europe – and even more so in the UK – steelmaking plants are often specialised in a relatively narrow range of steel products. Given the enormous barriers to entry in this high capital-intensive sector with slim profit margins, shutting down an operational unit would mean a permanent loss of productive capacity and valuable specialisation, further increasing foreign dependency.

5. **Other countries' policies**

   Steelmaking is becoming one of the most affected industries in trade disputes, while European countries are providing massive subsidies to their domestic industries. Steel has been central to the new tariff policy by the US administration, which has raised tariffs on steel imports to 50 per cent in June 2025 (with the UK getting a 25 per cent exemption), followed by another round of 50 per cent duty on 407 steel products in August. In parallel, European countries have been supporting the decarbonisation and competitive survival of their steelmaking industries with subsidies approved under state aid exemptions. Steel is also one of the key sectors selected by the European Commission in its recent 'Clean Industrial Deal' plan (European Commission 2025).

5.3 IMPACT OF STEELMAKING DISRUPTIONS FOR THE UK

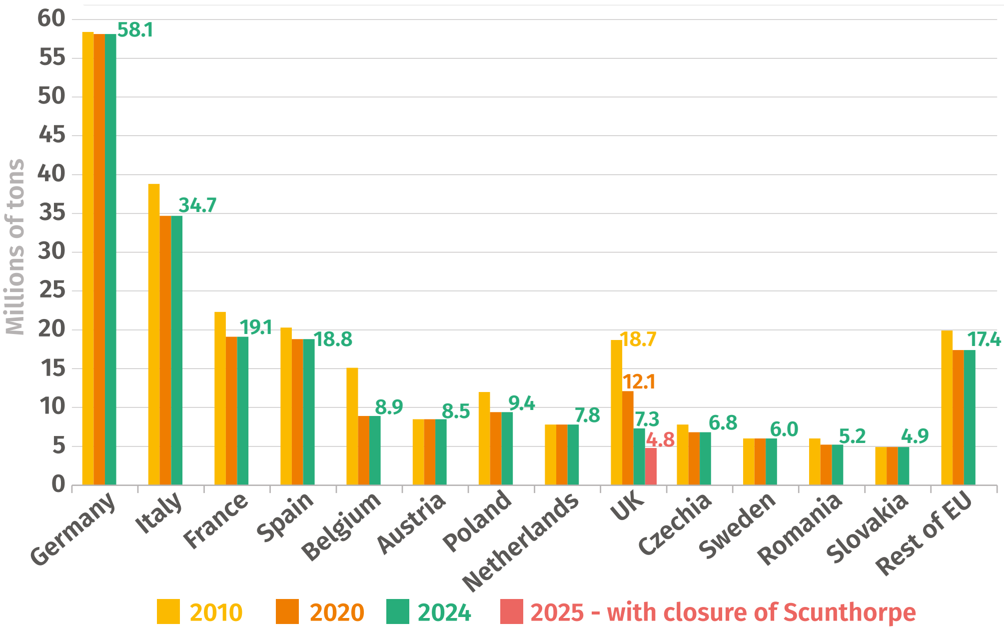
5.3.1 The UK's steelmaking capacity

The UK stands out as one of the countries with the largest reductions in steelmaking capacity since 2010. Following the closure of Port Talbot last year, capacity has fallen to 7.3 million tons – below that of Belgium, Austria, Poland and the Netherlands (see figure 5.1).

If Scunthorpe's blast furnaces were to shut down, as threatened earlier in April, the UK's steelmaking capacity would fall below that of Czechia, Sweden, Romania and Slovakia. Moreover, the UK would become the first G7 nation to end primary steelmaking, thereby becoming entirely dependent on imports of certain flat steel products used in manufacturing.

FIGURE 5.1: THE UK'S STEELMAKING CAPACITY HAS BEEN FALLING STEADILY SINCE 2010 AND MORE THAN THAT OF OTHER EUROPEAN COUNTRIES

Steelmaking capacity among European nations in the years 2010, 2020 and 2024.



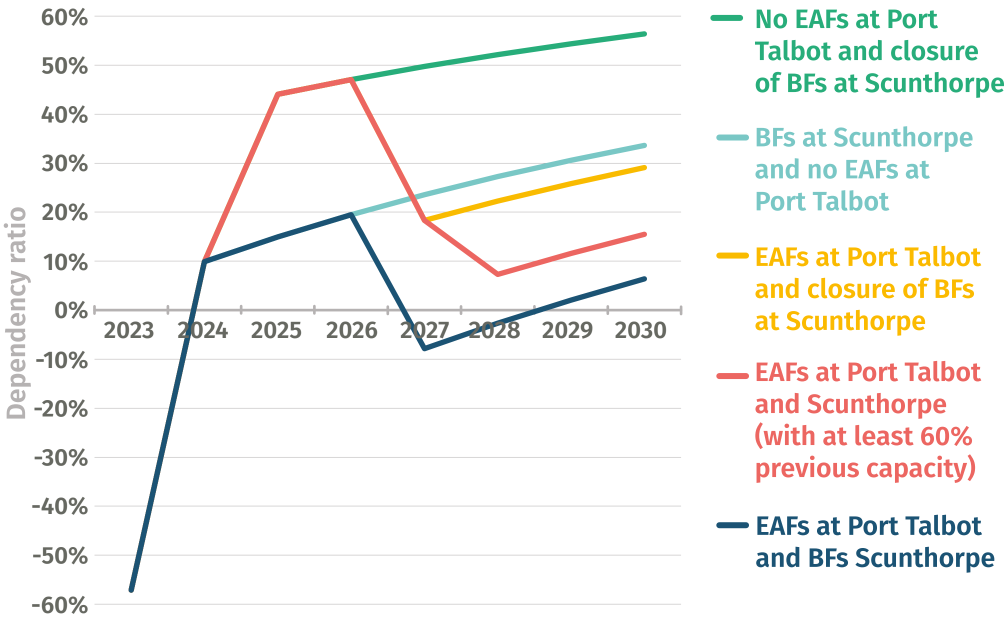
Source: Authors' analysis of OECD (2024, 2025)

5.3.2 Dependency ratio in the UK's steelmaking industry

In steelmaking the UK had excess capacity relative to its demand needs until 2024, when the closure of Port Talbot brought national productive capacity below annual consumption levels. In figure 5.2 we calculated five different scenarios for UK dependency ratios in steelmaking. With the closure of Scunthorpe, and without the planned new EAFs at Port Talbot replacing the previous blast furnaces, by 2030 the dependency ratio would be higher than 50 per cent. But even in the case where the planned EAFs became operational at Port Talbot in 2027, and without the shutting down of Scunthorpe's blast furnaces, by 2030 the UK would nonetheless maintain structural dependency on imports.

FIGURE 5.2: THE UK DEPENDENCY RATIO IN STEELMAKING WILL DEPEND ON FUTURE INVESTMENTS IN STEELMAKING CAPACITY

Estimated dependency ratios for UK steelmaking 2023–2030



Source: Authors' analysis of Worldsteel (2025) and companies' press releases

Note: See appendix for more details on the methodology.

5.3.3 Impact of steelmaking disruptions on national policy priorities

Steelmaking capacity is vital to the UK's current and future economic competitiveness. Once lost, capacity and capability are extremely difficult and costly to restore. This could undermine long-standing relationships between UK steel producers and downstream industries that depend on specialised products. The risk is particularly severe if it ends up affecting primary steelmaking capacity, which remains essential for producing specific types of flat steel used in manufacturing, especially in the automotive industry.

A decline in capacity could also indirectly undermine net zero and energy security goals if the lack of specific steel products slows the adoption of clean energy technologies that could be manufactured in the UK (eg wind turbines and supporting infrastructure).

TABLE 5.4: DISRUPTIONS TO UK STEELMAKING WOULD HAVE SERIOUS AND DIRECT CONSEQUENCES FOR NATIONAL ECONOMIC COMPETITIVENESS

Policy	Degree of impact	Description
Industrial base and jobs	★★★★★	UK steelmakers are specialised in various steel products that are used as inputs of major British companies (UK Steel 2024b). Often, steelmakers and steel-consuming businesses enjoy established long-term commercial relations. Losing production capacity and capabilities – specifically on flat steel products demanded by key manufacturing industries – would expose groups of UK companies to an undefined period of uncertainty and to the inevitable full dependency on foreign suppliers.
Energy security	★★	Steel finds numerous applications in clean energy equipment, notably in wind turbine manufacturing (Lumen 2025), on which the UK relies to accelerate wind energy deployment (Gasperin and Emden 2024). Steel also plays a critical role in the energy infrastructure required to support the electrification of the economy – through products such as transmission pylons and overhead ground wires – making steel production extremely relevant for the UK's energy security.
Net zero objectives	★★	Abandoning domestic steel production is not a viable solution for reducing emissions in this highly emission-intensive sector, as steel will still be required and would instead be imported — adding to the overall carbon footprint through transport. Achieving meaningful decarbonisation in steelmaking should be done by preserving existing capacity and specialisation, and by transitioning from blast furnace production.

