EFFECTIVE INDUSTRIAL POLICIES TO TRANSFORM INDUSTRIES FACING NEGATIVE EXTERNALITIES

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This paper provides a brief overview of the associated costs of negative externalities in the EU. It highlights which sectors should be politically prioritized to foster industry transformation and reduce external costs. Industrial policies in the form of command-and-control and market-based policies are compared to conclude which form of industrial policy is most beneficial to reduce negative externalities. Lessons are drawn from various industrial policy examples from the EU and the US. The EU should foster market-based policies to disincentivize harmful production and consumption. Revenues obtained should be re-invested into industry transformation to accelerate economic growth and reduce external costs.

The European Union is facing a dual challenge: lagging competitiveness and rising structural costs. While other major economies, most notably the United States and China, have responded to recent crises with assertive industrial strategies and substantial investment packages, the EU continues to struggle with weak growth dynamics and industrial inertia. Beneath this sluggish performance lies a less visible but economically decisive issue: the mounting burden of negative externalities. From climate damages to public health crises, the EU economy is absorbing vast hidden costs that undermine productivity, divert resources from innovation, and strain the social contract.

This paper argues that effective industrial policy must confront these externalities directly, not as side effects to be corrected at the margins, but as central barriers to sustainable economic transformation. Negative externalities are no longer confined to narrow environmental or health policy silos; they are economic liabilities that prevent the emergence of competitive, future-ready industries.

The scale of these liabilities is striking. Climate-related damages alone amounted to an estimated €162 billion between 2021 and 2023. Smoking consumption leads to roughly 700,000 premature deaths per year within the EU, with economic costs of 4.6% of EU-27 GDP, amounting to €544 billion in 2009 (GHK, 2012). Applying the same proportion to today's GDP, this would equate to approximately €780 billion in 2024 (European Union, 2024). Alcohol-related health costs in high-income countries are estimated to cost some 2.6% of GDP (WHO, 2024a), while sugar-related diseases such as diabetes generate an annual burden of around €145 billion (IDF Europe, 2016). These figures do not merely represent moral or public health concerns; they signal a massive

misallocation of resources and a structural drag on economic renewal.

Addressing these externalities is not a constraint on growth but a condition for it. Public and private capital that is currently absorbed by health care costs, environmental remediation, and social welfare responses to preventable harm could be redirected toward innovation, clean technologies, and productive infrastructure. As former ECB President Mario Draghi has recently argued, the EU must mobilize up to €800 billion annually in public and private investment to secure its economic future. Dealing with negative externalities is a foundational step toward unlocking that scale of investment.

To do so effectively, policymakers must identify which sectors to prioritize and how. The answer lies in targeting those industries that simultaneously impose high external costs and offer credible paths to structural transformation. High-emission sectors such as energy, transport, and heavy industry are obvious candidates. But so too are consumer-facing sectors like tobacco, alcohol, and processed foods, where targeted interventions could yield outsized health and productivity gains.

This paper builds the case for industrial policies that directly tackle these burdens. It offers a framework for prioritizing sectors, compares the merits and limitations of market-based and command-and-control tools, and draws lessons from successful policy experiments in Europe and beyond. The goal is not simply to reduce harm but to convert that reduction into a catalyst for innovation, resilience, and long-term competitiveness.

This paper proceeds as follows. The initial epigraph called "Tools of industrial transformation: mandates and market mechanisms" elaborates on the two different ways of governmental interventions into the economy, a mandate-based "command and control" approach or an incentive-based "market approach". The next epigraph, "Case studies of industrial policies in markets with negative externalities" provides four comprehensive case studies of measures taken to transform industries with high external effects into flourishing and green sectors. Moreover, the following epigraph, "Rethinking pigouvian taxation" discusses potential improvements in the market-based approach of Pigouvian taxation. The last epigraph recommends policy responses. The article ends with conclusions.

TOOLS OF INDUSTRIAL TRANSFORMATION: MANDATES AND MARKET MECHANISMS

Europe's weak economic performance has become a defining challenge for the continent. Since the financial crisis, the European Union has consistently underperformed relative to its global peers, not only in GDP growth terms, but also in investment levels, technological dynamism, and industrial renewal. While the United States has combined aggressive fiscal expansion with robust innovation ecosystems, and China has pursued a state-led industrial strategy on an unprecedented scale, the EU has remained constrained by fragmented governance, limited fiscal coordination, and cautious regulatory frameworks. As a result, Europe risks falling further behind in critical industrial sectors, from clean energy and digital technologies to health and mobility. The consequences are not merely financial: strategic dependencies, weakened productivity, and rising political fragmentation all stem from the inability to renew the industrial base.

