

THE ROLE OF TECHNOLOGICAL NEUTRALITY IN EU CLIMATE POLICYMAKING

ASSESSMENT AND ALTERNATIVES FOR STRATEGIC POLICIES

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EXECUTIVE SUMMARY

Technological neutrality is a key guiding principle for EU policymaking in many areas, including climate action and decarbonisation. While often presented as a clear and objective standard of regulatory design, both its meaning and effectiveness remain ambiguous and disputable. The urgency of the climate crisis demands rapid technological transitions. However, the study demonstrates through a critical academic review that technological neutrality systematically fails when applied to the complex, systemic transformations required for deep decarbonisation.

In addition, technological neutrality rarely functions as an operational rule for economic efficiency. Rather, it increasingly functions as a strategic communication tool deployed by incumbent interests to resist targeted interventions, obscure distributional consequences and protect legacy capital. Two case studies – the fierce contestation over the inclusion of nuclear energy in the EU Sustainable Finance Taxonomy, and the protracted political battle over the phasing out of internal combustion engines (ICE) – exemplify this situation. In both instances, technological neutrality was not applied as an ex-ante design principle, but rather invoked ex-post as a reactive mechanism to force symbolic inclusions, such as the e-fuels carve-out, and to delay systemic transitions that threaten incumbent industrial assets.

Pragmatic alternatives related to policymaking, economy and communication exist to counter the technological neutrality narrative and design more effective climate policies through mission-oriented innovation, developmental coordination and performance standards. With these alternatives, real discussions on the future of European industry and the protection of its workers can move forward, instead of delaying necessary transformations and decreasing the EU's competitiveness.

1. INTRODUCTION

Technological neutrality is a key guiding principle for EU policymaking in many areas, including climate action and decarbonisation. It is often presented as a pristine, objective standard of regulatory design – a commitment to letting markets, rather than governments, select the most efficient technological solutions. At its core, the principle dictates that legislation should neither mandate nor discriminate against specific technologies. **Yet, while the urgency of the climate crisis demands rapid, systemic technological transitions, technological neutrality rarely functions as an operational rule for economic efficiency. Rather, it increasingly functions as a strategic communication tool deployed by incumbent interests to resist targeted interventions, obscure distributional consequences and protect legacy capital.**

This policy study seeks to systematically deconstruct technological neutrality and the way it is used in EU policymaking, thereby exposing its structural flaws and ideological function. The policy study begins by discussing the meaning of technological neutrality, tracing its theoretical lineage from classical liberal economics, its appraisal in academic literature and its practical application in local governance. This critical review demonstrates that, while technological neutrality may work in narrowly bounded contexts to address well-defined externalities, it systematically fails when applied to the complex, mission-oriented transformations required for deep decarbonisation. In these transformative contexts, “neutrality” merely ratifies the dominance of mature technologies, suffocating immature but necessary innovations under the guise of formal equality.

The core of this policy study then examines how the concept is operationalised in contemporary EU policymaking. Two detailed case studies – the fierce contestation over the inclusion of nuclear energy in the EU Sustainable Finance Taxonomy, and the protracted political battle over the phasing

out of internal combustion engines (ICE) – reveal a consistent pattern. In both instances, technological neutrality was not applied as an ex-ante design principle, but rather invoked ex-post as a reactive mechanism to force symbolic inclusions, such as the e-fuels carve-out, and to delay systemic transitions that threaten incumbent industrial assets. Finally, the study charts pragmatic alternatives, outlining how policymakers can counter the neutrality narrative and design more effective climate policies through mission-oriented innovation, developmental coordination and performance standards. With these alternatives, real discussions on the future of European industry and the protection of its workers can move forward, instead of delaying necessary transformations and decreasing the EU’s competitiveness.

2. TECHNOLOGICAL NEUTRALITY: FROM GUIDING PRINCIPLE TO ILLUSION

2.1 What does technological neutrality mean?

Technological neutrality is a **contested regulatory principle, the implementation of which reveals tensions between market efficiency claims and strategic use by incumbents**. At its core, it holds that regulation should neither mandate nor discriminate against specific technologies, allowing markets to determine outcomes. This definition, codified in the EU's 2002 Framework Directive,¹ requires authorities to avoid imposing particular technologies or restricting providers' choices. The rationale is that technology-specific rules risk obsolescence, create lock-in and constrain innovation.²

The origins of technological neutrality lie in US debates on performance standards in the 1980s, which emphasised outcome-based regulation rather than prescribed technologies. A series of policy processes and regulations, such as the Federal Communications Commission (FCC) Computer Inquiries, the Telecommunications Act of 1996³ and the 1997 US Framework for Global Electronic Commerce,⁴ shaped how technology-neutral principles were institutionalised in US law and influenced subsequent EU approaches (see Box 1).⁵ In Europe, the concept developed through the 1999 Communications Review and subsequent legislation.⁶ Technological neutrality then mostly encompassed three meanings: (1) performance-based regulation allowing flexible compliance; (2) consistent regulation across technologies; and (3) a prohibition on steering markets toward specific outcomes. These meanings often overlapped but produced different policy implications. For example, technology-neutral spectrum licensing still requires regulatory approval for changes, exposing tensions between neutrality and administrative control.⁷

The EU's prevailing definition combines these strands in a common approach: regulation must neither impose nor restrict technologies.⁸ This establishes technological neutrality as an effects-based constraint on regulatory authority, requiring assessments of functional equivalence and discriminatory impacts. In practice, these assessments remain contested, turning a seemingly technical principle into a strategic battleground over technological transitions and incumbent protection.⁹ Overall, technological neutrality remains an ambiguous concept and policymaking principle. Importantly, tracing its origins underlines how the principle was initially developed to address a specific challenge linked to information and communication technologies, not as a guideline for all technology-related policies.

BOX 1. THE HISTORICAL ROOTS OF TECHNOLOGICAL NEUTRALITY IN TELECOMMUNICATIONS REGULATION.

Technological neutrality became central to US telecommunications policy through the FCC's Computer Inquiries (1966-1986), which addressed the convergence of telephony and computing.¹⁰ The challenge was to prevent dominant carriers, like AT&T, from leveraging infrastructure control to exclude competitors, while avoiding rigid technology mandates.¹¹ The FCC distinguished between "basic" transmission services and "enhanced" services involving data processing. Over time, regulation shifted from separating different parts of the industry to using rules that promote fair treatment, like nondiscrimination rules. This created a

framework where innovation could occur independently of dominant network operators.¹²

This approach is widely seen as a precondition for the internet's development, as it enabled open platforms while constraining incumbent power. It also influenced the US Telecommunications Act of 1996, which aimed to promote competition through technology-neutral principles.¹³ However, implementation challenges led to re-consolidation and mixed outcomes. More recent debates on internet neutrality illustrate the concept's ambiguity: while framed as technology-neutral, such rules impose specific technical obligations. Similarly, interoperability standards require some level of technological prescription, revealing a core paradox: neutrality often coexists with implicit standard-setting.

2.2 The ideological background behind the concept

In its current form, technological neutrality draws on **liberal economic theory** privileging market allocation over state-directed technological choice. Its roots lie in the critique of mercantilism proposed by classical political economy. Adam Smith argued that **government-imposed technologies and monopolies distorted markets and misallocated resources due to informational limits**.¹⁴ Friedrich Hayek's "knowledge problem" further highlighted that regulators lacked access to dispersed and evolving information about technologies and markets,¹⁵ making technology-specific mandates particularly error-prone in dynamic sectors.¹⁶ John Stuart Mill similarly warned that intervention often disrupted the link between effort and reward, unless justified by clear harm.¹⁷ German ordoliberalism refined this view by emphasising competition as a means

of preventing technological lock-in.¹⁸ Rather than prescribing technologies, the state should maintain a "privilege-free" competitive order, where outcomes are determined by performance.¹⁹ The liberal tradition, however, did not refuse all kinds of state intervention. Mill's political philosophy, for example, prioritised individual freedom, but allowed for state intervention when individual actions harmed others – a precursor to the do-no-harm principle.²⁰

It is important to acknowledge that these theories advocating for a certain type of technological neutrality were developed in contexts of static resource allocation and do not fully address systemic transitions requiring rapid technological change.²¹ In a system rapidly evolving and in need of rapid transformation, technological neutrality could equally be deployed as a principled application of liberal theory or delay the necessary changes by blocking state intervention.

