Arkansas
Industrial Electrification Potential

November 2023

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Arkansas **emitting facilities** (EPA GHGRP)

Arkansas reported stationary emissions

Sector	Number of Facilities	GHG Emissions tCO2e	% of Total Industry Emissions
Power Plants	18	31,969,541	--
Chemicals & Petrochemicals	11	2,160,141	24%
Metals	8	1,629,981	18%
Pulp and Paper	6	1,396,173	16%
Waste	20	1,374,319	15%
Minerals	5	1,295,569	15%
Other	20	895,626	10%
Petroleum & Nat. Gas Systems	7	159,616	2%

Source: EPA GHGRP 2023

Reported **industrial** stationary emissions

Arkansas emitting industrial units

Unit Type	Number of Units	Total CO2 Emissions tCO2
OCS - Other Combustion Source	82	2,931,318
Boiler	19	524,147
Process Heater	11	347,796
Pulp Mill Lime Kiln	7	160,131
Chemical Recovery Furnace	8	145,519
Stoker Boiler	3	95,202
Fluidized Bed	1	27,897
Simple cycle Combustion Turbine	2	12,653
Comfort Heater	4	3,504
Product Dryer	2	2,978
Incinerator	1	2,755
NG Line Heater	7	1,379
RICE - Reciprocating Engine	6	519
Furnace	1	1

Source: EPA GHGRP 2023

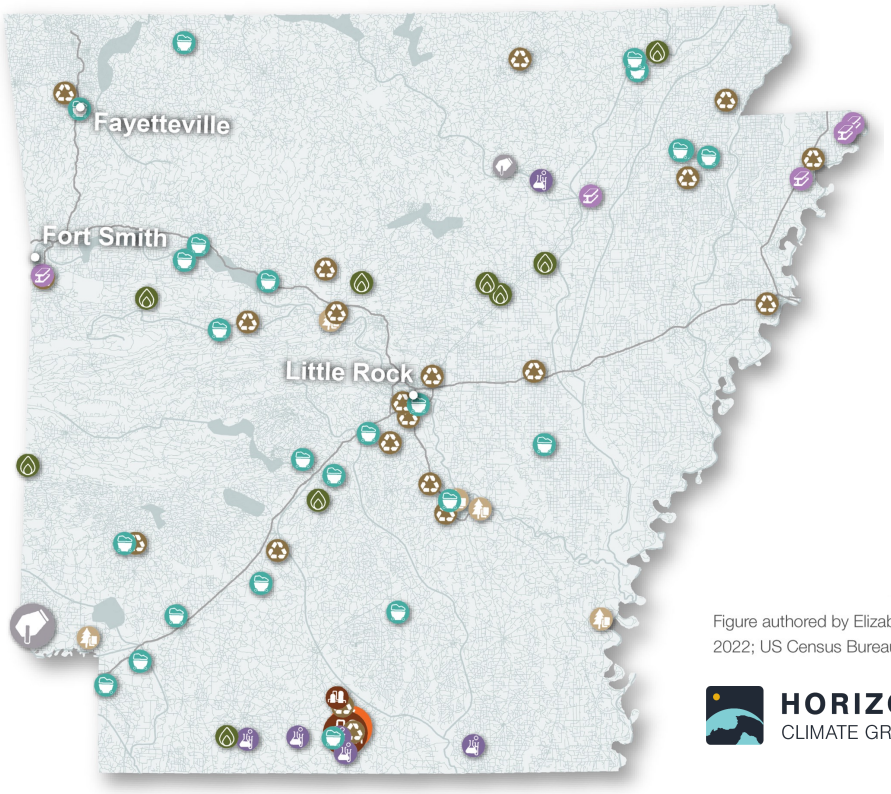

Figure authored by Elizabeth Abramson based on EPA GHGRP 2022; US Census Bureau 2020; FHWA 2020; USGS 2010.