Reversing this trend requires more than marginal policy adjustment. It demands a structural transformation of the EU's industrial landscape: One that promotes innovation, attracts private investment, and addresses the growing drag of negative externalities. The EU currently remains heavily reliant on mature industries with low innovation intensity. These sectors are often shielded by legacy regulation and slow to adapt to technological disruption. At the same time, the EU's dense regulatory environment, while designed to safeguard citizens and the environment, can suppress innovation by creating compliance burdens

that deter experimentation and reduce the payoff from investing in transformation.

Meanwhile, the costs of inaction are mounting. Climate-related damages between 2021 and 2023 alone have been estimated at €162 billion within the EU (European Environment Agency, 2024). Unhealthy consumption patterns, among others unhealthy diets, alcohol consumption, and smoking, contribute to substantial productivity losses and health care burdens, with estimated costs exceeding USD 8 trillion every year, according to the United Nations Food and Agriculture Organization (FAO, 2024). These negative externalities do not simply affect well-being; they directly undermine the EU's capacity to invest in growth. Fiscal resources are consumed by health crises and environmental remediation. Innovation capital is diverted from high-potential sectors to managing preventable damage. Productivity is damaged by preventable illness, emissions, and infrastructure degradation. In this context, externalities are not merely social or environmental failures, they are economic constraints. In light of these negative externalities, industry transformation should focus on sectors with the largest greenhouse gas emissions and, in the realm of health issues, on the sectors that use alcohol and tobacco for their products.

If Europe is to regain its competitive edge, it must target these externalities not just with mitigation policies, but with transformative industrial strategies. Addressing harmful outputs must take place together with creating new, cleaner, and more productive industrial pathways. The most effective route forward is not to dismantle regulation, but to reshape it and to combine it with targeted public investment and innovation incentives. That means moving beyond reactive regulation and toward a forward-looking industrial policy that directly confronts the sources of long-term economic decline.

This paper contributes to that objective by first examining the policy instruments available to governments aiming to transform industries marked by high external costs. The next section outlines and compares market-based tools and command-and-control approaches, assessing their ability to reduce externalities while encouraging innovation, and considering the trade-offs that shape their political and economic feasibility.

To effectively transform industries that generate significant negative externalities, policymakers can draw on two main categories of intervention: command-and-control regulation and market-based instruments. Both approaches aim to reduce harmful outputs and external effects while accelerating industrial transformation. However, the channel of impact is widely different: 'Command and control' measures use action-based policy interventions that shall regulate a certain behavior (Blackman et al., 2018). Examples are technology or carbon emission minimum or maximum levels that must not crossed.

In contrast, market-based instruments are policy interventions targeting certain outcomes rather than actions. In the context of climate policies, market-based instruments may limit, for instance, the amount of carbon emissions (the outcome) but do not specify how this goal should be reached by firms and consumers (Blackman et al., 2018). There is evidence that market-based interventions are more efficient and that combinations of market and "command and control" mechanisms are worse as they negatively interact, i.e., interfere with each other (see, e.g., Tuladhar et al. 2014). Still, most states apply a mix of both types of measures. Hence, the current policy-making habits demand the designing of coherent combinations able to align incentives, create enforceable standards, and enable innovation.

Command-and-control regulation relies on direct mandates, for example, bans, emissions ceilings, minimum performance standards, or mandatory technology adoption. These instruments offer a high degree of regulatory certainty, making them particularly suitable for situations where time is short, the harms are clear, or market incentives are insufficient. In sectors like energy, transport, or construction, such regulations have played a key role in pushing out outdated technologies and raising the baseline of environmental and safety performance. The EU's fleet-wide carbon emis-

sion standards for vehicles, for instance, have significantly reduced average emissions across the bloc.

The appeal of command-and-control tools also lies in their visibility: they are easy to communicate and can create the political momentum needed to overcome resistance from entrenched industries. However, their limitations are equally clear. They can be rigid, reducing flexibility for firms to choose cost-effective compliance strategies. Poorly designed standards may lock in suboptimal technologies or discourage experimentation. Furthermore, administrative complexity and enforcement costs can be significant, particularly in fragmented regulatory environments like the EU.

Market-based instruments operate differently. They aim to internalize external costs by adjusting price signals and, as a result, incentivizing actors to change behavior in response to economic logic. Examples include Pigouvian taxes (on carbon, alcohol, or sugar), tradable permit systems (such as the EU Emissions Trading System), and innovation subsidies. When well-calibrated, these tools offer efficiency: they allow firms to find the most cost-effective path to compliance while encouraging ongoing improvement rather than mere rule-following.

