Industrial Decarbonisation Frontiers Report

Policy and Governance

Since its launch in 2021, the Industrial Decarbonisation Research and Innovation Centre (IDRIC) has funded 100 projects, investigating and addressing the key dimensions of the whole system of industrial decarbonisation. This work has generated a vast body of knowledge, offering critical insights into the challenges we face in decarbonising and into the solutions – technical, economic and social – that are emerging. The *Frontiers Reports* series brings together all these insights to share with our industry and policy stakeholders.

Each report synthesises key findings from multiple projects conducted on a closely related theme, providing a comprehensive perspective on a specific aspect of industrial decarbonisation. Far more than simply research summaries, these reports translate academic insights into practical, evidence-based recommendations for our stakeholders. These recommendations are shaped by the expertise and evidence gathered by our research teams and are designed to support decision-makers in advancing their net zero goals.

The *Frontiers Reports* are anticipated to serve as catalysts for meaningful discussions between academia, industry, and policymakers on the most viable paths forward. We welcome constructive debate and are eager to support the implementation of recommendations that best align with our stakeholders' priorities and goals towards net zero.

This report brings together all IDRIC's research on Policy and Governance.

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Executive summary

Industrial decarbonisation and net zero strategy is one of the most important policy challenges of the modern era. This report consolidates IDRIC's research in this space; exploring emerging policy recommendations, assessments of politics, and concerns over governance. The report's core focus in on the setting of policy and, where relevant, brings in policy implementation and policy outcomes.

Key findings

Policy
The UK has positioned itself as a leader in industrial decarbonisation through a broad set of enabling policies and regulations. This has included a dedicated Industrial Decarbonisation Strategy (2021) and particularly strong support for the deployment of carbon capture, utilisation, and storage (CCUS) and hydrogen. Challenges in regulatory uncertainties, delays in business model development and a potential over-reliance on CCUS and hydrogen over other decarbonisation strategies risks hindering progress towards decarbonisation.

Politics
The political landscape of industrial decarbonisation is shaped by complex tensions between industry, government, and public stakeholders. Key challenges include balancing financial support across clusters and industries, while addressing regional disparities and ensuring fair allocation of resources to prevent unintended consequences, such as the relocation of high-carbon industries. Fiscal austerity vs. the need for significant net-zero investments remain a source of major tension in government. Public trust is crucial and concerns over job opportunities can influence support for decarbonisation initiatives.

Governance
Successful industrial decarbonisation requires coordinated governance across national, regional and industrial levels. International experience suggests that the most successful industrial clusters act as policy actors themselves, rather than being passive recipients of policy. Clusters across the globe collectively highlighted the need for faster permitting, viable business models, private investment incentives and shared standards for carbon accounting – underscoring the value of cross-border knowledge sharing.

Recommendations for industry

Engage proactively and transparently with government and regulators to take an active role in shaping the policy and regulatory process.

Enhance public and community engagement by fostering transparent dialogue about project impacts, benefits, and challenges to build trust and reduce risk of public opposition.

Invest in local workforce development through training and upskilling programs, ensuring that decarbonisation efforts create long-term job opportunities and support a just transition.

Strengthen collaboration within and beyond clusters by building partnerships with universities, policymakers, and businesses to secure funding, share knowledge, and drive innovation.

Recommendations for policymakers

Provide long-term regulatory and financial certainty to avoid uncertainty in carbon pricing or business models which risks deterring investment and undermining the UK's competitiveness.

Diversify technological approaches beyond CCUS and hydrogen to enhance resilience and avoid over-reliance on any single solution.

Strengthen industrial decarbonisation policies at the regional level by ensuring that non-clustered industries and smaller enterprises also benefit from support mechanisms.

Ensure that government and industry collaboration is seen to be serving broader public and environmental goals, rather than private sector interests alone.

Encourage cross-border collaboration and knowledge sharing by learning from international best practices, particularly in regions that have successfully implemented industrial decarbonisation policies.

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Introduction

Industrial production is responsible for approximately 20% of global greenhouse gas (GHG) emissions. Until recently, cutting emissions from heavy industry received relatively little attention compared with other sectors such as electricity generation and transport. This is in part because it was seen as a ‘hard-to-abate’ sector due to the technical and policy challenges involved. However, this situation changed with the UNFCCC Paris Agreement in 2015 and the publication of the 1.5°C report by the Intergovernmental Panel on Climate Change. These events helped to drive an increase in climate policy ambition, with the adoption of net zero targets in many countries. The net zero agenda has made it clear that sectors such as industry must now decarbonise rapidly, within the UK and abroad.

