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Reconciling the European Union's clean industrialisation goals with those of the Global South

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Executive summary

CLEAN INDUSTRIALISATION IS a political and economic priority for the European Union. For it to work, affordable clean energy is needed. However, producing this energy in Europe is constrained by limited renewable energy endowments (sunshine and wind) and land availability, while the transportation costs for imported clean energy (in the form of electricity or hydrogen) are much higher than for fossil fuels.

AN ALTERNATIVE WAY to fuel Europe's clean industrial sector would to import energy-intensive primary tradeable products such as ammonia, methanol and reduced iron. We estimate that more than ten percent of total future EU clean energy demand will be met by such products.

PUBLIC POLICY IN Europe should aim to facilitate trade in energy-intensive intermediate inputs, which are cheaper to import that energy directly. Imports of these inputs could boost the competitiveness of downstream stages in the energy-intensive value chain (such as steel production). By lowering overall energy demand and thus electricity prices, such imports would also raise EU competitiveness more broadly. In many cases, they would replace imports of less energy-intensive commodities such as iron ore, therefore not adding to Europe's overall import dependency. The direct economic impact in terms of jobs and value added that would be offshored is not substantial.

THE INTERNATIONAL BENEFIT of such a strategy would be that it would embed third countries – especially emerging and developing economies – into clean industrial value chains. Stable European demand can help such countries develop export-driven, clean industrial strategies. Politically, this could be an important incentive that could offset the EU's carbon border adjustment mechanism.

GOVERNMENTS SHOULD THEREFORE not use taxpayer money to fight the relocation of energy-intensive and tradeable primary products, beyond some minimum threshold that is desirable for economic security and innovation reasons. Meanwhile, ongoing negotiations with third countries to establish Clean Trade and Investment Partnerships should put trade in energy-intensive clean products at the core of new international clean supply chains.

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1 Introduction

Can the growth strategies of the European Union and developing countries be made consistent with each other and with decarbonisation? On the face of it, the answer appears to be no.

The European Union wants to boost production from green energy-intensive industries and increase domestic manufacturing of clean technologies needed for the energy transition to 40 percent of consumption by 2030[1]. The European Commission's February 2025 Clean Industrial Deal (European Commission, 2025a), building on Draghi (2024), seeks to reconcile decarbonisation and industrial strength by *"lowering energy prices, creating high quality jobs and the right conditions for companies to thrive"*[2]. An accompanying Affordable Energy Action Plan (European Commission, 2025b) seeks to ensure cheap green energy for European manufacturing industries[3].

But expanding green manufacturing and retaining or expanding heavy industry in decarbonised form is exactly the growth model successfully pursued by China in the last decade. Many developing countries want to emulate this, including India, which wishes to raise its share of manufacturing in value added (Sen, 2025).

The EU wants to expand green manufacturing and retain heavy industry in decarbonised form – exactly the growth model successfully pursued by China in the last decade

This disconnect poses a significant problem, for two reasons. First, growth strategies that seek to promote the same set of green industrial jobs tend to result in subsidy races and/or trade conflict. This is already happening with the Trump administration's tariff wars, which are motivated by the desire to reshore industrial jobs. While the EU has taken more measured steps – by, for example, imposing countervailing duties on Chinese electric vehicles and putting in place a carbon border adjustment mechanism, both of which are arguably consistent with World Trade Organisation rules – even these are viewed as protectionist by China and by countries such as India (Sen, 2025).

Second, inconsistent national industrial development plans imply that proposed strategies for international decarbonisation may be politically unfeasible. For example, a major expansion of international climate finance, funded by a coalition of advanced countries can be shown to be in the economic interests of the coalition, as measured by the coalition's share of the avoided global social cost of carbon (Bolton *et al*, 2024; Bolton and Kleinnijenhuis, 2025). But fiscal transfers in support of green growth in the South will hardly be politically feasible if viewed as threatening the industrial growth ambitions in the financier countries.

A reverse problem arises in Deese's (2024) proposal for a *"Clean Energy Marshall Plan"* in which advanced countries would offer massive financial support for emissions reduction in the South, in exchange for raw materials to support green industrialisation in the North. This brand of global decarbonisation is likely to be rejected by developing countries that wish to reduce dependency and raise their manufacturing shares.

This Policy Brief argues that European and developing-country industrialisation ambitions can nevertheless be made consistent, for a simple reason: Europe is energy poor, leading to high energy costs. While costs may fall as zero-emission energy sources are expanded, energy in Europe will remain expensive relative to other regions, particularly developing countries with much richer endowments of wind, hydro and solar energy. Green-energy trade will not equalise these energy cost differences because electricity and hydrogen are expensive to transport.

This suggests an international division of labour in which the South specialises in green production of energy-intensive intermediate inputs, such as ammonia and reduced iron ore, while the EU imports these inputs as a cheaper alternative to direct energy imports. While the EU will have lost the value added and jobs associated with these inputs, these amount to

1 In the EU Net-Zero Industry Act (Regulation (EU) 2024/1735).

2 See European Commission, 'Clean Industrial Deal', undated, https://commission.europa.eu/topics/eu-competitiveness/clean-industrial-deal_en.

3 See https://energy.ec.europa.eu/strategy/affordable-energy_en.

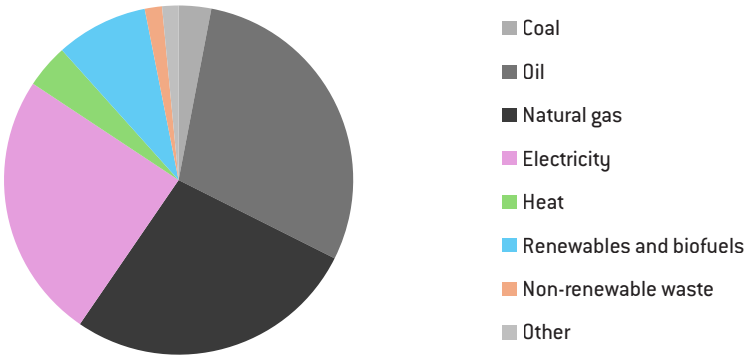
only a small fraction of overall industrial value added – and the resulting reduction in energy demand in Europe will help make the rest of industrial production competitive.

