ABOUT NARUC

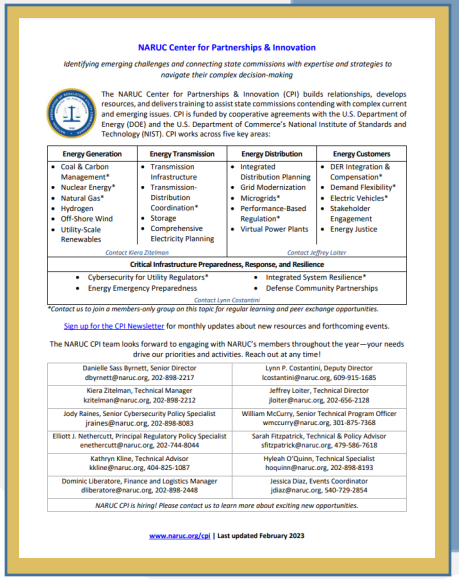
- The National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization founded in 1889.
- Our Members are the state utility regulatory Commissioners in all 50 states & the territories. FERC & FCC Commissioners are also members. NARUC has Associate Members in over 20 other countries.
- NARUC member agencies regulate electricity, natural gas, telecommunications, and water utilities.

THE NARUC CENTER FOR PARTNERSHIPS & INNOVATION

Background & Focus

- NARUC staff dedicated to providing technical assistance to members.
- CPI identifies emerging challenges and connects state commissions with expertise and strategies to inform their decision making.
- CPI builds relationships, develops resources, and delivers trainings.
- All CPI support is federally funded via cooperative agreements with DOE and NIST.

Newly updated CPI fact sheet with recent publications, upcoming events, new member working groups located under Quick Links at: www.naruc.org/cpi



NARUC Center for Partnerships & Innovation

Identifying emerging challenges and connecting state commissions with expertise and strategies to navigate their complex decision-making

The NARUC Center for Partnerships & Innovation (CPI) builds relationships, develops resources, and delivers training to assist state commissions contending with complex current and emerging issues. CPI is funded by cooperative agreements with the U.S. Department of Energy (DOE) and the U.S. Department of Commerce's National Institute of Standards and Technology (NIST). CPI works across five key areas:

Energy Generation	Energy Transmission	Energy Distribution	Energy Customers
• Coal & Carbon Management* • Nuclear Energy* • Natural Gas* • Hydrogen • Off-Shore Wind • Utility-Scale Renewables	• Transmission Infrastructure • Transmission-Distribution Coordination* • Storage • Comprehensive Electricity Planning	• Integrated Distribution Planning • Grid Modernization • Microgrids* • Performance-Based Regulation* • Virtual Power Plants	• DER Integration & Compensation* • Demand Flexibility* • Electric Vehicles* • Stakeholder Engagement • Energy Justice
Contact Kiera Zitelman		*Contact Jeffrey Loiter*	
Critical Infrastructure Preparedness, Response, and Resilience			
• Cybersecurity for Utility Regulators* • Energy Emergency Preparedness		• Integrated System Resilience* • Defense Community Partnerships	
Contact Lynn Costantini			

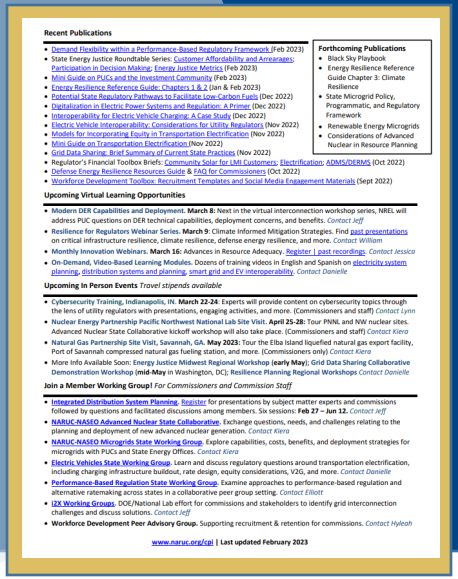
**Contact us to join a members-only group on this topic for regular learning and peer exchange opportunities.*

Sign up for the CPI Newsletter for monthly updates about new resources and forthcoming events.

The NARUC CPI team looks forward to engaging with NARUC's members throughout the year—your needs drive our priorities and activities. Reach out at any time!

Danielle Sass Byrnett, Senior Director dbyrnett@naruc.org, 202-898-2217	Lynn P. Costantini, Deputy Director lcostantini@naruc.org, 609-915-1685
Kiera Zitelman, Technical Manager kzitelman@naruc.org, 202-898-2212	Jeffrey Loiter, Technical Director jloiter@naruc.org, 202-656-2128
Jody Raines, Senior Cybersecurity Policy Specialist jraines@naruc.org, 202-898-8083	William McCurry, Senior Technical Program Officer wmccurry@naruc.org, 301-875-7368
Elliott J. Nethercutt, Principal Regulatory Policy Specialist enethercutt@naruc.org, 202-744-8044	Sarah Fitzpatrick, Technical & Policy Advisor sfitzpatrick@naruc.org, 479-586-7618
Kathryn Kline, Technical Advisor kkline@naruc.org, 404-825-1087	Hyleah O'Quinn, Technical Specialist hoquinn@naruc.org, 202-898-8193
Dominic Liberatore, Finance and Logistics Manager dliberatore@naruc.org, 202-898-2448	Jessica Diaz, Events Coordinator jdiaz@naruc.org, 540-729-2854
NARUC CPI is hiring! Please contact us to learn more about exciting new opportunities.	

