U.S. DEPARTMENT OF ENERGY

Industrial Heat Shot™

U.S. Department of Energy
Industrial Heat Shot™
Frequently Asked Questions

U.S. Department of Energy
1000 Independence Avenue SW, Washington, D.C. 20585

Table of Contents

What is industrial heat? What is it used for?

- Industrial heating processes refer to the many methods by which heat transforms materials into useful products. Heat is pervasive in manufacturing—it is used to make everything from food to cement and steel.
- Just as we use heat in our homes in many ways—to dry clothes, boil water, grill food, etc.—manufacturers use heat to turn materials into useful products (though at a much larger scale and sometimes much higher temperatures!).
- For example, industrial heat is used to:
  - Dry a variety of materials, such as paper and batteries
  - Create steam to pasteurize food
  - Distill mixtures to separate and purify chemicals
  - Melt materials, such as plastics to semiconductors
  - Make metals in smelting operations, such as iron or copper
  - Make cement and specialty materials

Why do we need an Energy Earthshot™ for industrial heat?

- It's a big source of emissions in the United States. In 2020, the industrial sector accounted for 33% of the nation's primary energy use and 30% of energy-related carbon dioxide (CO_2) emissions. The industrial sector is uniquely difficult to decarbonize, due in part to the variety of energy sources powering its vast array of industrial processes and operations. Much of that energy demand is used for a wide range of thermal operations in manufacturing. Industrial heat accounts for about 9% of all domestic emissions in the United States.
- Achieving the Biden Administration's overarching goal of net-zero carbon emissions economy wide by 2050 will require a drastic reduction in the greenhouse gas (GHG) emissions generated through industrial heating. Through the Industrial Heat Shot™, the U.S. Department of Energy (DOE) has established a goal of developing cost-competitive industrial heat decarbonization technologies with **at least 85% lower greenhouse gas emissions by 2035**. This would entail reducing the current emissions intensity of industrial heat from an average of 65 kilograms of CO_2-equivalent per 1 million British thermal units (65 kg CO_2e/MMBtu) to 8.8 kg CO_2e/MMBtu.

How does DOE intend to achieve its goal?

- DOE has identified three technology pathways to reducing GHG emissions from industrial heating:

- Generate heat from clean electricity: By electrifying equipment and operations and using clean electricity with adequate energy storage, we can lower emissions and improve energy efficiency.
  - Examples of technologies in this field include resistive electric heaters, industrial heat pumps, microwave heating, and thermal storage.
- Integrate heat from low-emissions sources: By generating heat through methods other than the combustion of fossil fuels, we can facilitate the transition to low-emissions heat sources.
  - Examples of alternative low-emissions sources include solar thermal, nuclear, or geothermal energy, as well as burning clean hydrogen, and some sustainable fuels.
- Innovate low- or no-heat process technologies: By promoting the use of new chemistries and emerging biotechnologies, we can invent entirely new ways to make products while producing less GHG emissions. These approaches use little heat or entirely different mechanisms to transform materials.
  - Examples of innovation in this field include bio-based manufacturing, electrolysis, ultraviolet curing, and advanced separations.

How would an 85% reduction in GHG emissions from industrial heating affect the average American?

- The average American will benefit from cost-competitive, cleaner products for use in their daily lives.
- Communities located near existing manufacturing facilities will enjoy the health benefits of the transition away from burning fuels and the release of co-pollutants.
- American workers will benefit from the competitive advantage these innovations give U.S. manufacturers and the corresponding stability of manufacturing jobs and operations.
- The use of clean, localized, highly efficient energy sources will encourage manufacturing in new locations, enabling specialized, smaller-scale factories and expanding job opportunities.

How does this fit into DOE's wider industrial decarbonization efforts?

- The Industrial Heat Shot™ will support the overarching strategy detailed in DOE's "Industrial Decarbonization Roadmap." The Roadmap emphasizes the urgency of deep decarbonization across the industrial sector and presents a staged research, development, and demonstration (RD&D) agenda for industry and government that will deliver the technologies needed to dramatically reduce emissions, increase American manufacturing competitiveness, and create high-quality jobs. In addition to the Industrial

Heat Shot™, DOE will pursue other RD&D work, as outlined in the Roadmap, to achieve full industrial decarbonization.

- In June 2022, DOE issued a funding opportunity announcement of up to $70 million for the development and funding of a new manufacturing innovation institute that will conduct RD&D focused on developing and scaling electrified processes that reduce emissions, improve flexibility, and enhance energy efficiency of industrial heating processes.