The remainder of this Policy Brief proceeds as follows. In section 2, we identify a green industrialisation strategy that maximises EU competitiveness, focusing on the question of how Europe can overcome its relative energy shortage at least cost. In section 3, we explain how this strategy can be made consistent with the (green) industrialisation ambitions of the Global South. Finally, in section 4, we discuss EU policies – domestically, and with respect to international trade and investment partnerships – that would implement the strategy.

2 Green industrialisation in the European Union

Two-thirds of the energy products consumed by European industry come from oil products, natural gas and coal (Figure 1)[4]. There is little extraction of fossil fuels in Europe, so almost all of these energy products are imported. Green European industrialisation involves substituting these imports for new industrial processes powered by green energy. Europe's future industrial competitiveness will depend on the price of this green energy.

Figure 1: Industrial demand for energy commodities, EU 2023



Source: Bruegel based on Eurostat.

We define green energy as electricity produced without burning fossil fuels, and chemical fuels derived from electricity (such as hydrogen). In principle, the EU has three ways to meet its demand for green energy: domestic production, direct imports (in the form of electricity or green hydrogen), and imports of green energy embedded in highly energy-intensive tradeable inputs, such as ammonia and direct reduced iron ore (DRI).

Industrial strategies in Europe rely on these three approaches to varying degrees. The European Commission's strategy, including the Clean Industrial Deal, is focused mostly on domestic production, particularly after the 2022 Russian invasion of Ukraine and the ensuing energy crisis illustrated the dangers of dependence on imported energy sources. Modelling from the European Commission (2024) on achieving climate neutrality in 2050 sees negligible volumes of direct electricity imports and overall energy import dependency falling dramatically. However, non-electricity energy imports would continue to play a role at EU level, particularly for energy value chains involving hydrogen, a focus of the EU's 2020 hydrogen strategy (European Commission, 2020). At the level of EU member states, hydrogen

4 2,000 TWh out of a total 3,300 TWh demand across energy and non-energy uses.

imports play a disproportionate role in Germany, where the government hydrogen strategy foresees hydrogen imports accounting for 50 percent to 70 percent of total domestic hydrogen demand.

The idea that it might make sense to import energy in the form of intermediate products has received little political attention

The idea that it might make sense to import energy in the form of intermediate products has received less political attention – perhaps because it requires accepting the principle that Europe might need to offshore at least some energy-intensive production traditionally done in Europe. However, the energy price hikes of 2022 have already prompted the offshoring of some particularly energy-intensive intermediate products, such as ammonia. Furthermore, both Germany's hydrogen strategy and the EU's RePowerEU (issued after Russia's invasion of Ukraine to wean the EU off Russian energy imports) plan include hydrogen derivates (such as ammonia) in hydrogen imports (BMWK, 2023; European Commission, 2022).

In the rest of this section, we argue that if European industry is to maintain or regain its competitiveness, imports of energy-intensive intermediate inputs will need to play a much greater role than currently recognised. Sections 2.1 and 2.2 make the *prima-facie* efficiency case. Relative to other world regions, Europe's clean energy endowments are poor and thus some degree of energy imports is efficient. Intermediate products are much cheaper to import than energy directly.

Sections 2.3 and 2.4 evaluate the economic costs and benefits for European industry of offshoring energy-intensive production stages. Costs include the direct loss of value added and potential adverse spillovers on the rest of the economy. Benefits would include lower input costs, boosting the competitiveness of the energy-intensive production stages that would remain in Europe, and lower industrial energy demand and hence energy prices, benefiting all European energy consumers – including industrial customers.

Finally, section 2.5 briefly evaluates the potential effects on economic security. These depend on the counterfactual (whether the alternative to increased offshoring of intermediate inputs is greater reliance on domestic energy or higher direct energy imports), and on how offshoring is managed.

2.1 Europe's green energy endowments are relatively poor

The EU needs much more green energy. In 2023, the bloc produced 1,810 TWh of clean electricity[5]. Modelling by the European Commission (2024) suggested that 6,300 TWh to 7,000 TWh of clean electricity will be required by 2050 to reach net-zero. This implies annual growth in clean electricity of 165 TWh compared to annual growth of 17 TWh since 2020.

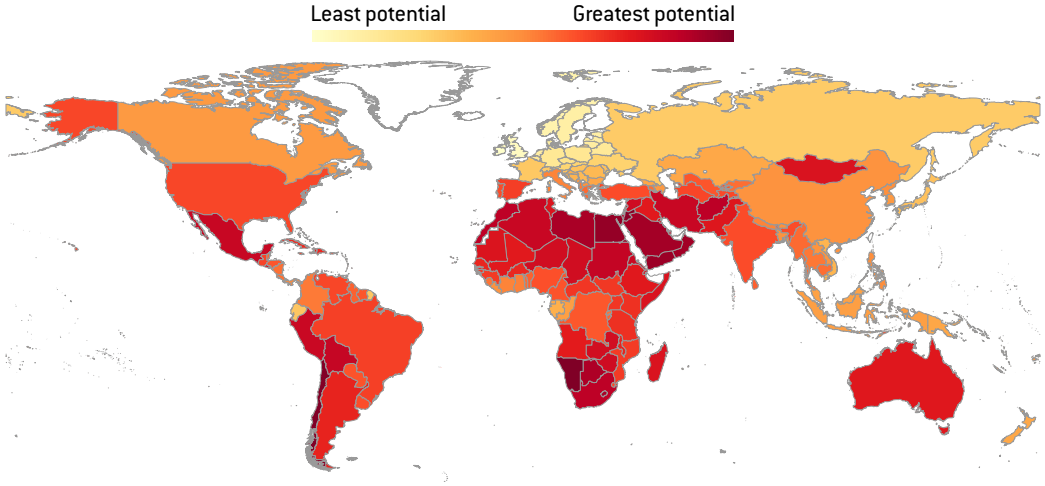
Meeting these green energy requirements is challenging because domestic production faces constraints. Land availability for new construction is limited, and voters sometimes push back against construction near to their homes. While 51 percent of Germany is potentially suitable for wind deployment, just 9 percent remains after regulatory, environmental and technical constraints are accounted for (McKinsey, 2022).