www.naruc.org/cpi | Last updated February 2023



Recent Publications

- Demand Flexibility within a Performance-Based Regulatory Framework (Feb 2023)
- State Energy Justice Roundtable Series: Customer Affordability and Arrearages; Participation in Decision Making; Energy Justice Metrics (Feb 2023)
- Mini Guide on PUCs and the Investment Community (Feb 2023)
- Energy Resilience Reference Guide: Chapters 1 & 2 (Jan & Feb 2023)
- Potential State Regulatory Pathways to Facilitate Low-Carbon Fuels (Dec 2022)
- Digitalization in Electric Power Systems and Regulation: A Primer (Dec 2022)
- Interoperability for Electric Vehicle Charging: A Case Study (Dec 2022)
- Electric Vehicle Interoperability: Considerations for Utility Regulators (Nov 2022)
- Models for Incorporating Equity in Transportation Electrification (Nov 2022)
- Mini Guide on Transportation Electrification (Nov 2022)
- Grid Data Sharing: Brief Summary of Current State Practices (Nov 2022)
- Regulator's Financial Toolbox Briefs: Community Solar for LMI Customers; Electrification; ADMS/DERMS (Oct 2022)
- Defense Energy Resilience Resources Guide & FAQ for Commissioners (Oct 2022)
- Workforce Development Toolbox: Recruitment Templates and Social Media Engagement Materials (Sept 2022)

Forthcoming Publications

- Black Sky Playbook
- Energy Resilience Reference Guide Chapter 3: Climate Resilience
- State Microgrid Policy, Programmatic, and Regulatory Framework
- Renewable Energy Microgrids
- Considerations of Advanced Nuclear in Resource Planning

Upcoming Virtual Learning Opportunities

- **Modern DER Capabilities and Deployment. March 8:** Next in the virtual interconnection workshop series, NREL will address PUC questions on DER technical capabilities, deployment concerns, and benefits. *Contact Jeff*
- **Resilience for Regulators Webinar Series. March 9:** Climate Informed Mitigation Strategies. Find past presentations on critical infrastructure resilience, climate resilience, defense energy resilience, and more. *Contact William*
- **Monthly Innovation Webinars. March 16:** Advances in Resource Adequacy. Register | past recordings. *Contact Jessica*
- **On-Demand, Video-Based Learning Modules.** Dozens of training videos in English and Spanish on electricity system planning, distribution systems and planning, smart grid and EV interoperability. *Contact Danielle*

Upcoming In Person Events *Travel stipends available*

- **Cybersecurity Training, Indianapolis, IN. March 22-24:** Experts will provide content on cybersecurity topics through the lens of utility regulators with presentations, engaging activities, and more. (Commissioners and staff) *Contact Lynn*
- **Nuclear Energy Partnership Pacific Northwest National Lab Site Visit. April 25-28:** Tour PNNL and NW nuclear sites. Advanced Nuclear State Collaborative kickoff workshop will also take place. (Commissioners and staff) *Contact Kiera*
- **Natural Gas Partnership Site Visit, Savannah, GA. May 2023:** Tour the Elba Island liquefied natural gas export facility, Port of Savannah compressed natural gas fueling station, and more. (Commissioners only) *Contact Kiera*
- More Info Available Soon: **Energy Justice Midwest Regional Workshop (early May); Grid Data Sharing Collaborative Demonstration Workshop (mid-May** in Washington, DC); **Resilience Planning Regional Workshops** *Contact Danielle*

Join a Member Working Group! *For Commissioners and Commission Staff*

- **Integrated Distribution System Planning.** Register for presentations by subject matter experts and commissions followed by questions and facilitated discussions among members. Six sessions: **Feb 27 – Jun 12.** *Contact Jeff*
- **NARUC-NASEO Advanced Nuclear State Collaborative.** Exchange questions, needs, and challenges relating to the planning and deployment of new advanced nuclear generation. *Contact Kiera*
- **NARUC-NASEO Microgrids State Working Group.** Explore capabilities, costs, benefits, and deployment strategies for microgrids with PUCs and State Energy Offices. *Contact Kiera*
- **Electric Vehicles State Working Group.** Learn and discuss regulatory questions around transportation electrification, including charging infrastructure buildout, rate design, equity considerations, V2G, and more. *Contact Danielle*
- **Performance-Based Regulation State Working Group.** Examine approaches to performance-based regulation and alternative ratemaking across states in a collaborative peer group setting. *Contact Elliott*
- **12X Working Groups.** DOE/National Lab effort for commissions and stakeholders to identify grid interconnection challenges and discuss solutions. *Contact Jeff*
- **Workforce Development Peer Advisory Group.** Supporting recruitment & retention for commissions. *Contact Hyleah*

www.naruc.org/cpi | Last updated February 2023

MODERATOR

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RENEWABLE THERMAL COLLABORATIVE

Industrial Electrification in U.S. States

Renewable Thermal Collaborative

May 25, 2023

What is the RTC?

