



Electrifying U.S. Industry

There is a significant opportunity to decarbonize the industrial sector by shifting heat production away from carbon-intensive fossil fuels to clean sources such as electrification where low- or zero-carbon electricity is used.

Thermal energy needs in industry are a significant challenge for decarbonization efforts. Heat represents two-thirds of all energy demand in the industrial sector, and one-fifth of energy demand across the globe. However, only 10 percent of this demand is met using renewable energy. In the United States, fossil fuel combustion to produce heat and steam used for process heating, process reactions, and process evaporation, concentration, and drying creates about 52 percent of the country's industrial direct greenhouse gas (GHG) emissions.

Technical Assessment

The report's Technical Assessment provides an analysis of the current state of industrial electrification needs, the technologies available, and the potential for electrification in thirteen industrial subsectors. The subsectors included in this analysis are shown in the table below, along with the change in total final energy use and carbon dioxide emissions after electrification of certain processes in those industries. The total technical annual energy savings potential (with 100 percent adoption rate) in the thirteen subsectors studied is over 529 petajoules (PJ) per year in 2019, and 663 PJ per year in 2050. **This corresponds to annual CO₂ emissions reduction of over 134 million tonne (Mt) per year in 2050.** The report also analyzes a separate scenario for electrification of all conventional boilers in the U.S. industrial sector.

No.	Sectors	Change in total final energy use after electrification (TJ/Year)				Change in sector's net CO ₂ emissions after electrification in U.S. (kt CO ₂ /year)			
		2019	2030	2040	2050	2019	2030	2040	2050
1	Aluminum casting	-2,314	-2,546	-2,800	-3,080	17	-112	-195	-294
2	Paper (from virgin pulp)	-33,995	-32,295	-30,681	-29,147	26,970	9,997	2,075	-5,080
3	Recycled paper	-75,121	-82,634	-90,897	-99,987	4,239	-4,402	-9,827	-16,295
4	Container Glass	-5,745	-6,320	-6,952	-7,647	747	-1,240	-2,498	-3,996
5	Ammonia	-22,695	-24,965	-27,461	-30,207	21,868	-779	-14,516	-30,991
6	Methanol	75,688	86,310	96,933	106,228	11,896	5,046	883	-4,275
7	Recycled plastic	-257,955	-283,751	-312,126	-343,338	-19,743	-16,032	-14,508	-12,519
8	Steel (H ₂ DRI EAF)	-123,599	-136,527	-150,024	-154,712	-6,211	-24,022	-35,825	-46,668
9	Beer	-20,591	-22,132	-23,427	-24,660	-92	-669	-1,010	-1,381
10	Beet Sugar	-7,801	-8,385	-8,875	-9,342	662	-441	-1,076	-1,775
11	Milk powder	-3,657	-4,023	-4,425	-4,868	-104	-223	-304	-400
12	Wet corn milling	-20,305	-21,825	-23,102	-24,318	3,717	-1,095	-3,853	-6,892
13	Crude soybean oil	-31,732	-34,107	-36,102	-38,002	-46	-1,865	-2,934	-4,100
Total		-529,824	-573,199	-619,938	-663,079	43,919	-35,837	-83,590	-134,665

Electrification Technologies Considered

- ultra-violet (UV) heating
- microwave heating
- electric induction melting
- plasma melting
- electric boilers
- heat pumps
- electric arc furnaces
- induction heating
- electrolytic reduction
- radio-frequency heating
- electric infrared heaters



Electrifying U.S. Industry

The electrification technologies considered in this analysis may not be the only electrification option for each process and subsector. Other electrified heating technologies might be available and applicable, or may become available in the future. In addition, other processes within the subsectors studied might have electrification potential which is not considered in this study. **In summary, the energy savings and carbon dioxide reduction potentials shown in this study are only a portion of total savings potentials that can be achieved by full electrification of these industrial subsectors in the U.S.**

Barriers and Opportunities

The report reviews the major technical, economic, market, institutional, and policy barriers to scaled development and deployment of industrial electrification technologies as well as proposals that could help to overcome these barriers. Barriers and proposals fall into six main categories: technology; knowledge and education, including research needs; financing; costs; policy; and electric utility connection and reliability. This analysis of barriers and proposals was informed in part by a survey of industrial energy experts, offering insights into how important identified barriers are to decision making, and how effective proposals may be to overcome these barriers.

Action Plan

The report's Action Plan identifies key actions that industrial companies, governments, utilities, and suppliers of electrification technologies or equipment can take to accelerate the electrification of thermal energy in industry. Several **key recommendations** are listed below. Detailed recommendations are included in Chapter 8 of the report.



Industrial Sector

- i. **Initiate partnerships** with academia, national labs, think tanks, and other stakeholders to develop or scale electrification technologies.
- ii. Work with stakeholders to **educate** policymakers, utilities, and financial institutions about the benefits of electrification and what policy, regulatory, and financial support is required to electrify industrial processes.
- iii. **Provide training** for employees and contractors about electrified technologies. Government and utilities should support such training programs.



Government

- i. **Provide incentives** for electrification technology development and demonstration and use the capacity at the U.S. Department of Energy (DOE) national labs to advance electrification technologies for industry.
- ii. Work with utilities to **provide financial incentives** in the form of tax credits or grants for pilot projects and demonstration of emerging electrification technologies in industry.
- iii. **Adopt a variety of policies and programs** to support industrial electrification.



Utilities

- i. **Evaluate the demand response** (DR) potential that increased electrification in the industrial sector can provide to utilities and its financial implications.
- ii. **Provide information** about their electric rates, market structures, and grid upgrade implications of industrial electrification.
- iii. **Adopt electricity rate designs** that encourage electrification.

Learn more by reading the full report to the Renewable Thermal Collaborative, authored by David Gardiner and Associates along with Global Efficiency Intelligence: *Electrifying U.S. Industry: A Technology- and Process-Based Approach to Decarbonization*. The RTC focuses on renewable thermal solutions generally and is exploring various renewable thermal technology options through technology-specific reports, projects, and working groups. Visit our [website](#) to learn more about industrial electrification and other renewable thermal technology solutions.