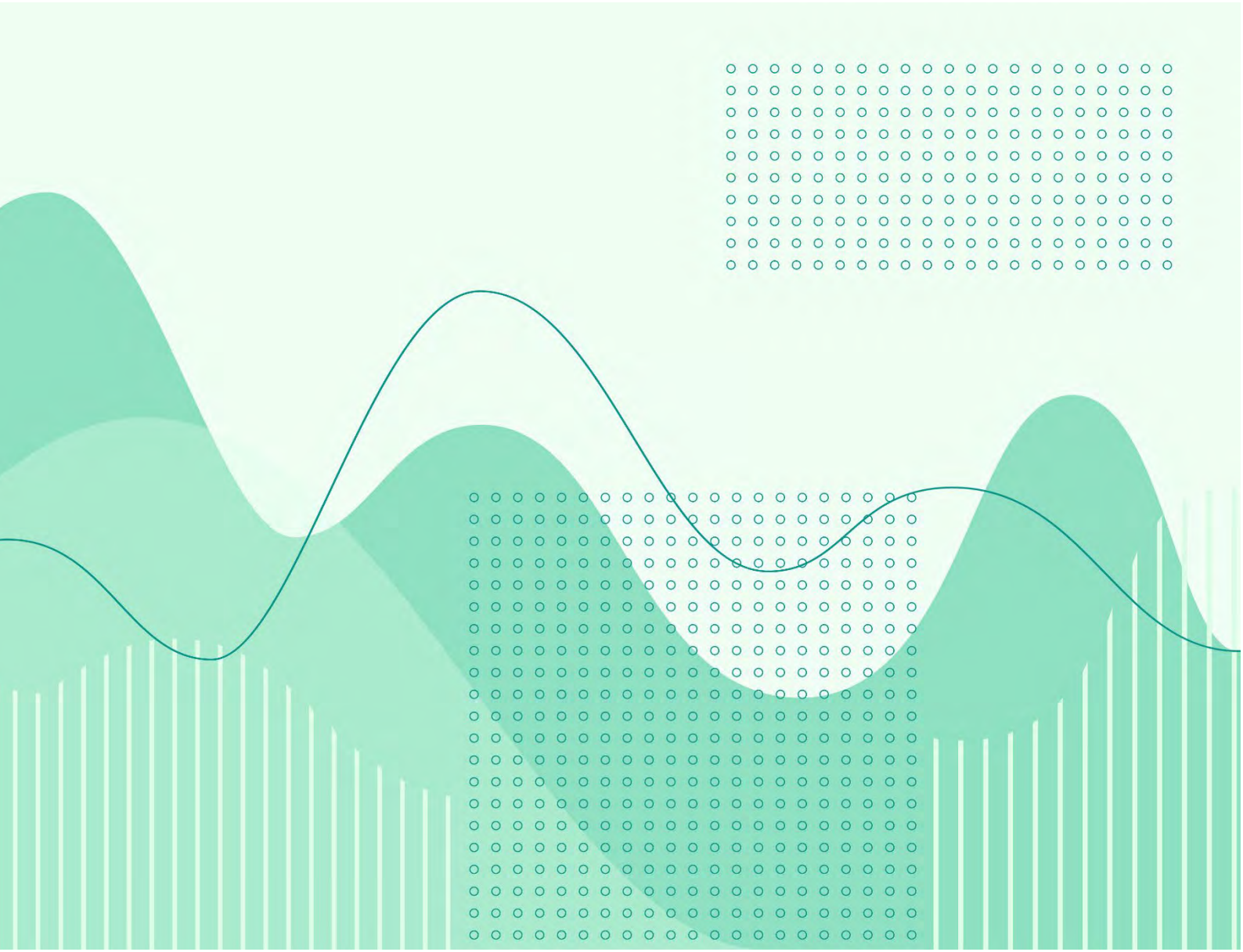
UNIVERSITY OF CAMBRIDGE

Cambridge Industrial Innovation Policy

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INDUSTRIAL POLICY PERSPECTIVES

An introduction to green industrial policy: concepts, industrial needs, and policy options



About this policy brief

This policy brief introduces the concepts, industrial needs, and policy options associated with green industrial policy and green industrial transitions. It examines the distinct challenges of industrial decarbonisation and green industrialisation, and how governments can support them through coordinated policy packages. This publication is part of a series of policy briefs produced under an Open Society Foundations-funded project through which Cambridge Industrial Innovation Policy collaborates with governments in Mexico and Indonesia to strengthen the design and implementation of green industrial strategies. The aim of the series is to bridge the gap between long-term strategic ambitions and practical policy delivery by providing evidence-based analysis and actionable policy insights.

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Executive summary

What is green industrial policy?

Green industrial policy comprises public interventions that shape production, investment, technological change, and productive capabilities in pursuit of economic and environmental objectives. This brief distinguishes between **industrial decarbonisation** – reducing the dependence of existing industrial activities on fossil-fuel-based resources – and **green industrialisation**, which involves developing the capabilities and infrastructure to supply the goods, technologies, and services needed for economy-wide decarbonisation. Together, they constitute the **green industrial transition**.

Industrial decarbonisation involves **six pillars**: material efficiency and circularity; energy efficiency and process optimisation; industrial electrification; low-carbon fuels and feedstocks; carbon capture, utilisation, and storage; and cross-sectoral enablers such as infrastructure, institutions, finance, and skills. Their importance varies by sector. For example, food processing offers significant opportunities for lower-temperature electrification, while cement also requires solutions for emissions arising from production chemistry.

Many technologies needed for deeper decarbonisation are **not yet commercially available**. Almost 60% of the clean energy technologies tracked by the International Energy Agency[1] have not reached market uptake. The transition will therefore require not only mature solutions to be deployed but also emerging technologies to be developed, demonstrated, and scaled.

Barriers to green industrial transitions

Green industrial transitions do not happen automatically. Firms and industrial systems face several interacting barriers:

- **Technical barriers.** New technologies may require modifications to existing plants and processes, while firms may lack the expertise to evaluate, integrate, and operate them.
- **Economic barriers.** High investment and operating costs, long payback periods, uncertain demand, and long-lived existing assets can weaken the business case for transition investments.
- **Organisational barriers.** Decarbonisation requires coordination across functions within firms and among producers, utilities, infrastructure providers, financiers, and governments.
- **Innovation system barriers.** Weak research–industry links, limited demonstration facilities, and the financing challenges of first commercial projects can prevent emerging technologies from reaching scale.
- **Cross-sectoral constraints.** Missing electricity, hydrogen, or carbon infrastructure, uncertain regulation, lengthy permitting, and shortages of specialised skills can block otherwise viable investments.

How green industrial policy differs from traditional industrial policy

- **Similar instruments, different emphasis.** Green industrial policy uses many of the same tools as traditional industrial policy. What changes is their relative importance, design, and sequencing under greater technological, environmental, and coordination challenges.
- **Stronger market creation role.** Green products often face greater demand uncertainty because their environmental benefits are not fully rewarded by markets, and demand may depend on policy. Procurement, standards, incentives, and offtake commitments therefore play a larger role.

[1] IEA (2025) ETP Clean Energy Technology Guide

- **Greater innovation and scale-up support.** Technological uncertainty is higher because many green technologies are still at demonstration or early commercial stages, meaning policy must support research and development (R&D), demonstration, and first commercial deployment, as well as diffusion.
- **More intensive infrastructure coordination.** Green industrial projects often depend on new low-carbon infrastructure, such as renewable electricity, hydrogen networks, and CO2 transport and storage. For this reason, industrial and infrastructure investments need to be coordinated more closely.
- **A harder balance with domestic development.** Local content requirements are harder to impose when green projects are already costly or commercially fragile. More gradual conditions around training, research, and supplier development may better support domestic capabilities.
- **Stronger environmental definitions and safeguards.** Green industrial policy must define not only which activities merit support but what qualifies as genuinely green or a credible transition activity. This means taxonomies, roadmaps, and safeguards are important policy requirements.
- **More demanding monitoring and evaluation.** In addition to economic outcomes, green industrial policy must measure environmental performance, including emissions reductions and transition progress, which are often harder to verify.
- **Greater importance of policy packages.** Because technology, demand, finance, infrastructure, and skills are highly interdependent, green industrial policy places greater emphasis on coordinated packages than on isolated instruments.

International examples

- **China's electric vehicle (EV) policy** combined technology development, production support, public fleet demonstrations, consumer incentives, and charging infrastructure, adjusting the policy mix as the industry matured.
- **Australia and Norway** illustrate how national strategies can organise finance, innovation, infrastructure, and skills policies around shared long-term industrial objectives.

Implications for developing countries

- **Transition pathways are context-specific.** Sectoral needs, existing assets, and domestic capabilities shape feasible pathways, and decarbonisation does not automatically generate domestic industrial development.
- **Finance is only part of the solution.** Project preparation, technical assistance, infrastructure coordination, and institutional capabilities are also essential.
- **Policy continuity and credibility matter.** Predictable policy direction can strengthen investment confidence, while clear green and transition taxonomies, transparent reporting, and independent verification reduce green- or transition-washing.

1. Introduction

The transition towards a low-carbon economy involves more than changing how energy is generated and consumed. It also requires changes in what economies produce, how production is organised, and the technologies, infrastructure, and capabilities on which industrial activity depends. Industry has a dual role in this transformation: it must reduce emissions from its own activities while supplying the materials, equipment, technologies, and services needed to decarbonise other parts of the economy. Green industrial policy brings these production and capability-building questions into climate policy, while bringing environmental objectives into industrial development.

This brief distinguishes between two related processes: **industrial decarbonisation** concerns reducing emissions from existing industrial activities through changes in energy use, materials, production processes, and supporting systems; and **green industrialisation** involves developing the productive and technological capabilities needed to supply the goods and services required for decarbonisation across the economy. Together, these processes constitute the green industrial transition. They can reinforce each other, but their relationship is not automatic: reducing emissions does not necessarily build domestic productive capabilities, while developing new green industries does not necessarily decarbonise existing production. This distinction is particularly important for developing countries seeking to connect environmental improvements with technological learning, skilled employment, and industrial diversification.

Understanding this transition requires a focus on the characteristics of different industries. A food-processing facility, a steelworks, and a cement plant have different energy requirements, emissions sources, production technologies, and investment cycles. Some improvements can be achieved using established technologies, while others depend on solutions that require development, demonstration, and commercial scale-up. In both cases, progress depends on more than the availability of cleaner equipment. Firms also need appropriate finance, reliable infrastructure, skilled workers, technical support, and sufficient demand for their products. These requirements are interconnected, making the transition a challenge of transforming industrial systems rather than simply replacing individual technologies.