Source: Authors' analysis

Note: the degree of impact is measured with stars between low (one star) and high (five stars).

5.4 POLICY ACTIONS TO INCREASE THE RESILIENCE OF STEELMAKING

The UK steelmaking sector needs to maintain its productive capacity and specialisation – to address demand needs and support long-established user-producer relationships with UK businesses. This short-term existential priority is intrinsically linked to the longer-term objectives of enhancing its competitiveness and ensuring its full decarbonisation.

The UK government should commit to a policy of 'keepshoring': retaining domestic production capacity, phasing out blast furnaces and substituting them with electric arc furnaces, while ensuring the ability to make 'virgin' steel domestically, either through indigenous ironmaking capacity (with the installation of DRI facilities) or via (green) iron trade with countries specialised in ironmaking.

Investment partnerships for 'green iron trade corridors' could be established with resource- and energy-rich countries to source sponge iron produced in DRI facilities powered by renewable hydrogen, enabling the UK to manufacture near zero-emission virgin steel.

Finally, joining open plurilateral agreements with neighbouring countries – mainly the EU – could secure access to a substantial market for green steel, where the UK's future low-carbon production could be more competitive.

TABLE 5.5: POLICY ACTIONS ON STEELMAKING

Timeline	Policy action	Description
Short term (within two years)	Keepshoring	**Preserving steelmaking capacity and capabilities while transitioning towards low-carbon production processes.** The UK steelmaking industry needs relief on electricity costs, which are significantly higher than in other European countries (UK Steel 2025b), and whose consumption volumes are expected to rise with the transition to EAFs. In previous work, IPPR recommended a specific role for Great British Energy (GBE) to install renewable generation capacity near production sites and sell electricity directly to industrial consumers via favourable Power Purchase Agreements (Gasperin and Evans 2025). This recommendation could specifically apply to UK steelmakers. Financial support is also necessary to help transition investments reach breakeven, including grants and other financing sources – such as equity via the National Wealth Fund (NWF). Any additional funding needed to deliver the EAF investment at Port Talbot could be provided through an equity injection into Tata Steel UK. In the case of British Steel, full or partial state ownership should not be ruled out – as was done with Sheffield Forgemasters in 2021 – if current owners are unwilling or unable to maintain production and transition to EAFs. State ownership is common among China's leading steel companies, and even in Europe, Sweden's SSAB – a partially state-owned firm – is making the world's most advanced investment in green steel production through the DRI process. Further support could come through domestic demand policies, such as raising the relevance of green steel criteria in public procurement tenders for infrastructure projects – although this would primarily affect long steel products.
Medium term (within two to five years)	Investment partnerships	**Establishing 'green iron corridors' to ensure a stable supply of green sponge iron for British steelmakers.** To preserve the UK's domestic capacity for producing virgin steel without relying on blast furnaces, it is essential to secure access to sponge iron. At present, sponge iron is mainly produced through coal- and gas-based DRI processes, predominantly in India and Middle Eastern countries such as Iran and Saudi Arabia. However, nations like Brazil, Canada, Sweden, Australia, South Africa and Mauritania – which possess both iron ore reserves and abundant (or potential) clean energy resources – could become key partners in establishing 'green iron trade corridors'. These countries would be well positioned to produce affordable sponge iron using renewable hydrogen. Investment partnerships should include financial and technical support for developing ironmaking capacity in partner countries, while promoting offtake agreements with UK steelmakers that would use the reduced iron in electric arc furnaces to produce low-carbon steel.
Medium term (within two to five years)	Open plurilateral agreements	**Collaboration with the EU main policy initiatives aimed at creating a protected market for low-carbon steel products.** The UK could participate in the EU's Carbon Border Adjustment Mechanism (CBAM) and align with the Ecodesign for Sustainable Products Regulation. Both pieces of legislation aim to stimulate a European market for green steel, protect domestic steelmaking from external dumping, and favour decarbonisation of the industry globally.

Source: Authors' analysis

6.
CRITICAL MINERALS

6.1 THE PROCESS OF OBTAINING CRITICAL MINERALS FOR CLEAN ENERGY MANUFACTURING

The manufacturing of clean energy equipment is highly dependent on the availability of critical minerals (IEA 2021). In particular, lithium, nickel, cobalt, manganese and graphite are essential in making battery anodes and cathodes. Rare earth elements (including neodymium, praseodymium, dysprosium and terbium) are fundamental to the production of the permanent magnets deployed in wind turbines and electric motors in EVs. Copper underpins all electricity-related technologies. It is also the largest source of material costs for heat pump manufacturing – where material costs account for over 80 per cent of total production costs (IEA 2024e). In this report we focus on copper, lithium, nickel, cobalt, graphite, rare earth elements, manganese and purified phosphoric acid.

While attention often centres on *mining extraction*, this is only part of the story. Clean energy manufacturing requires *refined* critical minerals. This implies a separate analysis and policy approach.

TABLE 6.1: THE CYCLE OF CRITICAL MINERALS EXTRACTION, DEPLOYMENT AND RECYCLING

First-time production	Application	Recycling	Application
Reserves			
↓			
Mining			
↓			
Refining →	Clean energy equipment →	Recycling	
		↓	
		Refining →	Clean energy equipment

Source: Authors' analysis

Mining and refining are also specific to each critical mineral. Nevertheless, an analytical distinction can be made between a first-time refining process, following the mining extraction from proven reserves, and refining that takes place after recycling. In both cases, specialised refining capacity is needed to obtain a material that can be used in further stages of the manufacturing process for clean energy supply chains.

6.2 RISK OF DISRUPTIONS IN CRITICAL MINERALS FROM THE UK PERSPECTIVE

6.2.1 Concentration of critical mineral mining and refining capacity at the global level

While the geographical distribution of mining is dependent on the availability of a given critical mineral in the ground (see table 6.2), the localisation of refining capacity is determined by where investments in transformation processes have been made. As a result, critical mineral refining at the global level is more concentrated than mining (see figure 6.1).

TABLE 6.2: CRITICAL MINERALS ARE EXTRACTED IN A PLURALITY OF COUNTRIES (MOSTLY OUTSIDE EUROPE), WITH CONCENTRATIONS VARYING DEPENDING ON THE SPECIFIC MINERAL

Global concentration of mining for critical minerals in 2024

	Copper	Lithium	Nickel	Cobalt	Graphite	REE	Manganese	Phosphate
Chile	24.0%	19.2%						
DRC	12.6%			62.0%				
Peru	11.5%							
China	8.0%	22.4%	3.4%	2.5%	85.5%	59.2%	3.9%	45.8%
Russia	4.8%		4.9%	2.5%	1.6%			5.8%
Indonesia	4.7%		63.3%	18.1%				
Australia		35.3%	2.6%	1.9%		4.2%	14.1%	1.0%
Argentina		5.1%						
Zimbabwe		9.0%						
Canada		2.4%	3.0%		0.6%			
Philippines			8.9%	0.9%				
Madagascar					4.0%			
Mozambique					2.1%			
Myanmar						16.9%		
US						9.9%		8.3%
South Africa							37.3%	0.9%
Gabon							23.2%	
Morocco								12.5%
Rest of the world	34.3%	6.7%	13.9%	11.5%	6.2%	9.8%	21.5%	25.7%

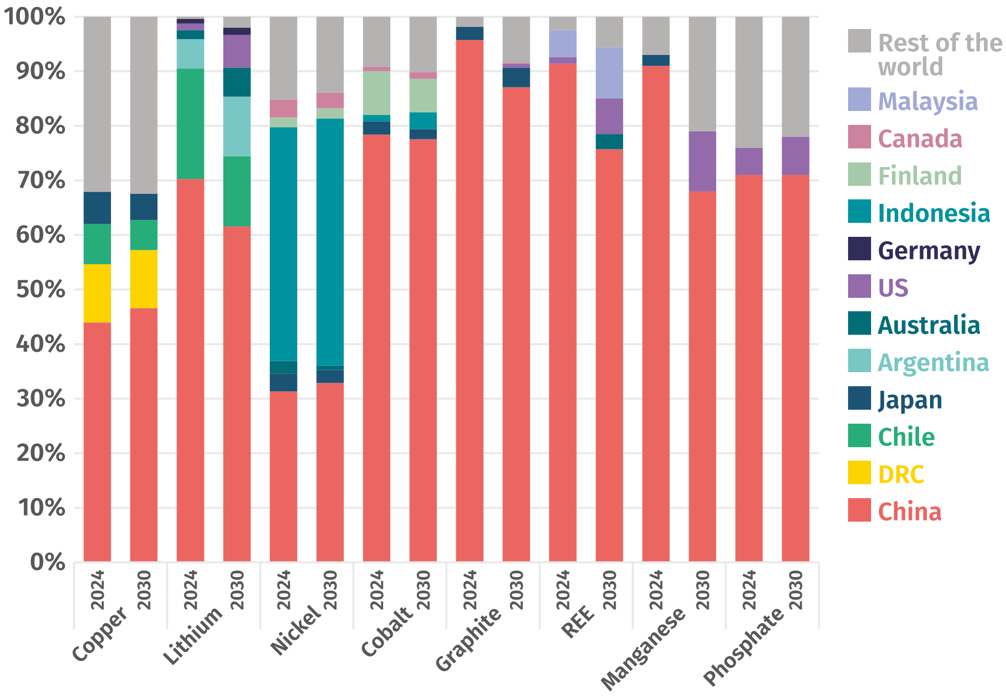
Source: Authors' analysis of IEA figures

Note: REE refers to rare earth elements. Red denotes the country with the highest global share of mining capacity for a given mineral.