2.3 Academic assessment of technological neutrality as a guiding principle in policymaking

Academic scholarship has subjected technological neutrality to increasingly systematic critique, exposing structural flaws that undermine its theoretical coherence and practical effectiveness as a policy principle. First, legal scholars identified foundational problems with prediction, penumbral ambiguity, perspectival inconsistency and the pretence of neutrality, which collectively demonstrate that the concept of technological neutrality operates as "both suboptimal and often self-defeating"²². Brad Greenberg's comprehensive analysis reveals that legislators fundamentally "cannot adequately predict whether and to what extent a law should regulate a new technology until that technology is known", meaning that **ostensibly neutral frameworks drafted for unforeseen technologies inevitably embed assumptions from existing technologies, producing poor tailoring and unintended discrimination against genuinely novel innovations**.²³

This critique identifies a more fundamental problem: **the myth of a neutral baseline**. Karl Polanyi's institutional economics demonstrates that markets themselves constitute politically constructed artifacts embedded within historically specific social relations, legal frameworks and power configurations, rather than natural states preceding intervention.²⁴ Ha-Joon Chang extends this analysis to technological development, documenting how contemporary "free market" economies emerged through extensive state direction of technology choice: from textile machinery restrictions to infant industry protection and defence procurement determining semiconductor trajectories. This means that technology-neutral policies applied to markets already shaped by historical interventions necessarily favour incumbents, whose dominance reflects prior political choices rather than intrinsic superiority.²⁵ The formal equality of treating all technologies identically thus produces substantive inequality: **established technologies benefit from accumulated infrastructure investments, institutional complementarities, workforce skills, supply-chain networks and regulatory frameworks** optimised for their operation, conferring massive advantages independent of neutrality rhetoric. Critical legal studies scholarship emphasises that this "formal equality, substantive inequality" dynamic operates precisely as technological neutrality's political function: obscuring distributional consequences behind technocratic language while entrenching existing power configurations.²⁶

Economic critiques expose the static-versus-dynamic efficiency trade-off embedded in neutrality frameworks. Joseph Schumpeter's evolutionary economics established that capitalist progress emerged through creative destruction. This approach acknowledges that discontinuous technological transitions might require temporary protection of inferior but potentially transformative innovations against market pressures favouring mature incumbents. Technology-neutral policies optimise static efficiency by selecting current lowest-cost options but **systematically underperform regarding dynamic efficiency, such as innovation, learning-by-doing and capability development generating long-term productivity growth**.²⁷ Giovanni Dosi's

path-dependency framework demonstrates that technological development exhibits increasing returns, network externalities and irreversibility that render "letting markets choose" insufficient for system-level transitions. Indeed, early advantages compound through learning curves and complementary asset co-specialisation, meaning neutral policies arriving after lock-in merely ratify incumbent dominance.²⁸ Christian Azar and Björn Sandén's empirical analysis confirms that **technology-neutral climate policies systematically favour mature technologies closest to market deployment while disadvantaging "promising but immature technologies" requiring support** to traverse development valleys; precisely inverting innovation priorities for decarbonisation.²⁹

Another economic critique highlights the "coordination failure" of technological neutrality, challenging the presumption that disaggregated market signals suffice for complex transitions. Albert Hirschman's development economics established that **transformative industrialisation required coordinated complementary investments across infrastructure, supply chains, skills and demand**. Since these investments are not internalised by individual profit-maximising actors, coordination traps occur where better technologies remain unexploited without orchestration.³⁰ Dani Rodrik's industrial policy framework extends this logic to contemporary technological transitions: achieving electric vehicle (EV) adoption requires simultaneous investments in charging infrastructure, battery production capacity, rare-earth mining, grid upgrades and regulatory frameworks. Such coordination problems cannot be solved by technology-neutral carbon pricing because individual actors face prohibitive first-mover disadvantages.³¹ This reveals the incompatibility between technological neutrality and mission-oriented policies addressing collective challenges. Mariana Mazzucato further demonstrates that **achieving societal goals, such as climate neutrality, pandemic preparedness and strategic technological sovereignty, requires directionality and prioritisation, not neutrality**. As will be further developed in Section 4, missions involve coordinating ecosystems of public and

private actors toward defined outcomes that markets alone will not generate.³²

Epistemic critiques expose how neutrality rhetoric masks political abdication. Sheila Jasanoff's science and technology studies argue that claims of technological uncertainty invoked to justify "letting markets decide" often constitute epistemic abdication, that is, **avoiding legitimate public deliberation about technological direction by falsely presenting directional choices as technical optimisation problems**.³³ Michel Callon's sociology of markets demonstrates that market devices themselves, such as pricing mechanisms, accounting standards and regulatory categories, embody contested political judgments about what constitutes equivalent technologies and comparable performance, meaning neutrality claims obscure value-laden categorisations as objective market discovery.³⁴ The depoliticisation function of technological neutrality proves particularly consequential: **framing inherently political decisions (which energy systems to build, which industries to protect, whose capabilities to develop) as technical market outcomes obscures responsibility and renders winners and losers invisible, undermining democratic accountability for consequential technological choices**.

The different critiques presented above point to a common conclusion: the demonstrated shortcomings of technological neutrality as a stand-alone framework render it unfit to guide the systemic transformations needed to decarbonise our economies and achieve climate neutrality. On a more general level, the principle of technological neutrality is unlikely to foster innovation. It is therefore important to question its function in climate and industrial policies (see Section 3).

2.4 Real-life implementation: (When) does technological neutrality work?

Despite substantial theoretical criticisms, a pragmatic assessment shows that, **in some specific contexts, technological neutrality can deliver effective policy outcomes**. These contexts

are characterised by functionally equivalent technologies addressing well-defined externalities through market mechanisms.

The **EU's Emissions Trading System (ETS)** is often considered an exemplary success case for technological neutrality. Launched in 2005 as the world's first international carbon market, the system caps total greenhouse gas emissions from power generation and heavy industry while permitting regulated entities to determine cost-minimising abatement strategies without prescribing technologies.³⁵ Despite persistent criticisms of low carbon prices relative to social cost estimates, a widely cited empirical assessment highlights its effectiveness in delivering "almost half of what EU governments promised to reduce under their Kyoto Protocol commitments"³⁶ and having "reduced overall EU emissions by 14-16 percent, relative to a no-policy counterfactual".³⁷ The EU ETS, as a technology-neutral carbon pricing mechanism, manages to reduce emission for different reasons: it deals with a global, fungible pollutant; it exploits large differences in abatement costs across firms; and it operates in sectors where usable low-carbon options already exist. However, while a substantial reduction in emissions was achieved, the EU ETS did not contribute to a broader transformation of the European industrial base or economy, nor did it contribute to any notion of just transition.

German municipal climate governance illustrates another context where technological neutrality can be considered a success. It operates within a multi-level system where federal targets coexist with local implementation flexibility. The Federal Climate Change Act sets national goals, while municipalities control areas such as buildings, procurement and infrastructure. Funding frameworks like the *Kommunalrichtlinie* embed technological neutrality by focusing on outcomes rather than specific technologies.³⁸ Cities will then pursue climate neutrality through targets and enabling frameworks rather than prescribing technologies, relying on municipal assets, planning tools and voluntary partnerships.³⁹ This reflects institutional constraints: municipalities lack authority to impose binding technology standards on private actors and

rely on higher-level support. As a result, technology neutrality is largely uncontroversial at the local level because regulatory capacity is limited. Where municipalities do exercise authority, such as in infrastructure or planning, technology-specific choices often emerge to ensure compatibility and efficiency.

Concretely, Freiburg's energy transition strategy and Heidelberg's co-creation framework operationalise technology-neutral approaches by focusing on domains under their direct municipal control: public building retrofits; district energy infrastructure; land-use planning; and voluntary partnership facilitation. These interventions avoid technology prescription not primarily through principled policy choice but because municipalities lack legal authority to impose binding technology mandates on private actors, which limits the municipalities to "soft" governance instruments.⁴⁰ This institutional configuration explains the pragmatic success of technological neutrality at local levels: municipalities function primarily as market participants selecting cost-effective technologies for their own operations rather than regulators constraining private choices, eliminating tensions between neutrality rhetoric and directive intervention.