Against this background, this policy brief introduces the concepts, industrial needs, and policy options associated with green industrial transitions. It addresses three practical questions: what does green industrial policy seek to change; why do technically feasible transitions not necessarily take place; and how do the resulting policy requirements differ from those of traditional industrial policy? The analysis focuses on climate change mitigation in industry, while recognising that infrastructure resilience and environmental effects beyond carbon emissions also influence the design of industrial transitions.

The central argument is that green industrial policy draws on familiar instruments, including public procurement, grants, tax incentives, loans, guarantees, infrastructure investment, research support, training, standards, and regulation. Its distinctive features lie principally in how these instruments are designed, combined, sequenced, and evaluated. Greater emphasis is placed on creating markets, managing technological uncertainty, coordinating interdependent investments, defining credible environmental improvements, and assessing economic and environmental outcomes together.

The brief proceeds as follows. Section 2 introduces the key concepts and working definitions. Section 3 examines the transition needs of different industries, including common decarbonisation pillars, sector-specific pathways, and differences in technological maturity. Section 4 explains the barriers that prevent these transitions from taking place. Section 5 discusses the available policy instruments and their distinctive application in green industrial policy. And Section 6 draws together the conclusions and considers their implications for developing countries.

2. Key concepts

2.1 What is green industrial policy?

Green industrial policy has become increasingly prominent in debates on climate action, competitiveness, and economic development, but it remains loosely defined. Its scope partly depends on how industrial policy and environmental objectives are understood. Industrial policy may refer narrowly to support for particular sectors and technologies, or more broadly to public action that shapes productive structures, capabilities, and technological change. Environmental objectives may centre on climate change mitigation, or extend to climate change adaptation, climate change loss, and damage management, or other environmental impacts such as pollution and biodiversity loss. Some approaches also emphasise reducing or phasing out forms of production whose environmental impacts cannot be sufficiently mitigated.[2] Green industrial policy consequently spans a range of approaches reflecting different combinations of these objectives and forms of intervention.[3]

What distinguishes green industrial policy is its focus on changing the productive economy in pursuit of economic and environmental objectives. It uses public intervention to shape production, investment, technological change, and productive capabilities, including what firms produce, how they produce it, the technologies and inputs they use, and the capabilities and positions in value chains that an economy develops. This focus distinguishes between green industrial policy and environmental or climate policy more broadly, which may reduce emissions or other environmental harms without seeking to reshape production or industrial capabilities.[4]

This focus on the productive economy encompasses two related transformations: **industrial decarbonisation** and **green industrialisation**. Industrial decarbonisation concerns reducing emissions from existing industrial activities by changing energy use, feedstocks, production processes, and other features of industrial production. This may involve efficiency improvements and retrofits, but deeper reductions often require new production technologies, different materials and energy sources, reconfigured supply chains, or replacing and phasing out incompatible assets. Green industrialisation involves building the productive and technological capabilities needed to supply the goods, technologies, and services required for decarbonising all areas of our economies, including industry itself, energy and transportation systems, the built environment, and agriculture, forestry, and other land use (AFOLU). The capabilities required for green industrialisation include manufacturing capabilities and the wider support ecosystem, such as R&D activities, engineering services, testing and certification systems, and workforce skills development systems.[5] Together, these two processes constitute what this brief refers to as the **green industrial transition**. They may reinforce each other, but they should be assessed separately: reducing industrial emissions does not necessarily build domestic productive capabilities; and developing green industries does not necessarily decarbonise existing production.

Both processes can transform the productive structure, but in different ways. Industrial decarbonisation changes **how** existing industries produce, while green industrialisation can change **what** an economy produces, the technologies and value chains in which it participates,

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[2] Hauge and Hickel (2025). A progressive framework for green industrial policy.

[3] OECD (2024). Green Industrial Policies for the Net-Zero Transition; Juhász, Lane and Rodrik (2024). The New Economics of Industrial Policy; OECD (2011). Towards Green Growth; Peres et al. (2026). Green Industrial Policy: Where From, Where To?

[4] Juhász, Lane and Rodrik (2024). The New Economics of Industrial Policy; Hallegatte, Fay and Vogt-Schilb (2013). Green Industrial Policies: When and How; Meckling (2021). Making Industrial Policy Work for Decarbonization.

[5] UNIDO (2011). UNIDO Green Industry: Policies for Supporting Green Industry; Anzolin and Lebdioui (2023). Policy Action for Greening Industrial Development: Coordinating Low Carbon Consumption, Production & Innovation.

and the capabilities it develops. Structural transformation can therefore occur through changes in **existing sectors** and through the emergence of **new ones**. Replacing core technologies, inputs, and production systems in established industries can amount to substantial productive transformation.[6]

Decarbonisation pathways differ across sectors in the technologies, energy sources, feedstocks, infrastructure, and capabilities they require, as well as in the barriers that constrain their adoption. Understanding these differences requires sector- and technology-specific analysis. The remainder of this brief therefore examines the transition requirements of different industries, the barriers that prevent firms and production systems from meeting them, and the policy and institutional responses needed to overcome those barriers.

2.2 Working definitions used in this brief

Green industrial policy. Public interventions that shape production, investment, technological change, and the development of productive capabilities in pursuit of economic and environmental objectives.

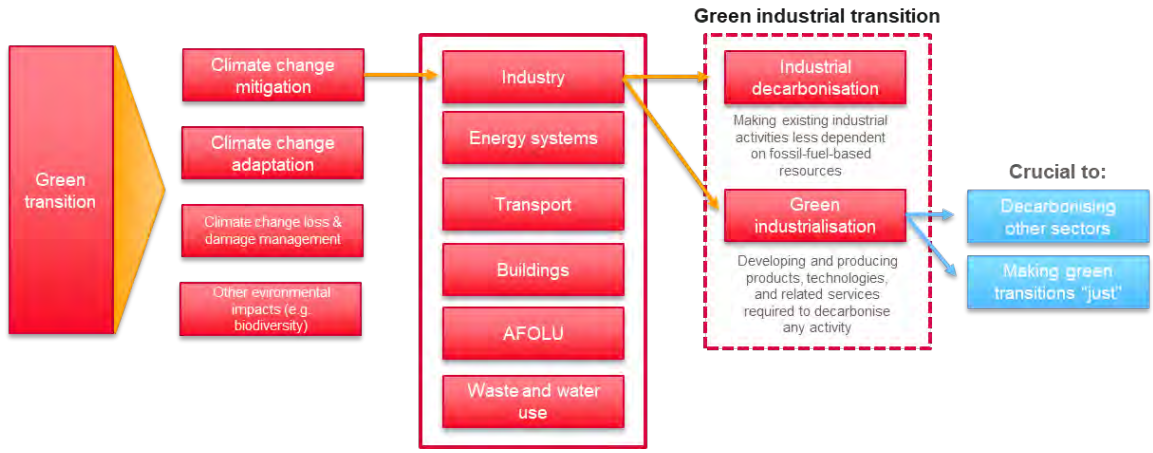
Green industrial transition. The transformation of an economy's industrial structure and activities towards a more environmentally friendly state, combining the processes of industrial decarbonisation and green industrialisation.

Industrial decarbonisation. Changes to existing industrial activities to make them less dependent on fossil-fuel-based resources.

Green industrialisation. Developing productive and technological capabilities and infrastructure to supply the goods, technologies, and industrial services required to decarbonise the whole economy.

Although green industrial transitions can also conceptually include climate change adaptation considerations, in this brief our focus is on climate change mitigation in industry. Figure 1 provides a schematic summary of the scope of the analysis in this policy brief.

Figure 1. Scope of the analysis: green industrial transitions



Source: Cambridge Industrial Innovation Policy.

[6] Peres et al. (2026). Green Industrial Policy: Where From, Where To?; IEA (2022). Achieving Net Zero Heavy Industry Sectors in G7 Members.

3. Green transition needs of different industries

Designing effective green industrial policy requires a clear understanding of how transition needs differ across industries. In broad terms, industrial decarbonisation involves adapting, reconfiguring, or, in some cases, replacing production processes, business models, and supply chains. It involves deploying mature practices and technologies that are more resource-efficient, less emissions-intensive, and less environmentally harmful than incumbent alternatives, and developing and scaling new solutions needed for deeper emissions reductions.

The relative importance and technical application of these solutions vary considerably by industry, meaning there is no single pathway for industrial decarbonisation. Although industries share several broad transition pillars, the technologies, infrastructure, and implementation strategies associated with each pillar must be tailored to sector-specific production processes and emissions sources.

3.1 Common pillars of industrial decarbonisation

Industrial decarbonisation strategies generally converge around six recurring pillars[7]:

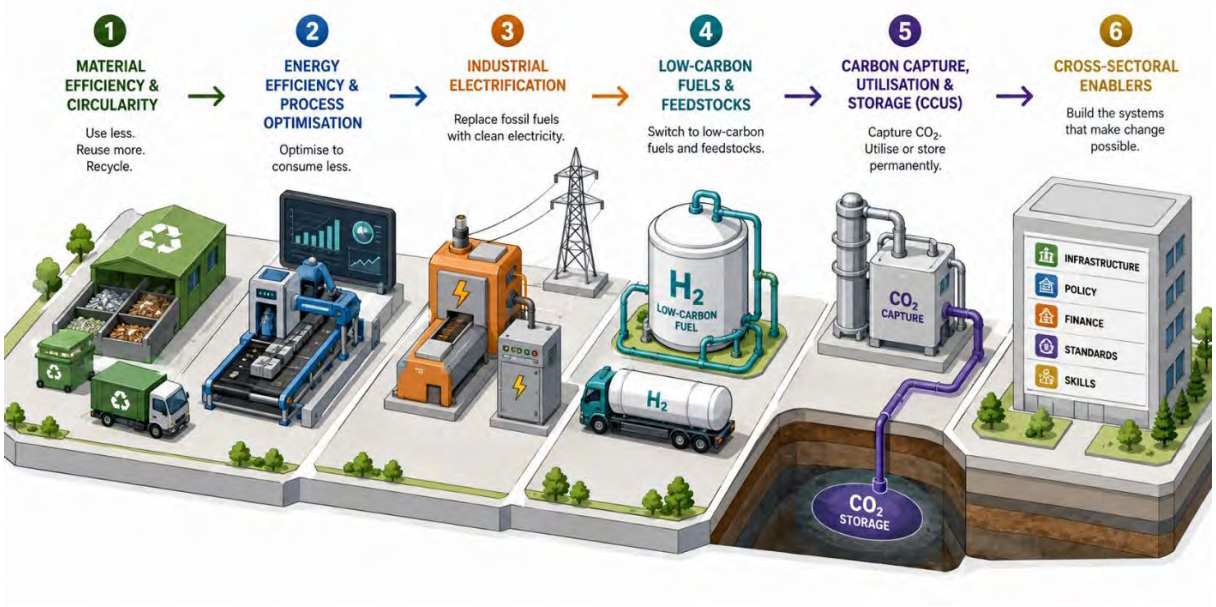
- **Material efficiency and circularity.** This pillar seeks to reduce demand for emissions-intensive primary materials by improving product design, extending product lifetimes, reducing waste, and increasing reuse, repair, and recycling.
- **Energy efficiency and process optimisation.** Firms can lower energy consumption and emissions by upgrading equipment, recovering waste heat, improving process control, and using digital technologies to optimise production.
- **Industrial electrification.** Electrification replaces the direct use of fossil fuels with electricity in industrial equipment and heat-generation processes, provided that sufficient low-carbon power and grid capacity are available.
- **Low-carbon fuels and feedstocks.** Where direct electrification is technically difficult, fossil fuels and material inputs may need to be replaced with alternatives such as green hydrogen, sustainable biomass, biogas, or synthetic fuels.
- **Carbon capture, utilisation, and storage (CCUS).** CCUS can capture residual emissions from industrial processes, particularly in sectors where carbon dioxide is generated by the chemistry of production and cannot be eliminated through fuel switching alone.
- **Cross-sectoral enablers.** The deployment of these solutions depends on supporting infrastructure, effective institutions and regulations, access to finance, technical standards, and a workforce with the skills required to install and operate new technologies.

