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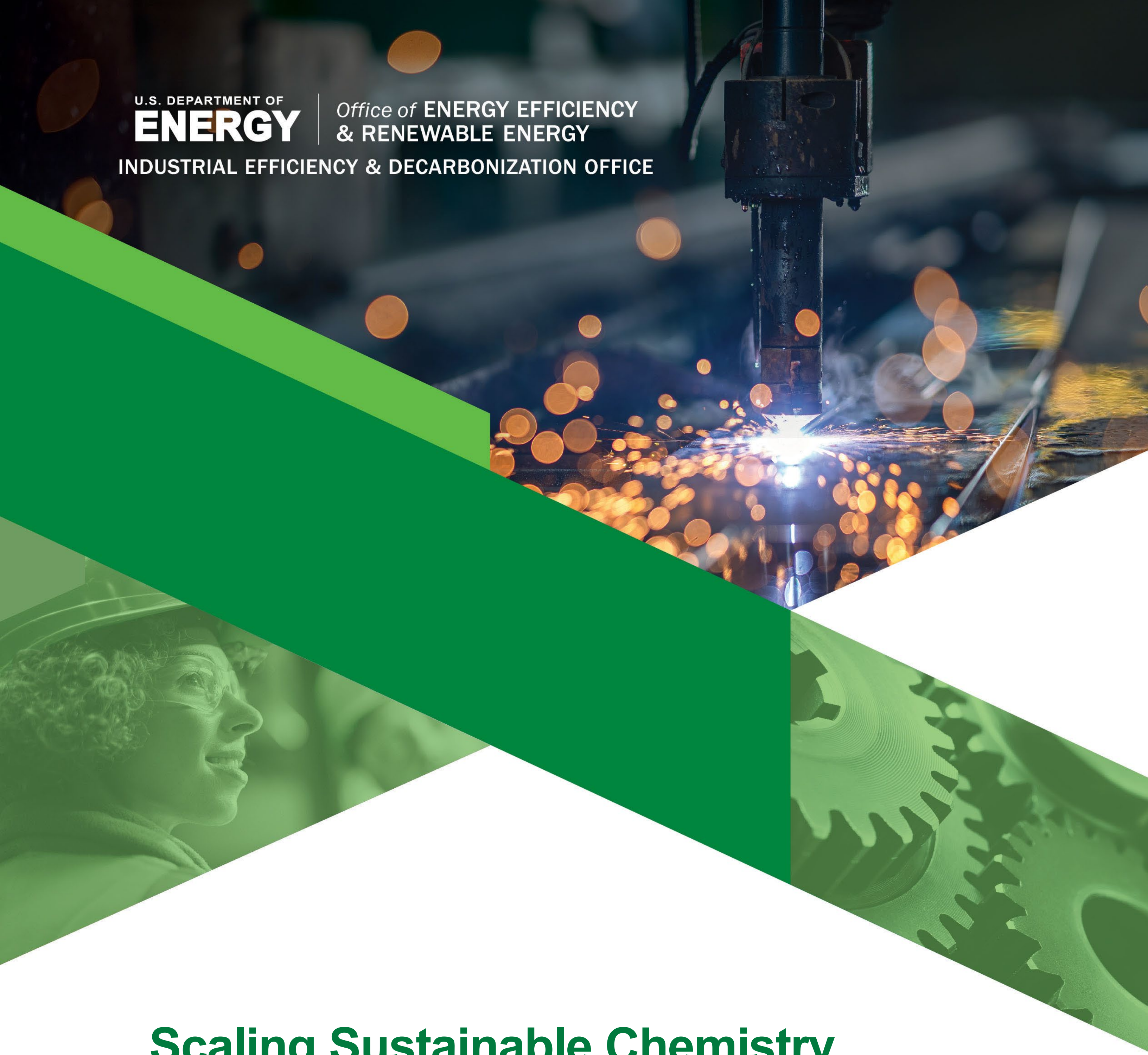

Scaling Sustainable Chemistry for an Industrial Transformation Forum and Roundtable

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Disclaimer

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Executive Summary

The U.S. Department of Energy (DOE) Industrial Efficiency and Decarbonization Office (IEDO) and Change Chemistry co-hosted the "Scaling Sustainable Chemistry for an Industrial Transformation Forum and Roundtable" on August 1, 2024. The forum brought together thought leaders and stakeholders from diverse backgrounds to address the opportunities and challenges associated with bringing sustainable chemistry to scale in the U.S. economy. This report is a summary of the views expressed by individual participants during the roundtable; it is not intended to represent DOE's views or programmatic priorities.

IEDO's involvement with sustainable chemistry is grounded in its focus on key energy issues and on accelerating transformative industrial technologies across industrial subsectors, including the chemical industry. The U.S. chemical manufacturing sector holds a leading economic role: a $633 billion industry, the second largest chemical producer globally, and responsible for 10% of US export goods. It directly employs over 550,000 people, supports 4.1 million additional jobs, and is responsible for $32.6 billion in capital investment.[1] It is also a large energy consumer, totaling 8,139 trillion BTU for fuels and feedstocks in 2018,[2] with associated emissions of 322 million tons CO_2 equivalent, the largest in the U.S. economy. [3,4] Energy and emission intensity of the current industry is intrinsically linked to several other issues such as environmental and human health and the supply chains that run our economy. All these issues are critical to national security, prosperity, equity, and the nation's capabilities for economic competitiveness.

Change Chemistry works with companies along the value chain, governments, business groups, non-profits, and others to understand and address barriers and enablers that advance commercialization, adoption and scale of sustainable chemistry. Spurring innovation in sustainable chemistry is central to its mission, and Change Chemistry is uniquely positioned to accelerate progress in this exciting sector, with members ranging from emerging start-ups to global product manufacturers and brands. The organization focuses on policies and programs that incentivize research, demonstration, and adoption of safer and sustainable chemistry solutions at scale.

IEDO and its predecessor, the Advanced Manufacturing Office (AMO), have partnered with Change Chemistry to host two prior roundtables for sustainable chemistry. This event builds upon those prior events held in 2020 and 2023. Since the first roundtable, significant progress has been made in advancing research, financing, and interagency coordination around sustainable chemistry, in part due to the implementation of the Sustainable Chemistry R&D Act, the Inflation Reduction Act,

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[1] American Chemistry Council, "The Business of Chemistry by the Numbers," downloaded Dec 31, 2024. https://www.americanchemistry.com/chemistry-in-america/data-industry-statistics/the-business-of-chemistry-by-the-numbers

[2] U.S. Energy Information Administration, 2018 Manufacturing Energy Consumption Survey (MECS), Data for Chemicals sector (NAICS 325) in Tables 2.2 and 3.2, downloaded Dec 31, 2024. https://www.eia.gov/consumption/manufacturing/data/2018/

[3] U.S. Department of Energy, Manufacturing Energy and Carbon Footprint for Chemicals sector. https://www.energy.gov/eere/iedo/manufacturing-energy-and-carbon-footprints-2018-mecs

[4] Industrial Decarbonization Roadmap. U.S. Department of Energy, Report DOE/EE-2635, September 2022.

and the White House Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy. Previous roundtable discussions collected key insights for developing technologies, challenges in markets and supply chains, the role of public-private partnerships, and consideration of environmental justice issues, all of which IEDO has incorporated into program planning since 2021 including funding solicitations and programmatic strategies. This event focused on how to successfully scale sustainable chemistry, convening leaders and stakeholders from private, public, and environmental spheres to gain insights. Three core topics were addressed: (1) the technologies needed to scale sustainable chemistry; (2) the investments and incentives needed to scale sustainable chemistry; and (3) the ecosystem needed to support successful scaling.

