

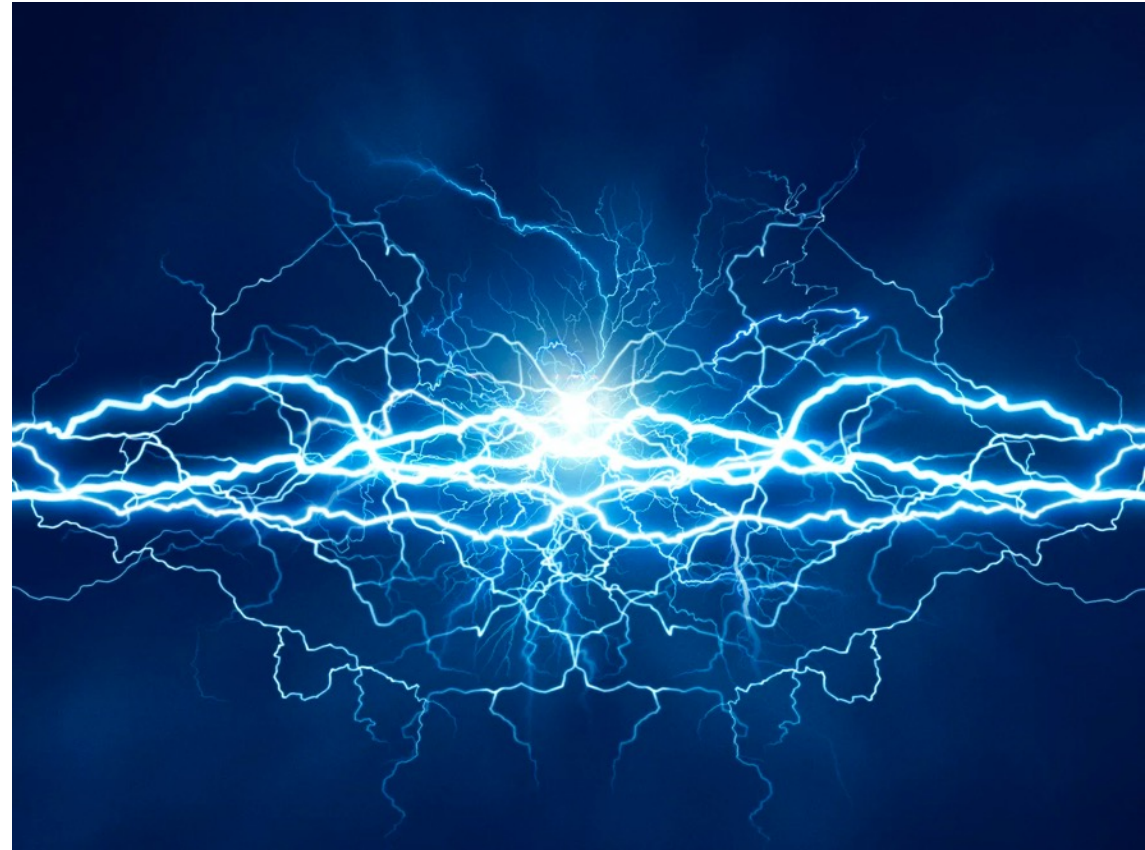
Electrifying U.S. Industry

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Electrifying U.S. Industry

Partners: Global Efficiency Intelligence and Renewable Thermal Collaborative

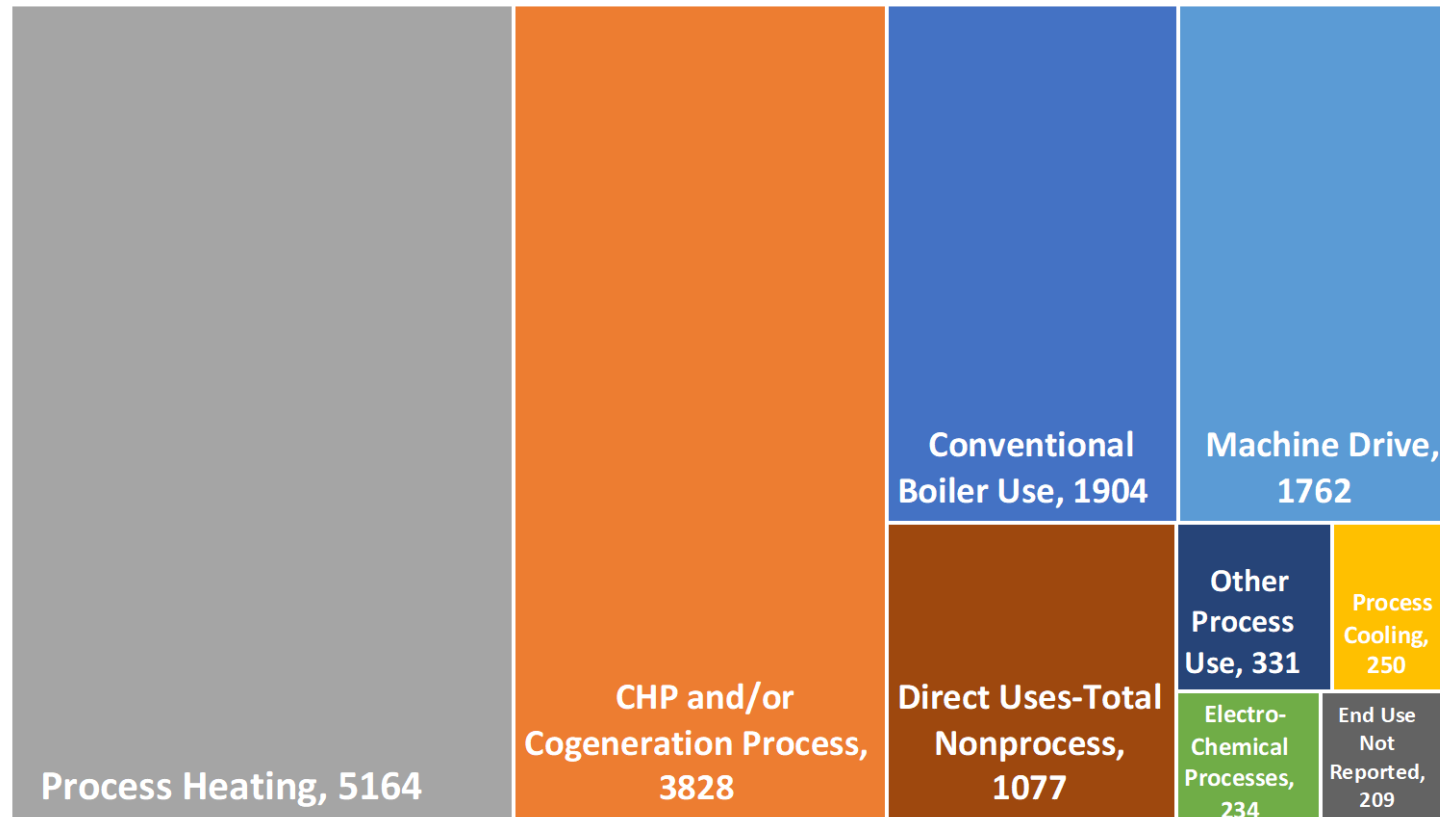
Supported by: Energy Foundation

Project Goal: Accelerate electrification in the industrial sector.

How:

- Conducted bottom up subsector, systems, and technology-level analysis for electrification of 13 subsectors
- Conducted survey of industrial plants regarding barriers and drivers for electrification
- Developed an Action Plan for scaling up electrification in industry.
- The RTC, GEI and RTC industrial partners will promote this Action Plan with key stakeholders, including:
 - Industrial companies
 - Electric utilities
 - Policy makers and regulators
 - Key opinion leaders

U.S. manufacturing energy use by end uses (Trillion Btu)