These pillars are complementary rather than mutually exclusive. A single industrial facility may need to combine material efficiency, energy optimisation, electrification, alternative fuels, and carbon capture to achieve deep emissions reductions. The appropriate combination will depend on the sector, the age and configuration of existing assets, local energy and infrastructure conditions, and the maturity and cost of the available technologies.

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[7] IEA (2022). Cross-Cutting Technologies & Infrastructure.
US Department of Energy (2022). Industrial Decarbonization Roadmap.
Energy Transitions Commission (2020). Making Mission Possible: Delivering a Net-Zero Economy.
Rissman et al. (2020). Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070.
Kim et al. (2024). Energy, material, and resource efficiency for industrial decarbonization: A systematic review of sociotechnical systems, technological innovations, and policy options.

Figure 2. Six pillars of industrial decarbonisation



Source: Cambridge Industrial Innovation Policy.

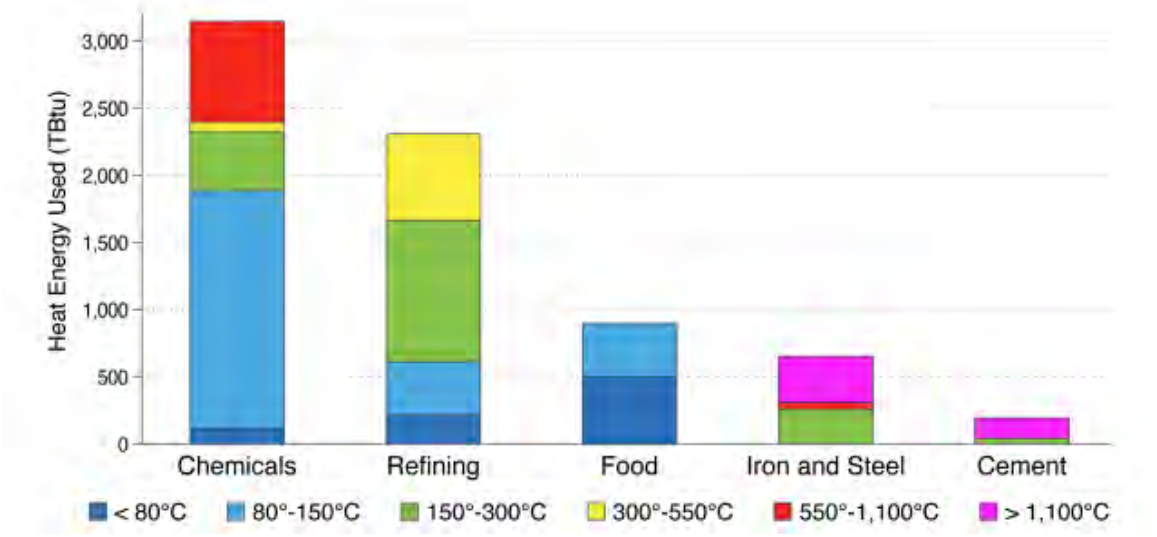
Some measures, particularly energy-efficiency improvements and process optimisation, can be implemented through incremental changes to existing facilities, but deep decarbonisation often requires more than the retrofitting of incumbent assets. In hard-to-abate sectors such as steel, cement, or chemicals, altering the underlying chemistry or physics of production may require new plant configurations, utility connections, feedstock supply chains, and logistics systems. In some cases it may be necessary to retire fossil-fuel-dependent assets before the end of their expected economic life and invest in new production routes.

3.2 Industrial sectors require different decarbonisation pathways

Differences in industrial process heat illustrate why sector-specific strategies are necessary. The US Department of Energy estimates that industrial heat requirements range from approximately 80°C for activities such as milk and cream pasteurisation to well above 1,000°C in cement production. Process heating is also the largest source of industrial energy use. This variation matters because low- and medium-temperature heat can often be electrified using established technologies, including heat pumps and electric boilers, whereas very-high-temperature processes may require specialised electric technologies, hydrogen-based fuels, sustainable biomass, or combinations of these options (many of which are not yet commercially available).[8]

[8] IEA (2022). Cross-Cutting Technologies & Infrastructure.
US Department of Energy (2022). Industrial Decarbonization Roadmap.
Energy Transitions Commission (2020). Making Mission Possible: Delivering a Net-Zero Economy.
Rissman et al. (2020). Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070.
Kim et al. (2024). Energy, material, and resource efficiency for industrial decarbonization: A systematic review of sociotechnical systems, technological innovations, and policy options.
[8] US Department of Energy (2022). Industrial Decarbonization Roadmap.

Figure 3. Distribution of process heat temperature ranges by US industrial subsector, 2014



Source: US Department of Energy (2022).

The same principle applies to industrial feedstocks. In the chemicals sector, fossil resources such as natural gas are used as both energy sources and material inputs. In conventional steelmaking, coal provides heat, acts as a chemical reductant, and supplies carbon to the final alloy. Replacing fossil fuels in these sectors therefore involves more than changing the source of energy: it may require alternative molecules, new equipment, and different production routes.

Consequently, transition priorities differ markedly across sectors. Cement producers must address both fuel-related emissions and process emissions from the calcination of limestone. Iron and steel producers must replace or substantially modify carbon-intensive reduction processes. And chemical producers need to reduce emissions associated with both energy use and the carbon embedded in feedstocks and products. By contrast, the food and beverages sector generally relies more on lower-temperature heat and may have greater opportunities for electrification, efficiency improvements, heat recovery, refrigeration optimisation, and changes in packaging and logistics. The sectoral comparison in Figure 5 similarly shows that the same broad decarbonisation pillars translate into substantially different technologies in steel, cement, chemicals, food and beverages, and heavy-duty transport.

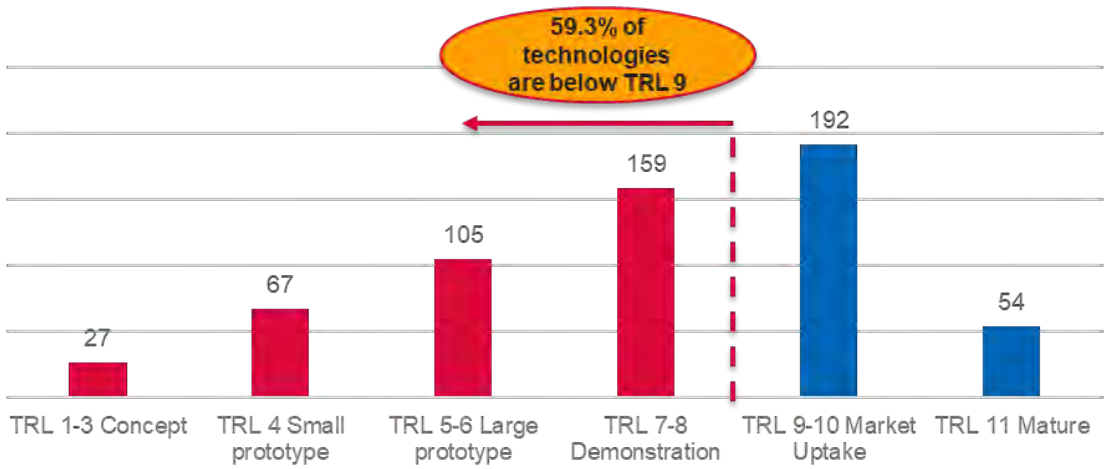
These differences have important policy implications. Governments cannot rely on horizontal measures that treat all industrial firms alike. They need sufficient sectoral knowledge to identify the technologies, infrastructure, investment cycles, and coordination needs associated with each industry. Policy sequencing must also reflect differences in asset lifetimes and technological maturity: measures that can deliver rapid emissions reductions in one sector may be technically inappropriate or economically unviable in another.

3.3 Many essential technologies still need to be developed and scaled

A second defining feature of the green industrial transition is that many of the technologies required for deep decarbonisation have not yet reached widespread commercial deployment. The International Energy Agency's *ETP Clean Energy Technology Guide* tracks hundreds of technology designs and components, together with their maturity, development plans, and deployment status. The analysis reproduced in Figure 4 indicates that approximately 60% of

these technologies remain below technology readiness level (TRL) 9[9] and have therefore not reached the market uptake stage.

Figure 4. Technology readiness levels of clean energy technologies, 2025



Source: Cambridge Industrial Innovation Policy, based on IEA (2025).

Green industrial transitions consequently depend on two parallel processes. The first is the rapid diffusion of mature and commercially available solutions, including many energy-efficiency measures, material-efficiency practices, and established electrification technologies. These can deliver near-term emissions reductions while generating experience and learning-by-doing. The second is the development, demonstration, and scaling of emerging technologies that will be necessary for deeper decarbonisation, including hydrogen-based industrial processes, high-temperature electrification, synthetic fuels, and advanced CCUS systems.

Reaching a high TRL is just one stage in this process. Once a technology has been technically demonstrated, manufacturing capacity must be expanded, supply chains established, workers trained, standards and regulations introduced, infrastructure built, and production costs reduced. Firms must also secure customers and financing for first commercial plants, which are often much more expensive and riskier than mature alternatives.

These characteristics mean that green industrial policy must address a heterogeneous set of needs. It must support the diffusion of proven solutions while simultaneously funding research, demonstration, and early commercial deployment. It must also coordinate investments in production facilities with investments in electricity networks, hydrogen supply, carbon transport and storage, logistics, standards, skills, and other shared capabilities. Industrial decarbonisation is not just a matter of encouraging firms to adopt cleaner equipment; it is a system-wide transformation requiring sector-specific strategies and coordinated action across technologies, infrastructure, institutions, and markets.