The cases of the EU ETS and German municipal climate governance enable the identification of **success conditions**: technological neutrality works when addressing well-defined externalities with fungible impacts across functionally equivalent mature technologies; when regulatory intervention targets specific bottlenecks without requiring systemic coordination; and when regulatory authority remains bounded to domains where governments act as participants rather than system architects. The EU ETS succeeds because carbon emissions constitute location-independent pollutants that can be addressed through pricing mechanisms applied to sectors with existing technological alternatives. German municipalities succeed because limited competencies confine interventions to asset management and voluntary frameworks incapable of prescriptive technology mandates. Conversely, technological neutrality systematically fails where policy objectives require

coordinating complementary investments across interdependent systems, directing innovation toward immature technologies with learning potential, or orchestrating rapid transitions away from path-dependent incumbent regimes. This makes technological neutrality a poor guiding principle to address contemporary climate, energy and digital infrastructure challenges.⁴¹

3. TECHNOLOGICAL NEUTRALITY IN EU POLICYMAKING

The climate and clean technology domains display the most consequential political dimension of technological neutrality. Proponents argue that technology-neutral mechanisms, such as emissions trading systems covering all sectors, deliver cost-effective decarbonisation by letting markets select optimal solutions. The European Commission and figures like Mario Draghi have championed this approach as the most efficient pathway to net-zero targets. However, and as evidenced in the literature review presented in Section 2.3, technological neutrality presents many flaws. In the area of climate and clean technology, critics such as the Helmholtz Centre for Environmental Research contend that technology-neutral frameworks in renewable-energy support systematically favour mature, incumbent technologies over emerging alternatives with distinct deployment profiles.⁴² The renewable-energy industry has documented how technology-neutral auction schemes disadvantage nascent technologies like ocean energy⁴³ and offshore wind⁴⁴, which require differentiated support to achieve cost reductions through learning by doing. More fundamentally, recent analyses⁴⁵ reveal that technological neutrality is functioning as a rhetorical device in EU politics to maintain fossil-fuel dependencies. In hydrogen policy, calls for “technology neutrality” based solely on emissions intensity, without rigorous life-cycle accounting or clear thresholds, legitimise high-carbon production pathways while undermining genuinely sustainable alternatives.⁴⁶ This section analyses how technological neutrality has been operationalised in EU policymaking.

3.1 The status of the concept in fundamental EU politics

Technological neutrality occupies a distinctive position in the EU’s regulatory architecture: it is embedded as a **guiding principle across multiple policy domains yet lacking formal codification**

in primary treaty law, existing instead through secondary legislation, Commission guidance and doctrinal evolution. As mentioned in Section 2.1, the foundational articulation of the principle emerged in the European Commission’s 1999 Communications Review, where it was formally defined: “legislation should define the objectives to be achieved, and should neither impose, nor discriminate in favo[u]r of, the use of a particular type of technology to achieve those objectives”.⁴⁷ This formulation achieved legal force through the 2002 Framework Directive 2002/21/EC, which established technological neutrality as one of five core regulatory principles for electronic communications networks. Recital 18 of the Framework Directive specifies that national regulatory authorities must “take the utmost account of the desirability of making regulation technologically neutral, that is to say that it neither imposes nor discriminates in favo[u]r of the use of a particular type of technology”.⁴⁸ Subsequent telecommunications frameworks, including the 2009 Better Regulation Directive and the 2018 European Electronic Communications Code, reinforced this principle, establishing technological neutrality as “a key regulatory principle in the EU since the late 1990s” that has been “further reinforced by the emphasis on digital policy over the past decade”.⁴⁹

The European Commission’s Better Regulation Toolbox institutionalised technological neutrality as a **horizontal governance standard applicable beyond telecommunications**, stipulating that “[e]xcessively prescriptive and detailed regulation can create barriers to entry for innovative solutions, even if the innovation could contribute to achieving the policy goal of regulation”.⁵⁰ This guidance operationalises neutrality through specific recommendations: relying on functional rather than technological definitions, focusing on outcome requirements instead of prescriptive means, adopting principles-based regulatory frameworks, delegating implementation to independent regulatory authorities with adaptive

capacity, and employing soft-law instruments enabling bottom-up industry consensus through standards and codes of practice. The European Interoperability Framework explicitly identifies technological neutrality as Underlying Principle 5, arguing that “laws and regulations are technology neutral” because “regulations tied to a particular technology may quickly become obsolete and require further amendment”, while “technology-specific regulations lead to dependency on specific manufacturers”.⁵¹

Recent scholarship characterises technological neutrality in EU law through a procedural lens: **the concept fundamentally requires “delegation of the power to determine the technical contents of the law” to actors beyond the legislature**, whether these are regulatory agencies, standardisation bodies, industry consortia or regulated firms themselves.⁵² This delegation occurs because achieving neutrality necessitates that general legislative principles be translated into context-specific technical requirements by entities possessing specialised expertise and capacity for rapid adaptation to technological evolution. The General Data Protection Regulation exemplifies this approach: Article 25 on data protection by design and by default requirements and Article 32 on security obligations impose technology-neutral performance standards while delegating specific technical implementation to data controllers based on “the state of the art, the costs of implementation and the nature, scope, context and purposes of processing”⁵³. The Digital Services Act similarly invokes technological neutrality regarding platform content moderation systems, requiring transparency and accountability without prescribing technological solutions.⁵⁴

However, the application of the principle across EU digital regulation reveals significant ambiguity in the definition and inconsistent operationalisation. As the next section will demonstrate, the same ambiguity and inconsistency arise in climate-related cases.

3.2 Concrete policy cases: Nuclear energy and ICE

3.2.1 How was technological neutrality deployed in the discussion on nuclear energy and the EU Sustainable Finance Taxonomy?

The EU’s decision to include nuclear energy as a transitional activity in its Sustainable Finance Taxonomy followed a long dispute involving scientific debate; intergovernmental politics; and escalation through the Commission, Parliament and courts. Unlike most EU classification cases, the issue was not the carbon footprint of nuclear energy but whether its long-term waste risks could satisfy the “do no significant harm” (DNSH) standard of the Taxonomy and qualify it for green investment. Tracing the debates from the origins of the Taxonomy in 2018 to the inclusion of nuclear energy in the 2022 Complementary Climate Delegated Act and Austria’s unsuccessful 2025 legal challenge allows us to understand how technological neutrality was mobilised.

2018: The architecture of sustainable finance and the silence on nuclear energy

The European Commission’s Action Plan on Financing Sustainable Growth, published on 8 March 2018, established the institutional framework within which the taxonomy debate would subsequently unfold.⁵⁵ The Action Plan identified the **misalignment between private capital flows and the EU’s climate commitments as a structural problem requiring regulatory intervention** and tasked a new Technical Expert Group (TEG) on Sustainable Finance with developing a classification system for environmentally sustainable economic activities. A positive taxonomy classification carries significant financial leverage, as it makes assets eligible for green bonds, sustainability-linked instruments and institutional investor mandates. The stakes of the classification were therefore high. That the Action Plan left nuclear undiscussed was a political choice. By framing the taxonomy project around climate objectives and directing the TEG to focus on activities with a substantial contribution to climate change mitigation or adaptation, **the Commission allowed**

for nuclear energy to be plausibly included, while leaving the question formally open. This deliberate ambiguity would structure all subsequent debates.

2019: The TEG technical report and the deferral of nuclear

The TEG published its Taxonomy Technical Report in June 2019, identifying nuclear energy as a technology with life-cycle emissions broadly compatible with climate mitigation objectives but declining to recommend its inclusion on the grounds that the “DNSH” criteria for nuclear waste had not been adequately assessed.⁵⁶ The TEG explicitly **acknowledged the carbon performance of nuclear power while deferring its classification to a separate expert process.** In December 2019, the EU agreed on the new rules for green investments without resolving the nuclear question.⁵⁷ By institutionalising the ambiguity of nuclear energy rather than resolving it, the EU created a deferred decision with high and politically charged expectations on all sides.

2020: The taxonomy regulation and the nuclear question left open

Regulation (EU) 2020/852, adopted on 18 June 2020, established the legal framework for the taxonomy, again without resolving the nuclear question.⁵⁸ **The Regulation created the criteria and institutional architecture but explicitly left the classification of nuclear and gas to subsequent EC delegated acts,** acknowledging that these were politically sensitive determinations requiring separate assessment processes. The European Parliament and Council’s decision to defer was structurally significant: it preserved the formal openness of the classification question while ensuring that the political conflict over nuclear would be displaced to a later implementation phase with less democratic oversight, that is, the delegated act process. Environmental civil society actors recognised that leaving gas and nuclear for later was a political concession, reflecting the influence of member state lobbying (particularly from France).⁵⁹

The pro-nuclear coalition’s argument was structured around the concept of technological neutrality. It argued that a classification framework which

acknowledged renewable energy but excluded nuclear was not neutral between low-carbon technologies, making an implicit choice about which clean energy pathway was institutionally preferred. This framing would prove politically durable. **The concept of technological neutrality was thus entering the taxonomy debate, not at the moment of original design, but in response to the TEG’s deferral.** The ex-post character of the neutrality claim would define the entire subsequent process.