How will DOE work to achieve the Industrial Heat Shot™ goals?

- Achieving the goals of the Industrial Heat Shot will require investment in an RD&D portfolio that spans the research spectrum—from fundamental research to applied technology development and demonstration.
- The following critical research areas are starting points for RD&D that will ultimately yield emissions reductions. The topics will be analyzed and assessed by DOE through continued engagement with external stakeholders as the initiative progresses.
  - Lower-cost, compatible equipment: Advanced designs and manufacturing, materials science
  - Improved system performance: Next-generation controls and AI optimization, materials science to improve efficiencies, process intensification, modeling and simulation
  - Demonstration of integrated energy systems: Integration of clean heat, electricity generation, and thermal storage in industrial facilities
  - Research for alternative low- and no-heat processes: Foundational biological, chemical, and physical research—including materials, catalysis, and process development
  - Understand co-benefits to emission reductions: Enhanced and expanded modeling & analysis for costs and equipment performance

How will new technologies developed through the Industrial Heat Shot™ become cost competitive?

- The Industrial Heat Shot™ aims to develop a portfolio of technologies that are cost-competitive with current industrial heat sources. Given the diversity of the American manufacturing sector, heating requirements and energy costs vary widely across different regions, industries, and business models. Additionally, cost structures differ across the three “pathways” that will guide DOE’s efforts (e.g., pricing reduced heat demand for low/no heat technologies, regulatory considerations for nuclear, etc.) and establishing a cost target to natural gas is not feasible due to its price volatility.
- The Industrial Heat Shot™ will invest in RD&D for emissions-reducing industrial technologies that meet or exceed operational demands, are cost-competitive and can be implemented at industrial scale. Investing in these technologies in the near term to make

them more cost-competitive with conventional technologies will set the stage for widespread deployment over the coming decades.

- The RD&D portfolio covered under the Industrial Heat Shot™ will include a range of technology readiness levels, heat characteristics (e.g., temperature), energy inputs, and industries. DOE will direct techno-economic analyses and carbon-impact studies to ensure that technologies funded through this initiative have a path to cost competitiveness, meet emissions targets, and address the heating demands of the manufacturing sector. As appropriate, costs will be analyzed on a per-unit-heat basis and/or a per-unit-product basis to reflect the potential benefits of innovative heat decarbonization technologies (e.g., improved productivity, reduced heat demand).
- Electricity and fuels are major contributors to the cost of industrial heating. Investments under the Industrial Heat Shot™ to reduce technology costs and improve energy efficiency will be complemented by efforts across DOE to reduce the cost of clean electricity and clean fuels, such as the Floating Offshore Wind Shot™ and the Enhanced Geothermal Shot™.

How does the Industrial Heat Shot™ improve energy security?

- The dominant source of heat for the manufacturing sector today is combustion of natural gas. As a result, American manufacturers are exposed to an energy market with significant volatility. According to the Energy Information Administration, the Henry Hub price of natural gas in August 2022 was more than double the price in August 2021 and nearly four times the price in August 2020.
- The Industrial Heat Shot™ will develop a diverse portfolio of technologies to lower GHG emissions from industrial heating processes, providing manufacturers with the flexibility to meet their needs while reducing their exposure to volatile energy markets. DOE will also use this initiative as an opportunity to collaborate more actively with international partners in this area.

Which DOE Offices will play a role in this initiative?

- The Advanced Manufacturing Office
  - RD&D in manufacturing processes, technologies, products, facilities, and supply chains through advancements in energy and materials efficiencies, innovation, and competitiveness.
- The Office of Nuclear Energy
  - RD&D activities to expand nuclear energy beyond supporting the electricity grid
  - Integrating nuclear energy systems with various industrial, transportation, and energy storage applications

- The Bioenergy Technologies Office
  - RD&D of processes using alternative feedstocks and low/no heat manufacturing options
- The Hydrogen Fuel Cell Technologies Office
  - RD&D of clean hydrogen technologies for low-carbon feedstocks and fuels
- The Solar Energy Technologies Office
  - RD&D in concentrated solar thermal and thermal storage technologies
- The Office of Science
  - RD&D in biological, chemical, and material research
  - Capabilities at the SC User Facilities
  - High-performance computing for manufacturing
- The Office of Fossil Energy and Carbon Management
  - RD&D on developing innovative solutions to convert captured carbon into products without the need for heat or using substantially less heat