While not always being the leading mining nation, China dominates global refining of almost all critical minerals – with the exception of nickel. Indonesia has become the world's number one producer of this mineral since toughening its export ban on nickel ore, although most of its processing facilities are Chinese-owned. China has a near global monopoly in the refining of graphite, manganese and rare earths. It also accounts for more than three quarters of global lithium and cobalt refining, having seen its share increasing since 2021 (IEA 2025b). Copper is the only other mineral – excluding nickel – where China's share is below 50 per cent and where refining capacity is more evenly distributed across the world.

FIGURE 6.1: THE REFINING OF CRITICAL MINERALS IS HIGHLY CONCENTRATED IN CHINA, AND ITS DOMINANCE IS SET TO PERSIST IN THE FOLLOWING YEARS

Global concentration of critical mineral refining in 2024 and projections for 2030



Source: Authors' analysis of IEA figures

Excluding nickel, European countries currently have almost no refining capacity in most of the selected critical minerals. Two exceptions are Finland, the world's second-largest country in cobalt refining (albeit limited to an 8 per cent share), and Germany with a 2.3 per cent global share of copper refining capacity (USGS 2025).

Projections for 2030 see only slight decreases in concentration of refining for lithium, graphite and rare earth elements. Phosphate, cobalt and nickel refining are likely to maintain the current distribution of production. Copper and Nickel refining are expected to see modest increases in concentration (figure 6.1).

6.2.2 UK import dependency on critical minerals

The UK is currently fully dependent on imports for critical minerals with applications in clean energy technologies.

6.2.3 Other factors influencing resilience in critical minerals

1. **Market characteristics and trends**

   Fluctuating demand for critical minerals generates price volatility, jeopardising investments in new mining operations. With supply being fairly rigid and limited, sudden changes in demand for critical minerals create disruptive price volatility.[24] An abrupt and prolonged decrease in prices can constrain profit margins and disincentivise mining players from expanding supply, reducing the scope for a broader geographical diversification of sources. But price movements in the opposite direction can affect the cost structure of a whole range of clean energy supply chains, as critical minerals account for a substantial portion of overall production costs. For instance, a tenfold increase in the price of lithium, nickel and graphite can lead to a 40–50 per cent increase in battery prices (IEA 2025b).

2. **Substitutability**

   Most critical minerals have very few efficient substitutes in applications to clean energy technologies. The growing dominance of LFP batteries is making cobalt and nickel less indispensable, but lithium remains essential as long as sodium-based alternatives prove commercially unviable. Rare earth elements are still technically superior for wind manufacturing, given that simple iron magnets are heavier and less efficient, although cheaper. Aluminium could replace the more expensive copper, but only in long-distance power lines.

3. **Lead times to scale up capacity**

   Lead times for new mining operations are typically very long, often exceeding 16 years (IEA 2022). In contrast, establishing new refining facilities can be accomplished in a much shorter time frame (normally five to six years) – as Indonesia demonstrated by moving from two to 44 nickel smelters between 2014 and 2024 (Catarata and Terzer 2025).

4. **Other countries' policies**

   Export controls on critical minerals are now part of ongoing trade disputes. As a response to the Western ban on certain technologies, China has been introducing restrictions on the export of critical minerals related to the semiconductor industry.[25] Further trade tensions are likely to affect critical minerals specifically used in clean energy applications, where China's dominance could be effectively weaponised. For instance, in April this year, China imposed export controls on seven rare earth elements (Baskaran and Schwartz 2025), followed in October by similar measures targeting products that contain them (MOFCOM 2025c). Additional restrictions on other critical minerals are reportedly under consideration (IEA 2025b).

6.3 IMPACT OF CRITICAL MINERALS DISRUPTIONS FOR THE UK

6.3.1. The UK's capacity in mining and refining critical minerals

The UK has no live extraction of critical minerals, despite having some deposits of lithium, nickel and cobalt. In terms of refining, the UK has some nickel capacity – around 1.1 per cent of the world's total in 2022 (USGS 2023) – but it does not produce battery-grade material. There is also some capacity for refined graphite and lithium (BaT Committee 2023).

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24 Over the past 10 years, 15 critical minerals have recorded greater price volatility than oil, and 10 of them have experienced more volatile prices than natural gas (IEA 2025b).

25 In 2024, China banned the export of gallium, germanium and antimony to the US in response to restrictions preventing US semiconductor companies from exporting to China.

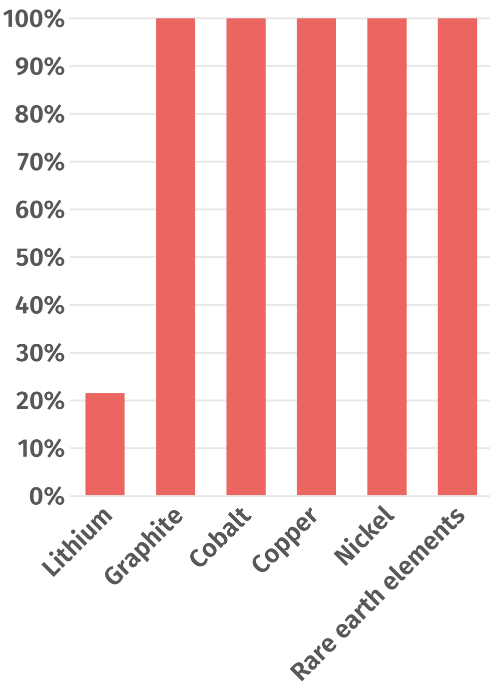
6.3.2 Dependency ratios in UK's access to critical minerals

In most critical minerals, the UK will always be fully dependent on imports (see figure 6.3). The potential exception is primary lithium, where it could become almost self-sufficient in extraction and refining if existing plans for Cornish Lithium and British Lithium, alongside other refining projects, come to fruition (Zylinski 2025). There could also be some domestic production of battery-grade nickel if investment enabled it at the existing nickel refinery in South Wales, but there are no plans for this at present.

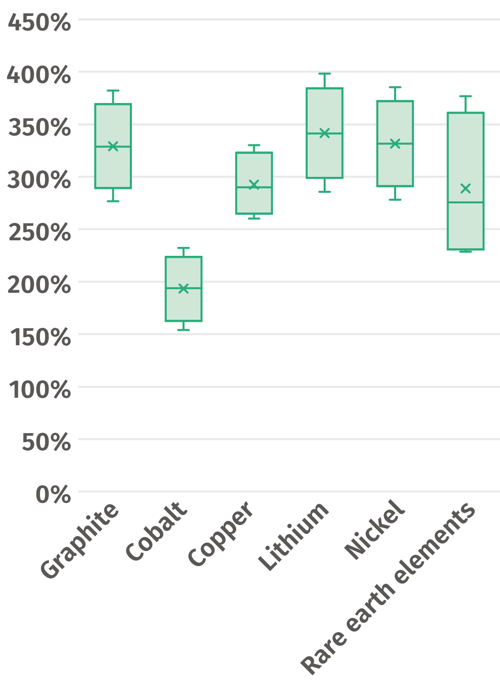
A disruption to critical minerals supplies can cause significant damage to UK clean energy technology supplies (and to the broader industrial sector). However, specific impacts are hard to model due to the range of critical minerals and their varied roles in different clean technology supply chains.