Moreover, market-based approaches have the advantage of being dynamic: they reward frontrunners and penalize laggards, creating continuous pressure for technological upgrades. Importantly, they can also generate fiscal revenues that can be reinvested into innovation, infrastructure, or compensation for vulnerable groups. However, they are not without challenges. Setting the right price level is technically and politically difficult. Behavioral responses may be weak if prices are too low or elasticities too high. Moreover, such instruments can be regressive unless accompanied by redistribution or earmarked social investment.

Ultimately, both approaches are essential. Regulation provides the floor; market mechanisms shape the incentives above it. Transformation requires not only pushing harmful practices out of the market but also creating the conditions under which new models can emerge and scale. Industrial policy must therefore work across both fronts: Setting clear boundaries for the status quo while opening space for the technologies and business models of the future.

The following section examines how this dual approach has worked in practice, drawing on case studies from Europe and beyond to extract lessons on effectiveness, efficiency, and political feasibility.

CASE STUDIES OF INDUSTRIAL POLICIES IN MARKETS WITH NEGATIVE EXTERNALITIES

While the theoretical toolbox for managing negative externalities is well developed, it is the practical application of policy that determines impact. The following case studies illustrate how industrial policy can be deployed, sometimes through taxation, sometimes through public investment, and often through a mix of both, to transform sectors burdened by externalities into drivers of sustainable growth.

The cases cover five distinct domains: transportation (Norway), energy production (Denmark), fossil fuel consumption (British Columbia), tobacco consumption (Sweden) and renewable energy manufacturing (Spain). Each demonstrates how governments can shape markets through fiscal incentives, regulation, or strategic investment, whether by shifting consumer behavior, crowding in private capital, or supporting domestic industry. At the same time, the cases reflect the tensions and trade-offs that arise between environmental goals and fiscal balance, between regulatory ambition and institutional adaptability, and between transformation and unintended consequences.

While the first four cases showcase successful trajectories of industrial transformation underpinned by coherent, evolving policy mixes, the fifth, Spain's solar feed-in tariff collapse, offers a critical counterpoint. It illustrates how 'command and control' policies (even if well-intentioned) can unravel in the absence of policy credibility,

adaptive design, and fiscal foresight when exposed to exogenous shocks and institutional weaknesses.

These examples offer more than isolated success stories or cautionary tales. Taken together, they show what it takes to make industrial policy work in complex, politically contested domains: alignment of fiscal tools and regulatory frameworks, clarity of purpose, long-term commitment, and a market-based policy architecture that aligns economic incentives with societal goals while remaining robust to shocks and course corrections.

Case Study 1: Norway's electric vehicle policy

Norway's success in promoting electric vehicles (EVs) is often viewed as a textbook case of regulatory ambition. It reflects a hybrid industrial policy, combining Pigouvian incentives with targeted non-price regulation. The Norwegian government levied high taxes on internal combustion engine (ICE) vehicles while offering full exemptions from VAT, registration fees, and road tolls for electric cars. These fiscal incentives were complemented by non-monetary advantages such as access to bus lanes and subsidized public charging infrastructure.

The results have been transformative: by 2024, nearly 89% of new car sales in Norway were fully electric, marking the highest EV penetration rate in the world (Adomaitis, 2025). The policy has not only reduced emissions but also catalyzed a shift in automotive manufacturing, distribution, and energy infrastructure. However, the strategy has come at a fiscal cost, with foregone tax revenue prompting recent revisions to the incentive structure (OECD, 2022)

EVs are exempt from import taxes and the 25% value-added tax (VAT), significantly reducing the purchase price compared to conventional vehicles. Furthermore, they benefit from half price for road tolls, ferry, and parking fees. Beyond fiscal incentives, the government spent the public budget on investments in nationwide charging infrastructure to alleviate range anxiety and support EV usage (OECD, 2022).

These regulatory measures have led to a dramatic increase in EV adoption. In 2024, 88.9% of new cars sold in Norway were fully electric, up from 82.4% in 2023, which already meant a lion's share of electric vehicles among all new-car sales. This shift has significantly reduced greenhouse gas emissions from the transportation sector and positioned Norway as a model for EV integration. While the policy has been successful in promoting EV adoption, it has also resulted in decreased tax revenues from vehicle sales. The government is now exploring adjustments to the incentive structure to balance environmental goals with fiscal sustainability (OECD, 2022).