Discussions at the roundtable highlighted progress being made in advancing a sustainable chemistry ecosystem in the U.S. – due to market forces, existing RD&D and recognition programs, and emerging new federal policies. Strategic public and private sector investment along the whole technology readiness level (TRL) pathway is needed to spur innovation and accelerate already moving markets for products of sustainable chemistry. A facilitated, whole-of-government approach is needed to take advantage of the current drivers and opportunities that supports domestic capacity, creates demand, and builds the necessary research, educational/training, policy, and incentivization structure for sustainable chemistry to thrive. A portfolio view should be taken recognizing the roles of small, large, and emerging companies and challenges faced by each, both common and unique. A set of approaches that address these factors is needed across the core areas of technology, investments and incentives, and the ecosystem. Key takeaways from discussion are summarized below.

Technologies to Scale

The chemistries and process technologies need to provide high impact for GHG reduction, energy and resource efficiency, and other attributes like toxicity reduction, a core element of sustainable chemistry. High volume building blocks and other simple molecules such as monomers, alcohols, acids, and solvents are central to U.S. progress in building the sustainable chemistry sector. Specific examples include green ethylene, bio-butanediol, bio-terephthalic acid. Focusing on bio-derived, circular, or CO_2-based materials are also impactful due to their low carbon footprint and the opportunities for diversification of U.S. markets.

Targeted opportunities for scaling smaller volume, higher margin applications, should also be considered to demonstrate scalability. These create points of entry to accelerate overall adoption of sustainable chemistry and provide proof-of-concept for higher volume applications, which have higher barriers to entry for process and material changes.

Process technologies were identified that offer impactful benefits for sustainability and competitiveness. Advantages such as increased efficiency, lower energy consumption, avoided carbon emissions, reduced toxicity, and reduction of unwanted byproducts can be accessed in process technologies for sustainable chemistry. These include catalysis, electrochemical reactions, biotechnology, advanced separations, and advanced reactors (e.g. process intensification, modularization). Scaling new and existing process technologies was seen as critical to advancing sustainable chemistry which would enable a US manufacturing sector that can meet the global market demands for safer, more sustainable products.

Investments and Incentives

Continued investment is needed to derisk the scaling of sustainable chemistry technologies. Derisking involves technical, economic and financial aspects. R&D and engineering must be applied to overcome technical challenges, while piloting and demonstration scale activities also need to be carried out. Government grants, loans, and tax incentives can provide key support for bridging the "valleys of death" across all technology readiness levels (TRLs).

Supply chains, systems, infrastructure, and other supporting resources need investment. The supply chains of sustainable chemicals and materials are not mature, and there are issues with availability, limited numbers of suppliers, reliability, and quality. Several key energy-related technologies need scaling as well, such as the supply of low cost, clean energy; technologies for electrification; and efficiency technologies. Moreover, additional equipment and infrastructure for scaling activities are needed, such as piloting and demonstration facilities.

Well-designed incentives accelerate market adoption and address systemic barriers that block innovation. Incentives can target choices driven by consumers or product manufacturers. The government can take direct action by applying its purchasing power to sustainable chemicals and materials, mandating certain product sustainability standards, or prioritizing sustainable products in its approval and permitting processes. Both governmental actions provide important support to enable private sector innovation in sustainable chemistry.

Supportive Ecosystem

An ecosystem with collaboration, information sharing, and community engagement provides critical support to successfully scale sustainable chemistry. Key collaborative areas include facilitation of stakeholder connections, inter-agency government action, government-industry action, and community engagement. Information sharing provides transparency, encourages informed substitutions, fosters decision making aligned with sustainability criteria, and equips communities to engage in decisions around sustainable chemistry in a meaningful way.

Evaluation tools, data and standards need to be established across the industry. Clear, consistent and transparent criteria for both safer and sustainable chemicals and processes are needed to help U.S. industry move quickly to take advantage of global market demand for sustainable chemistry products. Core evaluation tools are life cycle assessment (LCA), techno-economic analysis (TEA), and toxicology assessments Providing metrics, data and tools would greatly assist decision-making, both providing standardization and often removing resource barriers, particularly with LCA.

Introduction

Event and Goals

The U.S. Department of Energy (DOE) Industrial Efficiency and Decarbonization Office (IEDO) and Change Chemistry (formerly the Green Chemistry & Commerce Council, GC3) co-hosted "Scaling Sustainable Chemistry for an Industrial Transformation Forum and Roundtable" on August 1, 2024. It consisted of a forum featuring panel discussions with thought leaders from business, public service, and environmental justice backgrounds, followed by a roundtable with facilitated breakout groups. The event brought together 121 participants, comprising a broad mix of stakeholders from industry, government, national laboratories, small businesses, community advocates, and non-profits. The goal was to gain insight into the steps needed to scale sustainable chemistry.

There are increasing market, policy, and scientific drivers for investments in sustainable chemistry that can enhance domestic manufacturing and competitiveness, secure supply chains, and create product and process safety and sustainability. This event builds upon two previous roundtables and seeks to understand challenges to scaling sustainable chemistry technologies that address both safety and sustainability. Three specific areas were addressed:

1. **Scaling Technologies**: The development of new chemicals and processes is a fundamental task that has critical challenges for scaling.
2. **Investments and Incentives to Sustainable Chemistry:** Effective and impactful incentives promote innovation, development, commercialization, and adoption of sustainable chemistry. Significant investment of private and public resources is required to develop and build the desired industrial capabilities, leveraging public and private collaborations.
3. **Supportive Ecosystem for Sustainable Chemistry:** The creation of a supportive and inclusive ecosystem enables scaling equitable and effective sustainable chemistry solutions.

Previous Roundtables

DOE's Advanced Manufacturing Office (AMO) and Change Chemistry (known as GC3 at the time) hosted the initial roundtable for sustainable chemistry on November 17, 2020. The event titled "Sustainable Chemistry in Manufacturing Processes" collected industry stakeholders' perspectives on incorporating sustainable chemistry practices into the production of consumer and commercial products. Discussions focused on:

- Scalability for both feedstocks and processes, where derisking is key to both.
- Information-sharing and collaboration along the value chain to drive market adoption.
- Consistent evaluation tools and criteria (e.g., technoeconomic analysis, TEA, and lifecycle assessment, LCA).
- Supply chain integration.
- Chemical manufacturing processes.

