Incentivizing Sustainable Chemistry

A Policy Framework for Innovation, Manufacturing, & Market Transformation

RESEARCH REPORT

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Contents

About this Project ... ii

Preface ... iii

Executive Summary ... iv

1 Introduction ... 8

A Working Definition of Sustainable Chemistry ... 8

Drivers for Sustainable Chemistry ... 9

The Economic Case for Sustainable Chemistry ... 10

Market Barriers to Sustainable Chemistry ... 12

2 Framework Overview ... 14

Key Insights Guiding the Framework ... 15

Desired Outcomes ... 17

Categories of Policy Incentives ... 18

Supply-Push Incentives ... 19

Demand-Pull Incentives ... 19

Design Criteria for Policy Incentives ... 20

How Policy Criteria Were Applied to Scenarios ... 22

3 The Six Incentive Categories ... 23

Supply-Push Policy Incentives ... 24

Industrial and Academic R&D Grants ... 24

Subsidies ... 28

Tax Incentives ... 32

Demand-Pull Policy Incentives ... 36

Market Support and Derisking Incentives ... 36

Labeling, Recognition, & Preferential Purchasing ... 40

Regulatory Incentives ... 44

Applying the Six Incentive Categories ... 48

4 Incentive Scenarios ... 51

5 Implementing Sustainable Chemistry Policy Incentives ... 54

6 Conclusion ... 58

Literature Cited ... 60

About this Project

Over a 12-month period in 2025, the **Sustainable Chemistry Catalyst** at the University of Massachusetts Lowell and **Change Chemistry**'s Transatlantic Policy Working Group—representing more than 50 companies across the chemicals value chain and multiple sectors—collaborated to identify barriers to sustainable chemistry innovation, adoption, and market transformation and to explore how targeted government policy incentives could address those barriers. The process was informed by: 1) a survey of 75+ companies and associations representing the full value chain and multiple sectors (30% response rate); 2) interviews with 10 companies and external experts; 3) seven discussions with the Working Group; 4) two policy design charettes; and 5) extensive literature review.

Incentivizing Sustainable Chemistry: A Policy Framework for Innovation, Manufacturing, & Market Transformation is the result of this collaboration. The Framework is aspirational, representing a fully articulated and robust approach to supporting both demand creation and supply of sustainable chemicals. At the same time, it provides a practical and flexible menu of options spanning the full innovation and adoption pathway—from early-stage research and development (R&D) through commercialization, adoption and scale—that can activate the marketplace and derisk private investment.

The Framework is designed to inform policy development across jurisdictions and to encourage coordination among governments, investors, and the private sector to magnify impacts. Given that incentives rely on limited public funds, prioritization, monitoring, and program evaluation are vital to ensure that incentives efficiently and effectively achieve policy goals and enable robust private investment. It is intended to serve as a living tool, updated as new policy models, examples, and insights emerge.

Project Leaders

The **Sustainable Chemistry Catalyst** at the University of Massachusetts Lowell is an independent research and strategy initiative, focused on accelerating the transition to safer, more sustainable chemistry.

Change Chemistry is a network of over 100 companies—along the full value chain and across multiple sectors—collaborating to drive market transformation toward safer, more sustainable chemistry.

Preface

This report is grounded in a simple but urgent premise: regulation alone, while important, is insufficient to deliver the pace and scale of change needed to transition markets toward safer, more sustainable chemistry. Policymakers need to *both* address the environmental, health, and economic risks of problematic incumbent chemistries while *also* enabling innovation, investment, and manufacturing competitiveness. Well-designed policy incentives—working alongside regulatory approaches—can play a critical role by reducing risk, lowering adoption barriers, harnessing private investment, and sending clear market signals that reward more sustainable solutions.

Incentivizing Sustainable Chemistry: A Policy Framework for Innovation, Manufacturing, & Market Transformation equips policymakers with a practical and flexible set of tools to do just that. Drawing on foundational research and insights from across the chemicals value chain, the Framework illustrates how coordinated supply-push and demand-pull incentives can accelerate innovation, commercialization, adoption, and scale. It is aspirational in scope and practical in application: recognizing fiscal constraints, jurisdictional differences, and supply chain complexity. It is also designed as a living resource, to be informed by ongoing evaluation and emerging practice.

This work would not have been possible without the collective effort of many contributors. We are deeply grateful to the companies that participated in the Change Chemistry's Transatlantic Policy Working Group, whose insights and engagement shaped the Framework throughout. We thank the teams at the University of Massachusetts Lowell and Change Chemistry for their sustained collaboration and analytic rigor, and the numerous reviewers whose critical input significantly improved the report. We are especially grateful to Molly Jacobs and Michele Jalbert, whose leadership and contributions were indispensable to this effort. We also thank the broader membership of Change Chemistry, whose dues partially funded this report, and the New York Community Trust for providing critical support. Their commitment reflects a shared investment in accelerating market transformation toward sustainable chemistry.

Joel Tickner
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Executive Summary

Incentive policy is critical to market transformation.

Regulators, investors, consumers, and companies are aligned in supporting the shift to more sustainable chemicals. Companies across the chemicals value chain are under increasing pressure to not only address carbon, but also toxicity and circularity. These pressures are reinforced by litigation and reputational risks associated with many incumbent chemistries. At the same time, the potential benefits of sustainable chemistry investments are becoming clearer in terms of economic competitiveness and job creation, as well as health, safety, and environmental cost savings.

Replacing incumbent chemicals with preferable alternatives is complex. Incumbent chemicals are often low-cost, fossil-based, and deeply embedded in global value chains. They have also benefited from decades of public and private policy support, investment, optimization, and scale. As a result, more sustainable chemicals frequently encounter structural disadvantages in the marketplace. While Change Chemistry member companies are committed to advancing sustainable chemistry, the economic and market adoption challenges are often too great to drive large-scale and lasting change through market forces alone.

Barriers to innovation and adoption of sustainable chemistry are significant. Research and development (R&D), revamping manufacturing processes, reformulation, recertification, and regulatory approvals require substantial time and investment, which often exceed regulatory or market timelines. High switching costs--combined with reluctance to incur extra costs along the value chain--further slow adoption.

Well-designed government policy can play a critical role in addressing these barriers. A predictable and credible policy framework enables firms to invest in long-term R&D and commercialization activities, while targeted incentives can lower switching costs, reduce risk, accelerate market adoption, and enhance competitiveness. Experience from other sectors, such as renewable energy and electric vehicles, demonstrates the effectiveness of coordinated policy strategies and incentives in driving industrial transformation.

Incentive policy should target both supply and demand.

This report offers a practical Policy Framework for advancing sustainable chemistry through innovation, manufacturing, and market transformation.

The Framework benefits from the input of more than 50 companies along the full chemicals value chain and across multiple sectors.

The Framework identifies six types of policy incentives that, when thoughtfully combined, could help accelerate the pace of both innovation and market adoption for more sustainable chemicals.

No single policy measure is sufficient.

A central finding is that no single policy measure is sufficient to drive market transformation. Effective strategies require targeted and coordinated combinations of supply-push and demand-pull incentives that address barriers across the full innovation and adoption pathway.

Moreover, **the transition toward sustainable chemistry involves the entire value chain, and policy incentives must reflect that reality**. From early-stage innovators to large chemical producers, manufacturers, brands and retailers, incentives must recognize this complexity, addressing differences in company size, value chain position, and technology development stage. In particular, small and medium-sized enterprises, the engines of chemistry innovation, need accessible incentives.

To enable a meaningful market shift toward more sustainable chemical ingredients and products, policy must provide predictability and value chain stability. Chemical suppliers—both small and large—require confidence in future demand across the value chain to justify investment. Product manufacturers need reliable access to sufficient supply of inputs. Retailers and purchasers depend on credible, independently verified standards to differentiate safer, more sustainable products.

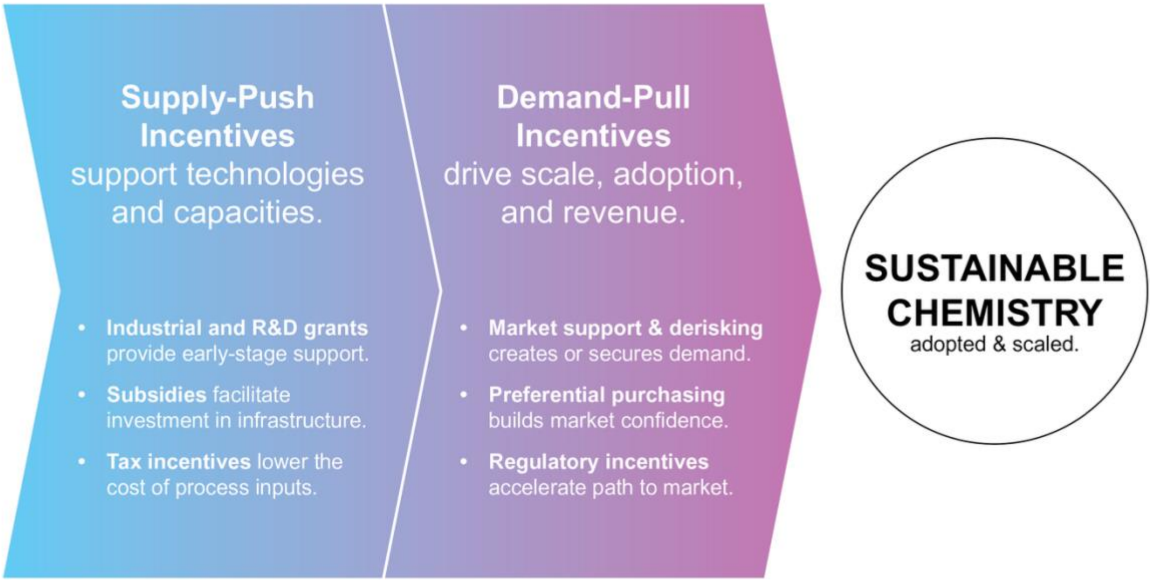
Effective incentives should send clear market signals, level the playing field for emerging sustainable chemistries, and enable coordinated action across value chains and among other stakeholders, including investors and regulators. They should be designed with clear, consistent, yet flexible criteria and evaluation processes to reduce the risks of regrettable substitution and greenwashing, while supporting continuous improvement. Finally, incentives must reflect the timelines of chemical innovation and market adoption. Durable—though not indefinite—policy support over realistic time horizons enables planning, investment, reformulation, recertification, scale, and ultimately market transformation.

Given that most policy incentives rely on public funds with competing priorities, governments need to strategically select among incentive types or concentrate a more robust set of incentives on targeted sustainable chemistry priorities (e.g., specific chemistries, product categories, or sectors) to most effectively support innovation, adoption, and market transformation. While the Framework is comprehensive in scope, it can also be applied selectively to guide incentive choices aligned with specific policy goals and to leverage government signaling to catalyze private investment.

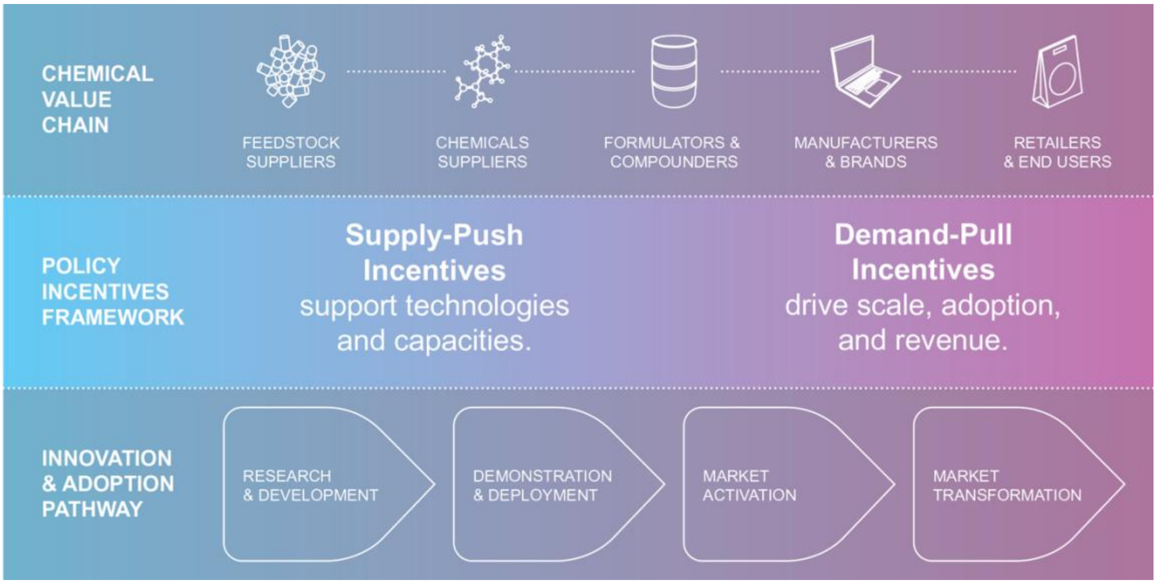
Ongoing co-creation and refinement of the Framework—based on evaluation of the performance of specific incentives and combinations of them - will be important to maintain its relevance and strengthen its ability to accelerate sustainable chemistry innovation and market adoption that co-delivers economic, social, and environmental benefits.

Key figures and tables from the report are included here for convenience.

Graphic 1. Categories of Policy Incentives for Sustainable Chemistry



Graphic 2. Incentives in the Context of the Market Transformation Ecosystem



Graphic 3. Core Elements of a Robust Incentives Program for Sustainable Chemistry

SYSTEM IMPACT

Transformation
Design incentives as part of a broader, strategic program focused on clearly stated, long term technology, sectoral, or ecosystem changes that advance sustainable chemistry goals.

Coverage
Ensure that incentives span the full innovation and adoption pathway—from pre-deployment and deployment through market activation and long-term market transformation.

Durability
Provide predictable, long-term market signals that are sufficiently stable to foster innovation and encourage sustained private-sector investment.

Adaptability
Build in periodic evaluation, sunset provisions, and flexibility so that incentives can be adjusted or replaced as goals are achieved, conditions change, or unintended consequences emerge.

MARKET ENGAGEMENT

Activation
Create strong demand signals and reduce market risk to accelerate adoption along the value chain, from upstream feedstock and chemical suppliers to downstream brands and retailers.