Case Study 2: British Columbia's carbon tax

British Columbia (BC), Canada, implemented a revenue-neutral carbon tax in 2008, aiming to reduce greenhouse gas emissions through market-based mechanisms. The tax applies to the purchase and use of fossil fuels, effectively putting a price on carbon emissions. Beck and coauthors (2015) summarize the policy's key features as follows: Initially, the price per ton of carbon emission was set to CAD$ 5, but steadily increased and reached an amount of CAD$ 30 per ton in 2012. Important for consumers as well as producers is revenue neutrality. All revenues generated from the carbon tax are returned to residents and businesses through reductions in other taxes, such as personal and corporate income taxes. While some 60% went to business, the remaining 40% of the tax income was transferred back to private households.

By doing so, the Pigouvian carbon tax achieved two major goals. It did not only affect consumer behavior by channeling their consumption decision towards more eco-friendly options. It also financed a cut in corporate taxes, which made firms in British Columbia more competitive.

Despite the policy's effectiveness, public awareness of the tax rebates has been lim-

ited. Surveys indicate that many residents are unaware of the financial benefits they receive, which could undermine long-term support for the carbon tax (Mildenberger et al., 2022).

Case Study 3: Denmark's wind energy sector

Denmark's wind energy sector offers a textbook example of how consistent industrial policy, public-private collaboration, and long-term regulatory commitment can transform a domestic market into a global leader in clean technology. As an analysis of the UNFCCC Technology Executive Committee (2023) of the United Nations reports, the Danish government established a concerted initiative in response to the oil shocks of the 1970s. It began investing in renewable energy R&D, using revenue from newly introduced energy taxes to support early-stage innovation. From the outset, wind energy was treated not just as a climate policy tool, but as a strategic industrial opportunity.

Throughout the 1980s and 1990s, Denmark developed a dense ecosystem of supportive measures: feed-in tariffs that guaranteed stable revenues for wind producers, public funding for turbine technology development, and strong backing for local energy cooperatives. Importantly, national energy targets were translated into predictable policy frameworks that enabled both community investment and large-scale industrial coordination. The Technical University of Denmark played a central role in standardizing turbine technologies and advancing wind energy research while emerging firms benefited from export-oriented industrial policy and public support for offshore wind deployment.

The results have been transformative. By 2022, wind and solar accounted for nearly 60% of Denmark's electricity consumption, with wind alone providing over half of that sum. The country is now a world leader in wind turbine design and offshore wind development.

Denmark's success can be attributed to four key factors: a long-term industrial vision that outlasted electoral cycles; close coordination between government, research institutions, and industry; strong public buy-in through local ownership models; and continuous reinvestment in innovation (van Est, 2022). In contrast to more volatile policy regimes, Denmark's stable and strategic approach created the regulatory credibility needed to attract investment and build a globally competitive clean-tech sector.

Case Study 4: Sweden's strategy to mitigate smoking

Tobacco smoking represents a classic example of negative externalities, where the additional health and economic costs incurred by a minority of smokers are borne by society as a whole.

Although tobacco has long been one of the most heavily taxed commodities, dating back to 1790 in the United States (Lynch & Bonnie, 1994), it was not until the 1990s, with the emergence of the economics of tobacco, that cigarette taxation was explicitly framed as a Pigouvian tax (Reubi, 2013). Since then, global smoking prevalence has steadily decreased, suggesting some effectiveness of Pigouvian taxes on combustible tobacco (WHO, 2024).

However, smoking remains a major driver of preventable deaths worldwide, with approximately 700,000 annual fatalities in Europe alone. This indicates that traditional tobacco regulation, primarily through taxation, is insufficient to fully mitigate negative externalities and sustainably transform consumer behaviors and industry practices.

A fundamental limitation is the reality of consumer behavior: individuals have genuine needs and desires, including tobacco use and other leisure products. Incrementally increasing taxes to curb consumption can resemble a paternalistic, gradual, prohibition. However, this does not eliminate the underlying demand. Instead, it creates a demand vacuum frequently filled by il-

licit products, where state control is limited, and smoking prevalence may not sustainably decline.

In contrast, Sweden provides a successful alternative model. The country employs a differentiated taxation strategy that incentivizes smokers to abandon combustible cigarettes in favor of less harmful alternatives such as Snus, a smokeless tobacco product that provides nicotine without combustion-related harm and supports smoking cessation (PHAS, 2024a).

The outcomes of Sweden's approach are compelling. The country has achieved the lowest smoking rates in Europe, with daily smoking prevalence dropping to just 5.3% in 2024, approaching the smoke-free threshold of 5% (PHAS, 2024b).

Sweden's case demonstrates how Pigouvian taxes can be used to funnel demand and guide consumer preferences to ultimately transform the industry towards alternative, less damaging, products. This shift in demand, in turn, mandates an adaptation of the supply side.