The distribution of renewable energy endowments (mountains for hydroelectricity, solar irradiation and high and consistent wind speeds) further limits regional green energy potential. Regions with good renewable energy endowments are often located far from industrial demand centres. The continental electricity system needs major investment and political impetus in order to move green energy around efficiently (Heussaff and Zachmann, 2025).

Europe's solar PV potential is particularly poor – except for the Mediterranean countries. Figure 2 shows 'practical' solar PV potential, a measure that reflects both theoretical solar PV potential (determined by climatic variables such as solar irradiance and air temperature) and land availability, excluding land with physical or technical constraints, such as built-up environment or rugged terrain (ESMAP, 2020).

5 Bruegel calculations based on the Ember electricity dashboard: https://ember-energy.org/data/electricity-data-explorer/.

Figure 2: Average practical solar PV potential (kWh/kW)



Source: Bruegel based on ESMAP (2020). Note: we plot the variable average practical potential (PVOUT Level 1) from the dataset.

While nuclear energy can play an increasingly important role in supporting electrification in Europe – particularly by providing much-needed low-carbon dispatchable power to complement the variability of renewables – it remains a relatively costly way of compensating for the continent's limited renewable energy endowment. The levelised cost of electricity for new nuclear in advanced economies remains significantly above that of solar and wind. Nuclear projects are capital intensive and subject to long permitting procedures and, very often, significant construction delays. Political and societal resistance to nuclear energy in several European countries further limits its deployment potential. Advanced nuclear reactors – including small modular reactors – promise to overcome these barriers, but it is unclear whether this promise will be delivered, as development of the technology is still at an early stage.

Attempting to meet all the EU's clean energy needs domestically would thus result in higher energy costs than in other regions, and is unlikely to be desirable either politically or economically (Neumann *et al,* 2024). The EU faces a 'make or buy' decision: how much green energy to produce domestically and how much to import (Scholten *et al*, 2016). Regional differences in the social acceptance of land use and the possibility for spatial arbitrage imply that some green energy imports are efficient and likely (Schmidt *et al*, 2019).

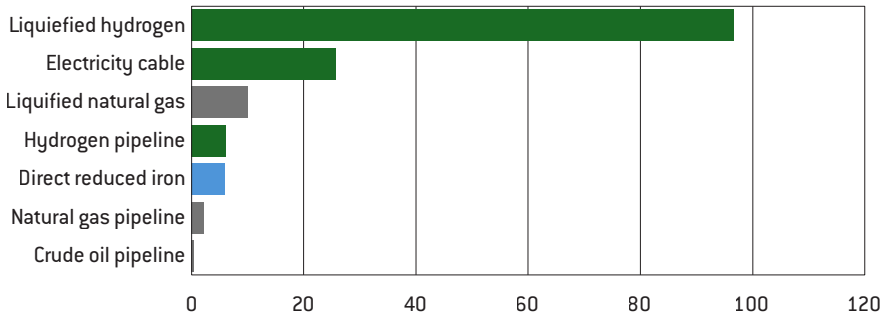
2.2 Importing energy-intensive inputs is cheaper than importing energy directly

It is substantially more expensive to transport electricity and hydrogen than oil and gas (Saadi *et al,* 2018; DeSantis *et al,* 2021). Transportation costs are sufficiently high to make imports of green hydrogen from North Africa or Chile (where production is far cheaper than in Europe) economically unattractive (Galimova *et al,* 2023; McWilliams and Zachmann, 2021).

Figure 3 shows estimates of the costs of transporting one unit of energy via different clean and fossil-energy carriers. Liquid fuels are more expensive to transport because of fixed liquefication and regasification costs, which dominate overall costs. We compare these fossil and green-energy costs to the implied costs of transporting green energy contained within reduced iron[6]. The implied cost is higher than for gas and oil via pipeline, but cheaper than green alternatives.

6 We assume freight rates are the same as for moving iron ore, as in Bilici (2024). At a freight rate of $10 per tonne, the implied energy transfer cost per 1 MWh is $5.90.

Figure 3: Stylised costs of transporting one MWh of energy over 1000km ($)



Source: Bruegel. Note: amortised costs of transporting one unit of energy (a MWh) in different forms through pipelines (crude oil and natural gas) and electricity through a high voltage direct current line from DeSantis *et al* (2021), and for hydrogen through a pipeline from Guidehouse (2022). For the transport of liquid fuels we use a set of assumptions on the costs of liquefication, freight rates and regasification at destination terminals, based on Al-Breiki and Bicer (2020), Johnston *et al* (2022), Connelly *et al* (2019), ACER (2024); Gaffney Cline (2024) and FTI Consulting (2024).

Therefore, the future global green energy system will likely be characterised by far less direct energy trade than currently. The present reality in Europe does little to dispel this notion. Only a small share of electricity is imported, while plans for hydrogen pipelines are long delayed.

Meanwhile, the uneven distribution of green energy endowments will create economic pressure for industrial relocation and trade in both final goods and intermediate inputs. This pressure will be particularly strong for commodities or products for which energy costs are a large share of total production costs (Samadi *et al*, 2023). Examples include ammonia and methanol (inputs into long value chains including fertilisers, synthetic fuels, olefins, resins and other high-value chemicals), and reduced iron, which can be transported by sea, much like iron ore is today, and accounts for approximately 70 percent to 80 percent of the energy consumption across the green primary steel value chain (Box 1). At the same time, there is little relocation pressure beyond intermediate products because the energy demand for production of semi-finished products, such as flat steel products or plastic pellets, is low and transport costs are not reduced further compared to transporting intermediate products.

Box 1: Implications of energy cost differentials for trade in intermediate inputs

Steel offers a clear example of the potential for trade in green intermediate products. Traditional production of primary steel involves burning iron ore using coking coal, both of which are imported by European steelmakers. A potentially economically attractive decarbonisation pathway for the production of green steel is to instead reduce iron ore using hydrogen. Reduced iron can then be transported by sea, much like iron ore today. Producing reduced iron would account for up to 80 percent of the energy consumption across the green primary steel value chain (Vogl *et al*, 2018; Alikulov *et al,* 2024). European steelmakers who want to green their production must thus choose between importing reduced iron or importing iron ore and importing or producing hydrogen.