[9] TRLs describe the maturity of a technology from early scientific research to widespread commercial deployment. The framework used here is as follows: TRL 1 – basic principles observed; TRL 2 – technology concept formulated; TRL 3 – experimental proof of concept; TRL 4 – technology validated in the laboratory; TRL 5 – technology validated in a relevant environment; TRL 6 – technology demonstrated in a relevant environment; TRL 7 – system prototype demonstrated in an operational environment; TRL 8 – complete system qualified and proven to work; TRL 9 – technology proven through successful operation in its intended environment; TRL 10 – technology enters market uptake and wider commercial deployment; and TRL 11 – mature technology, commercially established and deployed at scale.

Figure 5. Technological needs and cross-sectoral enablers for green industrial transitions in five hard-to-abate sectors

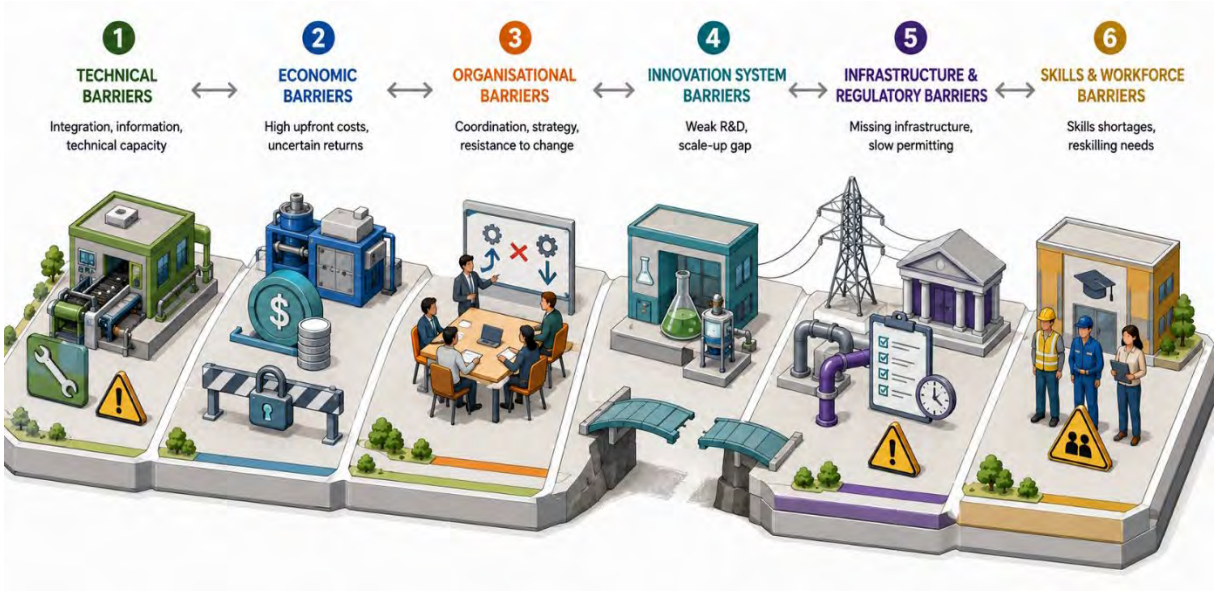
Non-exhaustive examples in hard-to-abate sectors	Steel		Cement		Chemicals		Food & drinks		Heavy-duty transport	
	Deploying mature practices & technologies	**Developing and scaling up early-stage technologies**	**Deploying mature practices & technologies**	**Developing and scaling up early-stage technologies**	**Deploying mature practices & technologies**	**Developing and scaling up early-stage technologies**	**Deploying mature practices & technologies**	**Developing and scaling up early-stage technologies**	**Deploying mature practices & technologies**	**Developing and scaling up early-stage technologies**
1. Material efficiency & circularity	• Scrap-based steel via EAFs • Yield & material efficiency	• Light-weighting in end-use sectors • High-strength lightweight steels	• Clinker substitution with SCMs • Optimised concrete mix design	• Novel binders (LC, geopolymers) • Bio-based construction materials	• Improved product design & reduced material intensity • Mechanical recycling of plastics	• Advanced chemical recycling • Circular business models	• Reducing food loss & waste • Packaging optimisation	• Circular packaging & reuse systems • Upcycling of food by-products	• Vehicle light-weighting • Improved logistics & load factors	• Deep freight demand reduction & modal shift • Battery & materials circularity
2. Energy efficiency & process optimisation	• BAT BF–BOF upgrades • Waste heat recovery	• AI-enabled process control • Near-net-shape casting	• Modern preheater / precalciner kilns • Waste heat recovery	• AI-based kiln optimisation • Advanced digital control	• High-efficiency cracking & distillation • Catalyst improvements	• Membrane & hybrid separations • AI/digital twins	• Boiler/steam optimisation • Efficient motors & refrigeration	• Integrated heat cascading • AI optimisation of batch processes	• Engine efficiency improvements • Aerodynamics / rolling resistance	• Truck platooning & connected driving • AI logistics optimisation
3. Electrification	• Electric arc furnaces	• Hydrogen-DRI • Electrolytic ironmaking	• Electrified auxiliary systems	• Electric kilns • High-temperature heat pumps	• Electrified drives & pumps	• Electric steam crackers • Electrochemical production routes	• Electrified low-temp processes • Electric boilers	• Industrial heat pumps • Electrified drying/baking	• Battery trucks (urban/regional) • Depot charging	• Megawatt charging for long-haul • Hydrogen fuel-cell trucks
4. Low-carbon fuels & feedstocks	• Natural gas–DRI • Biomass co-firing	• High-share H_2 BF injection • Green H_2–DRI	• Biomass/waste fuels for kilns	• Hydrogen kiln fuel • Synthetic fuels for kilns	• NG-based H_2 (SMR) • Bio-naphtha/bio-oils co-processing	• Green ammonia Bio-based & CO2-based plastics	• Biogas / NG switching • Biomass residue heat	• High-share biomethane • Hydrogen/e-fuels	• HVO / biodiesel • LNG/biomethane trucks	• Green hydrogen for HDV • Synthetic e-fuels
5. CCUS	• CO2 capture on BF–BOF	• Smelting reduction + CCUS • DRI + CCUS	• Amine capture on kilns	• Oxyfuel kiln + capture • Calcium looping	• Capture from high-purity streams	• CCS on crackers CO2-to-chemicals	• Capture on centralised CHP (limited implementation)	• BECCS (bioenergy CCS)	• CCUS at fuel-production	• On-board CO_2 capture • BECCS in biofuel production
Cross-sectoral enablers	**Infrastructure** • Clean energy systems • Hydrogen networks • CO2 transport and storage • Industrial clusters		**Institutional framework** • Regulations on green technologies • Standards and certifications on green technologies • Reporting standards on emissions		**Workforce skills** • Skilled technicians on green technologies • STEM workers specialised in green technologies					

Source: CIIP (forthcoming). Green industrial transition needs and barriers.

4. Green industrial transition barriers

The technological pathways described in Section 3.3 do not translate automatically into industrial decarbonisation. Firms face a combination of **technical, economic, organisational, and innovation system barriers**, compounded by weaknesses in cross-cutting enablers such as infrastructure, institutions, finance, and workforce skills (Figure 6). These barriers affect both the deployment of mature technologies and the development, demonstration, and scaling of emerging solutions.

Figure 6. Green industrial transition barriers



Source: Cambridge Industrial Innovation Policy.

Technical barriers arise because even commercially available technologies must be integrated into existing equipment, production processes, and operating conditions. Adoption may require plant modifications, production interruptions, and changes to upstream or downstream processes. Firms may also lack the **absorptive capacity** needed to evaluate, adapt, and operate unfamiliar technologies, particularly small and medium-sized enterprises (SMEs) with limited engineering resources and access to specialised expertise. As a result, technologies that are technically mature may still be perceived as operationally risky.

Economic barriers are particularly significant. Green industrial projects often involve high upfront capital costs, long payback periods, and uncertain future revenue. Low-carbon production routes may remain more expensive than conventional alternatives because of the higher costs of electricity, hydrogen, sustainable feedstocks, or specialised equipment, while customers may be unwilling to pay a premium for greener products. This creates substantial **demand uncertainty**, particularly for relatively homogeneous products such as steel, cement, chemicals, and fertilisers. Long-lived existing assets further complicate investment decisions: firms may delay replacing carbon-intensive equipment before the end of its economic life, while investing too early in emerging technologies creates the risk of technological obsolescence.

Organisational barriers can further slow the transition. Decarbonisation requires changes in corporate strategies, routines, and responsibilities and often demands coordination between sustainability, production, procurement, engineering, and finance functions with different priorities and time horizons. In multinational companies, major investment decisions may also be made at headquarters, limiting the autonomy of local subsidiaries. Beyond individual firms, many transition projects require simultaneous action by producers, utilities, infrastructure operators, technology providers, financial institutions, and governments, creating significant coordination challenges.

For less mature technologies, these challenges extend to the **innovation system**. Underinvestment in R&D, weak links between research organisations and industry, and limited demonstration infrastructure can slow technology development. A particularly important bottleneck is the **"valley of death"** between demonstration and commercial deployment, where first-of-a-kind (FOAK) projects may be too capital-intensive for venture investors but too risky for conventional lenders. Commercialisation also requires complementary capabilities – including suppliers, manufacturing capacity, standards, certification, testing facilities, and maintenance services – which may not exist.

Finally, green industrial transitions depend on **cross-sectoral enablers** that individual firms alone cannot provide. Large-scale electrification requires adequate grid capacity and low-carbon electricity; hydrogen-based production depends on hydrogen production, transport, and storage; and CCUS requires shared transport and storage infrastructure. This creates a recurring coordination problem: firms may wait for infrastructure before investing, while infrastructure providers may wait for sufficient demand. Lengthy permitting, uncertain regulation, inconsistent standards, and weak monitoring, reporting, and verification systems can also increase risk and delay investment. Shortages of engineers, technicians, electricians, construction workers, and other specialised workers can become an additional constraint across all transition pathways.

These barriers reinforce one another. A technically viable project may remain commercially unattractive because of high costs or uncertain demand; an economically promising investment may be blocked by missing infrastructure or skills; and emerging technologies may fail to scale because finance, regulation, and complementary capabilities are absent. The green industrial transition is therefore a **system-level coordination challenge** rather than simply a matter of deploying available technologies. Effective green industrial policy must address several of these constraints simultaneously – reducing project risks while creating markets, coordinating infrastructure, and strengthening technological, institutional, and workforce capabilities. Section 5 examines the policy instruments available to perform these functions.

5. Green industrial policy instruments: how are they different from traditional industrial policy?

The barriers described in Section 4 cannot be overcome through a single policy instrument. Technical uncertainty, weak demand, high costs, organisational constraints, and missing infrastructure interact with one another, meaning financial support alone will rarely be sufficient. Effective green industrial policy combines measures that support firms and technologies with measures that create markets, coordinate infrastructure, build capabilities, and establish credible environmental standards.