The industrial decarbonisation challenge is complicated, because it covers a wide variety of industries (iron and steel, cement, refining, chemicals, glass, ceramics, pulp and paper, food and drink etc.), and multiple processes that produce GHG emissions from energy use, especially heat, and directly from industrial processes. There is also a wide range of potential technical solutions, that differ across these industries. Trade exposure, high capital costs, long investment lifecycles and low profit margins make government intervention essential.

The UK has been an early leader in this policy area, signalling an intent to reduce industrial emissions as part of its 2017 *Industrial Strategy and Clean Growth Strategy*, and developing a full *Industrial Decarbonisation Strategy* in 2021. It has also formulated major support programmes for the deployment of CCUS and hydrogen infrastructure in clusters of heavy industry around the country.

Research findings

The research findings from the IDRIC projects covered in this report address both policy – including policymaking and the setting of policy instruments, standards, and regulations – as well as politics, the political actors, institutions, and agendas of those seeking to shape policy and governance.

Seven IDRIC projects contributed to this report. They are referred to by their project IDs throughout.
→ See further information.

Project ID	Project name
MIP 1.4	Smart policy and governance for industrial decarbonisation
MIP 2.2	CO_2 ports to pipelines
MIP 2.6	Integrated assessment of BECCS in context: Environmental, policy, regulatory and social factors
MIP 4.3	The politics of industrial decarbonisation policy
MIP 6.5	Protective space and social licence to operate industrial decarbonisation
MIP 9.1	Learning from international experience in decarbonising industrial clusters
FF 1-10	Global lessons on net zero: Harnessing best practices of industrial decarbonisation for UK clusters

Table 1

Key industrial decarbonisation policies in the UK by category[1]

CCUS Carbon capture utilisation and storage
BECCS Bioenergy with carbon capture and storage
ETS Emissions trading scheme
EU European Union

Policy category	Name	Description	Year implemented
Climate change	Climate Change Act	Commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050	2008, updated in 2019
Carbon pricing	UK Emissions Trading Scheme	Came into force on January 1, 2021 to replace the UK's participation in the EU ETS, which was established in 2005.	2021
	Climate Change Levy	An environmental tax charged on the energy that businesses use, intended to encourage businesses to be more energy efficient in how they operate, as well as helping to reduce their overall emissions	2016, updated annually
Competitiveness support	UK ETS Free Allowances	Provides £1.05 billion in allowances to targeted industrial clusters	2019
	Financial relief for energy-intensive industries	Gives £470 million per year in reduced electricity costs	2012 – 2021
	Climate Change Agreements	A voluntary scheme that encourages businesses in a wide range of industrial sectors with energy-intensive processes – such as chemicals, paper and ceramics and agricultural businesses such as intensive pig and poultry farming – to invest in energy efficiency measures	2015 – 2021
Demonstration Funding	Energy Innovation Program	Offers £505 million in support that aims to accelerate the commercialization of innovative clean energy technologies and processes	2016
	Net Zero Innovation Program	Provides £1 billion in support for low-carbon technology such as offshore wind, nuclear advanced modular reactors (supported through the aligned Advanced Nuclear Fund), energy storage and flexibility, bioenergy, hydrogen, direct air capture and greenhouse gas removal, industrial fuel switching, and CCUS	2021
	Transforming Foundation Industries	Disburses £66 million to the cement, metals, glass, paper, ceramics, and chemicals industries to make them more internationally competitive	2020
	Industrial Energy Transformation Fund	Budgets £315 million to help businesses with high energy use to cut their energy bills and carbon emissions through investing in energy efficiency and low carbon technologies	2019
	Industrial Decarbonization Challenge	Offers £170 million to the six largest industrial clusters in their mission to decarbonize at scale, laying the foundation for developing at least one low-carbon industrial cluster by 2030 and the world's first net-zero industrial cluster by 2040	2019
Deployment Funding	CCUS/Hydrogen Business Models	Provides revenue support to hydrogen producers and CCUS facilities, making up the operating cost gap between low-carbon and higher-carbon fuels via 15 year contracts	2022
	Renewable Heat Incentive	A scheme that provides £684 million per year aiming to encourage uptake of renewable heat technologies amongst householders, communities and businesses through financial incentives, and increase heating coming from renewable sources	2014 (closing in 2022)
	Net Zero Hydrogen Fund	Provides up to £240 million to support the development and deployment of new low carbon hydrogen production to de-risk investment and reduce lifetime costs	2022
Deployment Funding	Clean Steel Fund	Pledges £250 million to support the UK steel sector to transition to lower carbon iron and steel production	2019
	Industrial Heat Recovery Support	Offers £18 million to encourage and support investment in heat recovery technologies	2018 (closing in 2022)
Infrastructure	CCUS Infrastructure Fund	Allocates £1 billion for CCUS transport and storage networks, coupling to bioenergy via BECCS, and capital expenditure for CCUS-enabled "blue" hydrogen projects	2020
	Heat Network Improvement Program	Provides £320 million to increase the number of heat networks being built, deliver carbon savings, and create the conditions necessary for a sustainable heat network market	2018
Demand-side and behaviour	First Demand-Side Policy Introduced	Supports demand-side measures such as the introduction of product standards, labelling schemes or procurement policies	2021

