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116TH CONGRESS *2d Session*	SENATE	REPORT 116–251

SUSTAINABLE CHEMISTRY RESEARCH AND DEVELOPMENT ACT OF 2019

R E P O R T

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ON

S. 999

AUGUST 12, 2020.—Ordered to be printed

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

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SUSTAINABLE CHEMISTRY RESEARCH AND DEVELOPMENT ACT OF 2019

AUGUST 12, 2020.—Ordered to be printed

Mr. WICKER, from the Committee on Commerce, Science, and Transportation, submitted the following

R E P O R T

[To accompany S. 999]

[Including cost estimate of the Congressional Budget Office]

The Committee on Commerce, Science, and Transportation, to which was referred the bill (S. 999) to provide for Federal coordination of activities supporting sustainable chemistry, and for other purposes, having considered the same, reports favorably thereon with an amendment (in the nature of a substitute) and recommends that the bill (as amended) do pass.

PURPOSE OF THE BILL

The purpose of S. 999, the Sustainable Chemistry Research and Development Act of 2019, is to designate an interagency entity to coordinate Federal research and promote sustainable chemistry. It would also support collaborative research of sustainable chemistry at institutions of higher education and with industry through Federal partnerships in order to improve training and professional development in the field.

BACKGROUND AND NEEDS

Sustainable chemistry can generally be summarized as the design of chemical products and processes that reduces or eliminates the generation of hazardous substances released into the environment that may pose a danger to public health or the environment.[1]

[1] Environmental Protection Agency, "Basics of Green Chemistry," Mar. 21, 2017 (*https://www.epa.gov/greenchemistry/basics-green-chemistry*) (accessed May 13, 2020).

Sustainable chemistry's aim is to prevent pollution at any point in the life cycle of a chemical product, "including its design, manufacture, use, and ultimate disposal."[2] The legislative origin of Federal activities related to sustainable chemistry has its roots in the Pollution Prevention Act of 1990, which "focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use," rather than relying on remediation.[3] Section 2 of the Pollution Prevention Act of 1990 establishes a pollution prevention hierarchy which ranks preventing pollution at the source as the most important and preferred method of pollution reduction.[4] Sustainable chemistry inhabits this most important level of pollution prevention because it aims to reduce the intrinsic hazards of chemical pollution at the source.[5]

As a result of its cross-disciplinary application, sustainable chemistry is a broad concept unified by 12 design principles. The primary principle of sustainable chemistry is that a chemical, process, or product is sustainable if its chemical syntheses is designed to prevent waste.[6] The remaining 11 design principles of sustainable chemistry are essentially methods through which the core goal of preventing waste may be achieved.[7] The second design principle is maximizing atom economy by designing chemical syntheses "so that the final product contains the maximum proportion of the starting materials[,]" thus capitalizing the incorporation of all materials used in the process.[8] The third design principle is to design less hazardous chemical syntheses in order to "use and generate substances with little or no toxicity to either humans or the environment."[9] The fourth principle of sustainable chemistry is to design safer chemicals and products which "preserve efficacy of function while reducing toxicity."[10] The fifth principle is to use safer solvents and reaction conditions by avoiding, to whatever extent possible, the use of "solvents, separation agents, or other auxiliary chemicals" or, in the alternative, to use safer ones.[11] The sixth principle is to increase energy efficiency by running chemical reactions at ambient, or room, temperature and pressure where possible.[12] The seventh principle is to use starting materials, or feedstocks, which are renewable. Fossil fuels such as petroleum and coal are depletable feedstocks. Agriculturally derived products such as biodiesel and bioethanol are examples of renewable feedstock.[13] The eighth principle of sustainable chemistry is to reduce the use

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[2] Id.

[3] Environmental Protection Agency, "Summary of the Pollution Prevention Act," Aug. 15, 2019 (*https://www.epa.gov/laws-regulations/summary-pollution-prevention-act*) (accessed May 13, 2020); Basics of Green Chemistry, supra note. 2.

[4] "Basics of Green Chemistry," supra note 1; Environmental Protection Agency, "Pollution Prevention Law and Policies," Jul. 15, 2019 (*https://www.epa.gov/p2/pollution-prevention-law-and-policies*) (accessed May 13, 2020).