FIGURE 6.2: UK DEMAND FOR CRITICAL MINERALS IS SET TO SKYROCKET BY 2030, AND WE ARE LIKELY TO BE 100 PER CENT DEPENDENT ON IMPORTS FOR MOST OF THESE

Dependency ratio in 2030 by selected critical minerals, after accounting for announced extraction and refining capacity



Range of projected increase in demand for selected critical minerals between 2025 and 2030, based on UKCMIC projections under four energy transition scenarios



Source: Authors' analysis based on reported announcements of domestic critical mineral extraction and refining projects (left) and authors' analysis of UKCMIC (2024) (right)

Note: Graphite refers to natural graphite rather than synthetic graphite. Both are used in battery production.

6.3.3 Impact of critical minerals disruptions on national policy priorities

Disruptions in critical minerals could increasingly impact the UK's economic competitiveness and growth, particularly as domestic manufacturing of clean energy technologies expands. Effects on net zero and energy security would be indirect, arising if supply constraints and higher costs slow domestic deployment of these technologies.

TABLE 6.3: DISRUPTIONS TO THE UK'S ACCESS TO CRITICAL MINERALS WOULD HINDER THE DEVELOPMENT OF DOMESTIC CLEAN ENERGY MANUFACTURING

Policy	Degree of impact	Description
Industrial base and jobs	★★★★	Disruption in the availability of critical minerals in the UK can affect the domestic wind and heat pump manufacturing industries. These are two areas where the UK has a nascent competitive edge (Narayanan et al 2024; Gasperin and Emden 2024; Gasperin et al 2024), which could be further exploited with the planned expansions of both markets.
Energy security	★★	Access to critical minerals has essentially no *direct* impact on energy security and net zero policy objectives. However, difficulties in accessing critical minerals could increase the manufacturing cost of wind turbines, putting pressure on developers and creating uncertainty around the delivery of future wind farm projects. This could ultimately undermine the government's goal of doubling onshore wind capacity and tripling offshore wind capacity by 2030, a key contribution towards achieving both energy security and power sector decarbonisation (DESNZ 2024).
Net zero objectives	★★	

Source: Authors' analysis

Note: the degree of impact is measured with stars between low (one star) and high (five stars).

6.4 POLICY ACTIONS TO INCREASE THE RESILIENCE IN CRITICAL MINERALS

Countries around the world are already engaging in significant and extensive international cooperation and agreements on critical minerals. However, many existing initiatives focus on extraction when it is refining capacity that is particularly critical, being more concentrated.

Access to critical minerals could be secured and made more resilient by encouraging investment in refining capacity in countries that already have mining facilities. This is as true of advanced economies such as Australia or emerging markets and developing economies (EMDEs) such as South Africa. More initiatives related to innovation could bolster existing efforts either to reduce dependencies on dominant players or to reduce dependencies on the minerals themselves.

TABLE 6.4: POLICY ACTIONS FOR CRITICAL MINERALS

Timeline	Policy action	Description
Short term (within two years)	Investment partnerships	**Offering concessional loans or equity finance to de-risk investments in refining capacity outside China.** The UK could do this unilaterally through its own public finance institutions or it could pool finance with other countries and commercial actors in plurilateral or multilateral investment initiatives.
Short term (within two years)	Investment partnerships	**Offering offtake agreements to ensure stability of demand for new critical minerals refining.** An international critical minerals buyers' club could facilitate offtake agreements between refineries in new countries and manufacturers who would use the minerals as inputs. This would increase the predictability of revenue streams making projects more attractive for investors. Facilitating offtake agreements should be tied to responsible sourcing and transparency standards to help strengthen market confidence in countries developing refinement capacity.
Short term (within two years)	Science and innovation partnerships	**Technical assistance and vocational upskilling/educational and skills partnership** Zambia is set to open Africa's first cobalt sulphate refinery at the end of this year, primarily funded by the Nigeria-based Africa Finance Corp (Masunda 2024). This marks an important step up the value chain of lithium-ion battery manufacturing (Masunda 2024). To support the sustainable development of emerging refinery industries outside China, like the one in Zambia, the UK should leverage its expertise in the mining industry. This should be done through science and innovation partnerships with Zambia centred on knowledge transfer, technical assistance and vocational training. The previous government made similar partnerships with South Africa that focus on vocational and technical education and expert exchanges (Beuter et al 2025).
Medium to long term (within five to 10 years)	Science and innovation partnerships	**Accelerating innovation in new battery chemistries.** There could be greater collaboration between the UK's R&D ecosystem, like UK Research and Innovation (UKRI) and those of other advanced economies such as Japan or South Korea to develop technologies that use more abundant mineral resources. These partnerships could also encompass mineral-rich countries such as the South American 'Lithium Triangle' of Chile, Argentina and Bolivia, alongside African nations like Zambia and South Africa.

Source: Authors' analysis

7.
CROSS-CUTTING CONSIDERATIONS ON POLICY

7.1 RETHINKING INTERNATIONAL RELATIONSHIPS FOR RESILIENCE

TABLE 7.1: MAIN COUNTRIES FOR INTERNATIONAL COLLABORATIONS ON SELECTED CLEAN ENERGY SUPPLY CHAINS FROM A UK PERSPECTIVE

	Battery	Solar PV	Steelmaking	Critical minerals
Onshoring				
Keepshoring				
Transnational industrial policy				
Stockpiling				
Investment partnerships				
Open plurilateral agreements				
Science and innovation partnerships				

Source: Authors' analysis

This report has stressed the point that policy approaches will differ in each supply chain, as will the countries the UK needs to partner with in order to increase resilience across each one. While the list of countries is not exhaustive, it reflects the diversity of those that the UK should seek to collaborate with. For instance, to onshore battery manufacturing capacities the government should consider working with countries like China, South Korea and Japan, whereas Chile would be a better choice of partner for investment and science, and technology partnerships in the battery supply chain. Similarly, partner countries range from the EU, Turkey and the US to Malaysia, India and Vietnam depending on policy intervention in the solar PV supply chain.

Mapping potential partner countries is a valuable policy exercise as it provides a visualisation of the geographical spread and diversity of existing and potential international partnerships. This exercise can help determine where bilateral cooperation would be most effective and where engagement through regional or plurilateral groupings and initiatives make better sense. It also highlights where there are opportunities to work with partner governments across multiple supply chains, allowing for a more strategic and coordinated approach to building supply chain resilience.

CLARIFYING THE STANCE ON CHINA AND THE US

The UK government needs to set out a clear position on China, including the level of tolerance with Chinese investment and involvement in specific supply chains. This will give more certainty and confidence for businesses operating in these supply chains and could provide a clear signal to the market where they can work with China and where they must find alternative suppliers. In doing so, the government must take a pragmatic approach to collaborating on joint economic interests. This will require careful geopolitical management. Firstly, China's security interests are often at odds with the UK. Secondly, where there is closer collaboration with China, the US may take issue with this and put pressure on the UK to weaken its ties. It does not serve Britain's economic interests to not work with China on some level, so policymakers should be prepared to defend its decisions to collaborate with China from any potential economic coercion from the US.

7.2 CROSS-CUTTING INTERVENTIONS

7.2.1 Addressing a gap in UK public finance institutions for concessional finance in international projects

There is a gap in the tools that UK finance institutions can deploy for investments in alternative suppliers. Concessional finance or equity capital are often required for the kinds of investments needed to establish and scale production centres in new countries. Of the internationally facing public finance institutions, only British International Investments (BII) can offer this kind of finance. However, BII is limited by its mandate as a development finance institution to only invest in countries which qualify for Official Development Assistance (ODA).

UK Export Finance (UKEF) can de-risk projects through loans and guarantees but is constrained to lower-risk financing activities and does not offer equity or concessional finance. It is also limited to initiatives that have a direct link to UK export activities, so it cannot invest in projects that are beneficial for domestically focussed businesses. This means there is no single public finance body empowered to simultaneously take equity risk, operate internationally, and step outside ODA requirements.

To begin to get around this, we recommend a UKEF pilot equity financing facility for the battery supply chain, to complement the existing critical minerals supply finance product. There are pros and cons for tweaking the mandates of any of the public financial institutions – do we introduce more risk into UKEF's activities, stretch the mandate of the NWF even further while it is still in a relatively early stage of operation, or loosen the ODA mandate of BII? Given the scale and well-established nature of UKEF's operation, this seems like the best candidate. The organisation could develop equity products for investments in other countries that are linked to UK exporters. This could, for example, support the UK battery industry to find alternative suppliers of cathodes and anodes.

7.2.2 Creating a focal point for collaboration on resilience in clean energy supply chains through the Global Clean Power Alliance (GCPA)

The UK could advocate for a GCPA 'resilience agency'. This would have the tools to do the following.

