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Rethinking Industrial Transformation: Enablers for Systemic Change

Authors

ETC Team: Vitaliy Soloviy (AIT), Emilinah Namaganda (DRIFT), Jonathan Köhler (Fraunhofer ISI), Klaus Kubeczko (AIT), Gijs Diercks (DRIFT).

EEA Team: Lorenzo Benini, Henrik Larsen.

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Executive summary

Industrial policy is central to advancing the European Union's long-term priorities and goals. In recent years, the EU has faced multiple shocks that affected European people, economy, environment and security. Ensuring that EU industrial policy remains agile and responsive to evolving challenges requires exploration of diverse enablers for industrial transformation.

This report recognises transformative change as a complex process that demands fundamental shifts across many dimensions, including not just economy and technology, but also societal, ecological, political and cultural aspects. It applies a **six-lens analytical framework on transformative change** to identify cross-cutting enablers for industrial transformation, building on a synthesis of literature, expert inputs and fifteen case studies.

The **three enablers for industrial transformation** presented in the report are outlined below.

Culture, people, and places. Industrial transformation unfolds within broader processes of social and cultural change, where actors have diverse visions, needs and perspectives. The chapter shows how empowered social partners can catalyse change and how narratives, symbols, and emotions shape transformations. Addressing Europe's geographic and cultural diversity, and attention to the social contract, are explored as essential building blocks for credibility and legitimacy of transformations.

Destabilisation and phase-out. The chapter emphasises phase-out as an integral component of industrial renewal, drawing on successful cases and warning of the risks of neglecting deliberate discontinuation, such as structural lock-ins that impede necessary change. It also highlights how low-hanging fruit can be harnessed to foster systemic change, and the role of social and labour dimensions in ensuring the long-term viability of policy mixes.

Broadening the view on resilience. The chapter deepens current understandings of industrial resilience, underscoring its interconnected, dynamic and multi-dimensional nature. It illustrates how distributed systems enable systemic and coordinated action, how industrial restructuring can enhance adaptability to shocks and how crises can be harnessed through deliberate transformation.

Together, these enablers address issues of high relevance for the EU and provide significant leverage for fostering a fair, resilient, and regenerative industrial future for Europe.

1. Introduction

Industrial policy is critical to the broader priorities and goals of the European Union. Over the past few years, the region has been exposed to multiple shocks, which have brought into question established assumptions, such as the rule-based international order, the stability of global value chains, and long-term shared security. These changes have impacted the competitiveness and sustainability of European industry, necessitating fundamental changes in its structuring. However, a substantial amount of work remains to be done in ensuring the current industrial transformation priorities stay agile and up to date with the evolving landscape of challenges.

In other words, industry is in a phase of systemic change, i.e. *"a fundamental, transformative, and cross-cutting form of change that entails major shifts and reorientation in systems goals, incentives, technologies, social practices and norms, as well as in knowledge systems, and governance approaches. For core societal systems, this means rethinking not just technologies and production processes but also consumption patterns and ways of living, as well as key paradigms that underpin the current economic model, in view of more sustainable alternatives focusing on, for example, well-being and resilience"* (EEA, 2021).

The goal of this report is to broaden the discussion on the systemic change in the industry[1] and explore what industrial transformation could entail, given the changes in external conditions and based on the emerging interdisciplinary knowledge base around systemic and transformative change. While focusing on specific sectors, this report argues for a nuanced understanding of what industrial transformation entails and requires, including deliberation of directionality, implications of different policies and policy mixes, and the **difference between narrow and incremental change and deep, broad and systemic change** (Andersen et al., 2023)**.** This includes consideration of overlooked factors and emerging issues that may drive or constrain transformation processes, with the sources of such knowledge often spanning across multiple disciplines and stakeholder groups (Sovacool et al., 2024).

This report, therefore, aims to provide a broad and ambitious framing of industrial change, much needed to face the severity and complexity of the challenges of the present moment and those yet to come, to inform and enable collectively desirable and deeply transformative industrial trajectories. This implies a conceptualisation of **transformation as inherently complex, contested and plural, and thus requiring multiple perspectives and knowledges**, rather than a single unified approach (Patterson et al., 2024; Sovacool et al., 2023).

Such framing of industrial transformation is particularly pertinent for navigating emergency frames and antagonistic contexts as factors behind possible narrowing of industrial policy towards primarily techno-economic thinking that tends to prioritise technological innovation, productivity, efficiency and throughput. As such**, the report outlines a broader framing of industrial transformation** that, in addition to economic and technological factors, also includes ecological, cultural, political, as well as individual and collective aspects as critical elements of policy design and implementation. Such thinking is particularly important for navigating undesirable lock-ins and remaining open to promising alternative imaginaries of the future that structure and entrenched norms that are at the core of systemic change. (EEA, 2025).

[1] For this, report, we define industry as sectors in which value is created through material production, typically involving a combination of technology, craftsmanship and automation. This includes both the traditional heavy industries (such as steel, chemicals, and cement) and the broader manufacturing sectors, including high-tech, machinery, precision manufacturing, and the assembly of a wide range of physical products. This definition also means that we generally exclude two areas: the extraction of virgin resources, which we consider a separate category, and the creative industries more broadly, as these are too large a category and less directly connected to material production. We acknowledge that these definitions and boundaries are contested and have treated them with flexibility—for example, we have included some cases from the extractive industry because they are closely related to and intertwined with industrial production.

The report builds on an analytical framework for assessing transformative change developed throughout 2024, which introduced six distinct lenses, each highlighting different aspects of transformative change, as a narrow focus on any single lens risks overlooking vital interconnections and could lead to ineffective policy outcomes. It is designed to offer a solid foundation for approaching transformative change in a systematic and structured way, enabling the effective integration of diverse and complementary knowledge domains to address the complex challenges that are the focus of EEA work.

In 2025, this task applied the framework to the theme of industrial transformations, with the ambition of informing and guiding current policy debates in more transformative directions and supporting European policymakers in enabling and advancing a more ambitious, systemic transition. In the first quarter of this year, we applied the six lenses identified in the framework to conduct a discourse analysis of the European Commission's Clean Industrial Deal (CID).

CID sits within a broader suite of flagship EU policy initiatives designed to steer Europe's industrial transformation, including the Competitiveness Compass, the Net-Zero Industry Act, and Industry 5.0 (European Commission, 2025a). But the CID represents more than just another addition to this policy landscape; it signals an evolution, even a course of correction, in how the EU conceptualises industrial transformation. The transformative ambitions of the European Green Deal and its commitments to climate neutrality, circularity, and just transitions remain integral, but these objectives are now clearly repositioned within a more strategic framework focused on achieving economic resilience, industrial transformation and strategic autonomy.

This report applies and adapts this framework to the context of the EU industrial change, considering what systemic and transformative approach would entail. This background analysis further informed a discourse analysis of the Clean Industrial Deal, which represents a meeting point of EU ambition around green and digital transitions within the broader context of reviving and rethinking industry. Based on synthesising and prioritising identified potential intervention areas within and across the six perspectives, followed by contrasting them against the discourse analysis of the Clean Industrial Deal, as well as expert consultations, the report identifies three cross-cutting enablers that hold significant potential for rethinking EU industrial policy. While some of the aspects identified within those enablers are already nascent within specific sectoral policies or in specific national or regional contexts, taking them seriously could contribute to addressing some of the major challenges of EU industrial policy.

The enablers presented here aim to work within the industrial transformation priorities, as well as in the context of the EU's long-term sustainability objectives: they highlight blind spots, elevate underdeveloped themes, and identify enablers already present in the current strategy that can be leveraged more effectively. In doing so, they aim to support a more integrated approach to industrial transformation. Each enabler draws on the intersection of different lenses, spanning socio-technical, socio-political, socio-ecological, socio-economic, socio-cultural, and socio-personal dimensions, and is formulated to be both actionable and relevant to ongoing EU policy work. Together, they offer a forward-looking agenda to help reimagine industrial policy not just to achieve competitiveness and progress, but as a vehicle for shaping fair, resilient, and regenerative futures.

2. Methodology

This section presents the main steps undertaken in the development of this report, including the application of the analytical framework to the context of industrial transformation, the discourse analysis of the Clean Industrial Deal (CID), and the identification of key enablers enhancing its transformative potential. The preliminary enablers, derived from applying the framework to the CID, were informed by the discourse analysis and subsequently validated, refined, and prioritised during the expert workshop.

These enablers were then further elaborated and illustrated through a set of case studies selected to ensure both geographical balance and representation of diverse innovation needs across European industrial contexts. The discourse analysis revealed how the CID frames industrial transformation around three main enablers, as presented in Chapters 3 to 5. Details on the analytical lenses, methodological notes on the discourse analysis, and workshop materials are provided in the appendices.

The full process is demonstrated in Table 1.

Table 1 Methodology: overview of the main steps

1	2	3	4	5
Adaptation of the transformative change framework	**Discourse analysis of the Clean Industrial Deal**	**Expert workshop on enablers for transformation**	**Case selection and prioritisation**	**Case development, expert feedback and synthesis**
Literature analysis was conducted to tailor the transformative change framework to industrial transformation and identify potential enablers for industrial transformation.	The analysis examined the Clean Industrial Deal using six lenses. The synthesis of insights across the lenses resulted in a list of seven enablers for the EU's industrial transformation	Previously identified enablers were discussed and prioritised during the workshop with the EEA and invited experts, converging on three key enablers.	15 cases were selected to showcase how each enabler operates based on criteria of relevance to the EU policy context, credible evidence, and sectoral and geographic diversity.	Detailed case studies, together with the background literature and additional consultations, formed the basis for defining key facets of each enabler within specific chapters.

Source: own elaboration

2.1 Adapting the transformative change framework to industrial transformation

To better understand the EU industrial policy, the first step required adapting a multi-perspective analytical framework developed in the first year of the task. The framework employs six complementary lenses to examine transformation in multiple, complementary ways that extend beyond technical and economic aspects. Each lens captures distinct yet interconnected dimensions of change, from power dynamics and governance arrangements to cultural narratives, nature-society relationships, and individual agency. Literature analysis was conducted to adapt the framework to the context of industrial transformation in the EU. This step enabled the identification of enablers that could accelerate transformation and risks that may constrain or misdirect it (see **Annex 1.**).

Table 2 Six lenses framework: implications for industrial transformation, summary of analysis

Lens	Implications for industrial transformation
Socio-political	The lens frames industrial transformation as a political struggle over authority, distribution and legitimacy, viewing sustainability transitions as inherently contested and power-laden (Scoones et al., 2020). It highlights how geopolitical shifts and actor alliances shape the feasibility of industrial strategies (McNamara, 2024) and how power asymmetries may deepen democratic capability or reinforce incumbency (Pichler, 2023).
Socio-technical	The lens conceptualises industrial transformation as systemic reconfiguration rather than incremental technological optimisation, building on frameworks that treat industries as socio-technical regimes with co-evolving infrastructures, rules and practices (Sovacool et al., 2023). It stresses the importance of destabilising carbon-intensive regimes while supporting niches demonstrating alternative industrial futures, including coordination and activities beyond technological deployment (Sovacool et al., 2024).
Socio-personal	The lens interprets industrial transformation as shaped by human agency, emotions, identity and inner capacities, recognising these as deep leverage points for behaviour change (Woiwode et al., 2021). It foregrounds values and emotional responses such as loss, hope or fear as factors that shape support for or resistance to industrial change (Wojtynia et al., 2023; Wullenkord & Hamann, 2021).
Socio-ecological	The lens situates industrial transformation within long-term socio-ecological regime shifts and changing material–energy flows (Fischer-Kowalski et al., 2012). It highlights how resource constraints, land use pressures and ecological feedbacks set hard boundaries for industrial pathways (Krausmann et al., 2008) and how crises expose regime limits and open space for regenerative or adaptive industrial configurations (Barth et al., 2019).
Socio-cultural	The lens views industrial transformation as shaped by cultural narratives, imaginaries and practices, which influence what kinds of industrial futures feel desirable, legitimate or threatening. It explains how symbols, stories and collective memory stabilise incumbent pathways or enable alternatives (Hajer & Versteeg, 2019), and how cultural resonance impacts the uptake of technologies and practices (Sovacool & Griffiths, 2020).
Socio-economic	The lens understands industrial transformation as restructuring provisioning systems to meet needs within ecological limits, ensuring sufficiency and social foundations (Fanning et al., 2020). It emphasises shifts in societal metabolism, process funds and core infrastructures (Bärnthaler & Gough, 2023) and links industrial strategy to long-term competitiveness and resilience via institutional redesign (Aiginger & Rodrik, 2020).

Source: own elaboration

2.2 Discourse analysis of the Clean Industrial Deal

The analytical process began with a systematic discourse analysis of the CID through each of the six lenses. The CID, launched by the European Commission on 26 February 2025, aims to connect industrial decarbonisation with competitiveness to support EU-made clean manufacturing. The strategy focuses on energy-intensive industries such as steel, metals, and chemicals, alongside clean technology sectors.

Each research team member applied one or two lenses to analyse the CID communication and supporting documents. This involved examining how the CID addresses (or overlooks) key dimensions relevant to each perspective, with a set of generic and lens-specific questions based on the scope of each lens. The full analysis is presented in **Annex 2**. The table below summarises the main findings.

Table 3 Application of the six lenses framework to Clean Industrial Deal

Lense	Main conclusion
Socio-political	The CID positions itself as a strategic response to geopolitical instability, shifting toward a more protectionist, industry-focused narrative. It maintains commitments to a just transition to a limited extent, addresses power asymmetries, foregrounding incumbent industrial actors, and engages place-based processes only sporadically. Participation is framed mainly around supporting competitiveness and financing, rather than mobilising wider public engagement.
Socio-economic	The CID seems to move beyond the mainstream economic belief that governments should not pick winners and only focus on framework conditions for industry. Overall, it advocates for stronger public sector engagement. More radical economic ideas on state ownership, systems, community-centred cooperative economies, systems of provision, economies of care, and post-growth sufficiency approaches are not mentioned or further developed.
Socio-cultural	The CID provides a broad socio-cultural narrative arc, but it stays at this high level of abstraction, referring to broad ideas such as 'Europe's industrial heritage' without going deeper into aspects that would signal strong sensitivity to the diversity of local cultures or approaches towards the future of industry. As such, there remain options for better embedding CID into various local cultural contexts and for exploring creative reinterpretations of industrial futures.
Socio-technical	Although there are some openings, the CID has not fully articulated the place-based and demand-side dimensions of transitions and phase-out, including through the involvement of consumers and citizens. Limited consideration of those aspects could undermine sustainable and just pathways and undermine the credibility and legitimacy of transformations.
Socio-ecological	The CID creates some room for more circular, bio-based and climate-resilient industrial strategies, yet it remains rooted in a relatively shallow ecological perspective. Its growth-centred logic, narrow environmental focus on CO_2, and short temporal horizon risk-reinforcing modernistic worldviews, overlooking non-climate ecological limits, and delaying the deeper transformations required to operate within planetary boundaries.
Socio-personal	The CID mentions aspects of social transition by emphasising skills and competencies and acknowledging the role of values. However, it could further leverage the potential of engaging workers, citizens, and the values that shape how people experience industrial change and the social networks that influence their actions. Diverse identities, emotions, and everyday dynamics require further consideration for navigating industrial change.

Source: own elaboration

This work was shared, presented and discussed among all team members to create a more consistent assessment that diminishes any individual bias. At the same time, this assessment should still be considered highly interpretive, but given the scope and goal of this task, a relatively quick assessment of the main tenets of the CID based on the earlier developed framework is a suitable strategy.

The discourse analysis revealed that while the CID articulates an ambitious agenda for industrial decarbonisation and competitiveness, it remains largely rooted in a techno-economic framing. The analysis identified many potential complementary enablers that could inform a broader policy agenda for transformative change. Such as power asymmetries and alternative economic models, place-based and cultural diversity, attention to phase-out policies, collective agency, stronger public sector engagement, just transitions, as well as alternative treatment of nature-society relationships and the inclusion of emotional dimensions and interpersonal dynamics shaping change.

A first step in the process for selecting these enablers was to list them and find common themes within and across lenses. This led to a short list of seven potential enablers for a broader transformative agenda that the research team found promising to explore further. These themes were:

- Fostering a whole-of-society transition
- Embedding place-based and cultural dimensions
- Exploring the role of government in enabling systemic change
- Creating space for alternative perspectives and long-term visions
- Harnessing cross-cutting, emergent and disruptive impacts of digitalisation
- Broadening the scope of industrial resilience
- Addressing structural lock-ins and incumbent power

2.3 Expert workshop on enablers for industrial transformation

The preliminary enablers identified through the lens-based discourse analysis were subsequently validated and prioritised through an online expert workshop with the European Environment Agency on 18 June 2025.

The workshop brought together diverse expertise spanning industrial policy, regional development, sustainability transitions, and environmental governance. Workshop participants engaged with the analytical findings and deliberated on which enablers would be most relevant and actionable for informing EU policy development. The process involved structured discussions around three key questions: Why is this entry point important? What empirical cases can help argue for this entry point? What policy developments should we connect to?

Through this collaborative process, participants converged on three priority areas for deeper exploration.

- Embedding place-based and cultural dimensions within industrial transformation, recognising that geography and local contexts shape the feasibility, acceptance, and success of policy interventions, which also integrated the aspects of whole-of-society transformation and social contract.
- Addressing structural lock-ins and incumbent power, acknowledging that transformation requires understanding and working with existing power dynamics.
- Broadening the scope of industrial resilience beyond geopolitical and supply chain concerns to encompass resource efficiency, circularity, and ecological limits.

This process ensured that the enablers selected for deeper exploration resonated with both analytical insights and policy priorities. Participants also suggested concrete empirical cases and policy developments relevant to each enabler. The workshop results provided crucial guidance for the subsequent case selection process and are summarised in **Annex 4.**

2.4 Case selection and prioritisation

Following the workshop, a case search and prioritisation process was conducted to identify well-documented examples demonstrating how each enabler operates in practice and what could be learned from them. The selection process was guided by multiple criteria designed to ensure both analytical robustness and policy relevance.

Relevance for the EU policy context. These cases should showcase the clear impact of policies or other dedicated measures on structural change across sectors or in the broader relevance of industrial development in each context. This included the presence of elements that are not covered by the current EU policies. Those cases should be of relevance to the EU policy landscape and provide insights for learning about policy options that have not been considered or failures not be repeated.

The presence of specific changes was important for articulating the relevance of the case, including changes to the goal-orientation (e.g. decarbonisation, competitiveness, justice) or structure of industry-relevant activities (e.g. exporting, innovation, electrification) within national or regional contexts. This included evidence of a trajectory of success or failure, based on peer-reviewed literature.

Diversity and heterogeneity. Each case was selected for its ability to demonstrate, with grounded local evidence, how the identified enabler can be translated into a practical strategy and the kinds of policies that can accompany and support it. As such, they can provide positive creative input with ongoing policy developments, including the Clean Industrial Deal, Industrial Emissions Directive, Net-Zero Industry Act, Circular Economy Act, and sector-specific action plans for automotive, steel, and chemicals, even if the cases as such are not always success stories or represent stories in the making.

Geographical balance. To ensure that the cases both inspire and feel relatable, we sought a balance between highly illustrative international examples (often less familiar to a European audience and therefore particularly thought-provoking) and European cases that demonstrate the same enablers in ways that resonate more directly with local contexts.

Where possible, cases were selected to represent diverse European regions, including both Western and Eastern Europe, northern and southern contexts, and urban and rural settings. While we prioritised European examples, we deliberately included several international cases, as they add significant value to the overarching narrative and help broaden the perspective on what transformative change can look like.

Sectoral diversity. The selected cases span both traditional energy-intensive industries (steel, chemicals, cement) and emerging clean-tech sectors (renewable energy, circular economy, digital services). This range ensures insights applicable across the industrial spectrum addressed by the CID.

The case selection process involved iterative discussions among the research team to ensure each case illustrated specific enabler dynamics while collectively providing comprehensive coverage of the relevant industrial transformation dimensions.

Table 4 Overview of selected case studies by enabler, sector, and geography

Case	Short description	Region
People, places and culture		
Lab-grown meat	Highlights the need to engage with food cultures when exploring alternative proteins industries.	International
Fryslân's interpretation of a circular economy	Illustrates how new regional circular cultures can be built around traditional and local values	Netherlands
Kyoto textile industry	Leverages traditional industrial cultures to support contemporary transformation.	Japan
Addressing local resistance around Dutch data centres	Develops adaptive regional strategies to manage resistance to data centre expansion.	Netherlands
Responsible mining in Finland	Outlines the role of broad societal dialogue to address tensions around mining activities.	Finland
Destabilisation and phase-out		
Genk's industrial heritage	Explores regional transformation efforts in response to the emerging coal phase-out.	Belgium
Green steel needs red lines	Phase-in and phase-out dynamics in global steel production	Global
Adaptivity of the Canadian automotive industry	Addresses the significance of overcoming structural lock-ins in the automotive sector.	Canada
Banning single-use plastics in Ireland	Demonstrates how small, early steps can initiate plastic phase-out.	Ireland
Negotiating the transformation of Austria's steel industry	Involves broader stakeholder engagement to manage the phase-out effectively.	Austria
Broader view on resilience		
Norwegian maritime sector	Highlights the strength of specialised, high-quality industrial niches amid shifting global competitiveness.	Norway
Barcelona Fab City	Explores the potential of trans-local, distributed, and resilient small-scale industrial models	Spain
Ukraine wartime production	Showcases how distributed production models can scale and perform under crisis conditions.	Ukraine
Japan's rare earth crisis	Offers insights into managing industrial supply chain disruptions during geopolitical tensions.	Asia / National
Thailand disaster response	Provides lessons on industrial resilience in the face of natural disasters.	Asia / National

Source: own elaboration

2.5 Case development and synthesis

The final phase involved developing detailed case narratives that systematically explore how enablers manifest across contexts. Each case was researched through academic literature, policy documents, grey literature, and, where possible, interviews or consultations with key experts in our network.

Table 5 The structure of case studies

Category	Guiding questions for case study development
Case summary	
Location	Where does the case take place? What geographic or regional contexts are relevant?
Sectoral focus	Which industry, value chain, or cross-sectoral domain does the case target?
Temporal scope	What time frame does it cover? How has it evolved? What is the current stage of the initiative?
Enablers addressed (key, complementary)	Which enablers played a central role? Which acted as supporting conditions?
Lenses addressed (key, complementary)	Which analytical lenses are most relevant?
Policy orientation	How does the case engage with EU priorities such as competitiveness, decarbonisation, wellbeing, productivity, and resilience?
Case structure	
Introduction	Why is the case noteworthy? How does it contribute to EU key topics like competitiveness, strategic autonomy, resilience, decarbonisation, digitalisation, and justice?
Why: challenges or needs	What problems or policy needs does it respond to? What objectives guided the intervention?
How: policy mechanisms	How were policies designed and implemented to enable and support the intended change, particularly through industrial or innovation activities?
What happened: actors and outcomes	What actions took place? Who were the actors, and how were they engaged?
Lessons and insights for EU policy	What can be learned from this case to enrich or adapt the current EU policy mix? Which key lessons or action points can be transferred?

Source: own elaboration

3. Culture, people and places: beyond transition versus innovation

This chapter considers industrial transformation as fundamentally a socio-cultural and context-sensitive process going beyond economic restructuring, new investments or technological change. The European Commission's industrial policy agenda puts a strong focus on competitiveness, green and digital transitions, and strategic autonomy. However, the success of these ambitions depends on factors that policy frameworks tend to treat as complementary, rather than central to transformations. The matters of culture, geography and participation put into focus in this chapter can both strengthen and enable industrial transformation in Europe, but also open new possibilities for transformative change.

KEY TAKEAWAYS

Industrial transformations unfold within broader processes of socio-cultural change that impact the uptake of innovations. One example is how alternative proteins challenge traditional food cultures. The case of Singapore's cultivated meat industry shows how early dialogue with religious, vegetarian, and environmental groups can build acceptance. Such socio-cultural dynamics demand consideration in domains of industrial transformation that are highly sensitive to changes in values.

Empowered social partners are crucial for broader societal support for change. Institutionalised participation and trust can help to mediate potential societal conflict, but require continuity and trust. The Finnish Network for Sustainable Mining provides examples of how trust-building might take place in one of the most contentious areas of industrial policy. While investing in and collaboration between societal groups may be considered slowing down innovativeness during stable times, it often becomes a key asset in times of crisis and under local resistance and deserves more policy attention.

Narratives, symbols, and emotions are essential for navigating change. People make sense of the future through stories that describe possible and desirable futures. Today's public and political discourses, influenced by social media and geopolitical turbulence, risk narrowing imagination around industrial futures. EU policymaking could leverage creative infrastructures to enable bold and transformative visions of industry. The case of the Frisian reinterpretation of the circular economy around local narratives, practices and identity is a great example of opening up these diverse futures.

New social contracts are central to industrial transformations. New industrial infrastructure can have significant social and environmental impacts and requires negotiation and reconsideration of what matters to society. Contemporary industrial processes mediated by automation, artificial intelligence and centralised data flows raise questions about fairness and ownership, for instance, when it comes to public good versus private benefit. This is demonstrated by the Dutch case on the fast rise of data centres, leading to a growing competition for water and energy. The case shows how new social realities can be negotiated, hence minimising both perceived and actual externalities.

Credible transformation requires accounting for Europe's geographic and cultural diversity. Regions differ in industrial legacies, skills, and identities, requiring place-based strategies that link innovation with local meanings, capacities and needs. Building on local capacities can deepen ownership and ensure that transformations remain locally grounded and desirable. Kyoto's Nishin district serves as an inspiring example of how traditional and local craftsmanship can align with digital and environmental transitions. Addressing cultural perspectives and values can enable transformations to be better rooted in the needs of local communities, thus increasing viability, credibility and legitimacy of transformations.

Industrial transformations do not occur in a vacuum and are deeply rooted in local histories, economies, and values. Enabling regional specificities, cultural identities, and emotional attachments to place can help reduce resistance, enhance responsivity and uptake, and foster greater ownership, creative agency, and commitment to change. It would also better enable EU policies on industrial transformations to address critical local issues and barriers to adoption, such as distinct elements of local identity and pride, visions of the good life, or public attitudes shaped by past experiences of industrial policy and change.

3.1 Industrial transformations and the broader processes of socio-cultural change

Those changes impact the uptake of innovations and are impacted by technological change. One example is how alternative proteins challenge traditional food cultures. Such socio-cultural dynamics demand consideration of both long-term value changes and rapid discursive shifts, operating at timescales that are different from those of the policy and investment cycles. In the current EU policy landscape, socio-cultural dynamics are increasingly recognised, including in the new strategic priority on *European social fairness* for 2024–2029. The Commission links social fairness to managing green and digital transitions in a way that "supports people, strengthens our societies and our social model" (European Commission, 2024), with a focus on quality jobs, fair wages, skills, and the reduction of regional disparities.

Socio-cultural dynamics manifest in multiple ways. Among other issues, it is about the interplay of the new and the old, and how culture mediates perceptions of novelty and persistence of tradition. This challenge is particularly vivid in the industrial changes stemming from the adoption of new technologies that have significant cultural ramifications, such as the case with the uptake and standardisation of cultivated meat, which remains a highly contested and uncertain technology that has created significant resonance.

Case 3.1: Cultivated meat and lessons from Singapore's societal dialogue

Cultivated meat shows how technological change interacts with long-standing food traditions and moral debates. In Europe, the Farm to Fork Strategy promotes alternative proteins, but cultivated meat still awaits EFSA approval, reflecting both regulatory caution and cultural hesitation. Italy's 2023 ban and farmers' protests highlight worries about rural decline and loss of food identity, while projects in the Netherlands and Spain explore how biotechnology complements regional gastronomy and sustainability goals. The story of cultivated meat reveals that industrial transformation is inseparable from the way societies negotiate what they value, trust, and accept. Singapore's 2020 approval demonstrated how early dialogue with halal, vegetarian, and environmental groups can build acceptance, showing that the pace of change depends not only on scientific advances or policy process but also on evolving values, public debates and local identities *(see Annex 3 - Case A3.1 - for the detailed case)*.

3.2 Empowered social partners as catalysts of change

Trust and collaboration across society are particularly important in the context of crisis and change. EU Industrial policies highlight the role of social partners, industry leaders, and workers in shaping the transition, proposing instruments such as Clean Transition Dialogues to foster inclusive engagement. Broadening engagement allows addressing diverse needs, while catalysing participation and ownership.