1 Sovacool et al (2024), Leading the post-industrial revolution? Policy windows, issue linkage and decarbonization dynamics in the UK's net-zero strategy (2010–2022), Industrial and Corporate Change, 33:1487

Policy

Although it has faced risks such as deindustrialisation, offshoring and increasing competition globally, the UK has emerged as a leader in net zero industry and industrial decarbonisation policy (see IDRIC projects MIP 1.4 and FF 1-10). It has implemented a wide range of important policies and regulations shown in Table 1.

UK policymakers started exploring the challenge with a series of *Industrial Decarbonisation and Energy Efficiency Roadmaps* in 2015, which in 2017 were followed by seven *Industrial Decarbonisation and Energy Efficiency Action Plans* that were jointly developed with industry. These explorations increased confidence and prepared the ground for the 2017 *Clean Growth Strategy*, which articulated a general sense of direction for industrial decarbonisation and highlighted the need to go beyond energy and material efficiency innovations toward fuel switching and CCS.

Subsequently, the Government's 2018 *CCS Action Plan* not only emphasised an industrial cluster approach to CCS but also articulated specific targets such as the development of a first CCUS facility by the mid-2020s and deployment at scale during the 2030s.

In 2018, policymakers also created the Industrial Strategy Challenge Fund, which had clean growth as one of its four themes. The Fund, which is backed by £2.6 billion of public money and £3 billion in matched funding from the private sector, enabled industrial firms to engage in more detailed pre-FEED (Front End Engineering and Design) studies of low-carbon technologies. Policy momentum further increased in 2019, when the UK government enshrined in law a net zero emission target with an amendment to the 2008 Climate Change Act, and again in 2020 when the Prime Minister's Ten Point Plan for a *Green Industrial Revolution* aimed for the production and use of 5GW low-carbon hydrogen by 2030 (mostly from natural gas and CCS) and the deployment of CCS in two industrial clusters by 2025 and four clusters by 2030.

This was followed by a landmark Industrial Decarbonisation Strategy published in 2021, which set out a multitude of formal goals. It posited that four of the largest industrial clusters would be linked up to "necessary decarbonisation infrastructure" by 2030, and that at least 3 million tons of carbon dioxide equivalent of industrial emissions would be captured and stored by that year as well. It also spotlighted the role of low-carbon fuels such as electricity, hydrogen, and bioenergy as substitutes for at least 20 TWh of fossil fuel electricity generation, along with "maximum energy, resource, and material efficiency within industry," the creation of a market for low-carbon materials, approaches to equip workers with new skills, and cooperation with other leading nations committed to industrial decarbonisation.

In addition to these targets, the *Industrial Decarbonisation Strategy* espoused the four principles of strategy (aligning net zero with other goals such as clean growth and levelling up), effectiveness (holding industry accountable if remedial action is needed), proportion (placing the burden dually on government and industry), and flexibility (being responsive to changes in technology, society, or markets). Figure 1 features an overview of the Strategy's technology targets from 2020 to 2050.

IDRIC's research has emphasised the importance of policy certainty in enabling long-term planning for Industrial Decarbonisation (ID) and Bioenergy with Carbon Capture and Storage (BECCS) projects.

The findings in IDRIC project MIP 2.6, which focused specially on the implementation of BECCS in the UK, highlighted the Northwest Cluster's potential to achieve substantial negative emissions – contingent on governmental support for business models and regulatory frameworks. However, for BECCS, challenges emerged within the environmental planning and permitting process, where capacity limitations could lead to significant delays. This regulatory bottleneck, coupled with

IDRIC's research has emphasised the importance of policy certainty in enabling long-term planning for Industrial Decarbonisation and Bioenergy with Carbon Capture and Storage projects.