1. **Generate demand for alternative suppliers**: this means funding and a remit to offer offtake agreements or facilitate offtake agreements between commercial actors within the GCPA member states.
2. **Encourage investment to establish and scale up capacity in specific areas**: this means a remit and funds to offer concessional finance to businesses that are attempting to scale up production for the first time in an alternative supplier country.
3. **A mechanism to enable the creation of buffer stocks for supply chains that are particularly risky.** This means an organisation that could monitor supply chains, manage financing and joint procurement, and run emergency protocols when buffer stocks are triggered.

Doing this through the GCPA would give both advanced economies and EMDEs access to resilience-building tools. The GCPA's Finance Mission makes clear that EMDEs in the GCPA are likely to be the beneficiaries of investment in green industrialisation. But additional mechanisms to support demand for emerging green industries in EMDE countries, alongside measures that reduce the risk of supply shocks, would enable a collaboration that improves resilience and enables development

8.
CONCLUSIONS

Despite progress in building the foundations of a net zero economy, the UK remains exposed to risks that could undermine its transition. Decades of overreliance on open market structures have left the country vulnerable to clean technology supply chain shocks. In an era marked by geopolitical tension, the UK can no longer rely on open trade alone to deliver affordable access to the materials and technologies it needs. Instead, ensuring supply chain resilience must now be viewed as a core pillar of national economic and security policy.

This report highlights that the UK must use a larger variety of policy tools and use them strategically. A proactive policy approach to increasing supply chain resilience can help diversify supply, foster partnerships with emerging producer nations, and strengthen domestic capabilities in certain areas.

Collaboration with other countries will be key if the UK is to succeed in its green transition, but it matters what countries we partner with.

If the UK can combine international economic policy with targeted domestic investment, it can build cleaner, more resilient supply chains that underpin energy security, industrial renewal and the UK's green transition. By setting out clear strategies for supply chain resilience, the UK can protect living standards, unlock green growth, and secure its place at the forefront of the clean energy economy.

REFERENCES

Altilium (2025) ‘Altilium announce successful production of UK’s first EV battery cells made from recycled materials’, news. https://altilium.tech/2025/03/17/altilium-and-ukbic-announce-successful-production-of-uks-first-ev-battery-cells-made-from-recycled-materials/

Anghel I (2025) ‘UK shipping rates climb in fresh inflation worry for BOE’, Bloomberg. https://www.bloomberg.com/news/newsletters/2025-07-09/trade-war-latest-shipping-costs-for-uk-companies

Battery-News (2025a) ‘Battery Active Material Production in Europe’. https://battery-news.de/en/2025/06/06/battery-active-material-production-in-europe/

Battery-News (2025b) ‘PTL Cancels Anode Factory in Sweden’. https://battery-news.de/en/2025/03/11/ptl-cancels-anode-factory-in-sweden/

Baskaran G and Schwartz M (2025) ‘The consequences of China’s new rare earths export restrictions’, CSIS. https://www.csis.org/analysis/consequences-chinas-new-rare-earths-export-restrictions

Bennett S, Gül T and Lomardo T (2025) ‘How can innovation help secure future battery markets and mineral supplies?’, commentary, International Energy Agency. https://www.iea.org/commentaries/how-can-innovation-help-secure-future-battery-markets-and-mineral-supplies

Beuter P, Bhuee R, Gabadadze L, Gnanguênon A and Hofmeyr J (2025) *Mapping Africa’s Green Mineral Partnerships,* Africa Policy Research Institute. https://afripoli.org/projects/crm-mapping/

BloombergNEF (2024) ‘Lithium-Ion Battery Pack Prices See Largest Drop Since 2017, Falling to $115 per Kilowatt-Hour’, press release. https://about.bnef.com/insights/commodities/lithium-ion-battery-pack-prices-see-largest-drop-since-2017-falling-to-115-per-kilowatt-hour-bloombergnef/

Bradsher K (2025) ‘China puts new restrictions on E.V. battery manufacturing technology’, New York Times. https://www.nytimes.com/2025/07/15/business/china-electric-vehicle-battery-manufacturing.html

Campbell P, Dempsey H and Davies C (2023) ‘The search for winners in the new battery era’, Financial Times. https://www.ft.com/content/34c6c191-a803-495a-938d-e1328d53d77c

Catarata M and Terzer T (2025) ‘Nickel, power, mobility: Indonesia’s new role in the global battery supply chain’, blog, Sinolytics. https://sinolytics.de/global-business-news/blog/geolytics/indonesias-role-in-global-battery-supply/

Caldara D and Iacoviello M (2025) 'Geopolitical Risk Index', dataset. https://www.matteoiacoviello.com/gpr.htm [accessed 10 September 2025]

Chappell L, Pultz S and Srinivasa Desikan B (2025) *Reset: Building modern partnerships with countries of the global south*, IPPR. https://www.ippr.org/articles/reset-building-modern-partnerships

China Daily (2024) ‘China establishes new centrally administered SOE on resource-recycling’. https://www.chinadaily.com.cn/a/202410/18/WS67124e87a310f1265a1c8676.html

Coibon O, Georgarakos D, Gorodnichenko Y, Kenny G and Meyer J (2025) ‘Geopolitical risks and their implications for consumer expectations and spending’, CEPR. https://cepr.org/voxeu/columns/geopolitical-risks-and-their-implications-consumer-expectations-and-spending

Department for Business and Trade [DBT] (2025a*) Industrial strategy,* policy paper. https://www.gov.uk/government/publications/industrial-strategy

Department for Business and Trade [DBT] (2025b) ‘Chapter 5: Secure and resilient trade’, *The UK’s trade strategy,* policy paper. https://www.gov.uk/government/publications/uk-trade-strategy/the-uks-trade-strategy#chapter-5-secure-and-resilient-trade

Department for Energy Security and Net Zero [DESNZ] (2024) *Clean Power 2030 Action Plan: A new era of clean electricity.* https://www.gov.uk/government/publications/clean-power-2030-action-plan

Department for Energy Security and Net Zero [DESNZ] (2025) ‘Energy Trends: June 2025’, dataset. https://www.gov.uk/government/statistics/energy-trends-june-2025

ECCO (2022) *A green steel strategy: options and challenges of decarbonisation,* ECCO. https://eccoclimate.org/wp-content/uploads/2022/09/REPORT-ACCIAIO-Una-strategia-per-lacciaio-verde-en.pdf

European Commission (2025) *The clean industrial deal: a joint roadmap for competitiveness and decarbonisation*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0085

European Union [EU] (2023) ‘Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC‘, EUR-Lex. https://eur-lex.europa.eu/eli/reg/2023/1542/oj/eng

Gasperin S and Emden J (2024) *A second wind: Maximising the economic opportunity for UK wind manufacturing*, IPPR. https://www.ippr.org/articles/a-second-wind

Gasperin S, Narayanan P and Emden J (2024) *The heatwave: Unlocking the economic potential of UK heat pump manufacturing*, IPPR. http://www.ippr.org/articles/the-heatwave

Gasperin S and Evans J (2025) *2030 and beyond: Great British Energy's role in the green transition,* IPPR. https://www.ippr.org/articles/2030-and-beyond

Greitemeier T, Kampker A, Tübke J and Lux J (2025) ‘China's hold on the lithium-ion battery supply chain: Prospects for competitive growth and sovereign control’, *Journal of Power Sources Advances*, vol 32, 100173. https://www.sciencedirect.com/science/article/pii/S2666248525000071

Hezlet E (2025) *UK Gas Power Stations: Capital Costs*, Watt Direction. https://wattdirection.substack.com/p/uk-gas-power-stations-capital-costs#footnote-1-160183199

International Energy Agency [IEA] (2021) *The role of critical minerals in clean energy transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

International Energy Agency [IEA] (2022) *Securing Clean Energy Technology Supply Chains*. https://www.iea.org/reports/securing-clean-energy-technology-supply-chains

International Energy Agency [IEA] (2022) *Solar PV Global Supply Chains*. https://www.iea.org/reports/solar-pv-global-supply-chains

International Energy Agency [IEA] (2023a) *Energy Technology Perspectives 2023*. https://www.iea.org/reports/energy-technology-perspectives-2023

International Energy Agency [IEA] (2023b) *The State of Clean Technology Manufacturing.* https://www.iea.org/reports/the-state-of-clean-technology-manufacturing

International Energy Agency [IEA] (2023c) *Emissions measurement and data collection for a net zero steel industry*. https://www.iea.org/reports/emissions-measurement-and-data-collection-for-a-net-zero-steel-industry

International Energy Agency [IEA] (2024a) *Energy Technology Perspectives 2024*. https://www.iea.org/reports/energy-technology-perspectives-2024

International Energy Agency [IEA] (2024b) *Recycling of Critical Minerals.* https://www.iea.org/reports/recycling-of-critical-minerals