Empowerment of workers, communities and citizens in industrial transformation and decarbonisation programmes tends to encounter familiar collective action challenges, such as coordination failures, free riding, power asymmetries and the shifting of risks onto actors with weak bargaining power. Research on just transition shows how these tensions appear in concrete industrial settings, where ambitious transition

goals coexist with unclear responsibilities, fragmented policies and uneven capacity to participate in decisions (Healy & Barry, 2017; Newell & Mulvaney, 2013; Sovacool, 2021)

Processes positioned as co-creation can also be used to stabilise incumbent agendas when they are organised around narrow options and controlled problem framings, rather than broad deliberation on alternative pathways. (Ruess et al., 2023). Addressing these challenges requires long-term work on trust, fairness, reciprocity and careful attention to existing relationships, local cultures and shared identities. Research on everyday climate politics and consumption also warns that public engagement often narrows citizens into green consumers who are asked to choose responsibly within markets, rather than collective actors who can contest and reshape infrastructures, institutions and rules. (Maniates, 2001). This raises questions about industrial transformation strategies that rely heavily on information campaigns and price signals while leaving limited space for collective and community action, and social movements to influence core choices about investment, ownership and the pace and direction of change (Boda et al., 2022)

For industrial regions affected by disruptions or technological shifts, local social infrastructure plays a central role in transformations. Studies of disasters and shocks show that networks of civic associations, neighbourhood groups and informal ties can predict recovery and adaptive capacity more effectively than physical damage or external assistance (Aldrich, 2012). Civil society organisations and local networks provide trusted intermediaries, shared knowledge and coordination when formal institutions face limits.

Case 3.2: Regional identity as a catalyst for industrial transformation: The case of Fryslân, Netherlands

In the Dutch region of Fryslân, an agricultural province with a strong regional identity, a distinct local culture of circularity is emerging through continuous dialogue and practical experimentation. One dimension of this shift involves reinterpreting broad circular economy principles to emphasise local ownership and regional autonomy, linking them to a deep-rooted sense of communal responsibility known locally as Mienskip. Fryslân's circular economy also centres on redefining the role of local materials, as the agricultural landscape is reimagined through the revival of traditional practices such as using flax for circular insulation or harvesting cattail and hemp as valuable regional resources.

The provincial association Vereniging Circulair Fryslân plays a pivotal role in sustaining this cultural shift by offering a shared platform for collaboration among public authorities, private companies, academic institutions, and civil society. This cooperation—exemplified by the renewed use of flax in the regional textile industry—supports transition pathways that diverge from the more eco-modernist approaches often promoted at the European level. The case illustrates that when collective local initiatives ground broad circular economy principles in regional narratives and histories, they foster genuinely place-based practices as catalysts for industrial transformation *(see Annex 3 - Case A3.2 - for the detailed case)*.

3.3 The role of narratives, symbols, and emotions

People interpret industrial and technological shifts through stories that define what kinds of futures appear both possible and desirable. The 1939 General Motors Futurama exemplified this narrative power, with more than 20 million visitors encountering an imagined, car-centred future that felt natural rather than constructed. This careful performance of progress translated a specific corporate vision into a shared vision of modernity, embedding automobility into infrastructure, policy, and cultural identity for decade. It also showed how visual and experiential storytelling can align emotion with pre-defined agendas, lending inevitability to some pathways while rendering others invisible.

Social psychological research suggests that mobilisation is more likely when people believe their actions can have an impact and identify with a group that stands for change (van Zomeren et al., 2008). Studies on transitions in industrial regions point to the importance of shared narratives, which can make coordinated sacrifice and risk-sharing politically imaginable, while also highlighting conflicts around whose interests are represented in such narratives (Healy & Barry, 2017; Newell & Mulvaney, 2013; Sovacool, 2021). Today, industrial narratives emerge in a highly fragmented and heterogeneous landscape. Digital media amplify both utopian and dystopian visions, polarising societies and depleting human attention. Coupled with geopolitical instability, climate anxiety, and accelerating digitalisation, this fragmentation narrows collective imagination, reducing complex futures to competing extremes of techno-optimism and fatalism. Policymakers therefore face the paradox of possessing strong technological capacities but weak shared stories, risking transitions that are efficient yet lacking purpose or direction.

One possible response lies in strengthening creative infrastructures that reconnect technological ambition with cultural imagination. Initiatives such as collective sense-making, speculative prototyping, design storytelling, and creative foresight can help rebuild meanings around industrial transformation. For the European Union, integrating these approaches with frameworks like the New European Bauhaus, the Culture Compass, and Industry 5.0's human-centric vision could link industrial strategy with the deep and broad potential of culture. By investing in capacities that help communities envision distinct yet connected futures, the EU can foster transformations that feel collectively owned and emotionally resonant. Yet another one comes also from Japan, where artisans and designers co-create new aesthetics through digital weaving and circular design, exemplifying future-oriented and yet locally rooted imagination that sustains and revives local economies.

Case 3.3: Weaving textile futures: tradition meets innovation in Kyoto's Nishijin

Kyoto's Nishijin district shows how heritage industries can become spaces of creative renewal and experimentation. Once central to silk production, Nishijin's weaving and dyeing crafts entered crisis by the late twentieth century as kimono demand and supply networks declined. Rather than disappearing, the sector was reframed as a strategic cultural industry. The Traditional Craft Promotion Act provided institutional support, while later city initiatives fostered new collaborations among artisans, universities, and design schools. More recent projects have fused digital jacquard looms, AI-inspired motifs, and low-impact dyeing to produce textiles that combine aesthetics, sustainability, and innovation. These experiments linked traditional craftsmanship with digital and environmental transitions. Their success rested on mentoring and skill, but also on allowing innovations such as circular design and digitalisation. Nishijin stands as a model of how cultural industries can combine continuity with creativity, ensuring that technology enriches rather than replaces the human craft and labour *(see Annex 3 - Case A3.3 - for the detailed case)*.

3.4 Industrial transformations and the challenge to the social contract

Industrial processes mediated by automation, artificial intelligence and centralised data flows raise questions about fairness and ownership, such as when it comes to public good versus private benefit. While the EU industrial policy rightly prioritises supply-side innovation and investment, it would also benefit from placing greater emphasis on the cultural and societal shifts required that shape industrial futures, responding to the challenges that emerge alongside those developments, such as in the case of new competing energy and water uses from infrastructure for artificial intelligence.

The social contract defines the baseline for what people and the state agree on, including mutual obligations and responsibilities. The contract may be challenged by factory closures, automation, and competition for resources, also challenging the guarantees for essential services and support. When the state protections are credible and reliable, workers can view the transition as a managed risk. Without them, the process is more likely to be rejected as a threat to survival. Applying a social contract lens also exposes potential tensions between goals at different governance Establishing credible and legitimate governance arrangements is thus crucial for any transformations that would endure beyond early successful investment, as demonstrated by the case of data centre governance in the Netherlands.

Case 3.4: Negotiating responsible data centre development in the Netherlands

The case illustrates the challenges brought about by data centres' expansion in the Netherlands and how the authorities handled this through multi-level deliberative processes. The Netherlands' rise as Europe's "Digital Gateway" over the last two decades turned Amsterdam and Noord-Holland into dense data-centre clusters represented by Google, Microsoft, and Meta. Permissive policies enabled growth throughout the 2000s and 2010s.

As of 2018, warnings grew of energy demand, while growing water demand also raised questions about the impact on local well-being. When Microsoft's Hollands Kroon site got attention due to water consumption levels amidst the 2020 drought, Amsterdam and Haarlemmermeer froze new centres in 2019 to open dialogue with residents, unions, and firms. Consultations produced new rules on energy efficiency, heat reuse, and non-potable water sourcing, while provinces introduced tiered permits and new hyperscale projects were redirected to the north. One major construction has been cancelled, while other new sites involved greater investments in water infrastructure. Industry groups also contributed to better coordination of data centre development and transparency around their impacts.

Together, those efforts reframed data centres as infrastructures with environmental and social impacts, enabling enhanced planning and governance *(see Annex 3 - Case A3.4 - for the detailed case)*.

3.5 Europe's geographic and cultural diversity, and legitimation of change

Regions differ in industrial legacies, skills, and identities, requiring place-based strategies that link innovation with local meanings, capacities and needs. Building on local capacities can deepen ownership and ensure that transformations remain locally grounded and desirable. More inclusive approaches are likely to enhance the success and long-term effectiveness of top-down policy measures.

A whole-of-society approach that would actively involve citizens and other societal actors can help align industrial goals with social aspirations, lifestyle changes, and cultural values. Strengthening participatory processes allows fostering a deeper, more democratic and dynamic basis for change, and contributes to a wider deliberation on a new social contract underpinning industrial transformations.

A more explicit integration of place-based approaches could help tailor transition strategies to diverse regional contexts, thereby enhancing both their effectiveness and public support. The EU's existing experience with Smart Specialisation and regional development could be more strongly mobilised to foster inclusive transitions that address nascent opportunities and deep underlying tensions.

Case 3.5: Towards responsible mining in Finland

Finland's mining sector in Kainuu, centred on Talvivaara, exposes the challenges high-trust welfare states face in the green transition. During the 2000s boom, Talvivaara opened as a nickel bioleaching facility to tackle unemployment in a remote region. However, a November 2012 gypsum waste pond breach released wastewater containing nickel and uranium, causing lasting ecological damage and legal prosecutions. The disaster triggered stricter regulations and a sharp loss of trust in state-owned firms, and the government responded in 2014 by establishing the Network for Sustainable Mining. Created under a national sustainability plan, this multi-stakeholder forum united mining companies, ministries, municipalities, Sámi representatives, and NGOs. To strengthen transparency and bolster Finland's image as a responsible battery metal producer, the network introduced performance scores, engagement guidelines, and dispute procedures. However, the initiative soon faced its own limits as Sámi representatives and NGOs withdrew shortly, arguing that participation risked normalising mining on culturally significant lands without addressing structural inequalities. Today, the region remains dependent on mining jobs despite ongoing remediation, illustrating how consensus orientation can improve accountability yet struggle to resolve deeper conflicts. For EU policy, this underscores that the push for strategic autonomy in critical raw materials requires not just deliberative governance, but legally robust social safeguards to deal with local resistance and needs, paired with an expanded focus on the interplay of mining and environmental goals *(see Annex 3 - Case A3.5 - for the detailed case)*.

Concluding remarks

EU industrial policy reflects a strong European identity, drawing on shared industrial heritage and a shared spirit around sustainability and innovation. It recognises the importance of local communities and regional actors, referencing multilevel governance and local implementation in several places. Nonetheless, it could go further in leveraging diverse local cultures, aspirations, and unique capacities of regions to drive change. By building stronger connections between industrial policy and local narratives, the CID can deepen its relevance across Europe's many regional transformation pathways, while also unlocking new bottom-up opportunities for innovation, resilience, and positive redundancy that are not present in top-down approaches. Investment in new industrial infrastructure, technologies and skills needs to be matched by sustained support for the social fabric that allows people in affected regions to interpret change, deliberate benefits and trade-offs, and co-design transformation strategies.

4. Destabilisation and phase-out policies as catalysts of transformative change

The European Commission's industrial policy agenda puts a strong focus on phase-in policies to decarbonise industrial production. However, the success of these ambitions partly depends on policies that actively phase out undesired or unsustainable industries, as well as policies that support and guide those sectors entering a process of emergent decline. This chapter, therefore, explores the role of phase-out policies within policy mixes addressing industrial transformation.

KEY TAKE-AWAYS

Phase-out has always been an integral part of industrial renewal and transformation. Phase-out policies are key both to actively phasing out undesired or unsustainable industries, as well as supporting and guiding those sectors entering a process of emergent decline. Any industrial policy strategy, therefore, merits a dedicated and explicit phase-out strategy. The cases discussed in the chapter provide a broad evidence base for such strategies.

Targeted phase-out policies are key complements to phase-in policies. Increased production through cleaner processes without decommissioning more polluting capacity can lead to overproduction and market distortions. The global market distortions created by state-subsidised production of green steel illustrate this transition dynamic. Subsidies, innovation incentives, and demand-creation tools can therefore best be accompanied by time-bound phase-out instruments such as stricter standards, plans for retiring fossil assets, and carbon price mechanisms. With this combined approach, policy is more likely to avoid subsidising overcapacity or expanding total output.

Phase-out policies are also key for dealing with those industries entering emergent decline. Besides the deliberate phase-out of unsustainable industries, phase-out policies are also relevant under industrial decline due to broader shifts in the global political-economic landscape. Here, policy functions as a form of palliative support – helping industries wind down while enabling affected workers and communities to transition into new jobs. The case of the Austrian Steel Foundation shows how a public–private initiative can support displaced workers and managers through retraining and reintegration.

Addressing structural lock-ins can facilitate processes of phase-out and subsequent industrial renewal. Structural lock-ins can be eased by putting pressure on unsustainable industrial models and by gradually reducing the policy, financial, and institutional conditions that keep incumbent actors central in the system. The Canadian automotive industry took this approach in the 1960s and 1980s and regained competitiveness in the face of multiple pressures.

Phase-out processes gain effectiveness through flexible and adaptive policy approaches. Phase-out policies can begin with incremental steps targeting low-hanging fruit to build momentum and carry along societal actors. These steps can be embedded within a long-term industrial strategy that ensures such early actions serve as catalysts for bigger, systemic change. This is illustrated via the phase out of plastic bags in Ireland, which laid the grounds for addressing more complex challenges.

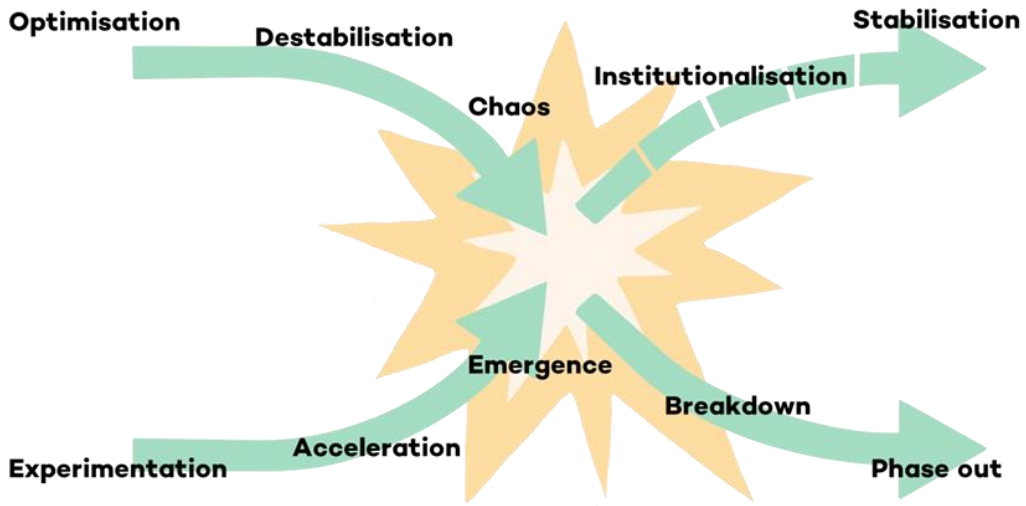
Just transition mechanisms can ease phase-out processes. Comprehensive just transition approaches - that consider not only labour aspects but also procedural fairness, recognitional inclusion, and an equitable sharing of benefits and burdens across regions and communities - can support industrial transformation. The case of the former mining region of Genk can provide some inspiration. When the city ceased mining activities, it allowed for many bottom-up citizen and NGO initiatives to come up with alternative approaches to generate revenues and create opportunities, fostering broad-based support.

There is potential for contemporary European industrial policies to better integrate phase-in and phase-out measures to regain global competitiveness and broader socio-economic and environmental sustainability. The Clean Industrial Deal (CID) demonstrates the current focus on phase-in measures. It outlines a commitment to industrial decarbonisation, placing innovation and clean technologies at the core of its strategy. This focus fosters the build-up of new clean-tech sectors and the electrification of existing industries, which are essential steps toward climate goals.

Transformative policy mixes, however, benefit from going beyond phasing in alternative practices. They also require deliberately destabilising and phasing out existing unsustainable industrial systems, including by interrupting and severing patterns of inertia and resistance that entrench the status quo and inhibit transition efforts (Hebinck et al., 2022; Langhelle et al., 2019; Roberts et al., 2018). Moreover, phase-out processes are strategic not only for industries deliberately targeted for elimination due to their unsustainability or negative societal and environmental impacts, but also for those entering decline as a result of broader shifts in the global political-economic landscape (Hassink, 2010; Turnheim, 2022).

The need to couple phase-in with phase-out policies in Europe, amid a changing global political-economic landscape, is underscored by Europe's 2026 vision to build a more sovereign and independent continent in response to the economically consequential shifts in global political alliances (European Commission, 2025b). Achieving strategic autonomy depends on an earnest consideration of what practices to eliminate, maintain, or introduce so as to minimise the continent's exposure to economic and industrial vulnerabilities. In other words, in the context of sustainable industrial transformations, industrial policies necessitate a mix of both policies aiming for the creation of new industries and practices (innovation) and for the elimination of the old, unsustainable and uncompetitive ones (Kivimaa & Kern, 2016). Such a policy environment would also ensure that industrial transformations remain fully coherent with the long-term objectives of the 8th European Environment Action Programme (European Parliament & Council of the European Union, 2022).

Figure 1 The X-Curve illustrating synergies between phase-in and phase-out processes in sustainability transformations.



Source: Hebinck et al., 2022

The CID makes a promising start to address this key topic, but mentions phase-out only sparingly and does not yet address the potential phase-out of specific high-carbon sectors (see Annex 2). Strengthening this aspect would enhance the effectiveness of its ambitions by ensuring that long-standing power structures and fossil-intensive industries are fully engaged in the transition. Also from a strategic autonomy perspective, not all energy-intensive industries hold equal value for Europe's future. In the context of a renewable energy supply that remains constrained, costly, and not yet abundant, it is critical to foster an open and informed debate: which energy-intensive sectors are essential to retain within Europe, and where continued support is less justified or even counterproductive? To enhance the transformative potential of Europe's industrial policy, strategies such as the CID would benefit from adopting a more deliberate approach to managing the decline and transition of legacy sectors. Lessons can be drawn from effective historical and ongoing phase-out processes in Europe and elsewhere.

4.1 Phase-out as an integral part of industrial renewal and transformation

Phase-out is a critical component of transformation and merits dedicated and strategic attention from policy. As society transforms in the face of macro developments - such as geopolitical shifts, environmental changes, technological change and demographic shifts - some previously important industries become obsolete. In such contexts, phase out also involves recognising emerging decline as an economic, political, and societal inevitability, with policy functioning as a form of palliative support - helping industries wind down while enabling affected workers and communities to transition into new economic activities. Supporting the decline of specific industries does not necessarily entail the decline of economies. Emergent industrial decline has also historically and contemporarily been a stimulant for a timely transformation of industry and a renewal of regional economies. Genk, a former coal mining region that has refashioned itself into a thriving knowledge- and innovation-driven economy following the economic decline of coal, illustrates these dynamics (see Case 4.1). The case illustrates that the imminent decline of industries can be harnessed to stimulate technological and social innovation towards the type of industries suited for the current and future societies.

Case 4.1: Genk's managed industrial transition: from coal to a diversified regional economy

Following the first mine closures in the 1960s, Genk replaced coal with car manufacturing. While this secured economic stability over the following decades, the city remained dependent on a single industrial sector. A more fundamental transition began after Ford's closure in 2014, which marked a shift toward a diversified, knowledge- and innovation-driven economy. A key strategy was the adaptive reuse of Genk's mining infrastructure, with each former mining site given a distinct focus - such as clean technology, cultural and leisure activities, or energy-related innovation. This thematic differentiation formed part of a *coordinated regional strategy* to avoid internal competition for the same resources, facilitate new regional identities and functions, and enable targeted innovation and investment. A binary governance strategy, combining top-down measures - including a nationally funded investment plan - and bottom-up approaches - including social innovations - aligned local needs and ideas with regional economic goals (European Commission, 2025). From coal to cars, from cars to creative hubs, clean-tech clusters, and community-led regeneration, Genk presents an inspiring case of clear phase-out strategies enabling long-term regional industrial transformation *(see Annex 3 - Case A3.6 - for the detailed case)*.

4.2 The risks of neglecting phase-out

Clean industrial policy without parallel phase-out measures risks producing counterproductive market distortions, such as state-subsidised overcapacity in certain sectors. In a functioning market, government interventions that stimulate additional green production expand total supply. Without simultaneously reducing conventional production, this can depress prices and lead to surplus capacity rather than driving a genuine transition toward a greener market. This dynamic is visible in the energy sector, where scholars increasingly refer to an *energy addition* rather than an *energy transition*: new (often state-supported) renewable capacity is added, yet fossil fuel production remains largely unchanged, resulting in growth of the total energy system instead of substitution (York & Bell, 2019). A similar pattern can be observed in the global steel market (see Case 4.2).

The case of the global steel industry illustrates these dynamics. (Algers & Åhman (2024a) find a considerable risk of steel overcapacity and related trade frictions due to the ongoing expansion of government-supported green steelmaking in the four major steel-producing jurisdictions, without well-matched phase-out strategies of emission-intensive plants. While a variety of potential phase-out policies – such as state aid for capacity reductions and international finance for closures – are possible, the authors observe a lack of policies that lower the barriers to exit for emission-intensive plants, possibly slowing the transition. The introduction of such phase-out policies would create the space for a faster expansion of low-carbon steelmaking.

Case 4.2: Why global green steel production needs red lines

The steel sector, responsible for around 7% of global energy-system emissions, is now at the forefront of industrial decarbonisation. New production routes - especially green hydrogen–based steelmaking - can cut emissions by up to 95% and are rapidly expanding in regions with abundant renewable electricity, supported by an emerging wave of industrial policies, subsidies, and, in some jurisdictions, high carbon costs. Nearly half of all global green steel projects rely on public support, signalling a major shift toward state-backed low-carbon industrial strategies. However, recent analysis reveals a significant imbalance between phase-in and phase-out policies (Algers & Åhman, 2024a).

While green steel capacity is growing quickly, most jurisdictions lack clear plans to retire emission-intensive blast furnaces. As a result, many new projects add to existing capacity rather than replacing it, reinforcing overcapacity and undermining the viability of cleaner plants. Deep structural inertia - long-lived assets, high upfront costs, and strong regional dependence on steel production - creates political and economic lock-ins that hinder the exit of fossil-based technologies. The global steel sector thus illustrates a critical lesson: industrial transitions need both phase-in and phase-out processes. Without deliberate sunset strategies, decommissioning plans, and just transition support, the shift risks becoming additive rather than transformative, leaving carbon-intensive incumbents in place and slowing progress toward a low-carbon industrial future.

4.3 Addressing structural lock-ins to speed up processes of necessary industrial renewal

The challenge of fundamentally transforming outdated industrial systems is rooted in path dependence and structural lock-ins. Lock-ins refer to the reinforcing dynamics in a range of domains - including technology, institutions, and behaviour - that create inertia and inhibit systemic transformation (Sweeney et al., 2020; Tilsted et al., 2023).

These dynamics manifest in persistently stabilised socio-technical systems and shape transformation processes (Turnheim, 2022). For instance, in fossil fuel-dependent energy systems, infrastructural and technological lock-ins arise from the long lifetimes of existing physical assets and technologies, and the potential value losses for capital owners associated with the premature retirement of this fossil infrastructure (Tilsted et al., 2023). This implies that addressing structural lock-ins is necessary for the required deep transformations of industry from socially and environmentally unsustainable trajectories toward climate neutrality, broader environmental sustainability, and a just society (EEA, 2024a).

Yet addressing such lock-ins and the power structures that sustain them often pose formidable challenges for policymakers. There is a persistent tendency to protect, rather than diversify away from, incumbent actors and established industries, even when this protectionism undermines long-term transformation goals (Sweeney et al., 2020; Unruh, 2000). Historical responses to structural lock-ins in the Canadian automotive industry between the 1960s and 2000s offer valuable lessons for contemporary European industrial strategies (see Case 4.3). The country's automotive history shows how transformation-oriented industrial policy can unlock structural rigidities, whereas stabilisation-oriented policy risks entrenching them. The contrast between strategic transformation before 2000 and stagnation thereafter offers lessons for contemporary industrial transitions.

Case 4.3: Overcoming lock-ins in Canada's automotive sector

By the late 1950s, recession, rising import penetration, and falling employment exposed structural weaknesses in Canada's automotive sector, which was built around a US branch-plant model. Policy responses supported institutional collaboration and increased integration with global supply chains, culminating in the 1965 Auto Pact with the United States. This managed free trade agreement enabled cross-border specialisation, attracted investment, and boosted the scale and competitiveness of Canada's auto industry.

Between 1980 and 2000, rising global competition, technological change toward smaller, fuel-efficient vehicles dominated by Japanese producers prompted renewed adaptation. The government encouraged Japanese automakers to establish Canadian plants through tariff waivers and export restraints, diversifying ownership and production. This strategy reduced dependence on US producers, partially loosened the rigid branch-plant model, and contributed to revitalising the sector, with Canadian output surpassing three million vehicles annually by 1999, placing it in the five top producers worldwide. Here, industrial policy worked with global trends to leverage new entrants, spur innovation, and weaken existing lock-ins.

After 2000, however, structural renewal stalled. The WTO's termination of the *Auto Pact,* Mexico's rise under NAFTA, and global diffusion of technology eroded competitiveness. Policy shifted from transformation to stabilisation, supporting incumbents such as GM and Chrysler through subsidies and bailouts, but efforts to pivot toward a knowledge- and innovation-based future remained fragmented. Instead of phasing in new capabilities and phasing out outdated structures, policy largely protected the existing model. While the industry experienced some recovery, its competitiveness has not matched earlier peaks. Canada's experience illustrates that long-term, structural transformation is essential for aligning industrial competitiveness with sustainability and technological change *(see Annex 3 - Case A3.7 - for the detailed case)*.

4.4 From low-hanging fruits to systemic change

Phase-out can begin with incremental steps targeting low-hanging fruit to build momentum and carry along societal actors. When embedded within a long-term strategy, such early actions can serve as catalysts for deeper, systemic change rather than isolated policy successes. Research on sustainability transitions underscores that successful phase-outs require careful sequencing, social legitimacy, and actor alignment (Kern et al., 2017; Rogge & Reichardt, 2016). Incremental yet visible early measures can demonstrate feasibility and fairness, reducing resistance and creating political space for more disruptive change. The gradual phase-out of plastic bags in Ireland, for instance, laid the foundation for growing public support to address more complex and environmentally harmful plastics (see Case 4.4).

Case 4.4: From ubiquity to targeted phase-outs: Ireland's plastic bag levy

Ireland's 2002 plastic bag levy marked one of the world's first deliberate phase-outs of an unsustainable consumer product. Targeting a visible but relatively low-stakes issue, the levy disrupted everyday habits and demonstrated how small, well-designed interventions can unlock broader societal change. Rather than taxing producers, the government introduced a consumer-facing charge of €0.15 per bag, well above the average willingness to pay. This direct price signal, combined with clear communication, stakeholder consultation, and legal adaptation, made the measure both credible and acceptable. Revenues were channelled into an Environment Fund, reinforcing legitimacy and public trust. The results were immediate: plastic bag use dropped by over 90%, litter nearly disappeared, and reusable bags became the social norm. Retailers and citizens, initially sceptical, came to view the levy as a point of civic pride. The initiative showed that phase-out policies can succeed when early, visible actions target "low-hanging fruit," building momentum and public engagement for more complex transitions *(see Annex 3 - Case A3.8 - for the detailed case)*.

4.5 Social and labour dimensions of industrial change

Incorporating just transition mechanisms within phase-out processes can significantly smoothen industrial transformation by addressing the social and labour dimensions of structural change. Literature on sustainability transitions highlights that phase-outs which neglect social concerns risk triggering political backlash, eroding public trust, and slowing down decarbonisation efforts (McDowall, 2022; Newell & Mulvaney, 2013).

Coupling phase-out of unsustainable industrial practices with well-designed just transition measures - such as worker retraining, income support, and regional development programmes - helps align social and environmental objectives. This integration not only cushions affected communities and workers but also strengthens the political and moral foundations for ambitious structural transformation. The experience of the Austrian steel industry, where a transition instrument was co-developed with trade unions to manage employment impacts, illustrates how proactive social dialogue can reduce resistance and foster legitimacy for transformative change (see Case 4.5).

Transformative industrial change depends not only on the creation of new technologies and markets but equally on the deliberate destabilisation and managed decline of unsustainable ones. Destabilisation and phase-out policies act as catalysts for such change by disrupting structural lock-ins, reallocating resources, and creating the political and material space for industrial renewal.

Case 4.5: Defossilisation of steel production and energy provisioning – a decades-long transition

Linked to geopolitical upheavals and global energy crises, Austria's steel industry faced multiple existential shocks from the 1970s onward. Once centred on a state-owned conglomerate that traded steel for Soviet oil, the sector collapsed in 1986 following the breakdown of this barter system, triggering massive layoffs and regional economic distress. Rather than treating the industry as a "sick patient" that could be cured with a short-term industrial policy, Austria used the crisis as a turning point.