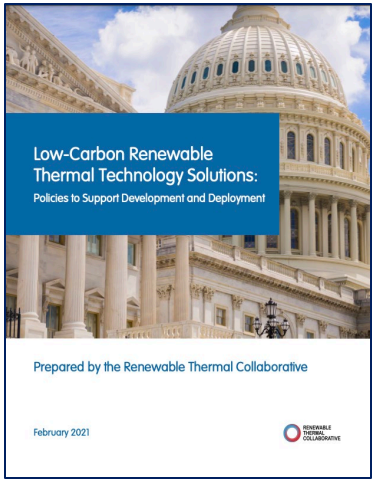
The RTC is the only global, buyer-led coalition focused on decarbonizing thermal energy with renewables.

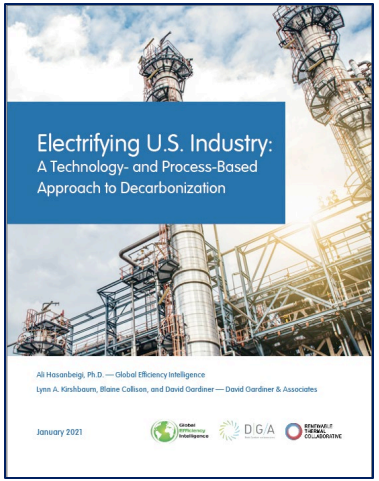
We focus our work across the intersecting issues of **technology**, **market development**, and **policy**.

RTC Members (buy-side) and Sponsors (solutions-side) are invited to participate in multiple RTC workstreams to:

- Identify and address barriers;
- Accelerate solutions;
- Implement projects and policies.

Facilitated by: C2ES Center for Climate and Energy Solutions; DGA David Gardiner and Associates; WWF





RTC Members


Ansell
AstraZeneca
Bristol Myers Squibb
Cargill
city of CINCINNATI
COLGATE-PALMOLIVE
CORNING
DIAGEO
gm
Henkel
HONDA
Johnson & Johnson
KAISER PERMANENTE
Kimberly-Clark
LACTALIS US YOGURT
L'ORÉAL USA
MARS Tomorrow starts today
novo nordisk
THE ORIGINAL OATLY!
PEPSICO
City of Philadelphia
THE CITY OF PITTSBURGH
P&G
Roche
SAINT-GOBAIN
sanofi
ThermoFisher SCIENTIFIC
Unilever
UNIVERSITY OF CALIFORNIA
OEI
Wisconsin Office of Energy Innovation