Competitiveness
Design incentives to level—or tilt—the playing field in favor of sustainable chemistry, counteracting legacy policies and market dynamics that advantage incumbent technologies.

Accessibility
Ensure incentives are readily accessible to companies of different sizes, business models, and stages of development along the value chain.

EFFECTIVE GOVERNANCE

Collaboration
Encourage value chain and sectoral collaboration and collective action, including active engagement of stakeholders throughout policy design, implementation, and evaluation.

Coordination
Coordinate across agencies, levels of government, and—where appropriate—with private-sector actors to maximize innovation, adoption, and policy coherence.

Integrity
Incorporate criteria, processes, and enforcement mechanisms to ensure that public funds deliver verifiable outcomes and prevent misuse, greenwashing, or regrettable substitution.

1 Introduction

Chemicals are essential inputs to most products and manufacturing processes, contributing to product quality, safety, performance, and functionality. They also enable sustainability benefits, such as product longevity, lightweighting, and improved energy storage. The chemical industry and its downstream value chains are major drivers of the global economy. At the same time, a growing body of scientific evidence links the production and use of chemicals and materials to chemical pollution, waste generation, and climate change, with significant impacts on human health and ecosystems. The chemical industry is the largest industrial energy user and in the top three industrial carbon dioxide emitters globally, primarily driven by basic chemicals production.[1] Recent analyses suggest that exposures to just four groups of chemicals (PFAS, phthalates, bisphenols and pesticides) could generate up to $3 trillion/year in avoidable societal costs.[2] The externalized costs along chemical value chains can represent significant cost for governments and taxpayers.

A Working Definition of Sustainable Chemistry

Sustainable chemistry can be defined as the development and application of chemicals, chemical processes, and products that achieve functional and societal needs with: 1) lower toxicity, climate and biodiversity impacts; and 2) improved efficiency, circularity and transparency across their lifecycles. [3]

Achieving both safety and sustainability across the lifecycle is central, including both efforts to "defossilize" chemistry using renewable carbon sources and "detoxify" chemicals relative to existing incumbent chemistries.[4] While criteria exist to define safer chemicals,[5] broader sustainability attributes—carbon footprint, circularity, resource efficiency—are less standardized,[6] although frameworks such as the European Commission's *Safe and Sustainable by Design*[7] guidance and the World Business Council for Sustainable Development's Portfolio Sustainability Assessment[8] tool offer approaches.

Drivers for Sustainable Chemistry

Growing scientific evidence of chemical risks is driving regulatory, market, and investor pressure for safer and more sustainable chemicals that meet existing or new functional needs, lower costs, and create new market opportunities, while reducing human and ecosystem impacts across the lifecycle.[9]

- **Regulatory:** Over the past decade, the European Union and multiple US states have enacted or proposed restrictions on chemicals of concern given their toxicity profile, either in specific product categories (e.g., personal care products, toys) or chemical classes (e.g., PFAS). Increasingly, these regulatory bodies require disclosure of hazardous ingredients in products and processes.
- **Market:** Consumers, advocacy campaigns, and brand reputation concerns are prompting retailers, manufacturers, and institutional purchasers to demand greater transparency, restriction of chemicals of concern, substitution with safer alternatives, and adoption of credible eco-labels. Many companies are also seeking lower-carbon products to reduce Scope 3 emissions.
- **Investor:** Investors are leveraging tools such as ChemSec's ChemScore,[10] the Chemical Footprint Project,[11] and the Mind the Store Retailer Report Card[12] to address reputational, litigation, and regulatory risks related to chemicals, while promoting adoption of sustainable chemistry alternatives and alignment with net-zero goals. Investors are increasingly viewing toxicity as an important avoidable risk for firms.[13]

These combined pressures are motivating companies to review portfolios, gather chemical use and toxicity information along supply chains, prioritize substitution, and initiate R&D for sustainable chemistry solutions.

The Economic Case for Sustainable Chemistry

Research demonstrates a strong economic and business case for sustainable chemistry innovation.

Beyond reducing regulatory, reputational, litigation, and environmental risks, the use of sustainable chemistry can positively differentiate companies in the marketplace, creating competitive advantage.[14] US point-of-sale data indicate that products marketed as sustainable, green, or safer chemistry—based on company self-assessment rather than standardized criteria—are growing faster than conventional products across ten consumer product categories (See **Error! Reference source not found.**).[9] From 2015 to 2019, the products in these categories accounted for just 14.3% of market share but drove 62% of market growth. Their market share has continued to expand significantly, underscoring the commercial opportunity of investing in safer and more sustainable chemistry.[15]

A 2021 survey of Change Chemistry companies across the value chain indicated increased green chemistry R&D investment in the previous five years with companies noting the likelihood of increased demand, investment, and moderate to strong market growth in the next five years.[9] A 2026 Gordon and Betty Moore Foundation survey reiterated this finding, with 75% of R&D and technology leaders indicating that green chemistry investments can fuel innovation, long-term advantage, cost savings and job growth.[16]

The commercial opportunity is manifested in the proliferation of early-stage companies offering sustainable chemistry solutions in the marketplace. **Market projections from multiple sources indicate compound annual growth rates above 10.7% for the green chemistry sector**; these forecasts are driven in part by increasing demand for biobased products—particularly in applications such as packaging—as well as broader policy, corporate sustainability, and supply chain pressures.[17,18]

Growth in sustainable chemistry can drive jobs and broader economic development. Estimates suggest that for every job in sustainable chemistry—which is projected to grow faster than conventional chemistry—up to eight additional jobs are created across the economy.[9] Sustainable chemistry investments also generate significant economic value: for the sustainable (green) chemistry industry, each dollar of value added creates over six dollars of value added throughout the broader US economy.[9] For example, research on the US biobased products sector found that in 2017, it supported over 4.6 million people, generated $470 billion in value added, and had an economic multiplier of 2.79.[19]

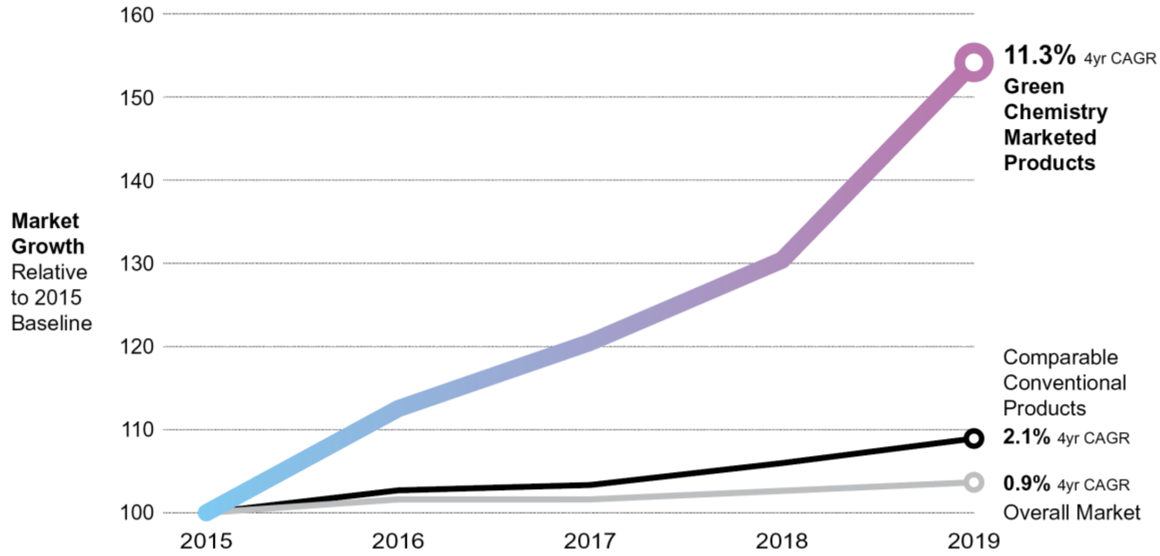


Figure 1. Growth of Green Chemistry Marketed Products, 2015 to 2019
Adapted from J. Golden et al. (2021)

Market Barriers to Sustainable Chemistry

Despite strong drivers, increased R&D, and demonstrated economic value, sustainable chemistry innovation and adoption are not occurring fast enough or at sufficient scale to enable market transformation.

Sustainable chemistry is taking root primarily in small, niche product categories with higher margins or a willingness to absorb additional cost, representing only a small portion of chemical production and use. Business decisions regarding production and purchasing along value chains still generally focus on price and performance, favoring incumbent chemistry.

Sustainable chemistry thus faces significant headwinds that pose barriers to innovation, commercialization, and market adoption. Low-cost, established chemistries— primarily fossil fuel-based—dominate global supply chains, benefiting from decades of optimized production, supply chain infrastructure, capital investment, and policy support. Developing chemical alternatives across applications requires costly R&D, new manufacturing processes, reformulation, recertification, and regulatory approvals, which can take 3–15 years, often exceeding market or regulatory phase-out timelines for substitution. Alternatives may also perform differently, require process changes, or lack multiple suppliers or sufficient volumes, creating high switching risks and costs, and reluctance across value chains.

For many companies, short-term return on investment (ROI) expectations often conflict with the patient capital needed for sustainable chemistry. Changing regulatory or market priorities add uncertainty, particularly for early-stage firms, and as a result, commercialization decisions tend to favor cost, short-term returns, and market adoption over long-term sustainability value.[20]

Two examples illustrate these challenges:

- **Eastman Chemical** developed Omnia solvent applying green chemistry principles to meet EPA Safer Choice criteria. Although cost- and performance-competitive, adoption was slow due to switching costs and limited clear drivers for use.[21]
- **Danimer Scientific** invested in new production of polyhydroxyalkanoate (PHA) plastics to meet anticipated brand demand. Supply chain disruptions, inflation, and unmet customer commitments led to underutilized assets, liquidity challenges, and bankruptcy in 2025.[22] Several additional companies in the sustainable chemistry space, including Circa chemicals, Amyris, and BioAmber have closed in recent years due to other market challenges.

A 2015 analysis for Change Chemistry identified a number of barriers as well as accelerators of sustainable chemistry (see Figure 2Figure 2).[23] Earlier stage companies trying to bring new substances or materials to market struggle with sustained investment from early stage through capital buildouts (through the "valley of death") and securing market assurances for ready to deploy technologies. Larger chemical companies wanting to introduce more sustainable options, on the other hand, face conflicting signals across regulators, investors, and customers as to what constitutes “sustainability” attributes. Additionally, sustainable chemistries experience regulatory barriers that often do not exist for incumbents, which have been exempt from many regulatory review processes. Brands and formulators interested in sustainable alternatives are challenged with supply disruptions, inadequate supply, and reformulation and performance testing demands. Finally, retailers face challenges in adding sustainable products to their portfolios due to limited resources for identifying safer and more sustainable products as well as limited consumer willingness to pay a premium.

Despite clear drivers for sustainable chemistry, the economic and adoption challenges are often too great to drive changes at scale. Well-designed policy incentives can address these challenges by overcoming barriers and enabling accelerators.

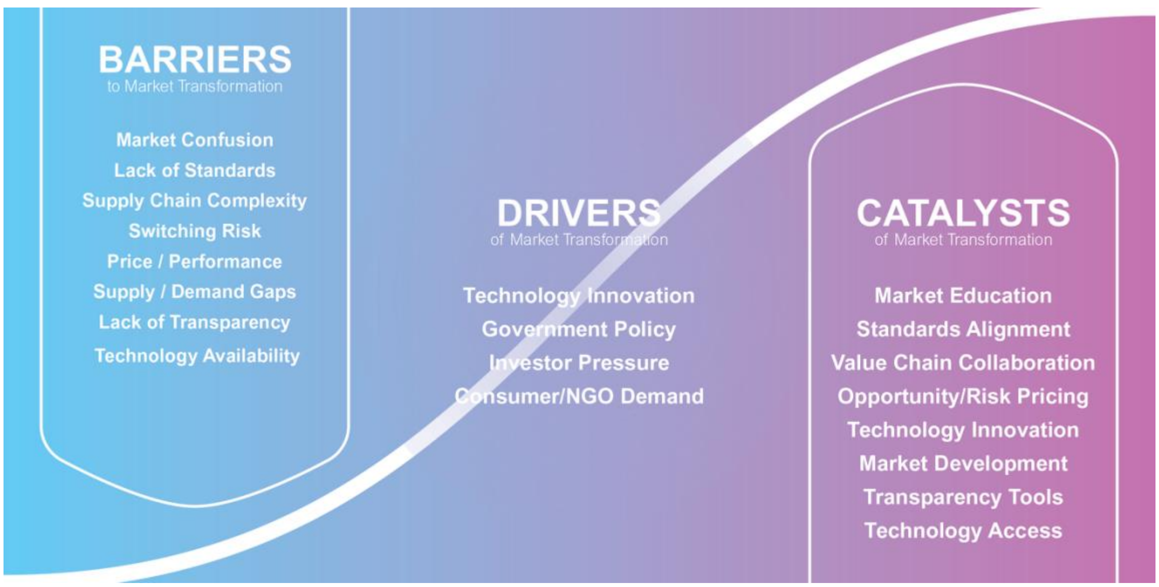


Figure 2. Market Transformation Factors
Based on T. Fennelly and Associates (2015)

2 Framework Overview

The transition to more sustainable chemistries is foundational to long-term economic competitiveness in addition to protecting human health and the environment.

Yet despite growing awareness of the negative impacts of incumbent chemistries and the benefits of sustainable chemistry, both the pace and scale of R&D investment and the market adoption of safer and more sustainable alternatives remain limited. A coordinated set of policy incentives is needed to guide action, stimulate innovation, reduce costs, and accelerate the speed and scale of commercialization and market uptake of sustainable chemistries across the value chain. Government action can trigger marketplace uptake and derisk private sector investment. The current generation of chemicals and materials benefited from sustained government support over decades. New sustainable chemistry innovations will require similar support to compete against incumbents. Yet, despite the many barriers identified and the potential to deliver economic competitiveness, job and manufacturing opportunity, and significant health benefits valued in the trillions of dollars,[24] government policies and incentives for sustainable chemistry have been sporadic and fragmented as compared other innovation and sustainability areas, such as renewable energy.