A coordinated strategy of restructuring, technological upgrading, and social partnership turned Upper Austria into one of Europe's fastest-growing industrial regions by the 2010s. The restructured Voestalpine emerged as a globally competitive, research-intensive steel producer. A key enabler of this transformation was the Stahlstiftung ("Steel Foundation"), a public–private initiative that supported displaced workers and managers through retraining and reintegration. By coupling industrial modernisation with active labour market policy, Austria sustained regional skills, employment, and social cohesion. The Austrian case shows that effective industrial transformation depends on aligning restructuring with innovation and social policy *(see Annex 3 - Case A3.9 - for the detailed case)*.

The evidence from diverse cases shows that well-sequenced, socially inclusive phase-outs can transform resistance into momentum. Incorporating just transition measures further strengthens these processes by embedding fairness and participation at their core. Ultimately, treating destabilisation and phase-out not as signs of industrial decline but as strategic instruments of renewal is key to achieving climate neutrality, competitiveness, and a just and sustainable European economy.

Concluding remarks

Phase-out policies can bolster a systemic shift to a cleaner and more sustainable industry in Europe. Such policies are key both to deliberately eliminating undesirable – albeit still competitive - industries, as well as supporting and guiding those industries entering a process of emerging decline due to shifts in global competitiveness dynamics. The cases discussed in this chapter provide a broad evidence base for feasible strategies for coupling phase-in with phase-out policies in industrial transformations towards more sustainable practices. The importance of identifying and addressing structural lock-ins, adopting flexible and adaptive policy approaches, and drawing on more comprehensive just transition approaches is emphasised.

5. Broadening the scope of industrial resilience

This chapter considers resilience as the ability of a system to adapt to changing conditions – not by reverting to a previous state, but by evolving into a new form. This is a break with more instrumental framings of resilience within mainstream policy that see resilience as the ability of a system's capacity to withstand shocks and persist without altering its core characteristics. The chapter offers many examples of how structural adaptations can lead to more resilient and future-proof industries and how crises can be used as catalysers of such transformative change.

KEY INSIGHTS

Alternative structuring of industries can support adaptation to a changing global competitiveness landscape. In the context of new economic realities, industrial transformation plans that link short-term crisis responses with long-term structural change can enable systemic resilience. This is illustrated in the case of Sunnmøre/Norway, where targeted policy support helped the maritime industry to transform - twice - to a highly specialised, more socially and environmentally sustainable niche in an industry otherwise dominated by cost-competitiveness and cheap labour.

Distributed forms of production provide alternatives to globalised, resource-intensive, and vulnerable supply chains. Distributed forms of production and consumption provide a more adaptive complement to centralised industrial clusters. The Barcelona Fab Lab – which contributed to the city's resilience during the Covid-19 pandemic - demonstrates the latent potential of distributed production systems in reducing manufacturing vulnerabilities. Additionally, Ukraine's wartime industry illustrates how decentralised, rapidly reconfigurable production capacities have complemented traditional, centralised industries under conditions of geopolitical disruption and extreme uncertainty. Developing national and/or regional strategies to support distributed manufacturing can support more adaptive industrial ecosystems.

Rapid developments in digital infrastructure can boost industrial resilience. Developments in digital technologies present new avenues to restructure industries in new global conditions. Automation, advanced manufacturing, precision technologies, and specialised skills development can enable the anchoring of high-value activities locally, even in the context of political and economic shocks. The aforementioned cases in Norway, Ukraine, and Spain harnessed digital technologies, boosting resilience in the relevant industrial systems.

Crises can be a source of systemic resilience. The context of multiple, reinforcing crises challenges a focus on long-term sustainability goals. However, multiple historical cases show that crises can be wielded in ways that enable industries not only to bounce back, but rather to bounce forward to more sustainable and competitive production and consumption structures. Cases in Japan and Thailand demonstrate how industries recovered from and built stronger bases to enable absorption of contemporary and future geopolitical and environmental shocks, respectively. The role of foresighted industrial policies, particularly in the Japanese case, was crucial.

Industrial resilience is a mainstay of EU policy strategies for sustainability transitions. Although originating from different parts of the EU institutional architecture, initiatives such as the European Green Deal, Industry 5.0, and the Clean Industrial Deal all underscore the importance of strengthening industrial resilience. Across these frameworks, however, the notion of resilience is treated differently, drawing - often in combination - on instrumental, normative, and substantive framings.

An instrumental framing of resilience focuses on sector-specific ends that are essential for addressing immediate concerns such as industrial viability under increasing global competition, decarbonisation pressures, and supply-chain risks arising from geopolitical frictions. In this instrumental view, resilience is situational rather than systemic, prioritising domains recently stress-tested while inadvertently leaving others exposed (Horan et al., 2025). In the face of multiple and intersecting shocks - environmental, geopolitical, and economic - the instrumental framing has gained precedence. This is illustrated in the contrast between the wider, transformative understanding of resilience invoked in the European Green Deal and the narrower, situational framing emphasised in the latter CID.

5.1 The need for a broader view on resilience

In the interest of maintaining competitiveness and protecting industrial assets in a shifting global landscape, the CID's current framing of resilience foregrounds economic and techno-managerial aspects. Resilience is conceptualised largely through efficiency improvements, technological upgrading, and strengthened risk-management systems, which allow industry to withstand and adapt to external pressures such as supply chain vulnerabilities from geopolitical frictions and enable industry to harness developments such as decarbonisation to its advantage. This understanding of resilience sticks close to its original ecological meaning, where resilience refers to the ability of a system's capacity to withstand shocks and persist without altering its core characteristics (Sprecher et al., 2015).

Yet in the context of sustainability transitions, the pressure on existing systems has become so great that a return to "business as usual" is no longer sufficient for long-term sustainability. Societal systems increasingly face the unsustainability of prevailing ways of thinking, organising, and doing, prompting the recognition that their fundamental characteristics must change (Geels, 2011; Voulvoulis et al., 2022). Consequently, resilience in the context of sustainability transitions cannot be reduced to the ability to sustain existing practices in the face of shocks or uncertainties. It must include the capacity to fundamentally transform those practices when severe shocks or persistent stress render the status quo impossible. It must also go broader to anticipate and adapt to a broader range of shocks (EEA, 2024b; Folke et al., 2021). In this sense, resilience is increasingly understood as the ability of a system to adapt to changing conditions - not by reverting to a previous state, but by evolving into a new, improved form (EEA, 2024b; Walker, 2020). Multi-dimensional resilience thus requires industries, regions, and societies not only to withstand disruption, but also to live with it, adjust to new realities, and transform in response to cascading risks, from droughts to biodiversity loss and supply-chain instability. Meeting this challenge demands rethinking infrastructure, production models, and territorial planning in ways that anticipate non-linear change and systemic fragility. Anticipation and transformation are therefore central to this more holistic approach to resilience. (EEA, 2024b), as also captured in the EU preparedness strategy, which focuses on the ability of European countries to anticipate, prevent and respond to new threats and crises.

Valuable insights on how this more multi-dimensional conceptualisation of resilience might look and can be enacted upon can be drawn from historical and ongoing processes across Europe and beyond. This chapter presents key takeaways from a review of cases from Norway, Spain, Ukraine, Japan, and Thailand wherein industries, firms, and regions have either withstood and/or bounced back from major shocks, and

in some instances, transformed systems and increased their adaptability to new contexts and to future threats. The chapter ends with conclusions that based on the cases and key related literature.

5.2 Restructuring industrial clusters to support adaptability to shocks

In the face of threats to industrial survival and competitiveness, policy is defaulting to short-term optimisation and efficiency measures. This sidelines longer-term aims such as a redesign of industry to foster symbiotic rather than extractive nature-society relations. The tendency to prioritise short-term over long-term goals is reinforced by the assumption that the latter can be deferred until immediate crises are subdued (EEA, 2024b). Yet when fundamental structural changes are postponed, they can become harder to achieve. In the meantime, short-term emergencies tend to recur driven by the same system logics.

While short-term measures may allow industries to withstand pressure or recover from shocks, they rarely return to and much less exceed previous levels of competitiveness (Grillitsch & Asheim, 2024; Sweeney et al., 2020). The Canadian automotive sector illustrates this: in the early 2000s, a resistance to structural change enabled short-term recovery but prevented renewed or enhanced competitiveness. Moreover, it left the sector vulnerable to supply chain shocks (see case 4.3; Chapter 4). Reluctance to pursue fundamental change may also stem from the belief that structural transformations take too long and cannot address urgent matters. Yet rapid responses can also be aligned with longer-term transformation strategies. The Norwegian maritime industry illustrates this possibility. Faced with globalised value chains organised around cost minimisation, offshoring, and the erosion of local production capabilities, the region reached a crossroads. Rather than doubling down on the neoliberal economic logic of cheap labour and externalised environmental and social costs, actors pursued a different path: investing in automation, precision technologies and local manufacturing capabilities. This shift enabled the industry to anchor high-value activities at home, rebuild lost know-how, and compete through innovation rather than cost-cutting.

Case 5.1: The two transitions to alternative fuels in the Norwegian maritime industry

Shipbuilding is a major industry in the Norwegian economy, and in the late C19th and C20th had the largest deepwater cargo fleet after the UK. Shipping is also a fundamental part of Norwegian culture, from the Vikings through to polar exploration with Nansen. Norway's shipping and shipbuilding industry faced a collapse due to the 1970s oil crisis and global competition from the development and subsequent global dominance of shipbuilding in Asian countries: Japan, then South Korea, and, more recently, China. Following the discovery of oil in the North Sea in this period, the industry survived by developing new, complex designs to meet a new growth market in Platform Supply Vehicles (PSVs) and ferries. This industrial capability for advanced technology in ship design and shipbuilding influenced national policy to support technology development to reduce NOx, which was becoming an increasing environmental concern, through Liquefied Natural Gas (LNG) systems. This enabled the Norwegian shipbuilding industry to become a world leader in LNG for PSVs and ferries. When the global policy environment changed to requirements for GHG emissions reduction in addition to NOx emissions, the Norwegian government initiated a second transition through R&D support, changing to battery and hydrogen technologies, complemented with government procurement of new battery and hydrogen ferries. Norway's technology capability has been strong enough to move from being a world leader in LNG maritime technologies to being a world leader in battery and hydrogen technologies. The mobilisation of diverse stakeholders, including the Norwegian shipbuilding industry and a very strong R&D innovation system of universities and maritime research institutes, has been key to affecting these two transitions. This case shows that established industries can adapt to a new competitive environment by drawing on their high technical capabilities to identify and enter new markets *(see Annex 3 - Case A3.10 - for the detailed case)*.

By reorienting toward a highly specialised, high-quality market niche, Norway's maritime industry strengthened both its long-term position and its immediate competitiveness within a global sector otherwise driven by low-cost production. The two transitions, first to LNG and later to battery- and hydrogen-powered vessels, were backed by policies that aligned research and innovation with emerging market opportunities, created early demand to make new markets viable through instruments such as government procurement, and balanced economic objectives with environmental and cultural considerations. The case demonstrates that structural change need not be slow or purely defensive. When grounded in capability development and responsible value chains, it can enhance economic performance while reshaping nature-society relations in more regenerative and less extractive ways.

5.3 Distributed forms of production as more resilient industrial alternatives

Industrial policy has often prioritised reinforcing centralised production systems and infrastructure, yet these systems remain deeply embedded in globalised, resource-intensive value chains whose geography and governance create environmental pressures and supply-risk vulnerabilities for European economies. Research highlights that alternative ways of organising industries can enhance resilience by reducing dependency on these globalised systems (Rumpala, 2023). Distributed forms of production are recognised for their capacity to improve resilience and tend to be more adaptive to technological, environmental, and market shifts. They also help to mitigate the vulnerabilities associated with resource-intensive global supply chains by localising key production capabilities and enabling shorter, more circular material flows (Diez, 2012; Rumpala, 2023), as exemplified by the The Barcelona Fab City case.

Case 5.2: Barcelona's Fab City: Distributed Urban Production and Resilience

Fab (Fabrication) Cities are cities designed as productive, self-sufficient ecosystems capable of addressing local challenges - such as energy, manufacturing, and material use - while remaining connected to global innovation networks. Barcelona's Fab City movement began in 2014 as a vision for localising production and closing material loops within the city. The initiative, a network of several fab labs arising out of an idea developed in the early 2000s at Massachusetts Institute of Technology (MIT), sought to equip citizens and small enterprises with tools and training for rapid prototyping, repair, and small-scale manufacturing. By 2019, dozens of labs were active in Barcelona, supporting open-source design communities and collaborations with local universities, businesses, and the city administration. The Fab City approach was supported by the city's urban policies that sought to orient Barcelona toward a digital sovereign city. Key policy instruments included the 22@ innovation-district regeneration (which repurposed former industrial land into a mixed cluster of technology, creative and research activity) and the Barcelona Digital City Plan (which funded digital fabrication infrastructure, skills and open-source tools) (Calleja-López et al., 2025; Morisson, 2020).

The relevance of these distributed and adaptive production systems became evident during Barcelona's response to the COVID-19 pandemic. Barcelona's Fab City network played a pivotal role in addressing urgent shortages of protective equipment for hospitals, social services, and retirement homes. Makers across the city mobilised to produce protective face shields, respiratory masks, door openers, and ear protectors. Local and municipal fab labs together contributed to meeting the demand for protective equipment across all hospitals in the city and metropolitan area, mitigating the impact of disrupted global supply chains. Regional policies in support of cleaner, smarter, and inclusive cities created the enabling conditions for the emergence, development, and sustenance of these alternative production systems *(see Annex 3 - Case A3.11 - for the detailed case)*.

Rather than relying on centralised industrial infrastructures tied to global, resource-intensive supply chains, Barcelona demonstrates the dynamics that make diffuse production systems comparatively resilient: modularity, redundancy, localised skills development, and the integration of digital fabrication technologies. These characteristics strengthen resilience and enhance adaptability to future technological developments that will shape the next generation of industrial systems (Walker, 2020).

The Fab City initiative offers a salient illustration of how investment in digital competencies and distributed manufacturing can strengthen urban and regional resilience. By embedding technological innovation within supportive social, institutional, and governance frameworks, Fab City demonstrates how the twin transitions - digital and green - can be operationalised locally to promote circularity, reduce dependence on long and fragile supply chains, and build capacity for rapid adaptation. It illustrates how diffuse production systems can enhance regional adaptability to the supply chain, reducing external vulnerabilities while contributing to environmental goals. The relevance of such systems is also seen in the case of Ukraine, where a diffuse military equipment production structure has been mobilised during the conflict, with decentralised and reconfigurable capacities proving highly responsive and functional.

Case 5.3: A dynamic and multi-dimensional perspective on resilience: Ukraine's innovation and industrial ecosystems under the full-scale Russian invasion

Ukraine's defence-industrial transformation since 2022 offers insights into industrial resilience and transformation under the "perfect storm" conditions of the full-scale Russian invasion. Following Russian strikes on major defence plants in early 2022, Ukraine's defence industrial base did not collapse but rebounded with the rapid development of a polycentric innovation ecosystem dynamically linked with the military-industrial system. Existing networks, workshops, startups and initiatives, adapted civilian facilities, expanded domestic defence innovation, and output, most visibly in drone manufacturing. This shift drew on civil–military collaboration, adaptation of civilian technologies, and new flows of public, private, and allied finance, channelled through initiatives such as the Army of Drones and the Brave1 defence technology platform. Emergence of new platforms such as DOT-Chain enabled orders to match needs, while feedback from the frontline units sped up the innovation cycle.

Coordination in this new system relies less on hierarchical control and more on platforms and civil society organisations as intermediaries, connecting military, producers, and funders. This supports rapid experimentation, scaling, and specialisation on timescales of days to weeks, whilst specific designs may become obsolete within months. In this hybrid system, the roles of actors are changing, with decreased focus on state control and articulation of demand, but a strong necessity of supportive regulation and platform provision, as well as continuous oversight and adaptation. Attacks on energy and logistics infrastructure underscore the need for close integration of civil defence, cyber security, industrial planning, and energy resilience. Meanwhile, dependence on imported electronic components sustains exposure to external policy and supply-chain shocks, while rapid innovation in drones and robotics can also backfire through large-scale imitation by Russia.

Despite the challenges, as of late 2025, Ukraine's experience highlights the crucial importance of polycentric industrial systems, rapid and responsive innovation, and flexible scaling and phasing out, under extreme pressure and rapidly changing conditions and technologies *(see Annex 3 - Case A3.12 - for the detailed case)*.

Together, the two cases of the Barcelona Fab Lab and Ukraine's military industrial ecosystems demonstrate the value of diffuse, adaptive systems in bolstering industrial resilience, particularly in response to crises. They also indicate that the effectiveness of these alternative production systems is reliant on a supportive innovation policy and co-creative spaces for engagement of diverse actors.

5.4 Rapid developments in digital infrastructure as a boost to industrial resilience

Digitalisation holds significant promise and challenges for industrial transformation, capable of multiplying and accelerating both desirable and less desirable trajectories. While reflected in CID through focus on technological advances such as smart grids, digital twins, automation, and digitalisation also has a crucial impact from the perspective of power relations, value distribution, and whole-system reconfiguration.

Digitalisation can indeed foster material efficiency, transparency, and cross-sectoral integration. It streamlines production processes, reduces material waste, and enables a circular economy while addressing workforce challenges in ageing EU member states. However, these efficiency gains should not be treated in isolation and should not be taken for granted as elements of broader path-dependency.

Digitalisation could also enable alternative modes of production and use based on sufficiency, repair, and localised manufacturing that go beyond optimising throughput. This is evidenced across the three cases highlighted above (Norway, Spain, and Ukraine), where digital innovations have been employed to facilitate localised, adaptive supply chains.

Digitalisation also comes with socio-economic challenges for industrial transformation, including issues such as job displacement, growing material demand, geopolitical dependencies, cybersecurity, and democratic control. Labour market disruptions particularly affect routine and low-skilled work, but equally critical is how algorithmic management reshapes all work. While optimising industrial energy use, the expanding digital infrastructure creates a parallel metabolism that could offset decarbonization gains and undermine climate and social priorities, and more broadly unsettle desired directionalities of change.

These concerns also regard a broader production and distribution of value from digitally mediated and reshaped processes. Further mainstreaming of algorithmic governance and management in industrial transformation choices will have an impact on who, how, and for whose benefit decisions are made, and it is important to reflect on the implications this has for the future of Europe's industry, people, and nature.

5.5 Crises as a catalyst for systemic resilience

In conceptualising industrial resilience, policy rightly considers crises as shocks to be faced. However, crises can also be harnessed as an opportunity to restructure and build more robust industries. This perspective is particularly useful in the current state of so-called global polycrisis, where multiple crises, including geopolitical conflicts, climate change, and economic instability, are linking together to produce devastating socio-economic and environmental impacts (Lawrence et al., 2024).

On one hand, when crises become entangled, their interactions create dynamics that, among others, overwhelm institutional capacity, drain resources, polarise societies, and shorten political time horizons. Such feedbacks erode the very conditions required to use crises as opportunities for resilience. On the other hand, crises present 'system change potential', that is, opportunities that can be leveraged for systemic resilience (Migdal, 1988).

Crises often disrupt existing systems, institutions, and path dependencies. That disruption can produce windows for rapid policy change, political willingness to break from business-as-usual, increased public attention, and opportunities for innovation and coordination. In other words, while not easy, there are conditions under which crises could generate systemic resilience. This was already evident in the cases of resilience in Norway, Spain and Ukraine.

Across several cases of how major shocks which have previously occurred elsewhere and to which Europe is now vulnerable have been harnessed for long-term systemic resilience. We highlight the responses of actors in Japan and Thailand to geopolitically motivated supply chain and environmental shocks, respectively. The 2010 rare earth crisis provides a compelling illustration of how a geopolitical supply shock can catalyse industrial transformation, policy-led diversification, and innovation (see Case 5.4).

Case 5.4: Resilience amid geopolitical shocks: The resilience of Japan's electronics industry in the rare earth crisis (2010)

Following an incident involving the arrest of the captain of a Chinese fishing trawler that sailed near the Senkaku/Diaoyu Islands administered by Japan, reflecting long-term structural tensions, China allegedly slowed or suspended rare earth exports to the country, targeting materials essential for high-tech industries such as magnets, electric vehicles, and renewable energy technologies.

The crisis revealed the systemic risks of concentrated supply chains and prompted coordinated action by Japanese industry and government to strengthen strategic autonomy and long-term supply chain resilience. Before the crisis, Japanese policymakers and firms had begun to proactively restructure the rare earth sector to mitigate potential supply disruptions. Such actions included enhanced resource diplomacy and strategic use of Official Development Assistance (ODA) to support overseas resource development and mutual investment, recycling and stockpiling of rare metals, exploration of seabed resources, fostering of innovation to lower material intensity and a substitution of rare earth elements in industrial applications. These measures aimed to diversify supply sources and reduce dependency on rare materials and single suppliers of these materials.

During and after the crisis, the government, industrial users, in collaboration with research institutes and universities, accelerated these efforts. The result was a dramatic, permanent reduction in rare earth demand: from 2010 to 2013, overall consumption fell by roughly 60%. This mitigated immediate supply risks and increased the economy's flexibility and adaptive capacity for future shocks. The 2010 rare-earth embargo illustrates how proactive and concerted efforts to systemically address a geopolitical crisis can collectively transform a highly vulnerable supply chain into a more resilient system. These internal efforts, however, remain vulnerable to broader challenges of a highly competitive international electronics industry, and should be equated to overall industrial resilience and success in international positioning *(see Annex 3 - Case A3.13 - for the detailed case)*.

Through a combination of proactive and collaborative efforts, both domestically and internationally, the Japanese government was able to bounce back from the crisis. This case illustrates that resilience should not be limited to short-term efforts to bounce back, but also to long-term efforts. A similar strategy is seen in the case of Thailand following a major environmental shock on the firm level. In the event of crises, critical nodes can be the source of high vulnerability but can also be the source of resilience. In Thailand, firms that had diversified their procurement were able to recover faster than those with high exposure.

Case 5.5: Building industrial resilience to environmental shocks: Insights from the 2011 flood disaster in Thailand (2011)

In 2011, Thailand experienced severe flooding, inundating seven industrial estates in the low-lying provinces of Ayutthaya and Pathum Thani, and causing large manufacturing production losses. The inundated estates included a total of 804 companies, predominated by the automotive and electronics industries.

Nissan recovered more quickly (29 days) than other auto companies in part because of its pre-disaster structure. The firm had diversified supply sources, globalised procurement, and maintained higher inventories. In contrast, Toyota lost almost the same amount of operating profit as Honda, even though Toyota's three assembly plants were dry while Honda's were flooded. The automobile sector suffered these enormous losses primarily because one company, which produces critical components, such as power integrated circuits and transistors, was inundated. This experience underscored that supply chain characteristics, for example, the dependence on critical nodes, inventory management, and supplier networks, determine the capacity for rapid recovery and adaptive resilience. Overall, firms with extensive networks of suppliers had a quicker recovery.

The experience with the 2011 floods in Thailand showed that while complex supply chains are a source of increased risks, they nevertheless provide a network of trading partners and economic gains that can facilitate recovery. Additionally, the Thai government created the National Catastrophe Insurance Fund (NCIF) and the Catastrophe Insurance Policy (CIP) in 2012 to ensure that industrial firms could insure against flood losses, an element that had been inadequately covered before the disaster. This case underscores the importance of such industrial policies that lower systemic risk in key sectors such as automotive and electronics *(see Annex 3 - Case A3.14 - for the detailed case)*.

Concluding remarks

Industrial resilience in the current state of overlapping crises necessitates a broader policy approach. Resilient industries will likely be those that are able not only to withstand shocks and bounce back to conditions similar to pre-shock levels, but those that are able also to bounce forward to emerging niche opportunities. As demonstrated by the cases showcased in this chapter, this requires foresighted policies, an openness to the transformation of uncompetitive and/or unsustainable production structures, the adoption or experimentation with alternative production systems, a harnessing of digital developments, and learning from crises. A cross-cutting theme is to look beyond sector-specific to broader systemic responses to risks and shocks.

6. Discussion and conclusion

European industries are navigating an exceptionally challenging moment. Economic pressures and geopolitical tensions are mounting, the need to rapidly decarbonise is growing more urgent, and the broader challenge of keeping industrial production within planetary boundaries is looming in the background. The Clean Industrial Deal (CID) is an important attempt to respond to these pressures.

The CID has been the starting point of our assessment, which we analysed using the transformative change framework developed earlier in this task (see Annex 2). This framework distinguishes six lenses through which transformative change can be conceptualised: the socio-political, socio-economic, socio-cultural, socio-technical, socio-ecological, and socio-personal. Together, these lenses offer a broad analytical scope that draws on multiple fields within the social sciences and enables a more systematic and consistent evaluation of transformation efforts within policy initiatives (see Annex 1).

Our assessment shows that the CID marks a significant and welcome step forward. Our transformative change framework complements the techno-economic orientation of the CID to include further perspectives that could help pursue a broad systemic strategy for industrial transformation as set out in the introduction of this document. During an expert workshop (see Annex 3), the assessment of the CID was presented, and together with the workshop participants, three potential enablers of transformative change were selected that can offer additional insights for policy assessments. They open new avenues for exploration, both within the CID and in other arenas of European policy.

Taking culture and people seriously (Chapter 3)

We showed that local cultures, values and people matter profoundly for any transformative agenda. Positive cases, such as the Friesians' local interpretation of the circular economy and Singapore's early negotiated adoption of cultivated meat, illustrate that aligning innovation with local narratives and cultures makes change more socially and politically feasible. This shows the importance of engaging with the symbols, emotions and stories through which societies make sense of change.

At the same time, our cases also show that local resistance is not a failure but a predictable part of transformation. Cases such as Austria's long-term social-partner engagement or Finland's social dialogue around mining demonstrate how trust-building and negotiation can mediate difficult yet inevitable trade-offs. The Dutch data-centre example illustrates how negotiation and taking time to reflect on what matters for society can be crucial to finding ways forward.

Navigating phase-out and the art of letting go (Chapter 4)

Transformative change inevitably involves creative destruction. There are no examples of historical transitions where destabilisation and phase-out have not been part of the process. Making this explicit helps policymakers navigate the social and political complexities that go along with this inevitability. Our cases illustrate, on one hand, the importance of proactive strategies: from the need for phase-out policies in the green steel transition, breaking structural lock-ins in the Canadian car industry, or the potential of small yet symbolically meaningful steps like Ireland's gradual ban on single-use plastics.

However, phase-out does not always require proactive sunset policies. Sometimes it is enough to avoid reinforcing structural lock-ins and allow natural phase-out dynamics to unfold. The Genk and Austrian cases show the importance of recognising when to "let go" and instead provide the palliative support needed for a just transition and to rebuild on what has once been a key part of the local identity.

Multi-dimensional resilience (Chapter 5)

We examined how a more multi-dimensional understanding of resilience can broaden industrial policy options. The Norwegian maritime sector demonstrates that resilience can emerge not only through 'robustness' and fortifying existing positions but through structural reforms that allow industries to adapt to new realities and cascading risks. Similarly, the Barcelona FabLab and Ukraine's wartime industrial response highlight the potential of distributed production systems. These models can complement and, in some contexts, outperform traditional centralised manufacturing and potentially provide a more radical niche that can help navigate Europe's uncertain industrial futures.

Finally, cases from Japan and Thailand show how crises can become sources of systemic renewal, enabling industries not just to "bounce back" but to bounce forward into more sustainable, competitive structures of production and consumption. For policy, this suggests the importance of creating institutional conditions that allow crises to be leveraged as windows of opportunity. For policy, this means supporting radical niches long before a crisis - helping them survive, mature, and remain available as alternatives - and once a crisis hits, being ready to rapidly redirect investment and steer industries toward more sustainable and future-proof pathways. This demands strong foresight capacities in all layers of government.

Interrelationships across the enablers of transformative change

These three perspectives address areas which are linked to each other and to the technical and economic issues of the CID. The issue of managing phase-out involves planning for a change not only in specific industrial technology but also in entire sectors. This will impact the employment and, therefore, the social conditions in the places that are affected. The phase-out of a technology will need to be accompanied by measures to develop the new skills and investment opportunities that new clean technologies offer. At the same time, the culture of 'traditional' industries determines the skill sets available in the population and the acceptance of new industrial/economic activities. New activities will require the training of the local workforce, who may otherwise face long-term unemployment.