International Energy Agency [IEA] (2024c) *Renewables 2024*. https://www.iea.org/reports/renewables-2024

International Energy Agency [IEA] (2024d) *Integrating solar and wind*. https://www.iea.org/reports/integrating-solar-and-wind

International Energy Agency [IEA] (2024e) *Advancing clean technology manufacturing*. https://www.iea.org/reports/advancing-clean-technology-manufacturing

International Energy Agency [IEA] (2025a) *Global EV Outlook 2025*. https://www.iea.org/reports/global-ev-outlook-2025

International Energy Agency [IEA] (2025b) *Global Critical Minerals Outlook 2025*. https://www.iea.org/reports/global-critical-minerals-outlook-2025

International Energy Agency [IEA] (2025c) *Global Energy Review 2025.* https://www.iea.org/reports/global-energy-review-2025

IPCEI Batteries (2024) *Battery cell production in Europe: Status quo and outlook.* https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/publications/2024-05-BZF_Kurzinfo_Marktanalyse_Q2_engl.pdf

International Renewable Energy Agency [IRENA] (2017) *Electricity storage and renewables: Costs and markets to 2030*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017.pdf

International Renewable Energy Agency [IRENA] (2024) *Geopolitics of the energy transition: Energy security*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Apr/IRENA_Geopolitics_transition_energy_security_2024.pdf

International Renewable Energy Agency [IRENA] (2025) *Renewable Power Generation Costs in 2024*. https://www.irena.org/Publications/2025/Jun/Renewable-Power-Generation-Costs-in-2024

Khan T and Jones D (2024) 'The future of the North Sea: three priorities for the UK government', Uplift, blog. https://www.upliftuk.org/post/the-future-of-the-north-sea-three-priorities-for-the-uk-government

Knehr K, Kubal J, Ahmed S (2024) 'Estimated Costs of EV Batteries 2019-2024', Argonne National Laboratory, dataset. https://www.anl.gov/sites/www/files/2024-08/EV%20Costs%202024%20for%20GPRA%20reporting%20%28August%2019%2C%202024%29.pdf

KPMG (2025) *Rough seas ahead: How are renewed geopolitical conflicts impacting supply chains?*, blog. https://kpmg.com/in/en/blogs/2025/08/rough-seas-ahead-how-are-renewed-geopolitical-conflicts-impacting-supply-chains.html

Labrunie M (2025) 'The role of industrial policy in shaping a more resilient Southeast Asia', Cambridge Industrial Innovation Policy. https://www.ciip.group.cam.ac.uk/reports-and-articles/industrial-policy-shaping-a-more-resilient-southeast-asia/

Lumen (2025) *Bill of works: a review of UK capability & capacity to supply offshore wind steel requirements*. https://www.uksteel.org/versions/2/wizard/modules/fileManager/downloadDigitalFile.php?url=https%3A%2F%2Ffiles.cdn-files-a.com%2Fuploads%2F8346772%2Fnormal_67ced276d338a.pdf

McBride K, Langengen T, West D, Bradley J and Mökander J (2025) *Sovereignty, Security, Scale: A UK strategy for AI infrastructure,* The Tony Blair Institute. https://institute.global/insights/tech-and-digitalisation/sovereignty-security-scale-a-uk-strategy-for-ai-infrastructure

Masunda O (2024) 'Africa inches closer to establishing its inaugural cobalt refinery on the continent', Modern Mining Zambia. https://modernminingzambia.com/africa-inches-closer-to-establishing-its-inaugural-cobalt-refinery-on-the-continent/

Ministry of Commerce of the People's Republic of China [MOFCOM] (2025a) 'The Ministry of Commerce spokesperson answered reporters' questions regarding adjustments to the Catalogue of Technologies Prohibited and Restricted for Export from China', [English translation]. https://www.mofcom.gov.cn/syxwfb/art/2025/art_072f1b88bcb4415fae1f05bbd569fd50.html

Ministry of Commerce of the People's Republic of China [MOFCOM] (2025b) 'The Ministry of Commerce and the General Administration of Customs issued Announcement No. 58 of 2025 on the implementation of export controls on items related to lithium batteries and artificial graphite anode materials', [English translation]. https://www.mofcom.gov.cn/zwgk/zcfb/art/2025/art_79646f0161564975a938fe00fee158d5.html

Ministry of Commerce of the People's Republic of China [MOFCOM] (2025c) 'The Ministry of Commerce and the General Administration of Customs issued Announcement No. 57 of 2025, announcing the decision to implement export controls on some medium and heavy rare earth-related items', [English translation]. https://www.mofcom.gov.cn/zwgk/zcfb/art/2025/art_59ec4f6bec0b459aa4a30c4bbd0a41c1.html

Morris M and Chappell L (2025) *Navigating trade-offs in the global economy: A framework for a world between orders*, IPPR. https://www.ippr.org/articles/navigating-trade-offs-in-the-global-economy

Narayanan P, Dibb G, Vanino E, Gasperin S and Murphy L (2024) *Manufacturing matters: The cornerstone of a competitive green economy*, IPPR. http://www.ippr.org/articles/manufacturing-matters

OECD (2024) *Latest developments in steelmaking capacity and outlook until 2026,* OECD. https://one.oecd.org/document/DSTI/SC(2024)3/FINAL/en/pdf

OECD (2025) *OECD steel outlook 2025,* OECD. https://www.oecd.org/en/publications/oecd-steel-outlook-2025_28b61a5e-en.html

Ofgem (2025) 'Gas Prices: Forward Delivery Contracts - Weekly Average (GB)' dataset. https://www.ofgem.gov.uk/news-and-insight/data/data-portal/wholesale-market-indicators

Philips S, Fraunhofer, PSE Projects (2025) *Photovoltaics Report,* Fraunhofer Institute for Solar Energy Systems. https://www.ise.fraunhofer.de/en/publications/studies/photovoltaics-report.html

Reeves R (2024) Rachel Reeves Mais Lecture 2024, Labour, press release. https://labour.org.uk/updates/press-releases/rachel-reeves-mais-lecture/

Shaw V (2025) 'China adds export restrictions for minerals used in thin-film solar', PV Magazine. https://pv-magazine-usa.com/2025/02/07/china-adds-export-restrictions-for-thin-film-solar-minerals/

Sinovoltaics (2025) 'Europe Solar Supply Chain Map Edition 1 – 2025', webpage. https://sinovoltaics.com/sinovoltaics-europe-solar-energy-supply-chain-map/

SolarPower Europe (2024a) '#MakeSolarEU: Rebuilding European solar manufacturing'. https://www.solarpowereurope.org/advocacy/make-solar-eu

SolarPower Europe (2024b) 'Inverter explained 2.0: Strengthening Europe's inverter industry'. https://www.solarpowereurope.org/advocacy/position-papers/inverters-explained-2-0-strengthening-europe-s-inverter-industry

SolarPower Europe (2025) 'Joint Statement: Iberian Blackout'. https://www.solarpowereurope.org/press-releases/joint-statement-iberian-blackout

Society of Motor Manufacturers and Traders [SMMT] (2025) 'September new car market delivers record number of EVs', dataset. https://www.smmt.co.uk/september-new-car-market-delivers-record-number-of-evs/

SNE Research (2025) 'From Jan to Dec 2024, Global EV Battery Usage Posted 894.4GWh, a 27.2% YoY Growth', press release. https://www.sneresearch.com/en/insight/release_view/371/page/0

The Faraday Institution (2024) *UK electric vehicle and battery production potential to 2040*, The Faraday Institution. https://www.faraday.ac.uk/wp-content/uploads/2024/09/Gigafactory-Report_2024_final_17Sept2024.pdf

UK Steel (2023) *Steel scrap: a strategic raw material for net zero steel*. https://www.uksteel.org/steel-scrap

UK Steel (2024a) *UK steel stats guide 2024,*. https://www.uksteel.org/reports-and-publications

UK Steel (2024b) *UK steel capacities and capabilities*. https://www.uksteel.org/reports-and-publications

UK Steel (2025a) *UK steel statistics 2025*. https://www.uksteel.org/reports-and-publications

UK Steel (2025b) *Industrial Electricity Prices*. https://www.uksteel.org/electricity-prices

US Geological Survey [USGS] (2023) *Mineral commodity summaries 2023*. https://pubs.usgs.gov/publication/mcs2023

US Geological Survey [USGS] (2025) *Mineral commodity summaries 2025,* U.S. Geological Survey. https://pubs.usgs.gov/periodicals/mcs2025/mcs2025.pdf

Walter D, Bond K and Butler-Sloss, S (2025) 'The Electrification Imperative', Ember. https://ember-energy.org/latest-insights/the-electrification-imperative/