Taking a global perspective, Bilici *et al* (2024) showed that increasing trade in green reduced iron could reduce global production costs for steel by 2.2 percent to 3.9 percent. Gielen *et al* (2020) found it would be efficient for Australia to shift from exporting iron ore to green reduced iron. This could reduce global emissions while maintaining steel production in countries that currently process iron ore into steel, including Japan, South Korea and China.

For Germany, Egerer *et al* (2023a) evaluated the three sectors with the highest projected hydrogen demand: green iron for steelmaking, ammonia production and conversion into urea, and methanol production and processing into ethylene. For each value chain they assessed full domestic production, hydrogen imports to feed domestic value chains, imports

of intermediate products for further processing, and imports of final products. They found that energy costs will impact future green value chains and that relocation of some productive capacity to countries with excellent renewable energy conditions is likely. The effects are most striking for urea and ethylene, for which full German domestic production and hydrogen imports would be uncompetitive internationally – 15 percent to 25 percent more expensive than production abroad. Only by importing intermediate products does final urea and ethylene production in Germany become internationally competitive.

Verpoort *et al* (2024) performed a similar analysis and arrived at similar conclusions. Importantly, they found that trading intermediate products (reduced iron, ammonia and methanol) would eliminate *"almost all relocation savings"* because the energy demand for producing semi-finished products is relatively low.

Green steel value chains are only just emerging and hence empirical evidence on relocations is lacking. However, ArcelorMittal has expressed interest in importing reduced iron to its European plants[7]. A survey of managers at the world's 50 largest steel and chemical companies found renewable energy potential to be the most important factor influencing locational investment decisions (Eicke and Quitzow, 2025).

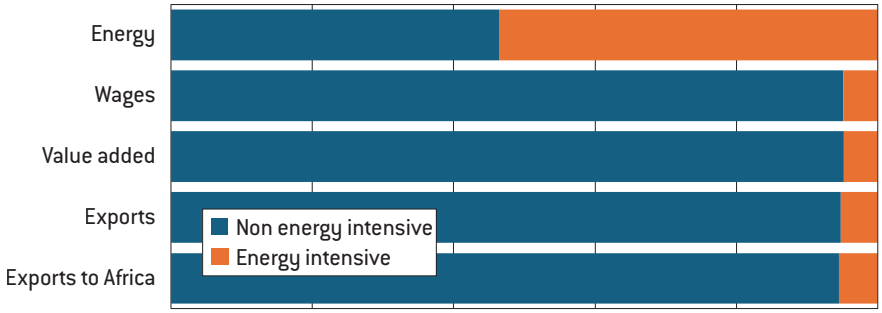
2.3 Economic costs for the EU

Offshoring of the most energy-intensive intermediate inputs could negatively impact industrial activity in the EU though the loss of some industrial jobs and value added, and via spillover effects that reduce output in the rest of industry. However, these effects are likely small.

Direct impact on value added and employment

The relocation of green energy-intensive manufacturing would not have major direct effects on the European economy. High energy consumption occurs at early stages of value chains, where wages and value added are relatively small. For context, just eight industrial processes account for over half of German industrial energy demand, while providing 5 percent of wages, 6 percent of value added and 7 percent of exports (Figure 4).

Figure 4: Distribution between intensive and non-energy-intensive industrial activities in Germany



Source: Bruegel based on DeStatis. Note: data is at the granularity of up to four-digit industry (WZ) code. An energy-intensity indicator is calculated using energy consumption and turnover by industry. The eight most energy-intensive industry codes are assigned to the 'energy intensive' category. These are 2351 (manufacture of cement); 241 (basic iron and steel and ferro-alloys); 2011 (industrial gases); 2015 (fertilisers and nitrogen compounds); 2014 (other organic basic chemicals); 2311 (flat glass); 2352 (lime and paperboard); 2362 (paper and paperboard).

7 Rachel Parkes, 'Green hydrogen is too expensive to use in our EU steel mills, even though we've secured billions in subsidies,' *Hydrogen Insight,* 21 February 2024, https://www.hydrogeninsight.com/industrial/green-hydrogen-is-too-expensive-to-use-in-our-eu-steel-mills-even-though-weve-secured-billions-in-subsidies/2-1-1601199.

'Cascading' deindustrialisation?

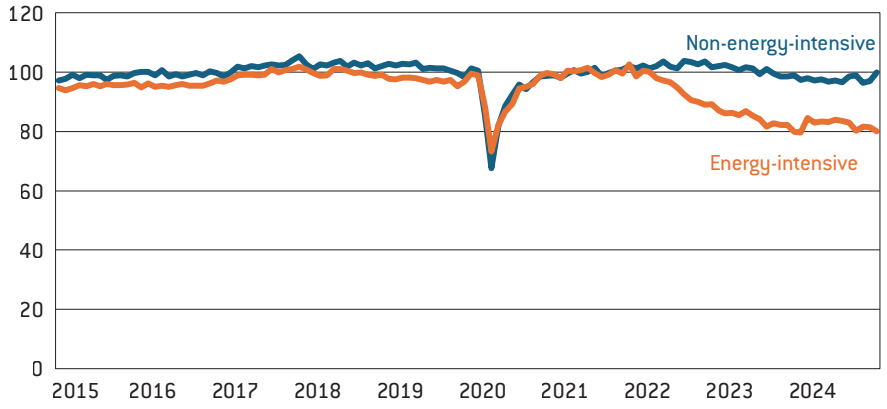
'Cascading effects' could spill over onto later value-chain stages. This could happen if many industrial processes see the benefits of being located near to intermediate product output, both for supply chain efficiencies and agglomeration benefits. Whether this happens depends on the interplay of unit transport costs and the economic inefficiencies associated with different value chain stages being dispersed. If transport costs for a set of tradeable energy-intensive products are low compared to agglomeration advantages, factors including skilled labour availability and proximity to demand play more important roles in the locational decisions of any later or associated value chain stages. This is the case for most current industrial processes, which locate largely independently of fossil-fuel or mineral reserves.

For steel, the costs of transporting direct reduced iron are similar to the costs for transporting iron ore (Bilici *et al,* 2024), suggesting there will not be major pressure for other iron and steelmaking processes to locate alongside DRI production. Germany's steel industry in the twentieth century grew close to locally sourced coal and iron. As domestic coal production and iron ore extraction were phased out in favour of imports, locations have remained resilient (Egerer *et al*, 2023a). For the chemical sector, ammonia – produced from natural gas – is already a widely traded intermediate product (Egerer *et al*, 2023b).