These impacts are part of the considerations of social and industrial resilience. If they are successfully managed, the planning of change can enable the industry to develop and adopt new (clean) technologies and develop a capacity for innovation in response to new social/policy and market drivers that can also address challenges in the future. If such a social and economic structure is developed that fosters industrial change, the competitiveness of the region is supported, and the resilience under change is increased.

Concluding reflections

This report is not a comprehensive assessment of the CID, nor is it a full exploration of all dimensions of industrial policy. It is best understood as an exploratory exercise: applying analytical lenses from a broad range of academic literature to identify under-acknowledged enablers of transformative change and illustrating these with practical cases. As such, this report does not offer a prescriptive policy blueprint. Instead, each chapter inspires alternative policy pathways that can be explored, deepened, or strengthened. The cases provide examples with evidence from both inside and outside Europe that a broader transformative agenda is feasible, while responding to the pressures of global competitiveness and social change. The strength of this approach lies in its ability to widen the conversation and surface alternative pathways grounded in real-world experiences. Its limitation is that it remains selective, which is a direct trade-off of the broad scope that was chosen and the limited set of cases that were possible to explore in-depth.

We hope that this report contributes to a broader and more transformative approach to industrial policymaking in Europe. Most importantly, it invites policymakers, stakeholders and analysts to actively use these broader lenses when discussing, designing and implementing industrial policy. Our key message is that, through the application of a broad range of approaches to industrial transformation, structural change can be managed in such a way as to accept the decline of some markets and technologies and use the EU's knowledge and capabilities to create new, sustainable industrial structures.

However, for this to happen, transformation requires more than new technologies and economic instruments; it requires, to start, also attention to people, cultures, resilience strategies, and the political realities of phase-out. But above all, it requires a deeper understanding of what transformative change can entail. The polycrisis facing EU industry demands that all creative ideas and potential transition pathways remain part of the conversation, rather than being ruled out prematurely or not even being considered in the first place.

While several of the reflections and policy implications speak directly to the CID, many extend beyond its remit and relate to wider EU policy domains, including the Industrial 5.0 strategy, smart specialisation, and research and innovation policy. This focus is partly the logical outcome of the CID's deliberately narrow scope, centred on key manufacturing sectors such as steel, cement, chemicals and core industrial activities like automotive. Yet there is a more fundamental issue at stake. As we already argued in the introduction to this report, a genuinely transformative approach requires a broader understanding of what industry is, how it interacts with and is shaped by wider societal dynamics. The key contribution of this report is that extending the perspective of industrial policy for sustainability and competitiveness can be done systematically and consistently, and offers significant potential to inform industrial policy, in particular the CID, by identifying complementary policy and social measures.

The analysis presented in this report does not fully explore the breadth of the transformative change framework. While the implications of three key enablers have been analysed, further potential enablers of transformative change have been identified that could also generate new insights. These are:

- Clarifying the role of government in enabling systemic change: expanding the role of government beyond regulation and market stimulation to include visioning, convening, and orchestrating systemic change
- Creating space for alternative perspectives and long-term visions: Creating space for alternative perspectives and long-term visions, and creating protected spaces for experimental initiatives
- Harnessing cross-cutting, emergent and disruptive impacts of digitalisation: develop a more anticipatory, responsive, and agile approach within CID and future industrial policy to adapt to the disruptive and rapid impacts of some digital technologies, and new degrees of interdependence among multiple domains it creates. This includes exploring linkages between industrial change, reconfiguration of labour markets, and change in collective identities influenced by digitalisation and AI.

Further analysis could extend the use of the socio-political, socio-economic, socio-cultural, socio-technical, socio-ecological, and socio-personal lenses to other areas of industrial and competitiveness policy, e.g. transport, energy or agriculture. The approach of assessing enablers of change to generate policy insights could include the additional enablers mentioned here, which might have a higher priority in other policy contexts.

7. List of abbreviations

Abbreviation	Name	Reference
AI	Artificial Intelligence	
CID	Clean Industrial Deal	http://data.europa.eu/eli/reco/2025/1307/oj
EU	European Union	https://european-union.europa.eu/index_en
EEA	European Environment Agency	www.eea.europa.eu

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Annexes

Annex 1. Adaptation of the framework to industrial transformation

Each analytical lens was examined using the same set of guiding questions. This ensured consistency across perspectives while allowing each lens to surface distinct dynamics of industrial transformation. The following questions have been used for the analysis. The analysis was first conducted by individual researchers and then discussed with the team over several iterations.

The adaptation of the lenses to the context of industrial transformation also led to initial discussion around the potential enablers. The following common approach was used for the analysis.

Table 6 Guiding questions for examining the analytical lenses

Aspect	Details
1. Why does this lens matter for industrial transformation?	Clarifies what becomes visible through this lens and why it is necessary for understanding transformative industrial change beyond technical or sectoral approaches.
2. Approach to industrial transformations	Describes how the lens frames the industrial transformation conceptually, including its assumptions about what "industry" is and how transformation should be understood
3. Understanding of change (how change happens)	Explains the mechanisms, dynamics and pathways through which transformation is expected to occur from the perspective of the lens
4. Means to navigate and steer	Identifies the main strategies, instruments or practices the lens highlights for actively shaping and guiding industrial transformation processes
5. Guiding questions for discourse analysis	Outlines how the lens can be used to inform the analysis of policy documents on industrial transformation
6. References	Main references for the analytical application of the lens in the context of industrial transformation.

Source: Own elaboration

The summary of the analysis conducted for each of the lenses is presented below.

A1.1 Socio-political lens

Why does this lens matter for industrial transformation?

This lens shows that industrial transformations are inherently Political processes shaped by power, legitimacy, contestation and institutional arrangements. It reveals how political systems, participation, geopolitical shifts and power asymmetries determine what futures are considered feasible, desirable and legitimate.

Approach to industrial transformations

Industrial transformations are approached as outcomes of political and policy processes embedded in broader political economies, including party politics, governance structures, state–industry relations and social movements. Transformation is understood as a struggle over authority, resources and the distribution of costs and benefits.

Understanding of change (how change happens)

Change unfolds through democratic participation, political contestation and policy-making shaped by political cycles, institutional arrangements and geopolitical shocks. Political commitment can enable ambitious agendas, but polarisation, regulatory capture and misalignment across governance levels can inhibit transformation.

Means to navigate and steer

Steering requires attention to timing, context and power relations. Political shocks can be windows of opportunity for reframing industrial transformation but may also entrench incumbency. Participatory processes, multi-level governance alignment and mobilisation of social movements can enable more legitimate and transformative trajectories, while vigilance is needed against opportunism and manipulation.

Inputs for discourse analysis

The lens into questions of authority in industrial policy debates, how participation is framed and enacted, which interests are marginalized, how justice and distribution are addressed, and how political narratives legitimise or constrain alternative industrial futures.

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A1.2 Socio-economic lens

Why does this lens matter for industrial transformation?

This lens shifts attention from competitiveness and growth alone to the underlying economic logic shaping industries, including provisioning systems, societal metabolism and institutional arrangements. It highlights long-term prosperity, resilience and wellbeing rather than short-term efficiency.

Approach to industrial transformations

Industrial transformations are conceptualised as fundamental shifts in the real economy: changes in material and energy flows, production processes, organisational forms, and institutional and governance structures. This contrasts with conventional industrial economics focused on technological cycles and market competition.

Understanding of change (how change happens)

Change occurs through the build-up and reconfiguration of process funds (infrastructure, labour, capital, land), shifts in growth mechanisms under biophysical constraints, institutional change, and scientific and organisational innovation. Governance decisions and social contracts are central drivers.

Means to navigate and steer

Steering involves reshaping institutional frameworks, investing in provisioning systems and infrastructures, reducing uncertainty, supporting reflexive knowledge generation, and recognising the state’s role in enabling sustainable competitiveness through public goods and common pool resources.

Inputs for discourse analysis

The lens examines how economic models are framed, how trade-offs between growth, wellbeing and resilience are articulated, how provisioning systems are addressed in industrial policy, and whether alternative economic logics (sufficiency, foundational economy, long-term value creation) are visible.

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A1.3 Socio-cultural lens

Why does this lens matter for industrial transformation?

This lens reveals how cultural narratives, identities and imaginaries shape what industrial futures are imaginable, acceptable or resisted. It exposes cultural barriers and deep leverage points such as values, norms and identities that strongly influence transformation outcomes.

Approach to industrial transformations

Industrial transformations are embedded in socio-cultural change processes where meanings, practices and identities are reconfigured. Policies and strategies are not only implemented but performed, communicated and experienced through cultural and symbolic systems.

Understanding of change (how change happens)

Change happens through narrative framing, meaning-making and cultural performance. Compelling imaginaries can connect actors across scales, while cultural attachment to incumbent industries can block transformation. Cultural industries, media and art play a key role in shaping perception and imagination.

Means to navigate and steer

Steering includes developing culturally resonant narratives, using creative foresight, art-based research and cultural intermediation, and deploying media and artistic practices to foster reflection, counter manipulation and reimagine industrial futures.

Inputs for discourse analysis

The lens asks which imaginaries dominate industrial debates, how identities and heritage are mobilised, how culture enables or constrains acceptance of change, and how symbolic practices perform specific industrial futures.

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A1.4 Socio-technical lens

Why does this lens matter for industrial transformation?

This lens matters because it broadens industrial transformation from production capacity to whole systems of production and consumption, highlighting the risks of lock-in and mere optimisation when strategies focus narrowly on technologies or output. It uniquely foregrounds exnovation and phase-out policies, demand-side market creation, place-based strategies, and the agency of workers, unions, users and citizens in shaping transformative pathways.

Approach to industrial transformations

Industrial transformations are conceptualised as fundamental changes in socio-technical systems (e.g. mobility instead of cars, housing instead of concrete, food instead of fertiliser). Industrial strategy is therefore not confined to supply-side innovation but includes services, practices, infrastructures and lifestyles that redefine what industrial capacity is needed.

Understanding of change (how change happens)

Transformations occur through the co-evolution of technologies, actors and institutions. Users shape how innovations are adopted; governments influence pathways through both supply-push and demand-pull policies; workers and unions act as internal innovators and drivers of change. Change is inherently plural and place-based, consisting of many context-specific transitions rather than a single linear process.

Means to navigate and steer

Steering relies on strategic niche management, combining technological and social innovation, and on deliberate regime destabilisation and phase-out of unsustainable industries and practices. Demand creation tools (public procurement, regulation, labelling, pricing), narrative building, and spaces for worker-led experimentation are central, alongside exnovation policies that "let losers go" to enable transformative alternatives.

Inputs for discourse analysis

The lens directs attention to whether industrial policies explicitly address phase-out and exnovation, how demand-side measures are framed, how regional and place-based dimensions are acknowledged, and how workers, unions and civil society are positioned—as barriers, recipients or agents of transformation.

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A1.5 Socio-ecological lens

Why does this lens matter for industrial transformation?

This lens grounds industrial transformation in material reality, emphasising ecological limits, planetary boundaries and the instability of socio-ecological systems. It defines a clear operating space for industrial activity and highlights resilience and adaptation as central concerns.

Approach to industrial transformations

Industrial transformations are conceptualised as changes in how industrial processes interact with nature, encompassing material flows, ecological feedbacks and human–nature relations. The lens distinguishes between shallow ecological responses and deeper relational transformations.

Understanding of change (how change happens)

Change occurs through co-evolution of social systems and ecological constraints, often triggered by crises. Responses range from efficiency and substitution to hard limits and deeper value shifts that redefine societal relationships with nature.

Means to navigate and steer

Steering involves operationalising planetary boundaries into concrete constraints, building resilient and adaptive industrial systems, and supporting deeper cultural and ethical shifts in human–nature relations, including regenerative and symbiotic practices.

Inputs for discourse analysis

The lens examines whether ecological limits are acknowledged and operationalised, how resilience is framed, and how industrial policies conceptualise the relationship between society and nature.

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A1.6 Socio-personal lens

Why does this lens matter for industrial transformation?

This lens matters because industrial transformation ultimately unfolds through human decisions and actions. It brings a unique perspective by foregrounding personal agency, emotions, values and identities as core drivers of change and inertia. It highlights that transformation is not only technological, economic or political, but also deeply personal, affecting how individuals understand themselves, their work and their relationship to the world.

Approach to industrial transformations

A socio-personal perspective conceptualises industrial transformations as deeply human processes. Industrial systems change because individuals decide, act, feel and make sense of change in particular ways. This lens focuses on how individuals' experiences, emotions, behaviours and identities shape—and are shaped by—industrial change. Understanding industrial transformation therefore requires taking these personal dimensions seriously, rather than treating them as secondary or residual effects.

Understanding of change (how change happens)

Industrial change is shaped by the choices and actions of individuals across roles and positions. People actively adapt, revise habits and pursue new visions. A key factor is self-efficacy—the belief in one's ability to influence outcomes—which drives proactive behaviour, entrepreneurial confidence and willingness to engage with change. How individuals frame change matters: growth-oriented mindsets foster openness, while rigid mindsets can lead to resistance.

Emotions and reason are deeply intertwined. Transitions evoke strong emotional responses such as fear, anxiety, hope and excitement, which significantly influence behaviour and decision-making. Paying attention to emotions enables more effective policy and organisational responses. Supporting emotional adaptation—through reflection, dialogue and spaces for meaningful conversation—helps individuals process change and build resilience.

Change happens through how individuals redefine who they are. As transformations unfold, people renegotiate personal and professional identities based on whether emerging roles and futures align with their values (e.g. a coal miner becoming a wind turbine technician). Identity work is therefore central to embracing or resisting change. Posthuman perspectives extend this further by challenging fixed human–nature boundaries and highlighting interdependence and relationality.

Means to navigate and steer

Steering industrial transformation from a socio-personal perspective involves promoting leadership, proactive decision-making and self-efficacy from boardrooms to factory floors. It requires explicit attention to emotional dimensions of change, creating spaces for reflection, discussion and sense-making. It also involves challenging traditional human-centred identities and supporting more relational, posthuman perspectives that recognise interdependencies with the natural world.

Inputs for discourse analysis

The lens directs attention to how EU policy discourse represents individual agency and motivation: whether people are framed as passive recipients or active shapers of transformation, and whether policies aim to strengthen self-efficacy among workers, managers, entrepreneurs and policymakers. It asks whether emotional dimensions—such as fear, anxiety or hope—are acknowledged and addressed. It also examines how policies enable identity transformation beyond skills and competencies, including alignment with values, purpose and posthuman perspectives emphasising interdependence with nature and technology.

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Annex 2. Discourse analysis of the Clean Industrial Deal

CID articulates a clear and ambitious agenda for industrial decarbonisation, innovation, and sustainable competitiveness. It introduces many potential enablers for industrial transformation, including mission-oriented government, stressing the importance of energy security and decarbonisation, engaging with workers for just transitions, and promoting clean transition dialogues that could foster a whole-of-society approach. While these are promising developments, the strategy remains largely rooted in a techno-economic framing, which may constrain its capacity to catalyse more systemic and inclusive change. Such systemic change is crucial to realising the long-term vision of 'living well within the limits of our planet', as set out in the 8th Environment Action Programme to 2030.

Here we present the conducted analysis. The individual analyses feature some structure variations, which were resolved through subsequent discussions, and the results were synthesised in a consolidated manner in representation of relevant enablers and risks. These were further synthesised into a common list of enablers from across different perspectives.

A2.1 Socio-political lens

The socio-political analysis revealed a need to more directly engage with the political dimension of industrial transformation, addressing power, governance, and institutional arrangements at multiple levels. It underscored the importance of local deliberative models—such as citizen assemblies, participatory councils, and civil society forums—that broaden democratic ownership of transitions. It also highlighted gaps in exploring alternative ownership and governance approaches, including shareholder reform, community ownership, and state-led industries, which remain underdeveloped across this and other perspectives.

This analysis explores the Clean Industrial Deal (CID) through a socio-political lens, guided by four questions derived from the original scan for the socio-political perspective on industrial transformation. We first provide an overview of key insights along with the questions, followed by a reflection on how CID addresses enablers and risks from a socio-political perspective and broader reflections.

How does CID address issues of power dynamics and inequalities?

The CID aims to "level the playing field" for clean technologies and industries through public procurement, direct EU funding, and the incentivization of private investment in clean sectors:

"Public procurement policies are a powerful instrument to help overcome barriers to market entry." (p.7)

"The EU needs to increase its annual investments." (p.9)

"Mobilising and leveraging private capital is key." (p.10)

Furthermore, the CID aims for a socially just transition, focusing on supporting workers affected by change, harnessing talent, and enabling quality and fair jobs:

"Ensuring fair job transitions for workers." (p.20)

"Social leasing for clean products to ensure that all Europeans benefit from the clean transition." (p.21)

Affordability and availability within CID are primarily constructed from the perspective of the industry players; however, it also aspires to protect the citizens "against excessive power, including in the digital realm", "ensuring that new players operate fairly and do not concentrate economic and strategic power unduly". The CID also highlights the need to avoid "compromising the high environmental and social standards our society demands", however, without detailing any more ambitious stances that would exceed already established standpoints.

The CID does not provide any in-depth elaboration on power dynamics or underlying inequalities. It also does not differentiate and regional or other disparities in terms of the impacts of transformation. One of the strongest emphases within the deal is on empowering the industry "to exercise bottom-up leadership" (p. 23).

How does CID use socio-political arguments to legitimise transformations?

The CID legitimises its transformational agenda by emphasising urgency, existential threat, and inevitability, invoking a "triple crisis" and coupling issues of competitiveness, security, and decarbonization.

"It is clear that a competitiveness and decarbonization strategy is also a security imperative." (p.1)

"The EU must urgently address three challenges at once: a climate crisis and its consequences, competitiveness concerns, and economic resilience." (p.1)

How are insiders and outsiders constructed in the CID?

The CID constructs insiders as EU member states and industry actors needed for their transformation aims. Outsiders are non-EU states and global competitors who may act in ways that threaten EU industries:

"We aim to increase sustainable and resilient production in Europe." (p.1)

"Unfair global competition." (p.1)

"Fast and efficient use of Trade Defence Instruments (TDIs)." (p.19)

At the same time, the CID acknowledges that international partnerships are necessary for its success:

"The EU cannot realise its clean industrialisation objectives without partnerships on the global stage." (p.16)

This duality of international agents as both threats and necessary collaborators reflects a tension between economic protectionism and global interdependence. It, however, also signals the remaining strong dependencies that the EU tried to disentangle while limiting the economic impacts of those changes.

4. **How does CID use participatory processes to fulfil its aims?**

The CID emphasises participation, primarily of market actors, member states, and consumers:

"Keeping workers and local communities at the centre of the industrial transformation, harnessing talents and further building up needed skills is essential for a successful clean transition" (p. 19)

“Social leasing for clean products to ensure that all Europeans benefit from the clean transition.” (p.21)

“Give Member States an incentive to allocate more national resources.” (p.10)

“Creation of Public-Private Partnerships.” (p.11)

CID contrasts previous “siloed” approaches and aims to enable collaborations along the value chain. The focus lies primarily on cooperation with the private sector, while grassroots movements, labour unions, and other bottom-up perspectives are limited.

CID also puts significant focus on “creating opportunities that inspire and engage the next generation”, framed as primarily means towards the ends. It also highlights the need to “engage in dialogue with local authorities and stakeholders”, which is yet to be seen in terms of how this is implemented.

Enablers

The CID features a very limited mobilisation of enablers identified in the scan. However, it was possible to identify other ways socio-political considerations are addressed, including the potential to prioritise economic and security concerns, and the uptake of the emergency and urgency rhetoric as legitimation tools. The CID seeks to harness the socio-political momentum while preserving the commitment to a just transition that benefits everyone. It also highlights the involvement of various levels of governance, aiming to make access to EU funding easier for member states and industry actors; however, this participatory element is rather selective and constrained.

Risks

The CID directly tackles the risk of fragmentation by encouraging involvement at the level of regions and acknowledging the geopolitical momentum; however, it does not elaborate in detail on issues regarding established power structures, elite dominance, or institutional inertia. Its pursuit of simplification, while promising, may create new risks about accountability and transparency of intended transformations. The framing of transformation also suggests risks of depoliticisation and undermining alternative perspectives on industrial change.

Conclusion

The CID is positioned as a confident strategic response to geopolitical turbulence and uncertainty about EU dependence on other actors, addressing some already well-known challenges, such as the energy crisis triggered by Russia's war on Ukraine, increasing confrontation with China, as well as a weakening of ties with the US.

The CID, therefore, marks at least a partial rhetorical shift toward a more protectionist, industry-focused narrative that pertains to alignment with the climate targets, digitalisation, and just transition; however, it features weaker linkages to previous EDG priorities such as biodiversity, water, and other environmental aspects. It also limits engagement with the just transitions to the issues of jobs, skills, and talent, glossing over broader issues of equality and power dynamics. It makes a case for the inclusion of actors from regional and national levels; however, it does not elaborate on this in detail.

The CID acknowledges preserves commitments to a just transition; however, it does is without addressing underlying power asymmetries, societal inequalities, or unequal distribution of benefits and burdens of

industrial transformation. The CID foregrounds the significance of incumbent and large industrial actors, and approaches bottom-up and place-based processes in a more ad hoc manner. CID also utilises emergency rhetoric of triple crisis – climate, competitiveness, and geopolitics – to legitimise its scope and ambition, emphasising the urgency to act.

The CID constructs protectionist stances as a response to geopolitical polarisation, alongside ambitions for preserving international cooperation and securing supply chains. Participatory mechanisms are mostly aimed at supporting clean industries in remaining competitive, enabling member states to better finance the industrial transition, and helping consumers access "green" products. The CID does not aim to mobilise wider public engagement or diversity of perspectives as potential inputs to framing the industrial transformation as such.

A2.2 Socio-economic lens

The socio-economic analysis pointed to limitations in starting from a conventional industrial-economic logic, which risks narrowing how transformative change is envisioned. It emphasised the importance of reconfiguring the fundamental economic models shaping industry, moving beyond the global shareholder system geared toward extraction and short-term profit. Potential pathways identified include Rhineland-style capitalism, stronger state ownership and public sector engagement, community-centred cooperative economies, and post-growth sufficiency approaches. These variations offer a distinctive lens for policy assessment, enabling exploration of how alternative futures are being discussed, tested, and implemented. Following the structure of the socio-economic lens on transformations, the following 'unique perspectives' for the lens were identified:

- Changes in **societal metabolism** (energy and materials) between sectors and the environment
- **Institutional/governance structures change**
- **qualitative changes** in the production process and focus on organisational innovations, shift in market relations from commodities to services, e.g. energy prosumers
- **Qualitative dimension** of wellbeing, value creation and growth potential through economic processes

Assessment

It is important to **clarify understanding of what „clean industry" encompasses in the Clean Industrial Deal (CID)** and how other economic sectors may substantially contribute to a transformation. The CID mentions the following areas in terms of clean industry: Electrification, decarbonisation (coal and oil but not gas (taxonomy), climate-neutral investments in energy-intensive industries and clean tech and circular economy.

Changes in societal metabolism can be identified in the CID as a change in the energy system through decarbonisation and a change in materials through the circular economy. Plans for the Automotive, Steel and metals, Chemicals sectors, together with a **Sustainable Transport Investment Plan** for renewable and low-carbon fuels for aviation and waterborne transport, are being developed. A bioeconomy strategy and a European Ocean Pact are also in preparation.

Analysis of CID from a socio-economic perspective

Affordable energy:

The CID introduces several conventional but essential institutions to improve economic competitiveness, including Power-Purchase Agreements (PPAs) such as cross-border PPAs, Contracts for Difference (CfDs), and counter-guarantees to manufacturers of grid components. It also establishes the Clean Industrial Deal State Aid Framework, shorter depreciation periods, tax credits, and measures to scale down and phase out fossil fuel subsidies. Improving gas markets has a negative effect, as it encourages the adoption of a technology which only brings small decarbonisation benefits.

From a socio-economic perspective, the following qualitative changes and potential structural change measures are missing energy efficiency, decentralisation to reduce the need for new renewable energy infrastructure such as energy storage, transmission lines, and hydrogen pipelines, as well as to lower cement and steel demand and enable lightweight design to reduce energy use in transport. Other missing elements include the use of alternative materials and 3D printing processes to cut steel, cement, and energy demand, and a shift from output growth as a primary measure of success toward energy, emissions, and pollution efficiency as indicators of improved well-being.

Institutions and well-being

The CID introduces the following institutions: the Industrial Decarbonisation Accelerator Act, which will embed resilience and sustainability criteria to support a clean European supply for energy-intensive sectors; life cycle assessments for product standards; a regulatory framework to guide the energy system transition toward low-carbon hydrogen from electrolysers; and trade agreements for clean technologies. Missing elements include exnovation, as well as support for digitalisation and material-saving production processes through 3D printing, and for demand reduction by identifying major user sectors and fostering innovation to lower demand through alternative materials and greater energy efficiency.

Financing

The CID introduces the following economic measures: shorter depreciation periods and tax credits. Missing elements include government-supported loan guarantees for venture capital and clean technologies, as well as requirements for financial institutions to incorporate emissions, pollution, and material efficiency into investment criteria when determining required rates of return and payback periods.

Circularity and access to materials: how economic models shape industries

The CID introduces the following measures: the Circular Economy Act in 2026, the Ecodesign for Sustainable Product Regulation with a work plan to be adopted in April 2025, Trans-Regional Circularity Hubs, and the diversification of supplies across the entire value chain. Missing elements include actions in areas where critical resources and materials such as plastics, glass, and paper are not yet recycled, along with support for projects that establish separate collection and a recycling ecosystem, recognizing that households and industrial waste generators also play key roles. In addition, there is a lack of reference to alternatives to critical raw materials and investments or subsidies aimed at reducing the cost of geographically diversifying sources, as well as insufficient support for design for re-use and recycling of materials like plastics, carbon fibre, and graphene, and the development of circular economy infrastructure for identification, collection, and reworking.

Global markets and international partnerships: international trade in terms of material flows and stocks

Complementing Free Trade Agreements (FTAs), the CID also introduces a new institutional measure: Clean Trade and Investment Partnerships (CTIPs).

Possible measures in terms of qualitative structural change include exploring clean tech markets beyond the EU and the US, identifying potential new global low-carbon energy and energy value chain flows, and developing cooperation and trade measures to incentivise these new value chains. Additionally, making trade deals for clean technologies can help establish and strengthen global lead markets.

Skills

The CID includes a Quality Jobs Roadmap as a plan to support workers in transitions through a framework to support restructuring processes (i.e. including exnovation)

Horizontal enablers

The CID lists the following enablers: cutting red tape, fully exploiting the scale of the Single Market, including through gradual integration of candidate countries, boosting digitalisation, accelerating the deployment of innovation, promoting quality jobs and better coordinating policies at the EU and national level. Digitalisation is also mentioned in the context of reductions in waste. Of these, the only qualitative structural change is digitalisation.

In terms of the energy system, AI-driven smart grids and IoT-based energy monitoring are mentioned. Digitalisation of permitting procedures should make the processes more efficient. Digitalisation of waste reporting (producer responsibility), demolition permits and pre-demolition audits should be introduced. Competition policy will also be enacted for the digital 'realm', i.e. digital services.

A broader view of 'systems of provision' (Ben Fine), in e.g. food or transport, could suggest qualitative structural change beyond the intermediate products of the steel, metals, chemicals, and cement sectors. For example, transport decarbonisation can be assessed and promoted in terms of sustainable mobility rather than e-vehicles and e-fuels.

Potential new perspectives

There are a multitude of perspectives that could be addressed in addition to the CID. These include:

- Economic growth of digital services, equipment and business processes in the sectors and areas considered. There is no mention of how new intermediate goods and services sectors will arise from digitalisation.
- There is no mention of adaptation to climate change impacts and the possibilities for change in sector requirements and organisation arising from significant climate change (+2-3°C or more by 2050) and consequent change in ecosystems.
- Changes in the structure of demand as suggested by the other lenses: culture, ecology, technology, and personal.

Tensions between long-term and shorter-term drivers of growth, wellbeing and competitiveness

From the socio-economic lens, the main tensions arise from the disruption that system change will bring to current economic activity. The tensions arise from the need to maximise current economic performance

within the current business paradigm, while transformation will require a new business paradigm, new business models and new firms. Following Schumpeter, system change involves 'creative destruction'. In other words, current industries may decline and even disappear. In a context of such disruption to current economic structures, businesses will need to recognise that their products may no longer be required, or that the business must fundamentally change its business model to survive, e.g. IBM, which changed from computer manufacture to software services in the 1980s.

There is no recognition in the CID of the design changes in goods that are necessary for an effective implementation of mass reuse as well as recycling. The design af all products for recycling or reuse needs a strong policy intervention to regulate, for e.g. modular design, simple or automated dismantling, rather than, e.g. crushing of used cars, dismantling of moulded plastic goods, etc.