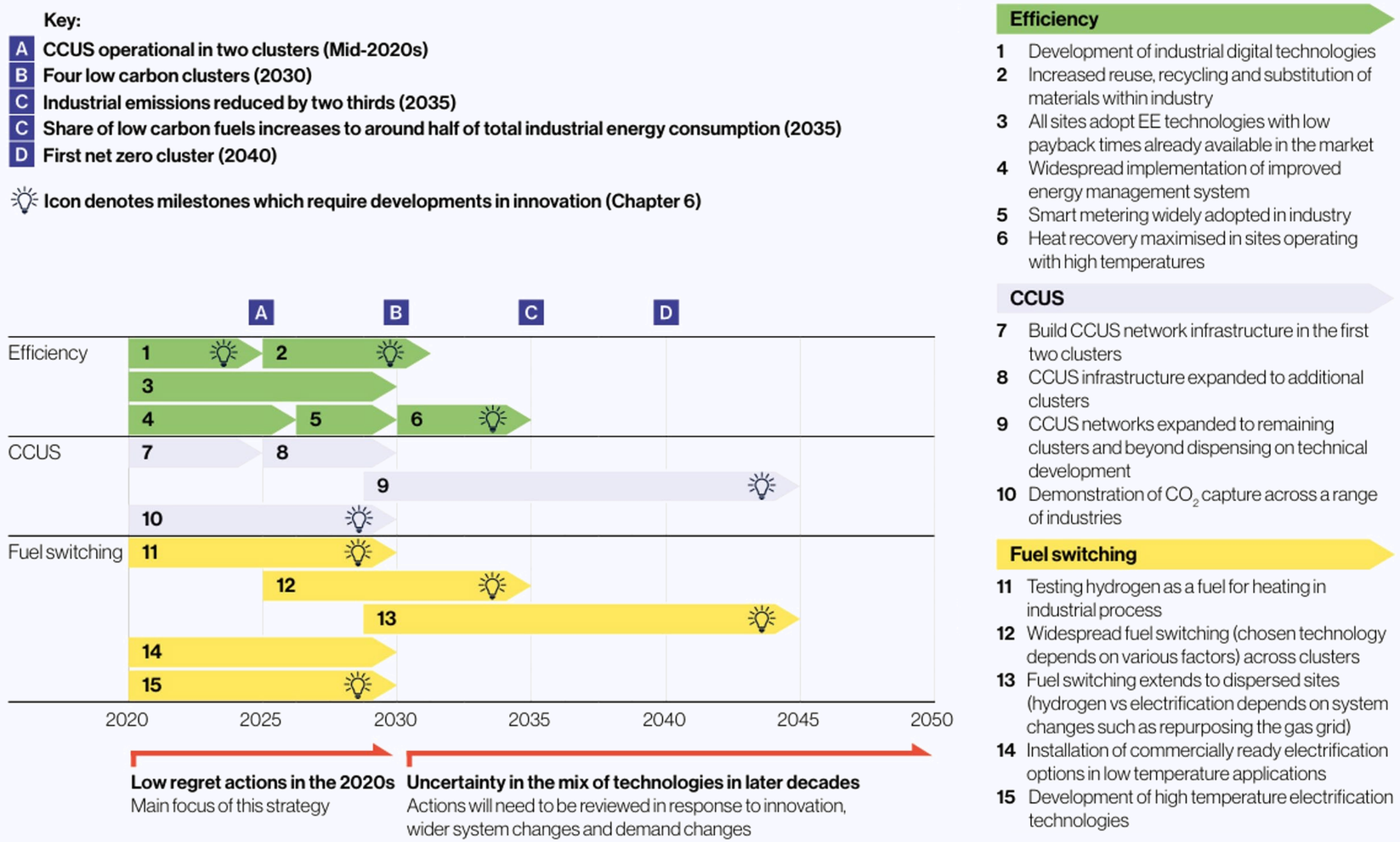
the prioritisation of large-scale BECCS initiatives over smaller, dispatchable projects, poses potential risks to a holistic decarbonisation approach. Strategic allocation of biomass resources is required to support a variety of BECCS supply chains, including those that other renewable alternatives may not be available for, accounting for current and potential new uses of biomass across the economy.

Within project MIP 2.6, verification and monitoring processes were also highlighted as being crucial for the credibility of carbon offset markets, with stakeholder and public trust hinging on consistent, transparent data. The research underscores the necessity of a multi-dimensional approach to meet emissions targets, with joint Government and industry initiatives welcomed but dependent on transparency and clear evidence of alignment with climate goals.

A study carried out by project MIP 2.2, which analysed the life cycle costs of different CO2 shipping scenarios for carbon capture and storage (CCS), found that policy mechanisms like the Emission Trading System (ETS) proved highly impactful, with potential cost reductions of up to 69.3% for larger vessels, emphasising the value of policy support in facilitating cost-effective CCS operations.