2021: The JRC report, scientific contestation and the formation of the pro-nuclear coalition

On 29 March 2021, the Joint Research Centre (JRC) published its Technical Assessment of Nuclear Energy with respect to the “DNSH” criteria of the Taxonomy Regulation, concluding that nuclear energy did not cause significantly more harm to human health or the environment than comparable energy sources and that existing nuclear waste management frameworks in member states adequately satisfied the DNSH requirements.⁶⁰ This was politically decisive: it gave the Commission the scientific basis it needed for inclusion. However, the JRC’s methodology and institutional independence were immediately contested. The SCHEER (Scientific Committee on Health, Environmental and Emerging Risks)’s review of the JRC report raised concerns about the long-term safety of nuclear waste disposal and questioned whether the assessment adequately addressed the evidentiary requirements of the DNSH criteria.⁶¹ Germany’s Federal Office for the Safety of Nuclear Waste Management (BASE) published a parallel expert response in April 2021 that was more sharply critical, arguing that the JRC had underestimated the risks of long-term radioactive waste management.⁶² **Scientific and expert assessments were therefore mobilised to both defend and counter the inclusion of nuclear energy in the Taxonomy.**

Simultaneously, a pro-nuclear intergovernmental coalition was organising at the member state level in March 2021, arguing that the role of nuclear energy in EU climate and energy policy was being systematically undervalued and urging

the Commission to ensure that the taxonomy classification reflected the genuine contribution of nuclear energy to decarbonisation.⁶³ The French Senate political delegation sent a separate letter to the Commission in November 2021 reinforcing this position and framing inclusion as a matter of both energy sovereignty and technological neutrality.⁶⁴ **These interventions were explicitly constructed as demands for non-discrimination and for the removal of what was presented as a bias against a proven low-carbon technology.** The neutrality claim in the nuclear case was thus used by incumbent, potentially polluting technologies, to resist sidelining. In December 2021, the EU further delayed its decision on gas and nuclear in its green investment rules, describing the deferral as a reflection of the political difficulty of the file.⁶⁵

February 2022: The Complementary Climate Delegated Act and the consolidation of opposition

On 2 February 2022, **the Commission published its draft Complementary Climate Delegated Act, formally proposing the inclusion of nuclear and fossil gas as transitional activities under the taxonomy under specific conditions, including for waste disposal.**⁶⁶ The Commission's Q&A document framed these conditions as a rigorous application of the DNSH criteria, arguing that the evidentiary requirements attached to nuclear inclusion were more demanding than those applied to any other technology category.⁶⁷ **The civil society response was immediate and sharply negative.** Among many others, AirClim and Climate Action Network Europe published a joint position arguing that fossil gas and nuclear were incompatible with a genuine sustainable finance taxonomy and urging the Commission to withdraw the proposal.⁶⁸ The European Environmental Bureau published a formal position on 19 January 2022 – in anticipation of the draft's release – arguing that the inclusion of nuclear energy violated the DNSH principles and amounted to a political override of the scientific assessment process.⁶⁹ Greenpeace EU described the proposal as “greenwashing” and argued that classifying nuclear as sustainable would fatally undermine the taxonomy's credibility as a tool for

genuinely climate-aligned investment.⁷⁰ The S&D Group in the European Parliament sent a letter to the Commission in January 2022 expressing formal concern about the draft Complementary Delegated Act, arguing that the inclusion of nuclear and gas was incompatible with the taxonomy's founding objectives.⁷¹

July 2022: The European Parliament's failed objection and the entry into force of the Act

On 5 July 2022, the European Parliament debated and voted on a motion to object to the Commission's Complementary Climate Delegated Act under the scrutiny procedure available under the Taxonomy Regulation.⁷² The motion was defeated: 328 MEPs voted in favour and 278 against, falling short of the majority required to block the delegated act. The Commission Delegated Regulation (EU) 2022/1214 entered into force on 15 July 2022, formally including nuclear energy as a transitional activity in the EU Taxonomy.⁷³ The regulation represented a clear win for the pro-nuclear coalition. The University of Manchester's Political Perspectives analysis argued that the energy crisis triggered by Russia's invasion of Ukraine had played a decisive role in reshaping the political arithmetic around nuclear inclusion: energy security considerations had reframed the taxonomy debate in terms of strategic industrial necessity.⁷⁴ This contextual dynamic is analytically significant. **The neutrality claim was reinforced by an energy security argument that changed the political calculation.**

October 2022-September 2025: The Austrian legal challenge and its failure

Austria filed an action for annulment of the Complementary Climate Delegated Act before the General Court of the EU on 7 October 2022.⁷⁵ Austria's legal strategy targeted the procedural and substantive foundations of the act: it argued that the inclusion of nuclear energy was incompatible with the DNSH criteria of Regulation (EU) 2020/852 and that the Commission had exceeded its delegated powers by introducing conditions for nuclear classification that the Taxonomy Regulation parent text did not authorise. The transition from political contestation to litigation is a structural feature of

the EU regulatory process: when the Commission's delegated act blocks parliamentary reversal and coalition politics have settled the issue, litigation becomes the last resort for actors who cannot accept the outcome. The General Court issued its judgment on 10 September 2025, dismissing Austria's action.⁷⁶ The Court found that the Commission had acted within its delegated competence and that the conditions attached to nuclear inclusion were not incompatible with the DNSH criteria, as established by Regulation (EU) 2020/852. **The Court thereby supported the Commission's position that equal assessments had been carried out for the different energy sources and technological neutrality had thereby been applied.**

The legislative outcome in perspective

The purpose of this case study is not to defend or oppose the inclusion of nuclear energy in the taxonomy but to reflect on the use of technological neutrality in policymaking. Across the seven-year nuclear discussion, "technological neutrality" shifted from an implicit assumption in the taxonomy design to a decisive rhetorical instrument in disputes between member states, civil society actors and the Commission via its proxy – the DNSH principle. **Technological neutrality was deployed ex-post, once the classificatory trajectory had become politically costly for specific state and civil society actors, rather than serving as an ex-ante principle shaping the original architecture of the taxonomy.** At each critical juncture – 2019 (TEG deferral), 2020 (Taxonomy Regulation adoption), 2021 (JRC report publication) and most clearly in 2022 (Complementary Delegated Act and Parliament vote) – neutrality claims followed, rather than preceded, the policy direction already embedded in institutional commitments. They functioned as retrospective justifications, not as inputs into policy design.

3.2.2 How was technological neutrality deployed in discussions about the ICE phase-out?

The EU's decision to end the sale of new ICE passenger cars by 2035 was the outcome of a

long sequence of policy discussions, regulatory tightening and strategic signalling around transport decarbonisation that unfolded over more than a decade.⁷⁷ Early EU policies tightened CO₂ standards, promoted electrification and set long-term climate goals that implicitly limited the future of ICE technology. Over time, stronger climate ambitions, better batteries and the European Green Deal turned this implicit direction into an explicit regulatory endpoint.⁷⁸ The timeline below traces how technological neutrality appeared in ICE phase-out discussions.⁷⁹

2016: Directional commitment without a specific endpoint

The European Commission's Communication on a European Strategy for Low-Emission Mobility, published on 20 July 2016, affirmed that transport must be largely decarbonised by mid-century and identified electrification and zero-emission vehicles as key to that transition.⁸⁰ It did not call for an ICE ban or specify which technologies would achieve the goal.⁸¹ This deliberate openness reflected both the state of the industry at the time and a characteristic feature of early-phase EU regulatory design, namely, that trajectories are announced before any distributional consequences are made explicit. Nevertheless, the strategy embedded implicit technological assumptions which shaped the debate that followed. Indeed, **the EC established a framework that made electrification central to road transport decarbonisation** and set a 2050 horizon. The 2016 strategy did not raise the question of technological neutrality.