Warner J (2019) 'Airbus vs Boeing: a brief history', IG, market analysis. https://www.ig.com/en/news-and-trade-ideas/shares-news/airbus-vs-boeing--what-you-need-to-know-about-the-stocks-190225#:~:text=By%201980%20%E2%80%93%20a%20decade%20after,that%20still%20rumbles%20on%20today

Worldsteel (2015) *World steel in figures 2015,* Worldsteel Association. https://worldsteel.org/wp-content/uploads/2015-World-Steel-in-Figures.pdf

Worldsteel (2025a) 'The steelmaking process', Worldsteel Association, webpage. https://worldsteel.org/about-steel/steelmaking-process/

Worldsteel (2025b) 'World steel in figures 2025', Worldsteel Association, dataset. https://worldsteel.org/data/world-steel-in-figures/world-steel-in-figures-2025/

Yeh A and Woods M (2023) *Building a Green, Fair and Resilient Solar Supply Chain*, Friedrich Naumann Foundation for Freedom European Dialogue Programme. https://static1.squarespace.com/static/61d5a7bdbb804663a82e154a/t/655645fc55beb52b5accf725/1724930367521/CSRI_FNF_Solar_UK.pdf

Zylinski S (2025) 'Cornish Lithium: a public mineral development fund, supporting green industrialisation in the UK', Common Wealth, briefing. https://www.common-wealth.org/publications/cornish-lithium-a-public-mineral-development-fund-supporting-green-industrialisation-in-the-uk#footnote-15

APPENDIX

A.1 METHODOLOGY USED TO ESTIMATE DEPENDENCY RATIOS AND IMPACTS

In our definition, the dependency ratio is constructed by comparing the UK's planned production capacity with the expected domestic demand for batteries, solar panels, steel and critical minerals in 2030.

Battery supply chain

We estimate the UK's dependency ratio across three major segments of the battery value chain – cells, cathodes and anodes.

For cells, we use analysis and forecasts by the Faraday Institution. Faraday forecasts battery demand of 108GWh in the UK in 2030, compared to expected production capacity at announced gigafactory sites (the Agratas gigafactory in Somerset, with an expected capacity of 40GWh and the AESC gigafactories in Sunderland, with an expected capacity of 17GWh). Using these figures, it estimates that 53 per cent of expected demand could be met by domestic production. The inverse of this figure – the 47 per cent of demand that is not covered by domestic production – becomes our dependency ratio.

For cathodes, a few companies are attempting to build capacity in cathode material production. Altilium estimates that it would be able to meet 20 per cent of the UK's cathode demand by 2030 through its Teesside battery recycling plant. Our research has found no other companies with an estimated production capacity in cathode materials, so we take Altilium's estimate as an indication of domestic production capacity. The inverse – 80 per cent of demand – will need to be met by imports without additional investments in domestic capacity, so this becomes our dependency ratio.

For anodes, our research uncovered no planned anode production capacity in the UK, so without any additional investment, the dependency ratio is 100 per cent.

To illustrate the impacts of a supply shock on the UK economy, we model the impact on the EV industry of a supply shock where imports of cathodes and anodes are disrupted for a year. The basis of this modelling is the Faraday Institute's 2030 projections of:

- EV production (1,258,669 EVs produced)
- battery demand from the EV industry in 2030 (93.7 GWh)
- jobs in EV assembly (145,118).

For the battery industry jobs impact, we use Faraday's assumptions on direct battery manufacturing jobs per GWh of capacity (180 per GWh) and its assumed supply chain multiplier of 1.8 for indirect jobs in the wider battery supply chain.

The specific scenario we model is the loss of imports from the top supplier country for cathodes and anodes. With 2024 HMRC trade data, we estimate that the UK receives 52.9 per cent of anodes from the top import country for this product type, and 55.3 per cent of cathode materials from the top import country. In both cases there is uncertainty around this estimate due to the broad nature of HS trade product codes, which may be capture imports that are unrelated to battery components. We assume that in 2030, the top importing country retains its 2040 share of UK imports in cathodes and anodes. We also assume that substitution towards other import sources does not occur, and there are no major stocks of battery component supplies.

We work out how much battery production would be lost as a result. We assume battery production scales down proportionally to lost battery component supplies (eg if 50 per cent of battery supplies are lost, 50 per cent of battery production is lost). To work out lost battery component supplies we calculate the average of the share of imports from the top supplier country, weighted by the dependency ratio to ensure that any domestic production is factored in. From this approach, we calculate that 48.5 per cent of battery component supplies are lost. Applying this to battery demand from the EV industry based on the Faraday estimate leaves us with 45GWh of lost battery production.

The average electric vehicle in 2030 is expected to have a 78KWh battery (based on ICCT estimates in 2024). Assuming that EV producers are unable to source alternatives during the disruption, this corresponds to lost EV production of 583,017 (dividing 45GWh of lost battery production by 78KWh of batteries per car).

To get jobs at risk we assume that EV assembly jobs are affected in proportion to the share of expected EV production lost. Expected production is around 1,258,669 in 2030 and this corresponds to around 145,118 jobs. If 583,017 EVs are not produced, that is 46 per cent of EV production. So, we assume 46 per cent of EV assembly jobs are at risk, which is 67,219 (46 per cent multiplied by 145,118). To get gigafactory jobs at risk we multiply lost battery production by Faraday's assumed battery manufacturing jobs per GWh (45 multiplied by 180) to get 8,186. Finally, to get wider battery supply chain jobs at risk we multiply the battery manufacturing jobs at risk by Faraday's battery supply chain jobs multiplier (8,186 multiplied by 1.8) to get 14,734.

Solar PV supply chain

To calculate the UK's dependency ratio in the solar PV supply chain, we compared the planned domestic manufacturing capacity of solar modules with the average annual expected demand for solar power installations over the years 2026–2030.

While the UK's annual manufacturing capacity is projected to remain constant at 27MW, the annual demand for solar panel installations is more difficult to predict. We estimated it as the average annual requirement over the period 2026–2030, based on the government's *Clean Power 2030 Action Plan* (DESNZ 2024), which aims to achieve 47GW of solar power capacity by 2030.

Assuming the UK equals the same level of annual additional installation in 2025 as it did in 2024 (around 2GW), this would mean that in the five years between 2026 and 2030 the UK will need to install 26.8GW of solar power capacity to achieve its 2030 target. This corresponds to an average of 5.36GW per year. With domestic capacity able to satisfy only 27MW of that demand annually, the UK is facing a 99.5 percent dependency on solar panel imports, calculated on the 2026–2030 average demand, as a way of smoothing fluctuations over the years. In figure 4.2, we also estimated hypothetical annual dependency ratios, assuming a 35 per cent linear increase in additional installed capacity each year from 2026 onwards to achieve the 2030 installation target.

We also estimated the costs of potential disruptions to solar power installations occurring between 2026 and 2030 under two main scenarios:

1. **Full disruption**. This scenario captures the maximum potential impact of disruptions to solar panel imports, assuming the UK can rely only on its limited domestic manufacturing capacity – about 0.05 percent of its average annual demand, the inverse of the dependency ratio – to meet its 2030 installation targets. Under this scenario, the UK would fall short by 26.7GW of solar power capacity.
2. **Partial disruption from China**. This scenario considers a disruption affecting only solar panel imports from China, assumed to account for 55 per cent of

total imports – a conservative estimate. In fact, with the expected growth in solar power demand, dependency on Chinese imports is likely to rise. Under the 55 per cent assumption, a disruption to solar panel imports from China could affect up to 14.7GW of potential solar power capacity in the UK.

We converted the foregone nameplate capacity into lost electricity generation, using a reasonable capacity factor of 10 per cent. This means that the 26.7GW and 14.7GW of uninstalled capacity under the two scenarios would translate into potential annual shortfalls of 26.7TWh and 14.7TWh in solar power generation, respectively.

Using these figures, we could calculate the corresponding annual volume of natural gas required to generate the same amount of electricity, as well as the associated costs. These costs are based on the average weekly gas price associated with forward delivery contracts in the wholesale market over 2022–2024 (£59.4/MWh). We consider this assumption reasonable, as it is based on empirical data and theoretical considerations.[26]

The results apply from 2030 and represent annual hypothetical additional costs. In the full disruption scenario, failing to install solar power capacity would require an additional 2.7 billion cubic metres of natural gas, adding £1,583 million to the UK's annual total energy expenditure. In the partial disruption scenario, the extra need for natural gas would amount to 1.5 billion cubic metres, valued at £875 million per year.

Finally, these estimates reflect the costs associated with the annual operation of power plants, therefore excluding the initial capital expenditure. While it could be argued that the installed capacity for gas-fired power plants already exists (unlike the planned capacity for solar), much of it is outdated and will require major maintenance or replacement with new plants over the coming decades.