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Industrial electrification for low-grade process heat

- Processes across numerous sectors use low temperature heat
  - less than 300°C
  - ~35% of industrial process heat demand may be less than 165°C (Rissman, 2022)
- Electrification is a feasible option for low-grade heat applications under 300 °C
- Emerging technologies may allow electric replacement of even higher temperature units

Temperature ranges for process heat

Industry	Process	Range [°C]
Food & beverage	Pasteurization	60 – 80
	Sterilization	60 – 120
	Concentration	60 – 80
	Cooking	60 – 100
	Blanching	75 – 90
	Drying	120 – 180
Textiles	Bleaching/dyeing	60 – 90
	Drying	100 – 130
	Fixing	160 – 180
	Pressing	80 – 100
Paper & wood products	Cooking/drying	60 – 80
	Bleaching	130 – 150
	Pulp preparation	120 – 170
Petroleum refining	Distillation	370 – 425
Chemicals	Steam reforming	500 – 900
	Drying, distillation	170 – 230
Plastics	Preparation	120 – 140
	Distillation	140 – 290
	Separation	200 – 220
	Extension	140 – 160
	Drying	180 – 200
	Blending	120 – 140
Non-metallic minerals	Preheating	200 – 750
	Calcination	750 – 1000
	Sintering	1,200 – 1,450
Primary metals	Precipitation	200 – 300
	Annealing	300 – 500
	Ore reduction	1,000 – 1,100

Source: Schoeneberger et al. (2020)

Electrification potential

- The electrification potential of industrial units depends on:
  - Temperature range required
  - Fuel type (on-site by-product fuel is free)
  - Maturity of electric heating technology for the unit type

Unit type	Electrification potential
Boilers	Good
Process heaters	Good
Hot water heaters	Good
Line heaters	Good
Comfort heaters	Good
Ovens	Good
Furnaces	Good

Unit type	Electrification potential
Chemical recovery furnaces	Poor to none
Incinerators	Poor to none
Kilns	Poor to none
Thermal oxidizer	Poor to none
Calciners	Poor to none
Turbines	Poor to none
Reciprocating internal combustion engines	Poor to none

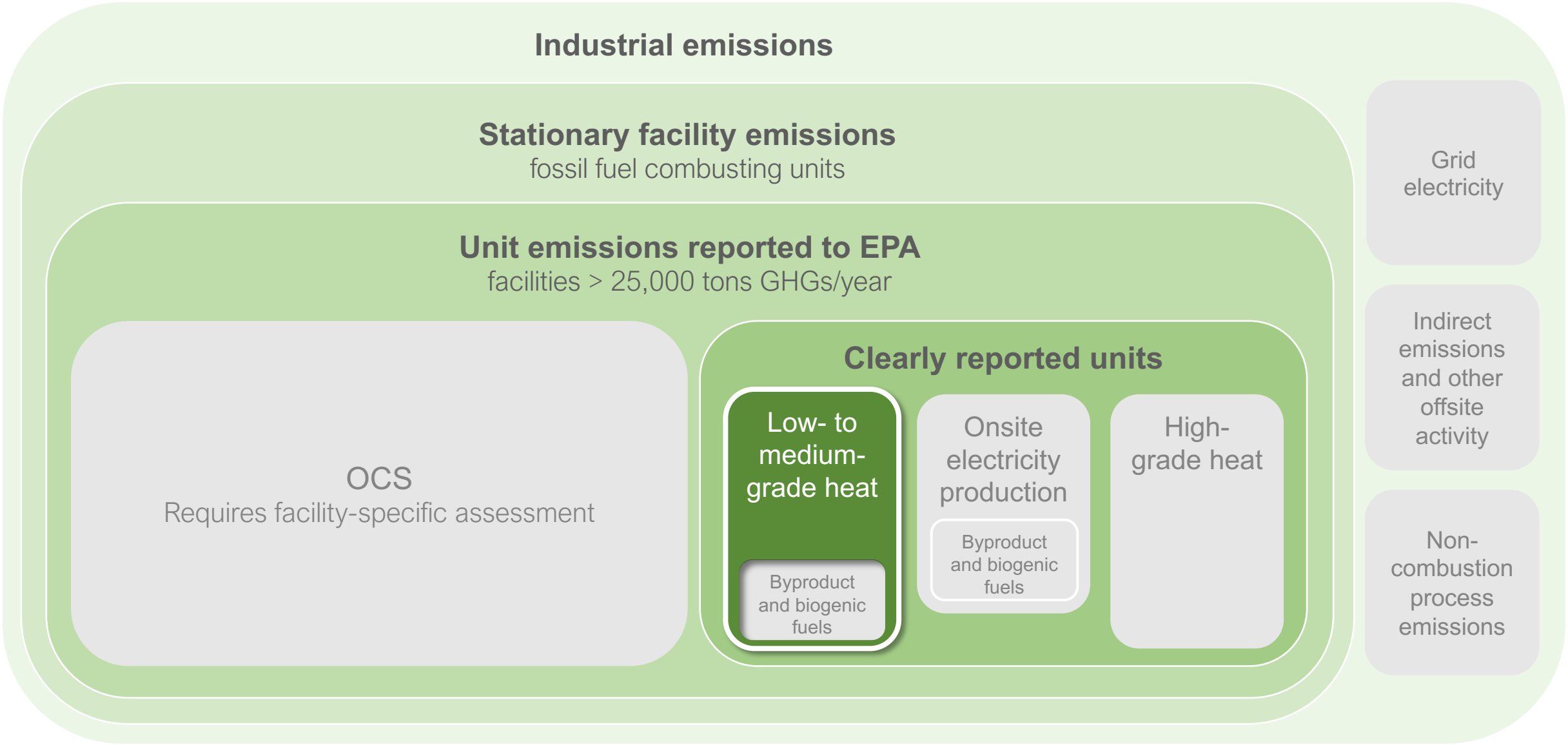
Electric options generally provide significant efficiency increases