RD&D opportunities were grouped under two categories: materials and processes/practices.

The second workshop "Sustainable Chemistry in RD&D to Transform the Chemicals Sector" was held on March 7, 2023. It was spurred by stakeholder discussions organized by the DOE's AMO and Change Chemistry showing that industrial efficiency and decarbonization, sustainable chemistry, and environmental justice are intrinsically linked. The participants shared their perspectives on the opportunities and challenges of addressing these key areas in a holistic manner. Key themes and takeaways included the following:

- Barriers to sustainable chemistry exist and need to be addressed, particularly in feedstocks, new processes and new materials/molecules.
- Sustainable chemistry is growing despite these barriers, but a clearer business case is needed.
- Sustainable chemistry investments should link decarbonization and environmental justice.
- Public–private partnerships can overcome barriers to sustainable chemistry to advance decarbonization and environmental justice goals.

Much has happened in the field of sustainable chemistry since the first roundtable. The Sustainable Chemistry R&D Act of 2021 established a whole of government approach to advancing sustainable chemistry R&D, commercialization and adoption. The Bipartisan Infrastructure Law and Inflation Reduction Act created unprecedented investments in decarbonization that impacts the chemicals sector. This includes the $6 billion Industrial Development Program focused on lowering emissions from high energy intensive sectors and billions of dollars in loan guarantees from the DOE Loan Programs Office for innovative biorenewable and sustainable chemistries and processes. Since 2021, four consecutive Funding Opportunity Announcements from IEDO awarded over $108M for applied R&D and pilots of transformational technologies in chemicals manufacturing that emphasize sustainable chemistry to enhance environmental and economic co-benefits.

Additionally, ambitious targets have been established and bold action taken in other areas. The Clean Fuels and Products Earth Shot set a goal of 50% of carbon-based chemicals from sustainable carbon sources by 2050. Similarly, the Bold Goals for the Bioeconomy created under the Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy, establishing a goal of 90% recyclable and biorenewable polymers by 2050. Finally, increasing concern over chemicals of concern, such as per- and polyfluoroalkyl substances (PFAS), and increased availability of safer alternatives for critical applications has resulted in greater collaboration across stakeholders for sustainable chemistry solutions, on both federal and state levels.

Morning Forum: Panels and Speakers

The first half of the event consisted of panel discussions with participants from private, public, and environmental justice communities. Opening remarks were delivered by Avi Schultz, Director of IEDO, and Dr. Joel Tickner, Professor at the University of Massachusetts Lowell and Executive Director at Change Chemistry.

Director Schultz explained IEDO's two main functions: funding the development of new technology and providing technical and workforce assistance to industry. The former is important because 60% of industrial emissions cannot be addressed with technologies that are currently market ready. Key initiatives in the area include the Clean Fuel and Products Shot, which targets massive GHG reductions in fuels and chemicals, and the recent $83 million funding opportunity for industrial decarbonization projects, which includes a focus on chemicals. Public-private partnership is key to drive these efforts, particularly to support changes to high volume, low margin incumbent technologies.

All American communities must be included in these efforts, recognizing past impacts on communities where chemical plants have been located, such as higher rates of asthma and cancer. As sustainable chemistry goals are pursued, stakeholders must be involved early in development and commercialization process, ensuring robust dialogue. To this end, all IEDO funding decisions have included energy justice considerations.

Transforming the industrial sector for the benefit of all Americans is a massive challenge but is met with concerted support from stakeholders in industry, academia, government agencies, and national labs, complimented by investments like the Bipartisan Infrastructure Law and partnerships with organizations like Change Chemistry and other engaged stakeholders.

Professor Tickner introduced Change Chemistry's partnership with the DOE to advance sustainable chemistry. He noted the need to leverage unprecedented investments to decarbonize the economy and build domestic manufacturing to drive innovation, adoption and scale of chemistries and chemical processes that are both safer and more sustainable. Sustainable chemistry – going beyond existing chemical products and production routes – is critical to advancing whole of government goals including decarbonization, the bioeconomy, semiconductor manufacturing, chemical pollution reduction, and environmental justice. He noted both progress and the need for continued action.

Panel Discussion: Leveraging Public-Private Actions to Scale Sustainable Chemistry

Michele Jalbert, Executive Director of Effective Advocates, led a private sector panel discussing efforts to scale sustainable chemistry. Viewpoints were presented from the investment community, a small chemical company and a large chemical company. Panel members included:

- Alexandra McPherson, Director, Investor Environmental Health Network
- John Shaw, CEO, Itaconix
- Paul Witt, Research Fellow, Dow Chemical Company

As consumer demand for safer products is increasing, consideration of sustainable chemistry in investment decisions is advancing among asset managers, with key developments in several areas. Recognition of different types of risk associated with non-sustainable options is growing, such as the costs associated with PFAS estimated by financial analysts. Collaborative or coordinated efforts are also key. For example, collective buying power of major players in consumer-facing personal care can be leveraged to bring investment to long-term, less favored sustainability plays. A key need has been the development of criteria for sustainable investments. To this end, establishing metrics and well-respected science-based standards, like EPA's Safer Choice have been important. Patient capital will be important to support the long-term investment timeframes in sustainable chemistry.

Itaconix presented their approach as a small company focusing on the manufacture of polymers from itaconic acid, where several sustainable attributes are brough to bear. The products are derived from highly sustainable cellulosic biomass and produced with a zero-discharge process at repurposed pulp & paper plants in North America. In addition, a key value-driver is that reformulation with their product can significantly reduce the total amount of chemicals used, a sustainability benefit often not considered. Applications focus on the consumer products market, where greatest returns and benefits are seen.

Dow's implementation of sustainable chemistry innovation across its large production ecosystem provided many opportunities for environmental and economic benefits, such as reducing/replacing high environmental impact materials, reducing waste discharge, lowering energy usage and reducing cost. Innovations receiving recognition of the Presidential Green Chemistry Challenge Awards provide examples: a polymer allowing elimination of bisphenol A in printing chemicals for paper receipts; an enhanced dispersant for titanium oxide in paints, reducing its associated environmental impacts; and a new process to make propylene oxide developed with BASF that reduces wastewater 70% and energy consumption 30%. Derisking, which requires testing and time, is central to scale sustainable chemistry, particularly for mid-level TRL technology to travel through the valley of death. Partnerships are key to derisking to sustainable products and processes.