RTC Sponsors

RTC Technology Workstreams

Renewable Natural Gas

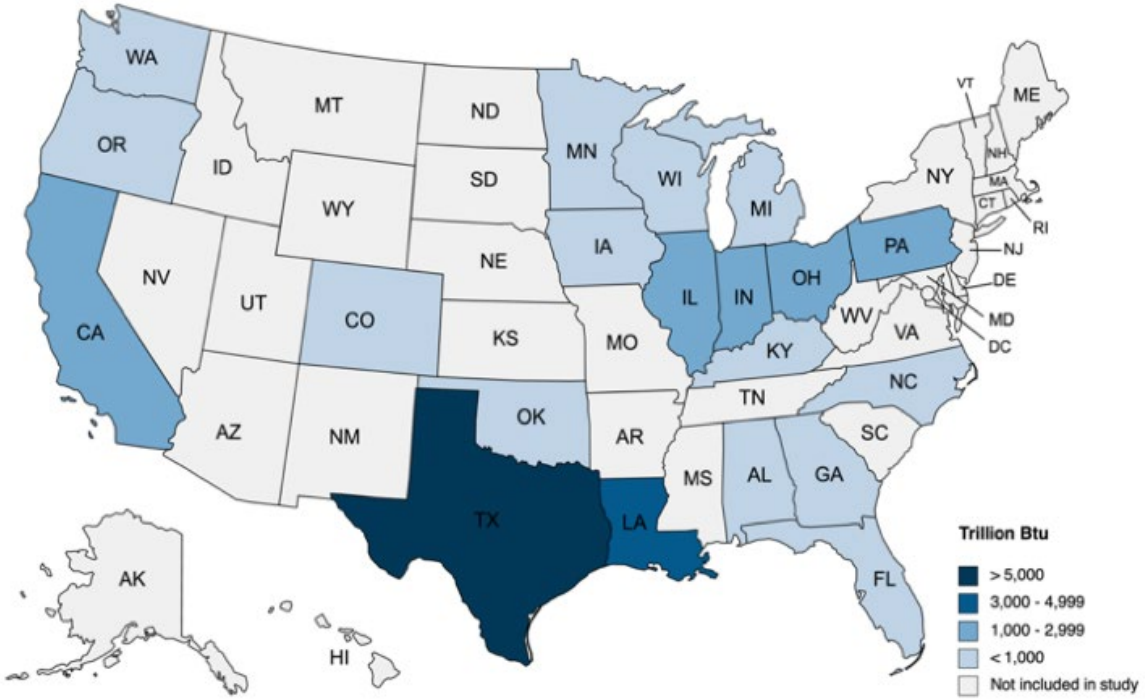
Beneficial Electrification

Green Hydrogen

Thermal Energy Storage

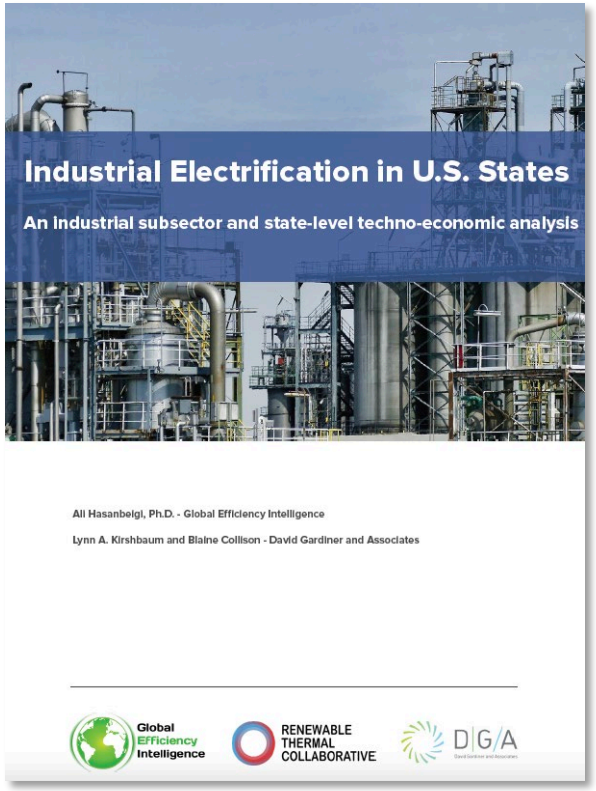
Solar Thermal

Industrial Energy Use in 2019 (trillion Btu)



RENEWABLE THERMAL COLLABORATIVE

Beneficial Electrification



Download the report:
https://www.renewablethermal.org/state-electrification-report/

Download state factsheets:
https://www.renewablethermal.org/state-electrification-factsheets/

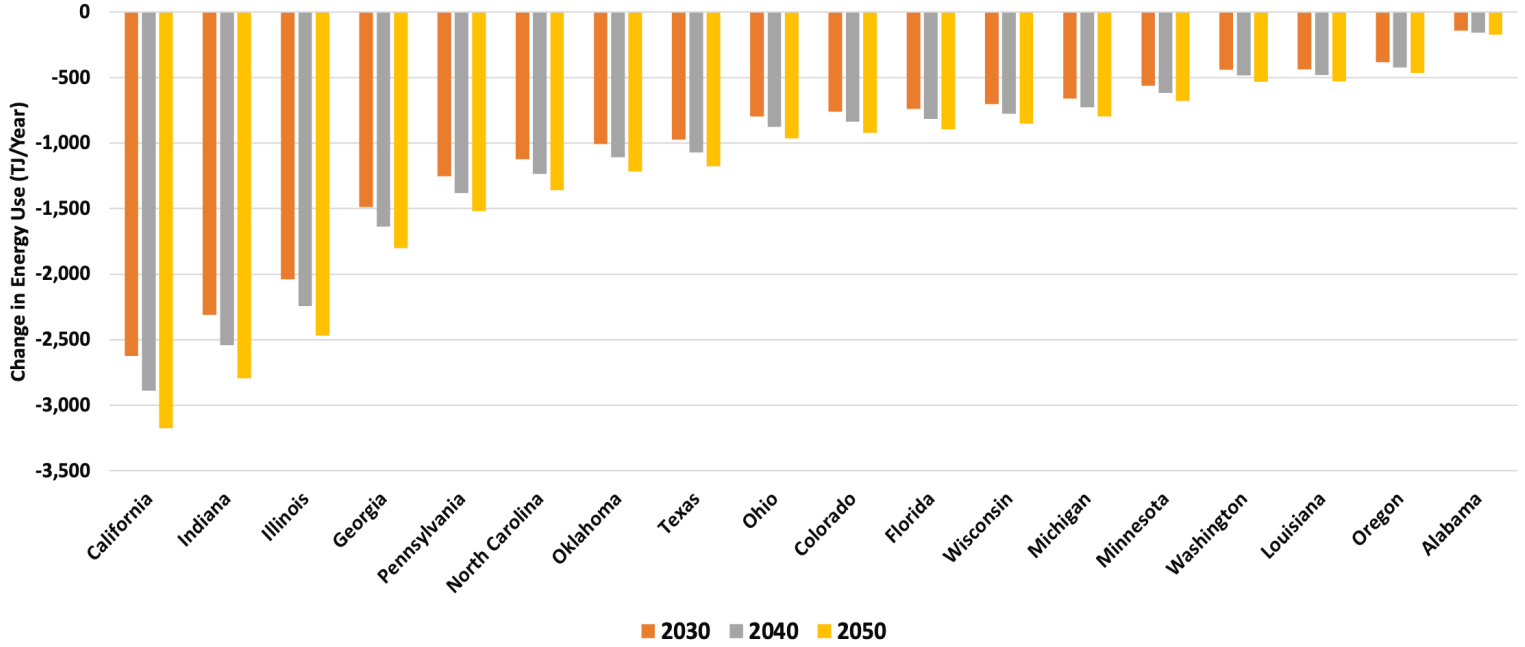
- Alabama
- California
- Colorado
- Florida
- Georgia
- Illinois
- Indiana
- Iowa
- Kentucky
- Louisiana
- Michigan
- Minnesota
- North Carolina
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Texas
- Washington
- Wisconsin