Key Insights Guiding the Framework

The Framework is shaped by three key lessons from the background research and expansive discussion with Change Chemistry members and other experts:

Regulation alone isn't enough to overcome market barriers or accelerate growth in sustainable chemistry. Well-designed, predictable and complementary regulatory policies are important to overcome inertia, internalize the externalized costs of incumbent chemistries, and create market "willingness" to innovate. And investor and market pressure can complement or serve in the absence of regulatory policy. But literature on technological innovation emphasizes the need for incentive policies that prioritize sectors, shape technological responses, and provide capacity and opportunity—through information, technical assistance, economic incentives, technology goals, and standards. A well-designed policy approach – that integrates both regulatory and economic "sticks" as well as incentive "carrots" can more effectively drive more transformative solutions. Cross-agency and muti-stakeholder policy coordination is essential to align environmental, sustainability, and economic objectives and maximize policy impact.[25]

Policy incentives must span the entire innovation and adoption pathway. Market readiness and adoption, rather than R&D, is often the primary bottleneck in advancing sustainable chemistry. Policy incentives are required along the entire innovation and adoption pathway - from R&D through piloting, deployment, adoption (e.g., reformulation and purchase), and broader industry transformation.

Traditional approaches to innovation incentivization focus primarily on supply and technology development along Technology Readiness Levels (TRLs). This construct fails to adequately capture commercialization or adoption challenges such as regulatory approvals, reformulation costs, value proposition, market acceptance, infrastructure, investment potential, or supply chain risk. As such, considering Adoption Readiness Levels (ARL)—a concept used by the US Department of Energy—is of equal importance in designing incentives (see Figure 3).[26] Since many technology innovations never reach the market, incentives must address not only technology creation but also their commercialization, diffusion, market readiness, and scale. Incentives can help create "lead markets" demonstrating proof of concept for sustainable chemistries in a particular sector or application that can support future scaling.[27]

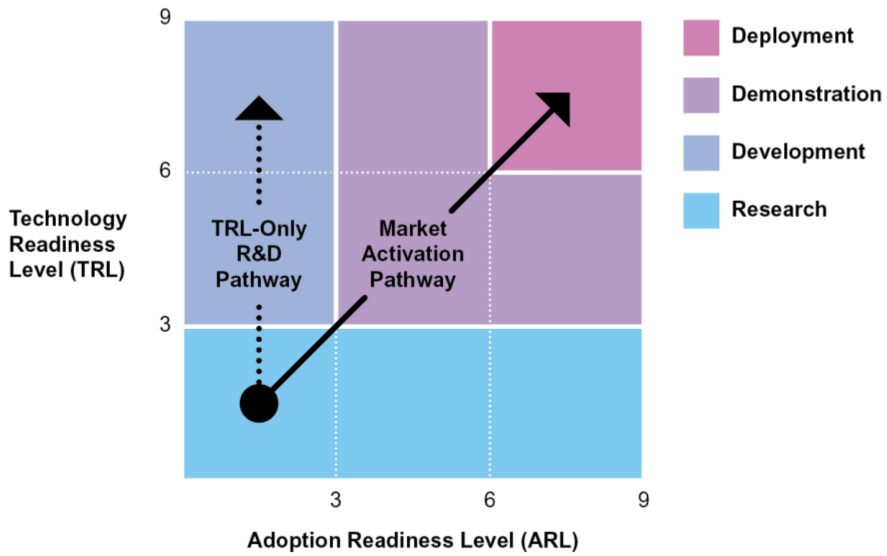


Figure 3. Market Activation Pathways
Based on Tian et al. (2023)

Incentivization along the value chain is essential. Switching to more sustainable chemistry involves all players along a value chain. Value chains are often complex, global, and include multiple tiers of chemical suppliers, formulators, compounders, distributors, manufacturers, retailers and other end users.[28] Even if a supplier commercializes a high-performing sustainable chemical, downstream manufacturers may resist reformulation or absorbing switching costs. Incentives must reflect position in the value chain: Suppliers need investment security, compounders need sufficient margins, manufacturers need reliable supply, and retailers require independent verification to differentiate safer or more sustainable products. Pre-competitive collaboration across sectors and the value chain can accelerate solutions more effectively than isolated efforts.[29] For example, Operation Warp Speed for Covid vaccines demonstrated how coordinated public–private collaboration can rapidly advance innovation by aligning incentives, sharing risk, and mobilizing resources at scale.[30]

Desired Outcomes

The Framework is intended to deliver durable, predictable, and targeted support for sustainable chemistry: fostering innovation, market uptake, and long-term competitiveness.

The Framework aims to achieve five policy outcomes that will accelerate the market transition to sustainable chemistry. Taken together, these desired outcomes offer a comprehensive guide for policy development.

1 **Discourage regrettable substitutions and "greenwashing".** Clear, consistent, and regularly updated criteria for evaluating sustainable chemistry are essential to avoid regrettable substitutes, prevent greenwashing and market confusion, and achieve sustainable chemistry policy goals. Transparent monitoring and assessment of incentives builds trust, ensures accountability, and supports credible, verifiable innovation.

2 **Provide predictable and time-appropriate support.** Incentives should provide funding that is adequate, stable, and of a reasonable duration to allow companies to plan projects, reformulate products, and scale production. Support that is too short term or variable can hinder investment and adoption, while overly long term or rigid incentives may lock in marginal improvements and divert resources from higher-priority sustainable chemistry initiatives.

3 **Design for complexity and flexibility.** Introducing new chemistries into the value chain is inherently complex, particularly when it involves reformulation, new manufacturing assets, regulatory approvals, or recertification. Incentives should reflect these realities—including resource needs and timeframes for R&D, commercialization, and substitution—while remaining flexible enough to allow iteration, adaptation, and continuous improvement.

4 **Link to appropriate performance indicators.** Incentives should be tied to measurable progress—such as new chemicals, improved processes, sustainability gains, or market outcomes. Linking support to performance helps distinguish next-generation sustainable chemistry solutions from incumbents, accelerate cost reductions through adoption, and strengthen long-term competitiveness.

5 **Recognize and use market power.** Governments have an important role in shaping and driving markets. Well-designed incentives can spur private sector investment and market uptake by derisking innovation, private investment, and public and private purchasing. As with net zero policies, incentives should embed sustainable chemistry considerations into the R&D, business, and sourcing decisions along the value chain and across sectors.[31]

Achievement of these outcomes would elevate sustainable chemistry as a core priority for the chemical sector and the value chains that depend on it. Achieving this vision requires policies and incentives designed to address the unique challenges of chemical innovation, from long R&D timelines to complex manufacturing transitions. The implementation of this vision will require coordinated government effort that prioritizes limited resources while triggering market action and private investment that maximizes impact.

Categories of Policy Incentives

The Framework defines six incentive categories that, together, can accelerate sustainable chemistry innovation and markets.

Based on surveys, interviews, and discussions with Change Chemistry members and others, the Working Group identified policy incentives most likely to advance sustainable chemistry R&D, deployment, and market uptake, based on the desired outcomes identified above and design criteria outlined below. These were selected regardless of prior use or region, with the goal of addressing barriers to innovation, adoption, and scale across the value chain. Starting with an initial list of 15 incentive categories, companies across the value chain highlighted those that would most benefit their sustainable chemistry efforts:

- **Startups and earlier stage companies** – industrial grants, tax incentives, subsidies, loan guarantees/equity participation.
- **Brand/manufacturers** – industrial grants, regulatory frameworks, labeling, preferential procurement.
- **Chemical suppliers** – regulatory frameworks, tax incentives, industrial grants, subsidies.

The Working Group further refined and prioritized the list into six core categories of policy incentives that, when thoughtfully combined, can accelerate both innovation in and markets for sustainable chemistry. These fall into two broad groups: (1) supply-push and (2) demand-pull incentives. (see Figure 4). Definitions are provided in a later section.

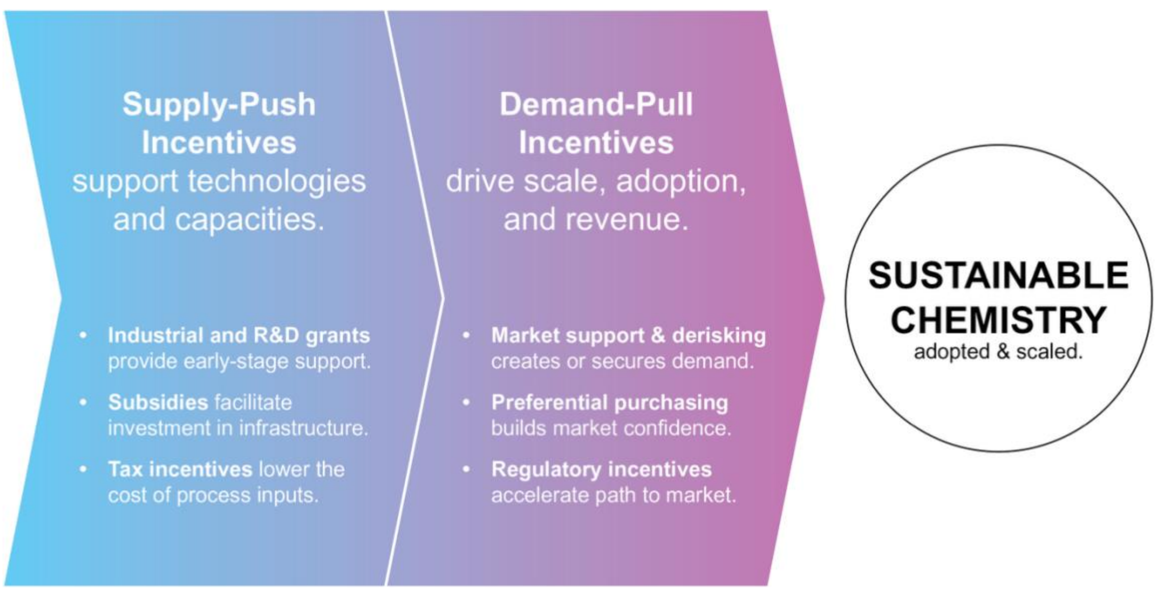


Figure 4. Categories of Incentives

These two groups of incentives are interconnected and reinforce each other. Some incentives (e.g., subsidies, tax credits) span multiple categories. Key drivers for sustainable chemistry can stimulate demand, which can then stimulate supply as a response to meet that demand. New sustainable chemistry innovations without a clear demand pull or driver will struggle in the marketplace. Yet, even when demand exists, if those innovations are not available at an acceptable price point or scale, they will not be adopted. As such, the timing and order of supply-push or demand-pull incentives may depend on the specific sustainable chemistry challenge.

Supply-Push Incentives

Also called innovation-enabling or technology development measures, supply-push incentives support the development, scale-up, and production readiness of new or existing technologies, materials, or processes. They aim to reduce technical, financial, and operational risks, lower costs and barriers to innovation, manufacturing, and scale. They can also expand the pool of viable solutions through R&D grants, pilot and demonstration facilities, infrastructure investment, or technical assistance. Supply-push incentives help firms— including early-stage companies—move innovations from research to commercial readiness or from deployment to scale, laying the foundation for market adoption and complementing demand-pull measures.

Categories of supply-push incentives include: 1) industrial and R&D grants; 2) subsidies, including direct financial support and infrastructure support; and 3) tax incentives. Rebates and purchase incentives fall under demand-pull incentives.

Demand-Pull Incentives

Also called demand-mobilizing or market-shaping measures, demand-pull incentives create or expand markets for specific products or technologies. These policy measures aim to support market readiness, derisk adoption, and accelerate economies of scale, helping overcome risk aversion in complex supply chains. By guaranteeing buyers, offering price supports, establishing procurement standards, and use of rebates, demand-pull incentives encourage firms to bring safer, cleaner, or more sustainable innovations to market and scale production.

Categories of demand-pull incentives include: 1) market support and derisking incentives, including content requirements and market assurances; 2) recognition, labeling and preferential purchasing; and 3) regulatory incentives such as taxes and preferential review.

Both types of incentives are essential and should be tailored to the challenge—whether advancing brand-new technologies or driving widespread market adoption of already available sustainable chemistry innovations.

Design Criteria for Policy Incentives

The Working Group defined six criteria to assess policy incentives for sustainable chemistry development, commercialization, and adoption. Applied to US and EU examples, they found that no single incentive met all criteria, and combined approaches work best. The criteria are:

ACTIVATION

Create demand-pull and derisk market adoption along the entire value chain.
Incentives should both expand supply and pull demand for sustainable chemistry across the value chain. Specifically, policies that reduce production and market risks can boost private investment and accelerate adoption.[32]

TRANSFORMATION

Achieve significant and lasting technology, sectoral, or ecosystem change.
Policy incentives should help achieve the greatest impact possible. They should help create new competitive sectors, solve societal and cross-sectoral challenges, scale new technologies or platforms, and/or create new business, job, and economic development opportunities.

COLLABORATION

Encourage value chain and sectoral engagement, collaboration, and collective action.
Collaborative innovation and partnership, including trusted cooperation between large and small companies, can expedite entry, enhance market activation, and lower costs.[33] This includes collaboration across sectors, value chains, and with regulators and investors to manage the complexity, cost, and timelines of adopting new chemistries.

COMPETITIVENESS

Create a level or "preferential" playing field for more sustainable chemistries.
Given decades of investment in incumbent chemistries, comparable incentives are needed to scale next-generation sustainable alternatives (see Figure 5). As with renewable energy, sustained policy support can lower costs, boost investment, and drive growth.[34] Supporting early adopters or lead markets can create domino effects accelerate market transformation.[35]

COVERAGE

Incentivize multiple Technology Readiness Levels (TRLs). (see Figure 6)
Public and private funds are often available at early development stages, but capital can be difficult to secure for pilot plants, "First-of-a-Kind" facilities, and through to deployment.

ACCESSIBILITY

Enable access for companies of different sizes and stages along the value chain.
Many incentive mechanisms are out of reach for small and medium sized enterprises (SMEs) and startups, despite their key role in innovation and the chemicals sector. Eligibility thresholds, differentiated support, and other mechanisms can ensure broad accessibility to incentives.