Fireside Chat: Level-setting Government Efforts for Sustainable Chemistry

David Turk, Deputy Secretary of DOE, led a panel addressing the relevance of sustainable chemistry to government priorities. Panel participants included:

- Brendan Owens, Assistant Secretary of Defense for Energy, Installations, and Environment, Department of Defense (DOD)
- Ben Beachy, Special Assistant to the President for Climate Policy, White House
- Erwin Gianchandani, Assistant Director of the Directorate for Technology, Innovation and Partnerships, National Science Foundation (NSF)

Deputy Secretary Turk introduced the session by emphasizing the essential role the chemical sector plays in life today, but also acknowledged the negative impacts it has had on emissions and communities. Addressing these challenges also bring enormous opportunity, including new markets for sustainable, low-carbon chemicals, and US companies are well positioned to stake their claim at every stage of the value chain. To address the challenge and opportunity, DOE has employed tools in three areas:

- Fundamental Science, including 51 Energy Frontier Research Centers supported by the DOE Office of Science, and the RENEW and FAIR awards for sustainable chemistry research that centers equity;

- Applied R&D, as embodied in strategic Earthshot initiatives like the Clean Fuel & Products Shot, targeting 85% emission reductions by 2035; and
- Deployment Support, a game-changing, new effort seen in the Industrial Demonstrations Program that invested $1.3 billion across projects in chemicals and refining, with potential to slash emissions by an estimated 3 million tons of CO2.

These awards create opportunities to address pollution and improve relationships with impacted communities. As part of the Justice40 commitment, economically distressed communities have received twice the investments relative to their share of the economy. Thus, these investments benefit the economy, the environment, and our communities, and point to the continued work still to be done.

The speakers emphasized that sustainable chemistry innovation is an essential component to national strategy on economic development and to national security. For example, sustainable chemistry serves two key roles that directly impact the DOD's ability to fulfill its mission: (1) It replaces chemistries that have required costly cleanup efforts (diverting funds from military efforts) and prevents future costs; and (2) It replaces critical material gaps that may occur as chemicals and materials are restricted by regulators or markets, as with the F-35 fighter jet that cannot operate without PFAS-based components. Ben Beachy explained how sustainable chemistry can address a "trifecta" of policy concerns: (1) emissions; (2) domestic economic competitiveness and jobs; and (3) public health. Trade and purchasing policies can help advance US interests in these areas. Finally, NSF's scientific efforts seek to ensure economic leadership, build tomorrow's workforce, rethink the industrial innovation base, and support national security. Sustainable chemistry addresses these goals, particularly with the new Directorate for Technology, Innovation and Partnerships (TIP) created to advance U.S. competitiveness and societal impact.

Moderated Conversation: Environmentally-Just Chemical Production

A third panel addressed the incorporation of environmental justice into the scale up of sustainable chemistry. Professor Tickner moderated this panel which featured two participants:

- Robin Collin, Former Senior Advisor to the Administrator for Environmental Justice, U.S. Environmental Protection Agency
- Laura Ebbert, Acting Deputy Assistant Administrator for Environmental Justice, U.S. Environmental Protection Agency

Professor Tickner introduced the discussion, noting that there is no need to accept chemical production that endangers the health of the surrounding communities, because there are tools to address such challenges. He presented a multi-stakeholder developed definition and criteria for sustainable chemistry (the ECOSChem group) that includes equity and justice, transparency, human and environmental health and safety, lowered climate and ecosystem impacts, and circularity considerations.

Former Senior Advisor Collin emphasized that past choices in chemicals development and production have led to "catastrophic failures" for communities and the environment. She noted that considering a specific need or function without considering its connection to the whole system is at the root of many community impacts and stressed the importance of reframing how risk is calculated to encompass cumulative risk. It is crucial to provide adequate resources for community engagement throughout the process of sustainable chemicals development and production to fully understand how communities may be affected by decisions.

Acting Deputy Assistant Administrator Ebbert explained that each community will need a unique approach because each has unique stressors. She also noted the journey to engage environmental justice may require “muscles” an organization may not have, indicating lack of experience or internal processes to address such issues. Resources are available to help, including the expertise in the EPA. She also emphasized the need for standardized tools to aid assessment and highlighted programs and tools to advance sustainable chemistry from EPA including the Green Chemistry Challenge Awards, Safer Choice program, EnergyStar, and the GREENSCOPE process design tool. Importantly, both speakers noted that that more effective decisions occur when diverse stakeholders participate fully throughout the process.

Afternoon Roundtable: Summary of Breakout Sessions

Dr. Gerri Richmond, the DOE Undersecretary for Science and Innovation, opened the afternoon session by noting the central role of chemistry in modern society, but also that health and environmental harms caused by pollution and hazardous chemicals require a transformation to sustainable chemistry. This motivated DOE investment in technologies that advance innovations in sustainable chemistry. For example, the Energy Earthshots set ambitious goals to accelerate breakthroughs of affordable, clean energy solutions in the next decade, with three relevant to the day’s discussion: (1) the Industrial Heat Shot, to develop cost-competitive heating solutions that lower emissions 85% by 2030; (2) the Carbon Negative Shot, to enable removal of CO2 from the atmosphere along with economical, durable storage; and (3) the Clean Fuels & Products Shot, which develops alternative carbon sources for fuels and chemicals to reduce emissions 85%.

As an example of the many projects supported by DOE, the work of ReSource Chemicals was highlighted, which scales production of a non-toxic, bioderived building block chemical that can serve as an alternative to the fossil-derived feedstock to polyester. This carbon-negative process uses CO2 and inedible biomass to enable production of plastics with superior performance than current ones. Beyond sustainable feedstocks, several transformations are needed to make chemistry sustainable and eliminate hazardous waste.

She noted the need to move from talking about problems and solutions to taking concrete actions to drive change emphasizing the role that all stakeholders in accelerating this work. For the remainder of the afternoon session, participants were divided among parallel breakout groups to discuss three topic areas in more detail:

1. Scaling Technologies
2. Incentives and Investments to Scale Sustainable Chemistry
3. Supportive Ecosystem for Sustainable Chemistry

The following sections capture highlights from the facilitated discussions. Observations and ideas shared here represent snapshots of the viewpoints shared by roundtable participants.

Topic Area 1 – Scaling Technologies

Chemistries and Technologies to Scale

Topic Area 1 – Discussion Questions:

- *What technologies (molecules or processes) are needed to reduce the toxicity and emissions of current chemical processes?*
- *How do we advance technologies (molecules or processes) to scale to reduce the toxicity and emissions of current chemical processes?*
- *What are the challenges to scaling sustainable technologies and process systems? What are the specific challenges for your stage of the value chain and/or sector?*

Targets for scaling sustainable chemistry should first address areas of highest impact in terms of emissions and/or toxicity. Such chemicals are often high-volume, basic molecules and building-block molecules like monomers, alcohols, acids and solvents (see Table 1). Examples include green ethylene or bio-based terephthalic acid for PET. Bio-derived, circular, or CO_2-based materials are also impactful due to the low carbon footprint. Solvents and the reduction of solvent use also represent opportunities for both decarbonization and detoxification. Toxicity discussions focused on replacing hazardous substances such as PFAS, hexavalent chromium, and halogenated compounds (e.g. methylene chloride). Replacements often depend on fulfilling a specific function in a specific application, and sometimes a system-level approach is needed instead of a "drop-in" chemical (e.g. laser de-painting to replace methylene chloride).

Though scaling sustainable chemistry in high volume chemicals can bring large impact, barriers to entry are high, so targeted opportunities with smaller volume, higher margin niche applications should be considered to demonstrate scalability. These can create points of entry to accelerate overall adoption of sustainable chemistry and provide proof-of-concept for higher volume applications.