The ideas of the Industry 5.0 report have several ideas for a qualitative system and organisational change in economies. The vision is: "Industry 5.0 means first and foremost a decisive move away from neo-liberal capitalism models with a focus on production for profit and 'shareholder primacy', towards a more balanced view of value over time and a multi-valent understanding of capital – human and natural as well as financial."

This implies a fundamental restructuring of the culture and functioning of EU economies. In terms of qualitative structural changes viewed through a socio-economic lens, these include decentralisation as a key step across all industrial sectors, a shift in digitalisation from an "internet of things" to "digital for people-planet-prosperity," and changes in investment decision-making based on 'return on material assets' and material decoupling, 'return on invested energy,' and 'return on natural assets,' alongside a stronger valuation of human and natural capital. It also involves shifts in mindset, priorities, and the culture of decision-making in policy, finance, investment, and corporate governance, as well as the redesign of value chains. Missing elements include new ways of delivering goods and services and the creation of new value chains for new forms of value creation.

Enablers

- Recognise the **mandate of the state** for creating sustainable competitiveness in provisioning through network infrastructures / common pooled resources/services to enable system change.

- Measures to measure and manage energy and materials stocks and flows in industry. This will develop a better **understanding of key material flows** (carbon-flows, water, raw materials) and energetic flows. Then it will be possible to fund more targeted defossilisation strategies and policies for implementing circularity

- Growth of data flows and digitalisation (e.g. related to the societal metabolism) can **improve competitiveness. Data and AI** will be a **necessity for** more **complex industrial ecosystems**, rather than a mere bureaucratic burden

- Taking a broader view of goods and services through viewing industry as part of a system of provision to meet consumer demand for housing, food, heating and cooling, transport, leisure, etc.

- Changing the view of policy making to include institutional and governance changes as part of whole-system change

Risks

- An industrial strategy focused on short-term competitiveness runs the risk of undermining its own bio-physical basis, thus losing sight of long-term prosperity, productivity and resilience.

- The CID is backwards–looking with the emphasis on energy-intensive industries, which are being implemented as Steel, Chemicals and automotive. While the energy sector is on the path to a low-carbon sector by 2050, the traditional energy-intensive industries need more than just the electrification of the current processes.

- The CID has a limited view of digitalisation. Countries with a more open and innovative view of digitalisation, will gain a competitive advantage by developing new technologies and new goods and services to exploit pervasive computing and the internet of things

- There is insufficient recognition to redesign goods and services to support reuse and recycling in a comprehensive way implied by the concept of 'circular economy'. This brings the risk that the necessary qualitative change to making most goods completely reusable or able to be dismantled for reuse of components and subsystems, as well as recycling of materials, will not happen

A2.3 Socio-cultural lens

The socio-cultural analysis demonstrated the value of compelling narratives that position and perform the future, addressing cultural barriers and sector-specific stories—such as those emerging in the automotive industry—that influence both resistance to and engagement with transformation. The analysis explores the Clean Industrial Deal (CID) through a socio-cultural lens, guided by four questions derived from the original scan for the socio-cultural lens on industrial transformation. We provide an overview of key insights along with the questions, followed by a reflection on enablers and risks.

How does CID utilise visions, narratives, and rhetorical devices? What is the dramaturgy of industrial transformation?

CID presents a classic hero journey, with clear differentiation of partners and villains along this journey. It includes the threat (urgency, tensions, competition), the transformation plan, and the desired future enabled through rhetorical dramatisation of change as challenging, urgent, and hopeful.

"Clean Industrial Deal aims to open a new chapter of European industrial history defined by growth, resilience, and leadership" (p. 3)

The narrative invokes and combination of predictability, persistence, and strength, aiming to build a perception of confidence in transformation, reinforced through tropes of competitiveness and resilience. The CID also elevates the centrality of industry to addressing a broad set of challenges and aspirations.

How does CID engage collective engage with collective identities and cultural diversity, cultural preferences, and local legacies?

The promise of CID is rooted in framing industry as an element of collective identity, making, and positioning industrial transformation as a continuation of a long transition.

"Our continent has a rich industrial heritage. For decades, our industries have been at the forefront of technological progress. They fuelled economic growth and sustained our social model" (p. 1)

In this way, CID falls into convention as a means of legitimising its agenda (Stacey et al., 2025). This historical legacy, meanwhile, serves as a safeguard from attempts to question or undermine the agenda, representing the natural order and progression of things. This, however, also may allow for closing the space to alternative framings of industrial change.

"all at the same time and across the entire continent" (p. 1)

The narrative also presents a perspective on industrial transformation as universally inclusive,

"*Every person, community, and business should benefit from the clean transition." (p. 20)*

This includes establishing a European Fair Transition Observatory (p. 22). While the rationales and purposes of transformation are already determined, the CID also mentions the need to consider vulnerable groups and dialogue with local actors. The rhetoric of streamlining and simplification may both enable local participation but also could undermine processes that require careful attention to nuance and detail.

How does CID engage with the broader processes of socio-cultural change? Does it endorse a specific culture around industrial transformation?

CID features a rather limited outlook on broader socio-cultural change and tends to build on and reinforce existing cultural standpoints towards industry. The CID is broadly framed with the logic of growth and optimisation and does not seek to challenge that logic, with the exclusion of a stronger commitment to the circular economy that represents a shift from linear to a more circular outlook on society. Beyond references to second-hand, circularity remains positioned as a rather technical fix which resonates with the narrative of innovation-driven modernity, celebrating skill, talent, persistence and clean tech.

Enablers

The CID features a rather straightforward logic of drawing enablers from policy instruments and incentives, but it does not engage a broad socio-cultural narrative of shared legacy and common future. Its top-down framing provides some flexibility for local action, like through the mobilisation of local industries. This does not engage the diversity of local preconditions for industrial transformations or the diversity of the visions of what the future of the industry might be. While mechanisms for dialogues and participation are put in place, there are no highlights of the need for sensitive cultural heritage, local crafts, or learning from traditional practices. The collective capacities for participating in industrial transformation are framed with a focus on skills and jobs, without any references to creative approaches.

Risks

The CID, to a limited extent, engages with the risks identified in the socio-cultural lens scan, with the promotion of more sustainable and responsible production practices. The broader unproblematic framing of local uptake without mobilisation of values and identities may risk cultural backlash and resistance.

Conclusion

The CID provides a broad socio-cultural narrative arc, but it stays at this high level of abstraction, without going deeper into aspects that would signal strong sensitivity to the diversity of local cultures or approaches towards the future of the industry. There remain options for better embedding CID into various local cultural contexts and for exploring creative reinterpretations of industrial futures.

A2.4 Socio-technical lens

The socio-technical analysis highlighted the role of exnovation and phase-out policies, demand-side and market creation strategies, and more place-based industrial policies. It also noted the transformative potential of workers and unions as change agents, bridging socio-personal dynamics.

Discourse analysis of the Clean Industrial Deal: A socio-technical lens

Assessment

1. **Destabilisation and phase-out policies**

- The CID emphasises **decarbonisation** of industries (naming it in total of 61 times). It acknowledges that current **industries are facing existential challenges** and that a process of **reindustrialisation** is needed.

- **The main strategy for decarbonisation is, however, through innovation**. Both through the growth of new (clean-tech) industries and the electrification of existing (energy-intensive) industries. These are transition pathways of conversion and build-up, not phase-out.

- **Phase-out is mentioned once**, in relation to fossil fuel subsidies. This is part of the recommendation to member states to revise their corporate tax system.

- As part of the eco-design for sustainable product regulation, it is mentioned that it is **needed to *move away from* fossil fuel materials** through mandating new raw material sources like recycled or biobased materials. This can be considered a phase-out policy.

Demand-side instruments and actors

- The communication sets out to appeal to entrepreneurs, business owners, workers and consumers. **Workers are extensively addressed** (supporting skills development and supporting them in transitions). **Consumers are rarely mentioned** or elaborated upon.

- The **clean transition dialogues** are mentioned as an instrument for the active engagement of industry leaders, **social partners and civil society**. It lacks more in-depth discussion in this communication, but a direct reference is made to a communication about the Clean Transition Dialogues that discusses this in more detail.

- There is ample attention to **demand-side creation from governments**, both through public procurement and through setting standards and regulations. Demand-side creation from private parties, through incentives for **private purchases**, is also discussed

Regional and spatial dimension

- The CID invokes European identity and industrial heritage, but fails to contextualise this in the need for more local and place-based approaches. It mentions local communities, stakeholders and authorities sporadically, but does not go into any detail on how they should be engaged with and to what end.

Conclusions

Enablers

- **Potential destabilisation and phase-out policies**: there is little to work from, but potential enablers are the ecodesign for sustainable product regulation and the recommendation to member states to revise their corporate tax system and make a work of phasing out fossil fuel subsidies

- **The clean transition dialogues** could, if organised well, become a meaningful entry point to create a **whole-of-society approach** towards industrial transformations.

- **There is a real appetite for a more mission-oriented government** that takes a central role in creating and shaping new markets. We can build on that and enrich it through our assessment.

Risks

- **Ignoring both the necessity as well as the inevitability of phase-out** risks locks into unsustainable trajectories, high sunk costs and more chaotic and unjust transition pathways. More attention to this is vital.

- **Disregarding consumers and citizens as actors in industrial transitions** is like demanding that farmers become sustainable without discussing food and diets. It makes transitions more difficult (if not impossible) as it leaves out many opportunities for transformative change.

- **Place matters, as there is not one industrial transformation, but there will be hundreds, if not thousands, all over Europe**. Overlooking the regional and place-based characteristics also fails to connect with the longstanding European work on smart specialisation.

A2.5 Socio-ecological lens

The analysis applied elements of critical discourse analysis and framing analysis approaches to the Clean Industrial Deal (CID) to examine how nature-society relations are conceptualised within its vision for clean industrial transformation. Practically, the CID text was examined based on the earlier shared 'possible guiding questions' that a socio-ecological lens prompts. Below you will find the results of our assessment and conclusions.

The socio-ecological analysis outlined different orientations to resource use: environmental pragmatism, adapting to existing limits, ecological limitations and aspects of reimagining human–nature relationships.

Acknowledgement of ecological limits

- CID advances the need to lower carbon emissions for industry to remain competitive and become more sustainable, implicitly acknowledging ecological limits relating to CO2. However, the importance of grounding industry within broader planetary boundaries is not referenced, and no particular thresholds are mentioned
- The emphasis is placed on environmental protection within industrial activities.

Resilience in industrial transformation

- Resilience is defined in terms of robustness and flexibility to climate-related, economic (supply chain), and geopolitical disruptions. The CID is more silent on resilience to environmental risks not necessarily connected to climate change (e.g., biodiversity loss, ocean degradation).
- The core strategy for a resilient industry is through technological innovation, indicating a bias toward ecological modernisation.

Nature–society relationship

- The strategy maintains an instrumental and extractive framing of nature-society relations, reflecting a bias toward a shallow ecology approach for industrial transformation. The pathway to a clean industry is largely framed around efficiency improvements and pollution control.
- Deeper transformation of the nature-society relationship is unaddressed.
- However, the strategy advances some industrial practices, such as a circular and bioeconomy, that recognise the nature-society interdependence and suggest a hybridising shallow/deep ecological discourse.

Enablers

- The urgency to change the nature-society relationship is cautiously acknowledged, for instance, through moving toward circular economies. The driving logic remains predominantly competitiveness/growth driven, but opens up the possibility for more fundamental change, nonetheless.
- Industrial resilience is actively pursued, particularly in relation to climate-related disruptions and resource scarcity.
- Technological innovations in support of circular and regenerative production, and the support for technologically neutral policy designs, can be potentially useful for centring socio-ecological objectives.
- While there is no mention of planetary boundaries, international collaboration, including around circular economies, is sought, potentially contributing to broader global environmental goals.

Risks

- Planetary boundaries and environmental risks that are not necessarily connected to climate change are overlooked, risking ecological overshoot even with proposed changes. It also risks externalising ecological harm abroad.
- Exclusion of alternative value systems entrenches anthropocentric and growth-oriented worldviews, potentially replicating contemporary environmental vulnerabilities.
- A shallow ecology bias risks delayed transformation. Similarly, the disconnect between the relatively short temporal horizon (ca 2050) considered in the strategy and long ecological temporalities could delay a deep transformation.

A2.5 Socio-personal lens

The socio-personal analysis underscored the critical role of individual and collective agency, calling for leadership development, proactive decision-making, and self-efficacy from boardrooms to factory floors. It stressed the importance of engaging with emotional and identity-based dimensions of change, creating spaces for reflection, dialogue, and targeted support to help workers transition into new roles, such as moving from coal mining to renewable energy careers.

Agency and motivation:

- The CID emphasises collective European agency, focusing on states, financiers, and businesses as key drivers of industrial transformation.

- Individuals are positioned mainly as passive beneficiaries, particularly through employment opportunities in emerging sectors and consumption gains (e.g., cheaper goods). The role of individual choices and everyday practices in shaping the transition is largely overlooked.

Emotions and mindsets:

- The policy implicitly recognises the emotional dimensions of industrial transformation. It addresses emotions such as anxiety and fear by adopting a hopeful tone and emphasising benefits such as innovation-driven job creation. Proposals for dialogue with social partners also suggest some recognition of emotional responses.

- All non-technoeconomic and environmental aspects appear to be tackled under 'just transition aspects', but are not specified, de-centring them from policy measures. A proposed European Fair Transition Observatory appears geared mainly toward labour issues.

Values and identity:

- The CID invokes European identity and industrial heritage, with a focus on skills development and labour market adaptation. However, it pays limited attention to personal values, local identities, or intraregional disparities. For instance, emotional ties to place – such as shifting identities in mining communities – are not addressed.

- The exception is sustainability, which is recognised as a core personal value and is considered in policy measures such as sustainability labels. This is, of course, aligned with the CID's bias toward technoeconomic and environmental concerns.

Conclusions

Enablers

- **Collective efficacy**: Framing the transition as a pan-European effort may foster intergovernmental cooperation and legitimacy, creating a starting point for deeper engagement with citizens.

- **Emphasis on skills and competencies**: The policy's labour focus is central to its social acceptability. However, reconceptualising workers not merely as recipients of new employment but as active agents in shaping industrial transformation could deepen engagement. For instance, through

recognising and taking into account the evolving understandings of work, shifting from wage-centred to meaningful employment.

- **Acknowledgement of sustainability values**: This resonates with contemporary values. However, greater attention to plural values, such as place attachment, could increase resonance and contribute to more just outcomes.

Risks

- **Misalignment with values, identities and emotional responses**: The CID may encounter resistance where policy narratives fail to reflect or engage with individuals' values or identities. Limited attention to transition effects beyond employment, which may have exclusionary consequences, and the omission of posthuman or relational perspectives that highlight interdependence with ecological systems, is indicative of this gap.

- **Neglect of social relational dynamics:** Emerging scholarship (e.g., Novaes, 2023) highlights the significance of social relationships in shaping adaptive responses to change. The CID, however, lacks engagement with the role of interpersonal networks—especially outside the workplace—in facilitating or obstructing transition processes.

- **Overlooking niche ideas for transformation:** The lack of attention to nurturing individual actions and everyday practices may overlook transformative practices that need upscaling.

Annex 3. Case studies of industrial transformation

A3.1 Cultivated meat and regional food futures

Table 7 Case summary of cultivated meat and regional food futures

Category	Details
Location	The EU, Singapore, the USA
Temporal scope	2010 – ongoing
Policy orientation	Competitiveness; strategic autonomy; resilience; cultural adaptation; decarbonisation
Sectoral focus	Biotechnology and alternative proteins, with impacts on national food security, sustainability, and culinary traditions
Enablers addressed	Singapore (regulatory first mover); United States (market scaling and contestation); Europe (ongoing regulatory debate)
Lenses addressed	Embedding place-based and cultural dimensions (central); fostering whole-of-society transition; clarifying government's role; addressing structural lock-ins

Source: Own elaboration

Introduction

Europe is among the world's largest meat consumers, and the meat sector remains a major source of negative environmental and social impacts from food and agriculture (Post et al., 2020). Although the European meat industry possesses a strong heritage, its products face declining international competitiveness as dependency on imports rises. Intensive industrial animal farming also faces growing consumer and regulatory pressure regarding sustainability, health, and animal welfare. These factors create demand for scalable alternatives to current industry practices to ensure food security and drive broader food system transformation. Cultivated meat has emerged as a promising innovation within this context, though it remains highly contested (Ferrari, 2025).

While surrounded by uncertainties, cultivated meat has attracted significant investment and wide interest. Recent trend reports indicate that assessing its potential requires a multi-dimensional approach that accounts for technological, environmental, and social uncertainties. Contrasting present European realities with developments in the US and Singapore highlights important lessons regarding actor engagement and cultural narratives. The case illustrates how food system industrialization is shaped by culture, politics, and public legitimacy as much as by science.

Although the EU has prioritised alternative proteins in its farm to fork strategy, cultivated meat is not yet authorized by EFSA. Consequently, debates about consumer trust, culinary traditions, and the role of incumbent livestock industries remain unsettled. Singapore and the US show that regulatory approval can create momentum, but consumer narratives and incumbent resistance are often decisive for uptake (Stephens et al., 2018).

Why – challenges and policy goals

Singapore and the US present different trajectories for cultivated meat. Singapore's vulnerability to import shocks led the state to prioritise cultivated meat for resilience (Choudhury et al., 2020). In the US, pressure to innovate emerged from sustainability debates, but resistance from agricultural lobbies complicated

broad acceptance. For Europe, the central challenge is reconciling climate goals with deeply entrenched cultural attachments to traditional meat, regional farming systems, and strong incumbents. Interviews conducted for this case emphasised that the idea of cultivated meat often travels faster than its material presence. Social acceptability and political viability, rather than scientific credibility alone, determine whether the technology becomes embedded in food systems (Bryant & Barnett, 2018).

How – policies and industrial activities

Singapore approved cultivated chicken in 2020, embedding it in a food sovereignty plan and engaging cultural groups to ensure acceptance. In the US, FDA and USDA approvals created regulatory clarity, but state-level politics interrupted progress; several states moved to ban cultivated meat under pressure from livestock lobbies, revealing the strength of incumbent resistance. In Europe, firms have advanced R&D, but EFSA focuses on risk assessment and is not designed to address the socioeconomic impacts that affect public acceptance. Industry patterns also show hedging behaviour, as large food companies invest across conventional meat, plant-based substitutes, and cultivated meat simultaneously to control patents and future supply chains (Choudhury et al., 2020).

What happened – actors and outcomes

In Singapore, partnerships between global firms and local food-service providers enabled early public trials. Israel's food-tech cluster grew rapidly with public funds, embedding cultivated meat into narratives of resilience and diaspora cuisine (Bryant & Barnett, 2018). However, a recurring pattern across all cases is the widening gap between the intensity of political debate and the limited material presence of the product. In the US, despite federal approval, resistance from state legislatures and conservative cultural framings slowed adoption. Surveys indicate European consumers remain cautious, citing naturalness concerns and cultural attachment to traditional meat (Bryant, 2020).

Within the European Union, the political landscape is increasingly fragmented by pre-emptive bans. Italy's 2023 ban was followed by emerging initiatives in Austrian federal states, where political mobilisation has been fueled by misinformation regarding the safety and unnaturalness of the technology (GFI Europe, 2024). These developments suggest the debate is frequently used as a proxy for broader cultural identity struggles. Political campaigns often invoke culinary heritage and national identities, which are then amplified by farm organisations to produce precautionary postures. While some European countries continue to advance national alternative protein strategies, others tend toward resistance through bans intended to protect tradition and industry.

Lessons and insights for EU policy

- **Active citizen engagement is necessary in shaping transformations on contentious issues.** Moving beyond a consumer-centric market framework toward collective deliberation aligns with the EU farm to fork strategy goal of building social legitimacy, ensuring that food policy is viewed as a shared political project rather than a private market choice.

- **Addressing resistance requires recognizing structural economic exposure and regional value-chain disruptions**. Transition frameworks are most resilient when they move beyond managing public opinion to offer proactive conversion plans and regional support, providing concrete economic alternatives for areas heavily dependent on industrial animal agriculture.

- **Regional diversity necessitates strategies that weigh diverse futures** e.g. whether localized production can maintain regional jobs and heritage better than centralized industrial plants, a critical distinction for maintaining economic stability across the EU's varied agricultural landscapes.

- **Policy and public discourses must work around uncomfortable truths**. A policy discourse that moves past simplified binaries to acknowledge continued animal use and complex human-nature relationships fosters a more transparent reflection on the long-term ethical future of European agriculture.

- **Comprehensive analyses of cultural, social and economic implications of novel technologies are necessary beyond technology and market readiness or safety assessments.** Bridging this gap involves considering regarding scalability limits, cultural contexts and environmental trade-offs into the policy process to manage public expectations and reduce protectionist pushback.

- **Industrial transformation depends on considering the role of emerging technologies within broader processes, instead of centering transformations around a single solution**. Anticipatory governance of such technologies includes ensuring that innovation remains accessible rather than exclusionary and tracking who controls the technology and how benefits are distributed across the food system, and how debates are constructed in pollical and public spheres.

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A3.2 Regional identity and imaginaries as a catalyst for industrial transformation: The case of Fryslân in the Netherlands

Table 8 Case summary of regional identity and imaginaries as a catalyst for industrial transformation

Category	Details
Location	Province of Fryslân (Friesland), the Netherlands
Temporal scope	2010s–present; formation of Vereniging Circulair Fryslân and emergence of regional circularity networks; ongoing cultural and industrial transformation towards 2025.
Policy orientation	Circular economy; regional autonomy; social and environmental wellbeing; cultural grounding of transformation; local industrial renewal driven by identity and community (Mienskip).
Sectoral focus	Agriculture, regional materials (flax, hemp, cattail), textiles, local manufacturing, and circular construction materials.
Enablers addressed	Regional collaboration, localicatlisation, while of society
Lenses addressed	Socio-cultural (central); socio-economic; socio-ecological; socio-political; socio-technical.

Source: Own elaboration

Introduction

In the Dutch region of Fryslân, an agricultural province in the northern part of the Netherlands with a strong regional identity, a distinct local culture of circularity is taking shape. This emerging culture develops through ongoing conversations and practical experimentation that gradually redefine what circularity means in a Frisian context.

This case matters because it shows how regional identity and cultural traditions can become drivers of industrial transformation. When broad circular economy principles are grounded in local meaning-making, they generate circular practices that are authentic and place-based, creating transition pathways different from the more eco-modernist approaches often seen at the European level.

Why

Fryslân faced the overarching challenge of aligning abstract national and EU-level circular economy ambitions with local social, cultural, and economic realities. As an agricultural province, its policy and industrial transformation needed to focus not just on technological innovation, but on community cohesion, local ownership, and regional autonomy.

At the heart of this process is the local concept of Mienskip, a concept of communal responsibility and mutual care, which links circular principles to the regional goals of shared prosperity, balancing social, environmental, and economic values. This approach reframes circularity from a technical challenge into a collective cultural project, aiming to restore agency and meaning to local communities while achieving sustainability objectives.

How

The provincial association Vereniging Circulair Fryslân (VCF) plays a pivotal role in sustaining and organising this cultural shift. It brings together all public authorities, private companies, academic institutions, and civil society organisations, creating a shared platform for experimentation and collaboration.

Through VCF and its partners, circular economy policies are reinterpreted through regional identities, stories, and histories, linking policy frameworks to the region's social fabric. Practical experimentation translates circular principles into culturally grounded industrial activities, including:

- Rediscovering old local circular practices, such as using flax for circular insulating materials.
- Reintroducing local crops like cattail and hemp as valuable regional resources.
- Developing a more sustainable regional textile industry built on local knowledge and materials.

These activities strengthen links between traditional craftsmanship and modern environmental innovation, fostering a transition that remains recognisably Frisian.

What happened – actors and outcomes

The actions and collaborations in Fryslân are rooted in collective engagement and shared learning. VCF provides the institutional backbone that connects farms, municipalities, educational institutions, and local enterprises into coordinated circular initiatives.

Stakeholders engage in co-designing circular practices and experimenting with value chains, drawing on regional skills and heritage. The process involves not only technical innovation, but also storytelling and cultural reinterpretation, which give circularity an emotional and symbolic dimension. This has helped to shape locally owned narratives of change, where circularity is embedded in a sense of belonging and regional pride.

Fryslân's transition pathways have come to express a distinct, embedded form of circularity, different from top-down eco-modern models. By reconnecting circular actions to local identity, craftsmanship, and materials, the region has activated new forms of collaboration and innovation. The Flax Value Chain initiative, for example, illustrates how the rediscovery of local materials can blend industrial renewal, cultural heritage, and environmental responsibility.

The growing network around VCF has institutionalised cooperation among public, private, and civic actors, building a durable foundation for circular transition. Fryslân is positioned as a European frontrunner in the place-based circular economy, demonstrating industrial change that is simultaneously cultural, ecological, and social.

Lessons for EU Policy

The Fryslân case provides valuable insights for EU-level industrial and sustainability policy:

- **Cultural grounding enhances legitimacy.** Transitions anchored in local identity and collective meaning receive broader public support.
- **Regional autonomy and diversity matter.** A one-size-fits-all eco-modernist model risks overlooking local drivers of change.
- Cross-sector platforms such as VCF demonstrate the importance of **sustained collaboration** among public, private, and civic actors.
- Place-based approaches to the circular economy can lead to more **socially resilient and context-sensitive forms of industrial transformation**.
- **Embedding circularity in stories, histories, and regional imaginaries** can generate not only new business models but also new cultures of sustainability.

These lessons suggest that the EU's industrial transition could benefit from recognising the cultural and narrative dimensions of sustainability as integral to circular innovation.

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A3.3 Kyoto's Nishijin and Traditional Craft Industries: Place-Based and Cultural Industrial Regeneration

Table 9 Case summary of Kyoto's Nishijin and traditional craft industries

Category	Details
Location	Kyoto's Nishijin
Temporal scope	Heian period origins; national craft promotion law in 1974; renewed local revitalisation plans from 2006 onwards; contemporary integration of digital and environmental technologies
Policy orientation	Competitiveness; resilience; cultural heritage preservation; circularity
Sectoral focus	Textiles (Nishijin weaving, Kyō-yūzen dyeing); allied crafts; linked to creative design and tourism
Enablers addressed	Kyoto City and Prefecture within Japan's national framework for traditional industries
Lenses addressed	Embedding place-based and cultural dimensions (central)

Source: Own elaboration

Introduction

Kyoto's traditional craft sector illustrates how cultural identity can be mobilised as an industrial strategy. While rooted in centuries-old practices, particularly Nishijin silk weaving, the sector has been reshaped by policies that seek to balance cultural authenticity with the demands of contemporary competitiveness and sustainability. For Europe, this case offers insights into how regional cultural industries can contribute to industrial resilience and circularity, aligning with EU strategies on textiles, creative industries, and sustainable production.

Why – Challenges and policy goals

By the late twentieth century, Kyoto's crafts faced a steep decline. Domestic kimono demand collapsed, artisan numbers fell, and the intergenerational transfer of knowledge became fragile. The supply chains for raw materials and specialised tools also risked disappearing. Policy goals were therefore to preserve intangible cultural assets, maintain industrial networks, and create new pathways for competitiveness, including export markets and environmentally sustainable production.

How – Policies and industrial activities

The 1974 Act on the Promotion of Traditional Craft Industries provided a stable legal basis for designation, subsidies, and successor training. Kyoto Prefecture and City complemented this framework with ordinances and multi-year revitalisation plans focusing on apprenticeships, joint branding under the "Kyomono" label, and the creation of shared facilities. More recently, collaboration with universities, design schools, and manufacturers has introduced clean and digital technologies. Waterless digital textile printing, parametric design, and AI-assisted motif generation are being selectively integrated, with the intention of supporting sustainability while maintaining artisanal authorship.

What happened – actors and outcomes

National and local governments, industry associations such as the Nishijin Textile Industrial Association, universities, and design labs have cooperated to maintain and adapt the sector. Outcomes are mixed. The supplier–customer network remains robust compared to other declining industries, yet the number of firms and artisans continues to shrink. At the same time, new niches have emerged in sustainable fashion,

digital jacquard weaving, and high-value exports. These developments show that cultural industries can adapt not by scaling up but by selectively embedding new practices that respect their symbolic and interpretive foundations.