2017: CO₂ standards, industry coalition-building and the first explicit invocations of technological neutrality

On 8 November 2017, the Commission published the Europe on the Move package, which contained a proposal for new CO₂ emission standards for cars and vans covering the period beyond 2020 and through 2030.⁸² The Commission's modelling acknowledged that reaching the 30% reduction target by 2030 would require large-scale electrification.⁸³ **For the first time, an EU car-sector proposal assumed a structural technological**

change rather than incremental improvements to the ICE. The industry's response was immediate.⁸⁴ In a joint statement, ACEA, CLEPA and IndustriAll declared that “decarbonising road transport will require a number of different pathways, technologies and solutions” and concluded that “technological neutrality is therefore essential to underpin Europe's manufacturing leadership”.⁸⁵ This is one of the earliest explicit references to technological neutrality in the EU's car CO2 standards debate.

This sequence reveals two important elements. Firstly, technological neutrality was not used as a design principle from the start, but as a response to the direction defined by the Commission. In other words, **the industry was not saying that regulation should be neutral before any path was chosen**; it only mobilised this argument when it deemed that the chosen path was not aligned with the preferred trajectory. Secondly, the joint industry statement, by calling for technological neutrality and “a number of different pathways”, shifted the debate from the overall goal of decarbonising transport to the choice of technologies to achieve this goal. This framing allowed the industry coalition to oppose specific regulatory instruments without seeming to reject climate goals.⁸⁶ Appeals to technological neutrality were strongest where existing assets, such as ICE factories, supply chains and engineering expertise, faced the greatest risk of loss.

2019: The European Green Deal hardens the endpoint

On 11 December 2019, the European Green Deal made climate neutrality by 2050 the EU's strategic objective and set the target of a 90% cut in transport emissions by 2050, relative to 1990, as the sector goal.⁸⁷ The Green Deal had a clear implication: continued widespread use of fossil-fuel vehicles was not compatible with the policy path. This direction became more binding and left less room for other technological options. The Green Deal did not rule out the neutrality argument. By leaving the technology mix unspecified at the highest level, it kept space open for competing technological claims. This is typical of transformative regulation: **broad commitments delay, rather than settle, questions**

about which technologies will be excluded. Actors who realised the Green Deal would reduce the value of ICE investments could use neutrality arguments later on, because the framework still left room for them. In this way, technical neutrality helped delay decisions about which technologies should be chosen.

2020: Consultation, mobilisation and competing visions of technology policy

The 2020 consultations on climate action and the Sustainable and Smart Mobility Strategy were the first chance for organised interests to formally respond to the Green Deal's transport plan.⁸⁸ FuelsEurope used these consultations to advance the case for renewable liquid fuels based on technological neutrality arguments, consistently emphasising that **a technology-specific approach privileging battery EVs would foreclose viable low-carbon alternatives**.⁸⁹ The submissions by FuelsEurope used scientific evidence selectively, relying on life-cycle and well-to-wheel analyses to argue that liquid renewable fuels could cut emissions but leaving out criticism that those claims depended on unrealistic assumptions about scale. The evidence was not used to question the need for deep transport decarbonisation, but to support the case that synthetic fuels could be part of the solution.⁹⁰

The September 2020 Climate Target Plan, which raised the EU's 2030 emissions reduction target from 40 to 55%, left no room for ambiguity in the Commission's modelling: meeting the revised target would require near-total zero-emission new car sales by the early 2030s.⁹¹ For the automotive and fuels sectors, this made the technology question much more urgent. If the Commission was building the path to decarbonisation around electrification, then the space for fuel-based alternatives was quickly narrowing. The response of the industry was to **intensify engagement around the concepts of technological openness, innovation and competitiveness**.⁹² These terms helped bridge free-market language with the fact that the same actors were also seeking state protection for existing industries. In practice, the neutrality argument hid the exclusion of technologies that a real decarbonisation

policy would inevitably create. A policy that reaches for near-zero fleet emissions by a target date cannot be fully neutral between technologies; it must favour some options over others, which means that exclusion happens through the market outcome rather than the wording of the rule.

2021: Fit for 55 and the crystallisation of industry opposition

The 14 July 2021 Fit for 55 package proposed a 100% CO₂ reduction target for new cars by 2035. *Reuters* framed this as an effective ban on new fossil-fuel car sales, shaping public debate as much as the proposal itself.⁹³ ACEA immediately released a statement warning that “without the availability of renewable fuels, a 100% reduction target in 2035 is effectively a ban of the internal combustion engine”, and **urging EU institutions to “focus on innovation rather than mandating, or effectively banning, a specific technology”**.⁹⁴ BusinessEurope stated that the target was “not in line with the principle of technological neutrality” and that it “disincentivizes investments into crucial technologies such as liquid low-carbon and renewable fuels”.⁹⁵ FuelsEurope argued that the Commission’s standard unfairly privileged battery EVs and failed to recognise the decarbonisation potential of synthetic and renewable fuels.⁹⁶

These interventions were strategically coherent. **By framing the Commission’s tailpipe-only standard as a violation of neutrality rather than as a legitimate policy choice, the industry coalition positioned itself as the defender of innovation and market openness against bureaucratic technology mandates.** The neutrality argument functioned precisely as a legitimising narrative shielding the industry’s actual interest, namely, the protection of incumbent capital, from direct scrutiny. By invoking neutrality, actors could contest the ICE phase-out without openly arguing against the decarbonisation target, thereby **avoiding the reputational cost of opposing climate policy while still pursuing an outcome that would delay or dilute the transition’s impact on their industrial base.** Clean Energy Wire noted at this time that “parts of the German car industry [...] have long fought to keep the combustion engine car alive”, and

that strong lobbying was directed at softening the 2035 target and the 2030 milestone.⁹⁷ The pattern was clear: technological neutrality claims were strongest where jobs and capital were at risk, and they were often turned into demands for exceptions like e-fuels carve-outs.

2022: Parliamentary endorsement and opening of the e-fuels question

The European Parliament voted on 29 June 2022 to back the Commission’s proposal with 339 in favour, 249 against and 24 abstentions. The Parliament simultaneously issued a mandate for trilogue negotiations. The rapporteur and the Renew Europe group, which had shaped the compromise, emphasised that the targets provided “clarity for the automotive industry and stimulate innovation and investment”.⁹⁸ Commission supporters used the same innovation and neutrality arguments to defend the regulation, claiming that stable rules were the most technology-neutral way to encourage innovation without choosing a specific technology.

By October 2022, the provisional trilogue agreement kept the 100% CO₂ reduction target for 2035 but added a review clause and later treatment of carbon-neutral fuels. Transport & Environment welcomed this as a landmark deal.⁹⁹ German press coverage of the provisional agreement already showed coalition tensions over e-fuels, and the FDP expected the review clause to create room for synthetic fuels. **The review clause, a provision formally designed to enable policy learning, was functioning simultaneously as a deferral mechanism,** shifting conflict to a future of technological possibility without reopening the 2035 target.

February-March 2023: Germany’s veto threat and the decisive role of technological neutrality

The critical juncture arrived in February 2023. On 28 February, Federal Transport Minister Volker Wissing, the FDP’s representative in Germany’s governing coalition, **declared that an effective ban on combustion engines was unacceptable unless it included a clause for vehicles running on “climate-friendly e-fuels”**.¹⁰⁰ The Council vote was

postponed, and Germany subsequently formed an informal alliance with Italy and other member states to withhold consent. The German intervention was not an ex-ante design argument. Rather, it was an ex-post attempt to reopen a process that had been politically settled, even if the review clause left a narrow legal opening for further debate.

Deutsche Welle and Clean Energy Wire reported that the FDP's support for synthetic fuels reflected domestic political interests as opposed to climate policy, especially in car-producing regions of Germany.¹⁰¹ The eFuel Alliance framed the German intervention as a vindication of technological neutrality, having consistently argued that CO₂-neutral synthetic fuels should count as equivalent to zero tailpipe emissions and that excluding them constituted regulatory discrimination.¹⁰² In its own analysis, Transport & Environment warned that e-fuels were constrained by supply and efficiency limits, and that the compromise on e-fuels, which the German position was partly constructed upon, risked becoming a loophole rather than a genuine policy opening.¹⁰³ What the exchange between the eFuel Alliance and Transport & Environment illustrates is a recurring pattern: **scientific and expert assessments were selectively mobilised not to resolve the fundamental strategic choice between EV-centred and fuel-based decarbonisation pathways, but to stabilise the political status of contested technologies.** The debate did not produce new empirical agreement; it produced competing technical framings of a conflict, the origins of which were political and economic.