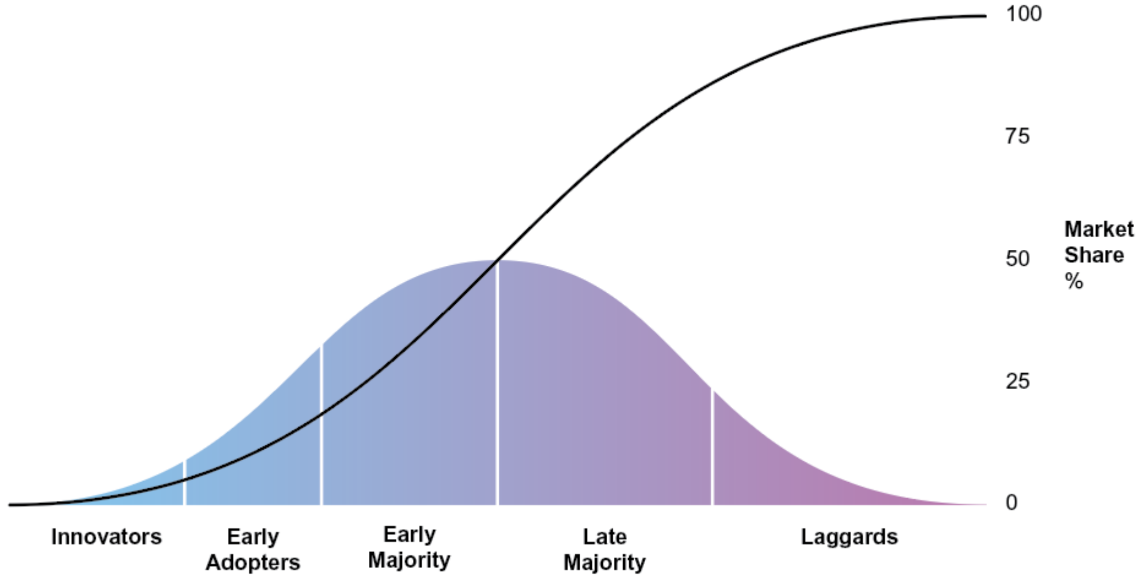


Figure 5. Diffusion of Innovations
Based on Rogers, *Diffusion of Innovations* (1962)

TRL 9	Actual system proven through successful mission operation
TRL 8	Actual system completed and qualified through test and demonstration
TRL 7	System prototype demonstration in an operational environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment
TRL 5	Component and/or breadboard validation in a relevant environment
TRL 4	Component and/or breadboard validation in a laboratory environment
TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
TRL 2	Technology concept and/or application formulated
TRL 1	Basic principles observed and reported

Figure 6. Technology Readiness Levels (TRLs)
Adapted from NASA (2016)[36]

How Policy Criteria Were Applied to Scenarios

In Section 3 (*The Six Incentive Categories*), each of the six policy incentive types is described and qualitatively characterized in terms of its performance against the above design criteria, with results summarized in a matrix. Lessons from applying these incentives to advance sustainable chemistry innovation and adoption are outlined, including strengths, gaps, limitations, and potential improvements. Examples of model programs in sustainable chemistry or related areas illustrate how these incentives can be applied in practice.

A subset of Change Chemistry Working Group member companies convened a structured policy design charrette, applying a scenario-based, qualitative policy modeling approach to evaluate how incentives could address key barriers to sustainable chemistry innovation and adoption. Using three illustrative case studies representing common barriers, participants conducted a systematic assessment of how specific policy incentives—or combinations thereof—could address challenges across the value chain and at different stages of the innovation and market adoption pathway. Discussions were guided by the Framework's design criteria to ensure consistent evaluation of effectiveness, accessibility, scalability, and market impact. By integrating scenario analysis, expert elicitation, and criteria-based evaluation, the charrette provides a rigorous qualitative foundation for identifying and testing targeted incentive strategies, as presented in Section 4 (*Incentive Scenarios*).

3 The Six Incentive Categories

This section reviews in depth the six priority policy incentive categories identified by the Change Chemistry Working Group. It explains how each incentive works, who it supports, and which stages of innovation or commercialization it targets. For each category, it provides a brief description, examples, and key lessons—highlighting strengths, limitations, and design considerations to inform future sustainable chemistry policy. Each category is also assessed against the Working Group's design criteria.

While some examples come directly from sustainable chemistry, many are drawn from other sectors (e.g., renewable energy, advanced materials, biobased manufacturing), where incentives policies to address challenges impeding technology development, scaling, and market readiness and adoption are more mature. Examples of incentives are primarily from the US and Europe.

This review does not attempt to catalog all policy incentives or assess how specific measures apply across regions or levels of government. Instead, it actively maps key categories of incentives that can help overcome barriers to sustainable chemistry innovation and market uptake. It draws on illustrative programs and design features to show how different approaches perform in practice and where important gaps persist.

By examining these patterns, the review informs the design of more effective incentive packages—that can coordinate action across the value chain, target technologies at the right stage of development and market readiness, and align with broader economic, societal, and environmental priorities. A later section addresses implementation considerations in more detail, including how evaluation and review processes can reduce risk, control costs, and ensure that incentives achieve their intended outcomes.

Industrial and Academic R&D Grants

Across countries, government grant programs form the backbone of public investment in innovations that service societal priorities. Grants provide non-repayable funding to support research, development, scale-up, and deployment of emerging technologies and innovations. Across sectors such as clean energy, advanced materials and manufacturing, and biotechnology, grants have played a central role in advancing foundational research, enabling technology translation, and strengthening the infrastructure and developing the expertise needed to bring new solutions to market. Grants' effectiveness depends heavily on program design, stage of technology, and accessibility.

Industrial and academic grants can take many forms, including direct funding for specific projects, research programs, or demonstration activities, as well as support for shared infrastructure, technical assistance, workforce development, and collaborative R&D. In both the US and Europe, grants are offered or co-funded at multiple levels—federal, state, EU, and Member State. There are three broad types of grant programs:

1. **Foundational research grants** – Support basic scientific discovery, such as creating new materials, molecules, or analytical tools, or developing scientific premises that underpin long-term innovation in emerging technologies.
2. **Translational and applied R&D grants** – Provide funding for prototyping, applied research, and early-scale demonstration, bridging the gap between discovery and market deployment.
3. **Piloting, demonstration, and early deployment grants** – Support validation, risk reduction, and demonstration activities that address commercial, technical, or regulatory barriers, helping technologies progress toward market adoption.

Grants can play an important role in advancing sustainable chemistry by enabling innovation across multiple TRLs, from early-stage discovery through demonstration and early deployment.

By providing targeted funding and facilitating public-private coordination, grants generate knowledge that might not occur through private revenue-driven investment alone, help derisk technologies, and strengthen industry-research linkages that can lead to new innovations and enhance adoption potential. Programs that integrate public and private resources, such as Horizon Europe, the US BioMade consortium, and the EU Circular Bio-Based Joint Undertaking (CBE JU – See Table 2) and "whole of government" models, such as the US National Nanotechnology Initiative, illustrate how coordinated efforts can effectively connect research to industry needs, strengthen technology translation, and catalyze systemic change across the value chain. Research programs increasingly include engagement criteria, encouraging collaboration with industry partners, multi-institutional teams, and, in some cases, supply chain actors. These strategies can help ensure that research addresses real-world challenges and enhances adoption potential.

A frequent R&D program challenge is that priorities often shift, placing viability of long-term research and development projects at risk. Foundational research grants rarely provide pathways for market translation, often leaving promising concepts stalled at low technology readiness levels. While some translational and pilot programs support demonstration and deployment, they often lack explicit requirements for supply chain engagement. This means capital-intensive projects remain difficult for small- and medium-sized enterprises (SMEs) to access, particularly where co-financing or significant grants management infrastructure are needed. Large firms with established R&D teams can participate more easily, while smaller companies often engage only indirectly through academic or collaborative partnerships. SME-tailored funding programs – such as the US Small Business Innovation Research Awards – and targeted grants support could facilitate greater access.

Fragmented funding across programs and agencies, complex administrative requirements, and limited alignment with downstream market and regulatory needs can further constrain impact. Addressing these gaps requires coordinated, multi-stage funding that bridges the "valley of death," supports demonstration-scale facilities, actively engages industry and value chain partners early, and leverages complementary incentives to accelerate commercialization and adoption.

While many grant programs already support sustainable chemistry, more targeted and coordinated programs or national initiatives with dedicated funding streams, could help accelerate R&D from basic research to demonstration and deployment.

Key Takeaways

- **Support the full innovation lifecycle.** Grants are most effective when they fund foundational research through applied R&D, piloting, demonstration, and early deployment, ensuring promising discoveries can progress toward market readiness.
- **Provide multi-year, predictable, durable and coordinated funding.** Sustained support with clear sustainable chemistry criteria supports results, enhances relevance, reduces uncertainty, and helps derisk private investment over the long term. Cross-agency coordinated funding can more effectively support specific technologies or solutions.
- **Integrate public-private coordination and value chain engagement.** Programs that require collaboration with industry, multi-institutional teams, and supply chain partners improve the applicability of research, accelerate translation, and increase adoption potential. Such requirements can, however, increase implementation complexity.
- **Target demonstration and early deployment gaps.** Capital-intensive pilot and demonstration projects are often bottlenecks to technology progress; targeted funding and accessible mechanisms are needed, particularly for SMEs, to bridge the "valley of death."
- **Design programs for broad accessibility.** Minimizing administrative complexity without degrading oversight and transparency, tailoring requirements for smaller firms, creating strong outreach channels to encourage program use, and enabling collaborations can improve participation across the innovation ecosystem, increasing equity and systemic impact.

Table 1. Performance against Criteria of Industrial and Academic R&D Grants

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	◒	Do not tend to support demand-pull but can support derisking by demonstrating viability of technologies in pilot or demonstration phases.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	●	Grants for technologies such as catalysis or new pathways or platform chemistries, can play an important role in supporting technology evolutions.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	◒	Do not generally require supply chain engagement, though some recent US and EU programs encourage inclusion of value chain partners.
COMPETITIVENESS Creates a level or "preferential" playing field for more sustainable chemistries.	●	Can help derisk technology and lower commercialization costs particularly for demonstration and deployment.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	●	Used to support companies and technologies across a range of TRLS, but more often for earlier stages.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	Broadly accessible to universities, research institutes, and sometimes industry partners, but may not be accessible to SMEs that lack research infrastructure or co-funding.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 2. Model Examples of Industrial and Academic R&D Grants

Building foundational scientific knowledge

The US National Science Foundation's Sustainable Polymers Enabled by Emerging Data Analytics (SPEED) program applies data analytics to polymer design to optimize sustainability. Similar grant programs for biomaterials or other sustainable chemistries are distributed across multiple US federal agencies such as the National Institutes of Health, Department of Energy, and the US Department of Agriculture, each emphasizing different research areas.

Horizon Europe's Excellent Science Pillar, supports early-stage research across the EU, guided by priorities set out in six-year plans. Research priorities for chemicals and materials are shaped by the Strategic Research and Innovation Plan (SRIP) with a priority focus on promoting safe and sustainable-by-design chemicals and materials.

Moving innovations toward application

The US Department of Defense's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) programs support applied research and demonstration-scale validation of safer, more sustainable alternatives to chemicals and materials of concern in operational environments.

The US Department of Defense's BioMade Consortium and the Department of Energy's Remade Consortium support bioindustrial and circular materials manufacturing, with co-financed applied research, pilot-scale validation, and early production pathways. These programs are part of the Manufacturing USA Program, which brings together industry, academia, and state and federal partners to advance technology, workforce development, and regional innovation ecosystems.

The US NSF Directorate for Technology, Innovation and Partnerships (TIP), funds projects to accelerate the translation of research into priority technologies with commercial potential, creating jobs and economic development in new sectors. The Regional Innovation Engines program supports innovation ecosystems in economically depressed regions.

The US Defense Advanced Research Projects Agency (DARPA) and the US ARPA-E (Advanced Research Projects Agency-Energy) fund high-risk, high-reward "sprint" research projects designed to rapidly evolve technology, transform markets, and bridge the "valley of death" where private investors are often reluctant to engage.

The Horizon Europe's *Global Challenges and Industrial Competitiveness* Pillar combines applied research funding with industry–research partnerships to advance societal priorities, including Safe and Sustainable by Design innovations such as the IRISS Project.

Supporting piloting, demonstration, and early deployment

The US Department of Energy Industrial Development Program (now closed) was established to accelerate technology deployment (TRL 7-8) projects in capital- and energy-intensive industries, providing manufacturers a competitive advantage in low- and net-zero carbon manufacturing.

The EU's Circular Bio-Based Joint Undertaking (CBE JU), co-funded with the private-sector Bio-Based Industries Consortium, advances circular bio-based industries through applied R&D, pilots, and deployment funding, including First-of-a-Kind facility support.

Subsidies

Subsidies represent a broad range of incentives designed to lower private sector costs and risks while supporting the development, scale-up, and deployment of emerging technologies. Current chemistries and processes have benefited for decades from sustained subsidies. Across sectors such as clean energy, advanced manufacturing, and low-carbon technologies, subsidies have played a central role in creating a level or preferential playing field under otherwise commercially unfavorable conditions, accelerating production and strengthening the infrastructure needed to bring new solutions to market. Their effectiveness depends heavily on program design, scale, and accessibility.

Subsidies can take many forms, including direct financial support—such as grants, loans, or public equity investments—as well as the provision of below-market goods or services, such as shared infrastructure, technical assistance, location bonuses, or reduced utility rates. In both the US and Europe subsidies are offered at multiple levels—federal, state, local, EU, Member State— but are rarely coordinated.

There are four broad types of subsidies:

1. **Financial support subsidies** – Provide direct assistance to support capital-intensive investments, including First-of-a-Kind facilities. Instruments include grants, concessional loans (loans offered at below market rates), loan guarantees (where an entity, usually a public entity, promises to repay a loan if the holder defaults), low-cost leases or location bonuses (such as lower utility costs), and public equity stakes (partial public ownership in exchange for some portion of output) to mobilize additional private investment.

2. **Market-based subsidies** – Create predictable revenue streams that reduce market uncertainty. Examples include price supports for specific chemistries, contracts for difference, and performance-based payments that narrow the cost gap between emerging and incumbent technologies.