Unit type	Typical efficiency	
	Fossil fuel	Electric option
Boiler	64 - 83%	99%
Process heater	75%	97%
Hot water heater	89 - 96%	99%
Line heater	89 - 96%	99%
Comfort heater	75%	99%
Oven	56 - 95%	99%
Furnace	52 - 65%	70 - 85%

- Improved efficiency (> 95%) can provide an immediate GHG benefit
- Overall GHG benefit depends on electric grid intensity
- Decarbonizing the electric grid, or using of on-site or purchased renewable electricity, can drastically reduce emission intensity

Source:

Focus on units with low- to medium-grade heat



Limitations and considerations

- This analysis represents **theoretical technical feasibility**: conversion of fossil energy to electric
- Investments in electric replacements could satisfy **regulatory requirements** and **decarbonization goals**, but would likely **need to meet financial criteria**
- **Investment cost** or project **break-even** would depend on **facility and unit configuration**, capacity factor and **performance requirements**
- Access to industrial wholesale rates and other utility programs would reduce energy costs compared to retail electric prices
- Local distribution and regional transmission **system planning** should **integrate expected load** from planned industrial electrification – most industrial sites have their own transformer substation
- Additional opportunities may exist in the ill-defined "**Other Combustion Source**" reporting category – OCS units are very numerous, though often small, or combined with other units