Figure 1

An overview of industrial decarbonisation technology pathways in the UK, 2020–2050 (Source: taken directly from UK Gov Industrial Decarbonisation Strategy (2021) — figure 4.1 p.47)



Politics

The politics of UK industrial decarbonisation policy is about the distribution of benefits and costs, with wide-ranging consequences for the delivery and sustainability, not least through its role in establishing support from the public for the required technologies and associated infrastructure. IDRIC research carried out by project MIP 4.3 and MIP 1.4 has confirmed that there are four inter-related dimensions, each of which carries risk for policy (Figure 2).

1

The first dimension concerns the overall level of policy resources allocated to industries (companies and workers) that must be paid for by taxpayers and consumers. Tensions between industry, taxpayer and consumer interests mean there is always a risk of policy instability (see below for more detail), but strong concern about regional inequality and a now ascendant industrial policy paradigm mean that significant and fairly stable support is now likely. However, Treasury requirements for value for money have imposed competitions, such as the CCS Cluster Sequencing process, which have implications for allocation between regions.

2

A second dimension is the allocation of policy resources between decarbonising technologies and practices. Uncertainty about solutions and differences in the strength of technology lobbies have meant that the main focus of policy has been CCS and hydrogen, while other approaches such as electrification and energy and material efficiency have received less attention, which brings delivery and specialisation risks.

3

A third dimension is the allocation of policy resources between the different clusters and high carbon industries. Focusing resources on a few clusters through competitions may increase efficiency but creates risks of demotivating other clusters and the more dispersed industries, and could ultimately lead to an unintended relocation of high carbon industries.

4

The fourth dimension is the allocation of costs and benefits at the local level, including impacts in job opportunitites, the local built environment and/or pollution. As policy enters the implementation stage, research carried out in projects MIP 2.6 and MIP 6.5 show that these impacts can sometimes create distrust among both industry stakeholders and local communities, potentially undermining local support for decarbonisation efforts. Industrial decarbonisation is a political phenomenon as well as a policy-relevant issue. Project MIP 6.5 found that residents living near clusters are very aware and supportive of the need to invest and act on climate change but also hit hard by cost-of-living increases.

Figure 2

Four interlinked political dimensions, carrying risk for industrial decarbonisation policy.

Expert interviews conducted as part of project MIP 1.4 reveal that, at its core, there is a tension between the politics of fiscal austerity (i.e. Treasury wanting to minimise government expenditure in a post-Covid world) and the need to invest billions in net zero infrastructure exists. One expert stated that:

> *"Certainly, there are tensions within government. You've got again very different drivers at different levels of government, cluster projects are trying to balance and manage four local authorities, two Local Enterprise Partnerships, and national goals of Parliament … it's tricky and takes continual conversation, consolidation, harmony, and again bringing people back to that shared goal that's actually if we fall out of this nobody gets it. You have to keep pushing the narrative that if we manage to stay together – everybody can reach net zero eventually, it's just a matter of when."*

Another expert spoke about tension and competition within clusters to secure funding for individual projects at the level of facilities versus shared projects that cut across facilities, and between clusters to attract the necessary financing and skills to implement plans and deploy technologies, especially with scarce contracting skills currently available as of 2021.

They articulated that:

> *"There are multiple tensions to be managed for net zero implementation. There is a tension between testing a wide range of new and innovative technologies against having projects which are highly credible and deliverable. We want clusters that can deliver significant levels of emissions reduction, can make a significant contribution most immediately as we look to meet our 2030 targets and deliver on carbon budget six. But we also want job creation and potentially revitalising industry in areas which have perhaps lost a lot of jobs in recent years. We want clusters that can demonstrate a range of technologies … Then, of course, there's the fact that we need to do this in a way that represents value for money for both the taxpayer and the energy consumer as well, both of whom will be impacted by the operation of direct government subsidy and the way the business models work."*

Each of these objectives – innovation, credible delivery, emissions reductions, job creation, and value for money – can conflict. What is most innovative technically, e.g., BECCS or direct air capture may not be credible or a sound value for money; what provides the most emissions reductions, e.g., energy or resource efficiency measures, may lower job creation.

In Europe, the most successful clusters are policy actors rather than passive recipients of policy.

Participants at the *Industrial Cluster Decarbonisation: Sharing international experience* workshop, London – June 2023 and *Industrial Decarbonisation: International pathways to net zero industries* workshop, Dubai – December 2023.