A more explicit evaluation of the output spillovers of reducing or relocating energy-intensive production can be performed by taking the 2022 energy crisis as a natural experiment. Russia's full-scale invasion of Ukraine and the associated gas export cut-off led to soaring prices in the EU and a reduction in output from energy-intensive industrial processes. The eight most energy-intensive industries saw output drop by one-fifth (Figure 5).

At the onset of the crisis, the aggregate economic impacts on the German economy were the subject of much debate. Estimates for the GDP impact from a full Russian gas cut-off varied wildly from a 2 percent to 12 percent loss (Moll, 2024). Larger negative estimates were driven by the assumption that a reduction in output from one area of the economy would have substantial knock-on effects on other processes. Fortunately, this did not happen. While production from energy-intensive industries fell by one-fifth, output from the rest remained broadly flat, despite inflationary pressures, geopolitical tensions and a large drop in European demand for automobiles (Figure 5).

Figure 5: Indexed EU industrial output, energy-intensive and non-energy-intensive sectors



Source: Bruegel based on DeStatis and Eurostat. Note: data from DeStatis is used to assign energy intensity values to industrial processes at the three-digit NACE level by comparing turnover and energy consumption (as in Figure 3). The set of most energy-intensive industrial processes is then mapped to Eurostat industrial output data to define the 'energy intensive' and 'non-energy-intensive' lines.

Part of the reason is that firms shifted into higher value-added products and used fewer intermediate products. This led to a decoupling of industrial output (which fell) and manufacturing value-added in Germany, which remained steady (Fletcher *et al,* 2024). Firms also

increased imports of intermediate products (Fontagné *et al,* 2023). These imports helped replace outputs from domestic energy-intensive processes, which in turn helped maintain the production of final products (Chiacchio *et al,* 2023). For fertiliser production in Germany, Stiewe *et al* (2022) found that growth in imports replaced domestic production of ammonia, keeping fertiliser production steady.

2.4 Economic benefits for the EU

The economic benefits of increased imports of energy-intensive intermediate goods can also be thought of in terms of direct and spillover effects:

- *Direct benefits to EU downstream industries*. The relocation abroad of early-value-chain stages can have positive economic effects by lowering input costs for downstream industries in the importing country. This argument applies both to the downstream stages of energy-intensive production and to associated services. For example, the international division of solar PV value chains has facilitated a boom in solar service jobs in Europe and the United States[8].
- *Spillover benefits for other industrial sectors and consumers*. Bas and Strauss-Kahn (2014) investigated firm-level imports into France from 1996 to 2005, finding that imported inputs raised productivity and exports. New imported inputs have been shown to facilitate the introduction of new products in the EU (Colantone and Crinò, 2011). In relation to imported energy-intensive products, the likely channel for beneficial spillovers will be electricity price cuts for other industrial consumers and for households, boosting competitiveness and making energy more affordable.

The magnitude of both effects will depend on the volume of energy embodied in imported intermediate inputs and its effect on prices. A rough estimate (see the appendix) suggests that imports of direct reduced iron, ammonia and methanol could reduce EU electricity demand by more than 500 TWh. This is more than one-quarter of today's green electricity production in the EU, and around one-tenth of 2050 projected demand. Trade in other products that undergo energy-intensive processes, such as polysilicon, refined minerals and aluminium, would increase the savings. It is also conceivable that air and sea transportation will be decarbonised by the use of synthetic hydrocarbons: chemical fuels that replicate mineral fuels such as kerosene but are produced using electricity to combine hydrogen with captured carbon dioxide. Synthetic hydrocarbons might be considered a form of intermediate product, potentially adding another large chunk of tradeable embedded energy.

EU imports of green energy embedded in basic intermediate products could reduce future green-energy demand by more than 10 percent

EU imports of green energy embedded in basic intermediate products could thus potentially reduce future green-energy demand by substantially more than 10 percent. The extent to which prices would be impacted would depend on price elasticities of supply and demand. For context, the European energy crisis of 2022 saw the loss of about 20 percent of natural gas supply, though impacts were dramatically exaggerated by the immediate and unexpected nature of the shock, which would not be the case for a longer-term structural reduction.

Importantly, maintaining some energy-intensive green-energy demand in the EU can have a positive system effect to the extent that it is flexible and can load-shift to follow swings in supply. Large point sources of electricity demand, which can quickly ramp their consumption up and down, can act almost as batteries – consuming when there is too much green energy in the grid and turning off when it is scarce. Therefore, maintaining some production of energy-intensive goods in Europe likely to be efficient (Neumann *et al,* 2024).

8 See the Bruegel European Clean Tech Tracker, https://www.bruegel.org/dataset/european-clean-tech-tracker.

2.5 Economic security

De-risking the European economy is a priority concern for policymakers, reinforced by ongoing impacts from the Russian gas cut-off. Sustainable green industrialisation requires de-risking of external economic relationships while maintaining most benefits of trade.

Developing new import relationships will expose European countries and companies to international supply-side risks. Natural disasters or political changes could disrupt trade routes and harm production. There is thus a partial trade-off between minimising economic security risks and achieving least-cost decarbonisation.

However, importing more green intermediate products would be less risky than Europe's current dependence on fossil fuels. To the extent that they help reduce fossil-fuel imports, imports of green intermediate products can even be security enhancing. Dependence on an imported industrial product is not comparable to dependence on an energy source. A disruption to trade in green intermediate products would affect industrial output, but not household heating or motorists.

Green intermediate products could be sourced from a wide pool of suppliers. The constraints to becoming a supplier are much less restrictive than for the export of fossil fuels, as abundant renewable energy sources (and mineral deposits) are present in many countries (Figure 2). Stockpiling could mitigate risks further. Therefore, while there is a trade-off, it can be offset by best practices that exploit the economic efficiencies of trade while minimising risks (section 4).