25-28 March 2023: The e-fuels compromise and formal adoption of the regulation

On 25 March 2023, the German Federal Ministry and the Commission agreed that the Commission would propose “without delay” a framework allowing vehicles running exclusively on CO₂-neutral fuels to be registered after 2035.¹⁰⁴ The eFuel Alliance confirmed the agreement and described it as the “first steps” toward a regulatory category for e-fuels-only vehicles. *Politico* noted that the FDP's core industrial interest was in **preserving the commercial viability of combustion engines**, especially for car

makers who had already invested in synthetic fuel production.¹⁰⁵ A few days later, the Council formally adopted Regulation (EU) 2023/851, with the e-fuels declaration annexed as a political commitment from the Commission. *Euronews* described the outcome as a “win for Germany”.¹⁰⁶

In structural terms, however, the outcome is better understood as an instance of symbolic inclusion without systemic endorsement.^[43] The 2035 zero-emission target remained intact. **The e-fuels carve-out was narrow, technically conditional on the exclusive use of CO₂-neutral fuels and – as Transport & Environment's subsequent analysis showed – practically limited by the scarcity of synthetic fuel supply at any commercially relevant scale.** The dominant transition pathway was not genuinely reopened, as the architecture of electrification remained the structural logic of the regulation. What the compromise delivered was not a real alternative pathway but a **political settlement that allowed the German government to claim a principled victory for technological neutrality** while the EU maintained the core of its regulatory design. This dynamic shows how the neutrality discourse worked: the Commission could claim openness while the rules still made electrification the main outcome. The FDP and e-fuels lobby could claim a future for combustion engines, if only for a very small market niche. The regulation translated a political fight into a technical exception out of reach of democratic accountability. This let both sides claim victory, while the **real conflict over industrial assets and transition costs was postponed** rather than settled. This constitutes a win for the ICE lobby as its lifespan was extended.

The legislative outcome in perspective

Across the seven-year arc from the 2016 Low-Emission Mobility Strategy to the formal adoption of Regulation (EU) 2023/851, “technological neutrality” evolved from a technical design criterion in regulatory modelling to the decisive rhetorical instrument of a high-stakes political confrontation.¹⁰⁷ This evolution followed a consistent pattern: the concept was invoked after the regulatory path became politically costly for certain industrial and national interests,

rather than shaping the original design. At each critical juncture (2017, 2021, 2022 and especially 2023), **neutrality claims appeared in response to a direction already embedded in institutional commitments, not as inputs to the design of those commitments**. What the 2035 ICE phase-out shows is that the regulation reflected the fact that EVs were the practical route to near-zero fleet emissions, while the e-fuels carve-out was a narrow political concession that did not change the overall direction. In this sense, technological neutrality functioned in the 2035 case less as an operational rule governing the regulation's content and more as a political instrument allowing affected and strong interest groups to slow down an unwelcome process.

3.3 Technological neutrality as an ideological principle and communication device

The two case studies reveal how technological neutrality is used in policymaking and its consequences. Firstly, **a consistent pattern can be observed where technological neutrality enters regulatory debates as a reactive instrument**. This timing is telling: policymakers invoke it once regulatory trajectories have already become politically costly, as a response to mounting opposition, rather than as an organising principle from the outset. Technological neutrality operates less as an operational rule and more as a legitimising narrative, as it shields policymakers from the accusation of picking winners.

Secondly, **once neutrality rhetoric enters the debate, the terms of discussion shift in different ways**. Whether it is openly acknowledged or not, every regulatory framework embeds implicit assumptions about infrastructure readiness, about which technologies can realistically scale and about how much time the transition allows. Invoking neutrality conceals these assumptions behind a language of openness, leaving them unexamined and uncontested and preventing necessary discussions. In addition, collective outcomes, such as decarbonisation speed and the distribution of transition risks, give way to questions about

individual technological options. This fragmentation is politically consequential: accountability disperses and responsibility for systemic outcomes becomes harder to assign. Finally, fundamentally, political compromises get reframed as technical exceptions, taxonomy "conditions" for nuclear energy and niche carve-outs for e-fuels. The political character of the decision retreats behind the appearance of procedural fairness.

Thirdly, both cases show that **neutrality arguments gain the most traction precisely where incumbent capital stock and industrial employment face write-down risks**. Automotive engine manufacturers and nuclear baseload operators stand to lose the most from decisive regulatory exclusion. Neutrality language offers these actors a politically legitimate foothold for resistance. The concept also performs a temporal displacement function. By gesturing toward future potential technological breakthroughs, such as advanced nuclear and scalable e-fuels, neutrality arguments defer conflict rather than resolve it. Hard choices get projected forward in time, providing political breathing room without addressing the underlying structural tension and without addressing the socio-economic consequences of potentially declining industries. It is a hidden choice for short-term profits over long-term economic stability, since it prevents honest discussions and planning for a just transition process that protects workers or for a large-scale technological reorientation of industries.

4. APPROACHES FIT TO ADDRESS 21ST CENTURY CHALLENGES

4.1 Pragmatic alternatives for efficient European policymaking

The obvious limitations of technological neutrality have renewed interest in policy frameworks that favour strategic coordination and clear outcomes over market primacy. The adherence to technological neutrality tends to obscure or delay real policy choices that governments make to shape markets through rules, infrastructure and funding. Alternative approaches make these choices explicit and link them to clear outcomes. The ones presented below reject the idea that regulation should stay neutral and let markets do the rest. Instead, they favour an active government role in steering technology, whether through mission-led direction, developmental coordination, strategic trade policy or outcome-based rules. As exemplified in the OECD's recent guidance on industrial policy, bringing these ideas together requires additional practical steps: setting up inter-ministerial coordination; clarifying roles across government levels; creating independent advisory councils; and building partnerships with business, unions and regional authorities.¹⁰⁸ This institutional architecture reflects the idea that **directive economic policy needs not only different tools, but also stronger overall state capacity.** It means moving from passive rule-setting to active market-shaping, with coordination, strategic foresight and the political legitimacy to make directional choices that technological neutrality avoids.

The following alternatives share a preference for democratic transparency over “faux neutrality”. Policy choices reflect priorities such as risk, transition speed, and how costs and benefits are shared. Governments can state these choices openly, allowing public debate and strengthening legitimacy and support for long-term policy.

4.1.1 Mission-oriented governance

Policy can start from defined public objectives rather than abstract efficiency goals. Governments set targets such as zero-emission mobility by a given year or a fully decarbonised power sector within a fixed timeframe. The key is alignment: regulation, public finance and procurement should all point in the same direction. This reduces fragmentation and gives firms a stable planning horizon. It also allows governments to track progress against delivery milestones rather than relying only on price signals.

Mariana Mazzucato's mission-oriented innovation policy represents the most systematically articulated alternative to technological neutrality, fundamentally reframing the state's economic role from market-failure corrector to market-shaper and co-creator. Rather than establishing neutral frameworks within which private actors optimise, mission-oriented approaches define specific societal challenges, such as climate neutrality, pandemic preparedness and mobility transitions. They then organise public institutions to determine “the direction of growth by making strategic investments throughout the innovation chain” from basic research through commercialisation to demand-side procurement.¹⁰⁹ This framework explicitly rejects the market failure theory that constrains government to “fixing” isolated inefficiencies while “allowing the playing itself to be done by the dynamic business community”. Instead, it positions innovation policy in a “market creation framework” where achieving missions “requires public and private sectors to work together, and a state both willing and able to take on extreme risks, independent of the business cycle”.

Operationally, mission-oriented policy employs decentralised strategic agencies with entrepreneurial mandates, exemplified historically by DARPA, NIH and ARPA-E, that function as lead investors willing to absorb high failure rates while directing

innovation toward predetermined objectives rather than technology-neutral optimisation.¹¹⁰ In an article for the International Monetary Fund's Finance & Development publication, Mariana Mazzucato characterised this approach as requiring governments to "shape markets, not just fix their failures" through outcome-oriented financing tools and institutions that "align with missions (the vertical component of new industrial strategy, in place of sectors in the old) and invest in the broader ecosystem (the horizontal component)".¹¹¹ Contemporary applications include the UK's *Invest 2035* industrial strategy, which explicitly embraces "actively shaping and directing the economy in this targeted way" through government prioritisation of specific subsectors where "policy can address barriers to growth"; the coordination of "simultaneous investments or complex value chains"; and partnership structures ensuring systematic alignment across national, regional and sectoral levels.¹¹²

4.1.2 State as market-shaper, not referee

Markets do not emerge on their own. They are structured through standards, subsidies and public demand. Governments can acknowledge this role and act accordingly. This means designing markets with a clear end state in mind. For example, setting rules that favour low-carbon production or creating lead markets through public procurement. The aim is to guide investment toward transition outcomes rather than assuming that neutral rules will produce them.