Key process technologies identified by participants are also listed in Table 1. These offer capabilities to increase efficiency, lower energy consumption, and, in some cases, avoid burning fossil fuels for power, as with electrochemical and biological reactions. Participants emphasized the continued importance – and challenge – of mitigating toxicity and other safety concerns while also investing in chemistries and processes that reduce greenhouse gas emissions.

Table 1. Examples of Sustainable Chemicals and Process Technologies

Chemicals	Process Technologies
• Small molecules/building blocks with high emissions impact such as monomers, alcohols, acids & solvents: green ethylene, bio-butanediol, bio-caprolactam, glucaric acid. • Alternative polymers. • Sustainable surfactants • Renewable hydrocarbon solvents/base fluids. • CO_2-derived products. • Alternatives to high toxicity materials: PFAS, hexavalent chromium, isocyanates in spray, chlorinated solvents. • May require application-level approach (e.g., paint, mining, etc.).	• Catalysis. • Electrochemical reactions (with catalysis). • Biotechnology (e.g., fermentation, enzymatic synthesis or other synthetic biology tools). • Advanced separations, including membranes. • Reactor design, including process intensification and modularization.

Opportunities and Challenges

Enabling Resources, Systems and Infrastructure

Scaling sustainable chemistry requires simultaneously scaling several supporting resources, namely those for material supply, energy and water. Piloting and production scale-up capabilities also need to scale, including contract manufacturing capacity. Table 2 lists some example challenges and needs under each of these areas. In some cases, scaling or repurposing existing feedstocks or process technologies is needed. Other cases call for increased deployment of technologies, e.g., waste heat utilization. However, for most of these issues, the challenge is connected to a larger system or infrastructure, where scaling must be addressed in concert with other major factors. For example, one option for low carbon energy is to use clean electricity, which in turn requires additional generation and distribution capacity. Thus, systems-level approaches are needed.

Table 2. Enabling Resources, Systems and Infrastructure

Resource and Infrastructure	Example Needs and Challenges
Sustainable Feedstock Supply • Carbon dioxide • Carbon monoxide • Biobased feedstocks • Recovered plastics • Renewable natural gas	• Access to multiple and scalable sustainable feedstocks. • Immature supply chain. Issues with availability, reliability, quality, transparency, and limited number of suppliers. • Feedstock variability. • Lack of waste collection and sorting. • Efficient transport and distribution from rural areas. • Carbon intensity/impact of agriculture. • Possible food competitive agriculture or biodiversity loss.
Energy Resources • Energy supplies • Electrification • Efficiency • Other low-carbon technologies	• Low-cost, clean, low-carbon energy availability at location. • Clean power and heating. • Waste heat utilization. • Scope 2 emission reductions.

Resource and Infrastructure	Example Needs and Challenges
Water Resources • Technology for efficiency/reuse • Infrastructure	• Geographical limitations for water supply. • Technology for water reuse and filtration.
Scaling Facilities & Resources	• Piloting/Scale up facilities. • Accessible infrastructure. • Equipment availability.

Improve and Accelerate Evaluation

Improvements are needed in key analysis areas of LCA, toxicity/hazard assessment, and TEA. Metrics and methods for LCA and carbon accounting need to be standardized and applied equally across industry and more standardized data needs to be made available. In addition, the speed and quality of hazard assessment needs to be improved. Current toxicology models (e.g., QSAR) are often not sufficiently robust for hazard prediction of new chemistries. Finally, improved technology diligence is needed, including early-stage TEA and better connection to value chain partners to accelerate uptake and scalability.

Use Digital, ML, AI Tools

The use of digital tools, including Machine Learning (ML) and Artificial Intelligence (AI), can support and accelerate sustainable chemistry solutions. Design efforts can benefit from large-scale simulation, including the use of digital twins, and digital tools can aid risk management. Participants felt that ML/AI could accelerate discovery, improve process design, and reduce experimentation for key areas like catalysis, and it could support more rapid toxicity prediction, identification of molecular substitutes, and material classification. For all these applications, data resources are needed along with shared repositories.

Market Challenges

Innovative sustainable chemistries generally face barriers to market entry, the first one being higher, disadvantaged costs, while incumbent products may have advantages with depreciated assets, highly available materials, and optimized technologies. Such challenges impede both small and large players alike, though often in different ways. For example, small companies may be challenged when seeking to break into the market, whereas large established companies can see barriers in the integrated systems they manage for highly competitive markets. Much of the needed technology exists but is not implemented because of insufficient incentives or barriers in the market. Effects are seen across the value chain, from adoption of end products to the availability of equipment. The existence of several relevant dimensions of sustainability (e.g., emissions, health impacts or equity) further complicates defining its value. Also, customers may not be aware of the need for sustainable chemistry in their product, or if they are aware, they may not be willing to pay for it or may not prioritize it in their purchasing decisions. But even those seeking to purchase sustainable chemistry products may have different ways to value sustainability and may lack objective criteria. Thus, there is also a need for clear standards, metrics, and a tie to consequential market value.

Studies demonstrating the economic costs due to GHG emissions and chemical pollution point to the need for stronger incentives or other provisions for such concerns. This could be applied to existing programs and incentives. For example, one could consider linking a program like Safer Choice to a financial incentive. Furthermore, new sustainable materials should place focus on strong differentiated value beyond their sustainability innovation.

Topic Area 2 – Investments and Incentives

Government Grants, Loans and Tax Credits

Topic Area 2 – Discussion Questions:

- *What incentives and investments are needed, or should be improved or expanded to drive scaling sustainable chemistry for decarbonization and detoxification? (5 - 10 year, 10 - 20 years, 20+ years)*
- *How do investments and incentives contribute to making interrelationships effective?*
- *How do we leverage and connect public/private incentives and investments to maximize impact?*

Participants confirmed the need for more investment to enable development of the sustainable chemistry sector, particularly from both federal and state governments through grants, loans, and tax credits. Specific sustainable chemistry requirements should be incorporated into these government tools. Investment needs to address the sustainable chemistries themselves as well as the supporting resources, systems, and infrastructure (i.e., topics covered in Table 1 and Table 2). For the former, support is needed across the entire range of TRLs from basic research to full commercial scale. These investments provide an essential derisking function needed to bridge the multiple "valleys of death" along the path to commercialization. At the late-stage activities include front-end engineering and design studies (FEED), first-of- a-kind demonstrations, and full production investments. Lower and mid TRL plays can be supported by public-private incubators and piloting/user facilities. High impact areas that require collaborative and coordinated momentum can be addressed with consortia, incubators, or other initiatives. In addition, efforts should address specific needs of small businesses who may have less resources to implement new technologies and may be more subject to market constraints.

In general, a portfolio view should be taken with respect to investments, including targeting small, large, and emerging companies. All play vital roles in the economy and in the supply chain for sustainable chemistry. Some challenges are shared (e.g., market barriers) while some are unique to different situation (e.g., resources for investment, market, etc.). Different approaches can be considered accordingly.