3 The view from outside: consistency with the industrialisation of the Global South

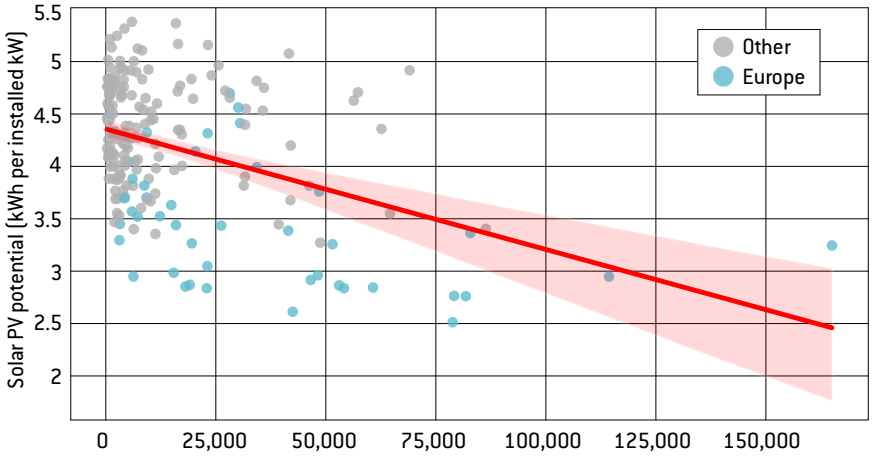
3.1 Economic benefits for the Global South

European firms currently import fossil fuels and raw minerals from the Global South, with few imports of intermediate products. This does not create significant value added in exporting countries. With weak institutions in exporting countries, it can also lead to the 'resource curse' of policymakers seeking to maximise their shares of rents associated with resource exports, rather than creating good business environments.

An EU shift to more imports of energy-intensive inputs would be much more attractive economically for the Global South. It would see fresh economic activity move to the Global South and diversification away from raw mineral and energy exports toward intermediate products – as happened in South Korea in the 1970s, for example. Many Global South countries have good renewable energy and critical mineral endowments (Figure 6).

Exports of intermediate products will create jobs and value added. For instance, exporting green reduced iron can raise local employment by 16 percent per tonne of DRI produced in Global South countries compared to exporting the equivalent volumes of green hydrogen and iron ore separately (Agora Industry, 2024). Meanwhile, countries in the Global North would retain more than 90 percent of existing jobs in the steel value chain, and the final production cost of steel would be reduced by 16 percent. Caiafa *et al* (2025) investigated the Brazilian state of Ceará, from where liquid hydrogen or green steel might be exported to the Netherlands. Performing the additional step of green steel production in Ceará could increase local value added (+3 percent), incomes (up to 23 percent) and employment (up to 35 percent) (Caiafa *et al*, 2025).

Figure 6: Practical solar PV potential vs GDP *per capita*



Source: Bruegel based on ESMAP (2020). Note: see Figure 2 for solar PV potential (average practical potential, PVOUT Level 1).

The desire to onshore additional value chain steps is a clearly stated policy goal for countries of the Global South. Chile is generally considered to have avoided the natural resource curse and been able to translate large resources of copper and lithium into economic growth through industrialisation strategies (Gutierrez *et al,* 2022). The Indonesian government plans an integrated battery value chain in order to leverage upstream domestic nickel resources that were previously exported[9]. Meanwhile, the Democratic Republic of Congo has reviewed agreements with Chinese mining firms that were deemed exploitive and now seeks partnerships with other investors[10].

Closer to Europe, plans for green-iron production are materialising in North Africa – in Mauritania, for example, where green iron will be produced alongside green hydrogen (Karkare and Medinilla, 2024). ArcelorMittal is exploring green hydrogen, iron and steel production in Mauritania[11]. In Egypt, Italian group Danieli has submitted a proposal to the government to build a green-steel plant to exports to the EU[12], while the German SMS group plans a 2.5 million tonnes green-iron facility in the Suez Canal Economic Zone, investing $1.06 billion (Karkare and Medinilla, 2024).

3.2 Global climate benefits

An EU green industrialisation strategy that only stimulates the production of enough green energy for domestic consumption is neither sufficient nor desirable. Establishing early value chains abroad is important for global green industrialisation. Large emission reductions can be driven by countries that specialise in line with their environmental comparative advantages. Modelling the impacts of a carbon tax, Le Moigne *et al* (2024) found that just over one-third of global emissions reductions could come from trade-enabled reallocation.

The creation of early green industrial value chains abroad can develop green knowhow

9 Isabelle Huber, 'Indonesia's Battery Industrial Strategy', *Commentary*, 4 February 2022, CSIS, https://www.csis.org/analysis/indonesias-battery-industrial-strategy.

10 Pesha Magid, 'Congo courts Saudi mining investors to help curb China dominance', *Reuters*, 14 January 2025, https://www.reuters.com/world/africa/congo-courts-saudi-mining-investors-help-curb-china-dominance-2025-01-14/.

11 See ArcelorMittal press release of 25 May 2022, 'ArcelorMittal signs MoU with SNIM to evaluate the opportunity to jointly develop a pelletisation plant and DRI production plant in Mauritania', https://corporate.arcelormittal.com/media/news-articles/arcelormittal-signs-mou-with-snim-to-evaluate-the-opportunity-to-jointly-develop-a-pelletisation-plant-and-dri-production-plant-in-mauritania.

12 Anna Vassileva, 'Egyptian govt weighs Danieli Group's plan for green steel complex', *Renewables Now*, 29 February 2024, https://renewablesnow.com/news/egyptian-govt-weighs-danieli-groups-plan-for-green-steel-complex-850074/.

and reduce the costs of developing full green value chains abroad. For example, the availability of cheap green iron is the crucial determinant of cost-effective green steel production, and the construction of a first green iron plant (perhaps for export) can reduce the costs of constructing a second (perhaps for domestic consumption).

Green industrial transformation in Europe and green industrialisation in the developing countries can reinforce each other. Huge growth in green industrial product manufacturing is needed, and critical for meeting global climate targets. The EU accounts for less than 10 percent of global industrial emissions and much future industrialisation will occur in the Global South[13]. In particular, developing countries lack scrap steel and are forecast to become increasingly dependent on the production of crude steel (Watari *et al,* 2023), which will be emissions-intensive unless the greening of this production takes place, supported by integration in global value chains. While controversial from an economic-security standpoint, the global climate benefits of China leading in the energy-intensive production of solar panels and batteries from the early 2000s have been enormous.