Modern industrial policy frameworks revive earlier developmental state approaches associated with Chalmers Johnson, Alice Amsden and Robert Wade, who showed that East Asian industrialisation relied on strategic state direction rather than neutral market mechanisms.¹¹³ These approaches emphasise **small, capable bureaucracies; close ties between state and business; and targeted tools such as infant-industry protection, directed credit, export requirements and technology transfer mandates.**

Dani Rodrik and Ha-Joon Chang brought this logic into mainstream economics by showing why strategic intervention could be justified where

coordination failures, learning spillovers and capability gaps blocked market-led adjustment.¹¹⁴ In a similar vein, the strategic trade policy developed by Paul Krugman and extended in Brander-Spencer models argues that subsidies or protection can be rational in imperfectly competitive sectors where governments can shape rents and market position. Although these approaches face real risks, including weak information, retaliation and capture, they support active intervention when neutral policy is unlikely to produce the desired industrial outcome.¹¹⁵

4.1.3 Conditional industrial policy

Governments already deploy subsidies and public investment at scale. A pragmatic approach attaches conditions to this support. These can include emissions reductions, local production, technology deployment targets or social conditionalities.¹¹⁶ Contracts-for-difference provide one example, where public funding is linked to measurable outcomes. The conditionality approach reduces the risk of passive subsidy and ensures that public spending delivers structural change.

Performance standards are one well-known form of conditionality, especially in emissions and environmental policy. They set measurable outcome requirements while leaving firms free to choose how to comply. Unlike design standards (see below), which mandate specific technologies and can create lock-in risks, **performance standards allow flexibility through process changes, fuel switching or other low-carbon solutions.** The International Panel on Climate Change (IPCC) notes that they can lower costs precisely because firms retain discretion over compliance, although they still require regulators with the capacity to set, monitor and update stringent targets as technologies evolve.¹¹⁷ Conditional industrial policy can also take other concrete forms. Another example is carbon contracts for difference, which are widely discussed as a way to support industrial decarbonisation by paying firms the gap between a market carbon price and a higher strike price, thereby making low-carbon production financially viable while tying support to verified emissions outcomes.¹¹⁸ Another is **local**

content requirements, which condition access to public support on domestic sourcing or production and are often used to build local industrial capability, although they can raise trade and efficiency concerns.¹¹⁹

4.1.4 Standards-led transition pathways

Standards can provide direction where markets struggle to coordinate. Governments can set clear and progressively tighter technical requirements, for example, on vehicle emissions or building efficiency. This creates predictability for firms and investors. It also helps align supply chains and infrastructure development. In sectors with strong interdependencies, standards can achieve coordination that price signals alone often fail to deliver.

Standards-led transition pathways are well established in the climate-policy literature as a way for governments to coordinate decarbonisation where price signals alone are too weak or too slow. The IPCC has long argued that **standards can lower costs and improve flexibility relative to technology mandates** because firms can comply through different methods, including process change, fuel switching or alternative technologies. Newell, Jaffe and Stavins's work on technology policy and environmental regulation shows why standards can steer innovation more effectively than neutral market frameworks. Firms respond to efficiency requirements by redesigning products, shifting technical effort toward compliance and improving the subset of technologies they offer, so regulation can pull innovation toward the policy goal rather than waiting for prices to take effect.¹²⁰ An often-cited example is building energy codes, which require minimum efficiency performance and thereby shape construction, materials and heating systems across an entire sector. This shows that standards are not neutral in a passive sense; they are an active tool for governments to create predictable long-term trajectories that guide investment across supply chains and infrastructure.¹²¹

4.1.5 Infrastructure-first planning

Infrastructure choices shape future technological options and can create long-lived coordination effects. Energy grids, transport systems and industrial clusters require strategic, long-term planning rather than passive demand-following. Governments can treat infrastructure as a coordination task: early investment in grids, charging networks or other enabling systems can crowd in private investment and reduce bottlenecks.

Research by the OECD's International Transport Forum on strategic infrastructure planning emphasises that long-lived, capital-intensive systems need stable, cross-sector prioritisation rather than project-by-project improvisation.¹²² This is also supported by the broader literature on infrastructure as a coordination problem, which shows that grids, transport networks and energy systems are interdependent, and therefore, require public planning to avoid bottlenecks and misaligned investment.¹²³ Together, this suggests that infrastructure policy is not just about building assets but about shaping the conditions under which private investment can happen at scale. For example, Norway's EV charging rollout applied coordinated public planning and support to build a dense network of chargers alongside rapid EV adoption. By placing chargers where drivers needed them and aligning infrastructure with broader EV policy, the public sector helped reduce range anxiety and make electric driving practical at scale.¹²⁴ Here, the state is not replacing markets as much as creating the conditions that allow them to work.

4.1.6 Just transition mechanisms

Economic transitions have distributional effects. Regions and workers face adjustment costs. A pragmatic approach integrates these concerns from the outset. This includes retraining programs, regional investment and social support measures. Addressing these issues early can reduce political resistance and improve policy durability. It also aligns climate policy with broader economic and social objectives.

Difficult to define in a few words, a just transition is best understood as a multi-dimensional idea: it may refer to labour protections, distributive justice, socio-technical transition, governance strategy or public legitimacy, rather than a single policy instrument.¹²⁵ Mehl, Thompson and Ringel build on this understanding by stressing that the central challenge is implementation: how support is sequenced, targeted and coordinated so that transition policies are not only fair in principle but workable in practice.¹²⁶ In this sense, a just transition is less about compensating losers after the fact and more about designing the transition so that affected groups are identified early, support is directed where it is needed and the process retains social legitimacy.

The way Germany managed its coal phase-out, where the transition was accompanied by major regional support, infrastructure investment, and compensation measures for affected workers and communities can be one guiding example.¹²⁷ This package did not eliminate conflict, but it helped reduce opposition by linking decarbonisation to regional economic development rather than treating it as a purely technocratic climate measure. The broader lesson is that transition policy works better when governments proactively anticipate who bears the costs and design support around those groups from the beginning.

4.2 Countering the concept of technological neutrality in communications

Debates on policy related to technological neutrality are often shaped as much by presentation as by substance. In the cases of ICE phase-out and nuclear power in the EU's taxonomy, technological neutrality functioned as a powerful rhetorical tool. The entrenched interests and the actors representing them used it to frame contested political choices as neutral or merely technical, even though the policy direction was already clear. Communication therefore matters because it can either hide or expose these underlying choices. A more pro-transformation narrative should make the

policy goal explicit, explain the trade-offs openly and present state intervention not as biased but as a legitimate way of organising change around public purpose. The following section will present several communications tools and framing options that can help organise along these lines.

4.2.1 Outcome-first framing

Outcome-first framing can be seen as the communications dimension of mission-oriented governance. Policy communication can begin with concrete goals, such as emissions reductions, system resilience, energy affordability or industrial competitiveness. This shifts attention away from abstract claims of openness to technologies and toward the measurable outcomes policymakers are trying to deliver. It also makes public reasoning clearer. Rather than presenting choices as neutral or purely technical, governments can explain how different options compare in terms of progress toward the stated mission. This creates more accountability and gives policymakers a stronger basis for decisions, since they are judged against explicit goals rather than against an unrealistic claim of neutrality.

4.2.2 Risk disclosure framing

Risk disclosure framing makes the unevenly distributed risks of different technologies more visible. Some options involve higher safety risks, some create greater fiscal exposure and others carry longer-term environmental effects. Governments should communicate these differences openly, rather than presenting all choices as equivalent. For example, a government could publish a clear comparison showing the grid, storage and life-cycle risks of nuclear versus renewable electrification in a given sector. This helps the public understand that neutrality is often an illusion. It also supports a more informed debate about which risks are acceptable, who bears them and how they should be managed.

4.2.3 Honest trade-off acknowledgement

Every policy choice involves gains and losses, and decision makers should state these trade-offs openly. For example, faster decarbonisation may raise short-term costs but reduce long-term exposure to fossil-fuel price shocks, import dependence and later adjustment costs. **Clear language strengthens credibility because it shows that policymakers understand the costs and the benefits.** A good example is Spain's 2020 framing of its renewable-energy push, which presented solar and other renewables as a route to economic recovery, industrial modernisation and greater energy security, despite the investment needed, rather than as a neutral technical choice. This kind of communication avoids the impression that policy decisions are purely technical and makes the rationale for action easier to defend.