So what – Lessons for EU policy

- Cultural heritage-based industries are **strategic components** of industrial policy rather than as a peripheral culture sector.
- **Establish long-term frameworks** for preservation of craftsmanship as a highly valued tradition, for skills transfer and preservation of endangered crafts alongside innovation policy.
- Use place branding and certification to **strengthen competitiveness in global markets** without eroding authenticity and keeping the high-quality and valued items approachable.
- Support the **integration of clean and digital technologies** in a way that reinforces, rather than replaces, cultural identity.
- Recognise that resilience in cultural industries may not lie in growth, but in **maintaining networks and creating sustainable high-value niches.**

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A3.4 Data, energy, water and jobs: how the Netherlands managed mounting impacts of data centres through responsive governance and multi-level policy alignment

Table 10 Case summary of how the Netherlands managed mounting impacts of data centres

Category	Details
Location	Netherlands
Temporal Scope	Mid-2000s, accelerated 2010s–present; turning points in the 2020s.
Policy Orientation	Competitiveness, digitalisation, resilience, decarbonisation, justice.
Sectoral Focus	Data centres (cloud, hyperscale, colocation) linked to AI and the platform economy
Location	Amsterdam and the Noord-Holland province, multi-level
Enablers Addressed	Whole-of-society transition, clarifying government roles, broadening industrial resilience.
Lenses	Socio-political, socio-cultural, socio-economic, socio-ecological

Source: Own elaboration

Introduction

The Netherlands hosts dense data centre clusters around the Amsterdam Internet Exchange, including major operators like Microsoft, Google, and Meta. Rapid data-centre growth since the late 2010s has strained environmental, water, and energy systems, with demand reaching about 10% of national electricity and significant potable water use during droughts, exposing tensions among digitalisation, sustainability, and justice. In response, Amsterdam and Haarlemmermeer imposed moratoria in 2019 to halt growth and rethink policies. Over five years, governance evolved from permissive and minimal toward conditional, integrated infrastructure planning, reframing data centres as strategic elements within interconnected energy, water, and spatial systems. This shift embodies broader European challenges of infrastructural lock-in, socio-ecological burden displacement, and just digital industrial transformation.

Why

The race to lead the future through AI has many material dimensions, and one of them is the construction and operation of data centres. Where those centres are located has strong impact for security, resilience and capacity to maintain a competitive edge in the presumably AI-driven future. Yet, this race also comes with significant impacts, which, following several cases in the media, have only recently started to garner wider attention from the public and policymakers.

The Netherlands' prominence as a data-centre hub traces back to AMS-IX's founding in 1994, fostering cloud and colocation investment waves. National and municipal strategies promoted the nation as a robust digital gateway, bolstered by hyperscale commitments from Microsoft, Google, and others by 2018 (Monstadt & Saltzman, 2022). However, rapid expansion has an impact on energy grids, water scarcity, and land use conflicts. While data centres bring tax revenues and jobs, they also localise ecological and social costs such as water depletion, noise pollution, and environmental change to proximity communities, often marginalised from governance processes (Rone, 2023). This reflects infrastructural inequalities and socio-material asymmetries (Velkova & Plantin, 2023).

This case underscores tensions central to Europe's dual Green and Digital transitions. Without systemic, integrated governance attentive to path dependencies, social justice, and infrastructural politics,

technological sovereignty ambitions risk exacerbating environmental degradation and social inequities. The institutional conditioning of data centre development illustrates pathways for balancing digital innovation, sustainability, and fairness in (European Commission, 2024).

How – the evolution of policy and governance

Early permissive approaches to data centre development in the Netherlands meant rapid growth, but also significant concentration of environmental and social burden (Monstadt & Saltzman, 2022). Governance reform thus demanded frameworks that would address issues such as demand far water and energy, but also unequal distribution of benefits and burdens (Rone, 2023).

The main policy and governance milestones reflect a gradual realisation of the existing deficiencies and response at different governance levels, following highlights of specific issues in the media.

- As of 2018, grid operators warned of capacity constraints in Noord-Holland and Flevoland, highlighting tensions between various energy uses (Liander, 2024).
- 2018–2021 increased public scrutiny due to reports of large water usage by Microsoft Hollands Kroon during drought periods (Techzine, 2022).
- In 2019, Amsterdam and Haarlemmermeer paused new data centre construction to conduct stakeholder consultations and develop necessary regulatory updates (Dutch Data Center Association, 2019).
- During 2020–2022, several important requirements were introduced, such as mandated energy efficiency, compulsory heat reuse, siting restrictions emphasizing non-potable water, and limited development to grid-backed designated parks (Dutch Data Center Association, 2019).
- 2022–2024: Noord-Holland implemented tiered permitting based on project scale and impact, while national moratoria redirected hyperscale growth northwards, further reflected in 2024 legislation (Noord-Holland Province, 2022; Greenberg Traurig, 2024).

The observed dynamics highlight the importance of considering the interplay of different scales, and how data centres play out as both durable infrastructures but also imminent sources of pressure on local environments and communities (Velkova & Plantin's, 2023) that thus need to be addressed through nuanced regulatory frameworks. The Dutch experience thus showcases comes about as an effort to tackle infrastructural path dependencies and power asymmetries inherent in digital infrastructure expansion, emphasising redistribution of benefits and burdens (Rone, 2023).

What – process and engagement

Policy response was not a sole source of action, but intertwined with public engagement, action by multinational companies and stringent media attention to the issues:

- **Municipal moratoria** created regulatory breathing room to institute conditional permits that would integrate previously unconsidered dimensions of impact.
- **Provincial permitting** tiers require hyperscale projects to prove grid capacity, credible non-potable water sourcing strategies, and heat reuse commitments.

- **National moratoria and legislation** confined hyperscale data centre siting to northern municipalities with infrastructural resiliency (Noord-Holland Province, 2022; Reuters, 2022).
- **Industry interventions showed willingness to acknowledge and act on the impacts:** Google built an industrial water pipeline at Eemshaven, Amsterdam centres connected to district heating despite operational challenges, while Microsoft increased public transparency following pressure (Google, 2023; Amsterdam Economic Board, 2023). One large-scale project by Meta was also cancelled in the process (Data Centre Magazine, 2022).
- **The Dutch Data Centre Association** transitioned from resistance to cooperation (Dutch Data Center Association, 2019).

These activities allowed for the integration of governance across administrative scales while acting practically on the imminent pressures.

Lessons and insights for EU policy

Data centres manifest complex ecological and social impacts requiring that governance recognises how infrastructures reshape socio-material conditions (Monstadt & Saltzman, 2022). The Dutch example yields essential lessons for concerted EU efforts to coordinate digital innovation, climate action, and just socio-ecological transitions. While some view the current policy developments as going in the right direction, others warn of potential billions in lost revenues due to diminishing global leadership (Innovation Origins, 2025). Still, more cautious analyses also emphasise that environmental impacts remain insufficient, and job benefits are significantly overestimated landscape (AlgorithmWatch, 2025, July. Sustainable data centre governance demands anticipatory, multi-level coordination, mitigating environmental externalities and fostering equitable benefit distribution.

Recommendations:

- **Coordinated governance** spanning municipal to national scales is imperative to reconcile industry competitiveness with climate and social imperatives.
- **Conditional permitting** needs to take a broad socio-ecological perspective, including aspects such as energy demand, heat recovery, water sourcing, and grid capacity to consider infrastructural resilience.
- **Agile demand balancing** is necessary for cases such as droughts, where multiple users may compete for scarce water resources.
- **Harmonise EU digital and environmental policies,** ensuring AI and Data initiatives align with enforceable climate, water, and land sustainability objectives.
- **Mandate codification** of data centre impacts and procedures to manage them, including heat reuse readiness, non-potable water sourcing, and grid adequacy as strict siting prerequisites for large data centres.

- **Foster anticipatory governance** for dealing with systemic contradictions and preventing uncoordinated data centre expansion, while fostering consolidiated and context-sensitive conditional development.

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A3.5 Mining, resistance and societal dialogue: experiences from Finland

Table 11 Case summary of mining, resistance and societal dialogue: experiences from Finland

Category	Description
Location	Finland (national governance); Kainuu region (Talvivaara/Terrafame mine); Sámi homeland in Lapland
Temporal scope	2005–2024
Policy orientation	Balancing extraction acceleration under the EU Critical Raw Materials Act with social license requirements; unresolved tensions between Indigenous consent rights, peripheral economic dependency, and green transition mineral demands.
Sectoral focus	Mining governance and social license; metallic minerals (nickel, cobalt, copper, zinc, gold); battery value chains.
Enablers addressed	Cultural and place-based aspects, whole-of-society transition.
Lenses addressed	Socio-ecological, socio-cultural, socio-economic, socio-technical.

Source: Own elaboration

Introduction

Finland is a key source of critical raw materials for the European Union, positioned at the core of European and global battery value chains. While the industry possesses a strong technological base, its expansion remains a point of significant environmental and social debate (Eerola, 2022). Traditional institutional trust, which Finnish citizens typically place in regulatory authorities, has been challenged by large-scale industrial incidents and the increasing complexity of oversight in northern regions (Jartti et al., 2020). High baseline trust in Nordic settings creates a dynamic where communities expect strong state oversight, making technocratic failures—like the Talvivaara disaster—particularly damaging to administrative legitimacy. Consequently, the governance of mining in Finland continues to navigate a difficult tension between strategic resource exploitation and the maintenance of high standards for local legitimacy.

Why – challenges and policy goals

The 2012 Talvivaara mine incident involved a series of gypsum pond leaks at a site utilizing bioheap leaching, resulting in the heavy contamination of local waterways. As noted by the Finnish Safety Investigation Authority (2014), the incident was attributed to inadequate risk management and the industrial-scale application of technology that was insufficiently tested under Finnish environmental conditions. This event catalyzed a systemic shift toward a more cautious permitting culture and highlighted the structural limitations of existing environmental impact assessments in predicting cumulative harm (Sairinen et al., 2017).

Currently, the pressure to accelerate permitting under the **EU Critical Raw Materials Act (CRMA)** has triggered transnational contestation regarding the weighting of local community impacts against European strategic goals (Götz & Harnesk, 2025). Faster processes, if not carefully designed, are viewed as inadequate by local actors, reminding communities of the legitimacy failures of the past and suggesting that efficiency is being prioritized over ecological safety.

How – policies and industrial activities

Following the Talvivaara incident, the Finnish Innovation Fund (Sitra) initiated the **Network for Sustainable Mining** in 2014. This voluntary self-regulation framework was designed to facilitate a "social license to operate" through multi-stakeholder dialogue, adopting international sustainability standards to rebuild trust (Kaivosvastuu, 2015). Despite these efforts, the consensus eventually fractured. The withdrawal of the Sámi Parliament in 2015 and the Finnish Association for Nature Conservation (SLL) in 2021 signaled that voluntary mechanisms were no longer viewed as sufficient to address flaws in the national Mining Act regarding exploration rights and land-use protections.

Simultaneously, the state-owned Terrafame Ltd assumed control of the Talvivaara site, achieving an EcoVadis Gold certification in 2024. Terrafame employs approximately 2,000 workers as of 2024, illustrating a deep regional economic dependency in Kainuu. In this peripheral context, municipalities must weigh ecological risks against vital employment needs, making the mine a central pillar of regional survival even as environmental pressures persist.

What happened – actors and outcomes

Environmental oversight remains divided between the Regional State Administrative Agencies (AVI), responsible for permits, and the Centres for Economic Development, Transport and the Environment (ELY Centres), responsible for monitoring. This dual-track system has faced criticism for limited administrative capacity and a lack of integrated social impact assessments (National Audit Office, 2021). This regulatory bifurcation—which Talvivaara exploited—persists as a structural vulnerability that complicates the path toward a unified safety culture.

The strain of this system is most visible in the north, where mineral exploration overlaps with Indigenous territories. In October 2024, **UN treaty bodies (CESCR and CRC)** found that Finland violated Sámi rights by granting exploration permits without adequate impact assessments or obtaining Free, Prior, and Informed Consent (FPIC). While voluntary standards like TSM require companies to "aim to obtain" FPIC, the lack of a legal requirement to actually secure it highlights the persistent gap between procedural dialogue and substantive legitimacy. For the impacted communities technical compliance however remains secondary to the fundamental cultural and economic sustainability of their grazing lands.

Lessons and insights for EU policy

- **Procedural legitimacy does not guarantee substantive outcomes for communities.** While inclusive dialogue is essential, it is not a silver bullet; securing a stable social license requires ongoing negotiation and the recognition that some stakeholders require categorical prevention rather than mere mitigation.
- **Transition frameworks must address peripheral economic dependency and regional disruption.** Opposition is often rooted in long-term economic risks, meaning regional mining ecosystems require proactive economic conversion plans to ensure benefits are distributed locally and balance global metal demand with local livelihood security
- **Permitting speed must not compromise environmental and social safeguards.** The implementation of the CRMA must account for local environmental specificities; identifying

administrative limits early helps manage expectations and reduces the risk of political backlash arising from mismatched goals.

- **Indigenous land rights require procedural leverage beyond simple consultative mechanisms.** The Finnish experience and 2024 UN rulings suggest that a lack of binding consent leads to persistent disputes; strengthening Indigenous rights is therefore a prerequisite for reducing social risk in mineral exploration.
- **Institutional trust relies on the transparency of risk management and safety culture.** The gap between technical risk assessment and public perception widens when safety cultures are perceived as inadequate; in high-trust Nordic settings, even minor technocratic failures can have disproportionate political consequences.
- **Effective oversight is necessary to ensure that mining serves broader social goals rather than narrow interests.** Policy must track how economic benefits and environmental costs are distributed across society, as strategic autonomy is ultimately linked to monitoring corporate conduct to ensure an equitable transition.

Finland's experience illustrates that institutional trust and collaborative accountability form the foundation of sustainable resource governance, but without addressing the underlying power imbalances and administrative gaps, the transition risks repeating the structural failures of the past.

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A3.6 Genk's managed industrial transition: from coal to a diversified regional economy

Table 12 Case summary of Genk's managed industrial transition

Category	Description
Location	Genk, Limburg, Belgium
Temporal scope	1917–2025
Policy orientation	Decarbonisation
Sectoral focus	Energy
Enablers addressed	Enabling phase-out and overcoming structural lock-ins; whole-of-society
Lenses addressed	Sociopolitical; socioeconomic; sociocultural

Source: Own elaboration

Introduction

A sustainable future depends on decarbonising energy systems, making the phase-out of coal and other fossil fuels essential for meeting climate and environmental goals. Genk's transition illustrates how this difficult process can be navigated. By repurposing former mining facilities into innovation hubs, green industry sites, and community spaces, the city demonstrates how economic renewal and environmental objectives can be pursued simultaneously.

Why – Challenges and policy goals

For much of the 20th century, Genk's economic and social fabric was shaped by its coal industry. However, as coal became increasingly uncompetitive, Genk - like many other European mining regions - faced a period of severe industrial decline. When the city permanently ceased mining activities, city leaders looked for an alternative approach to generate revenues and create opportunities. Thirty-five years after the last coal mine closed in Genk, the Limburg region is undergoing an economic transition process, shaped by its increasing use of old industrial heritage and infrastructure as assets for future development.

How – Policies and industrial activities

The first phase of Genk's industrial transformation was marked by *substitution* rather than systemic change. Following the closure of the first coal mines in the 1960s, Genk attracted the Ford Motor Company, which established a large manufacturing plant. Throughout the 1980s, related automotive and logistics companies followed, effectively replacing coal with car manufacturing. While this secured short-term economic stability, the city remained dependent on a single industrial sector, perpetuating a monocultural economy.

A second, more fundamental transition began after Ford's closure in 2014. This period is characterised by a *trajectory of diversification*, in which Genk repositioned itself as a more knowledge-driven and innovation-oriented economy. Rather than repeating the substitution logic, the city focused on broadening its economic base and embracing system change. A strategic element in this shift was the reuse of Genk's mining infrastructure. Former coal sites were redeveloped into cultural and innovation landmarks - most notably Thor Central and C-Mine.

To illustrate, Thor Park, one of the revived places situated in the former Waterschei coal mine, is a symbol of transition from coal mining to green energy: once a mine employing 7,000 people, it is now a hotspot for technology, clean energy and innovation. The 93-hectare technology park hosts companies in the fields of research & development, innovation, business, talent development and urbanisation. These sites were not demolished but repurposed, preserving their heritage while adapting them for modern economic activities. Each former mining site in Limburg was given a distinct thematic focus - such as clean technology, cultural and leisure activities, or energy-related innovation - ensuring that every location developed its own unique identity and function.

This thematic differentiation was not incidental, but part of a carefully designed, *coordinated regional strategy* aimed at preventing internal competition for the same resources, investments, or audiences. By aligning the redevelopment efforts across sites, the region fostered *complementarity rather than rivalry*, allowing each site to contribute distinctly to the broader economic transformation. This approach also helped reduce complexity in the early stages of transition, providing clear direction for stakeholders and enabling more targeted innovation and investment.

What happened – actors and outcomes

Genk has become a dynamic entrepreneurial city that devotes much attention to sustainable jobs and welfare creation. Genk's success in navigating long-term transformation can be traced to its ability to govern change within a complex, multi-stakeholder environment. Central to this was a binary governance strategy that deliberately combined top-down and bottom-up approaches. City leaders recognised that, to increase transformative innovation, bottom-up approaches were needed as much as larger-scale, often top-down, development projects. Small-scale initiatives started by residents, social entrepreneurs and civil society organisations are developed in tandem with larger-scale public and private investments in strategic redevelopment projects, aligning local needs and ideas with broader regional and economic goals.

In 2014, the Flemish government pledged €217 million, supported by tax incentives and EU ITI funds, forming the backbone of a broad investment plan. The city complemented this by allocating 8.5% of its 2015 budget to knowledge-building, creating a cross-departmental transition team, and promoting citizen engagement. This dual-track approach ensured strategic coherence, financial leverage, and local legitimacy, securing the support needed for a complex, long-term transition.

The case of Genk presents an inspiring story of industrial transformation: from coal to cars, from cars to creative hubs, clean-tech clusters, and community-led regeneration. Despite progress made, the region still faces the challenge of re-employing workers made redundant by the coal phase-out and automotive decline. Additionally, most transition initiatives remain vulnerable due to dependence on external funding. Genk, therefore, represents the case of an ongoing rather than a finalised transition, mirroring Europe's broader shift from production to coordination and from making goods to shaping future-oriented economies. Yet, as industrial activities are displaced elsewhere, environmental and social costs are often externalised, underlining that transformation must address both what is phased out and what sustainable systems are built in its place.

So what – Lessons for EU policy

- **Emergent decline management**: Transformative strategies must account for industrial clusters facing changing competitive landscapes, balancing investment, renewal, and managed decline.
- **Substitution versus systemic change**: Moving beyond single-industry substitution towards diversified, knowledge-driven economies enhances long-term resilience.

- **Leveraging industrial heritage**: Coordinated reuse of industrial sites with complementary thematic focuses can strengthen regional cohesion and sustainable redevelopment.
- **Whole-of-society governance**: Combining top-down coordination with bottom-up citizen and NGO initiatives fosters alignment, innovation, and broad-based support.
- **Concerns around Europe's future material base**: Transitioning to knowledge economies must consider Europe's reliance on global production systems to avoid externalising environmental and social costs.

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A3.7 Between phase-in and industrial lock-in: Canada's automotive sector

Table 13 Case summary of Canada's automotive sector: Between phase-in and industrial lock-in

Category	Description
Location	Ontario Province, Canada
Temporal scope	1960–present
Policy orientation	Competitiveness; decarbonisation
Sectoral focus	Automotive industry
Enablers addressed	Enabling phase-out and overcoming structural lock-ins
Lenses addressed	Socioeconomic (central); sociopolitical; sociotechnical

Source: Own elaboration

Introduction

Canada's automotive sector demonstrates how governments can navigate industrial lock-ins and orchestrate phased transitions from uncompetitive and unsustainable industrial structures. It offers lessons for transitions in the automotive industry in particular, but also for other industries.

The automotive industry is a cornerstone of the European economy, directly employing 1.4 million people and supporting 13 million jobs indirectly across the European Union. However, it faces the urgent challenge of reconciling decarbonisation imperatives with global competitiveness and economic security. Europe's long-standing strength in internal combustion engine (ICE) technologies has particularly created a technological and policy lock-in that hinders a transition to zero-emission mobility. While current EU industrial policies promote electrification, they often stop short of disrupting the entrenched ICE-based production system that remains economically dominant but environmentally unsustainable.

Canada's experience offers valuable parallels. Since the 1960s, the country's automotive sector has undergone repeated cycles of restructuring in response to shifts in the global competitiveness and technology arenas. The successive policy interventions illustrate how governments can balance industrial resilience with transformation.

Why – Challenges and policy goals

Following the Second World War, Canada's automotive sector was dominated by US-owned branch plants producing mainly for the domestic market. By the late 1950s, recession, rising import penetration, and falling employment revealed structural weaknesses in this model, exposing its limited competitiveness and vulnerability to external shocks. Growing import sales, from 12% to 26% of the market between 1951 and 1960, triggered production decline and significant pressure from labour, industry, and local governments for structural reform.

Between 1980 and 2000, the sector again faced mounting pressures from global competition, technological change, and oil shocks. The 1979 energy crisis accelerated the shift toward smaller, fuel-efficient vehicles dominated by Japanese producers, while North American manufacturers lost market share and required state intervention. The deep integration of Canadian operations within US parent firms further reduced domestic autonomy.

After 2000, the erosion of earlier advantages became acute. The WTO ruling against the 1965 Auto Pact removed Canada's privileged market access, leading to plant closures and falling investment. Competitive pressures intensified with Mexico's rapid rise under NAFTA as a low-cost production hub, while technological diffusion undermined Canada's traditional strengths. The sector's decline from fifth to eleventh in global production rankings underscored the risks of relying on incumbent structures and insufficient innovation-led renewal.

How – Policies and industrial activities

Between 1960-1980, Canada's policy responses included support for innovation, institutional collaboration, and increased integration with global supply chains, all of which contributed to industrial renewal. A pivotal element of this strategy was the 1965 Auto Pact (Automotive Products Trade Agreement), a managed free trade arrangement with the United States. The agreement enabled cross-border specialisation, attracted investment, and significantly enhanced the scale and competitiveness of the Canadian auto industry. It also reflected the broader sociopolitical context in which the United States was eager to secure tariff-free access to the Canadian market, reduce costs and improve the efficiency of its automakers, and strengthen North American economic integration in a strategic sector. The pact laid the foundation for long-term growth, including a sustained period of higher vehicle production, demonstrating how targeted integration can underpin industrial renewal and resilience.

From 1980 to 2000, policies focused on adapting to global competition through diversifying ownership and production. In response to disruptions and shocks linked to the Autopact, the government encouraged Japanese automakers to establish Canadian plants through tariff waivers and voluntary export restraints, facilitating a controlled phase-in of new entrants and more energy-efficient technologies. This deliberate diversification reduced dependence on US producers and partially unlocked the rigid branch-plant model, contributing to record production levels. By 1999, Canadian vehicle production exceeded 3 million units annually. Only the US, Japan, Germany, and France – all of which have multiple 'homegrown' automakers – built more cars than Canada that year.

After 2000, however, policy orientation shifted toward stabilisation rather than transformation. Industrial incentives and emergency loans helped sustain the operations of existing incumbent manufacturers, most notably the 2009 bailouts of GM and Chrysler, but did not fundamentally renew the industrial base. Parallel efforts to pivot the industry toward a knowledge- and innovation-based future, supporting automotive R&D, advanced technologies, and autonomous and connected vehicles, were fragmented and yielded limited impact: overall patenting and technology adoption remained low.

What happened – actors and outcomes

The Canadian experience illustrates how industrial lock-ins, stemming from capital intensity, long product cycles, and political influence, can inhibit adaptation. Earlier periods (1960–2000) demonstrated the potential of proactive industrial diversification, whereas post-2000 strategies largely preserved incumbents without enabling structural renewal. Effective resilience, therefore, depends on clear phase-out and phase-in trajectories, aligning competitiveness with sustainability and innovation.

So what – Insights (Lessons) for EU policy

- **Break structural lock-ins**: Resilience requires deliberate disruption of unsustainable or obsolete industrial models rather than their protection.

- **Pair phase-out with phase-in**: Industrial policy must simultaneously retire declining sectors and nurture emerging, sustainable ones.
- **Ensure adaptive policy capacity**: Periodic renewal and flexibility, as seen in Canada's earlier decades, are key to long-term competitiveness.
- **Promote strategic diversification**: Encouraging new entrants and technologies enhances resilience by reducing dependency on dominant actors and outdated production systems.

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A3.8 The global phase-out of single-use plastics in Ireland: from ubiquity to targeted phase-outs

Table 14: Case summary of the global phase-out of single-use plastics in Ireland

Category	Details
Location	Ireland
Temporal scope	2002–2014
Policy orientation	Clean production and consumption; regulatory innovation; phase-out policy
Sectoral focus	Petrochemicals; Environment
Enablers addressed	Enabling phase-out; overcoming structural lock-ins
Lenses addressed	Socio-ecological; socio-political; socio-cultural; socio-personal; socio-economic

Source: Own elaboration

Introduction

While many phase-out processes occur in the context of emergent decline, the case of Ireland's plastic bag levy indicates that unsustainable industries can also be deliberately phased out. Ireland's plastic bag levy, introduced in 2002, is widely cited as a pioneering example of how a targeted phase-out policy can reshape consumption habits and address entrenched behavioural and policy lock-ins. While Ireland was not the first or the only country to take action to discourage the use of plastic bags, it is perceived as one of the most successful in terms of public acceptance and stakeholder buy-in.

The case holds lessons not only for deliberate phase-out processes in general but also for the phase-out of single-use plastics (SUPs) in particular. Over the past decades, SUPs – including shopping bags, disposable cutlery, polystyrene food ware, and microbeads in cosmetics - have become a significant source of both terrestrial and marine pollution across the world. Beyond pollution concerns, the production of plastics is heavily linked to petrochemistry and fossil feedstocks, making the industry a key contributor to greenhouse gas emissions and a necessary target for green industrial policies. The EU has indeed launched various initiatives, including the 2018 Plastics Strategy and circular economy measures for plastics, and individual member states have adopted national legislation to tackle the persistent challenge.

Why – Challenges and policy goals

While plastic bags were not the most prevalent litter items in Ireland in the early 2000s, plastic bag litter was a visible and persistent component of litter pollution throughout the countryside and along the coastline. In March 2002, the Irish government introduced a levy of euro 0.15 per plastic bag provided to shoppers at point of sale in retail outlets. This tax was explicitly designed to change consumers' behaviour to reduce the presence of plastic bags in the rural landscape, and to increase public awareness of littering.

How – Policies and industrial activities

Although discussions began in the mid-1990s, the levy only gained traction once Environment Minister Noel Dempsey pushed for a strong consumer-facing signal rather than an upstream producer tax. This downstream approach, at €0.15 per bag, was designed to make consumers directly weigh the cost of convenience against environmental responsibility, challenging the cultural lock-in of disposable bag use. Estimates of consumers' maximum willingness to pay for a plastic bag, which had been determined from a consumer survey in 1999, showed that the tax, set at € 0.15, was more than six times higher than the

average maximum willingness to pay, around euro 0.024. To enable implementation, the Waste Management Act had to be amended, underscoring the need for legal and institutional adaptation when phasing out entrenched practices.

The levy succeeded because it secured broad stakeholder buy-in. Retailers initially resisted, fearing consumer backlash and reputational damage, but shifted their focus once government commitment became clear. Concerns were addressed through exemptions for hygiene-related uses and a high-profile publicity campaign that emphasized the environmental purpose of the levy. Revenues were hypothecated into an Environment Fund, financing recycling and cleanup initiatives - an important design choice that strengthened public legitimacy. This combination of consultation, transparency, and dedicated reinvestment helped overcome resistance, making the levy not just tolerable but popular among consumers, many of whom came to see avoiding bags as a marker of good citizenship. From an implementation standpoint, the levy was efficient: set-up and administrative costs were modest, enforcement was supported by both authorities and consumers, and revenues quickly outstripped costs.

What happened – actors and outcomes

Plastic bag use fell by over 90%, and plastic litter nearly disappeared from streets and landscapes. The levy led to an immediate drop in per capita, per annum consumption from 328 to 21. However, usage gradually increased to 31 bags per capita, per annum in 2006. The levy was subsequently increased to EUR .22 per bag in 2007. As of 2014, the per capita, per annum usage had fallen again to 14 and the levy rate has remained at EUR .22. The levy was not only a technical intervention but also a cultural one, shifting norms and expectations. Consumers reported feelings of guilt when forgetting reusable bags, indicating that the policy had succeeded in reshaping social practices around shopping. Because the levy was relatively small, popular, and applied only at the retail level, it created no competitiveness issues or cross-border shopping leakage with Northern Ireland.