Sectors Included in Study Scope

Table 1. U.S. industrial subsectors analyzed in this study

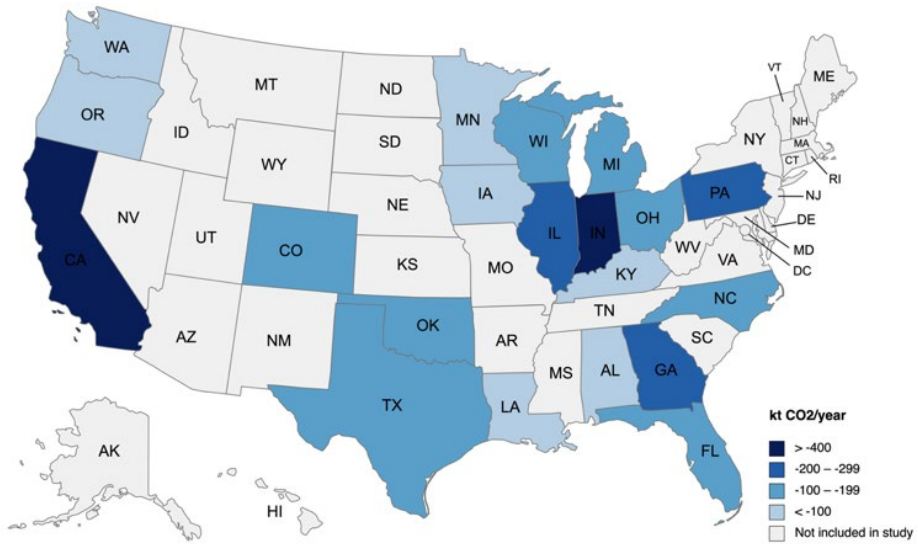
No.	Industry subsector	No.	Industry subsector
1	Aluminum casting	7	Steel
2	Pulp and paper	8	Beer
3	Container glass	9	Beet sugar
4	Ammonia	10	Milk powder
5	Methanol	11	Wet corn milling
6	Recycled plastic	12	Crude soybean oil

Electrification of the Container Glass Industry – Energy Saving (>30%)



Change in the container glass industry's total final energy use after electrification (Technical potential assuming 100% adoption rate)