Governance

IDRIC project MIP 9.1 carried out a rapid evidence assessment which explored international approaches to developing low-carbon industrial clusters, focusing on five main areas: policies and business models, technologies, governance, locational factors, and general policy recommendations. Key findings indicate that most information is on specific types of clusters–coastal, highly carbon intensive, longstanding and close to offshore CCS opportunities–such as those found in the UK and the Netherlands. This model may not be applicable globally, especially in non-market economies where industries may not operate under the same financial or policy logics. Across all regions, research shows long-term climate policy frameworks are critical to success.

In Europe, it appears that the most successful clusters are policy actors rather than passive recipients of policy. At the time of the study (2022) carbon capture and storage received the most academic focus, especially in hydrocarbon-producing countries, where existing infrastructures and tax incentives could be used. Hydrogen development, while discussed in the literature, was less advanced.

An international workshop, held by IDRIC in June 2023, with cluster representatives from 14 countries highlighted the need for faster permitting, viable business models, private investment incentives, and shared standards for carbon accounting, underscoring the value of cross-border knowledge sharing. A briefing paper, summarising the key finding from the workshop has been made publicly available. A follow-up event was held during COP-28 in Dubai, in December 2023, bringing together representatives from additional countries.

Recommendations to industry

Based on the research carried out, IDRIC recommends industry consider the following to support accelerated decarbonisation.

Key recommendations

1 Engage proactively and transparently with government and regulators to take an active role in shaping the policy and regulatory process.

2 Enhance public and community engagement by fostering transparent dialogue about project impacts, benefits, and challenges to build trust and reduce risk of public opposition.

3 Invest in local workforce development through training and upskilling programs, ensuring that decarbonisation efforts create long-term job opportunities and support a just transition.

4 Strengthen collaboration within and beyond clusters by building partnerships with universities, policymakers, and businesses to secure funding, share knowledge, and drive innovation.

Policy

- **Work with regulatory agencies** to follow existing regulatory processes to ensure projects can proceed without undue delays.
- **Ensure transparent relations with government**, which are essential to fostering trust, especially where lobbying efforts are perceived to influence decision-making.
- **Build strong connections with local communities**, through honest dialogue about project impacts. This is essential for maintaining credibility and preventing accusations of greenwashing. Present the advantages and disadvantages of projects openly, as attempts to gloss over potential drawbacks can erode public trust.
- **Commit to developing local skills**, offering training and employment opportunities to help integrate local workers into these projects and build a sense of connection and ownership across local populations.

Politics and governance

- **Build strong networks and partnerships**
  Whether inside or outside of clusters, businesses should establish and maintain strong partnerships with local business organisations, authorities, and universities. These networks are essential for securing competitive, bid-based funding and fostering long-term collaboration.
- **Ensure strong and consistent leadership**
  Our research indicates that the presence of clear leadership and a shared vision is more important than the type of lead organisation.
- **Engage proactively with all levels of government**
  Industry should take an active role in shaping the policy process by engaging with Government at all levels on decarbonisation. European clusters that have been actively involved in policy discussions have seen greater success, highlighting the benefits of a proactive approach.

Recommendations to policymakers

Based on IDRIC's research findings, we make the following recommendations to policymakers to support effective decarbonisation.

Key recommendations

1. Provide long-term regulatory and financial certainty to avoid uncertainty in carbon pricing or business models which risks deterring investment and undermining the UK's competitiveness.
2. Diversify technological approaches beyond CCUS and hydrogen to enhance resilience and avoid over-reliance on any single solution.
3. Strengthen industrial decarbonisation policies at the regional level by ensuring that non-clustered industries and smaller enterprises also benefit from support mechanisms.
4. Ensure that government and industry collaboration is seen to be serving broader public and environmental goals, rather than private sector interests alone.
5. Encourage cross-border collaboration and knowledge sharing by learning from international best practices, particularly in regions that have successfully implemented industrial decarbonisation policies.

Policy

- **Commit to strong, stable leadership**, offering transparent policy frameworks that encourage businesses to make long-term plans with confidence.
- **Ensure regulatory and financial stability**, as uncertainty in carbon pricing or business models risks deterring investment and undermining the UK's competitiveness. Such certainty is particularly important in emerging sectors like CCS and CO_2 markets, where ongoing investment is crucial to build sustainable pathways.
- **Ensure that government and industry collaboration is seen to be serving broader public and environmental goals**, rather than private sector interests alone.
- **Establish mechanisms to stabilise costs for transport and storage of CO_2**, with a standardised price per tonne, which would make it easier for facilities to provide predictable offsets to potential buyers.
- **Establish strong communication across all scales of government**, to bring industrial decarbonisation and its technologies into the wider public discourse; raising awareness of the role that the clusters can play in delivering climate and economic policies will be an important in developing support from the public for these technologies.
- **Expand the Emission Trading Scheme (ETS)** to further reduce life cycle costs (LCC) for CCUS, especially in large-scale CO_2 transport. This would enhance CCUS competitiveness and encourage broader industry adoption.