Viewed through the lens of phase-out policies, Ireland's levy illustrates how lock-ins - here, the everyday ubiquity of plastic bags - can be dismantled by coupling a clear price signal with cultural and institutional reinforcement. By phasing out the disposable bag as the default option and incentivizing reusable alternatives, the levy disrupted both consumer habits and retail practices, while minimizing resistance by ensuring fair cost distribution and visible environmental benefits. The Irish case shows that effective phase-out design requires not only economic instruments but also strong political leadership, legislative backing, and stakeholder engagement to overcome inertia and unlock transitions toward more sustainable practices.

So what – Lessons for EU policy

- **Emergent pressures catalyse change**: Visible ecological and social pressures can trigger intentional phase-outs.
- **Start with low-cost, politically feasible targets**: Early successes build momentum for broader industrial transitions; the targeted phase-out of plastic bags has, over time, paved the way for policies tackling more complex SUPs.
- **Engage civil society and raise public awareness**: Whole-of-society involvement legitimises and accelerates policy adoption.
- **Promote alternatives to enable substitution**: Availability of substitutes facilitates phase-outs and can drive systemic change.

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A3.9 Defossilisation of steel production and energy provisioning – a decades-long transition

Table 15 Case summary of defossilisation of steel production and energy provisioning

Category	Description
Location	Steel industry in Austria, Upper Austria
Temporal scope	1970s
Policy orientation	Competitiveness of the industry; wellbeing; social cohesion
Sectoral focus	Energy-intensive industry (from iron to steel, and research-intensive steel products; integrated plant engineering and construction)
Enablers addressed	Fostering a whole-of-society transition (central); broadening the scope of industrial resilience (infrastructure, social partnership); place-based
Lenses addressed	Socio-political; socio-economic; socio-personal; socio-technical

Source: Own elaboration

Introduction

Linked to tectonic geopolitical shifts and the global energy crisis, the Austrian steel industry has been facing several existential threats since the Cold War period, which have also affected whole regions and the state at large. Following the collapse of the industrial conglomerate in the late 1980s, and its turnaround and restructuring as the case, the region of Upper Austria became one of the fastest growing European industrial regions up to the 2010s, with Voestalpine as the key player.

For Europe, the experience demonstrates that times of tectonic geopolitical shifts and energy crises may also open opportunities to rebuild industrial structures in alignment with innovative labour market policy, regional development strategies and financial government backing. (Algers & Åhman, 2024).

Time scales of transition processes of the Iron and Steel Industry are in the range of several decades, with **long technical lifetimes of plants of up to 60 years**. Apart from the initial **large-scale investments**, multiple major refractory lining/rebuilding from 10-30 years implies long-term strategic decision-making milestones with opportunities of shifting or adapting a transformation pathway. In addition, as operational costs are dominated by energy prices, **energy crises** may **trigger** transition processes.

Although after the first energy crisis several, the technological innovations developed in-house helped the steel industry to become more energy-efficient and competitive, the business model of the 1980ies – meaning, barter-trade with steel products against raw oil with the Soviet Union and the COMECON (Council for Mutual Economic Assistance) – collapsed 1986, and caused an existential crisis for the Austrian steel industry with substantial structural changes and massive lay-offs of over 9000 employees out of 70000.

Why – Challenges and policy goals

In the 1970s, the main policy goal was to avoid rising unemployment triggered by the energy crisis and, as a consequence, its repercussions on the global steel industry. Therefore, the state-owned conglomerate had the **political backing for trade deals with** COMECON states**.** This unique position of Austria to have an export market in the East helped to keep employment rates low, but was **lost with the fall of the Iron Curtain** (Davis, 2012).

The collapse of the state-owned steel industry conglomerate in 1986 was a consequence of the failed hedging strategies of its barter-trading branch (Intertrading), in the wake of high uncertainties in the international oil market in the endgame of the Cold War.

As the primary goal to keep employment high could not be reached without the absorptive capacities of a strong industrial player, national policy goals were changed with the aim to regain a competitive position of the steel industry, thus prioritising economic growth over full employment. Still, softening the implications for fired employees remained a policy goal of social partnership.

How – Policies and industrial activities

Global recognition and technological leadership in steel production started in the 1950s with the development and implementation of the basic oxygen furnace LD-process. Based on pride and connectedness with the steel company over generations. It formed a cultural identification with the industrial character of the region, which helped to overcome the collapse of the steel industry in the 1980s.

The first oil crisis in the early 1970s was a critical moment for the steel industry, leading to technological innovations for reducing energy consumption in steel making and a business model of trading with the Eastern Bloc to barter steel exports against oil.

The collapse was followed by a fundamental restructuring and reorientation towards highly research-intensive steel production and specialised manufacturing industry, including for the automotive industry. This was accompanied by an active labour market policy. The **Stahlstiftung ("steel foundation")** played a transformative social, economic, and labour market role for the region of Upper Austria by supporting blue- and white-collar workers and managers affected by industrial restructuring, particularly. It is recognised as Austria's first labour foundation **for managers and workers** and a **model for active labour market policy** (Huemer et al., 2021; Wagner and Lassnigg, 2005).

The foundation substantially mitigated the effects of mass layoffs in Oberösterreich, especially following the economic crisis and downsizing within the steel sector. It offered affected workers career counseling, retraining, skills development, and psychosocial support at a time when public policy moved away from early retirement programs. Up to four years of vocational orientation, further education, and guidance were offered to help former steelworkers and other participants make a successful transition to new jobs or career paths. The Stahlstiftung coordinated with the Austrian Employment Service (AMS) and local industry, providing direct support through educational allowances and covering retraining costs, which led to a reintegration rate of around two-thirds (AMS Studie) for job seekers in the region.

Long-Term Effects of this was that over 9,000 people (out of a total of 70000 employees) were supported, stabilising the regional labour market and helping preserve social cohesion through periods of industrial volatility. The foundation continues to provide coaching, financial support, and guidance for individuals facing redundancy, with high satisfaction rates and ongoing state recognition for its role in quality management and social responsibility.

What happened – actors and outcomes

The collapse of the steel conglomerate in 1986 led to its dismantling, restructuring and stepwise privatisation from the late 1980s to the 1990s. Voestalpine reemerges as a **steel producer with an R&I-intensive product portfolio** and Austria being among the 5 largest steel production sites in Europe.

The **Stahlstiftung ("steel foundation")** was established in Linz in 1987 by Voestalpine and other companies in coordination with unions and the Austrian Employment Service (AMS). It helped to reintegrate around two-thirds of job seekers in the region within a few years. Upper Austria was able to absorb and adapt to industrial crises with social resilience, keeping labour skills relevant and maintaining high rates of economic participation among displaced steelworkers.

Lessons and insights for EU policy

- Europe is in a similar position to Austria was in the 1980s, on the national level, being confronted with a Zeitenwende, **whole-of-society transformation**, including other global players weakening Europe's industrial competitiveness.
- **Overcome outdated remedies for healing a sick patient**: Consider the iron and steel industry as more than a sick patient that can be cured with a short-term industrial policy.
- Industrial policy for energy-intensive industries requires **a whole-of-society approach,** and the role of the state should **not be reduced to derisking of investors**. It should rather be considered in the context of transformative change and thus policy mixes related to socio-economic, ecological and technical transitions and phase-in and phase-out policies (Algers & Åhman, 2024).
- Industrial, energy, infrastructure, research, social, climate and environmental policies, etc., should be aligned based on a **shared vision corresponding with the long-term character** of both energy **infrastructure and technical life-time** of iron and steel plants.
- Whole-of-society engagement of the **industry in collaboration with unions and state actors on all governance levels** to enhance resilience of the sector and **create solidarity for the hardships** of industrial recovery and transformation.
- As a pioneering, **innovative labour market policy**, the public-private partnership initiative **Stahlstiftung** could become a model for similar programs in Europe. It proved to soften the transition from traditional steel employment into diversified industrial and service roles, helping **keep skilled workers and managers with entrepreneurial spirit in the region** rather than pushing them into long-term unemployment or forced migration.

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A3.10 The two transitions to alternative fuels in the Norwegian maritime industry

Table 16 Case summary of the two transitions to alternative fuels in the Norwegian maritime industry

Category	Details
Location	Norway – national
Temporal scope	1980–present
Policy orientation	Transition away from heavy fuel oil and marine diesel fuel in shipping
Sectoral focus	Norwegian maritime industry and North Sea oil and gas
Enablers addressed	Broadening industrial resilience
Lenses addressed	Socio-technical; socio-political; socio-ecological; socio-economic; socio-cultural

Source: Own elaboration

Introduction

The OPEC oil crisis in the 1970s led to a decrease in demand for tankers. Collapse of Norwegian tanker and bulker shipbuilding in the 1980s. Norwegian production decreased by nearly 90% (in tonnage). Discovery of oil in the North Sea in the 1970s changed the structure of the Norwegian industry – a new offshore industry with a large increase in exploration in the 1980s, and the discovery of LNG in 1984, Snøhvit, Barents Sea. Norwegian shipbuilding changed to specialised PSVs and ferries. The growing importance of the offshore energy industry led to the state taking control of Statoil, the national oil and gas producer. There was little domestic demand for gas, as Norway had a hydroelectric power system. This led to Norway producing gas for export. There were initial studies for the use of LNG in shipping.

Simultaneously, there was an increasing change in Norwegian politics and society in understanding environmental issues. At the end of the 1980s and into the 1990s, NOx emissions were becoming an increasing concern (e.g. local air pollution from shipping in Bergen harbour). The Norwegian prime minister, Per Brundtland, led the Brundtland Report on sustainable development, published in 1987. The desire to find a market for LNG and the requirement to reduce local air emissions led to a Norwegian programme to develop LNG ferries in the early 1990s, due to the strong leadership of the Brundtland government. Norwegian manufacturers had expertise in LNG engines for ships. These developments led to the first LNG ferry, Glutra, delivered in 2000. Statoil was under pressure to reduce NOx emissions and ordered LNG PSVs in 2001. More LNG ferries followed. In 2007, the Norwegian NOx fund was introduced, taxing NOx emissions, but using the proceeds to support LNG vessels.

This led to a boom in Norwegian LNG ships. However, after 2012, there was a decline in LNG shipbuilding, partly due to the economic crisis of 2008-2009, but also due to a growing perception of the importance of GHG emissions reduction. Although LNG has almost zero NOx and SOx emissions, LNG only reduces GHG emissions by up to 20% in the most favourable circumstances. This led to a drop in support for LNG ferries. Instead, alternative technologies were becoming more popular. Development of batteries for electric ferries had started in 2010 in Norway, to drastically reduce GHG emissions. The first battery electric ferry, Ampere, was delivered in 2015.

Norway had agreed to 40% GHG emissions reduction obligations under the EU and Paris agreements. Within the IMO (International Maritime Organisation), Norway agreed to a target of 50% reductions in coastal shipping by 2035 compared to 2005. By 2019, battery technology had developed rapidly, and maritime hydrogen applications were beginning to emerge. There was strong Norwegian government

support for both battery applications and the development of hydrogen fuel cells and hydrogen production and supply systems (SINTEF 2019). The public company ENOVA, funded to support energy efficiency and low-carbon technologies, has funded the development of a hydrogen supply chain in Norway. There are pilot green hydrogen production hubs, e.g. Hellesylt Hydrogen hub, and, in the same way as for LNG, there is government funding for green hydrogen ferries. The world's first hydrogen ferry, MF Hydra for the state ferry operator Norled, was delivered in 2021. Two hydrogen ferries for the Bodø-Lofoten route are being built in Norway for delivery in 2026 and will operate on green hydrogen produced in Bodø. The operator Torghatten Nord is also converting two LNG ferries to operate on biofuels.

Overall, the Norwegian has orchestrated not just one but two technical transitions in the maritime industry from 1990, the LNG boom to 2015 and then batteries, followed green hydrogen technologies from 2010 onwards. This case is an unusual example of resilience in changing competitive conditions and a changing socio-political environment. Shipbuilding is a major industry in the Norwegian economy and in the late 19th 20th centuries had the largest deepwater cargo fleet after the UK. Shipping is also a fundamental part of Norwegian culture, from the Vikings through polar exploration with Nansen. When the industry faced collapse, it was able to change markets and technology to become a world leader in complex vessels and new fuel systems. A second technological transition is happening, and Norway is now a world leader in battery applications and hydrogen for ship propulsion.

How – policies and industrial activities

Norway had a very strong tradition of shipping and shipbuilding, but faced a collapse due to the 1970s oil crisis and global competition from the development to global dominance of shipbuilding in Asian countries: Japan, then South Korea and more recently China. The industry survived by developing new, complex designs to meet a new growth market in PSVs for the North Sea and ferries. This capability for advanced technology in ship design and shipbuilding gave the industry the capability to enable national policy for supporting technology development to reduce NOx through LNG systems.

This enabled the Norwegian shipbuilding industry to become a world leader in LNG for PSVs and ferries. When the policy environment changed to requirements for GHG emissions reduction as well as NOx emissions, the Norwegian government R&D support changed to battery and hydrogen technologies, complemented with government procurement of new battery and hydrogen ferries. Norwegian technology capability has been strong enough to move from being a world leader in LNG maritime technologies to being a world leader in battery and hydrogen technologies.

What happened – actors and outcomes

A combination of stakeholders was involved. The Norwegian shipbuilding industry was supported by a very strong R&D innovation system of universities and maritime research institutes in Norway. The new oil and gas industry was built on Norway's maritime capability to develop a new offshore oil and gas industry in Norway, with a new market for PSVs. Norwegian environmental policy on NOx and then GHG emissions was enacted in two ways: 1. market creation with the NOx fund and government company procurement of ferries through government ferry operators (in particular NORLED). 2. R&D funding for power trains and fuel supply, including regulation development.

Lessons for EU policy: Industrial resilience to changes in the competitive environment

- Established industries can adapt to a new competitive environment by changing to a new market if they have a high technical capability.

- A new market must be identified, in which the industry can apply its engineering and market knowledge.
- A rapid change is necessary, and this will require policy support to create demand in a new market or a new area in an established market, possibly with government procurement as part of market creation.
- This needs to be combined with governmental R&D support.
- Such strong political support is unusual. In this case, the cultural importance of shipping as well as a culture which values the natural environment very highly resulted in powerful environmental regulation and effective industrial policy.

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A3.11 Barcelona's Fab City: Distributed Urban Production and Resilience

Table 17 Case summary of distributed urban production and resilience in Barcelona's Fab City

Category	Description
Location	Barcelona, Spain
Temporal scope	2014–2020
Policy orientation	Sustainable production and consumption
Sectoral focus	Health
Enablers addressed	Broadening the scope of industrial resilience; whole-of-society approach
Lenses addressed	Socioeconomic; sociotechnical; socioecological; sociocultural; sociopolitical

Source: Own elaboration

Introduction

The case of the Barcelona Fab City responds to the challenge of overreliance on globalised, resource-intensive supply chains by demonstrating how localised, circular production systems can reduce carbon footprints, material waste, and external vulnerabilities. The Fab City model envisions cities as productive, self-sufficient ecosystems capable of addressing local challenges such as energy, manufacturing, and material use while remaining connected to global innovation networks. It promotes a shift from cities that primarily consume to those that produce, through distributed micro-factories embedded in the urban fabric. This model builds on the global network of Fab Labs: digitally equipped workshops that enable non-professionals to design and manufacture a wide range of products, from circuit boards to housing, using computer-controlled tools. The importance of these distributed and adaptive production systems became evident during Barcelona's response to the COVID-19 pandemic, when the city's Fab City network played a pivotal role in mobilising local manufacturing capacity.

Why – Challenges and policy goals

When COVID-19 spread across Europe in early 2020, Barcelona was hit hard like many other global cities. By June 2020, Catalonia recorded close to 75,000 infections and 13,000 deaths, of which about 21,000 infections and 4,300 deaths occurred in the city of Barcelona. In this context of crisis, characterised by rising infections, economic shock, disrupted supply chains, and strain on public services, local actors and the city government were pressed to find rapid solutions. The established network of Fab Labs in Barcelona, already active in open-source design, university and business collaboration, and community prototyping, became a frontline resource.

How – Policies and industrial activities

Barcelona's Fab City movement began in 2014 as a vision for localising production and closing material loops within the city. The initiative, a network of several fab labs arising out of an idea developed in the early 2000s at Massachusetts Institute of Technology (MIT), sought to equip citizens and small enterprises with tools and training for rapid prototyping, repair, and small-scale manufacturing. By 2019, dozens of labs were active in Barcelona, supporting open-source design communities and collaborations with local universities, businesses, and the city administration. These efforts laid the groundwork for rapid adaptation during the COVID-19 crisis.

Barcelona's Fab City network played a pivotal role in addressing urgent shortages of protective equipment for hospitals, social services, and retirement homes. Makers across the city mobilised to produce protective face shields approved by the Catalan Health Service, respiratory masks, door openers to minimise surface contact, and ear protectors for elastic-strap masks. Most of this equipment was produced using personal 3D printers at home, with production volumes and designs continuously adapted to the evolving needs of hospitals and municipal services. To coordinate these efforts, district-level nodes were established to collect, assemble, disinfect, and distribute the produced items. The first batch of equipment reached hospitals only seven days after Spain declared a state of emergency.

Recognising the strategic value of this civic-industrial mobilisation, the Barcelona City Council designated its network of Ateneus de Fabricació (fab labs facilitating citizen-led socio-digital innovation) as essential infrastructure. These facilities remained operational during the lockdown, providing staff, technical expertise, and over two dozen 3D printers to scale up production using open-source designs. Within weeks, local and municipal fab labs together met the demand for protective equipment across all hospitals in the city and metropolitan area, mitigating the impact of disrupted global supply chains.

This experience illustrated a highly innovative form of co-production of public goods and services, enabled by trust-based collaboration between civil society, technical experts, and local authorities. The effectiveness of the response stemmed from pre-existing cooperative relations within the maker community and between civic and municipal actors. Crucially, the city council's respect for the network's horizontal governance model and open-source ethos ensured agility, inclusiveness, and legitimacy in the collective response.

What happened – actors and outcomes

The experience of the COVID-19 pandemic accelerated the integration of distributed manufacturing into Barcelona's policy and regulatory frameworks. City authorities revised zoning rules to allow for more small-scale urban production, and further investments were made in training, digital skills, and materials recovery. Community networks that developed during the crisis continued to support circular economy initiatives, low-carbon manufacturing, and experimentation with neighbourhood-scale production. The Fab City initiative demonstrates how investment in digital competencies and distributed manufacturing systems can reinforce urban resilience. By embedding technological innovation within social and institutional frameworks, it exemplifies how the twin transitions (digital and green) can be operationalised at the local level to foster circularity and reduce supply chain vulnerabilities.

So what – Lessons for EU policy

- **Resilience through distributed, adaptive production**: Industrial resilience can be enhanced by developing localised, flexible production ecosystems which can serve as a buffer against global supply chain disruptions.
- **Embedding innovation within civic and institutional networks**: Integration with civil society institutions enables coordination and a scaling of local responses, while supporting long-term transformation in how goods are produced and circulated.
- **Digital capacity and social infrastructure as resilience assets**: The combination of digital capacity and social infrastructure turns technical capacity into coordinated, resilient action.
- **Proactive transformation beyond the crisis**: Disruption is an opportunity to further institutionalise resilience, through a strategic reconfiguration of urban-industrial systems.

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A3.12 Decentralized military innovation in Ukraine under the Russian invasion: hybrid governance, integrated resilience and institutional learning amid a perfect storm

Table 18 Case summary of decentralised military innovation in Ukraine under the Russian invasion

Category	Description
Location	Ukraine
Temporal scope	2014–2025, including gradual emergence (2014–2022), full-scale invasion and rapid experimentation (2022–2024), and scaling and institutionalization (2024–present); ongoing transformation under wartime conditions.
Policy orientation	Building resilience through polycentric innovation ecosystems; rapid innovation cycles; digitalized coordination; supply chain diversification. Directly relevant to EU strategic autonomy and defence industrial strategy.
Sectoral focus	Defence technology and unmanned systems; electronic warfare; battlefield management software
Enablers addressed	Resilience as a multi-dimensional and dynamic capability; whole-of-society engagement through polycentric governance and multi-actor collaboration
Lenses addressed	Socio-technological; socio-economic; socio-political; socio-cultural

Source: Own elaboration

Introduction

Ukraine's defence-industrial transformation since 2022 demonstrates industrial resilience under conditions where conventional analyses predicted almost immediate collapse. In early 2022 and in the following years Russian strikes destroyed or damaged multiple production, logistics and energy facilities. Yet, despite prolonged aggression and daily attacks, Ukraine managed to build a polycentric innovation and industrial ecosystem linking manufacturers, the military, civil society and international partners.

This case speaks directly to EU policy priorities around strategic autonomy, resilience, security and competitiveness amid growing geopolitical tensions. The European Commission's Defence Industry Transformation Roadmap explicitly cites Ukraine as an example of how dual-use innovation, software-driven systems, and organizational agility enable rapid capability development (European Commission, 2025c). The case complements that perspective by emphasising polycentricity and resilience as important features of a highly agile and iterative transformation (Alshamy et al., 2024). It explores how Ukraine built transformative capacity through polycentric networks that countered the limits of a parallel hierarchical system, enabling rapid innovation where products move from concept to deployment much faster. These changes also prompted an evolution in the state's role from monopoly provider and single articulator of demand to a more multi-faceted role that also includes platform provision and enabling of change.

The case also illustrates risks inherent to open innovation under adversarial conditions. Rapid innovation enabled the development of new capabilities, yet similar openness allowed adversary observation and copying (Alshamy et al., 2024; Kryzhanivska, 2025a). Attacks on energy infrastructure revealed how industrial capacity depends on cross-domain resilience spanning power, logistics and cybersecurity: disruption of a single node can produce significant ripple effects (International Energy Agency, 2024; Udovyk et al., 2025; United Nations Human Rights Monitoring Mission in Ukraine, 2024). The tensions between speed and security, openness and protection, domestic capacity and global integration showcase how industrial systems can evolve and build resilience under pressure.

Why – challenges and needs

Before 2022, Ukraine's defence industry operated through the state conglomerate Ukroboronprom, which oversaw numerous state-owned enterprises and was characterised by limited transparency that deterred investment (Stockholm International Peace Research Institute, 2025). Since 2014, reforms proceeded gradually under pressure from civil society and foreign partners but remained incomplete when the full-scale invasion began. The evolution toward civil-military fusion was enabled through a long-term culture of civic agency and created preconditions for the wartime response (Calcara et al., 2023; Kudlenko, 2023).

The transformation of Ukraine's defence capabilities, industrial base and innovation system represents a rapid, converging response to systemic disruptions and the broader challenges of a wartime economy. Russia's full-scale invasion in February 2022 targeted production and energy sites, creating acute challenges for facility location and necessitating relocation and restructuring of production, together with anti-missile protection measures. Manufacturers adapted by dispersing production across multiple sites to reduce targeting vulnerability; this dispersal can be interpreted as a practical expression of polycentric defence that reduces single-point failure while enabling experimentation and local knowledge use (Alshamy et al., 2024; Stockholm International Peace Research Institute, 2025a)

Ukraine's industrial and innovation ecosystem focused on integrating operational feedback in real time to rapidly develop, test, deploy and refine solutions. The battlefield created continuous pressure for technological advantage, and Ukraine showcased multiple innovations, including rapid UAV scaling and software-driven architectures (Bondar, 2025; Kryzhanivska, 2025b). However, innovations in battlefield conditions can be rapidly observed and copied, compressing the durability of advantage; open innovation thus enabled rapid development but also fostered adversary learning. Domestic dependence on external components further constrains scalability: export restrictions can take effect in weeks, whereas component localisation requires years of investment, producing structural vulnerability (Polovenko, 2025).

The case is also significant for insights into the implications of accumulated pressures, such as sustained strikes on energy infrastructure, which created acute vulnerabilities for industrial operations. Repeated attacks on Ukraine's energy infrastructure caused extensive harm to generation capacity, prompting decentralised and often improvised responses for manufacturing power supply and underscoring the need for cross-domain resilience investments.

How - policy mechanisms and instruments

Ukraine's response combined digital platform architecture, institutional innovation and allied financing mechanisms that transformed traditional defence procurement logic.

BRAVE1 Defence Technology Cluster. Launched in April 2023 by several Ukrainian ministries, BRAVE1 provides infrastructure for the innovation ecosystem, including grants, testing facilities and coordination for startups and small teams developing military technologies. By reducing barriers to entry, BRAVE1 enabled capability-based contracting and facilitated rapid feedback loops between developers and frontline users (Cabinet of Ministers of Ukraine, 2023; Directorate-General for Defence Industry and Space, 2025)

Digital procurement platforms. Ukraine developed digital platforms that substantially shortened procurement timelines and enabled more direct procurement between military units and manufacturers, while supporting coordination across the ecosystem. This bottom-up, decentralised approach supports quick testing in battlefield conditions and integrates end-user feedback into industrial processes. The

institutionalisation of dedicated training (e.g., Army of Drones) and the formal creation of an Unmanned Systems Forces further reinforced these feedback mechanisms (Ministry of Defence of Ukraine, 2025)

Allied financing mechanisms. Several allied governments began paying Ukrainian factories directly to produce for Ukrainian forces, bypassing traditional equipment transfers. In 2024, partner nations (including Denmark, Sweden and Iceland) started to scale financial mechanisms to support procurement for Ukrainian manufacturers. This mechanism both secures timely weapons provision and creates structural incentives for domestic defence-sector growth (English, 2025; Ministry of Defence of Ukraine, 2025). The approach has attracted wider EU interest and informed initiatives such as BraveTech EU to accelerate knowledge transfer and joint development (Directorate-General for Defence Industry and Space, 2025).

Energy decentralisation. Ukraine pursued a partial decentralisation of power generation, deploying distributed capacity and smaller units more resilient to targeting. Cities and utilities rely increasingly on distributed generation and microgrid-type configurations to keep critical services and manufacturing running during grid disruptions, illustrating that industrial capacity requires investment in supporting infrastructure (International Energy Agency, 2024; Udovyk et al., 2025).

What happened – actors and outcomes

The transformation unfolded through several phases that progressively institutionalised transformative capacities, intermediary functions and polycentric coordination.

Foundation building (2014–2022). Early volunteer networks after Russia's 2014 invasion developed parallel supply and support structures outside state institutions, including training and early drone use that scaled rapidly after 2022. These networks crowdfunded equipment, adapted commercial systems and coded software while state capacity caught up, establishing operating patterns where distributed actors could coordinate without centralised direction (Kudlenko, 2023).

Emergency response (2022–2023). During 2022–2023, Ukraine's military innovation and production diversified dramatically, with hundreds of state-owned and private producers scaling capacity through wartime relocation and hybrid ecosystems integrating startups via initiatives like BRAVE1. Private firms increased their share of state orders, and new defence companies demonstrated the ability to deliver solutions rapidly (Cabinet of Ministers of Ukraine, 2023). Despite rapid expansion, centralisation of financial flows persisted in 2022–2023, raising challenges in transparency, funding efficiency and resource distribution amid corruption risks and import dependencies (Polovenko, 2025).

Platform institutionalisation (2023–2024). BRAVE1 and digital procurement platforms institutionalised the shift from state monopolist to state as platform provider, enabling coordination across multiple decision centres rather than strict hierarchical command. This illustrates polycentric governance, where distributed actors coordinate through platforms and where capability demand signals guide industry toward greater innovation and readiness (Directorate-General for Defence Industry and Space, 2025; Marsh et al., 2024).

Allied integration and governance tensions (2024–2025). Allied financing mechanisms expanded and began to evolve from emergency measures into structural components of Ukraine's defence-industrial financing. Partnerships with Western companies have catalysed reforms while also pressing Ukraine to address corruption and inefficiency in some arms companies. The European Commission's Roadmap and related initiatives signal deeper integration between the EU and Ukrainian defence innovation ecosystems

(Directorate-General for Defence Industry and Space, 2025; European Commission, 2025c). These developments are accompanied by tensions about preserving the distributed character while adding accountability and coordination, as well as balancing speed and oversight, requiring ongoing negotiation.