Currently, capital costs per MW of gas-fired capacity – around £0.7 million (Hezlet 2025) – are similar to the total installation costs of solar power farms. In the UK, solar installation costs are estimated at approximately £0.87 million per MW, reflecting the smaller scale of projects and the resulting higher per-unit costs, while the European weighted average is below £0.6 million per MW (IRENA 2025) – a level that could potentially be achieved in the UK in the coming years. Given their similar operational lifespans of 25–30 years, the capital costs of building gas power plants and solar farms are broadly similar.

This justifies the significance of comparing operating costs, which remain essentially zero for solar farms, as they rely on sunlight, while natural gas plants incur positive costs due to fuel consumption.

Steelmaking

To calculate the UKs dependency ratio in steelmaking by 2030, we consider planned domestic steel production capacity under five scenarios:

1. closure of blast furnaces (BFs) at Scunthorpe with no investment in electric arc furnaces (EAFs) at Port Talbot
2. maintenance of BFs at Scunthorpe with no investment in EAFs at Port Talbot
3. closure of BFs at Scunthorpe, with the planned EAFs at Scunthorpe becoming operational in 2027

26 Although the three-year price reference includes 2022, a year of exceptionally high gas prices, the average cost in the first half of 2024 was actually lower than in the same period this year. Moreover, natural gas prices are not entirely independent of the level of energy independence that a higher share of renewable power can help deliver. Therefore, other things being equal, continued reliance on imported gas for power generation — due to insufficient deployment of renewables — would make natural gas more costly in the event of a crisis.

4. Planned EAFs at Scunthorpe becoming operational in 2027, and closure of BFs at Scunthorpe, replaced by EAFs by 2028 at no less than 60 percent of previous capacity
5. Maintenance of BFs at Scunthorpe, with the planned EAFs at Scunthorpe becoming operational in 2027.

We then compare these five scenarios with expected UK steel demand in 2030, around 11Mt. The dependency ratio is calculated as the inverse of production capacity under the five different scenarios divided by projected demand, expressed as a percentage.

Critical minerals

Dependency ratios for critical minerals were set to 100 per cent in all minerals apart from lithium, due our research uncovering no significant investment in UK minerals extraction and refining capacity in any other minerals. For Lithium, we use figures from Zylinski 2025. Zylinski reports that by 2030, British Lithium expects to produce enough to meet two thirds of UK demand, while Cornish Lithium expects to produce enough to meet 12.5 per cent of UK demand. We assume that these projects deliver as expected, which would mean UK productive capacity could meet 78.5 per cent of UK demand. The inverse of 21.5 per cent is our dependency ratio – the amount of demand that could not be met by domestic production.

A.2 HS CODES USED FOR TRADE DATA ANALYSIS OF BATTERY AND SOLAR PV SUPPLY CHAIN CHAPTERS

The analysis of import dependencies in the battery and solar PV supply chains, including the construction of the residual supply index for each segment within these supply chains, involved mapping HS codes to each supply chain segment. This report uses the HS code mapping set out by the IEA in the 2024 Advancing Clean Technology Manufacturing report with one major change. The IEA mapping for battery cathodes includes HS code 382499 (Chemical products, mixtures and preparations; n.e.c. heading 3824). This code was judged to be too generic to meaningfully identify cathode materials and was dropped from our analysis.

TABLE A.1: HS CODES USED FOR ANALYSIS OF SOLAR AND BATTERY SUPPLY CHAINS

Supply chain	Supply chain segment	6-digit HS code	HS description
Solar PV	Modules	854143	Electrical apparatus; photosensitive semiconductor devices, photovoltaic cells assembled in modules or made up into panels
Solar PV	Modules	854190	Electrical apparatus; parts for diodes, transistors and similar semiconductor devices and photosensitive semiconductor devices
Solar PV	Cells	854142	Electrical apparatus; photosensitive semiconductor devices, photovoltaic cells not assembled in modules or made up into panels
Solar PV	Cells	854190	Electrical apparatus; parts for diodes, transistors and similar semiconductor devices and photosensitive semiconductor devices
Solar PV	Wafers	381800	Chemical elements; doped for use in electronics, in the form of discs, wafers or similar forms; chemical compounds doped for use in electronics
Solar PV	Polysilicon	280461	Silicon; containing by weight not less than 99.99% of silicon
Batteries	Cells	850710	Electric accumulators; lead-acid, of a kind used for starting piston engines, including separators, whether or not rectangular (including square)
Batteries	Cells	850720	Electric accumulators; lead-acid, (other than for starting piston engines), including separators, whether or not rectangular (including square)
Batteries	Cells	850730	Electric accumulators; nickel-cadmium, including separators, whether or not rectangular (including square)
Batteries	Cells	850750	Electric accumulators; nickel-metal hydride, including separators, whether or not rectangular (including square)
Batteries	Cells	850760	Electric accumulators; lithium-ion, including separators, whether or not rectangular (including square)
Batteries	Cells	850780	Electric accumulators; other than lead-acid, nickel-cadmium, nickel-metal hydride and lithium-ion, including separators, whether or not rectangular (including square)
Batteries	Anodes	850790	Electric accumulators; parts n.e.c. in heading no. 8507
Batteries	Anodes	854519	Carbon electrodes; with or without metal, of a kind used other than for furnaces.
Batteries	Cathodes	850790	Electric accumulators; parts n.e.c. in heading no. 8507.
Batteries	Cathodes	284290	Salts; of inorganic acids or peroxoacids, other than double or complex silicates, including aluminosilicates, whether or not chemically, excluding azides
Batteries	Cathodes	284169	Salts; of oxometallic or peroxometallic acids, manganites, manganates and permanganates, other than potassium permanganate
Batteries	Cathodes	284190	Salts of oxometallic or peroxometallic acids; n.e.c. in heading no. 2841
Batteries	Cathodes	285390	Phosphides, chemically defined or not, not ferrophosphorus; other inorganic compounds n.e.c. (including distilled, conductivity water and water of like purity); liquid air, rare gases removed or not; compressed air; amalgams, not precious metal amalgams

Source: Authors' analysis of IEA (2024e)

A.3 POLICY EXAMPLES TABLE

TABLE A2: STRATEGIES AND TOOLS TO INCREASE SUPPLY CHAIN SECURITY AND RESILIENCE

Strategy	Tools	Examples
Creating demand for alternative suppliers	Regulatory	The proposed UK Carbon Border Adjustment Mechanism (CBAM) would apply a carbon price to imports of emissions-intensive products, which would increase demand for products made through greener production processes.
	Financial	Contracts for difference or price floor to guarantee stable prices for alternative suppliers. Tariffs that increase the cost of procuring supplies from the dominant supplier.
Creating buffer stocks	Regulatory	Minimum Stockholding Obligations (MSO) mandate businesses within a certain industry to hold a buffer stock with fines for non-compliance, such as the rules Australia uses to create buffer stocks of fuels.
	Financial	Government stockpiling initiatives, with state-led procurement, management and storage. Contractual buffer stock obligations through procurement contracts with private suppliers such as those used by the NHS to ensure there are resilient stocks of medicines. 'Virtual stockpiling' where government holds options contracts for a set amount of stock that is triggered under certain conditions, usually some kind of emergency.
Driving investment in supply chain capacity	Regulatory	The EU's Battery Regulation (2023), which mandates traceability for critical raw materials in batteries, links market access and compliance, which could incentivise investment in digital tracking technologies.
	Financial	Direct tax incentives, loans or credit guarantees, and grant subsidies to mobilise or sustain private sector investments, from central government or public finance bodies such as the National Wealth Fund (NWF) or UK Export Finance (UKEF). The latter could play a role in incentivising investments abroad. The government can also directly intervene in key sectors, as seen with British Steel's Scunthorpe plant, where public funds were used to keep industrial capacity operational.
Driving innovation in alternative technologies	Regulatory	Product standards, such as the Japanese Toprunner programme, which established energy efficiency requirements and pushed companies to develop less resource-intensive alternatives to existing technologies.
	Financial	Research and development (R&D) investments from public finance bodies like UK Research and Innovation (UKRI) are crucial for early-stage projects and sectors, as it can develop and scale alternative technologies.
Helping alternative supplier countries improve their economic infrastructure	Regulatory	Hard or soft law governance. The UK has a long history of being involved in forming international standards and regulations through the British Standards Institute (BSI).
	Financial	Development finance and public finance investing in infrastructure projects, upgrade power grids or establish stronger local financial systems. British International Investment (BII), the UK's development finance institution, can do this through ODA, whilst UKEF can deliver loans and guarantees to support investments that can support UK-based exporters.

Source: Authors' analysis

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