3. **Infrastructure and ecosystem support subsidies** – Provide shared services, infrastructure, land, or other institutional support to enable innovation and commercialization. Examples include physical infrastructure investments (facilities, logistics, transport), technical assistance programs, workforce development, testing support, and innovation clusters. Prize competitions or inducement awards offer lump-sum rewards or preferential market access after successful demonstration of high-risk, high-reward innovations.

4. **Policy-based subsidies** – Protect or support specific technologies or domestic manufacturing capabilities, such as permitting advantages, creating a more level playing field for emerging sustainable technologies.

Subsidies can advance sustainable chemistry by reducing risk, improving bankability, and building needed infrastructure, though they remain under-utilized. Financial and market-based support can overcome early commercialization barriers, while ecosystem investments provide the expertise and infrastructure firms need—together supporting development from research to commercial deployment..

Subsidies, however, are often short-term in nature and not tied to clear technology goals or roadmaps. Short-lived or politically contingent programs create uncertainty, undermining private investment and long-term adoption. The US Sustainable Aviation Fuel (SAF) Grand Challenge (2022-2025), which leveraged subsidies, research, and infrastructure support across multiple agencies to scale domestic SAF production is an example. However, the US Sematech initiative, designed to grow domestic semiconductor competitiveness, demonstrates the value of targeted, integrated approaches. Nonetheless, when extended too long, some subsidies can hinder innovation or lock-in technologies. Subsidies often focus on capital investments rather than engaging the full value chain or creating sustained downstream demand. Financial subsidies alone may be insufficient when operating costs are high or markets are uncertain. Without complementary demand-side policies—such as procurement standards, product requirements, or end-user incentives—new chemistries and technologies may face limited adoption even after deployment. Administrative complexity, cost-sharing requirements, or sophisticated verification systems can favor large, established firms, limiting accessibility for small- and medium-sized enterprises unless programs are intentionally designed to include them. Infrastructure and ecosystem support subsidies – including shared facilities and testing, evaluation, and certification support can be very helpful to earlier stage and smaller companies without dedicated capital or human resources.

Key Takeaways

- **Provide long-term, predictable, and durable support.** Mechanisms such as contracts for difference or revenue guarantees can improve project bankability, encourage private investment, and maintain confidence in the technology pathway over time. Long-term support should be tied to innovation gains to ensure continued competitiveness.
- **Target cost gaps during early commercialization and scale-up.** Subsidies are most effective when they reduce capital and financing barriers associated with First-of-a-Kind facilities and early deployment of technologies.
- **Invest in enabling infrastructure and innovation ecosystems.** Shared facilities, technical assistance, workforce development, innovation hubs, and testing support for smaller and earlier stage companies can help strengthen the broader ecosystem needed to scale sustainable chemistry and can support innovation across multiple technology readiness levels.
- **Design programs to expand participation across the value chain.** Reducing administrative complexity, tailoring requirements for SMEs, and supporting intermediaries or collaborative platforms can improve accessibility for smaller firms and downstream actors.
- **Pair supply-pull subsidies with demand-pull incentives.** Financial support has the greatest impact when complemented by policies that create durable markets for sustainable alternatives, such as procurement standards, product requirements, or end-user incentives.

Table 3. Performance against Criteria of Subsidies

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	◒	Have generally been used as a supply side incentive. However, some, particularly in the sustainable aviation fuels and hydrogen space, also support adoption.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	●	When carefully crafted, provide critical enabling long-term financing for technology transformation.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	◒	Have generally been focused on suppliers, but more indirect subsidies such as technical assistance and innovation clusters could effectively engage the full value chain.
COMPETITIVENESS Creates a level or "preferential" playing field for more sustainable chemistries.	●	Strong potential to derisk and lower cost of investment for sustainable chemistry solutions.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	●	Have been used to support companies across a range of technology readiness levels.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	While subsidies can lower costs and risks to support technology deployment, their effectiveness in reaching smaller firms along the value chain is often limited. Many programs favor established companies, require complex administrative capacity, or rely on partners with significant capital, infrastructure, or legal resources.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 4. Model Examples of Subsidies

Financial support subsidies
The US Department of Energy Loan Program Office provides loans and loan guarantees to support development projects for innovative energy and biomanufacturing facilities, including a robust investment assessment and support that derisks co-investment by the private sector.
Through its Defense Industrial Base Consortium (DIBC), the US Department of Defense funds the Distributed Bioindustrial Manufacturing Program and the American Center for Manufacturing and Innovation to scale biomanufacturing and create infrastructure through public-private industrial clusters to secure resilience.
The European Innovation Fund provides capital for mature and First-of-a-Kind industrial decarbonization projects to reduce emissions, share investment risk, and leverage private financing, including technical support for project promoters, supported by Carbon fees collected through the Emissions Trading System.
The Italian Green Manufacturing Subsidy Program provides capital funding for hydrogen, circularity, and decarbonization under the EU Recovery and Resilience Facility. Similar programs exist in other EU countries.
Market-based subsidies
The UK Hydrogen Production Business Model uses 15-year Low Carbon Hydrogen agreements to stabilize revenue for new green hydrogen production projects. Similarly, Germany's H2Global Instrument employs a state-owned intermediary to run supply and demand auctions with government-backed purchase agreements.
Carbon Contracts for Difference (CCfDs) in the EU subsidizes the cost gap between fossil fuel and low-carbon technologies, including for chemical manufacturing projects related to carbon capture and utilization (CCU). In 2024, Germany earmarked billions of euros in long-term "climate protection contracts" as national CCfDs.
The Washington State Department of Ecology provides small-scale capital support for companies producing or sourcing safer chemicals, typically targeting SMEs with fewer than 100 employees.
Infrastructure and ecosystem support subsidies
The New York Pollution Prevention Institute (P2I) (a state-funded collaboration of universities and Manufacturing Extension Partnerships) and the Massachusetts Toxics Use Reduction Institute provide research, training and technical support, potentially as a model for European Substitution Centres.
The US Department of Energy's 17 National Laboratories provide shared facilities, technology transfer, collaborative research, and technical assistance to support innovation in chemistry and biomaterials, with intellectual property made publicly accessible.
Thailand's Bio Circular Green Economy Plan supports biomanufacturing via industrial clusters, workforce development, import tax reductions on investments, and infrastructure like fermentation and logistics facilities.
The European Innovation Council awards recognition and financial prizes to accelerate development and market adoption of innovative technologies. The US Green Chemistry Awards provides non-monetary prizes, supporting visibility to markets and investors. The US federal government maintains a database of awards.
Policy subsidies
The EU's Carbon Border Adjustment Mechanism (CBAM) incentivizes regional low-carbon manufacturing with fees on high-emission imports and penalizing misreporting, leveling the playing field for domestic producers.
In the US, expedited, lower-burden, and coordinated permitting for technologies such as solar and wind projects, and semiconductor manufacturing production reduces regulatory costs and reduces time-to-market.

Tax Incentives

Tax incentives reduce a firm's tax obligations, and encourage investment in research, development, and commercialization of new technologies or practices. They can take the form of tax credits, accelerated depreciation, preferential deductions, or exemptions, all aimed at lowering costs and financial risk to stimulate private-sector investment that otherwise would not have happened. At local or regional levels, tax incentives are often used to support economic development, create supply chains, and foster new industries such as biomanufacturing. Tax incentives have been widely used to support low carbon and biorenewable feedstocks and renewable energy production. For example, the US Inflation Reduction Act created a series of R&D, production, investment, and adoption tax incentives to grow climate-friendly technologies. In the US, tax incentives – often uncoordinated - exist at the state, federal, and local level (e.g. property tax exemptions) but in Europe these are implemented at the Member State level, with some coordination support from the European Commission.

Three common types of tax incentives include:

1. **R&D tax credits** – Reduce a firm's tax liability based on qualified research and development expenditures, encouraging innovation and experimentation.
2. **Production tax credits** – Reduce tax liability based on output, rewarding scale-up, supporting downstream adoption, and derisking market entry.
3. **Investment tax credits** – Reduce tax liability based on eligible capital expenditures, helping defray the costs of infrastructure, equipment, or technology adoption.

When carefully designed, tax incentives can lower both upfront and operational costs, improving competitiveness for sustainable innovations and providing pathways for both established producers and newer market entrants. R&D credits reduce the after-tax cost of innovation, experimentation and technology demonstration. Production credits reward output to accelerate manufacturing scale-up and derisk market entry. Finally, investment credits help defray infrastructure and technology adoption costs. Tax incentives are often tied to specific policy goals and can help motivate new chemistries and technologies.

Tax incentives have important limitations. Existing programs drive limited engagement across the value chain, failing to encourage collaboration between upstream and downstream actors. Incentives typically target specific stages of technology readiness, leaving gaps across the full innovation lifecycle. Investment tax credits, while effective at lowering upfront capital costs, do not directly address operational or technical risks, and high capital and production thresholds can limit access for smaller or pre-revenue companies. Production credits can help create some market pull for downstream products, but demand-side impacts are often modest unless paired with complementary policies. Tax incentives may have limited benefit for pre-profit technologies. Production or investment tax incentives may provide little benefit for companies posting limited profits, in which cases other tax incentives such as payroll tax incentives may help.

Accessibility also remains a challenge: Smaller, pre-tax firms may struggle to meet eligibility requirements, navigate administrative processes, or leverage sufficient capital to benefit fully. Refundable (where governments refund the amount of the incentive to companies with no tax liabilities) or transferable (where a company can sell credits at a discount to another entity) credits can address that challenge as can tax write-offs for net operating losses. Without proper controls, however, this can result in tax burdens for government, as well as economic leakage from the sale of the credits.

Finally, temporary, uncertain, or politically contingent provisions can undermine business planning and reduce the effectiveness of tax incentives over time. While long-term tax incentives support sustained investment and can create markets, they should be regularly evaluated and phased out when goals are met to minimize the economic burden on taxpayers.

Complementary measures—such as grants, infrastructure support, and market-creation policies—remain critical to maximize adoption, demonstration, and scale-up of sustainable chemistry innovations.

Key Takeaways

- **Support new technologies across the full innovation lifecycle.** R&D, production, and investment credits are most effective when focused on building new technologies and sectors and coordinated to cover multiple technology readiness levels (TRLs), from early-stage research to demonstration and commercial deployment, particularly in capital-intensive industries.

1. **Reduce financial and operational barriers.** Tax incentives are most effective when they lower both upfront capital costs and ongoing operational expenses, helping emerging technologies compete with incumbent solutions. Investment credits can particularly support First-of-a-Kind facilities, though they do not directly address operational or market risks.

2. **Encourage broader engagement across the value chain.** Tax incentives have greater impact when paired with mechanisms that promote collaboration between suppliers, manufacturers, and downstream users, helping align innovation with market needs.

3. **Stimulate market adoption and create demand signals.** Production credits can accelerate manufacturing scale-up and downstream uptake, but complementary demand-side policies are often needed to generate strong, durable market pull.

4. **Ensure accessibility and durability.** Refundable, transferable, or SME-targeted provisions, along with administrative simplicity and lower capital thresholds, can expand participation for smaller firms or startups. Long-term, predictable policy commitments, phased out when goals are met, are essential to sustain private investment and maximize systemic economic benefit.

Table 5. Performance against Criteria of Tax Incentives

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	◒	Production tax credits can create market pull by reducing costs for companies producing downstream products and by stimulating customer demand.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	◒	Can be effective in building sectors (such as biorenewables) at a local or regional level, particularly when combined with other incentives.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	○	Generally, do not encourage collaboration across the supply chain, potentially limiting their application.
COMPETITIVENESS Creates a level or “preferential” playing field for more sustainable chemistries.	●	Create opportunities to reduce construction or production costs, support derisking and enhance ability to compete against incumbents. This is especially true for production credits.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	◒	Target specific TRLs; not generally support across all TRL stages.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	Can be designed to be accessible across firms of different sizes, especially when they include refundable credits, payroll offsets, or SME-targeted provisions. In practice, favor larger or profitable firms, as startups and smaller companies may lack sufficient tax liability, administrative capacity, or the capital needed to qualify.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 6. Model Examples of Tax Incentives

R&D tax credits
R&D tax credits have been used across the vast majority of Organization for Economic Development and Cooperation (OECD) countries. In the US, the Credit for Increasing Research Activities encourages companies to invest in domestic R&D by providing a tax credit for qualified research expenses. Credit is based on incremental qualified research expenses (wages, supplies, contract research) relative to a base amount; and reduces federal income tax liability or payroll tax for qualifying small businesses. Other R&D tax incentive models, such as Germany's Research Allowance (Forschungszulage), include higher credits for small and medium-sized enterprises (e.g., 35% versus 25% for large firms), are fully refundable with no tax liability, and have a low administrative burden.
Production tax credits
The Nebraska Renewable Chemical Product Tax Credit provides $0.075 per pound tax credit for eligible renewable chemical producers, capped at $1.5M per business annually. The state certifies up to $6M/year starting in 2024. Similar credits exist in Iowa, Kentucky, and Maine. Proposed U.S federal legislation, such as the Renewable Chemicals Act, would build on these state-level efforts to provide broader incentives for renewable chemical production.
The US Clean Hydrogen Production Credit –Provides a tiered tax credit of up to $3 per kilogram of qualified clean hydrogen, with amounts based on carbon intensity, to incentivize the development of a low-carbon hydrogen economy. Tiering can also prioritize specific investments, including domestic sourcing and support for low-income communities
Oklahoma's tax credits for wind energy – including property tax exemptions as well as construction and production credits successfully grew significant investment in wind energy and were phased out once economic goals were met to direct tax dollars to other priorities.
Investment tax credits
The EU Tax Incentives for its Clean Industrial Deal, as recommended by the EU Commission in 2025, targets tax credits for clean industrial technology investments, designed to free cash flow and encourage further investment. Credits may be refundable or offset against other national taxes, enhancing flexibility. Payroll tax offsets improve access for early-stage companies. Measures adopted are to align with the Clean Industrial State Aid Framework (CISAF), allowing bridging with other state aid, caps per project, and maximum aid intensities.