Electrification of the Container Glass Industry – CO_2 Emissions Reduction

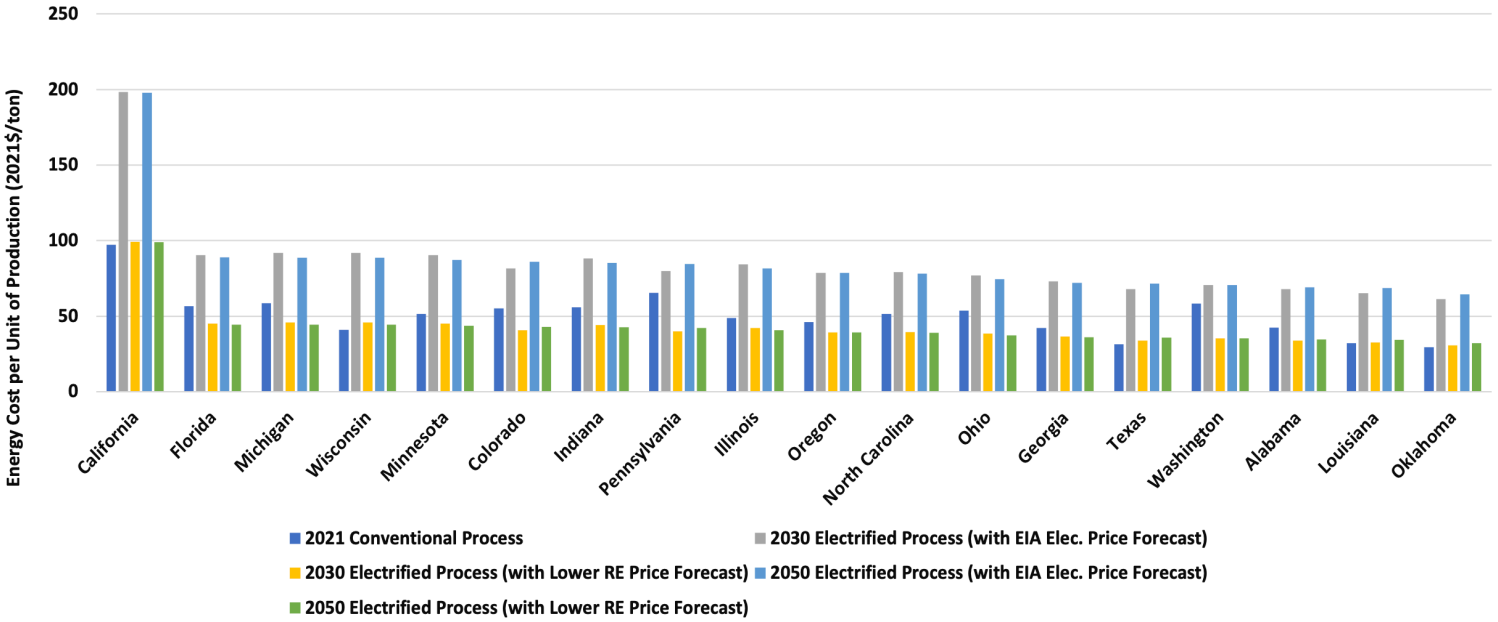


Change in CO_2 emissions in the container glass industry in 2050

- CO_2 emissions reductions can be achieved **today** using grid electricity in **Washington, Oregon, California, Illinois, Oklahoma, North Carolina, Pennsylvania, Georgia, and Alabama.**

- **Plant-level** CO_2 emissions reductions can be achieved **today** in **any state** through electrification projects that are **tied with sufficient renewable electricity** supply.

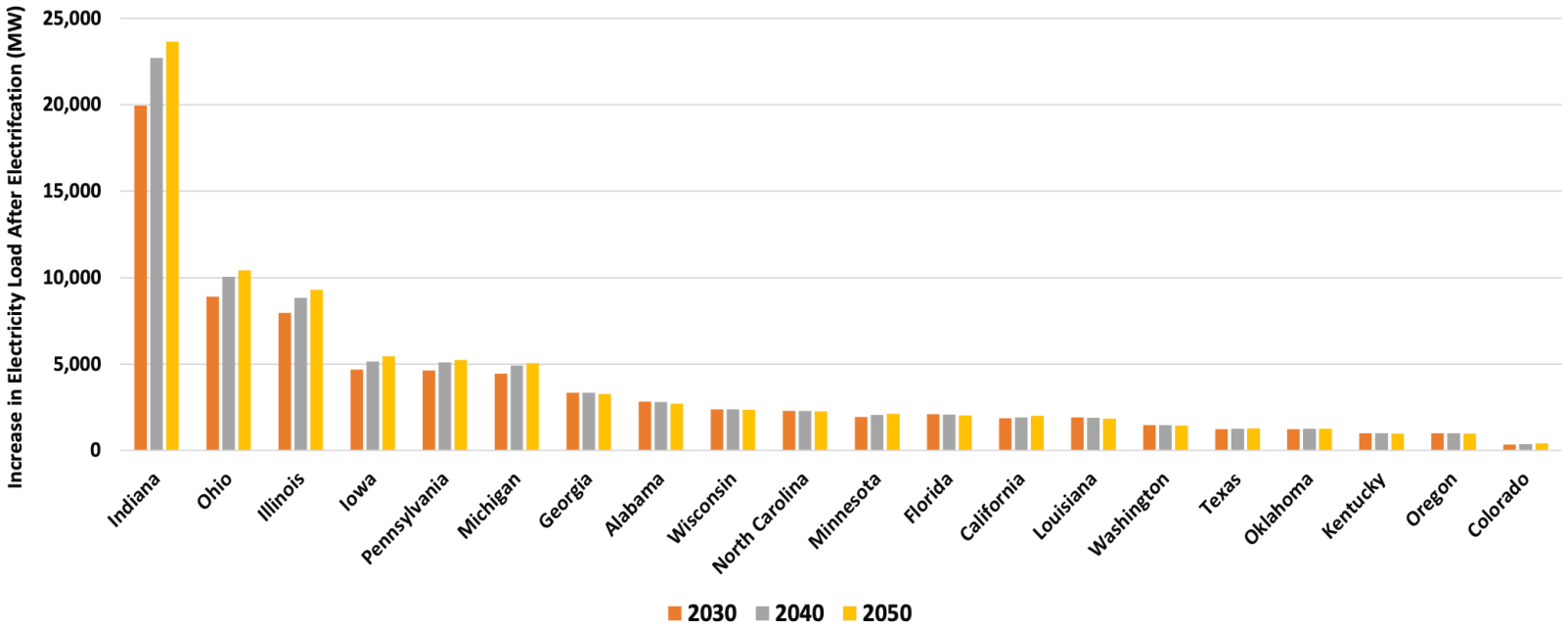
Electrification of the Container Glass Industry – Energy Cost



Energy cost per unit of production in the container glass industry

Energy cost is only a small portion of total manufacturing cost for many industrial subsectors. Therefore, a moderate increase in energy cost per unit of product resulting from electrification will have a minimal impact on the price of final product and final consumers.