Several ideas were identified specifically targeting safer chemistry, including pinpointed grants for alternatives to high toxicity concerns like PFAS. Tax credits or other incentives could be indexed to toxicity criteria or funding offered to companies to support the transition to safer chemicals (e.g., Safer Chemical Ingredients List from EPA's Safer Choice program). Additionally, incentives that address approval processes for lower toxicity technologies can derisk scaling such innovations.

Value for Carbon and Other Sustainability Goals

As noted earlier, the link between market value and sustainability is often challenged due to cost, creating a barrier for sustainable chemistry. Emissions reporting, even without any regulatory consequence, would provide transparency that could incentivize action. Another approach is to find ways to value carbon, toxicity or other measures. For example, GHG emissions can be addressed by carbon pricing, emission trading systems, the establishment of other limits, or other methods. Alternatively, incentives for GHG abatement or use of low carbon solutions were discussed, such as tax credits, carbon credit programs or other awards. These ideas can also be applied to other sustainability metrics, such as low-toxicity or circular solutions. Fewer incentives have been developed for toxicity reduction, though some examples exist in states, which could provide models for development.

Incentivizing Market Adoption

Incentives can be applied to several points of influence to spur market adoption as summarized in Table 3. These incentives would serve to derisk adoption, direct the purchasing power of the private and public sector, and accelerate technical and consumer adoption. There are numerous lessons from the federal government's efforts to scale sustainable aviation fuels, including setting clear goals, unifying demand, leveraging purchasing power, and providing incentives that could be applied to safer and more sustainable chemistries and processes.

Table 3. Market Adoption Incentives

Activity area	**Examples of Incentives**
Consumer adoption	• Incentives for consumer purchases. • Circular economy incentives for recycling and reuse.
Application adoption	• Support for application testing. • Incentives for reformulation or substitution with a sustainable product. • Support for trial implementation (e.g. process modification with new material).
Commercial procurement	• Incentives for supplier/customer collaborations to bring solutions to market. • Incentives for major brands and purchasers to leverage their purchasing power. • Support to secure offtake agreements, including government backstops/guarantees. • Incentives to facilitate connections between early-stage technology developers and product buyers.
Insurance	• Offtake insurance. • Insurance for loss from unplanned disruptions associated with new technology.
Government procurement	• Prioritization in government purchasing. • Expansion of Safer Choice. • Creation of a purchasing Restricted Substance List.

Activity area	Examples of Incentives
Other provisions	• Market programs such as E15 (ethanol requirement in fuel) and California Low Carbon Fuel Standard. • Extended Producer Responsibility programs (ERP) for end-of-life concerns. • Bans on specific chemicals or identification of chemicals to phase out (to drive new solutions, e.g. PFAS alternatives).

Approvals and Permitting

To ensure sustainable solutions advance, prioritized regulatory review and approval for demonstrably more sustainable options should be created for key areas such as chemicals approval and permitting. "Fast track" mechanisms can prioritize projects that meet key sustainability criteria, with clear metrics and methodologies supporting the process. For maximum impact, these mechanisms should include coordination across government agencies and jurisdictions, including state and local governments.

Workforce

Developing a workforce that will propel sustainable chemistry and the ecosystem supporting it requires significant investments. Education and training are needed for the next generation of workers as well as skill retooling for the current workforce. Existing, relevant community workforce development programs should be leveraged, and education should target future sustainable solution adopters and decision makers to enable informed and timely decisions.

Strategic Use of Investments and Incentives

Several approaches can be employed to ensure the impact and effectiveness of investments and incentives, as seen in Table 4. All the breakout groups emphasized tying such approaches to a central strategy with clearly defined focus areas and metrics. This clarity creates certainty and unlocks capital, which in turn brings options for economically viable sustainable solutions. Proper market incentives align the interests of technology development with those of investors.

Table 4. Participant Suggestions for Effective Investments and Incentives.

Topic	Investment approach
High Level & Systems Thinking	• Clearly communicate the strategy with a breakdown to specific areas and outcomes. • Apply systems thinking, extending beyond the chemical industry itself to resources, infrastructure and stakeholders.
Metrics	• Define sustainability metrics and standards, including a clear and consistent framework for the metrics and standards with lifecycle impacts and end-of-life fate. • Tie incentives and investments to clear metrics and standards.

Topic	Investment approach
Private Sector Engagement	• Examine private funding sources and their risk tolerances to determine where they are willing to invest. Only use public money to fill the gaps. • Leverage cost-sharing to encourage commitments from private investment. Consider how to make private investment more feasible. • Targeted investments & incentives for smaller businesses.
Innovation	• Create new ideas for mechanisms/approaches to advance sustainable chemistry. • Use idea labs for difficult problem spaces with all stakeholders involved and invest in research based on "out of the box" thinking. • Use incentives and investments to address known market failures.
Effective Structures & Conditions	• Design incentives and investments for complementarity. Align incentives, such as funding and speed of regulatory review, to support strategic goals. • Match time horizons for the market approach and the appropriations. • Create long-term incentives for sustainability. • Encourage stakeholder engagement from diverse parties when designing investments & incentives (e.g. size, region, industry). • Consider incentives that encourage equitable participation and benefit for stakeholders along the value chain with different levels of influence.

Topic Area 3 – Supportive Ecosystem

Topic Area 3 – Discussion Questions:

- *How can a supportive ecosystem be created or strengthened to accelerate the scale up of sustainable chemistry? What other relationships or factors will foster a supportive ecosystem?*
- *For the ecosystem that exists now, how can we optimize the intersection of innovation, markets and government to scale sustainable chemistry practices?*
- *What does progress look like in the growth of this supportive ecosystem and what would you like to see as an indication of progress?*

Community and Stakeholder Engagement

Discussions on scaling sustainable chemistry need to include all possible stakeholders, specifically voices that have been underrepresented or absent in the past. Government roundtables and DOE activities should ensure expanded participation from a variety of backgrounds and disciplines. Funding and technical support is needed for certain stakeholders to effectively engage. Public-private activity should include finance leaders such as asset managers and banks. Affected communities and environmental justice stakeholders should be considered and engaged in decision processes for as much of the research, development and commercialization process as possible, evaluating impacts to these stakeholders and ensuring their input. Such stakeholder engagement requires a shift in thinking and in processes. Finally, public funding for projects should include requirements for community engagement and community benefit agreements.

Effort must be taken to ensure community and stakeholder engagement is carried out effectively, including considerations of impacts of cost to attend events to ensure equitable access for community engagement. Education and training on stakeholder engagement methods are important but may be overlooked, particularly for technical, political, or business leaders with less experience in the area. It was agreed that different perspectives need to be considered, creating a productive dialogue where voices are heard and validated with follow-up and transparency.