Arkansas industrial **electrification potential**

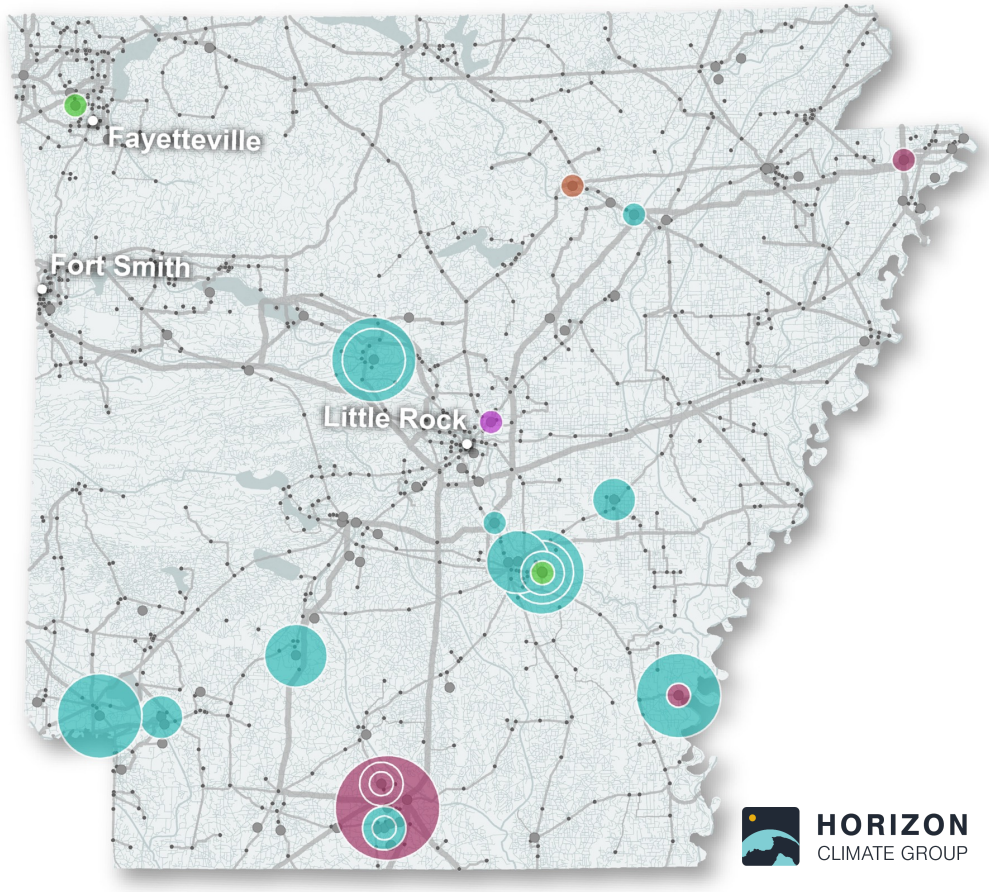
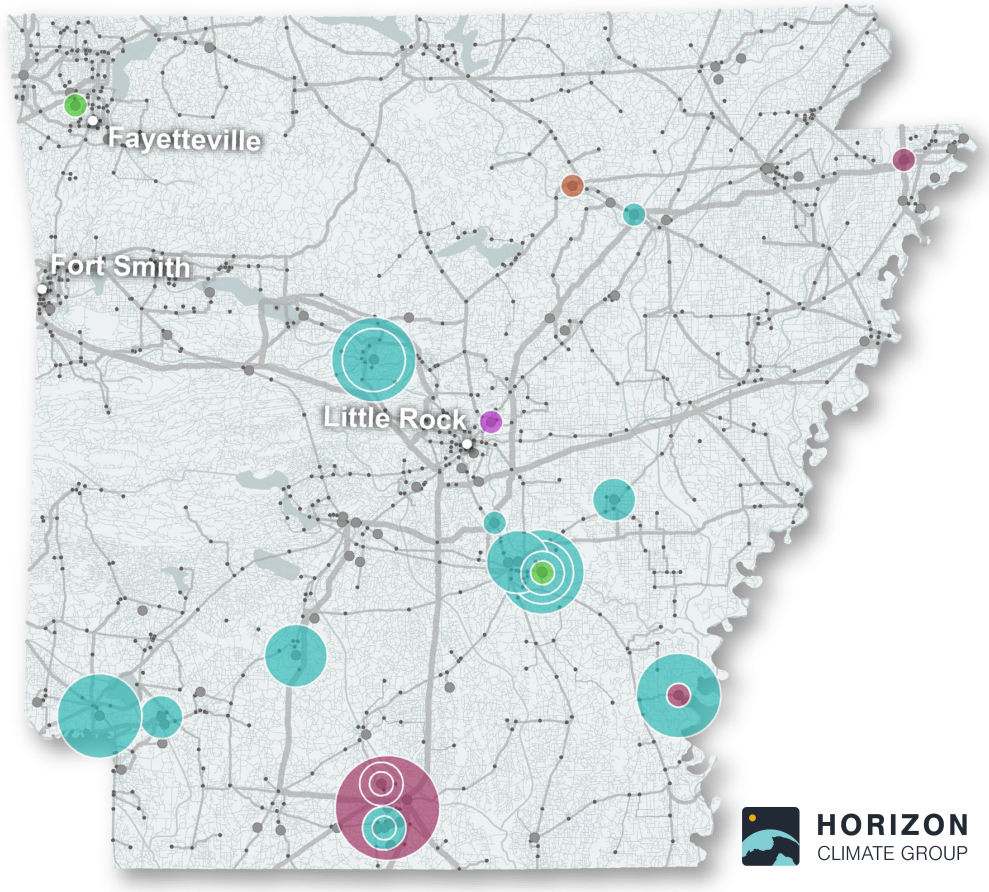


Figure authored by Elizabeth Abramson based on Jordan & McFarlane 2023; EPA GHGRP 2022; NREL 2018; US Census Bureau 2020; FHWA 2020; USGS 2010.