Industrial heat demand profile

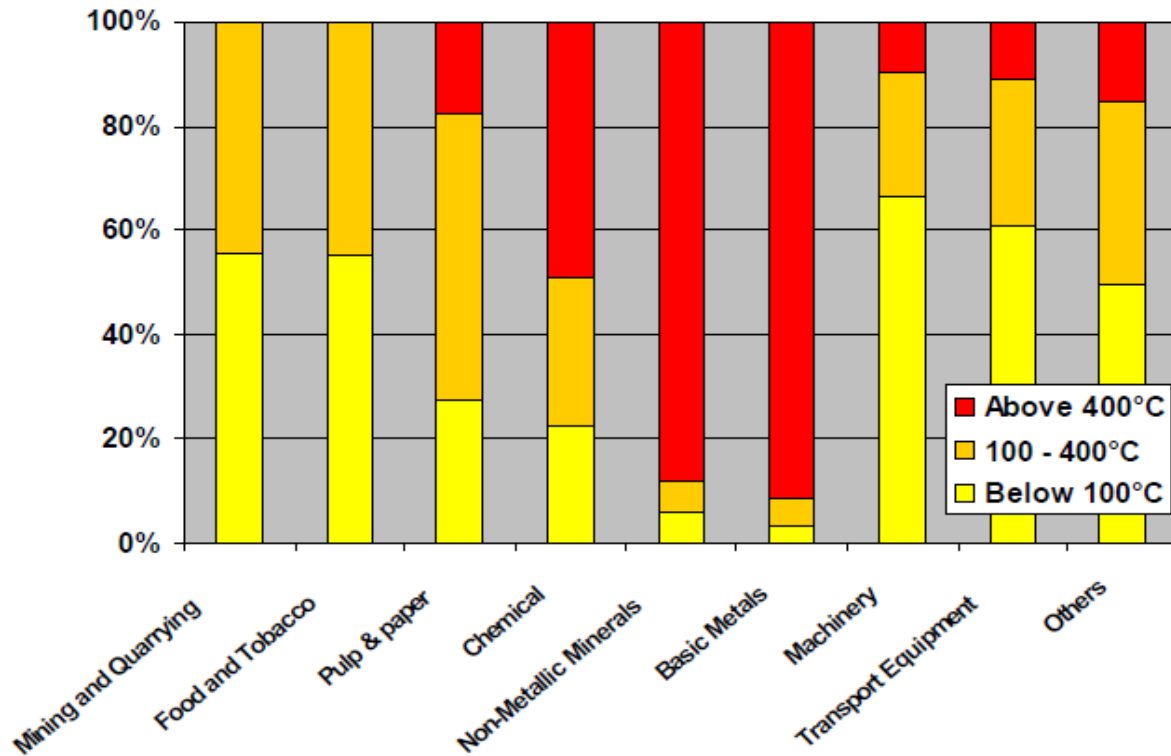


Figure a: Share of industrial head demand by temperature in selected industries

Two-thirds of process heat is used in the U.S. industry is for applications below 300°C (572°F)

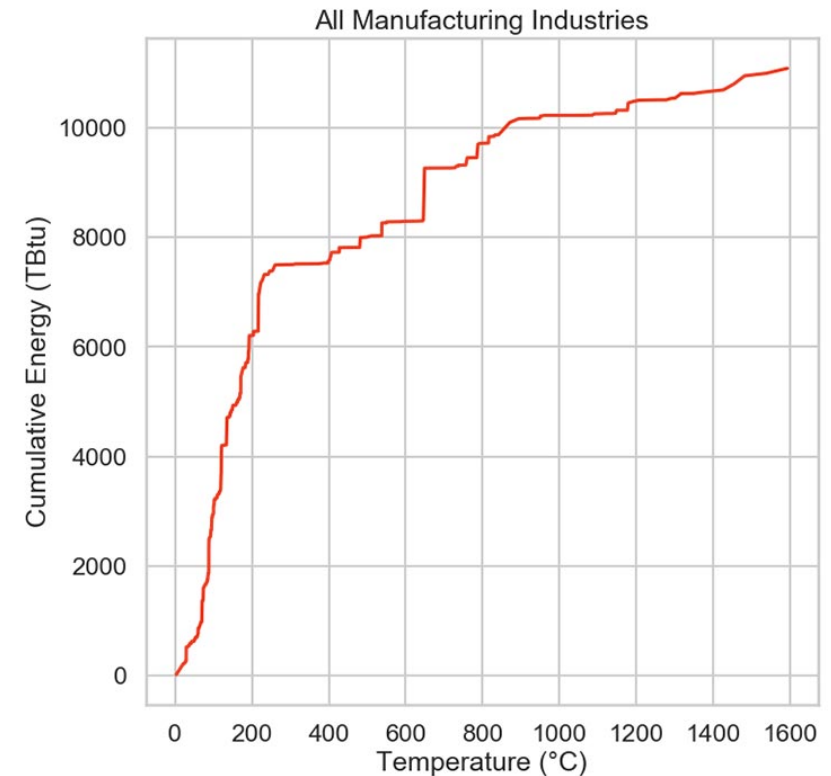


Figure b. Cumulative process heat demand by temperature in 2014

Bottom-up analysis method

Step1

- Detailed analysis of existing heating system

Step2

- Selection of suitable electrification technology

Step3

- Process integration assessment with new electrified heating technology

Step 4

- Calculation of changes in energy use and GHG emissions and cost implications

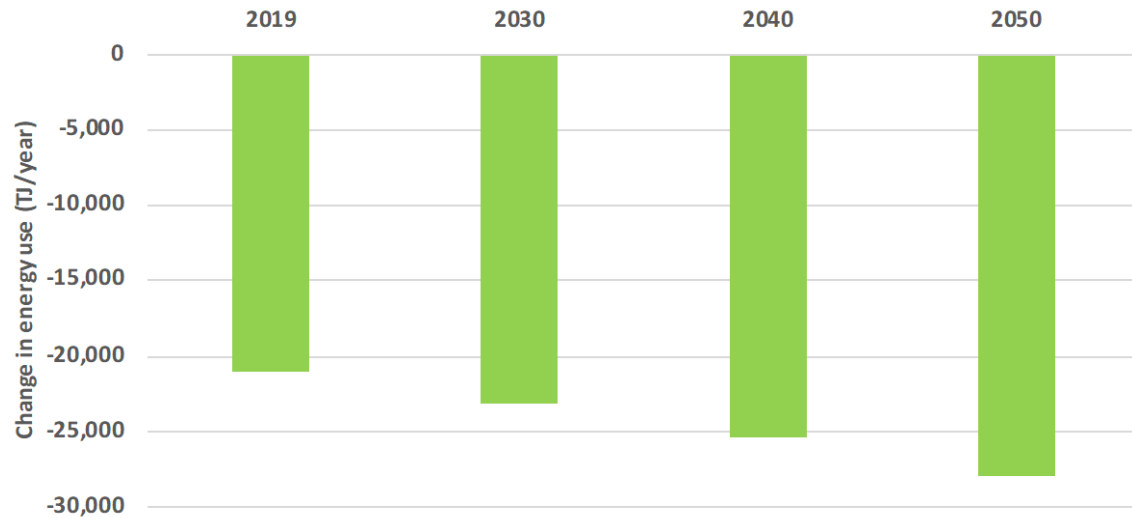
No.	Industry
1	Aluminum casting
2	Ammonia
3	Methanol
4	Recycled plastic
5	Paper (from virgin pulp)
6	Recycled paper
7	Container Glass
8	Steel
9	Beer
10	Beet Sugar
11	Milk powder
12	Wet corn milling
13	Soybean oil
	Electrification of all industrial boilers

Electrification of the Container Glass industry in the U.S.