Electricity Demand Impacts



Increase in electricity load after industrial electrification in 2030, 2040, and 2050 assuming 100% adoption rate (MW)

RTC Resources

Convenings:

Annual Summit (Oct 19-20, 2023 - Washington, DC):
https://www.renewablethermal.org/rtc-summit/

Monthly Community Calls: Second Tuesday, 11a-12p ET

Working Groups:
- Electrification, Green Hydrogen, RNG, Solar Thermal
- Greenhouse Gas Accounting and Claims
- Policy

Tools:

Policy Finder:
https://www.renewablethermal.org/policy-finder/

Partner Locator:
https://www.renewablethermal.org/partner/

Heat Pump Decision Support Tools: https://www.renewablethermal.org/heat-pump-decision-support-tools/

Electrification Road Map (update pending):
https://www.renewablethermal.org/electrification-road-map/

Publications:

Renewable Thermal Vision:
https://www.renewablethermal.org/vision/

Case Studies:
https://www.renewablethermal.org/category/publications/case-studies/

Industrial Electrification:
https://www.renewablethermal.org/state-electrification-report/

Green Hydrogen Technology Assessment:
https://www.renewablethermal.org/gh2-tech-assessment/

Communications:

Monthly newsletter:
https://www.renewablethermal.org/contact-us/

LinkedIn and Twitter

Thank You!

For more information, please contact:

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blaine@dgardiner.com

Ali Hasanbeigi, Ph.D.
Hasanbeigi@globalefficiencyintel.com

RENEWABLE THERMAL COLLABORATIVE

Global Efficiency Intelligence

D|G/A David Gardiner and Associates

Industrial Electrification: Hurdles to GHG Reductions

Edward Rightor
Director
Center for Clean Energy Innovation, ITIF

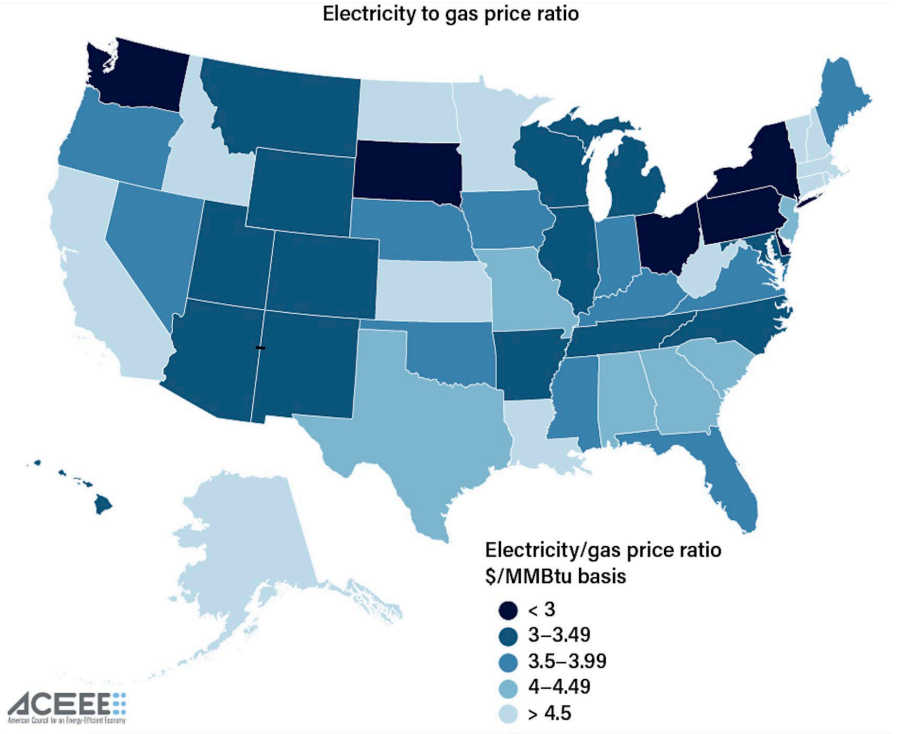
NARUC Webinar on Electrification for State Regulators
May 25, 2023

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

@ITIFd

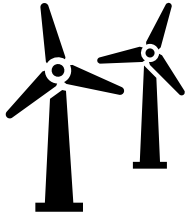
Spark Spread

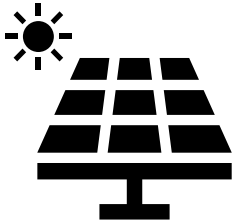
- Ratio of electricity/ natural gas price varies by state
- Where the ratio is high electrification has higher hurdles

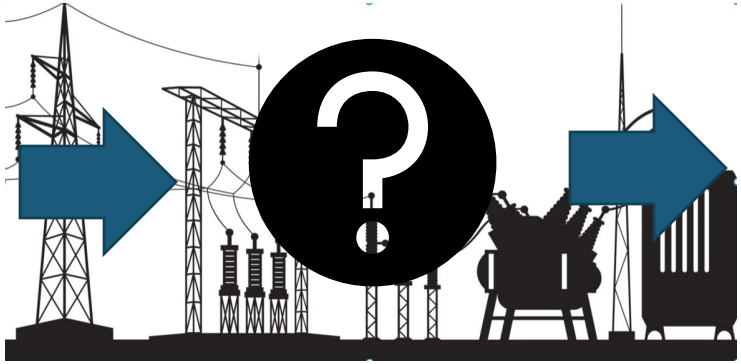


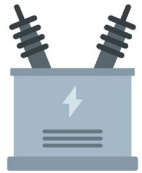
Rightor et al.