4 Implications for EU economic policy

To reconcile its clean industrialisation objectives with those of the Global South in a cost efficient and politically viable manner, the EU needs to adapt its domestic and foreign economic policies.

4.1 Domestic economic policy: smarter industrial policy for energy-intensive sectors

One of the toughest industrial policy questions facing Europe is how to handle energy-intensive industries (EIIs). Should Europe do whatever it takes to retain them all – for reasons spanning from jobs to economic security? Should they be retained on condition that they decarbonise in line with European Green Deal targets? Or should a more selective approach be taken that offers public support only to those EIIs and/or energy-intensive production stages that both embark on a green transformation and are likely to remain competitive, even if energy prices remain higher in Europe than elsewhere?

European governments, with the tolerance of EU state aid rules, have so far largely opted to subsidise energy-intensive industries unconditionally

European governments, with the tolerance of EU state aid rules, have so far largely opted for the first option: subsidising EIIs unconditionally. Energy subsidies are the clearest illustration. On average across Europe, EIIs pay 50 percent less per unit of electricity consumed than households, and in many countries the gap is even larger (Heussaff *et al*, 2025). Such differences arise because EIIs can sometimes access better rates from suppliers because of their scale, but also because they often pay lower network costs than households and frequently don't pay certain cost components, such as the costs of public support for new renewable projects.

The second option – maximum effort to retain EIIs provided they decarbonise – was advocated by Draghi (2024), who called for EIIs to be given preferential access to special low-cost electricity generation portfolios, publicly procured liquified natural gas and further electricity network tariff rebates. To prevent single market fragmentation triggered by national subsidies, and to ensure efficient distribution of activities across the EU in line with comparative advantage, Draghi (2024) also called for a prominent EU-level component in decarbonisation funding for EIIs, similar to the EU Innovation Fund's 'Hydrogen Bank,' and including reformed and

13 The industry sector in 2022 globally was responsible for 9.0 Gt CO_2 emissions; see IEA, 'Industry', undated, https://www.iea.org/energy-system/industry; total emissions from manufacturing in the EU were 0.7 Gt in 2023 (Eurostat).

expanded Important Projects of Common European Interest (IPCEIs)[14].

The EU Clean Industrial Deal plan (European Commission, 2025a) adopted a version of Draghi's recommendations. It proposes substantial EU-level instruments to fund EII decarbonisation, starting with a €100 billion EU Industrial Decarbonisation Bank to be created alongside the Innovation Fund. But it also proposes a friendlier approach to national state aid than Draghi (2024), calling for a new Clean Industrial State Aid Framework that would facilitate national support for EIIs and clean-tech manufacturing, replacing the Temporary Crisis and Transition Framework – Commission criteria for approving state aid *"to foster support measures in sectors which are key for the transition to a net-zero"*, adopted in March 2023 in response to clean-tech subsidies in the United States[15].

The second option would be far better than the first. Unlike the first option, it is consistent with Europe's net-zero goals. But it remains problematic from the point of view of European competitiveness and from a global perspective.

From a European perspective, the approaches of Draghi (2024) and the Clean Industrial Deal create a distributional problem that could reduce growth and competitiveness. Subsidising electricity consumed by EIIs implies higher costs for other electricity consumers and possibly taxpayers. For example, reducing electricity prices for EIIs to 2019 levels by shifting system costs among consumers would increase household electricity prices by about 15 percent (Heussaff *et al*, 2025). Likewise, removing value-added tax from electricity consumed by EIIs would create significant shortfall in national budgets, as tax revenues from VAT on electricity amount to tens of billions of euros each year in the EU. Preferential treatment of one category of energy consumer thus inevitably raises issues of fairness and efficiency. It makes no sense for Europe to provide scarce energy at a discount to sectors that provide less value added per unit of energy, rather than allowing less energy-intensive sectors with higher growth potential to flourish.

From a global perspective, the approach is problematic because it ignores the potential for greater gains from global trade and comparative advantage in a decarbonised global economy. Subsidising European EIIs encourages the continuation of high-cost production in Europe, instead of allowing market forces to direct energy-intensive manufacturing to those regions that, thanks to their renewable energy endowments, are best suited for such production. This raises the global cost of decarbonisation. It may also undermine international climate cooperation if developing countries with ample renewable energy endowments become frustrated with the unwillingness of advanced countries to integrate them into green supply chains.

Europe should be more selective when supporting EIIs. Industrial subsidies should depend on two main criteria: the greening of EIIs – an essential step to ensure their long-term international competitiveness in a decarbonising global economy – and the efficiency of production in Europe post-abatement, conditional on realistic assumptions about European energy costs. The latter hinges on two sub-criteria: i) energy intensity: how much energy the decarbonised process still requires, and whether this aligns with Europe's future green energy availability and cost; and ii) cost-effectiveness in a global context: whether similar emissions reductions could be achieved more efficiently by supporting abatement in the Global South, where decarbonisation costs may be lower.

To apply this approach, two main channels through which EIIs are currently subsidised should be distinguished:

1. Allocation of free allowances under the EU emissions trading system (ETS). From 2026 to 2034 approximately 2.8 billion ETS allowances will be allocated for free – a financial enve-

14 The Hydrogen Bank is a European financing initiative that supports clean hydrogen projects selected through competitive auctions. Consortia of hydrogen suppliers and off-takers bid for a subsidy necessary for their project to be realised. IPCEIs are cross-border projects through which European governments provide financial support to consortia in research, development and infrastructure for critical technologies such as microelectronics, batteries and hydrogen.

15 See European Commission, 'Temporary Crisis and Transition Framework', https://competition-policy.ec.europa.eu/state-aid/temporary-crisis-and-transition-framework_en.

lope of some €200 billion at current prices. As the point of free allowances is to prevent carbon leakage (relocation of carbon-intensive industry beyond the reaches of the ETS) before the EU carbon border adjustment mechanism (CBAM) enters fully into force, it is fine to allocate them only based on emission reductions, ignoring the energy-intensity of production.

2. Second, direct subsidisation of capital expenditure or production, including energy subsidies. In these cases, it is not acceptable to make subsidies conditional only on abatement. In addition, no subsidies should be provided to highly energy-intensive stages that it would be more efficient to offshore (with the exception of a minimum capacity that might be justified on security grounds).