4.2.4 System-fit narratives

Technologies operate within systems, so their value depends on how well they fit within the existing grids, supply chains, land-use constraints, skills and overall infrastructure. A technology that looks attractive in isolation may perform poorly if it needs new network capacity, scarce materials or major spatial reconfiguration before it can scale. Justifying choices in these terms by explaining not just what a technology does, but what kind of system it requires and whether that system can realistically be built. This provides a grounded rationale for prioritising some options and excluding others. It shifts the debate from abstract preference to system performance. This kind of framing is especially useful in areas where infrastructure and coordination effects are decisive. For example, heat pumps can be a strong fit in district-heating systems, where they can use existing network infrastructure and integrate with storage, the demand response and a renewable power supply, making the transition easier to scale. A system-fit narrative therefore helps communicate why one pathway is more credible, scalable or resilient than another, without pretending that all technologies are equally easy to deploy. It also makes public reasoning more transparent, because

policymakers can point to concrete constraints rather than hiding behind a vague claim of neutrality.

4.2.5 Sequencing logic

Transitions unfold over time, and they rarely happen in a single leap. In practice, some investments must come before others. **Decision makers can communicate this as a sequence of steps, showing that the transition is not just a matter of choosing the right end-state technology, but also of building the conditions which make that technology viable.** For example, grid expansion, permitting reform and storage capacity may need to be developed before large-scale electrification can proceed at full speed. Similarly, supply chains, workforce training and infrastructure upgrades often must scale ahead of widespread adoption. This kind of framing helps explain why transition policy is about coordination over time, not just about isolated technology choices. The advantage of sequencing is that it gives a clearer sense of direction, timing and dependency. It shows that some measures are enabling investments, while others are deployment measures that only become effective once those enablers exist. This makes policy communication more realistic, because it acknowledges constraints rather than presenting the transition as if everything can happen at once. It also helps reduce confusion about trade-offs, since audiences can see why certain actions are prioritised early and others are scheduled for later phases. In this sense, sequencing provides a practical road map for moving from ambition to implementation.

4.2.6 Public value language

Policy communication can be framed around shared outcomes that matter across society, rather than around narrow technical or market arguments. Clean air, energy security, lower exposure to volatile fuel prices, resilient infrastructure and stronger industrial capacity are all examples of benefits that people can understand in practical terms. **When policy is described as delivering public goods, it becomes easier to show why it is not just a specialist climate agenda, but part of a broader strategy for improving everyday life.** This approach

can also make climate policy more durable, because it links long-term decarbonisation to concerns that are immediate and widely felt, such as health, affordability, jobs and national resilience. Spain's 2019/20 energy and climate package, for example, was presented as a way to create jobs, reduce energy dependence, improve health through cleaner air and strengthen the country's industrial base. A public value frame also helps broaden support by making the policy coalition larger. Instead of speaking only to environmentally motivated audiences, it can appeal to households worried about bills, workers concerned about good jobs, businesses that want certainty and governments that want secure infrastructure. It is often more persuasive than language that focuses only on market freedom or consumer choice, because those themes can sound abstract or individually centred, while public value language explains what society gains collectively. In this sense, it turns climate policy from a niche intervention into a common-sense investment in public welfare.

being handled fairly. Just as importantly, it prevents the impression that outcomes are simply the result of neutral market forces, when they are shaped by policy choices, institutional design and political priorities. In that sense, accountability framing does more than explain governance; it helps make the transition feel legitimate, intentional and fair.

4.2.7 Responsibility clarity

Policy design allocates costs and benefits, but also responsibilities that are neither automatic nor value-free. In any transition, some actors will pay more upfront, some will receive more immediate benefits and some will be responsible for delivering the changes that make the policy work. **Being explicit about these roles helps people understand that policy is not an abstract process unfolding on its own, but a set of deliberate choices made by institutions and leaders.** It also makes it easier to explain why certain groups are asked to contribute, what they receive in return and how those decisions are justified in the public interest. Clear responsibility matters because it improves transparency, trust and democratic accountability. When governments spell out who is responsible for funding, implementation, oversight and enforcement, they reduce confusion and make it harder for political actors to shift the blame when problems arise. That kind of clarity can also improve public acceptance, because people are more likely to support change when they understand the logic behind it and can see that burdens are

5. CONCLUSION

While technological neutrality is often presented as a fair and open principle, the analysis presented in this study demonstrates that it is neither neutral in practice nor politically innocent in function. Rather than simply protecting innovation, it frequently serves as a communicative device through which incumbent interests can reorient policy discussions and, by doing so, resist change, preserve existing assets and delay the structural adjustments required by decarbonisation. Under the language of neutrality, policy choices that would accelerate the transition are recast as unfair distortions, while the continued dominance of legacy technologies is normalised as if it were the natural outcome of market competition. In this sense, technological neutrality does not remove politics from policymaking; instead, it conceals politics behind a paradigm that systematically advantages those already in place.

The two case studies on the ICE phase-out and the inclusion of nuclear energy in the EU's taxonomy allow us to understand this distorted use of technological neutrality in practice. In both cases, technological neutrality functions less as an objective governing principle and more as a rhetorical shield mobilised ex-post to delay policies and preserve incumbent interests under the appearance of balanced treatment. In the case of ICE phase-out, this framing erases the automotive industry's existing system benefits from decades of accumulated infrastructure, regulation and political support. Taken together, these sections show that the real issue is not whether governments should intervene, but how they should intervene openly, deliberately and in line with long-term societal goals.

The study also demonstrates that many alternatives exist, in both policy design and political communication. Policymakers do not have to treat transformation as something to be avoided or softened indefinitely. They can instead adopt directional, mission-oriented and strategically

sequenced approaches which acknowledge that structural change is unavoidable and, in many cases, necessary. The communicative challenge is not to deny disruption, but to explain it honestly: transition policies must be presented as deliberate efforts to manage disruption in a way that is socially fair, economically intelligent and institutionally credible. This means acknowledging that some industries will decline, but also making it clear that workers and regions can only be protected through proactive transition planning, retraining, investment and support. A successful transition narrative should therefore combine candour about the need for change with confidence that the change can be governed rather than merely endured.

For the EU, the implications are clear. Delaying change in the name of technological neutrality serves no one, least of all Europe's future competitiveness, industrial renewal and long-term prosperity. If the EU wants to remain economically strong in a decarbonising world, it must stop treating hesitation as prudence and start treating transformation as strategy. It must deploy more honest policy language that recognises the inevitability of the disruptions, the need for active planning and the importance of protecting workers while phasing out technologies and industries that no longer fit a climate-neutral economy. Only through such an approach can the EU combine legitimacy, resilience and competitiveness in the transition ahead.

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AI DISCLOSURE STATEMENT

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The author used several commercially-available AI tools to identify additional relevant sources for the literature review and to generate feedback on how to turn complex academic concepts into a more accessible format.

Technological neutrality is a key guiding principle for EU policymaking in many areas, including climate action and decarbonisation. While often presented as a clear and objective standard of regulatory design, both its meaning and effectiveness remain ambiguous and disputable. The urgency of the climate crisis demands rapid technological transitions. However, the study demonstrates through a critical academic review that technological neutrality systematically fails when applied to the complex, systemic transformations required for deep decarbonisation.

In addition, technological neutrality rarely functions as an operational rule for economic efficiency. Rather, it increasingly functions as a strategic communication tool deployed by incumbent interests to resist targeted interventions, obscure distributional consequences and protect legacy capital. Two case studies – the fierce contestation over the inclusion of nuclear energy in the EU Sustainable Finance Taxonomy, and the protracted political battle over the phasing out of internal combustion engines (ICE) – exemplify this situation. In both instances, technological neutrality was not applied as an ex-ante design principle, but rather invoked ex-post as a reactive mechanism to force symbolic inclusions, such as the e-fuels carve-out, and to delay systemic transitions that threaten incumbent industrial assets.

Pragmatic alternatives related to policymaking, economy and communication exist to counter the technological neutrality narrative and design more effective climate policies through mission-oriented innovation, developmental coordination and performance standards. With these alternatives, real discussions on the future of European industry and the protection of its workers can move forward, instead of delaying necessary transformations and decreasing the EU's competitiveness.

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