Market Support and Derisking Incentives

Market support and derisking (or risk mitigation) tools are designed to reduce the financial or market uncertainties, bridging the gap between technology development and commercial deployment. By guaranteeing future revenue streams or signaling market reliability, they encourage private investment in capital-intensive sectors like chemicals, where technology is ready, but demand is uncertain or variable.

While common in EVs and renewables, they are rarely used in sustainable chemistry, where they can also address upstream constraints like raw material availability.

Three broad types of market support and derisking incentives include:

1. **Content requirements** – Require inclusion of a certain percentage of sustainable content in a product category or sector, guaranteeing demand for specific materials or product types.
2. **Market assurances –** Guarantee payment or market to producers to derisk production and scale. Included in this group are offtake agreements, purchase guarantees, and advanced market commitments (for technologies not yet commercialized).
3. **Cost supports –** Lower the cost of adoption of more sustainable technologies, including adoption tax credits and preferential rates or price guarantees.

Market support and derisking incentives reduce financial uncertainty by boosting confidence in future demand, helping capital-intensive technologies scale. By stimulating adoption, these tools encourage firms to invest in new technologies that might otherwise stall due to high costs or limited early markets. The design of these incentives varies based on whether they target government, institutional, or retail buyers.

Lessons from sectors such as pharmaceuticals and biofuels suggest that these policy incentives can accelerate market adoption, foster competition, enable risk-sharing between producers and users, and establish tipping points for market transformation. By providing a credible signal of future demand—while leaving technology development risk largely with private firms—such measures can help unlock financing for capital-intensive industries and overcome the “chicken-or-egg” barrier between supply investment and buyer commitment. In the case of market assurances, governments or downstream purchasers may guarantee an agreed-upon payment regardless of whether they take delivery of a minimum quantity of a product (also called “take or pay”) to insure against market or regulatory shifts or guarantee payment only on delivery of a specified product, more important for novel technologies.

When paired with complementary supply-side measures—such as grants, R&D incentives, and investment or production credits—market support and derisking incentives can bridge the critical gap between demonstration and full-scale commercialization. They can also stimulate coordination along the value chain, providing early signals that encourage suppliers, manufacturers, and customers to engage with emerging solutions. Tools such as Value Chain Transition Funds can supplement government incentives by encouraging value chains to share upfront costs and risks of technology investment, internalize value for more sustainable chemistries, and create funding pools for further innovation.

Performance-based or time-limited criteria tied to innovation and improvements in sustainability performance or cost over time can ensure technologies are competitive and continue to improve during and even after direct support is phased out, while integration with other adoption incentives or procurement policies strengthens durability and long-term market growth and transformation.

Nonetheless, there are some barriers to the effective use of these demand-pull mechanisms. Barriers to demand-pull mechanisms include the need for large, creditworthy suppliers, high production capacity or long-term financial stability which can sideline startups and niche innovators. Effective deployment requires long-term funding and political commitment, which are often difficult to maintain.

Poorly designed mechanisms risk favoring specific technologies prematurely or reducing incentives for continued innovation. For instance, biofuel mandates can scale production quickly but may inflate prices or lock in sub-optimal technologies if not paired with supply-side support and robust sustainability criteria.

Access across the full value chain and support for early-stage technologies remain limited unless programs are intentionally designed to include SMEs and startups through partial or pooled purchase guarantees or other tailored measures.

Key Takeaways

1. **Reduce financial and market uncertainty.** Market support and derisking incentives are most effective when they provide predictable revenue streams or purchase guarantees that lower investment risk for capital-intensive projects.

2. **Create durable signals of demand and drive innovation.** Long-term commitments and time-bound contracts can strengthen market confidence and encourage adoption while maintaining criteria for continuous technology improvement ensures long-term sustainability impact and competitiveness.

3. **Encourage value chain engagement.** By signaling demand, these mechanisms can foster coordination between suppliers, manufacturers, and downstream customers, helping align production, innovation, and market uptake. Market assurances and cost supports derisk production for suppliers and incentivize adoption for large purchasers addressing key adoption challenges.

4. **Expand accessibility.** Program design should address barriers faced by SMEs and early-stage firms, such as high capital thresholds, supply requirements, or credit requirements, through measures like partial guarantees, pooled procurement, or other support.

5. **Integrate with supply-side measures.** Coupling derisking incentives with grants, R&D support, or investment credits improves the pathway from demonstration to commercial scale and helps bridge gaps across the technology and adoption pathway.

Table 7. Performance against Criteria of Market Support and Derisking Incentives

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	●	Designed to support demand creation and market adoption.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	◒	Can transform industries, when carefully combined with supply side incentives and other demand-pull incentives, as is the case of incentives for electric vehicles in Norway and solar in Germany.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	●	Can incentivize collaboration between suppliers and manufacturers or consumers particularly when focused on supporting purchasers.
COMPETITIVENESS Creates a level or "preferential" playing field for more sustainable chemistries.	●	Can reduce costs or provide preferential treatment for sustainable chemistry products versus incumbents. However, these tend to favor near-commercial or proven scalable technologies, leaving early-stage chemistries at a disadvantage unless paired with performance-based, or competitive mechanisms.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	◒	Work best for relatively advanced technologies closer to deployment and that need the support/derisking incentives to create market access but can also work to accelerate new technologies.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	Disproportionately benefit large firms, which can meet capital, credit, and contract requirements, while SMEs, start-ups, and niche innovators often struggle to participate. Earlier stage technologies can benefit if goal is to accelerate technology commercialization rather than scale.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 8. Model Examples of Market Support and Derisking Incentives

Content Requirements
The European ReFuelEU Aviation Regulation establishes mandates for the use of Sustainable Aviation Fuels requiring a minimum share of such fuels at EU airports. These mandates start with 2% SAF in 2025 and progressively increase to 70% by 2050.
The California Renewable Portfolio Standard (RPS) aims to advance renewable energy by setting continuously increasing renewable energy procurement requirements for the state's electrical load-serving entities.
Market Assurances
The US Operation Warp Speed initiative provided large-scale purchase commitments for COVID-19 vaccines when produced, enabling rapid development and deployment. Additional incentives, such as shared research support and expedited reviews, supported rapid development. Similarly, NASA's Commercial Orbital Transportation Services (COTS) program used milestone payments and purchase commitments to stimulate private-sector innovation in space transportation.
In the private sector, H&M Group and Syre entered into a $600 million, seven-year offtake agreement for textile-to-textile recycled polyester, providing a market for the new technology. Walmart has provided multi-year purchase commitments to support organic cotton production. Frontier Climate Initiative has pledged more than $1 billion in advance purchase commitments for permanent carbon removal technologies.
Cost Supports
German Feed In Tariffs–long-term, guaranteed payments, above retail rates for renewable energy—were used to stimulate wholesale distributed renewable energy production, enabling smaller local renewable energy projects on preexisting homes, buildings, and structures. The program, along with other incentives, stimulated Germany's solar industry reducing costs of electrical generation.
A number of countries globally have used a combination of direct rebates and tax incentives (both off income and of Value Added Tax) to stimulate consumer and large purchaser use of electric vehicles, renewable energy technologies, and energy efficient appliances.

Labeling, Recognition, & Preferential Purchasing

Eco-labels, recognition programs, and preferential purchasing incentives are complementary approaches that provide market signals to institutional buyers and consumers, encouraging product redesign, reformulation, and support for the adoption of safer and more sustainable products. Together, these incentives help bridge barriers to adoption. These incentives include two types:

1. **Eco-labels and recognition programs –** Identify and publicly recognize chemicals, products, processes, or companies meeting defined environmental or health criteria.
2. **Procurement incentives –** Aggregate demand and reduce market risk for specified (often certified) sustainable products.

Labeling, recognition, and preferential purchasing signal safer or sustainable products to consumers and institutional buyers, creating market pull, and encouraging innovation. Programs such as the US EPA Safer Choice, the EU Ecolabel, and the USDA BioPreferred illustrate how robust certification criteria, transparent verification processes, and integration with procurement policies can drive product reformulation, support early-stage innovations, and catalyze broader market adoption. Many programs now include requirements for full ingredient disclosure or biobased content thresholds, which can foster engagement across the supply chain and increase transparency.

Nonetheless, uptake is often constrained by low awareness among buyers, certification costs, and the availability of feasible, cost-effective alternatives. Large firms are generally better positioned to navigate administrative requirements and participate in procurement contracts, while smaller companies and SMEs may struggle to meet certification thresholds, achieve compliance, or scale production to supply institutional buyers.

Voluntary programs alone may not generate sufficient demand without complementary policies, such as targeted procurement or market incentives. For example, eco-labels tied to rebates and tax incentives for adoption, such as the US Energy Star program can have significant environmental and economic benefit. Standards created by sectoral organizations – such as the US Green Building Council's LEED rating system and the Global Electronics Council's EPEAT standard can have a stronger impact in driving sector-wide change, particularly when tied to purchasing. In addition, program credibility and impact depend on evolving and sufficiently stringent criteria, balanced to encourage market participation without excluding a substantial portion of producers. Support measures for smaller firms, such as technical assistance or cost-sharing for certification, as well as preferential procurement opportunities, can help broaden accessibility and systemic impact.

Key Takeaways

1. **Create market signals for sustainable chemistry.** Labeling and recognition programs are most effective when criteria are transparent, science-based, not too strict as to discourage participation, and evolve to support innovation. Tying programs to institutional or public procurement helps to derisk adoption and incentivizes reformulation and product redesign.

2. **Foster value chain engagement.** Sector-wide standards can help support broader supply chain engagement. Requirements such as ingredient disclosure or biobased content thresholds can encourage collaboration across suppliers, manufacturers, and downstream users, supporting reformulation and improving transparency and systemic adoption.
3. **Drive demand-pull and adoption.** Preferential purchasing and certification-integrated procurement programs provide early revenue signals, visibility, and institutional demand that support market uptake of sustainable products.
4. **Support innovation at multiple stages.** These programs primarily support later-stage, market-ready innovations, but programs can support innovation in earlier stage chemistries when specific incentives are offered for innovations, including pilot product certifications and expedited review or listing.
5. **Enhance accessibility and equity.** Smaller companies and SMEs often face barriers to certification or procurement participation; targeted technical assistance, cost-sharing, or simplified administrative processes can broaden participation and increase systemic impact.

Table 9. Performance against Criteria of Labeling, Recognition, & Preferential Purchasing

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	●	Labeling and procurement policies provide visibility and institutional demand, encouraging uptake.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	◒	Well-designed certification programs can shift market dynamics in a product category or sector, particularly when linked to procurement as evidenced by green building standards.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	●	Certification is at the product level, requiring the supply chain to collaborate. Ingredient disclosure requirements for certification ensure engagement of the supply chain to support such transparency.
COMPETITIVENESS Creates a level or "preferential" playing field for more sustainable chemistries.	◒	When programs are tied to public procurement and apply clear criteria for sustainable chemistry (e.g., toxicity or biobased content thresholds) they can provide strong market signals.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	○	Supportive of mostly later-stage, commercially available innovations.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	Larger firms and established manufacturers are better positioned to meet certification requirements, manage administrative burdens, and participate in procurement contracts. Smaller companies often lack resources for certification, compliance, or scaling production to meet procurement specifications unless specific preferences exist.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 10. Model Examples of Labeling, Recognition, & Preferential Purchasing

Labeling and Recognition
The US EPA Safer Choice program certifies products containing safer chemical ingredients using third-party hazard assessments and reviews. It requires full ingredient disclosure, supports labeling and environmentally preferable purchasing programs, and provides a public Safer Chemical Ingredients List to guide product innovation. The listing of safer chemical ingredients provides opportunities for smaller companies and facilitates additional market tools such as Cleangredients.
The EU Ecolabel is used to support green public procurement across Member States. It certifies products across multiple categories—including cleaning products, cosmetics, paints, and textiles—based on comprehensive criteria for chemical hazards considering the life cycle of the product.
The US Department of Agriculture BioPreferred Program certifies products against the USDA's biobased content standards and once certified, products can display the BioPreferred label, signaling environmental performance to consumers and institutional buyers.
Procurement
The EU Green Public Procurement framework incorporates the EU Ecolabel into tender specifications set forth by government authorities.
Modeled after earlier policies, a 2021 Presidential Executive Order was issued to build markets for low carbon technologies and sustainable products through government purchasing. One example, the Green Proving Ground program leverages federal buildings as pilot facilities for innovative technologies.
The EU Bioeconomy Strategy announced plans for an EU Buyer's Club to promote demand for certified carbon credits. Under such a program, government agencies pool procurement to lower costs by bulk purchase and streamline distribution of key technologies. The EU has created a similar regional purchasing approach for aggregating Member State gas demand under the AggregateEU program. India has used this pooled procurement approach to stimulate demand and scale adoption of energy-efficient air conditioners. Private sector models also exist, such as the World Environment Council First Movers Coalition.

Regulatory Incentives

Regulatory incentives – beyond restrictive or prohibitive measures – can guide markets toward safer and more sustainable practices. When designed effectively, regulatory incentives create predictable conditions that can reduce uncertainty for firms, speed up commercialization, lower costs for sustainable innovations compared to incumbents, and help align innovation, commercialization, and market adoption.

Three general types of regulatory incentives include:

1. **Taxes/fees –** Impose financial obligations on less sustainable chemicals or products. Such taxes and fees can be tiered based on toxicity or other factors with revenues applied to supporting more sustainable chemistries.
2. **Disclosure requirements –** Require information-sharing about chemical content or hazards across the supply chain.
3. **Process incentives (sometimes referred to as regulatory relief policies) –** Streamline regulatory approvals or reduce compliance burdens for preferred innovative products/technologies.

Regulatory incentives can provide predictable market signals that encourage the adoption of safer chemicals while generating funding for research, development of alternatives, and market transition. Fee- and tax-based programs – while punitive - can motivate substitution away from less sustainable chemicals and materials, especially when clear market signals are given, and revenue is reinvested in innovation or technical support. For example, carbon pricing is widely viewed as a successful tool to reduce emissions, drive innovation, and enhance competitiveness. A number of models for such tax and fee-based efforts exist but have not been widely applied. Disclosure policies enhance transparency across the supply chain, incentivizing reformulation and innovation. Process-based incentives, such as expedited reviews or reduced compliance burdens, can lower barriers for firms developing novel chemistries, supporting faster market entry and reducing uncertainty.