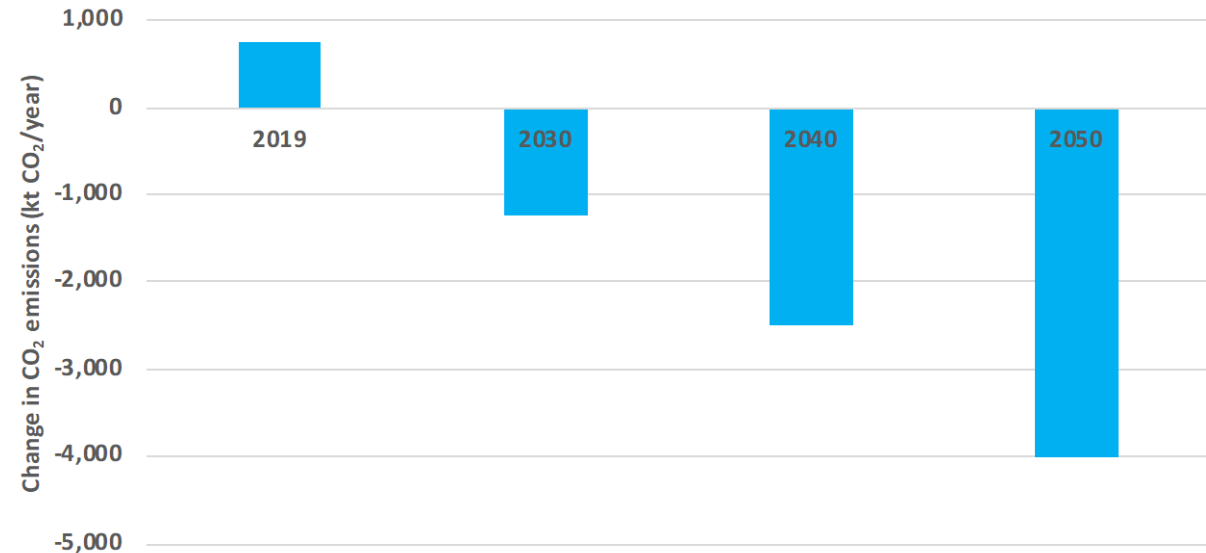
Conventional System Process				All Electric Process	
Heating Equipment	Electrical Demand (kWh/tonne)	Thermal Demand (kWh/tonne)	Process steps	Electrical Demand (kWh/tonne)	Heating Equipment
Electrically-powered mixer/crusher	161.0	0.0	Mixing	161.0	Electrically-powered mixer/crusher
Gas-fired furnace	204.0	1150.0	Melting	860.0	Electric glass melter
Forehearth and forming equipment	26.0	105.0	Conditioning & Forming	104.0	Electric forehearths
Gas-fired Annealing lehr	25.0	210.0	Post Forming(Annealing)	183.0	Electric Annealing lehr
	416.0	1465.0	Sum	1308.0	
	1881		Total Energy	1308	

Electrification of the Container Glass industry in the U.S.

Change in total final energy use after electrification in U.S.