Case Study 5: Spain's solar feed-in tariffs

Spain's early leadership in solar photovoltaic (PV) deployment stands as a cautionary tale of how industrial policy can backfire if not paired with fiscal discipline, adaptive design, and regulatory credibility. In the mid-2000s, the Spanish government introduced one of the world's most generous feed-in tariff (FiT) schemes to promote solar electricity. These tariffs guaranteed long-term, above-market prices for electricity generated from PV installations, offering investors both price certainty and low risk. The annual installed capacity notably increased in 2006 (103MW) and 2007 (544MW) and drastically surged to 2708 MW installed capacity in 2008. This was related to the generous subsidies but also resulted in a tariff deficit that grew relatively speaking by 50% from 2007 to 2008 and by some EUR 5 billion every year from 2007 to 2011 (Del Río & Mir-Artigues, 2014).

Yet this rapid growth revealed the fragility of command-and-control approaches when poorly calibrated. The FiT scheme operated through fixed administrative prices, rather than market-determined levels or responsive caps. Crucially, there were no dynamic adjustment mechanisms to moderate installation rates or align incentives with fiscal constraints. When the 2008 financial crisis triggered sharp budgetary contractions, the government retroactively abolished the fixed-guaranteed tariffs for existing installations, a move that shattered investor confidence (Castro-Rodríguez, F. & Miles-Touya, 2023).

This case illustrates a broader limitation of command-and-control industrial policies: while they can mobilize investment rapidly, they often lack the built-in flexibility to adjust to exogenous shocks or cost reductions. Fixed tariffs, like other rigid regulatory instruments, are vulnerable to over-compensation, boom-bust cycles, and political reversals. Without mechanisms for price discovery, automatic degression, or clear sunset clauses, such policies may inflate expectations that become politically unsustainable.

In Spain's case, the policy reversal not only undermined the domestic solar industry but also damaged the credibility of the broader clean energy transition. By contrast to market-based mechanisms like auctions or carbon pricing, which tend to evolve with market conditions, Spain's administratively set tariffs failed to adapt and ultimately collapsed under their own weight.

The lesson is clear: even well-intentioned interventions must be designed with policy durability in mind. Regulatory stability, adaptive design, and fiscal foresight are preconditions for effective, long-term industrial transformation.

Corollary

Taken together, these cases underscore a central lesson: successful industrial transformation is not the result of choosing the "right" instrument in abstract terms, but of tailoring interventions to context, comple-

menting fiscal tools with regulatory foresight, and maintaining public legitimacy over time.

Norway's EV strategy succeeded because Pigouvian logic was embedded in a broader industrial policy, namely one that coordinated public investment, infrastructure support, and social acceptance. British Columbia's carbon tax shows how market mechanisms can reduce emissions without harming competitiveness, provided revenues are transparently recycled. Denmark's wind sector demonstrates the power of stable, coordinated policy to create not only clean energy but competitive industrial ecosystems. Sweden has successfully transformed consumer preferences by nudging demand towards nicotine alternatives instead of prohibitively enforcing abstinence through taxation, thereby effectively mitigating negative externalities associated with smoking.

By contrast, Spain's solar FiT collapse reveals what happens when regulatory ambition is decoupled from institutional adaptability and fiscal planning. The policy succeeded in mobilizing investment at scale but failed to build the structures needed to sustain that investment over time. Its command-and-control logic, rooted in fixed administrative pricing, lacked mechanisms to moderate overshooting or adjust incentives dynamically. The result was a collapse in investor confidence and long-term damage, beyond the single case of the solar industry, to the credibility of Spain's commitment to intertemporally consistent economic policy.

None of these examples relied solely on textbook prescriptions. The successful cases worked because policymakers designed instruments with transformation in mind, adapted over time, and built coalitions across government, industry, and society. They recognized that effective industrial policy is less about ideological alignment, i.e., "market vs. state" and more about institutional design, timing, and credibility. Conversely, Spain's experience highlights the risks of rigidity, volatility, and political overreach when industrial policies are not equipped to evolve.

As the EU considers how to steer high-externality sectors through economic, technological, and environmental transitions, these lessons are essential: success depends not on policy orthodoxy, but on coherence, credibility, and commitment, i.e., qualities that must be built into policy architecture right from the beginning. Industrial policy should not just direct capital. It must also inspire confidence that the rules of the game will remain stable enough to justify long-term investment in transformation.

RETHINKING PIGOUVIAN TAXATION

Pigouvian taxes remain one of the most powerful tools for internalizing negative externalities. By raising the cost of harmful goods or activities, they reduce consumption and encourage the shift toward less damaging alternatives. However, to function as an effective instrument of industrial transformation, Pigouvian taxation must be designed and implemented not as a static price signal but as part of a dynamic policy pathway.