Nonetheless, fee- and tax-based programs carry the risk of cost pass-throughs to consumers or unintended “regrettable” substitutions if criteria are unclear or insufficiently enforced. Despite the relatively low implement costs and broad application, disclosure requirements alone do not guarantee adoption of sustainable chemistry. They rely on market awareness, the availability of sustainable alternatives, and complementary incentives to create tangible demand. Expedited reviews may raise concerns about whether potential unintended consequences of chemicals, materials, or processes are adequately addressed. Effective regulatory incentive programs require careful design that balances strong market signals with safeguards against unintended consequences, while also providing accessible pathways for firms of all sizes and technology readiness levels.

Regulatory incentives are most effective when paired with complementary supply-push or demand-pull incentives such as grants, R&D funding, procurement preferences, or reinvestment in sustainable chemistry solutions.

Key Takeaways

1. **Provide strong, targeted market signals.** Taxes, fees, disclosure, and process-based incentives can encourage market adoption of safer, more sustainable chemicals when tied to clear technology or policy outcomes.
2. **Connect fees to innovation support**. While taxes and fees can influence market transition towards more sustainable alternatives, connecting revenues back to innovation and support for substitution can enhance policy outcomes and reduce resistance.
3. **Pair regulatory incentives with complementary support.** Linking incentives with R&D, procurement policies, or technical assistance can strengthen innovation outcomes and adoption.
4. **Safeguard against unintended outcomes.** Clear criteria to help designate sustainable alternatives in taxes and expedited reviews can help avoid regrettable substitutions, cost pass-throughs, or lock-in of specific technologies.
5. **Increase accessibility for smaller firms.** Simplified processes, guidance, and support reduce barriers for startups and SMEs.

Table 11. Performance against Criteria of Regulatory Incentives

Design Criteria	*Rating*	*Explanation*
ACTIVATION Creates demand-pull and derisks market adoption along the entire value chain.	●	Offer modest to strong demand-pull by financially favoring safer products and derisking adoption/use by downstream users.
TRANSFORMATION Achieves significant and lasting technology, sectoral, or ecosystem change.	○	If used alone, will not generally drive large scale sectoral or ecosystem change.
COLLABORATION Encourages value chain and sectoral engagement, collaboration, & collective action.	◒	Only disclosure policies support value chain engagement given that product suppliers often rely on information from their suppliers to comply with reporting requirements.
COMPETITIVENESS Creates a level or "preferential" playing field for more sustainable chemistries.	◒	Provide direct economic signals, yet current models may lack sufficient provisions to safeguard against unintended consequences.
COVERAGE Incentivizes multiple Technology Readiness Levels (TRLs)	◒	Are usually for later-stage TRLs. However, some fee-based and regulatory relief programs provide benefits for earlier stage technologies and those not yet commercially available but awaiting regulatory approvals.
ACCESSIBILITY Enables ready access for companies of different sizes and stages along the value chain.	◒	Most often favor larger firms with dedicated regulatory teams, legal expertise, and capacity to meet compliance requirements or take advantage of streamlined processes. Smaller companies and startups may lack the resources to participate fully, though expedited process may support such companies.

Key to Ratings ● STRONG ◒ GOOD ○ POOR

Table 12. Model Examples of Regulatory Incentives

Taxes/fees
The Swedish Tax on Chemicals in Certain Electronics established an excise duty on electronics containing flame retardants, with rates by product weight and category. The updated tax structure offers up to 95% reduction for products free of chlorine, bromine, or phosphorus, and 50% reduction for products with phosphorus only. The tax has been criticized for administrative complexity, consumer cost pass-through, and limited protection against regrettable substitutions.
The California Non-Toxic Dry Cleaning Incentive Program is an excise tax imposed on chemical suppliers of perchloroethylene for dry cleaning operations. The tax initially at $3 per gallon, increasing annually - was imposed until perchloroethylene phased out of California (2023) for use in dry cleaning. Most funds were used to offer grants to derisk downstream users' uptake of safer alternatives.
Under California's Safer Consumer Products regulation, for priority products lacking safer alternatives, responsible parties may be required to fund green chemistry research. In the case of spray foam insulation containing unreacted methylene diphenyl diisocyanates (MDI), responsible entities are required to pay a $0.02 per pound fee on such products sold in California over a five-year period, generating a $4 million fund to support research into safer alternatives.
The US Soy Check-Off program, established under the 1990 US Farm Bill establishes farmer contributions of 0.5% of the market price per bushel sold, raising approximately $175 million to fund education, promotion and research on farming and product innovations to create new markets.
Disclosure requirements
The California Cleaning Product Right to Know Act (SB 258) requires manufacturers to disclose cleaning product ingredients both on product labels and online.
The European Corporate Sustainability Reporting Directive (CSRD) requires companies to report risks related to hazardous chemicals.
The European SCIP database (Substances of Concern In articles as such or in complex objects (Products)) as mandated under the Waste Framework Directive requires companies to submit information if their products/articles contain Substances of Very High Concern (SVHCs) above 0.1% weight/weight. Information in the database is made available to waste operators and consumers.
Process incentives
The US Environmental Protection Agency's Climate-Friendly New Chemicals Initiative streamlines the review for new chemicals with the potential to reduce greenhouse gas emissions and promote climate-friendly alternatives – a more efficient and consistent process.

Applying the Six Incentive Categories

The Sustainable Chemistry Policy Incentives Framework is designed to address the myriad challenges inherent in developing, deploying and driving adoption of more sustainable chemistries across complex, global supply chains. It represents a set of options that policymakers can utilize - individually or in combination - to address specific sustainable chemistry needs depending on priorities and available resources.

Each innovation stage requires different sets of incentives. The policy incentives identified are often most effectively utilized for specific technology lifecycle points or value chain segments, as shown in Figure 7. Early-stage supply-push incentives reduce financial and technical risk for upstream actors, while demand-pull measures help bridge scale-up, commercialization, and downstream adoption. Mapping these across the technology lifecycle and value chain segments clarifies where each type of incentive will have the greatest impact in advancing sustainable chemistry.

The various incentive types outlined in this report are summarized in Table 13, providing a "menu" to support policy development based on the stage of technological maturity and market readiness. For clarity, this report aligns TRLs with broader Adoption Readiness stages, distinguishing between: research and development (pre-deployment) (TRL 1–6); demonstration and deployment (TRLs 7–9); market activation; and market transformation.

In the **research and development or pre-deployment** stage (TRLs 1–6), which includes early-stage research, pilot testing, and prototype development, innovation is primarily supported by supply-push incentives, such as grants, tax credits, and early-stage subsidies. These incentives are critical for upstream actors—including raw material suppliers, chemical producers, and formulators—helping to advance sustainable chemistry solutions through technical validation and piloting.

As technologies move into **demonstration and deployment** (TRLs 7–9), encompassing pre-commercial demonstration and full commercial capability, a broader mix of incentives is required. In addition to continued supply-push support, infrastructure investments help overcome scale-up challenges, reduce capital costs, and support integration into manufacturing processes. At this stage, incentives increasingly engage mid-value chain actors such as product manufacturers and brands.

Beyond technical readiness, **market activation** focuses on accelerating early adoption and establishing viable markets for sustainable chemistry solutions. Here, demand-pull incentives—including market-based subsidies, derisking mechanisms, labeling and certification programs, and preferential procurement—play a more central role in stimulating demand and reducing market uncertainty.

Finally, **market transformation** represents the stage at which sustainable chemistry solutions achieve widespread adoption and begin to displace incumbent chemistries, transitioning the industry sector or application more broadly. This stage is driven by a combination of demand-pull policies, including regulatory frameworks, standards, and economic instruments that reinforce market signals and enable system-level change across value chains.

Together, the incentive types target specific stages of innovation and segments of the value chain, enabling a more coordinated approach to advancing technology development, accelerating market uptake, and ultimately driving market transformation toward sustainable chemistry solutions.

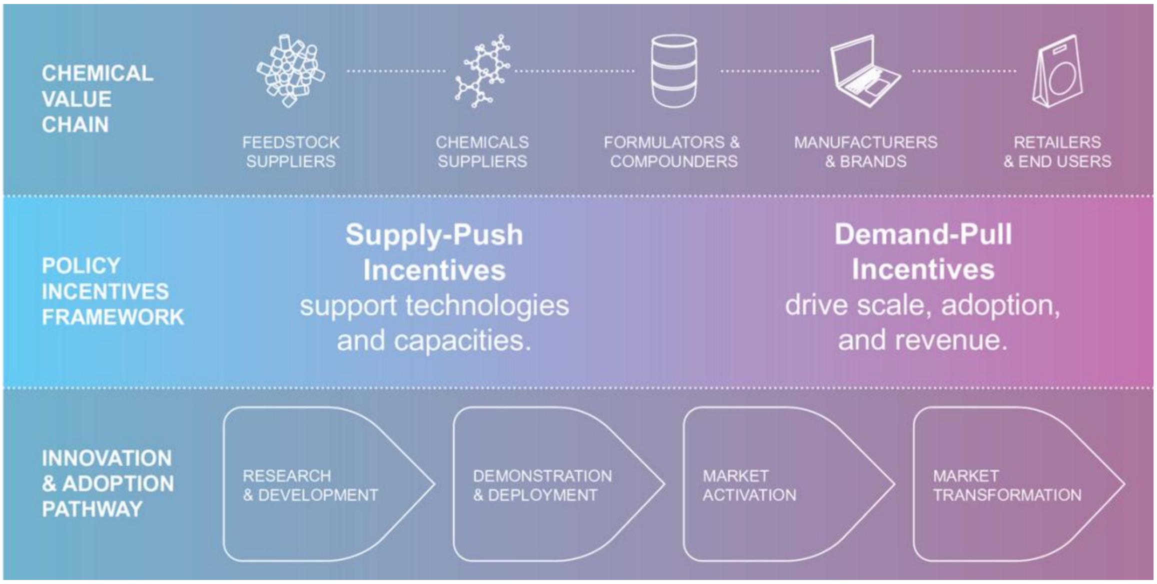


Figure 7. Incentives in the Context of the Market Transformation Ecosystem

Table 13. Relevance of Incentive Types to Innovation Stage, Adoption Stage, and Value Chain Position

	Innovation Stage					Adoption Stage				Value Chain Position				
	Early-Stage R&D	Pilot Testing	Prototype Development	Demonstration	Commercialization	Pre-Deployment	Deployment	Market Activation	Market Transformation	Feedstock Suppliers	Chemical Suppliers	Formulators / Compounders	Brands / Manufacturers	Retailers / End Users
Supply-Push Policy Incentives														
Industrial and Academic R&D Grants														
Foundational knowledge	●	○	○	○	○	●	○	○	○	●	●	○	○	○
Innovation to application	●	●	●	●	○	●	●	○	○	●	●	●	○	○
Piloting, demonstration & early deployment	○	●	●	○	○	●	●	○	○	●	●	●	●	○
Subsidies														
Financial	○	○	○	○	●	○	●	○	○	●	●	○	○	●
Market-based	○	○	○	○	●	○	○	●	○	●	●	○	○	●
Infrastructure/ecosystem	●	●	●	●	●	●	●	○	○	●	○	●	○	○
Policy	○	○	○	○	●	○	●	●	○	●	●	○	●	○
Tax Incentives														
Production tax credits	○	○	○	○	●	○	●	●	●	●	●	○	○	○
R&D tax credits	●	●	●	○	○	●	○	○	○	●	●	○	○	○
Investment tax credits	○	○	○	●	●	○	●	○	○	●	●	○	○	○
Demand-Pull Policy Incentives														
Market Support & Derisking														
Content requirements	○	○	○	○	●	○	○	●	●	●	●	○	○	○
Market assurances	○	○	○	○	●	○	●	●	●	●	●	○	○	○
Cost supports	○	○	○	○	●	○	●	○	○	○	○	○	●	●
Labeling, Recognition & Purchasing														
Labeling/Recognition	○	○	○	○	●	○	○	●	●	○	●	○	●	●
Preferred purchasing	○	○	○	○	●	○	○	●	●	○	●	○	●	●
Regulatory														
Taxes/Fees	○	○	○	○	●	○	○	●	●	○	●	○	●	●
Disclosure requirements	○	○	○	○	●	○	○	●	●	○	○	○	●	●
Regulatory process	○	○	○	○	●	○	○	●	○	○	●	○	●	○

4 Incentive Scenarios

Thoughtful combinations of incentives will be needed to address the unique challenges of innovation and market adoption.

Single measures—such as tax credits alone— often fail to address the full spectrum of challenges, including technology development, capital investment, reformulation costs, and uncertain market demand. With limited resources, governments cannot easily solve all of these challenges on their own, but they can provide strong signals that stimulate and direct private sector action.

Examples from renewable energy and other sectors show that strategic mixes of "stacked" incentives tied to a policy goal or industrial strategy can accelerate research and deployment, while also derisking private investment and market adoption.[37] Research indicates that policy measures that work in tandem are more likely to advance sustainable technologies and behaviors than single incentives alone.[38] However, policymakers must adapt incentives to the specific challenge they are trying to address. Strategically combining policy incentives can support sequencing, scale, and long-term investment certainty.

Adaptable packages of supply-push and demand-pull incentives are likely to achieve policy outcomes more efficiently and at lower cost. In some cases, new technologies will need to be developed, piloted, deployed, adopted, and scaled. In other cases, new capital investment or reformulation may be needed to drive adoption of innovation. Finally, the technology might exist at sufficient scale but need market support to address costs or other adoption barriers. While incentive combinations are often required, in some cases single incentives may be more effective in addressing a single barrier or achieving a specific outcome.

To explore how incentives can be combined to achieve sustainable chemistry outcomes in specific cases, a subset of the Change Chemistry Working Group convened a structured policy design charrette. Three illustrative case studies were used as analytic scenarios, representing typical challenges faced by firms at different points along the innovation and market adoption pathway. Each scenario reflects a distinct industrial need, which may vary by technology maturity, firm size, and market context.