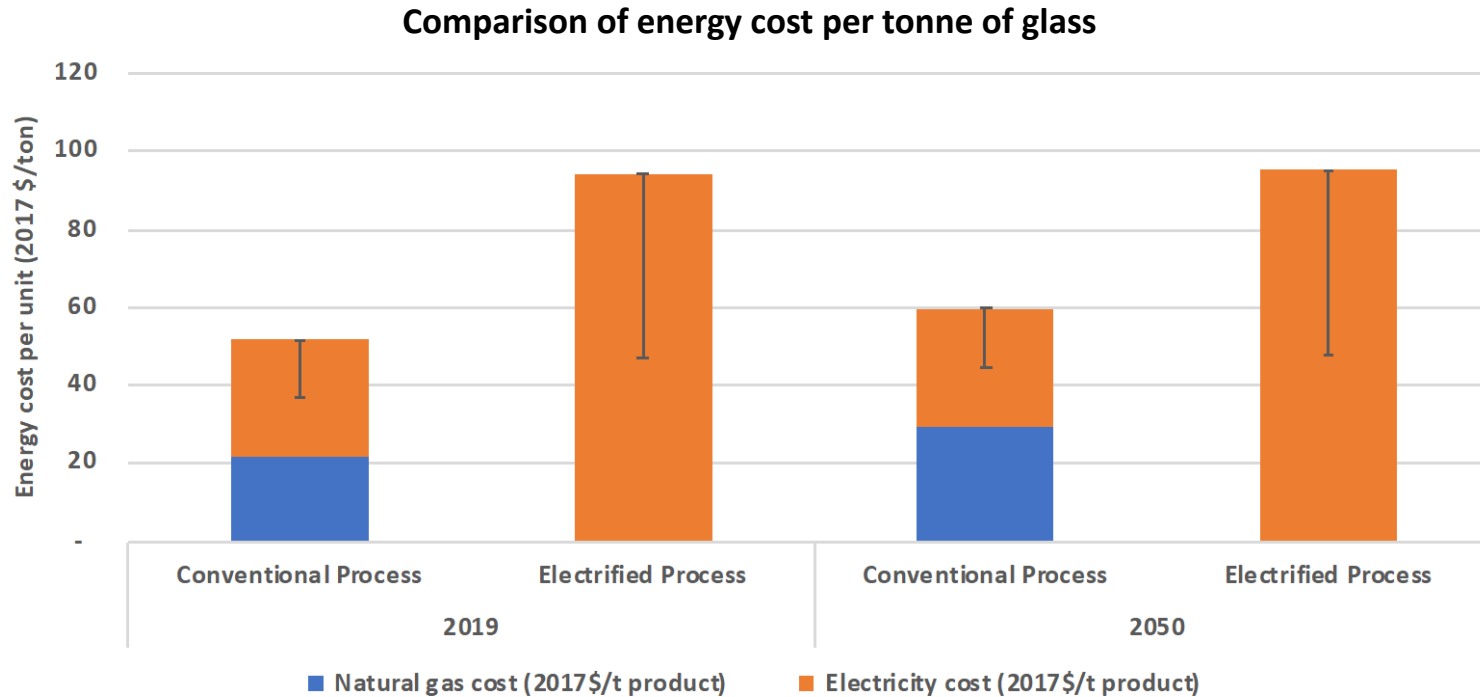
Change in net CO₂ emissions after electrification in U.S.



Note: This is the technical potential assuming 100% adoption rate in the U.S.

	2019	2030	2040	2050
Emission factor for grid electricity in US (kgCO ₂ /MWh)	414	207	103	0

Electrification of the Container Glass industry in the U.S.



Note: The error bars show the energy cost per unit of production when unit price of electricity is reduced by 50%.

	2019	2050
Average unit price of electricity for industry in U.S. (2017 US\$/kWh)	0.072	0.073
Average unit price of Coal for industry in U.S. (2017 US\$/kWh)	0.014	0.018
Average unit price of NG for industry in U.S. (2017 US\$/kWh)	0.015	0.020

Electrification of all industrial conventional boilers in the U.S.

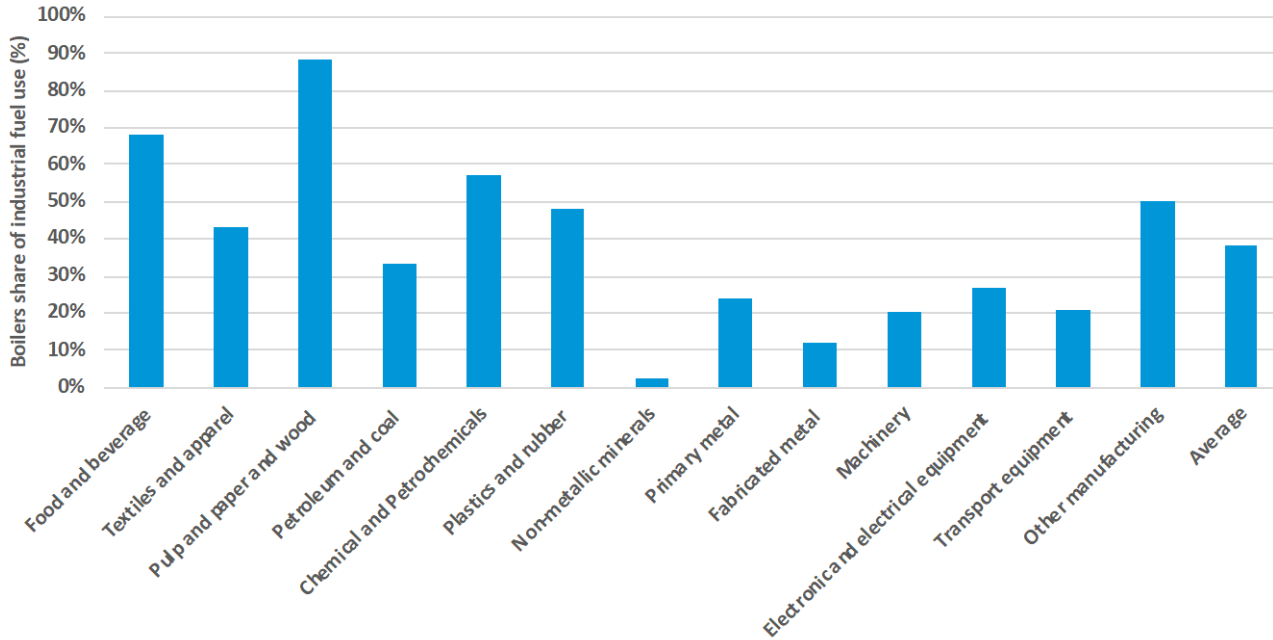


Figure A. Estimated share of boilers energy use as a percent of total fuel consumption in the U.S. industry (US DOE, 2017)