[5] "Basics of Green Chemistry," supra note 1.

[6] American Chemical Society, "12 Design Principles of Green Chemistry" (*https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green-chemistry.html*) (accessed May 13, 2020).

[7] Id.

[8] "Basics of Green Chemistry," supra note 1; "12 Design Principles of Green Chemistry," supra note 6.

[9] "Basics of Green Chemistry," supra note 1.

[10] "12 Design Principles of Green Chemistry," supra note 6.

[11] "Basics of Green Chemistry," supra note 1.

[12] "12 Design Principles of Green Chemistry," supra note 6; "Basics of Green Chemistry," supra note 1.

[13] "Basics of Green Chemistry," supra note 1.

of chemical derivatives, which require additional reagents and generate more waste.[14] The ninth principle is to minimize waste by using catalysts, which can carry out a single reaction multiple times, in place of stoichiometric reagents, which carry out a reaction only once.[15] The tenth principle is to design chemicals and products to degrade after use so they do not accumulate in the environment. The eleventh design principle is to "[i]nclude in-process, real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts."[16] The final principle of sustainable chemistry is to minimize the potential for accidents in the design of chemicals to reduce the likelihood of including explosions, fires, and releases to the environment.[17] Sustainable chemistry is promoted if a process or chemical product achieves any of these design principles. There are many ways in which sustainable chemistry can be applied to the field of science. Several examples follow below.

Metathesis

In 2005, the Nobel Prize in Chemistry was awarded to three scientists who developed a process in organic chemistry called metathesis, which is broadly applicable to the field of science.[18] Metathesis is a chemical process that uses less energy, is stable at normal temperature and pressure, can be combined with sustainable solvents, and produces less hazardous waste.[19] Metathesis directly furthers the principles of sustainable chemistry. In 2012, Elevance Renewable Sciences, an organization which produces high-performance, cost-advantage green chemicals from renewable oils, won the Presidential Green Chemistry Challenge Award by using metathesis to break down natural oils and recombine the fragments into chemicals which consume less energy and reduce greenhouse gas emissions by as much as 50 percent.[20]

Computer Chips

The manufacture of computer chips requires a large amount of chemicals, water, and energy. To make the process of manufacturing computer chips more sustainable, the Los Alamos National Laboratory developed a process whereby supercritical carbon dioxide is used in one of the steps of chip preparation. This single change in the process significantly reduces the quantities of chemicals, energy, and water needed to produce computer chips. Alternatively, Richard Wool, the former director of the Affordable Composites from Renewable Sources (ACRES) program at the University of Delaware, developed a method of using the keratin in chicken feathers to make a fiber light and tough enough to withstand

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[14] "12 Design Principles of Green Chemistry," supra note 6.
[15] "Basics of Green Chemistry," supra note 1.
[16] Id.
[17] Id.
[18] "The Nobel Prize in Chemistry 2005," NobelPrize.org press release, Nobel Media (*https://www.nobelprize.org/prizes/chemistry/2005/press-release/*) (accessed May 13, 2020).
[19] American Chemical Society, "Green Chemistry Examples" (*https://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/examples.html*) (accessed May 13, 2020).
[20] Environmental Protection Agency, "Presidential Green Chemistry Challenge: 2012 Small Business Award," May 14, 2018 (*https://www.epa.gov/greenchemistry/presidential-green-chemistry-challenge-2012-small-business-award*) (accessed May 13, 2020).

mechanical and thermal stresses.[21] This fiber can be used in computer chip circuit boards that work two times faster than traditional circuit boards.[22]

Paint

Oil-based paints release a large quantity of volatile organic compounds which evaporate from the paint as it dries, causing various environmental impacts. Paint manufacturers have been developing methods of minimizing hazardous volatiles in their products. Procter & Gamble, working with Cook Composites and Polymers, developed a mixture derived from soya oil and sugar that replaces fossil-fuel-derived paint resins and solvents.[23] This paint is safer to use, cuts hazardous volatiles by 50 percent, and produces less toxic waste.[24] Similarly, Sherwin-Williams developed water-based acrylic alkyd paints with low volatiles, made from recycled soda bottle plastic, acrylics, and soybean oil.[25] In 2010, Sherwin-Williams eliminated over 800,000 pounds of volatile organic compounds using these paints.[26]