Although centralised support is crucial, at the level of more localised policy, diverse teams working in inclusive environments strengthen science, research and innovation to the benefit of wider society. Therefore, we make the following **recommendations specifically for local planners and policymakers:**

- **Develop and implement strategies to build and support just, diverse, inclusive, equitable workforces and workplaces**, as well as training and educational pathways, which are integrated into research, industry, and policy making. It is important that training and re-skilling opportunities are not tokenistic.
- **Focus attention on workforce skill provision and distribution** including, for example, the quality and availability of jobs and workplace experiences. This should be underpinned with respectful two-way sharing of knowledge, skills and expertise between local workers already based within the region (local expertise) and workers brought in from outside the area (imported expertise).
- **Implement additional strategies to identify and address broader inequities**, exclusions and vulnerabilities within and across regions and geographies, as well as across generations. More information on this topic is available in IDRIC's Frontiers Reports: Public Perceptions and Just Transitions and Workforce for Net Zero: Skills, Planning, and Equality, Diversity and Inclusion.
- **Increase integration and action**, by improving cross sector/ organisational collaboration and knowledge sharing to accelerate achieving net zero targets equitably.

Politics

- **Seek to create long-term stability in support for industrial decarbonisation.** While this is delivered at the project level for CCS and hydrogen through contracts for difference, there is a bigger issue of the overall direction of policy. It may help to develop an institutional mechanism that's analogous to the control for low carbon levies which sets expectations about the overall envelope of support.
- **Be alive to the potential risks arising from the strength of CCS/hydrogen lobby**, and actively develop stronger policy in areas with weaker lobbies, including electrification and end-use material efficiency. On the latter, coordination between DEFRA and DESNZ should be strengthened.
- **Consider measures to maintain engagement with, and expectations of, businesses in clusters not receiving support in Tracks 1 and 2,** and in dispersed industries that sit mainly outside clusters.
- **Give greater attention to how skills policy can support industrial decarbonisation** and create opportunities at the local level. At the same time, be clear about the nature and scale of jobs that will be created (mainly temporary and in construction) to avoid creating unrealistic expectations that could ultimately undermine the credibility of the policy.

Governance

- **Approaches to decarbonisation should be tailored** to their specific regional context, which vary significantly based on local history, infrastructure, and resources etc., to ensure that the most effective technologies are prioritised.
- **Consider alternatives beyond carbon capture and hydrogen —** while both play a key role in decarbonisation, other approaches like industrial electrification, energy efficiency improvements, and resource efficiency are crucial, particularly where carbon capture isn't economically viable.
- **Adopt a more flexible, holistic approach to coordinate diverse technologies effectively**, ensuring that industrial clusters and supporting infrastructure evolve together without one aspect hindering another.
- **Strengthen collaborative networks for decarbonisation** — regions with established collaborative networks and infrastructure are generally better positioned for rapid decarbonisation. To ensure a just transition, policies should also support regions that may otherwise struggle to decarbonise or even bid for the resources that are needed to support their efforts.

Moving forward

Developing business models that support timely delivery of decarbonisation projects is essential, as without these, delays could compromise the broader net zero timeline and result in certain technologies, or approaches being prioritised according to progress in business model development rather than through a coordinated strategic approach. Policy should expand beyond CCS and hydrogen to address other decarbonisation methods, such as electrification of industrial processes.

Clear communication and a unified narrative on the purpose and benefits of decarbonisation, including economic and environmental advantages, will be vital as industry, policy and society align towards a sustainable future.

Engaging the public in a more open, inclusive national dialogue on decarbonisation would foster understanding and support, helping to locate cluster projects within a wider climate strategy. IDRIC's Frontiers Report on Public Perceptions and Just Transitions explores this topic in much more detail. Increasing transparency around government contracts, regulatory decisions, and the setbacks of previous projects will also be critical. Clear communication and a unified narrative on the purpose and benefits of decarbonisation, including economic and environmental advantages, will be vital as industry, policy and society align towards a sustainable future.

UK industrial policy is still in the early stages, with no significant investments yet underway. Further research could therefore look at the politics arising from implementation. This will include the local politics of implementation, but also policy feedback effects at national level. Another area for extending the work would be to undertake comparative research on the politics of industrial decarbonisation in different countries, to test and further develop the 'four dimensions' model discussed above.