Collaboration

A supportive ecosystem relies on mutually beneficial relationships. Suggested collaboration opportunities fell into four key areas – facilitating connections, cross-government action, government-industry action, and extended stakeholder or non-governmental activity – as seen in Table 5. A common theme is the key role the government plays facilitating and coordinating stakeholders, finances, and other resources, particularly where there is a gap in the market. Furthermore, expertise in building ecosystems to drive innovation can be gleaned from organizations with similar experience, and community perspectives can inform the entire process. An important goal in building a vibrant and transparent ecosystem is creating a shared definition of sustainable chemistry and, more importantly, shared criteria for designing and evaluating innovations as well as measuring progress.

Table 5. Suggested Collaborative Activities for a Sustainable Chemistry Ecosystem

Collaboration Area	**Example activity**
Facilitating Connections	• Business to business (B2B) networking for awardees of government funding. • Open innovation marketplace for sustainable chemistries providers and seekers. • Teaming sites for Funding Opportunity Announcements (FOA) applicants to foster connection and relationship building. • Expansion of the DOE Manufacturing Capital Connector program to new areas. • Matchmaking between startups and sustainable product buyers. • Facilitation of equitable partnerships between startups and incumbents.
Cross-Government Action	• Information sharing about available opportunities across agencies. • Incorporate EPA into DOE efforts for toxicity issues. • Interagency work groups for coordination and information sharing to reduce overlap (e.g. National Nanotechnology Initiative). • Cross agency initiatives and funding calls to drive specific topics and new interactions. • R&D cooperation between states to address different regulations.

Collaboration Area	Example activity
Government-Industry Action	• Identification of key challenges via stakeholder engagement and coordinated action plans. • Facilitation of faster studies and conclusions regarding open questions. • Funding of industry-specific communication initiatives to articulate the sustainable chemistry roadmap. • Coordination with financial organizations to include safer, sustainable chemistry in eco-loans. • Facilitating the consolidation of smaller, less-sustainable plants into a shared sustainable facility. • Engagement with emerging sustainable chemistry players from overseas to set up more domestic production. • Establishment of consortia, public-private incubators, or other entities to spur RD&D in high-impact areas (e.g. PFAS-replacements, plastic film packaging alternatives, zero-waste), including pre-competitive spaces.
Extended Stakeholder or Non-Government Activity	• More robust government support for community dialogue (e.g., providing stipends) and expanding engagement to innovation, market, and government stakeholders. • Ensure community representation and opportunities to speak concerns; ensure inclusion of community voices in each phase of sustainable chemistry development (early innovation through market entry) • Joint industry initiatives across the value chain for high impact areas (e.g. large groups of stakeholders. • Increased engagement of potential buyers and sellers across the value to drive solutions and address barriers (e.g. two or three stakeholders). • Increased partnerships between academia and industry. • Participation of former government researchers or grant awardees in venture capital activities.

Information Sharing

All the breakout sessions noted that information sharing is vital for a supportive ecosystem, connecting to key areas of outreach, collaboration, and transparency. Participants presented ideas in several themes:

Consider a central government coordinating entity to accelerate sustainable chemistry development and deployment. A coordinated approach with a clear vision for sustainable chemistry can fully leverage the impact of government action and ensure full engagement of diverse stakeholders in these efforts.

Connect stakeholders for networking and discussion. Face-to-face meetings, such as this event, provide valuable opportunities to share information and organize dialogue. Platforms, including online forums, for ongoing engagement were also suggested, both for technical and general matters. Such interactive platforms would allow stakeholders from different sectors and groups (e.g. community members, government, investors) to connect, share information, and develop ideas.

Share learnings to inform the advancement of sustainable chemistry. There was keen interest to acquire insights from and develop community awareness of past and ongoing efforts for R&D and commercialization, including successes, failures, and identification of key issues. Determining lessons learned from other industries could also be valuable, including the recent transitions in the energy sector.

Advance awareness of government and industry activities and results. A platform could track progress of industrial scaling efforts. Increased awareness of government activities and resources related to sustainable chemistry would be useful to stakeholders, particularly in a centralized, streamlined channel.

Educate and inform the public. There is a need to create demand for products of sustainable chemistry by promoting understanding among all types of purchasers of the benefits of sustainable chemistry compared to incumbent products and processes, including tools for how to recognize them in the marketplace. This could create a demand signal that can help address challenges of adoption or cost gaps.

Provide definitions, standards and metrics. Guidance is needed in areas like carbon measurement and carbon accounting, with consistency across industries and jurisdictions. Coordination with international standards and practices would be helpful.

Provide resources to support modeling, evaluation, and decisions. Data and tools for LCA would enable small companies to assess potential impacts without the burden of spending significant resources. Resources to support TEA and toxicity evaluation/hazard assessment would also improve evaluation capabilities needed to define sustainable options.

Provide transparency, particularly for industry and government activities. Once standards and metrics are set for safety and sustainability criteria, industry needs transparency to build trust and track progress. Approaches include ingredient labels, other sustainable chemistry labels/recognitions, public registries, and databases of reported metrics. An example of an in-depth label is the Battery Passport being developed by the Global Battery Alliance addressing criteria such as GHG emissions, supply chain participation by country, and human rights. For government transparency, stakeholders need to know what activities are ongoing and how decisions are made, such as with funding selections.

Closing Session and Next Steps

In the closing session, participants noted the value of the intersectoral convening focused on addressing needs for scaling sustainable chemistry and suggested regular convenings with multiple perspectives to advance dialogue and specific actions. Some of the proposed actions included: deep dive evaluations of specific sectors; evaluation and prioritization of strategic areas for investment; development of a shared definition and criteria; developing a roadmap to grow sustainable chemistry (similar to that for sustainable aviation fuel); and development of metrics to review progress in growth of sustainable chemistry. Participants noted that it is important to show progress against earlier DOE reports on sustainable chemistry and to identify and address barriers if progress is not happening.

Conclusion

Scaling innovative sustainable chemistry requires a coordinated mobilization of stakeholders and resources beyond technology and industry, extending to raw materials, investors, and community voices. As industry takes significant steps for implementation of sustainable chemistry to meet market demand, government holds key roles to engage stakeholders, develop strategy, define standards, and establish effective incentives to build U.S. industrial capacity in this space.

Continued investments and incentives are required to scale sustainable chemistry. Investment is needed for new sustainable chemistry technology across all TRLs. Derisking these technologies is critical due to the large capital involved for development and commercialization. Applied research and development and piloting are key to derisking the technical challenges. New technologies must be scaled, while also supporting supply chains and infrastructure, especially clean energy resources and feedstocks. Other resources for scaling are needed such as piloting facilities. To address fundamental market barriers, incentives are needed to accelerate market adoption by targeting choices driven by consumers or product manufacturers.

Collaboration, information sharing, and community engagement are vital to growing a connected ecosystem for scaling sustainable chemistry. Within the government, coordination across agencies provides coherent, strong influence. Establishing stakeholder connections and sharing information enhances transparency, promotes decision-making aligned with sustainable values, and empowers the public to knowledgeably engage with sustainable chemistry.