Medicine

The production of medicines which produce less toxic waste is a growing field within the pharmaceutical industry. Merck & Co., Inc., one of the world's largest pharmaceutical manufacturers, worked with Codexis, Inc., a protein engineering company, to develop a sustainable synthesis of sitagliptin, the active ingredient in Januvia, a type 2 diabetes treatment. This new process reduces waste and improves yield and safety. Simvastatin is a leading prescription for treating high cholesterol which uses hazardous reagents and produces a large amount of toxic waste. Professor Yi Tang, at the University of California, Los Angeles, created a synthesis of Simvastatin using an engineered enzyme and a low-cost feedstock which he, in conjunction with Codexis, Inc., optimized to reduce hazard and waste.

In 2010, Congress directed the National Science Foundation (NSF) to establish a sustainable chemistry basic research program.[27] The Environmental Protection Agency (EPA), Department of Health and Human Services (HHS), Department of Energy (EPA), Department of Defense (DOD), Department of Agriculture (USDA), Department of Commerce (DOC), and National Aeronautics and Space Administration (NASA) all fund and/or carry out activities related to sustainable chemistry.[28] While some of these entities coordinate with each other on an ad hoc basis, no Federal coordinating entity exists to strategically drive progress in this discipline.[29] The Committee notes that other nations are developing

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[21] "Green Chemistry Examples," supra note 19.
[22] Id.
[23] Id.
[24] Id.
[25] Id.
[26] Id.
[27] America COMPETES Reauthorization Act of 2010; Pub. L. 111–358.
[28] Government Accountability Office, *Technology Assessment: Chemical Innovation*, Feb. 2018 (*https://www.gao.gov/assets/690/689951.pdf*) (accessed May 13, 2020).
[29] Id.

national strategic plans and investing in sustainable chemistry research and development (R&D).[30]

SUMMARY OF PROVISIONS

S. 999, the Sustainable Chemistry Research and Development Act of 2019, would do the following:

- Establish an interagency entity under the National Science and Technology Council which would coordinate Federal programs that support research and development of sustainable chemistry. In coordination with stakeholders, the entity is tasked with developing a Federal strategic plan for sustainable chemistry and a consensus definition of sustainable chemistry.
- Require a report to be submitted to Congress summarizing federally funded sustainable chemistry research, the financial resources allocated to sustainable chemistry incentives, the current state of sustainable chemistry, an analysis of the entity's progress in achieving the goals designated by the legislation, recommendations for further program activities in support of sustainable chemistry, and an evaluation of efforts taken to date and future strategies to avoid duplication of efforts and spread best practices.
- Designate appropriate agency activities, including supporting the research and development of sustainable chemistry, disseminating information about sustainable chemistry, expanding sustainable chemistry education and training, examining methods related to sustainable chemistry standards, developing metrics for sustainable chemistry programs, and public outreach.
- Allow Federal agencies to partner with institutions of higher education and industry to create collaborative sustainable chemistry research, train students, develop curricula, and provide for professional development in the field of sustainable chemistry.

LEGISLATIVE HISTORY

S. 999 was introduced on April 3, 2019, by Senator Coons (for himself and Senators Collins, Capito, and Klobuchar) and was referred to the Committee on Commerce, Science, and Transportation of the Senate. On October 17, 2019, the Committee met in open Executive Session and, by voice vote, ordered S. 999 reported favorably with an amendment in the nature of a substitute and three first degree amendments.