In one important respect, the policy repertoire is not fundamentally new. Green industrial policy draws on many of the same instruments used in traditional industrial policy: grants and tax incentives, subsidised credit, public procurement, trade and investment measures, public infrastructure, support for R&D, workforce training, technical assistance, standards, regulation, and direct public investment, among others. The financing toolbox is similarly familiar and includes loans, equity, guarantees, credit lines, and risk-sharing arrangements.

The main distinction lies less in the individual instruments than in **their emphasis, combination, sequencing, and performance criteria**. Green industrial policy applies familiar tools under unusually demanding technological, environmental, and coordination conditions. It must frequently support markets before demand is firmly established, finance technologies before their risks are fully understood, coordinate investments across several interdependent systems, and verify outcomes that cannot be measured through conventional economic indicators alone.

Green industrial policy is therefore not a separate policy field with a new set of instruments. It is better understood as traditional industrial policy operating under more demanding environmental, technological, and infrastructural conditions. Its distinctive features, the industrial policy instruments associated with them, and selected real-world examples are summarised in Table 1. The instruments are generally not unique to green industrial policy, but what differs is their relative importance, design, conditionality, and combination in response to environmental and transition challenges.

Table 1. Distinctive features of green industrial policy, associated instruments, and examples

Distinctive feature	Associated industrial policy instruments	Examples
Creating demand for products whose environmental value is not fully rewarded by markets	Green public procurement; purchase or consumption subsidies; product and emissions standards; mandates and quotas; contracts for difference; offtake guarantees; carbon pricing and other mechanisms that narrow the green premium.	**Japan's GX/Climate Transition Bond programme** finances demand-side measures, including subsidies for clean energy vehicles and commercial vehicle electrification. These measures are intended to accelerate adoption and establish markets for low-carbon technologies, alongside support for production and technology development.[10]
Supporting uncertain technologies through demonstration and first commercial deployment	R&D and demonstration grants; FOAK project finance; concessional loans; public equity; guarantees and first-loss capital; blended finance; innovation funds; production incentives for emerging technologies.	The **Green Artha Clean Economy Fund** targets FOAK climate technologies at the difficult commercialisation stage between venture capital and conventional project finance, combining investment with concessional risk-sharing and technical assistance.[11] The **EU Innovation Fund** similarly focuses on innovative and FOAK projects and explicitly uses public funding to share technology and deployment risk.[12]
Combining finance with technical assistance and project preparation	Project-preparation facilities; feasibility and engineering studies; technical assistance; advisory services; accelerator programmes; capacity-building; blended finance platforms combining capital with non-financial support.	The **Asian Development Bank's Energy Transition Mechanism** combines concessional and commercial finance with technical assistance for feasibility work, safeguards, grid analysis, replacement power planning, and monitoring. The **Malaysia Development Bank Climate Finance and Investment Lab** uses project screening, accelerator programmes, technical support, and capital structuring to turn climate concepts into investment-ready projects.[13]

[10] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.
[11] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.
[12] European Commission (2026). Innovation Fund.
[13] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

Distinctive feature	Associated industrial policy instruments	Examples
Coordinating production investments with shared infrastructure	Coordinated infrastructure and industrial planning; public or regulated utility investment; industrial hubs and clusters; infrastructure funds; shared-asset vehicles and public–private partnerships (PPPs); revenue guarantees; spatial planning and accelerated permitting.	The **UK's industrial decarbonisation strategy** supports shared CO2 transport and storage networks that can serve multiple industrial sites, recognising that such infrastructure involves large upfront costs and coordination across firms. Government support has included the Carbon Capture and Storage Infrastructure Fund and dedicated business models for transport, storage, and industrial carbon capture.[14]
Balancing rapid decarbonisation with domestic capability development	Conditional grants and tax incentives; domestic supply chain and manufacturing support; R&D and innovation programmes; workforce and skills policies; supplier development programmes; community benefit or capability-building conditions attached to public support.	**Australia's Future Made in Australia** combines a net zero transformation objective with an economic resilience and security objective. Its policy package includes production incentives for renewable hydrogen and critical mineral processing, innovation, and manufacturing support, while the Community Benefit Principles seek to strengthen local communities, supply chains, and skills.[15] Japan's GX programme similarly combines decarbonisation support with investment in domestic battery and semiconductor supply chains.[16]
Defining credible green and transition activities	Green and transition taxonomies; technical screening criteria; sectoral decarbonisation roadmaps; eligible activity and exclusion lists; transition plan requirements; "do no significant harm" and social/environmental safeguards.	The **EU Taxonomy** requires eligible activities to make a substantial contribution to an environmental objective, to do no significant harm to others, to meet minimum safeguards, and to comply with technical screening criteria.[17] In **Zhejiang/Huzhou, China**, a textile-specific transition taxonomy identifies around seventy technical pathways and is used to determine eligibility for transition lending to textile firms.[18]

[14] DESNZ and BEIS (2021). Industrial decarbonisation strategy.
[15] Australian Treasury (2024). Future Made in Australia - National Interest Framework supporting paper.
[16] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.
[17] European Commission (2023). A user guide to navigate the EU taxonomy for sustainable activities.
[18] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

Distinctive feature	Associated industrial policy instruments	Examples
Measuring environmental performance in addition to conventional economic outcomes	Monitoring, reporting, and verification systems; emissions and life-cycle accounting; environmental key performance indicators; independent verification; impact evaluation; sustainability-linked loans and grants; performance-based subsidies and contracts.	The **Changxing Rural Commercial Bank Textile Transition Loan** combines a sector taxonomy with digital carbon-performance data and ongoing verification, with loan pricing adjusted according to verified transition progress. Huzhou's digital "Industrial Carbon Efficiency Code" provides shared data infrastructure for measuring firms' carbon performance. Japan's Climate Transition Bonds also use allocation and impact reporting, with different methodologies for R&D, capital investment, and demand-side projects, illustrating the need to distinguish between modelled future impacts and observed results.[19]

Source: Cambridge Industrial Innovation Policy.

[19] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

As Table 1 illustrates, most of these instruments are not unique to green industrial policy. Grants, tax incentives, public procurement, concessional finance, infrastructure investment, regulation, skills policies, and innovation support are all familiar elements of traditional industrial policy. What is distinctive is the greater weight placed on demand creation, technological and financial risk-sharing, infrastructure coordination, environmental eligibility and monitoring, and the need to pursue decarbonisation alongside industrial development objectives.

5.1 A stronger role in creating and shaping markets

Traditional industrial policy often supports activities that governments expect to become commercially competitive as productivity rises, firms learn, and markets expand. Green industrial policy shares this objective, but the demand for green products often depends more on public policy.

Customers may be unwilling to pay more for low-emissions steel, cement, chemicals, or other intermediate goods when these products perform the same immediate function as cheaper, emissions-intensive alternatives. The wider social benefit of lower emissions is not fully reflected in the purchasing decision. Demand can therefore remain weak even where low-carbon production is technologically feasible.

For this reason, green industrial policy must often do more than just helping producers to reduce their costs. It must also create significant demand. Table 2 summarises some of the main demand-side instruments and examples of how they have been used in practice.

Table 2. Demand-side instruments for creating and shaping green industrial markets

Instrument	Example
Carbon pricing and emissions regulation	**European Union Emissions Trading System (EU ETS).** Operating since 2005, the EU ETS puts a price on greenhouse gas emissions from electricity and heat generation and industrial manufacturing, as well as aviation and maritime transport. Its declining emissions cap and requirement for covered firms to surrender allowances increase the relative cost of carbon-intensive production, strengthening incentives to invest in and purchase lower-emissions alternatives.
Public procurement commitments for low-emissions materials	**US Federal Buy Clean Initiative.** During its 2023–24 implementation, the US General Services Administration (GSA) introduced requirements and dedicated funding for the purchase of lower-embodied-carbon asphalt, concrete, glass, and steel in federal construction projects. The GSA identified more than 150 projects using these materials, using federal purchasing power to stimulate demand for lower-carbon manufacturing.
Product standards and minimum emissions-performance requirements	**California Low Carbon Fuel Standard (LCFS).** The LCFS establishes progressively tighter life-cycle carbon-intensity benchmarks for transport fuels. Fuels with carbon intensity below the benchmark generate tradable credits, while suppliers of higher-carbon fuels incur deficits that must be offset. The standard therefore creates continuing demand for lower-carbon fuels without prescribing a single technology.
Quotas or mandates for recycled and low-carbon content	**EU Batteries Regulation.** The regulation establishes mandatory minimum recycled-content requirements for EV and certain industrial batteries. From 2031, covered batteries are required to contain minimum shares of recovered cobalt (16%), lead (85%), lithium (6%), and nickel (6%), with higher requirements for several materials from 2036. Such mandates create a predictable market for recycled materials and encourage investment in recycling and secondary-material supply chains.

Instrument	Example
Advance market commitments and long-term offtake arrangements	**Germany's H2Global programme.** H2Global uses a publicly backed intermediary, Hintco, to enter long-term purchase agreements for renewable hydrogen derivatives and resell them through competitive auctions. Public funding covers the expected gap between the higher purchase price and the lower price buyers are initially willing to pay. The long-term contracts give producers revenue certainty while helping to establish demand and price signals in an immature green hydrogen market. The first auction resulted in contracts for at least 259,000 tonnes of green ammonia to be supplied to Germany between 2027 and 2033.
Certification, labelling, and traceability systems	**Australia's Guarantee of Origin (GO) scheme.** Launched in 2025, the GO scheme provides product certificates recording where products were made and the emissions associated with their production, transport, and storage. It initially covers electrolytic hydrogen but the aim is to expand to products including hydrogen derivatives, low-carbon fuels, and green metals. By enabling buyers to verify emissions attributes, the system helps differentiated low-emissions markets to develop.
Consumer incentives	**China's EV policy.** China used consumer incentives as part of a wider policy package to build an early market for new-energy vehicles (NEVs). Early measures included national and local purchase subsidies, public demonstration programmes, and preferential treatment such as easier access to vehicle licences and traffic privileges in some cities. As the market matured, direct national purchase subsidies ended in 2022, while tax and replacement incentives continued. NEVs purchased in 2026–27 currently receive a 50% reduction in the vehicle purchase tax, capped at RMB15,000 per passenger vehicle, while the 2026 vehicle trade-in programme provides a larger subsidy for replacing an eligible old vehicle with an NEV than with an internal combustion vehicle. See Box 1 for a more detailed description of this policy.

Source: Cambridge Industrial Innovation Policy.

In these cases, policy does not just respond to an existing market but helps to constitute the market itself. The examples in Table 2 also illustrate that demand creation can operate through different channels. Carbon prices and performance standards alter the relative economics of high- and low-carbon products; procurement and offtake arrangements provide buyers directly; mandates create guaranteed minimum markets; certification makes environmental attributes visible and verifiable; and consumer incentives reduce the cost or inconvenience of adopting new technologies. Many green industrial markets are therefore better described as **policy-created or policy-shaped markets**.