Lessons and insights for EU policy

Ukraine's transformation offers insights for EU innovation, defence and industrial policies, particularly on their interlinkages:

- **Rapid response requires long-term investment**. Sustained development of volunteer networks and civil-military relationships since 2014 created latent capacities that supported Ukraine's rapid 2022 experimentation and further scaling.
- **Polycentric systems reduce single-point failures.** Polycentric governance leverages local knowledge, enables experimentation and broadens participation, fostering agility that bridges peacetime procedures and wartime innovation needs.
- **Resilience is dynamic and multi-dimensional.** It emerges from managing interdependencies across energy, cyber, supply chains and workforce skills; each component matters for overall performance
- **Distributed production requires platform coordination.** Dispersion of production capacities offers resilience against targeting but demands interoperable digital platforms and modular systems to coordinate actors and sustain rapid reconfiguration
- **Domestic baselines are essential to balance external dependencies**. Strong local sourcing at the materials and component level is critical for scalability and mitigation of supply-chain disruption
- **Openness fuels rapid innovation but risks adversary learning;** governance frameworks are needed to ensure velocity enhances rather than erodes security
- **Cross-domain coordination is essential**. Long-term success depends on linking procurement, energy resilience, cyber defence, industrial capacities and strategic intelligence to enable ongoing learning and oversight

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A3.13 Resilience amid geopolitical shocks: The resilience of Japan's electronics industry in the rare earth crisis (2010)

Table 19 Case summary of the resilience of Japan's electronics industry in the rare earth crisis

Category	Description
Location	Kinki region, Japan
Temporal scope	2010
Policy orientation	Supply chain resilience; competitiveness
Sectoral focus	The NdFeB permanent magnet industry, and related sectors including renewable energy and advanced technologies (e.g., robotics and defence systems)
Enablers addressed	Broadening the scope of industrial resilience
Lenses addressed	Sociopolitical (key); socioeconomic

Source: Own elaboration

Introduction

Shifts in global geopolitical power are intensifying tensions among economies that dominate the production of critical materials and technologies, with direct impacts on European and global supply chains. For instance, in April 2025, China imposed stringent export restrictions on heavy rare earths and permanent magnets, citing national security concerns. The decision disrupted European industries, particularly in the automotive sector, which faced shortages of essential components. These developments underscore the urgent need for Europe to reassess and fortify its supply chain strategies to ensure industrial resilience.

Japan's response to the 2010 rare earth crisis provides a compelling illustration of how a geopolitical supply shock can catalyse industrial transformation, policy-led diversification, and innovation. The case is highly relevant for Europe because it involves the NdFeB permanent magnet industry, which is strategically critical. These magnets are essential for clean energy and advanced technologies, powering wind turbines, electric vehicle motors, robotics, electronics, and defence systems. Despite being a major consumer, Europe has minimal domestic magnet production capacity and relies overwhelmingly on imports from China. This dependence constitutes a critical vulnerability, but at the same time, addressing it presents an opportunity for a more resilient, clean industrial base in line with the EU's Green Deal and Critical Raw Materials Act.

Why – Challenges and policy goals

In September 2010, the captain of a Chinese fishing trawler sailed into waters near the Senkaku/Diaoyu Islands, rammed Japanese Coast Guard vessels that tried to enforce Japan's administrative claims over the islands and their environs, and was subsequently detained. The Chinese government demanded the captain's release and an official apology. Following the incident, China allegedly slowed or suspended rare earth exports to Japan, targeting materials essential for high-tech industries such as magnets, electric vehicles, and renewable energy technologies.

At the time, China controlled around 97% of global rare earth production, while Japan held dominant intellectual property and manufacturing capabilities in high-performance NdFeB magnets. Twelve of the top 13 firms in processing rare earths were headquartered in Japan. This created a structural dependence on Chinese raw materials and exposed a critical vulnerability in Japan's industrial base. Prices for materials

such as neodymium and dysprosium, which are key components in the high-performance magnets, rose sharply, affecting Japan's high-tech and energy sectors. The crisis revealed the systemic risks of concentrated supply chains and prompted coordinated action by Japanese industry and government to strengthen strategic autonomy and long-term supply chain resilience.

How – Policies and industrial activities

Before the 2010 crisis, Japanese policymakers and firms had recognised the growing risks associated with China's dominance in the rare earth market and had begun proactively restructuring the sector to mitigate potential supply disruptions. The New National Energy Strategy of May 2006 outlined a comprehensive approach to strengthening resource security through enhanced resource diplomacy, energy and environmental cooperation, and strategic use of Official Development Assistance (ODA) to support overseas resource development and mutual investment. These measures aimed to diversify supply sources and reduce dependency on single suppliers. In the years that followed, Japan complemented these policies with initiatives to promote recycling and stockpiling of rare metals, explore seabed resources, and foster innovation to lower material intensity and substitute rare earth elements in industrial applications.

During and after the crisis, industrial users accelerated these efforts. The Japanese Government allocated an additional 101.2 billion Yen (730 million EUR according to 2015 exchange rates) for securing rare earths and other natural resources in the context of promoting green innovation. The Japanese Business Federation, in its proposal for Japan's Trade Strategy, called for restoring the rules against restrictive measures affecting exports of rare earths under the WTO agreements. Recycling efforts, particularly for cerium in industrial applications, were intensified, supported by government-funded projects, demonstrating an early recognition of the benefits of circular economy principles. Firms and government-industry consortia rapidly innovated to reduce material intensity. Companies optimised magnet design, developed low-dysprosium variants, substituted rare earths in less-critical applications, and completely 'destroyed demand' in some industries. Users in consumer goods like purses, golf hat clips and ball markers, and headphones, for instance, did not need the high performance of specialised rare earth magnets but were using them because they were cheap. Programs sponsored by the New Energy Development Organisation (NEDO) and collaborations with private companies, research institutes, and universities such as Tohoku University accelerated the adoption of these innovations.

On the supply side, companies drew on existing stockpiles, though many chose to expand them in anticipation of ongoing disruption. Simultaneously, trade deflection and the circumvention of export restraints through Chinese intermediaries provided partial relief. More strategically, Japan accelerated the development of alternative sources: new mining operations in Australia (Lynas) and the United States (Molycorp, later MP Materials) ramped up production, supported by Japanese investment and long-term supply contracts which ensured stability. These initiatives diversified supply and reduced dependence on any single exporter: a classic resilience mechanism.

What happened – actors and outcomes

The result was a dramatic, permanent reduction in rare earth demand: from 2010 to 2013, overall consumption fell by roughly 60%, with reductions in neodymium and dysprosium of 70%, and cerium by 75%. This not only mitigated immediate supply risks but also increased the economy's flexibility and adaptive capacity for future shocks.

Not all responses to the 2010 REE crisis contributed positively to system resilience. The two most explicitly negative responses were as follows. The first is panic buying by Japanese companies, who tried to increase

their stockpile only after the Chinese export quotas came into full force, which contributed greatly to price increases. The second is illegal mining and smuggling of Chinese rare earths (estimated at 40% of the official production), which has devastating environmental and social effects.

The 2010 rare-earth embargo illustrates how rapid, medium-term, and long-term adjustments can collectively transform a highly vulnerable supply chain into a more resilient system. In the short term, measures like recycling, material substitution, trade deflection, smuggling, and inventory management helped sustain supply and sharply reduced immediate demand pressures. Over the medium term, technological innovations, particularly in magnet design and other rare-earth applications, reduced material intensity and altered demand elasticity. Long-term investments, such as opening new mines outside China, further reshaped supply dynamics and reduced global concentration risks. Crucially, Japanese business and government actors anticipated vulnerabilities in the rare-earth sector and initiated adaptation strategies even before the embargo, demonstrating proactive industrial resilience.

So what – Lessons for EU policy

- **Substitute non-critical uses:** Replace critical materials where they are not essential to reduce exposure to supply shocks.
- **Diversify suppliers and production nodes:** Encourage firms to secure multiple, geographically diverse sources of critical materials to reduce dependency and systemic risk.
- **Material efficiency and technological innovation:** Promote low-material-intensity designs and alternative technologies to support not only resilience to supply chain shocks but also cleaner production.
- **Public-private collaboration:** Facilitate coordinated industry-government planning to anticipate geopolitical risks and respond proactively.
- **Integrate resilience into industrial strategy:** Develop metrics to assess dependency, supplier concentration, substitution potential, and recovery capacity, complementing decarbonisation and critical raw materials strategies.

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A3.14 Building industrial resilience to environmental shocks: Insights from the 2011 flood disaster in Thailand (2011)

Table 20 Case summary of building industrial resilience to environmental shocks

Category	Description
Location	North-Central Thailand (Chao Phraya River Basin)
Temporal scope	Post-2011
Policy orientation	Supply chain resilience; competitiveness; climate adaptation; environmental disaster risk management
Sectoral focus	Automotive and electronics industries
Enablers addressed	Broadening the scope of industrial resilience
Lenses addressed	Socioecological (key); socioeconomic; sociotechnical

Source: Own elaboration

Introduction

Europe has strong flood defences, with countries such as the Netherlands, Germany, and Austria recognised as leaders in flood risk management. Yet vulnerabilities remain, as revealed in July 2021 when floods in the Rhine-Meuse region claimed over 240 lives and caused billions in damages, including significant impacts on industry. Climate change is expected to increase the frequency and intensity of such events, posing particularly high costs for transport, energy, and industrial sectors. Building a sustainable industry in Europe will therefore require designing supply chains and industrial structures that are resilient to flood risks. However, while green policies such as the Clean Industrial Deal emphasise geopolitical and decarbonization risks, some tend to overlook environmental risks.

Lessons from jurisdictions that have faced major floods can inform a redesign of Europe's industrial policy to foster more environmentally resilient industries. Thailand's experience in the 2011 'great' floods, which disrupted the automotive and electronics sectors, is especially insightful. Recovery efforts showed how resilience can be strengthened through cluster governance, multinational–local collaboration, and strategies in support of rebuilding operations while enhancing long-term adaptability and competitiveness against environmental shocks.

Why – Challenges and policy goals

Firms and suppliers in Thailand tend to cluster in a small number of industrial locations to reduce costs. From June to December 2011, Thailand experienced severe flooding, inundating seven industrial estates in the low-lying provinces of Ayutthaya and Pathum Thani. The floods were the result of a combination of natural and human-made factors. A strong La Niña event caused exceptionally high rainfall, filling reservoirs before successive tropical storms arrived. Limited river channel capacity, breaches of levees, and flat terrain amplified flooding.

During the flooding, the industrial estates experienced large manufacturing production losses, nearing 30 per cent, between October 2011 and January 2012, due to physical asset damage and/or supply chain disruptions. The inundated estates included a total of 804 companies, predominated by automotive and electronics industries, close to 60 per cent of which were owned or operated by Japanese companies. As a result, flood impacts affected not only the regional and national economies but also global supply chains. Following this event, the companies affected by the supply chain disruptions, supported by their nations

of origin, were keen to recover operations as soon as possible and restructure their operations in ways that mitigate the recurrence of major losses from environmental shocks.

How – Policies and industrial activities

In the automotive industry, recovery times varied from 29 to 174 days and depending on the extent of the damage suffered at the factories in question. Nissan recovered more quickly (29 days) than other auto companies in part because its operations were mostly affected by supplier shortages rather than inundation, but also because of its pre-disaster structure. The firm had dissolved the Keiretsu system (a Keiretsu is a group of closely related family companies, often with interlocking ownership), diversified supply sources, globalised procurement, and maintained higher inventories. In contrast, Toyota lost almost the same amount of operating profit as Honda, even though Toyota's three assembly plants were dry while Honda's were flooded. The automobile sector suffered these enormous losses primarily because one company, which produces critical components, such as power integrated circuits and transistors, was inundated. This experience underscored that supply chain characteristics, for example, the dependence on critical nodes, inventory management, and supplier networks, determine the capacity for rapid recovery and adaptive resilience.

The recovery of the electronics industry was slower than that of the automobile sector. Constituent firms (e.g., Hard Disk Drive (HDD) companies) had facilities outside Thailand and could shift some production abroad, since electronics designs are highly portable across factories. However, because global HDD supply chains are highly concentrated (at the time predominantly in Thailand) and dependent on specialised components, bottlenecks persisted and slowed recovery. That said, the leading firm in the HDD industry, Western Digital, which had its factories inundated, took only six months to retake the lead in the market, and 2012 was actually a record high for the production of hard disk drives.

What happened – actors and outcomes

Following emergency measures, some of the automotive and electronics companies affected pursued longer-term resilience by moving their operations to places other than the original inundated industrial complexes. Furthermore, by 2014, companies had begun redesigning supply chains and shifting toward regional independence. For example, Toyota planned to move some production from Japan to the US and asked suppliers to mitigate risks by diversifying procurement, securing alternate facilities, and increasing inventories.

The 2011 floods also highlighted the importance of supply chains for the insurance industry. Swiss Reinsurance Company Ltd estimated its exposure at $600 million, with total industry losses around $10 billion, while Munich Reinsurance Company estimated $655 million. In Thailand, fire and profit insurance previously covered floods, unlike in countries such as Japan, which contributed to high insured losses. After the disaster, insurers introduced sub-limits for flood coverage, and the Thai government established the National Catastrophe Insurance Fund (NCIF) and the Catastrophe Insurance Policy (CIP) in 2012, allowing companies to insure against flood risks. The government also launched comprehensive flood prevention measures, including local defences, industrial park protection, infrastructure upgrades, river dredging, dikes, water gates, and forestation. The Japanese government, through JICA, supported Thailand with the Flood Management Plan for the Chao Phraya River, technical assistance for a Single Command Authority, and ongoing infrastructure improvements to maintain supply chain resilience.

The experience with the 2011 floods in Thailand showed that while complex supply chains are a source of increased risks, they nevertheless provide a network of trading partners and economic gains that can facilitate recovery. Overall, firms with extensive networks of suppliers had a quicker recovery.

So what – Lessons for EU policy

- **Diversify critical suppliers and production nodes**: EU industrial policy should incentivise firms to identify and diversify critical nodes to reduce systemic vulnerability.
- **Promote design and production flexibility:** EU industrial policy should incentivise firms to make design and production portable across sites, balancing substitutability with competitiveness.
- **Encourage regionalised production systems:** Support firms in creating regionally independent production networks to reduce dependence on centralised global supply chains.
- **Integrate insurance and financial mechanisms:** Develop robust public-private catastrophe insurance frameworks to cover environmental disaster risks in industrial supply chains.
- **Support cluster governance and multi-stakeholder coordination:** Formalise regional and cross-border cooperation among firms, governments, and partners to enhance industrial resilience.
- **Incorporate resilience metrics in industrial strategy:** Embed indicators such as alternative production sites, supply diversification, and recovery capacity into EU industrial planning.

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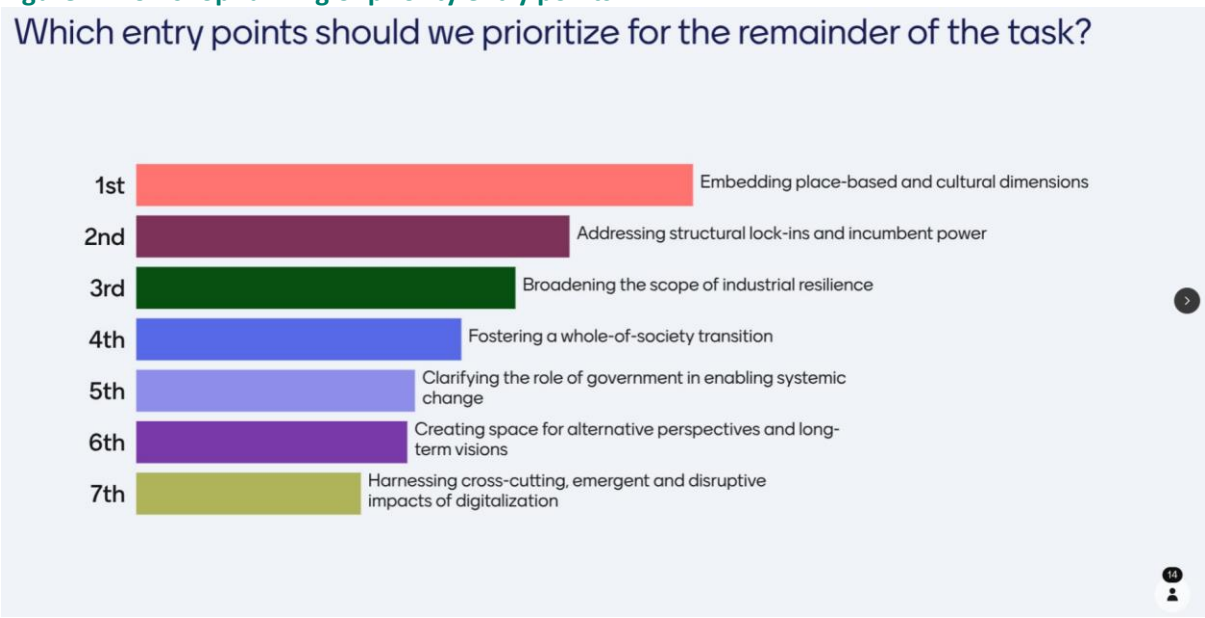
Annex 4. Enablers for industrial transformation workshop for EEA

This workshop aimed to reflect together on the work done so far, to receive insights on what enablers to specifically focus on in the continuation of the task for the remainder of the year and explore how this work can best connect with your activities. Your feedback will help us identify the most relevant entry points to focus on, in view of informing EU policy makers about the opportunities associated with a broader approach to industrial transformation and related enablers.

A background document prepared for the workshop has informed the report narrative; thus, the remainder of this Annex presents workshop results.

Figure 2 Workshop ranking of priority entry points



Source: Own elaboration

A4.1 Embedding Place-Based and Cultural Dimensions within the Industrial Transformation

Embedding geographical and cultural considerations into industrial policy is critical for sustainable and inclusive transformations. By highlighting place-specific strengths, addressing local barriers, and involving community stakeholders, regions can craft meaningful, adaptive, and culturally resonant policies. Empirical examples vividly demonstrate the potential and necessity of a place-based approach, reinforcing the call for nuanced, geographically explicit, and culturally attentive industrial strategies.

1. Importance of Place-Based and Cultural Contexts

Geography and are crucial factors shaping the feasibility, acceptance, and success of policy interventions. Top-down industrial policy often overlooks geographical nuances and cultural dynamics, leading to misalignment with local realities.

Discussion highlights

- **Regional infrastructures are rooted in local contexts:** industrial transformations should acknowledge the intertwining of ambitious goals and actual local capacities, infrastructures and development trajectories, including heritage, ageing infrastructure and previous failures and successes.

- **Acceptance and NYMB**: the speed, success and inclusivity of industrial transformations hinge on aligning with local values and practices. Local resistance is often rooted in perceived negative local impacts, is critical for policy acceptance.

- **The absence of geography**: geographical considerations remain underrepresented within influential reports (e.g. Draghi report) and policy agendas. This can reinforce the structural challenges of mismanaged industrial policy

- **Industrial clusters and symbioses**: Leveraging local resources and peculiarities of local infrastructure can increase chances of success. It is, however, necessary to move beyond idealised notions of industrial clusters toward practical, context-specific solutions is essential

- **Multi-level Governance**: Broader governance frameworks should include regional and local actors, fostering stronger alignment between policies and community needs. Industrial policies must actively bridge local community engagement to overcome cultural and economic detachment from broader transformations.

- **Geography of Mobility vs Accessibility**: addressing local transportation and accessibility disparities significantly influences the effectiveness of regional industrial strategies. The rural dimension also requires better recognition, but place-based does not equal rural and local.

2. Empirical Cases Illuminating Place-Based Insights

- **Territorial Just Transition Plans**: Transition strategies incorporating economic, social, and environmental elements tailored specifically to regions such as post-industrial areas in Poland demonstrate the power of comprehensive place-based planning.

- **Ports Transition (Rotterdam, Espia)**: These ports have adjusted successfully by responding to their geographic positions and cultural context, evolving their economic roles through spatially informed strategies, with examples such as shifts in focus, new processes and infrastructure and remanufacturing

- **Catalonian Regulatory Sandboxes**: The participatory co-design of regulatory frameworks, directly involving local stakeholders, demonstrates the effectiveness of place-based policy experimentation.

- **Water-Energy-Industry Nexus**: Local understanding of resource interdependencies highlights the importance of context-specific approaches to managing industrial ecosystems sustainably.

- **Urban Innovation Zones and University Campuses**: Cities and campuses becoming experimental grounds for innovation show how localised knowledge and resources foster contextually relevant solutions. Polish and Dutch cities as examples of the conversion of urban spaces.

- **Unpopular Jobs (Waste-Picking, Recycling)**: Recognising and addressing cultural perceptions and social stigmas around these jobs is critical for inclusive transitions. This also regards the concept of which jobs are deemed attractive, beyond what is considered 'quality jobs' in official policy documents.

- **Finland's Place-Based Experimentation**: Policy experimentation in Finland illustrates the effectiveness of geographically nuanced industrial strategies.

- **Learning from diverse engagement experiences:** there is no universal approach to harnessing cultural and contextual elements of industrial transformations

- **European monitoring of Industrial ecosystems**

3. Connecting to Policy Developments

For these insights to translate into tangible outcomes, policy developments must explicitly recognise and integrate geographical and cultural dimensions. Successful policy frameworks engage directly with local contexts, moving beyond one-size-fits-all approaches.

Explicit Examples:

- **Smart Specialisation (S3)**: The shift in DG Regio's approach towards more explicitly place-sensitive methodologies exemplifies strategic responsiveness to local contexts.

- **JRC's Partnerships for Regional Innovation**:

- **Efforts to align local-level Sustainable Development Goals (SDGs) with monitoring and implementation** reflect a deep commitment to localised policy innovation.

- **Rural Innovation Initiatives**: Emphasising rural innovation recognises and empowers traditionally neglected areas, utilising their distinct geographic and cultural strengths.

- **Capacity Building and Experimental Policy Journeys**: Developing policies explicitly oriented around local experimentation fosters adaptive, culturally sensitive, and geographically attuned policy frameworks around different types of industries

Notes on the way forward

- Elevate perspectives from critical geography and regional studies

- Explore the interplay of geography and culture

- Learn from a broad diversity of regional developments, but link to multi-level governance

- Elevate elements of regional identities that are particularly significant for industrial transformations, consider subsidiarity

- Challenges of integration and steering under diversity

- Cross-regional linkages and culture wars / divides over the future of industry

- Elevate the interplay of urban and rural
- Explore the diversity of cases across Europe, including different structures, transition dynamics and concepts of industrial development.
- Underline differentiated transformation pathways and capacity building needs, as well as areas of consolidation and collaboration

In connection with other perspectives

- Explore how geographical considerations play out in contexts of geopolitical crises and supply chain disruptions, but also with political volatility and change
- Explore the linkages to localised and multi-level aspects of resilience
- Connect local resistance to incumbency and lock-ins

A4.2 Addressing structural lock-ins and incumbent power

Why is this entry point important?

- Understanding: structural power, systemic lock-in and deliberate phased-out
- If you want to change something, go where the power is
- There are no historical cases of transition without breakdown and phase-out
- Important to understand the sources of power
- Important to understand why something is not happening while all other arguments are in favour

What empirical cases can help argue for this entry point?

- Fossil fuel subsidies (or industry more general)
- Historical cases of industrial de/reindustrialisation
- Discourse network assessment of Antwerp deceleration and the actors constructing that discourse. Transformation driven by other actors that have the capacity to act on opportunities to drive change (instead of fear). Companies activated by the green deal and now feel left behind
- Pluralising understanding of incumbency. And the transient nature of incumbency. (The incumbents of today are not necessarily the incumbents of tomorrow.)
- The role of social movements in the past in enabling transformative change

What policy developments should we be aware of/connect to?

- Work on power by Avelino
- Work on the phase out of Turnheim

Broader reflections or suggestions

- Variety of phase-out pathways (fast/slow, just/unjust, anticipated/passive, different scales) should be illustrated, perhaps on a particular sector, to point to the different ways these processes can be handled and anticipated by policy frameworks. For instance, different nuclear phase-out patterns across EU countries (including continuation). Also, historical coal phase-outs are very different. In agriculture, the phase-out of particular pesticides (DDT) occurred in parallel with the expansion of pesticide use, so scale matters.

- Without pointing fingers, it appears important to combine positive cases with less successful cases, to further underline the scope for improved handling of phase-out.

A4.3 Broadening the Scope of Industrial Resilience

Why is this entry point important?

- **A stronger emphasis on resilience and resource efficiency also sheds light on regional contexts and abilities**, enabling more future-proof policies for different regions.

- **Consideration of competition from cheaper non-EU countries with different socioenvironmental standards is crucial** for enhancing Europe's industrial resilience.

- **Circularity, resource-efficiency and resilience enable long-term competitiveness**. Measures targeting a circular economy and resource efficiency often have fewer environmental trade-offs compared for instance, end-of-pipe technologies. Some new technologies promoted might create new dependencies (e.g., nuclear-uranium import dependency). Circularity measures constitute low-regret or no-regret solutions for enhancing industrial resilience. Such measures are doubly important in the backdrop of the increasing scarcity of resources like cement and steel. Industry might need help preparing for longer-term material and water scarcity. An even broader perspective of a circular economy, beyond the current focus on waste, offers more options for strengthening industrial resilience. For instance, a bioeconomy also needs healthy soils and enough clean water to be productive.

- **More case studies needed to illustrate good practices**. Some social issues, such as the need for access to decent livelihoods and quality jobs, are dealt with in the current discussion on industrial resilience. However, there is a need for more explicit case studies illustrating good practices.

- **There is a need to clarify what resilience constitutes**. Resilience is defined differently by diverse actors. It could be defined in relation to climate change, for instance, the associated impacts on water and biomass availability. The industrial transformation to low carbon could be challenged without adaptation to water scarcity and floods, and to disruptions in the water cycle. However, resilience can also be defined differently.

- **Industrial resilience is interdependent with resource use and with security.** For instance, the drive to re-shore mining activities in the EU to promote strategic autonomy has environmental implications. Such nexuses between natural resources and industrial competitiveness justify arguments for responsible stewardship of the resources that underpin production. An EEA agenda on broadening industrial resilience could connect responsible resource stewardship to key priorities in Europe.

What empirical cases can help argue for this entry point?

- Cases in energy-intensive industries, elucidating their access to energy and the potential to electrify these hard-to-abate sectors. For example, the case of steel and cement in the construction sector – which Material Economics estimates at around 20-30% energy use globally - and the role building codes play, could be insightful.

- Cases relating to critical minerals:

  - Insights from such cases link to global stability (by potentially reducing the risk of "resource wars"): According to the scenarios developed by the European Commission, Europe will require between 15 and 60 per cent of the world's supplies of critical metals to implement the green transition: https://www.ivl.se/english/ivl/press/press-releases/2025-03-05-europes-requirements-for-critical-metals-are-unsustainable.html.

  - The Ongoing SUN2 project on the potential of the Circular Economy (CE) for critical raw material demand reduction. SUN2 has ongoing work to model the environmental and climate benefits of various CE interventions. The project has a database on the material resource consumption across industrial sectors that could be used to understand demand and bottlenecks, followed by an analysis of the potential to manage demand in target sectors. From 2028, the contents of this database will constitute official EU reporting.

- Cases could be developed based on the European Climate Risk Assessment (EUCRA) report (https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment).

- Case studies are the flagship of the EU's Climate-ADAPT platform; they showcase initiatives that are already being carried out in Europe. They have a comprehensive structure that covers all the key aspects in the implementation cycle of adaptation. https://climate-adapt.eea.europa.eu/en

- Case studies on "future risks" of not considering elements of resource efficiency and resilience in view of 'emerging sectors' like data centres could also be insightful.

- Overall, the EEA would appreciate examples of concrete cases from particular sectors.

What policy developments should we be aware of/connect to?

- Industrial resilience directive

- The Omnibus proposal. It encompasses changes (rollbacks) to the CSRD (Corporate Sustainability Reporting Directive), taxonomy (EU Taxonomy Regulation) and EPRTR (European Pollutant Release and Transfer Register), as a way to simplify EU sustainability rules and enhance competitiveness. It would be good to identify which topics in the omnibus are fixed and which ones are still up for consultation (and potentially openings to external influence).

- The preparedness strategy and strategic functions

- The climate adaptation plan

- The quality jobs action plan

- The 20 to 40 actions, roadmaps and legal proposals referred to in the Clean Industrial Deal.
- The upcoming circular economy act
- The net-zero industry act
- The state aid framework
- Sector-specific developments, for example, on battery recycling, steel and metals action plans, etc.
- The Emissions Trading System (ETS) and Carbon Border Adjustment Mechanism (CBAM)
- The upcoming bioeconomy strategy
- The Industrial Emissions Directive (IED) delegated acts and circularity targets (review and development of new BREFs (Best Available Techniques Reference Documents)). Unit ENV.1 of the European Commission's Directorate-General for Environment (DG ENV) will support the Commission in frontloading information for the review of the steel and cement BREFs, which give opportunities for highlighting circularity measures and benefits.
- Under the E-PRTR (European Pollutant Release and Transfer Register), industrial facilities will report on raw material consumption from 2028. ENV1 currently supports the Commission in determining the list of raw materials to be reported on.

Broader reflections or suggestions

- **Geopolitics is missing from the analysis**. Considering ubiquitous wars (such as Iran, Ukraine, etc.) and how they might affect policy development is crucial to include in analyses of the entry points to industrial transformation.