An identical bill, H.R. 2051 was introduced on April 3, 2019, by Representative Lipinski (for himself and Representative Moolenaar) and was referred to the Committee on Science, Space, and Technology of the House of Representatives. There are 16 addi-

[30] United Nations Environment Programme, *Advancing Entrepreneurship and Start-up Initiatives for Sustainable Chemistry: Learning from Case Studies,* Sep. 14, 2017 (*http://wedocs.unep.org/bitstream/handle/20.500.11822/22044/SC%20Startup%20WS_Case%20Studies%20Compilation_Final.pdf?sequence=1&isAllowed=y*) (accessed May 13, 2020); see also Chemical Watch, "'Green Chemistry' Key Plank of Brazil's Economic Strategy," Feb. 2011 (*https://chemicalwatch.com/6504/green-chemistry-key-plank-of-brazils-economic-strategy*) (accessed May 13, 2020); see also Shariq Khan, "A $163 Billion Sector Is Fighting Against a Hazardous Future," *Economic Times*, Oct. 23, 2019 (*https://economictimes.indiatimes.com/small-biz/sme-sector/a-163-billion-sector-is-fighting-against-a-hazardous-future-chemical-sector-india/articleshow/71716343.cms?from=mdr*) (accessed May 13, 2020).

tional cosponsors. On December 9, 2019, H.R. 2051 was passed on a motion to suspend the rules and pass that bill, as amended, in the House of Representatives.

ESTIMATED COSTS

In accordance with paragraph 11(a) of rule XXVI of the Standing Rules of the Senate and section 403 of the Congressional Budget Act of 1974, the Committee provides the following cost estimate, prepared by the Congressional Budget Office:

S. 999, Sustainable Chemistry Research and Development Act of 2019
As ordered reported by the Senate Committee on Commerce, Science, and Transportation on November 13, 2019

By Fiscal Year, Millions of Dollars	2020	2020-2024	2020-2029
Direct Spending (Outlays)	0	0	0
Revenues	0	0	0
Increase or Decrease (-) in the Deficit	0	0	0
Spending Subject to Appropriation (Outlays)	2	14	not estimated

Statutory pay-as-you-go procedures apply?	No	**Mandate Effects**	
Increases on-budget deficits in any of the four consecutive 10-year periods beginning in 2030?	No	Contains intergovernmental mandate?	No
		Contains private-sector mandate?	No

S. 999 would direct the Office of Science and Technology Policy (OSTP) to establish an interagency entity—with representation from at least nine federal agencies—to coordinate federal programs and activities in sustainable chemistry. The bill would require the entity to consult with stakeholders, develop metrics to assess sustainable chemistry, and report to the Congress on related initiatives and priorities. Participating agencies also would be required to incorporate sustainable chemistry into existing programs for research and development, demonstration, technology transfer, commercialization, and education and training.

Using information from the Government Accountability Office, CBO expects that many agencies are already conducting activities similar to those required under the bill.[1] On that basis, and using information from OSTP and several of the affected agencies, CBO estimates that each of the nine agencies and OSTP would require, on average, two additional employees at an average annual cost of $150,000 each to manage and participate in the interagency entity. CBO estimates that implementing S. 999 would cost $2 million in 2020 and $14 million over the 2020–2024 period; such spending would be subject to the availability of appropriated funds.

On November 15, 2019, CBO transmitted a cost estimate for H.R. 2051, the Sustainable Chemistry Research and Development Act of 2019, as ordered reported by the House Committee on Science,

[1] See Government Accountability Office, *Chemical Innovation: Technologies to Make Processes and Products More Sustainable*, GAO–18–307 (February 2018), www.gao.gov/products/GAO-18-307.

Space, and Technology on October 17, 2019. The two bills are similar, and CBO's estimates of their budgetary effects are the same.

The CBO staff contact for this estimate is Janani Shankaran. The estimate was reviewed by H. Samuel Papenfuss, Deputy Assistant Director for Budget Analysis.

REGULATORY IMPACT STATEMENT

In accordance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee provides the following evaluation of the regulatory impact of the legislation, as reported:

Number of Persons Covered

S. 999, as reported, would not create any new programs or impose any new regulatory requirements, and therefore will not subject any individuals or businesses to new regulations.

Economic Impact

S. 999 is not expected to have a negative impact on the Nation's economy. It is likely to have a net positive benefit by coordinating Federal research and promoting the field of sustainable chemistry.