Demand-side measures must nevertheless be designed carefully. If public support is temporary or frequently revised, firms may remain reluctant to invest in long-lived assets. Credible transition pathways therefore require predictable policy frameworks, clear implementation schedules, and sufficient certainty about the direction of travel, even where individual instruments are adjusted over time.

China's EV experience (Box 1) illustrates how this market-shaping role can evolve as an industry matures. Rather than relying on a single demand-side intervention, China combined support for technology development and production with measures to create early users, reduce adoption costs, and build the infrastructure needed for widespread use. As technological capabilities, production scale, and consumer demand developed, the policy mix also changed – from R&D support and public fleet demonstrations, through purchase incentives and production requirements, towards greater reliance on regulation, competition, tax incentives, and charging infrastructure. The case illustrates a broader feature of green industrial policy: supply- and demand-side instruments may need to evolve together as the principal barriers to market development change.

Box 1. China's green industrial policy for electric vehicles: sequencing supply- and demand-side support

China's EV policy illustrates how green industrial policy can combine supply- and demand-side measures and adjust them as technologies and markets mature.

Stage 1 – Technology development and demonstration

Supply side: building technological capabilities. In the early stages, policy focused on reducing technological uncertainty and developing domestic capabilities in vehicles and key components, particularly batteries, motors, and control systems. Public R&D programmes expanded substantially during the 2000s; research estimates indicate that funding for NEV development reached around USD1.5 billion during the 2006–2010 Five-Year Plan, alongside a wider set of technology development programmes and experiments.[20]

Demand side: creating lead markets through public demonstration. With private demand still limited, government procurement and demonstration programmes created early markets in which technologies could be tested under real operating conditions. The programme widely known as **"Ten Cities, Thousand Vehicles"**, launched in 2009, initially concentrated deployment in public service fleets such as buses, taxis, government vehicles, sanitation vehicles, and postal services. Central government subsidies supported vehicle purchases, while local governments also supported complementary infrastructure. The programme subsequently expanded to additional cities.

Stage 2 – Early market formation and scale-up

Supply side: encouraging production and technological improvement. As EV technologies became more viable, policy increasingly sought to expand production and improve vehicle performance. An important instrument was the **dual-credit policy**, adopted in 2017 and effective from 2018, which established parallel requirements for manufacturers relating to average fuel consumption and NEVs. Firms can trade credits and must compensate for deficits, creating a continuing regulatory incentive to increase NEV production and improve technological performance.

Demand side: reducing the cost and inconvenience of early adoption. Policy also sought to narrow the gap between EVs and conventional vehicles for private consumers. National and local purchase subsidies and tax incentives reduced upfront costs, while some large cities offered additional advantages such as preferential access to licence plates, exemptions from traffic restrictions, charging incentives, or preferential parking. These measures were particularly important where non-price barriers made ownership of conventional vehicles more difficult or EV ownership more convenient.

Stage 3 – Mass-market scale-up

Supply side: shifting from subsidies towards regulation and competition. As the industry expanded, policy relied less on direct support and increasingly used regulatory requirements, technical standards, and competition to shape the market. Purchase subsidies were progressively reduced from 2017, and the national purchase subsidy programme ended in 2022, while instruments such as the dual-credit system continued. China also removed foreign equity restrictions for NEV manufacturing in 2018, increasing the scope for foreign investment and competition in the sector.

[20] Helveston et al. (2019). Institutional complementarities: The origins of experimentation in China's plug-in electric vehicle industry.

Box 1. China's green industrial policy for electric vehicles: sequencing supply- and demand-side support

Demand side: enabling convenient mass adoption. As EVs moved towards the mass market, the challenge increasingly concerned the infrastructure and conditions required for everyday use. Policy therefore placed greater emphasis on charging networks and related infrastructure while retaining more targeted consumer incentives. China has become the world's largest market for public EV charging infrastructure; by the end of 2025 it accounted for more than 65% of public charging points globally.[21] Direct national purchase subsidies have ended, and from 2026 the previous full vehicle-purchase-tax exemption was replaced with a 50% tax reduction, illustrating the shift from broad purchase subsidies towards a more mature policy mix.[22]

Overall lesson

China's experience illustrates that green market creation is not necessarily a one-off intervention. Different constraints become binding as an industry develops. Early policy can reduce technological uncertainty and create lead users; subsequent measures can reduce costs and stimulate production and private demand; and, as the market matures, policy can shift towards standards, regulation, competition, and enabling infrastructure.

Source: Kohpaiboon (2026); Yong et al. (2023); IEA (2021); IEA (2023); IEA (2026); Helveston et al. (2019).

5.2 Greater emphasis on innovation, demonstration, and scale-up

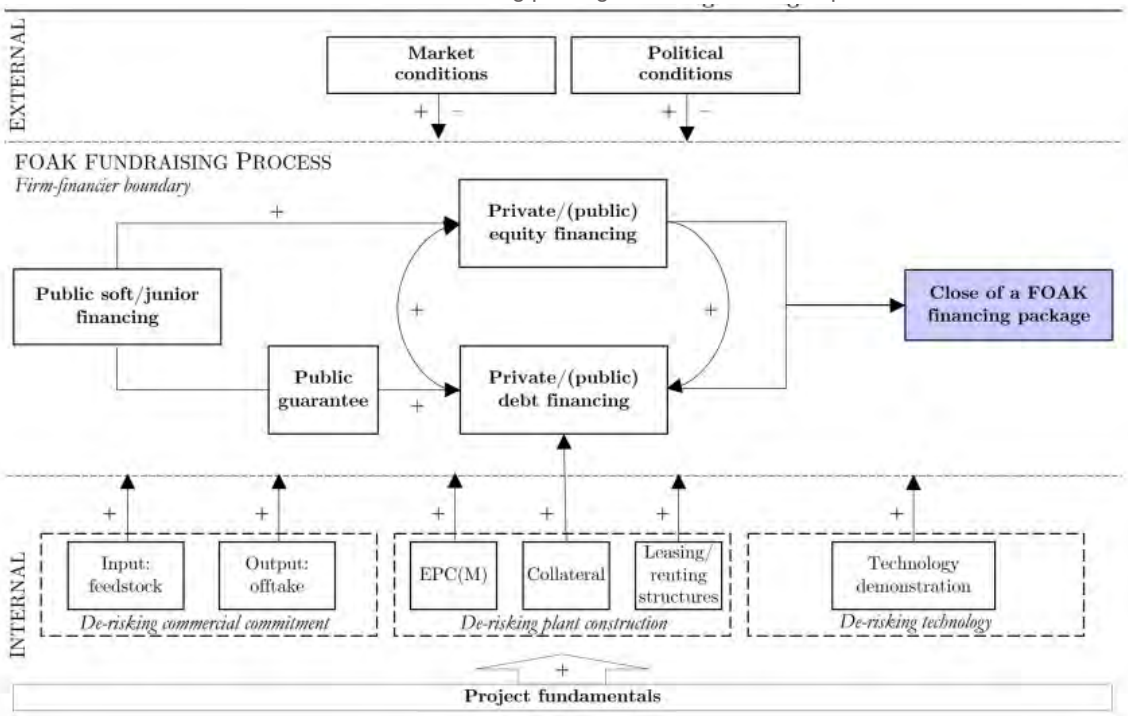
A second difference is the unusually large role of technological uncertainty. Traditional industrial policy has often supported innovation and infant industries, but many green industrial transitions require the simultaneous development of technologies, production capacity, infrastructure, suppliers, and markets.

This is especially important for first-of-a-kind (FOAK) industrial facilities. Technologies such as hydrogen-based production processes, some high-temperature electrification systems, and advanced carbon-capture configurations may have been technically demonstrated without having an extensive commercial track record. Their construction costs, operating performance, maintenance requirements, and market value may therefore remain uncertain. Conventional lenders are generally reluctant to finance such projects because the risks are difficult to estimate and there may be few comparable transactions.

Figure 7 illustrates the complexity of bringing a financing package for a FOAK plant to a successful close.

[21] IEA (2026). Global EV Outlook 2026: Electric vehicle charging.
[22] IEA (2026). Global EV Outlook 2026: Trends in electric cars.

Figure 7. Paths to the successful close of a financing package for a first-of-a-kind plant



Source: Heikkinen (2025).

Green industrial policy requires support across the full innovation cycle:

- **Research and early development** may require public research funding, innovation grants, university–industry partnerships, and shared laboratories.
- **Pilot and demonstration projects** may require grants, public co-investment, specialised testing facilities, and support for feasibility and engineering studies.
- **First commercial facilities** may require concessional loans, guarantees, patient equity, first-loss capital, and other blended finance structures that allocate certain risks to actors capable of bearing them.
- **Commercial diffusion** may require credit lines, tax incentives, technical assistance, supplier development, and demand-creation measures.

Financing instruments may not be sufficient. Green Artha, an Indian private fund that specialises in scaling FOAK industrial decarbonisation technologies, highlights the importance of combining capital with project preparation, technical assistance, and commercialisation support. The fund also suggests that concessional finance is most effective when directed at clearly identified risks – such as a FOAK technology risk or early project development costs – rather than being used as a general subsidy.[23]

Blended finance can be particularly valuable in this context (see Box 2). Public or concessional capital can absorb specified risks, improve financing terms, or provide longer maturities, allowing private capital to participate in projects it would otherwise avoid. But blended finance cannot compensate indefinitely for the absence of a viable transition pathway, so it should be used to address temporary risks and market development gaps, alongside policies that improve the project's underlying economics.

[23] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

Box 2. Financing instruments: the importance of blended finance and transition finance for green industrial policy

Green industrial transition projects are often poorly served by conventional commercial finance. They may require high upfront investment, involve technologies that have not been demonstrated at scale, depend on uncertain future demand for low-emission products, and generate returns over long time horizons only. These characteristics can make otherwise socially desirable projects appear too risky or insufficiently profitable to commercial lenders and investors. Blended finance and transition finance address different aspects of this problem: blended finance concerns how capital and risks are structured, while transition finance concerns which decarbonisation activities can be financed.

Blended finance. Blended finance is the strategic combination of concessional public or philanthropic resources – such as grants, guarantees, first-loss capital, subordinated finance, or below-market loans – with commercial capital. Its purpose is to improve the risk–return profile of investments that would not proceed on purely commercial terms and thereby mobilise additional private finance.

Blended finance structures can take many forms, depending on the project's barriers and the risk appetite of participating investors. Grants or project-preparation facilities may cover feasibility studies and other early-stage costs; guarantees can protect lenders against defined risks; first-loss or subordinated capital can absorb initial losses; and concessional loans can reduce financing costs or extend maturities. The central principle is that concessional resources should be used selectively to address specific risks or viability gaps rather than replacing finance that the private sector would otherwise have provided.