A common misconception is that taxation alone will eliminate demand for harmful goods. In reality, demand does not disappear. It can shift. Without the right framework designed to guide this shift, taxation may result in redirecting consumers toward more harmful alternatives. To avoid such outcomes, demand must be actively "funneled" toward more desirable substitutes, both through incentives and the creation of enabling infrastructure and proper regulation.

Moreover, Pigouvian taxation is often criticized for the difficulty of precisely quantifying the social cost of externalities. If the tax is set too low, it fails to alter behavior meaningfully; if too high, it may create excessive burdens or unintended spillovers. Thus, Pigouvian taxes should be understood as evolving instruments, not fixed solutions. They must be regularly reviewed and adjusted to reflect scientific understanding, technological development, and industrial readiness while providing predictability and planning security to affected sectors.

This allows firms time to adapt, reallocate capital, and invest in R&D, rather than simply absorbing the cost or passing it on.

Crucially, Pigouvian taxes are most effective when less harmful substitutes are available but not yet widely accepted. In these cases, taxes can play a dual role: discouraging harmful consumption and funding the transformation needed to scale alternatives. Revenues should be strategically recycled, e.g., into public research, innovation hubs, infrastructure investment, or consumer incentives for adopting cleaner technologies. British Columbia's carbon tax, which reinvests revenue into tax credits and clean energy projects, provides a successful example of how transparent recycling can build legitimacy and reinforce behavioral change (Beck et al., 2015).

Recent behavioral research further strengthens the case for such a dynamic design. Taxes do not merely shift consumption patterns. They can reshape consumer preferences over time through mechanisms such as path dependence, familiarity, and shifting social norms. Even when externally motivated initial behavioral changes often evolve into internalized habits, especially when supported by visible public investment and peer uptake. In Norway, this dynamic played out in the EV market. Although EVs initially faced resistance due to range limitations and weak infrastructure, targeted taxation of combustion vehicles, combined with incentives and infrastructure expansion, created a feedback loop that changed both the industry and consumer norms. Today, EVs dominate new car sales in Norway, with associated emissions falling sharply (Adomaitis, 2025; OECD, 2022).

To extend the impact of Pigouvian taxation across sectors, a more systematic, damage-based approach to tax design is needed. Currently, only a handful of industries are consistently targeted. Expanding this framework to other sectors with demonstrable externalities, based on a consistent assessment methodology, would enhance policy coherence and economic efficiency. Such a taxonomy would also enable prioritization, ensuring that industries with the highest social costs and the clearest paths to transformation are addressed first.

Finally, Pigouvian taxation must be embedded in a regulatory environment conducive to innovation. Without adjustments to broader frameworks, such as the overly rigid application of the precautionary principle, firms may face contradictory signals: punished for current practices but unable to scale alternatives. A more flexible, innovation-enabling regulatory foundation is therefore a necessary complement to fiscal disincentives.

Altogether, Pigouvian taxes are not standalone solutions, but levers within a broader transformation strategy. Their success depends on how well they are coordinated with reinvestment mechanisms, regulatory adaptation, and the promotion of viable alternatives. Without such complementary measures, taxes risk being politically fragile, economically inefficient, and socially regressive. With them, however, they can unlock powerful dynamics of industrial change.

POLICY RECOMMENDATIONS

An industrial policy aimed at addressing negative externalities must go beyond singular instruments. While Pigouvian taxation remains a cornerstone in correcting harmful market signals, its impact depends on how it is embedded within a broader strategic framework. The following four policy levers – effectiveness, efficiency, feasibility, and regulatory reform – should guide the design and implementation of future initiatives.

Effectiveness: expanding Pigouvian taxation is essential but insufficient on its own. Experience across sectors and countries shows that taxes can alter relative prices but may fall short in the presence of administrative complexity, consumer resistance, or unintended behavioral responses (McMorran & Nellor, 1994; Heutel, 2020). To strengthen their transformative potential, Pigouvian instruments must be paired with targeted industrial policy tools, such as direct subsidies, innovation grants, R&D

support, and transition financing. These complementary measures can accelerate the development and adoption of cleaner technologies, reduce adjustment costs for firms, and support systemic change where price signals alone are too slow or politically constrained. The goal is not to replace taxes but to build a coordinated policy mix capable of achieving measurable reductions in externalities while fostering industrial renewal.