Privacy

S. 999 would have no impact on the personal privacy of individuals.

Paperwork

S. 999 would require the newly created interagency entity to complete a report, to be submitted to Congress and the Government Accountability Office (GAO), relating to the state of sustainable chemistry and current Federal funds dedicated to the promotion of sustainable chemistry.

CONGRESSIONALLY DIRECTED SPENDING

In compliance with paragraph 4(b) of rule XLIV of the Standing Rules of the Senate, the Committee provides that no provisions contained in the bill, as reported, meet the definition of congressionally directed spending items under the rule.

SECTION-BY-SECTION ANALYSIS

Section 1. Short title.

This section would provide that the bill may be cited as the "Sustainable Chemistry Research and Development Act of 2019".

Section 2. Findings.

This section would establish that Congress recognizes the importance of sustainable chemistry as a key component to business competitiveness, open market innovation, avoiding environmental harm, and improving the efficiency of the use of natural resources to meet human needs. This section also finds that GAO has found that the Federal Government could play a key role in helping sustainable chemistry reach its full potential domestically.

Section 3. National coordinating entity for sustainable chemistry.

This section would convene an interagency entity (the Entity) responsible for coordinating Federal programs and activities in support of sustainable chemistry for a period of 10 years after enactment under the National Science and Technology Council. The Entity would be co-chaired by the Office of Science and Technology Policy and a representative from the EPA, National Institute of Standards and Technology (NIST), and NSF. The Entity would include representatives from the EPA, NIST, NSF, Department of Energy, USDA, DOD, National Institute of Health, Centers for Disease Control and Prevention, Food and Drug Administration, and any other appropriate Federal agency.

Section 4. Strategic plan for sustainable chemistry.

This section would require the Entity to develop a framework of attributes characterizing sustainable chemistry and to assess the state of sustainable chemistry in the United States. It would also require the Entity to coordinate and support Federal research development of sustainable chemistry, identify ways in which agencies can facilitate incentives for development, and identify major scientific challenges and/or roadblocks to progress in sustainable chemistry. This section would also require the Entity to consult with stakeholders in business and industry, the scientific community, the defense community, State, Tribal, and local governments, nongovernmental organizations, and other organizations as appropriate. These actions by the Entity would be required no later than 2 years after enactment.

This section also would require the Entity to submit a report to Congress and GAO not later than 3 years after enactment with a summary of federally funded sustainable chemistry research, the financial resources allocated to sustainable chemistry initiatives, the current state of sustainable chemistry, an analysis of the entity's progress in achieving the goals designated by the legislation, recommendations for further program activities in support of sustainable chemistry, and an evaluation of efforts taken to date and future strategies to avoid duplication of efforts and spread best practices.

Section 5. Agency activities in support of sustainable chemistry.

This section would require agencies participating in the Entity to carry out activities in support of sustainable chemistry as appropriate to each agency's mission. This includes coordinating their efforts, promoting sustainable chemistry education and training, disseminating information on sustainable chemistry, expanding sustainable chemistry education and training, examining methods related to sustainable chemistry standards, developing metrics for sustainable chemistry programs, and public outreach. It would limit the use of Federal funds provided for under this section to pre-competitive activities and not for the promotion of a specific product or technology, or to disparage a specific process or technology.

Section 6. Partnerships in sustainable chemistry.

This section would allow the agencies participating in the Entity to facilitate and support the creation of partnerships between insti-

tutions of higher education, industry, and nongovernmental organizations to create collaborative sustainable chemistry research, development, demonstration, technology transfer, and commercialization programs, as well as provide professional development in fields related to sustainable chemistry. To be eligible for support, a partnership must include a private sector organization.

This section would limit the ways in which Federal funds could be used by partnerships to preclude expanding regulatory chemical management programs under State law, constructing or renovating any building or structure, or promoting the sale of a specific product or technology.

Section 7. Prioritization.

This section would require the Entity to focus its support for sustainable chemistry on activities that best achieve the goals outlined in the Act.

Section 8. Rule of construction.

This section states that nothing in the Act would be construed to alter or amend any State law relating to sustainable or green chemistry.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, the Committee states that the bill as reported would make no change to existing law.

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