This approach is particularly important for FOAK industrial facilities, emerging technologies, and enabling infrastructure, where technological, construction, market, and policy risks may be too high for conventional investors. By allocating these risks to the institutions best able to bear them, blended finance can help turn promising project concepts into bankable investments and support their progression from demonstration to commercial scale.

Transition finance. Transition finance supports credible emissions reductions in sectors and activities that cannot immediately meet the eligibility criteria normally associated with green finance. Green finance generally focuses on activities that are already low-carbon or clearly aligned with established environmental classifications, such as renewable electricity or mature energy-efficiency technologies. This approach is essential, but it may not capture the full investment needs of emissions-intensive industries.

In hard-to-abate sectors such as iron and steel, cement, and chemicals, it may not yet be technically feasible or commercially viable to substitute existing processes. Decarbonisation may require a sequence of investments, including efficiency improvements, electrification, fuel and feedstock switching, process redesign, carbon capture, enabling infrastructure, and the gradual replacement of existing assets. Transition finance makes it possible to support these intermediate steps if they form part of a credible, time-bound pathway towards deep decarbonisation.

This flexibility must be accompanied by safeguards. Financing marginal improvements without a clear long-term transition strategy can prolong the life of carbon-intensive assets and create technological or emissions lock-in. Credible transition finance therefore requires sector-specific pathways, measurable emissions-reduction targets, transparent eligibility criteria, monitoring and verification, and consistency with long-term climate objectives. International cases show that transition finance is most credible when financing is embedded in clear taxonomies, policy frameworks, and robust reporting systems.

Box 2. Financing instruments: the importance of blended finance and transition finance for green industrial policy

For green industrial policy, the two approaches are complementary. Transition finance broadens the range of industrial investments that can legitimately receive climate-aligned support, while blended finance provides the financial structures needed to make those investments viable and attract private capital. Together, they allow governments and development finance institutions to support firms through the different stages of industrial transformation – from technology development and demonstration to first commercial deployment and large-scale diffusion. But their effectiveness depends on close alignment with industrial strategies, credible transition pathways, and complementary measures to create demand, develop infrastructure, and strengthen technological capabilities.

Source: CIIP (forthcoming). DFI instruments and mechanisms for supporting green industrial transitions; CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

5.3 More intensive coordination of infrastructure and industrial investment

Infrastructure has always been part of industrial policy, but what makes green industrial policy distinctive is the extent to which the viability of an industrial project may depend on new infrastructure that does not exist. Industrial electrification may require grid reinforcement, new substations, and additional low-carbon generation. Hydrogen-based production requires reliable hydrogen supply, transport, and storage. CCUS projects require carbon dioxide collection, pipelines, shared transport networks, storage sites, and liability arrangements. Circular production models depend on collection, sorting, and recycling systems. These investments often involve different owners, regulators, technologies, and construction schedules.

The result is a coordination problem. An industrial firm may be unwilling to invest before the necessary infrastructure is guaranteed, while the infrastructure provider may be unwilling to invest before sufficient industrial demand is committed. Individual project appraisal cannot resolve this problem because the viability of each investment depends on the others.

Furthermore, the infrastructure supporting green industrial transitions must be climate-resilient. Energy, transport, water, and communications infrastructure is increasingly exposed to climate-related hazards such as heatwaves, flooding, and droughts, which can damage assets and disrupt the services on which industrial production depends. Because infrastructure systems are highly interdependent, failures in one network can generate cascading disruptions across others. Green industrial policy therefore needs to coordinate not only the expansion and decarbonisation of enabling infrastructure but also its adaptation to future climate conditions. Climate risks should be incorporated from the outset into infrastructure planning, design, construction, operation, and maintenance, helping to avoid locking in vulnerability in long-lived assets and to protect the reliability and continuity of industrial systems.

Green industrial policy must therefore operate at the level of industrial systems and clusters, as well as individual firms. Instruments may include coordinated infrastructure planning, industrial decarbonisation hubs, public or regulated utility investment, shared assets and facilities, spatial planning, accelerated permitting, and mechanisms for aggregating demand among several industrial users.

This makes policy sequencing especially important. Production facilities, energy systems, transport infrastructure, standards, and workforce programmes need to be developed on compatible timelines. A subsidy for industrial equipment will have limited effect if the plant has to wait years for a grid connection or access to a low-carbon feedstock.

5.4 A more difficult balance between decarbonisation and local economic development

Traditional industrial policy frequently attaches conditions to public support, such as domestic content requirements, employment commitments, export targets, technology transfer, or local R&D. Such conditions seek to ensure that public resources generate wider developmental benefits rather than merely increasing firm-level profits.

These objectives remain important in green industrial policy, particularly for developing countries. Industrial decarbonisation should ideally strengthen domestic technological capabilities, create skilled employment, and expand local supply chains. Without such links, countries may become dependent on imported equipment and expertise while capturing only a small share of the economic value created by the transition. But conditionality can be more difficult to apply when green projects are already barely commercially viable. A strict requirement to use more expensive or less-tested local technology may increase the costs and risks. As one Asian Development Bank official put it:

> If industrial decarbonisation projects are barely bankable with the latest imported technology, they are for sure unbankable using less-developed local technologies.[24]

This creates a genuine policy tension. Weak conditions can allow public support to finance imported turnkey solutions with limited local learning. And excessively demanding conditions can prevent the investment from taking place at all. A more realistic approach may be to use **progressive and capability-oriented conditionalities**. Instead of requiring high local content from the beginning, governments could establish staged requirements linked to the maturity of domestic suppliers. Support could also be conditional on workforce training, partnerships with local research organisations, supplier development programmes, domestic maintenance capability, data sharing, or gradual localisation of selected components and services.

Conditionalities should therefore be aligned with existing capabilities and accompanied by measures that help domestic firms to meet them. Local content requirements without supplier development, finance, standards, and technical assistance are unlikely to produce competitive local industries.

5.5 Clearer environmental definitions and safeguards

Traditional industrial policy must determine which firms, sectors, and activities qualify for support. But green industrial policy faces an additional question: **What qualifies as green, or as a credible transition activity?** And this is not always a straightforward question. Financing a renewable energy plant is relatively easy to classify, but assessing an investment that partially reduces emissions from a steelworks, refinery, or chemical plant is more difficult. The project may deliver meaningful near-term reductions while continuing to use fossil inputs. Alternatively, it may claim that future conversion to hydrogen or carbon capture will eventually produce deeper reductions, although those future conditions are uncertain.

Green taxonomies, sectoral roadmaps, and eligibility criteria are therefore important policy instruments. Taxonomies define which activities meet specified environmental thresholds, and transition roadmaps can assess whether incremental investments are consistent with a credible long-term sectoral pathway. Both approaches can help direct finance and public support, although neither removes the need for case-specific judgement.

[24] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

Existing taxonomies illustrate different ways of addressing this problem. The **EU Taxonomy for Sustainable Activities,**[25] for example, sets technical screening criteria for economic activities across sectors, including emissions-intensive industries such as steel, cement, aluminium, and chemicals. An activity must make a substantial contribution to an environmental objective while meeting "do no significant harm" requirements and minimum safeguards, providing a relatively stringent basis for determining which investments can be classified as environmentally sustainable.

A different approach is emerging through **sector-specific transition taxonomies**. In Zhejiang Province, China, a taxonomy for transition finance in the textile industry[26] identifies around seventy technical pathways for reducing the environmental and carbon intensity of activities across raw materials, spinning, weaving, dyeing, and textile manufacturing. It is used alongside monitoring and verification systems to determine eligibility for transition lending, allowing finance to support firms that are not yet "green" but undertaking measurable improvements along an identified transition pathway.[27]

Poorly designed criteria create two opposing risks: criteria that are too permissive may support activities that prolong carbon-intensive production or generate marginal improvements; and criteria that are too restrictive may exclude hard-to-abate industries from finance, despite their need to make staged investments before fully low-carbon technologies become available.

Green industrial policy must also consider environmental impacts beyond carbon emissions. Some low-carbon technologies may create pressures relating to water use, land, biodiversity, waste, or critical mineral extraction. Eligibility frameworks should therefore include safeguards against shifting environmental damage from one area to another.

5.6 More demanding monitoring and multidimensional evaluation of policy success

Monitoring is important in all industrial policy. Traditional programmes commonly assess results through investment, output, productivity, exports, employment, or technological upgrading. Green industrial policy must retain these indicators while adding environmental performance as a central dimension of policy evaluation.

Relevant environmental indicators may include absolute emissions reductions, emissions intensity per unit of output, life-cycle emissions, energy and material efficiency, the share of recycled or low-carbon inputs, progress against sectoral transition milestones, and other environmental effects such as water use, pollution, and waste.

These outcomes are often more difficult to measure and verify than conventional economic indicators. Emissions reductions depend on the baseline used, the boundaries of measurement, and assumptions about what would have happened without the policy. Projects involving research, demonstration, or enabling infrastructure may not deliver measurable emissions reductions for many years, so estimated future impacts should be clearly distinguished from observed results.

Strong monitoring, reporting, and verification systems are necessary for both accountability and policy learning. They can show whether supported technologies are performing as expected, whether public finance is generating additional investment, and whether policies should be

[25] European Commission (2026). EU taxonomy for sustainable activities.

[26] National Standards Information Public Service Platform (SPC) (2024). Taxonomy of Economic Activities for Transition Finance in Textile Industry.

[27] For a detailed discussion, see CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

expanded, redesigned, or discontinued. Independent verification, transparent methodologies, and accessible data can also reduce the risks of green- and transition-washing.

Monitoring can also be linked to incentives. Loan pricing, grants, or tax benefits may be adjusted when verified environmental milestones are met or missed. The Textile Transition Loan from Changxing Rural Commercial Bank in Huzhou, China, for example, links financing conditions to sector-specific eligibility criteria and verified transition performance, illustrating how familiar financial instruments can be adapted to environmental objectives.[28]

More fundamentally, these additional measurement requirements reflect a broader difference in what constitutes **policy success**. Traditional industrial policy generally focuses on economic transformation: productivity, technological learning, exports, employment, investment, and structural change. Green industrial policy retains these objectives but adds emissions reductions and environmental integrity as central goals. A programme cannot be judged successful because it attracts investment or creates jobs if it fails to produce credible environmental improvements. Conversely, a policy that reduces emissions primarily through importing technologies may contribute to climate objectives while generating limited domestic capability or economic diversification.

Evaluation should therefore consider three interrelated dimensions:

1. **Environmental performance:** whether emissions and other environmental impacts have fallen in a credible and durable manner.
2. **Economic performance:** whether the policy has improved productivity, competitiveness, investment, and market development.
3. **Capability and distributional performance:** whether it has strengthened domestic technological capabilities, supply chains, and skills, and whether its costs and benefits are distributed fairly.

These objectives may reinforce one another, but they may also be conflicting. Green industrial policy requires evaluation systems capable of tracking multiple outcomes simultaneously and making trade-offs explicit rather than assuming that every green investment will automatically generate strong industrial development outcomes.