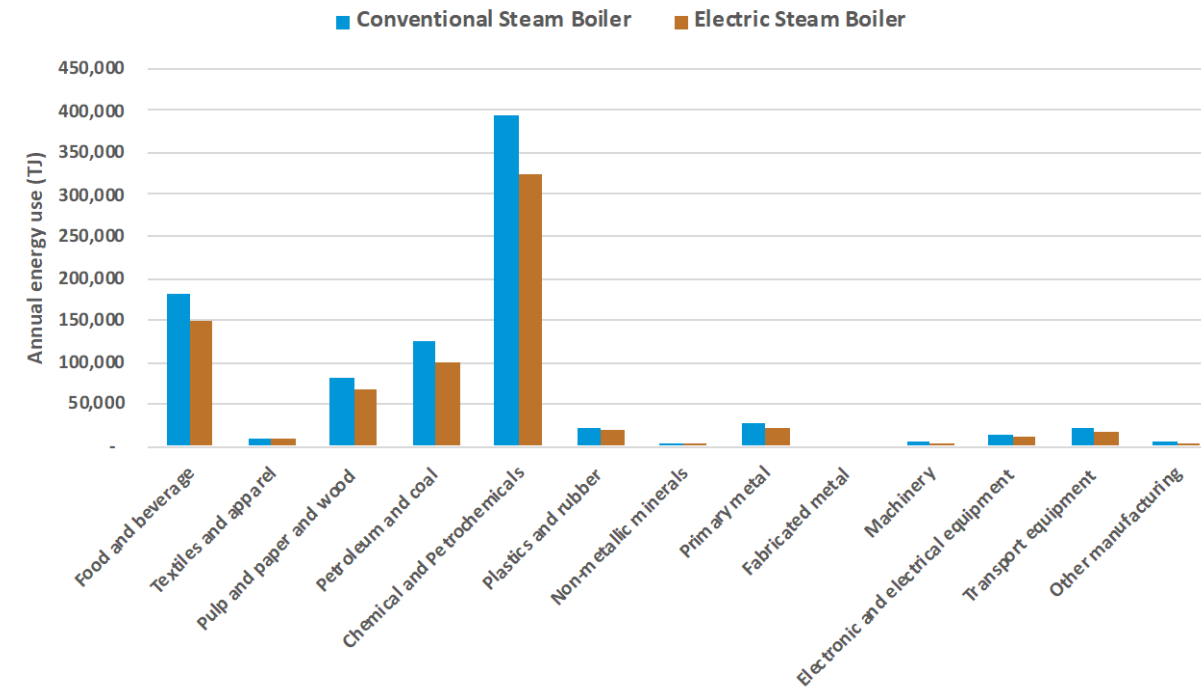
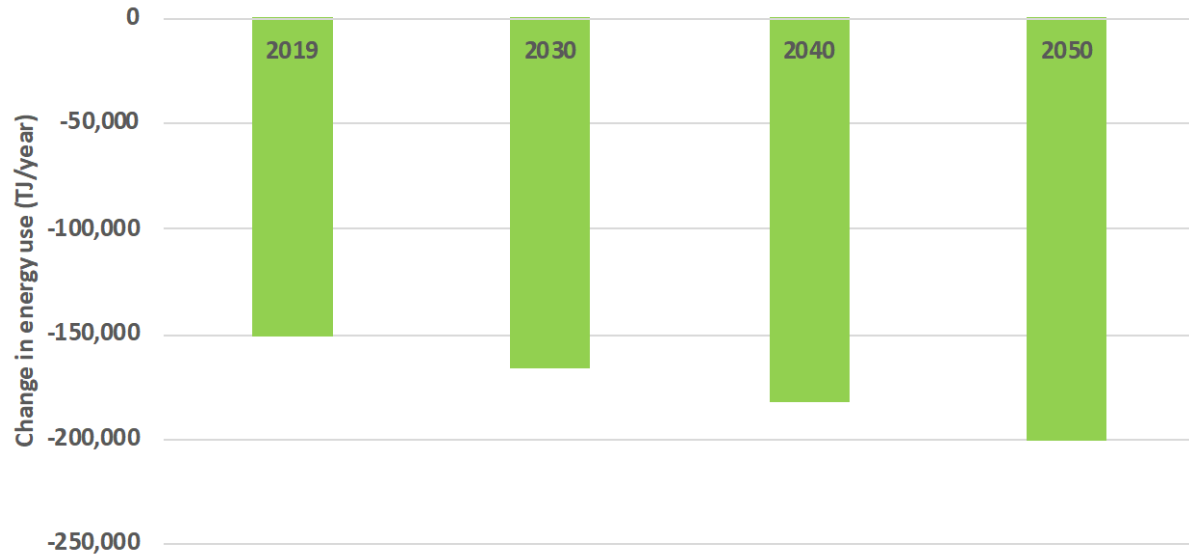