Efficiency: strategic reinvestment of Pigouvian tax revenues is critical to turning fiscal measures into engines of transformation. Rather than allowing revenues to disappear into general budgets, governments should earmark proceeds for innovation programs, clean infrastructure, technology deployment, and public goods that ease transition costs. This has both economic and political rationale. On the one hand, it increases the likelihood that taxed industries and consumers can shift toward sustainable substitutes. On the other, it enhances legitimacy and public buy-in, especially when the benefits are tangible and visible. Transparent recycling also mitigates regressivity and helps address concerns about equity, which are key barriers to lasting policy support (Lucas, 2024; McMorran & Nellor, 1994). At the same time, policy design must anticipate unintended consequences such as consumption leakage or substitution into illicit markets. Revenue recycling should therefore be conditioned on the availability and accessibility of viable alternatives, supported by accompanying regulation and market oversight.

Feasibility: the political sustainability of Pigouvian taxation hinges on more than economic theory. This policy instrument depends on how it is perceived and communicated. More broadly, policymakers must resist framing Pigouvian taxes as punitive measures. Instead, they should be cast as collective investments in shared infrastructure, industrial renewal, and long-term competitiveness (Lucas, 2024). Clear communication, accountability mechanisms, and demonstrable impacts are crucial to building enduring societal consensus.

Regulatory Reform: Finally, Pigouvian taxation must be accompanied by regulatory frameworks that enable technological and industrial evolution. This requires moving away from rigid, overly risk-averse regulatory principles toward innovation-compatible governance. A key step is reassessing the application of the precautionary principle in sectors where emerging technologies offer the potential to reduce social costs. Where appropriate, flexible approaches such as performance standards, regulatory sandboxes, and outcome-based regulation can help lower barriers to entry and accelerate the adoption of alternatives (Heutel, 2020). Streamlined regulatory processes also help firms adapt to new price signals and reduce uncertainty for long-term investment. Without such reform, even well-designed taxes may fail to trigger systemic change, as innovation is stifled at the point of deployment.

In summary, Pigouvian taxation should be seen not as a one-fits-all tool, but as a foundational component within a broader industrial strategy. Effective policy design requires integrating fiscal instruments with targeted investment, strategic revenue use, and adaptive regulation. Only when these elements work in concert can the EU achieve the dual goal of reducing externalities and revitalizing its industrial base for long-term economic and environmental sustainability.

CONCLUSION

The European Union's path to renewed competitiveness and sustainable growth runs through the transformation of industries that currently generate high social and environmental costs. As this paper has shown, negative externalities, whether in the form of carbon emissions, public health burdens, or environmental degradation, are not merely policy failures but economic liabilities that divert resources away from innovation and productivity. Addressing them is not a constraint, but a prerequisite for a resilient industrial base.

Effective industrial policy must be designed with a major transformation in mind. This means combining Pigouvian taxation with complementary tools: targeted public in-

vestment, innovation incentives, and regulatory reform. Real-world examples, from Norway's electric vehicle rollout to Denmark's wind industry, British Columbia's carbon tax and Sweden's strategy to fight smoking demonstrate how aligned, credible, and adaptive strategies can unlock private investment, shift consumer behavior, and build globally competitive sectors.

The challenge for the EU is not to choose between regulation or markets, but to design policies that integrate both. Taxes must be smartly calibrated, revenues transparently recycled, and rules crafted to reduce uncertainty while enabling innovation. If coordinated well, these instruments can not only reduce harm but catalyze the kind of structural renewal that Europe urgently needs.

With rising global competition, limited fiscal space, and mounting external costs, the stakes are clear. Industrial policy, done right, offers Europe a lever not just to manage decline, but to drive future growth.

REFERENCES

Adomaitis, Nerijus (2025), "In Norway, nearly all new cars sold in 2024 were fully electric," Reuters News, published 2 January, 2025, Available online: https://www.reuters.com/business/autos-transportation/norway-nearly-all-new-cars-sold-2024-were-fully-electric-2025-01-02/

Beck, Marisa, Nicholas Rivers, Randall Wigle and Hidemichi Yonezawa (2015), "Carbon tax and revenue recycling: Impacts on households in British Columbia," *Resource and Energy Economics* 41, pp. 40-69.

Blackman, Allen, Zhengyan Li and Antung A. Liu (2018), "Efficacy of command-and-control and market-based environmental regulation in developing countries," *Annual Review of Resource Economics*, *10*(1), 381-404.

Castro-Rodríguez, Fidel and Daniel Miles-Touya, (2023), "Impact of Spanish renewable support scheme reforms on the revenues of photovoltaic power plants," *Utilities Policy* 80, Art. No. 101476.