Unit Type	Number of Units	Emissions ktCO2e	Fossil Fuel Use billion Btu
Potentially Electrified	**46**	**2,129.4**	**64,734.9**
Boiler	14	1,109.5	13,650.2
Stoker Boiler	3	516.8	6,038.4
Process Heater	8	355.4	6,690.9
Product dryer	2	9.0	170.2
Comfort heater	4	3.5	66.5
NG Line Heater	6	0.4	6.6
Furnace	1	< 0.1	< 0.1
Unlikely to be Electrified	**13**	**199.1**	**3,757.8**
Pulp Mill Lime Kiln	7	159.7	3,006.2
Chemical Recovery Furnace	8	134.9	38,112.1
RICE - Reciprocating Engine	5	37.3	710.9
Incinerator	1	2.1	40.7
Unknown	**73**	**3,128.5**	**54,704.5**
OCS - Other Combustion Source	72	3,095.0	54,074.3
Fluidized Bed	1	33.5	630.2

Source: Horizon Climate Group 2023; EPA GHGRP 2022; NREL 2018.

Electric grid infrastructure and industrial electrification opportunities



Units sized by fuel use

- Boilers
- Comfort heaters
- Furnaces
- Line heaters
- Hot water heaters
- Ovens
- Process heaters
- Unit unlikely to electrify
- Electrical substation
- Electric transmission line
- Lake
- River
- Road

Figure authored by Elizabeth Abramson based on Jordan & McFarlane 2023; EPA GHGRP 2022; NREL 2018; US Census Bureau 2020; FHWA 2020; USGS 2010.

- OCS must be examined at the unit-level to identify electrification potential
- Access to industrial wholesale rates and other utility programs would reduce energy costs compared to retail electric prices
- Local distribution and regional transmission system planning should integrate expected load from planned industrial electrification – most industrial sites have their own transformer substation

Industrial Electrification Opportunities in Louisiana

Reducing fossil fuel use and greenhouse gas emissions with low-carbon electricity

Industrial sector operations in Louisiana

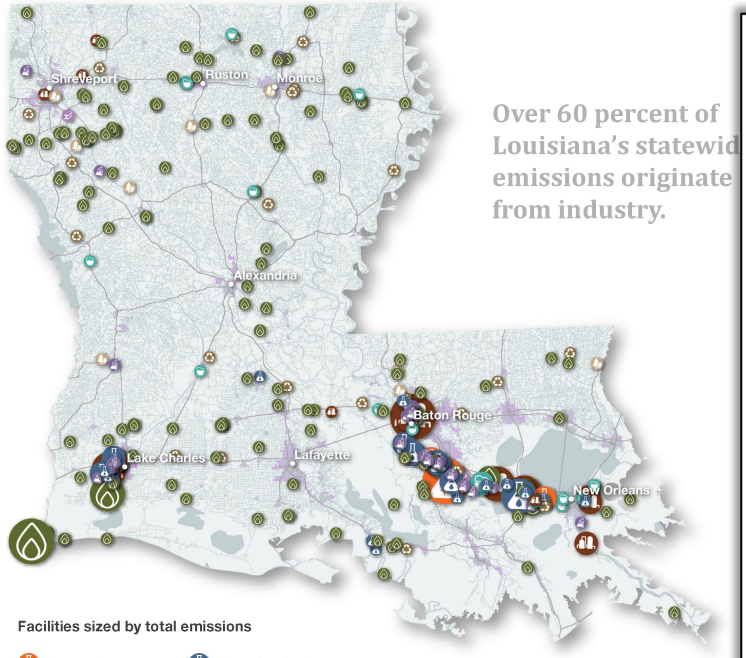


Figure authored by Elizabeth Abra based on EPA GHGRP 2022; US Bureau 2020; FHWA 2020; USGS

Over 60 percent of Louisiana's statewid emissions originate from industry.