Contributing projects

IDRIC projects included in this report

IDRIC ran three complementary strands of projects:

1 In-depth research projects embedded within nine Multidisciplinary Integrated Programmes (MIPs), each programme tackling a key challenge or pathway for industrial decarbonisation;

2 Shorter-term Flexible Fund (FF) projects designed to rapidly address emerging or urgent opportunities identified directly by industrial clusters;

3 Impact Accelerator (IA) projects aimed at maximising the impact of existing IDRIC projects.

Projects discussed within the report are referred to by their project number.

◣ – Principal investigator

Project ID	Project name	Researchers	
MIP 1.4	Smart policy and governance for industrial decarbonisation	Benjamin Sovacool ◣, Marfuga Iskandarova, Mathew Lockwood, Jeremy Hall, Kyle Herman, Siobhan Stack-Maddox	University of Sussex
		Frank Geels	University of Manchester
MIP 2.2	CO_2 ports to pipelines	Damon Teagle ◣, Lindsay-Marie Armstrong, Seyedvahid Vakili, Stephen Turnock, Wassim Dbouk, Panos Manias	University of Southampton
MIP 2.6	Integrated assessment of BECCS in context: Environmental, policy, regulatory and social factors	Clair Gough ◣, Sarah Mander, Diarmaid Clery, Muir Freer, Abhilasha Fullonton, Lisa Bell	University of Manchester
MIP 4.3	The politics of industrial decarbonisation policy	Matthew Lockwood ◣, Marc Hudson	University of Sussex
MIP 6.5	Protective space and social licence to operate industrial decarbonisation	Clair Gough ◣, Diarmaid Clery	University of Manchester
MIP 9.1	Learning from international experience in decarbonising industrial clusters	Peter Taylor ◣, Imogen Rattle	University of Leeds
FF 1-10	Global lessons on net zero: Harnessing best practices of industrial decarbonisation for UK clusters	Marfuga Iskandarova ◣, Benjamin Sovacool	University of Sussex

Project ID	Project Name	Outputs	Outputs continued →	
MIP 1.4	Smart policy and governance for industrial decarbonisation	Climate change and industrial F-gases	The socio-technical dynamics of net-zero industrial megaprojects	Journal
		Decarbonising the food and beverages industry	Industrialising theories	
		Industrial decarbonisation via hydrogen	Industrial clusters for deep decarbonisation	
		Decarbonising the glass industry	Decarbonising the cement and concrete industry	
		Decarbonising the ceramics industry	Six bold steps towards net-zero industry	
		Decarbonising the oil refining industry	Energy, material, and resource efficiency for industrial decarbonisation	
		Industrial decarbonisation via natural gas	Leading the post-industrial revolution?	
		Decarbonising the pulp and paper industry	"Oh Yes! Net-Zero": Sociotechnical capabilities and regional innovation systems for British industrial decarbonisation	
		Decarbonising the chemical Industry	Reconfiguring European industry for net-zero: A qualitative review of hydrogen and carbon capture utilisation and storage benefits and implementation challenges	
		Bigger than government	Framing industrial decarbonisation technologies in the public sphere: narratives from the digital 'town square' in the United Kingdom	
		Carbon capture utilisation and storage in review	Imagining a net-zero Teesside: Actors, networks, and expectations in industrial decarbonisation megaprojects	
MIP 2.2	CO_2 ports to pipelines	Technical, economic, and environmental assessment of CO2 ship transport in carbon capture and storage		Journal
MIP 2.6	Integrated assessment of BECCS in context: Environmental, policy, regulatory and social factors	Integrated assessment of BECCS in context: environmental, policy, regulatory and social factors		Webinar
		Co-deployment of bioenergy with carbon capture and storage in the UK: Growth or gridlock?		Journal
MIP 4.3	The politics of industrial decarbonisation policy	Dead and unburied: The resurrection of carbon capture and storage in the UK 2015-2018		Report
MIP 6.5	Protective space and social licence to operate industrial decarbonisation	Cluster Mapping Report: The Humber Industrial Cluster		Report
		Cluster Mapping Report: The North West Industrial Cluster		
MIP 9.1	Learning from international experience in decarbonising industrial clusters	Decarbonising industry through industrial clusters: lessons from international experience	Key findings from workshop on Industrial Cluster Decarbonisation	Briefing paper
		Decarbonisation strategies in industry: going beyond clusters	Factors driving the decarbonisation of industrial clusters	Journal

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