This approach would allow Europe to maximise the impact of public funds, support industries for which competitive green production is viable and contribute cost-effectively to global decarbonisation.

4.2 Foreign economic policy: supporting green industrialisation in the Global South

To support both global decarbonisation and the competitiveness of European production, selective domestic subsidies need to be complemented by a strong foreign economic policy that supports the development of manufacturing capabilities for energy-intensive intermediate products in Global South countries that are rich in both raw materials and renewable energy endowments, and integrates these products into Europe's green supply chains.

The European Commission has proposed Clean Trade and Investment Partnerships (CTIPs; European Commission 2025a, section 6.1). While detail and a framework are lacking at time of writing (some detail has been offered on the first CTIP being prepared with South Africa), this initiative is potentially important. Through CTIPs, the EU could engage with third countries more coherently than currently. The EU already runs several initiatives in parallel – including Energy Partnerships, Green Partnerships, Critical Raw Materials Strategic Partnerships and the Global Gateway – but these are often in silos. This prevents an integrated approach covering the whole green product supply chain, and makes EU climate and industrial diplomacy less efficient.

To be credible, CTIPs should be structured not only as trade diplomacy platforms, but as practical toolkits including both supply- and demand-side instruments to mobilise private-sector investment in green value chains.

On the supply side, blended finance instruments should be deployed, including those already available through the Global Gateway, new resources under the next EU budget (2028-2034) and from the European Investment Bank. This will reduce investment risk and crowd-in private capital. Technical cooperation on setting and harmonising green standards is also required, particularly for emerging sectors such as green steel, green cement and green chemicals, for which early alignment can shape global norms. Support for local green industrial ecosystems is essential. This could take the form of joint industrial clusters, similar to efforts in Namibia, where European and local firms collaborate to build integrated, low-carbon value chains[16]. Replicating and scaling-up such initiatives elsewhere – especially in countries rich in renewable energy and critical raw materials – would help embed industrial value creation locally, promote technology transfer and ensure that green value chains deliver inclusive growth and environmental benefits.

On the demand side, the credibility and success of CTIPs will depend on Europe's ability

16 In November 2022, Namibia and the EU signed a memorandum of understanding for a strategic partnership in sustainable raw materials value chains and renewable hydrogen, with the goal of mobilising €1 billion in investment from the EU, EU countries and European financial institutions. See European Commission press release of 24 October 2023, 'Global Gateway: EU and Namibia agree on next steps of strategic partnership on sustainable raw materials and green hydrogen', https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5263.

to offer stable and attractive long-term market signals. Guaranteed offtake agreements for the intermediate green products produced in the Global South under CTIPs should be supported, for instance by allowing them to qualify under sustainability and resilience criteria[17] in the EU Net-Zero Industry Act (Regulation (EU) 2024/1735). Expanding the geographical scope of such criteria to include CTIP partner countries could greatly enhance the cost-efficiency and the effectiveness of the measure.

The EU could also promote joint offtake pools or demand-aggregation platforms, similar to H2Global, a German scheme to support investment in renewable hydrogen production in non-EU countries, which will be then imported and sold in the EU. The H2Global scheme works as a double auction model, with the German government providing a subsidy to the most competitive bids for exporting green hydrogen (or derivatives such as ammonia) into Germany.

A broader range of green projects in third countries could also be fostered under the EU Innovation Fund – as is being done for hydrogen. By supporting green intermediate products outside the EU and linking them to guaranteed demand in Europe, such mechanisms would help anchor investment decisions in partner countries and deepen industrial cooperation along clean value chains. By integrating these demand-side tools, CTIPs can help bridge the commercialisation gap, making green industrialisation projects in partner countries bankable and scalable, while reinforcing the EU's own industrial resilience and climate leadership.

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Appendix: a rough estimate of European intermediate product green energy demand

We estimate the green energy demand required to produce three intermediate products in Europe: direct reduced iron as an input to the steel value chain, and ammonia and methanol as intermediate products for chemicals value chains (see for example Egerer *et al*, 2023a).

We start with current demand for each product in the EU, and estimate the volume of green energy that would be required to produce a similar volume of green products. For steel and ammonia, we assume constant demand; for methanol we assume an increase in demand because there is significant potential for methanol to replace some current hydrocarbon uses.

In 2023, the EU produced 126 million tonnes of crude steel (Eurofer, 2024), via two production routes: blast oxygen furnaces and electric arc furnaces. An electric arc furnace consumes electricity and overall emissions can largely be removed through the use of green electricity. Therefore, steel decarbonisation through hydrogen aims to replace supply from blast oxygen furnaces.

We calculate the hydrogen required to provide enough direct reduced iron to replace current EU blast oxygen furnace production of 70 million tonnes of steel annually (Eurofer, 2024). Producing one tonne of direct reduced iron requires 60 kilogrammes of hydrogen (Egerer *et al*, 2023a). One kilo of hydrogen is equivalent to 33 kWh energy. Therefore, the required hydrogen energy demand to produce 70 million tonnes of direct reduced iron is 140 TWh.

For ammonia, EU demand is 19 million tonnes with 17 million tonnes produced domestically, and net imports of 2 million tonnes (Kneebone and Piebalgs, 2023). We calculate the hydrogen required to replace all this demand domestically. The requirement to produce one tonne of ammonia is estimated at 197 kilos of hydrogen, or approximately 6,500 kWh of hydrogen energy. Total demand is therefore estimated at 125 TWh.

Current EU demand for methanol is a little under 10 million tonnes. Renewable methanol demand could replace conventional fossil methanol demand, but potentially also certain hydrocarbon uses – synthetic hydrocarbons can be produced using methanol as a base. Methanol demand in the EU might therefore grow to 18 million tonnes by 2030 (Kneebone and Piebalgs, 2023). Producing one tonne of methanol requires 210 kilos of hydrogen (Egerer *et al*, 2023a), equivalent to 7,000 kWh hydrogen energy. This implies total demand of 125 TWh of hydrogen.

For the EU to produce sufficient quantities of the three intermediate products, 390 TWh of hydrogen may therefore be required in total. There is considerable uncertainty about future demand and technologies and so this number is only illustrative of the potential. Producing this hydrogen domestically would require a little over 550 TWh of green electricity production, assuming an electrolyser operating at 70 percent efficiency.