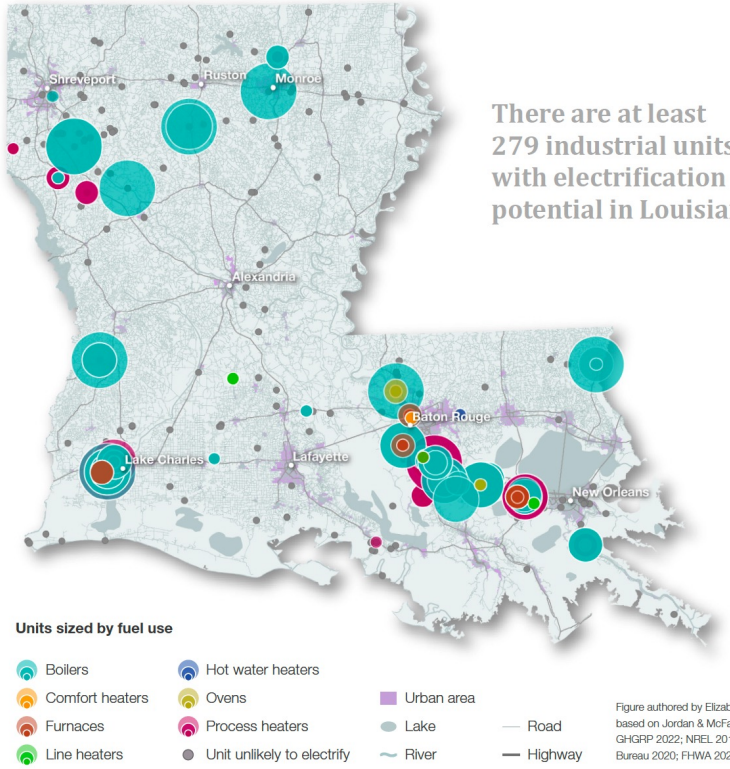
Louisiana's industrial sector accounts for 134 million metric tons CO_2 equivalent ($MtCO_2e$)

Electrification is a key opportunity for facilities that currently burn fossil fuels in equipment

Industrial Electrification Opportunities in Louisiana

Reducing fossil fuel use and greenhouse gas emissions with low-carbon electricity

Potentially electrified industrial equipment



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There are at least 279 industrial units with electrification potential in Louisiana.

Fossil fuel-based industrial equipment that delivers low- to medium-grade heat to manufacturing and other processes have good electrification potential due to the existence of efficient electricity-based alternatives that can provide similar levels of heat. These electric alternatives may provide GHG reductions through increased energy efficiency, and can produce even greater reductions when powered by low-carbon sources of electricity.

About 225 trillion Btu of fossil fuels were combusted in Louisiana in 2021 across seven unit types with identified electrification potential, resulting in emissions of about 14 $MtCO_2e$.[5] Industrial units that are unlikely to electrify were responsible for about 349 trillion Btu of fossil fuel combustion, emitting roughly 16 $MtCO_2e$. More detailed reporting would be required to characterize additional electrification opportunities among the more than 700 trillion Btu consumed by units classified as 'other combustion source.'