5.7 How to put it all together? A greater need for coordinated policy packages

Because of the many challenges involved in successfully implementing green industrial policies, there is a greater need for to implement them through coordinated policy packages rather than isolated policy instruments. Governments increasingly rely on high-level industrial strategies and roadmaps to organise policy packages around shared objectives. These strategies articulate long-term ambitions, identify priority sectors and technologies, establish production or deployment targets, coordinate infrastructure and skills investments, assign institutional responsibilities, and provide a framework for sequencing complementary policy measures. In doing so, they reduce policy uncertainty and signal long-term government commitment, encouraging private investment.

Recent green industrial strategies illustrate this shift. Norway's Green Industrial Initiative 2.0, for example, defines an overarching objective of creating socially, environmentally, and economically sustainable value creation while identifying nine priority industrial areas. It complements these priorities with cross-cutting actions on energy, infrastructure, capital, skills, research, governance, and regional cooperation. The roadmap frames these elements as interconnected, arguing that

[28] CIIP (forthcoming). Casebook of international practices for financing green industrial transitions.

successful industrial transformation requires coordinated action across multiple policy domains rather than isolated interventions (Box 3).[29]

Similarly, Australia's Future Made in Australia establishes a national framework to identify priority industries under net zero transformation and economic resilience objectives, while linking sector prioritisation with investment incentives, sustainable finance, innovation support, workforce development, infrastructure planning, and regulatory reform. Rather than introducing new policy instruments, the strategy provides an organising framework that aligns existing instruments around clearly defined industrial objectives and facilitates their coordinated implementation.[30]

As these examples demonstrate, green industrial policy is increasingly characterised not by novel instruments but by stronger strategic coordination. High-level strategies provide the institutional architecture within which subsidies, public finance, procurement, regulation, skills policies, and infrastructure investments can be combined into coherent policy mixes, adapted to the needs of specific sectors and regions, and sustained over the long-term horizons required for industrial transformation.

Box 3. High-level strategies as frameworks for green industrial policy: the cases of Australia and Norway

Recent green industrial strategies illustrate how governments are moving beyond isolated policy measures towards integrated frameworks that coordinate investment, innovation, infrastructure, and workforce development around long-term industrial transformation objectives.

Australia's Future Made in Australia strategy is designed to position the country to capture the economic opportunities arising from the global net zero transition while strengthening economic resilience and national security. Rather than focusing on individual programmes, it establishes a National Interest Framework that identifies priority sectors and coordinates policy instruments around shared industrial objectives. The strategy prioritises industries such as renewable energy, critical minerals, green metals, batteries, hydrogen, and clean manufacturing, and combines targeted investment incentives with innovation support, concessional finance, skills development, infrastructure investment, regulatory reform, and measures to mobilise private capital.

Specific measures include the production tax incentives for critical minerals processing, expanded financing through the Clean Energy Finance Corporation and National Reconstruction Fund, investments in transmission infrastructure through Rewiring the Nation, and workforce initiatives to expand training and increase women's participation in science, technology, engineering, and mathematics occupations. By linking these complementary measures within a single strategic framework, the initiative seeks to reduce investment uncertainty and accelerate the development of new industrial capabilities.

[29] Norwegian Ministry of Trade, Industry and Fisheries (2024). The Green Industrial Initiative. Roadmap 2.0.
[30] Australian Government (2024). Future Made in Australia.

Box 3. High-level strategies as frameworks for green industrial policy: the cases of Australia and Norway

Norway's Green Industrial Initiative 2.0 adopts a similarly integrated approach. It defines the overall objective of industrial policy as promoting socially, environmentally, and economically sustainable value creation while supporting the transition to a low-emission economy. The strategy identifies nine priority industrial areas: offshore wind, batteries, hydrogen, carbon capture and storage, process industries, manufacturing, solar industries, maritime industries, and forestry and other bioeconomy sectors. It also recognises that their development depends on a common set of enabling conditions, including affordable clean energy, infrastructure, access to capital, research and innovation, skilled labour, export markets, and effective governance.

Concrete measures include a target for at least 30% of public procurement to incorporate green criteria, expanded support for pilot and demonstration projects, strengthened export finance and guarantee schemes for green industries, investment in carbon capture and storage infrastructure, and the establishment of a Green Industry Council to coordinate implementation across government, industry, social partners, and research institutions.

Despite differences in national context and industrial structure, the two strategies reflect a common understanding of green industrial policy. Rather than introducing new policy instruments, both organise familiar tools within coherent long-term strategies, signalling sustained government commitment.

Source: Australian Government (2024). A Future Made in Australia; Norwegian Ministry of Trade, Industry and Fisheries (2024). *The Green Industrial Initiative. Roadmap 2.0.*

6. Conclusions and implications for developing countries

This brief has examined green industrial policy as a response to the interconnected technological, economic, and institutional challenges of transforming industrial production. Its central conclusion is that the green industrial transition is not simply a process of adopting cleaner equipment, instead involving changes in production technologies, energy and material inputs, infrastructure, markets, and productive capabilities. A technically viable solution may remain commercially unattractive, while an economically promising project may be unable to proceed because the necessary infrastructure, skills, or supporting institutions are missing.

Green industrial policy therefore differs from traditional industrial policy less through an entirely new set of instruments than through the demands placed on their design and implementation. Familiar tools are used to address greater technological uncertainty, create demand for environmental improvements, coordinate investments across industrial systems, and verify outcomes beyond conventional economic indicators. The relevant unit of analysis is consequently the **policy package** rather than the individual subsidy, loan, or regulation.

For developing countries, this analysis highlights six connected considerations:

Transition pathways depend on sectoral needs and existing capabilities. The common pillars of industrial decarbonisation provide a framework for analysis but not a uniform investment programme. Their application depends on production processes, existing assets, local energy and infrastructure conditions, technological maturity, and costs. The same instrument or technology may therefore address a significant constraint in one industry while having limited relevance in another. For developing countries, this makes an understanding of domestic industrial structures and capabilities central to assessing feasible transition pathways. It also distinguishes between two parallel tasks: diffusing commercially available solutions that can deliver near-term improvements; and developing the capabilities and supporting systems needed for deeper technological change. Treating the transition as either adopting mature technologies or investing in technological breakthroughs overlooks part of the challenge.

Domestic capability development is a distinct objective, not an automatic consequence of decarbonisation. An investment can reduce emissions while relying on imported equipment and expertise. Equally, imposing demanding domestic content conditions before local suppliers can meet them can increase the costs and risks, potentially preventing investment. The relationship between decarbonisation and industrial development therefore involves a sequencing problem rather than a simple choice between imported and domestic technology. The brief identifies progressive, capability-oriented conditions as one possible approach: linking support to workforce training, research partnerships, supplier development, maintenance capabilities, or the gradual localisation of selected components and services. These arrangements connect investment with domestic learning without assuming that all capabilities must already be present. They also broaden the meaning of green industrialisation beyond manufacturing equipment to include the engineering, technical, and other industrial services that support its use.

Market creation and infrastructure development are part of industrial investment, not separate supporting activities. Expanding production capacity does not necessarily establish a market for low-emissions products, particularly where buyers are unwilling to pay the additional costs. Similarly, investment in an industrial facility may depend on electricity networks, feedstock supplies, transport, or shared facilities that other organisations must provide. Designing a coherent policy package involves identifying these dependencies and aligning the associated commitments, responsibilities, and implementation schedules. Procurement, standards, and offtake arrangements address different aspects of demand, while coordinated infrastructure planning addresses the physical conditions for production. The infrastructure itself also faces climate risks that can disrupt industrial activity. For developing countries, the implication is that the feasibility of a proposed industrial transition depends on the wider production system and not just the technology or financial position of an individual firm.

Access to capital is just one part of the financing challenge. Some projects lack suitable finance because their technologies are unfamiliar or their investment horizons are long. Others face unresolved problems of project preparation, infrastructure availability, or future demand. These differences matter because additional lending alone cannot resolve every barrier. The brief identifies blended finance (which changes how capital and risks are structured) and transition finance (which broadens the range of credible decarbonisation activities that can receive support) as relevant financing practices. Both practices can be combined with feasibility studies, engineering support, and technical assistance. For governments and development finance institutions, this makes identifying specific risks and viability gaps an important part of financing design. Public or concessional resources may enable investment that would otherwise not proceed, but they cannot indefinitely compensate for the absence of a viable transition pathway or functioning market.

Policy continuity and clear taxonomies support investment confidence and environmental credibility. Industrial firms and investors need clarity about the long-term direction of travel before committing to technologies, production facilities, and infrastructure with long operating lives. Predictable objectives, implementation schedules, and support frameworks can provide this confidence, while allowing individual instruments to evolve as technologies mature and implementation experience accumulates. Clear taxonomies for green and transition activities complement this predictability by specifying which activities qualify for support and the environmental thresholds or transition requirements against which they are assessed. For governments, development finance institutions, and other support actors, these classifications provide a basis for identifying the evidence needed to assess eligibility and substantiate environmental claims, but taxonomies do not substitute for evidence of performance. Their application depends on measurable indicators, transparent reporting, and independent verification, with observed results distinguished from expected improvements. Together, clear definitions and credible evidence support actors to distinguish between genuine environmental progress and unsupported claims and to reduce the risk of **green- or transition-washing**.

Implementation depends on institutional and technical capabilities, as well as financial resources. The coordination demands described in this brief require knowledge of industrial processes, the ability to assess unfamiliar technologies, and arrangements for working across firms, infrastructure providers, research organisations, and public bodies. At firm level, limited engineering resources and access to specialised expertise can constrain adoption, particularly among SMEs. At system level, missing testing facilities, standards, certification, and workforce skills can prevent technologies from reaching commercial scale. High-level strategies can organise these interdependent activities by setting objectives, assigning responsibilities, and sequencing measures, but delivery still depends on the capabilities of the organisations involved. The country examples in the brief are therefore useful illustrations of policy functions and combinations rather than ready-made packages that can be transferred unchanged. A developing country’s implementation arrangements need to be understood alongside its industrial ambitions.

These considerations show why neither emissions reductions nor domestic industrial gains can be assumed to follow automatically from green investment. The challenge for developing countries is to connect credible decarbonisation pathways with the development of productive capabilities, while recognising the constraints and trade-offs involved. Green industrial policy provides a framework for examining these connections: between existing industries and new activities, between financial and non-financial support, and between individual projects and the systems on which they depend. Its results ultimately rest on how these elements work together rather than the presence of any single instrument.

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Cambridge Industrial Innovation Policy (CIIP) is based at the Institute for Manufacturing (IfM), a division of the University of Cambridge's Department of Engineering. CIIP brings together the Centre for Science, Technology & Innovation Policy at the IfM, the Policy Links Unit from IfM Engage, and the Babbage Policy Forum.

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