Table 14, Table 15, and Table 16 present a summary of this policy charette process. In the three scenarios, no single incentive appears sufficient to address the indicated barriers. The scenarios illustrate how combinations of incentives can be applied to achieve sustainable chemistry outcomes across diverse value chain actors. As technologies scale, earlier stage incentives may still be warranted to support continued evolution of sustainable chemistry innovations that can be competitive over time.

The structured exercise demonstrated that no single incentive is sufficient to achieve the necessary pace or scale of innovation and adoption. Instead, coordinated packages of incentives, tailored to different actors along the value chain and aligned with stages of technology development—from early research through demonstration to market adoption and scale—are required.

Table 14. Combining Policy Incentives: Scenario #1

Innovative Raw Material (Bioplastic)

- Commercially available but requires additional scale to meet market demand.
- Roughly three times higher cost than incumbent material.
- Requires some product reformulation.

BARRIER / CHALLENGE	RELEVANT POLICY INCENTIVE TYPE(S)
Funds to build a second facility	● Subsidies (financial subsidy) ● Tax Incentives (production tax credit)
Lack of guarantee for demand	● Subsidies (market subsidy) ● Market support/derisking incentives *(market assurance; content requirements)* ● Labeling recognition/preferred purchasing *(procurement incentives)*
Cost differential versus incumbent	● Market support/derisking incentives *(cost supports)*
Policy barriers for single use plastics	● Subsidies *(policy subsidy)* ● Regulatory incentives *(process incentive)*

KEY TO TYPES: ● SUPPLY-PUSH POLICY INCENTIVES ● DEMAND-PULL POLICY INCENTIVES

Table 15. Combining Policy Incentives: Scenario #2

Replacements of Anti-Degradant/Anti-Ozonate In Vehicle Tires

- Need rapid substitution at scale of alternative(s) that demonstrate lower toxicity to fish.
- Alternative(s) must undergo new chemical regulatory review prior to commercialization.
- Alternative(s) must be compliant with existing synthetic rubber formulation and meet required industry and regulatory standards

BARRIER / CHALLENGE	RELEVANT POLICY INCENTIVE TYPE(S)
Solution needed fast and must perform similarly	● Industrial/academic grants ● Subsidies (infrastructure and eco-system support subsidies)
Alternatives need regulatory approval	● Regulatory incentives *(process incentives to support expedited regulatory review processes/ compressed timeline)*
Need sufficient scale of alternative to meet demand	● Market support/derisking incentives *(market assurances)* ● Labeling recognition/preferred purchasing *(procurement incentives)* ● Regulatory incentives *(expedited permitting)*

KEY TO TYPES: ● SUPPLY-PUSH POLICY INCENTIVES ● DEMAND-PULL POLICY INCENTIVES

Table 16. Combining Policy Incentives: Scenario #3

Green Solvent

- Safer, bio-renewable solvent already produced at commercial scale for existing markets.
- Adoption requires product reformulation and currently costs ~2× more than the incumbent solvent considered "high concern" given toxicity profile.
- Enhanced performance reduces the quantity required, partially offsets higher costs.
- Incumbent solvent remains largely unrestricted, limiting regulatory drivers for substitution.

BARRIER / CHALLENGE	RELEVANT POLICY INCENTIVE TYPE(S)
Initial higher cost/requires reformulation	● Subsidies *(price supports)* ● Market support/derisking incentives *(cost supports)*
Limited regulatory drivers for substitution	● Labeling, recognition, and preferred purchasing *(procurement incentives and recognition programs)* ● Regulatory incentives *(taxes/fees on incumbents)*
KEY TO TYPES	● SUPPLY-PUSH POLICY INCENTIVES ● DEMAND-PULL POLICY INCENTIVES

5 Implementing Sustainable Chemistry Policy Incentives

Policy incentives work best when part of actionable, durable government strategies defining clear policy goals and technology outcomes, and leveraging multiple complementary policy tools.

This creates strong market signals, mobilizes underlying market drivers, and attracts both public and private investment. Examples such as the 2024 White House Sustainable Chemistry Strategy,[39] the US Department of Energy Decarbonization Roadmap,[40] the European Commission Clean Industrial Deal,[41] the European Chemical Industry Action Plan[42] and the European Commission Bioeconomy Strategy[42] all demonstrate how governments can signal clear policy and technology priorities. These strategies typically outline a range of actions—including regulatory measures and targeted incentives spanning research and innovation funding to support for "lead markets"— that work together to advance priorities.

Design for durablility and predictability. For such strategies to be effective, they must be supported by sustained public investment, which signals long-term commitment and reduces risk for private-sector actors. Equally important is durability. Shifting policy priorities and inconsistent support can undermine investment stability and slow innovation. For example, the recission of funding and incentives from the US Inflation Reduction Act and shifting political support for specific technologies (for example wind)[42] will likely have a significant impact on investment in and growth of renewable energy technology.[43] Similarly the US Department of Commerce's elimination of funding for Natcast—a non-profit established to run the National Semiconductor Technology Center founded under the US CHIPS & Science Act— may slow innovation and commercialization in advanced semiconductor manufacturing, undermining US competitiveness by disrupting coordinated R&D efforts and limiting access to shared prototyping infrastructure critical for scaling new technologies.[44]

Integrate incentives into a broader strategy. Policy incentives embedded within broader government priorities and strategies also need to be well coordinated to enable value chain engagement over relatively long R&D, deployment, and market adoption timeframes. A carefully crafted package of incentives implemented as part of a well-designed innovation policy can create "tipping points" or systematic transitions to safer and more sustainable technologies by amplifying positive signals, addressing incumbency of existing technology, and creating an enabling environment for new technologies to thrive.[45] Once market tipping points have been created—as has been the case in some renewables sectors—sustained government priorities and policy become less critical. In the case of sustainable chemistry, incentives to date have been sporadic and uncoordinated and have failed to create market transformation. Moving forward, the design and deployment of incentives need to be part of a coordinated system—sequenced over time and aligned across the value chain to achieve lasting market transformation.

Creation of a package of incentives to support sustainable chemistry innovation, market adoption, and scale is only the first step. Effective implementation is equally important, including:

- Supported and coordinated implementation across government agencies and levels of government, addressing conflicting or unaligned incentives.
- Engagement with key stakeholders to ensure successful implementation, uptake, and systemic change.
- Processes for monitoring and review of incentives and incentives policies

Ensure capacity for implementation. Incentives will not be fully effective if government does not have the capacity to implement them. Sufficient time and resources to establish review processes, performance measures, and evaluation and compliance approaches are necessary. This includes sufficient program staff, expertise in the focal area of the incentive, and support for independent, external review, where needed.

Encourage and support coordination across agencies and programs. Further, incentives should be designed in a way that creates synergies and supports coordination across implementing agencies, to avoid siloed efforts, potential conflicts over jurisdictional authority, and competing incentives or definitions/criteria for incentives. Centralized research and innovation programs, such as the National Nanotechnology Initiative[46] and Sustainable Aviation Fuel Grand Challenge[47] in the US represent whole of government approaches to technology innovation and market adoption. Similarly, the US Sustainable Chemistry Research and Development Act created a whole of government approach to sustainable chemistry research, innovation, and education coordinated through the White House Office of Science and Technology and its Sustainable Chemistry Strategy Team.[48] However, the Team's Landscape Report[49] found a diverse set of unconnected initiatives, research efforts, and activities. When incentives are distributed across government agencies and levels of government, clear and regular communication processes are important for avoiding duplication, synergizing incentives across levels of government and avoiding and potentially conflicting incentives. The European Bioeconomy Strategy and Communication on Accelerating Europe's transition to a circular economy[50] note the need for enhanced European Commission-Member State coordination to advance policy goals.[51] Similar efforts to synergize incentives between federal and state agencies in the US have generally not occurred.

Engage external stakeholders early and often. Engaging external stakeholders is essential to the effectiveness of policy incentives.[52] Partnerships with private sector investors amplify the impact of incentives and align financing with policy goals and public incentives. Collaboration with companies along the value chain helps government authorities understand industrial challenges and needs across sectors. Working with non-governmental organizations and academic researchers can identify potential red flags and enhance transparency and trust in the incentive programs. Coordination with external stakeholders is also critical to ensuring that businesses along the value chain – particularly SMEs – understand the available incentives and how to access them. Coordinated government portals can help support such communication.[53]

Build in fiscal protections. As incentives are funded by public money, governments need to protect their interests and be good stewards of taxpayer funds. There are a number of fiscal protections governments can use to reduce budget risks, such as caps and performance-based standards.[54] Review processes can include specific criteria or performance measures for incentives and regular monitoring for compliance.[55] Measurement, recording, and verification will be important to ensure that incentives support scalable, verifiable sustainable chemistries. Use of such programmatic monitoring approaches as policies are implemented also build trust in the outcomes, which can help reduce risks for private investment. Criteria for evaluating incentives (such as toxicity or carbon metrics) should be sufficiently rigorous to support coherence with overall goals but flexible enough to allow different approaches (including measurement approaches) to achieve results. Clear minimum criteria for incentives can help demonstrate directionality of sustainable chemistry goals, support compliance, and minimize regrettable substitutions or greenwashing. In additional to performance-based criteria for incentives, compliance monitoring can be tied to mechanisms for cost recovery ("clawbacks") where the incentivized activity was not undertaken or the financial benefits that the incentive was predicated on do not materialize.

Evaluate policy performance over time. To ensure fairness, transparency and durability (including future risk-taking), it is important to have a defined, periodic evaluation process that assesses the overall impact of the policy incentive.[56] Such evaluations can identify which incentives work best under specific circumstances and inform modifications. Incentives should be designed with sunset dates and sufficient flexibility to phase out, adjust, or replace them if goals are achieved, outcomes are not effectively or efficiently met, or unintended adverse consequences arise.[57]

Table 17 integrates this implementation guidance with design criteria refined through the policy incentives development process to outline ten core elements of a robust policy incentives program for sustainable chemistry.

Table 17. Core Elements of a Robust Incentives Program for Sustainable Chemistry

SYSTEM IMPACT	
Transformation	Design incentives as part of a broader, strategic program focused on clearly stated, long term technology, sectoral, or ecosystem changes that advance sustainable chemistry goals.
Coverage	Ensure that incentives span the full innovation and adoption pathway—from predeployment and deployment through market activation and longterm market transformation.
Durability	Provide predictable, long-term market signals that are sufficiently stable to foster innovation and encourage sustained private-sector investment.
Adaptability	Build in periodic evaluation, sunset provisions, and flexibility so that incentives can be adjusted or replaced as goals are achieved, conditions change, or unintended consequences emerge.
MARKET ENGAGEMENT	
Activation	Create strong demand signals and reduce market risk to accelerate adoption along the value chain, from upstream feedstock and chemical suppliers to downstream brands and retailers.
Competitiveness	Design incentives to level—or tilt—the playing field in favor of sustainable chemistry, counteracting legacy policies and market dynamics that advantage incumbent technologies.
Accessibility	Ensure incentives are readily accessible to companies of different sizes, business models, and stages of development along the value chain.
EFFECTIVE GOVERNANCE	
Collaboration	Encourage value chain and sectoral collaboration and collective action, including active engagement of stakeholders throughout policy design, implementation, and evaluation.
Coordination	Coordinate across agencies, levels of government, and—where appropriate—with private-sector actors to maximize innovation, adoption, and policy coherence.
Integrity	Incorporate criteria, processes, and enforcement mechanisms to ensure that public funds deliver verifiable outcomes and prevent misuse, greenwashing, or regrettable substitution.

6 Conclusion

The Policy Incentives Framework is a guide for targeted actions to accelerate innovation, adoption, and market transformation.

The drivers for sustainable chemistry, including the regulatory, litigation, and reputational risks associated with many incumbent chemistries, are well-established. At the same time, the potential economic benefits of investment in sustainable chemistry are increasingly clear, including new market opportunities, competitiveness, supply chain resilience, improved brand value, job creation, and reduced environmental and health impacts and their associated societal costs. There is a clear economic case for sustainable chemistry investment, particularly as such investments can address multiple sustainability challenges from toxicity to climate impact to plastics waste.

Yet the current generation of chemicals—deeply optimized and integrated into complex global value chains—have benefited from decades of sustained public and private investment. This has created a structural advantage that places emerging sustainable chemistries at a competitive disadvantage. Barriers to innovation and market adoption—including high switching costs, lengthy reformulation and regulatory approval timelines, capital investment needs and uncertain market demand—remain significant. And changing chemistry is inordinately complex as chemistry is an integral part of almost every sector of the economy, with thousands of chemicals used in a wide range of applications.

Addressing these challenges requires thoughtful and durable government strategies that combine a range of policy tools from regulatory to targeted incentives. Governments have successfully used coordinated policy incentives in building new sectors and supporting industrial transformations, including renewable energy technologies, renewable fuels, and electric vehicles, among others. Yet such efforts have yet to be fully realized for sustainable chemistry.

Co-developed with more than 50 companies and other experts, the *Sustainable Chemistry Incentive Policy Framework for Innovation, Manufacturing and Market Transformation* outlines a set of priority supply-push and demand-pull incentives to drive sustainable chemistry innovation, along with market adoption and transformation. The goal of the Framework is to provide a menu of options to guide government policy in accelerating the speed and scale of innovation and adoption, supporting the industrial transformation of the chemical sector while enhancing its competitiveness in a rapidly evolving global market. While the policy examples outlined in this report are region specific, the Framework was designed to be sufficiently broad and flexible to be adapted by any jurisdiction.

The Framework recognizes the capital intensity and complexity of chemical supply chains, which involve a wide range of actors—from early-stage innovators to large chemical suppliers, brands and retailers—all of whom play a role in innovation, substitution, and market uptake. Because the innovation and adoption challenges differ across these actors and stages, the types of incentives required also vary, necessitating a flexible and adaptable policy approach.

While aspirational, the framework outlines a comprehensive approach to guide governments in more effectively advancing sustainable chemistry innovation, adoption, and market transformation. It presents a menu of options of incentives governments can apply to address specific sustainable chemistry challenges or goals, adaptable to priorities and available resources.

Updating the Framework—based on evaluation of how different incentives or combinations of them perform—will ensure its continued relevance and utility and enhance its effectiveness in accelerating innovation and market adoption of sustainable chemistries that co-optimize economic, societal, and sustainability benefits.

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