Unit-level fuel use and emissions by opportunity tier

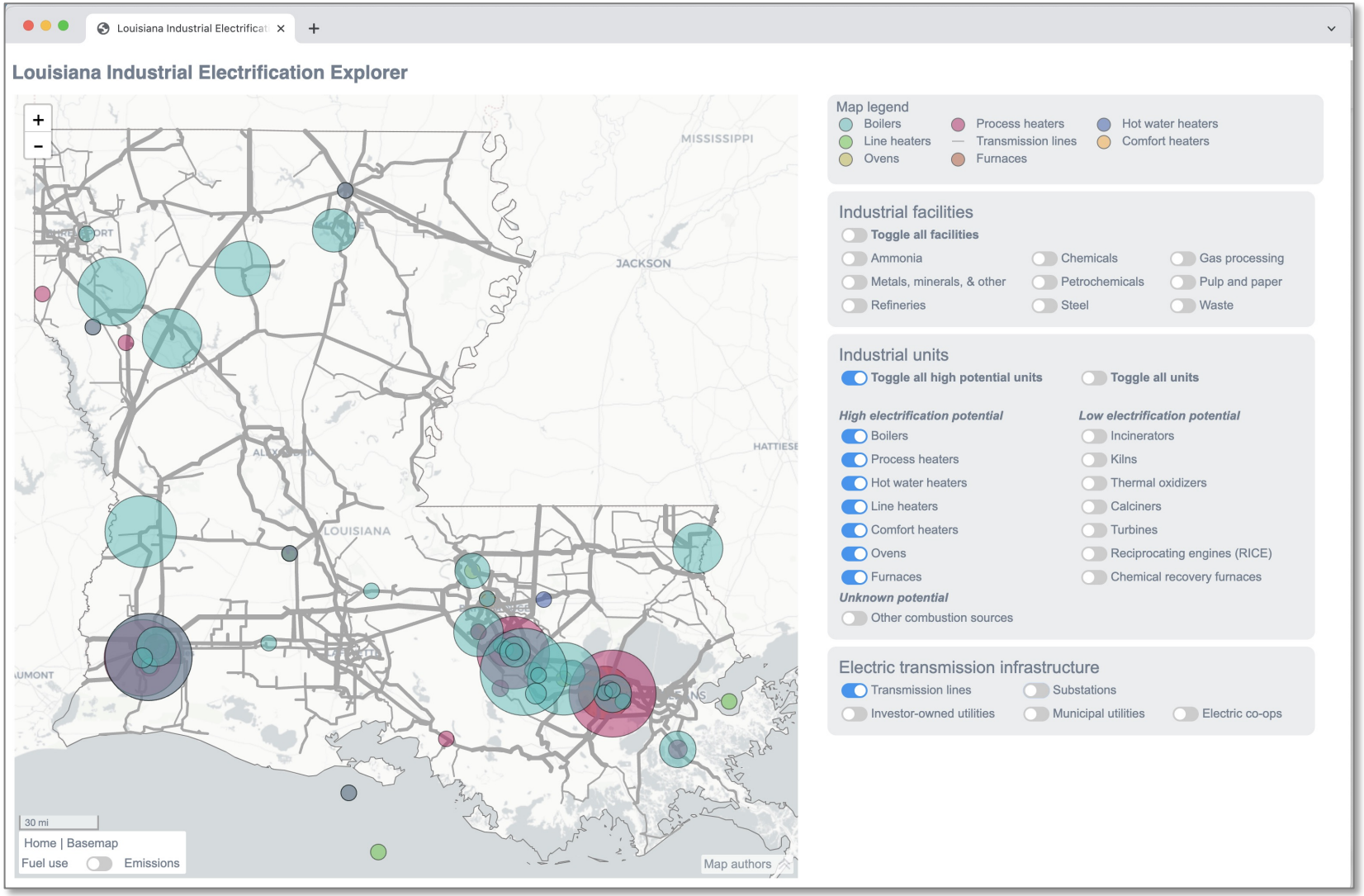
Unit type	Total # of units	Fossil fuel use Trillion Btu	Emissions $MtCO_2e$
Potentially electrified	**279**	**225.1**	**14.2**
Boilers	106	135.7	8.5
Process heaters	106	76.9	4.5
Ovens	8	1.1	0.1
Line heaters	19	0.4	< 0.1
Hot water heaters	2	< 0.1	< 0.1
Furnaces	35	11.0	1.1
Comfort heaters	3	0.0	0.0
Unlikely to be electrified	**452**	**349.3**	**16.2**
Turbines	131	253.5	13.7
Chemical recovery furnaces	11	60.1	0.2
Kilns	24	18.6	1.3
RICE	218	7.6	0.4
Thermal oxidizer	49	5.0	0.3
Calciners	2	2.8	0.3
Incinerators	17	1.7	0.1
Other combustion source	**467**	**707.6**	**39.5**
Total	**1,198**	**1,282.1**	**69.9**

Source: Jordan & McFarlane 2023; EPA GHGRP 2022; NREL 2018.

Louisiana Fact sheet July 2023

Web map – Louisiana July 2023

- View all facilities and high level GHGRP data
- Switch to satellite imagery for actual facility view
- Select sector and unit
- View electric utility territories and grid infrastructure



https://scripts.betterenergy.org/Louisiana/LouisianaIndustrialElectrification.html

Thank you!

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