European Environment Agency (2024), "Economic losses from weather- and climate-related extremes in Europe," *Published 14 October 2024*, Available online: https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related

European Union (2024), "Facts and Figures about the European Union," Available online: https://european-union.europa.eu/principles-countries-history/facts-and-figures-european-union_en

Del Río, Pablo and Pere Mir-Artigues (2014), "A cautionary tale: Spain's solar investment bubble," *International Institute for Sustainable Development (IISD),* February 2014, Available as PDF: https://www.iisd.org/gsi/sites/default/files/rens_ct_spain.pdf

FAO (2024), "Unhealthy dietary patterns drive $8 trillion in annual hidden costs of global agrifood systems," *Published 8/11/2024*, Available online: https://www.fao.org/newsroom/detail/SOFA2024-8-trillion-in-annual-hidden-health-costs/en

GHK (2012), "A study on liability and the health costs of smoking," *DG SANCO (2008/C6/046)*, Updated Final Report, April 2012, Available as PDF: https://health.ec.europa.eu/document/download/106b28dd-9b55-4b27-bba0-e94b54a93e56_en

Heutel, Garth (2020), "In defense of alternatives to pollution pricing," *Econfip Research Brief* May 2020.

IDF Europe (2016), "IDF Europe position on added sugar," April 2016, *International Diabetes Federation Europe*, Available as PDF: https://www.eu-patient.eu/globalassets/library/publications/added-sugar-final_idf-europe-position.pdf

Jolly, Suyash, Markus Steen, Teis Hansen and Samson Afewerki (2023), "Renewable energy and industrial development in pioneering and lagging regions: the offshore wind industry in southern Denmark and Normandy," *Oxford Open Energy* 2, Article No. oiad010.

Kitzing, Lena, Catherina Mitchell and Poul Erik Morthorst (2012), "Renewable energy policies in Europe: Converging or diverging?" *Energy Policy* 51, pp. 192-201.

Lucas, Gary (2024), "Shaping Preferences with Pigouvian Taxes," *NYU Journal of Legislation and Public Policy* 69.

Lynch, Barbara S. and Richard J. Bonnie (Eds.), "Growing Up Tobacco Free: Preventing Nicotine Addiction in Children and Youths," *Committee on Preventing Nicotine Addiction in Children and Youths, Institute of Medicine (1994),* Available as at: https://nap.nationalacademies.org/catalog/4757/growing-up-tobacco-free-preventing-nicotine-addiction-in-children-and

McMorran, Ronald T. and David Nellor (1994), "Tax Policy and the Environment: Theory and Practice," *IMF Working Paper* No. 94/106. International Monetary Fund.

Mildenberger, Matto, Erick Lachapelle, Kathryn Harrison and Isabelle Stadelmann-Steffen (2022), "Limited impacts of carbon tax rebate programmes on public support for carbon pricing," *Nature Climate Change* 12, pp. 141–147.

OECD (2022), "Norway's evolving incentives for zero-emission vehicles," *Case Study of the OECD*. Available online: https://www.oecd.org/en/publications/ipac-policies-in-practice_22632907-en/norway-s-evolving-incentives-for-zero-emission-vehicles_22d2485b-en.html

PHAS (2024a), "Towards a Smoke-Free Sweden," Available online: https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/living-

conditions-and-lifestyle/andtg/tobacco/towards-a-smoke-free-sweden/

PHAS (2024b), "Use of Tobacco and Nicotine Products," Available online: https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/living-conditions-and-lifestyle/andtg/tobacco/use-of-tobacco-and-nicotine-products/

Reubi, David (2013), "Health economists, tobacco control and international development: On the economisation of global health beyond neoliberal structural adjustment policies," *BioSocieties* 8, 205–228. Available as at: https://doi.org/10.1057/biosoc.2013.3

Tuladhar, Sugandha D., Sebastian Mankowski and Paul Bernstein (2014), "Interaction effects of market-based and command-and-control policies," *The Energy Journal* 35(1_suppl), 61-88.

UNFCCC Technology Executive Committee (2023), "Wind Energy in Denmark – Case study: Good practices and lessons learned on the setup and implementation of National Systems of Innovation," Available as PDF: https://unfccc.int/ttclear/tec/NSI.html

van Est, Rinie (2022), "The Success of Danish Wind Energy Innovation Policy: Combining Visionary Politics and Pragmatic Policymaking," in Caroline de la Porte, and others (eds), *Successful Public Policy in the Nordic Countries: Cases, Lessons, Challenges*. Oxford University Press, Oxford (UK).

WHO (2024a), "Cheers or tears? WHO playbook exposes alcohol's true cost to health," *World Health Organization (WHO) Europe Newsroom*, 8 November 2024.

World Health Organization (2024b), "Tobacco use declines despite tobacco industry efforts to jeopardize progress. Available online: https://www.who.int/news/item/16-01-2024-tobacco-use-declines-despite-tobacco-industry-efforts-to-jeopardize-progress

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