Figure B. Estimated final energy use in conventional and electric steam boilers in the U.S. industrial sectors

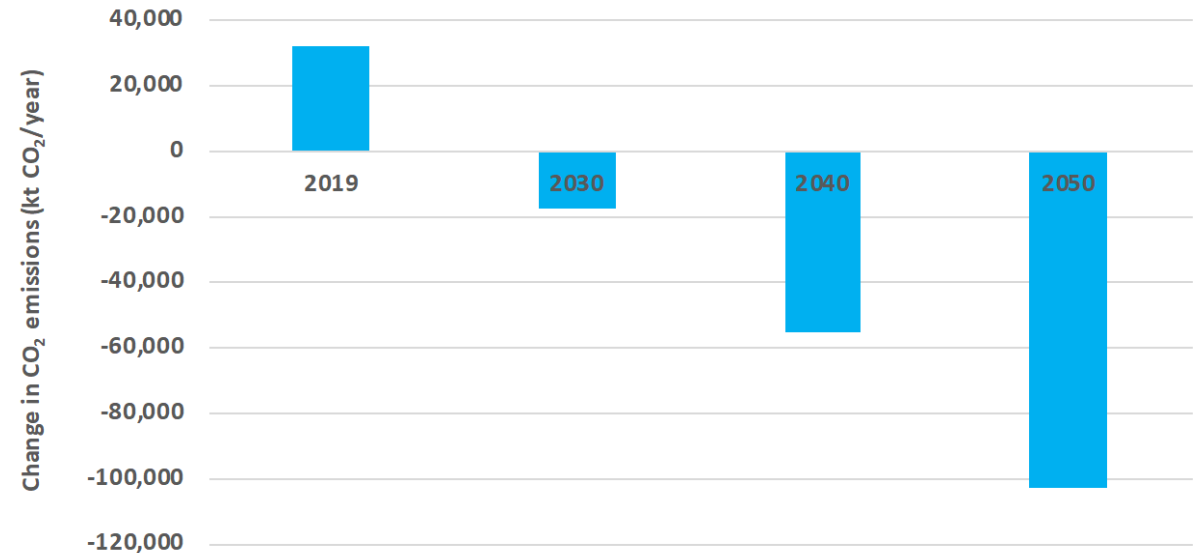
Electrification of all industrial conventional boilers in the U.S.

Change in total final energy use after electrification in U.S.



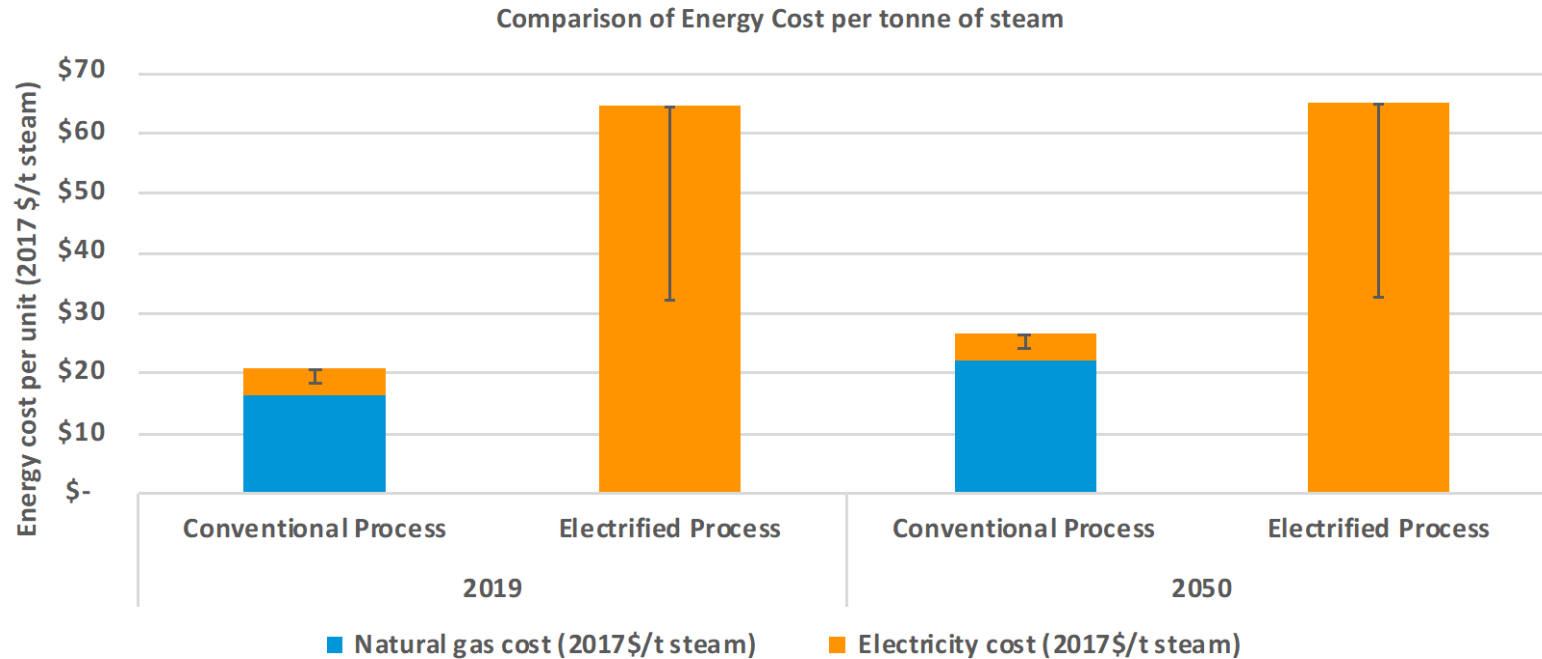
Note: This is the technical potential assuming 100% adoption rate in the U.S.