Appendix A. Agenda

Morning Forum Agenda

Time EST	Activity
8:30 AM – 9:00 AM	**Coffee and Networking**
9:00 AM – 9:15 AM	**Welcome and Opening Remarks** • Avi Shultz, Director, IEDO • Joel Tickner, Executive Director, Change Chemistry
9:15 AM – 10:00 AM	**Panel Discussion, Leveraging Public-Private Actions to Scale Sustainable Chemistry** A discussion on leveraging coordinated public-private actions to scale sustainable chemistry and address decarbonization, safety, and environmental justice goals. • Alexandra McPherson, Director, Investor Environmental Health Network • John Shaw, CEO, Itaconix • Paul Witt, Research Fellow, Dow Chemicals
10:00 AM – 10:45 AM	**Fireside Chat, Level-setting Government Efforts for Sustainable Chemistry** A discussion on the role of the federal government to advance a chemicals sector that provides critical chemistries that is decarbonized and safe. • David Turk, Deputy Secretary of the U.S. Department of Energy • Brendan Owens, Assistant Secretary of Defense for Energy, Installations, and Environment • Ben Beachy, Special Assistant to the President for Climate Policy • Erwin Gianchandani, Assistant Director of the Directorate for Technology, Innovation and Partnerships

Time EST	Activity
10:45 AM – 11:30 AM	**Panel Discussion, Environmentally Just Chemical Production** A discussion on the importance of incorporating environmental justice in to the scale up of sustainable chemistry. • Robin Collin, Former Senior Advisor to the Administrator for Environmental Justice, US Environmental Protection Agency • Laura Ebbert, Acting Deputy Assistant Administrator for Environmental Justice, U.S. Environmental Protection Agency
11:30 AM – 11:35 AM	**Forum Closeout** • Felicia Lucci, Technology Manager, IEDO
11:35 AM – 12:00 PM	**Networking**

Afternoon Roundtable Agenda

Time EST	Activity
12:00 PM – 1:00 PM	**LUNCH**
1:00 PM – 1:15 PM	**Welcome and Afternoon Session Breakout Plan and Purpose**

Time EST	Activity
1:15 PM – 2:30 PM	**Facilitated Discussion – Breakout Session 1** Parallel sessions for focused discussions on three rotating topics ***Scaling Technologies*** <u>Focus Questions</u> • What technologies (molecules or processes) are needed to reduce the toxicity and emissions of current chemical processes? • How do we advance technologies (molecules or process) to scale to reduce the toxicity and emissions of current chemical processes? • What are the challenges to scaling sustainable technologies and process systems? What are the specific challenges for your stage of the value chain and/or sector? ***Incentives and Investments*** <u>Focus Questions</u> • What incentives and investments are needed, improved, or expanded to drive scaling sustainable chemistry for decarbonization and detoxification? (5 - 10 year, 10 - 20 years, 20+ years) • How do investments and incentives operate in the larger context of interrelationships to make them effective? • How do we leverage and connect public/private incentives and investments to maximize impact? ***Supportive Ecosystem*** <u>Focus Questions</u> • How can a supportive ecosystem be created or strengthened to support the scale up of sustainable chemistry? What other relationships or factors will foster a supportive ecosystem? • For the ecosystem that exists now, in what ways can the nexus between innovation, markets, and government be optimized to scale sustainable chemistry practices? • What does progress look like in the growth of this ecosystem and how can we accelerate progress in impactful ways?
2:30 PM – 3:15 PM	**Facilitated Discussion – Breakout Session 2** **Breakout groups transition to second topic**

Time EST	Activity
3:15 PM – 3:30 PM	**BREAK**
3:30 PM – 4:30 PM	**Facilitated Discussion – Breakout Session 3** **Breakout groups transition to third topic**
4:30 PM– 5:15 PM	**Next Steps and Gap Analysis** • **What are the next steps to scale sustainable chemistry?** • **Gaps from day's discussions**
5:15 PM – 5:30 PM	**Closing Remarks and Adjourn**
5:30 PM – 6:30 PM	**Reception**

Appendix B. List of Roundtable Participants

Roundtable Participants

- Christopher Aiello, WD-40 Company
- Mel Anton, Nexight Group
- Aanindeeta Banerjee, ReSource Chemical Corp.
- Flora Barrow, Environmental Protection Agency
- Cameron Bordinat, Energetics
- Chris Bradley, Department of Energy, Office of Basic Energy Sciences
- Ross Brindle, Nexight Group
- Larrie Brown, Energetics
- Karsten Daponte, Nexight Group
- Ira Dassa, Twelve
- Tyler Del Rose, Department of Energy, Advanced Materials & Manufacturing Technologies Office
- Kate Drummond, P2 Science
- Ben Dunham, Dunham Law & Policy PLLC
- Tracy Gertsle, Department of Commerce, International Trade Administration
- Lisa Guay, Department of Energy, Bioenergy Technologies Office
- Kathleen Havelka, Advancion Corporation
- Lin He, National Science Foundation
- Michael Hershkowitz, IFF
- Chris Hewitt, BASF Corporation
- Henry Holbrook, Solugen
- Adrian Horotan, Safer Made, LP
- Michele Jalbert, Effective Advocates LLC
- Sarah Key, KBR
- Amol Kirtikar, Clariant Corporation
- John La Scala, SERDP-ESTCP, Office of the Deputy Assistant Secretary of Defense (Energy Resilience & Optimization)
- Edmond Lam, American Chemical Society
- Christian Lenges, IFF
- Thomas Lewis, BlueGreen Alliance
- Jie Li, Argonne, National Laboratory
- Felicia Lucci, Department of Energy, Industrial Efficiency & Decarbonization Office
- Paul Majsztrik, Department of Energy, Industrial Efficiency & Decarbonization Office
- Gail McLean, Department of Energy, Office of Basic Energy Sciences
- Alexandra McPherson, Clean Production Action
- Alexandra Melnyk, Department of Energy
- Christy Payne, National Science Foundation
- Matthew Pearson, Department of Energy, Industrial Efficiency & Decarbonization Office
- Damien Perriman, Gevo
- Elijah Petersen, National Institute of Standards and Technology
- Alexander Phearman, Department of Energy, Industrial Efficiency & Decarbonization Office
- Corrie Poland, Air Company
- Darcy Prather, Kalion
- Bennett Rosenberg, EWG
- Daniel Rosenberg, NRDC
- Monika Roy, Department of Energy, Office of Energy Justice & Equity
- Barclay Satterfield, Department of

Energy, Industrial Efficiency & Decarbonization Office
- Norah Schneider, Nexight Group
- John Shaw, Itaconix Corporation
- Heather Smith, Novonesis
- Steve Taylor, Coming Clean
- Joel Tickner, Change Chemistry
- Jack Tinsley, Nexight Group
- Emily Top, Nexight Group
- Laurie Valeriano, Toxic-Free Future
- Jeanne VanBriesen, National Science Foundation
- Natalia Vinas, Department of Defense
- Morgan Ward, Change Chemistry
- Jeffrey Whitford, MilliporeSigma
- Paul Witt, The Dow Chemical Company
- Ivanna Yang, Geno
- Winston Yau, RMI