Change in net CO₂ emissions after electrification in U.S.



	2019	2030	2040	2050
Emission factor for grid electricity in US (kgCO ₂ /MWh)	414	207	103	0

Electrification of all industrial conventional boilers in the U.S.

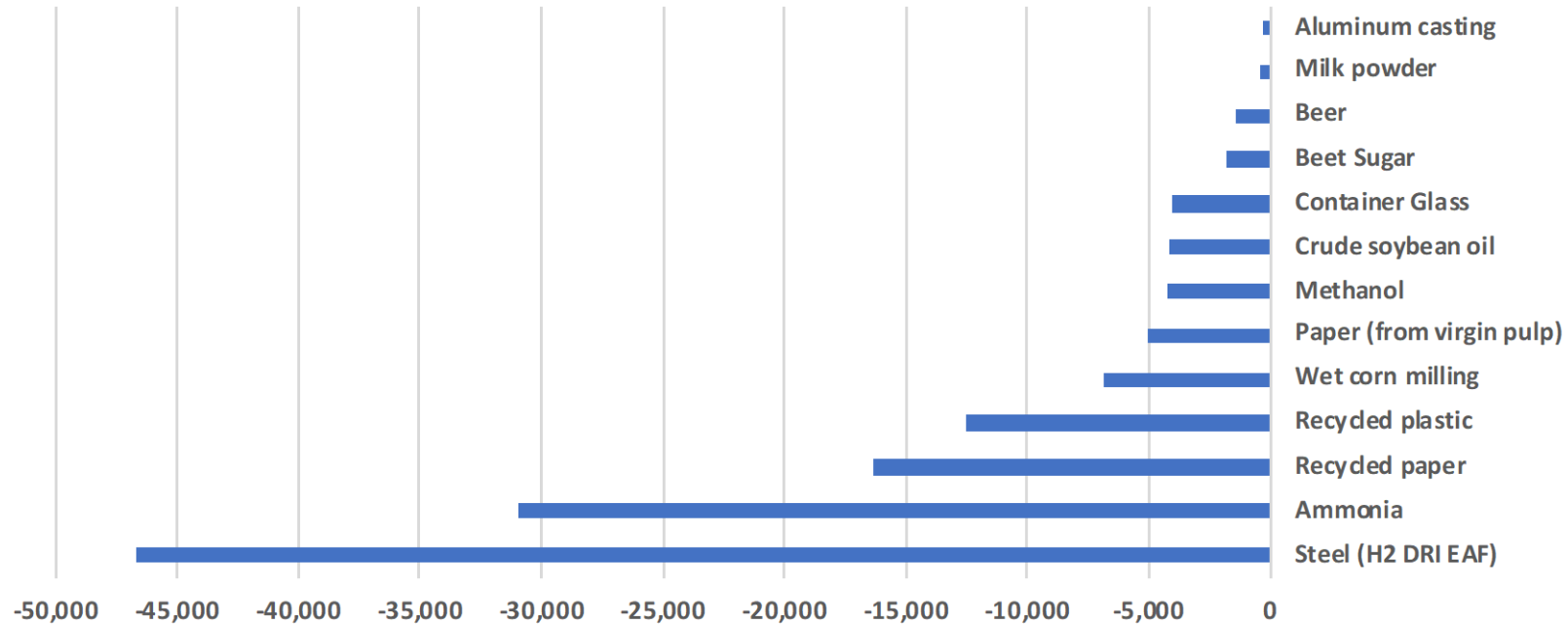


	2019	2050
Average unit price of electricity for industry in U.S. (2017 US\$/kWh)	0.072	0.073
Average unit price of NG for industry in U.S. (2017 US\$/kWh)	0.015	0.020

Results for all studied sectors in 2050



Change in sector's net CO₂ emissions after electrification in the U.S. in 2050 (kt CO₂/year)



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

Our report also covers

- Barriers and Opportunities for Industrial Electrification
- Technology Action Plan
 - Technology RD&D
 - Electrification Economics
 - Education
 - Policy Development
 - Workforce Development
 - Public-Private Partnerships

Thank You!

Download the report from our website: www.globalefficiencyintel.com

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