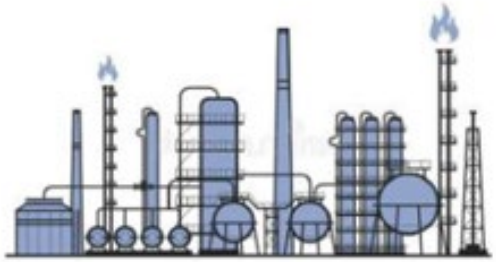
Interconnections @ Scale are Crucial to Adoption



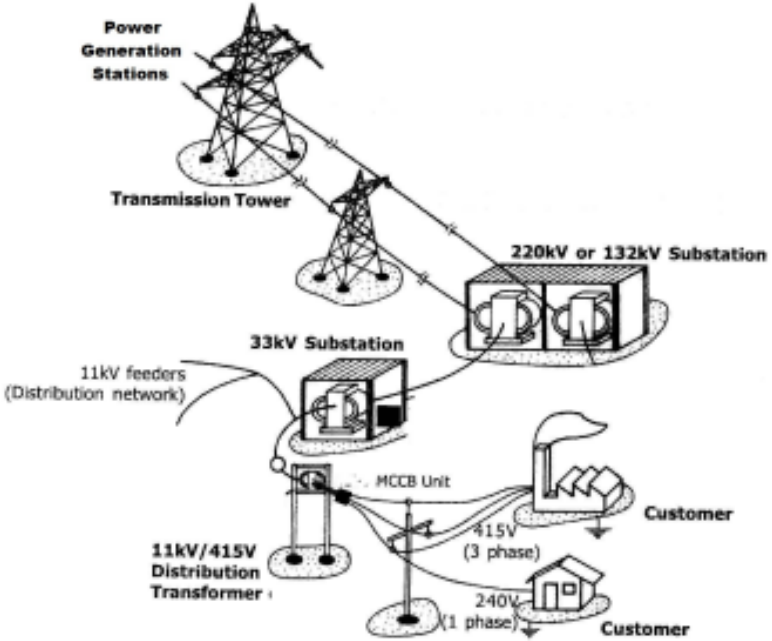


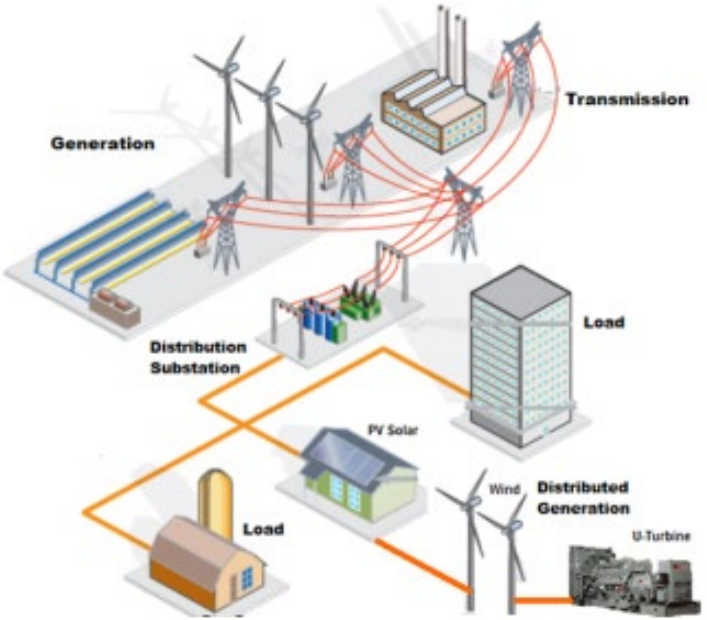






Grid Transformation & Bidirectional Needs





Aman et al.

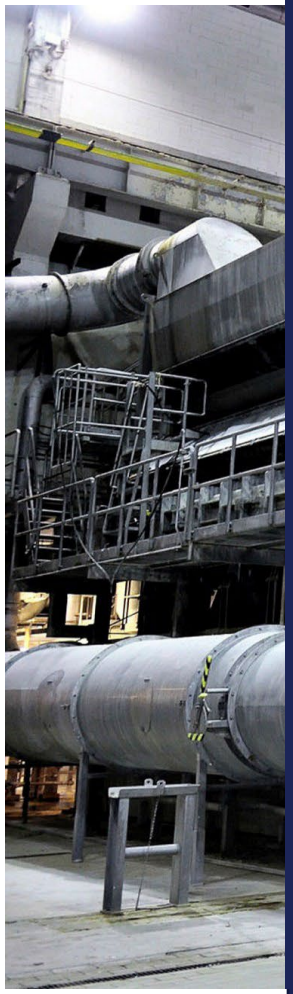
Electrification Needs

Address spark spread and lower hurdles for;

- Backend integration, electrical substations, busbars, transformers outside/ inside fence lines
- Interconnections with energy storage (thermal, electrical, chemical, mechanical…) **at scale**
- Sensing/ bidirectional response (know when clean electricity is available, competitively priced, responsive to dynamic needs)
- Effectively handling variable demand, generation, AND storage.
- **Price and performance parity, reliable, and resilient.**

Thank You!

Ed Rightor | erightor@itif.org | @ITIFdc

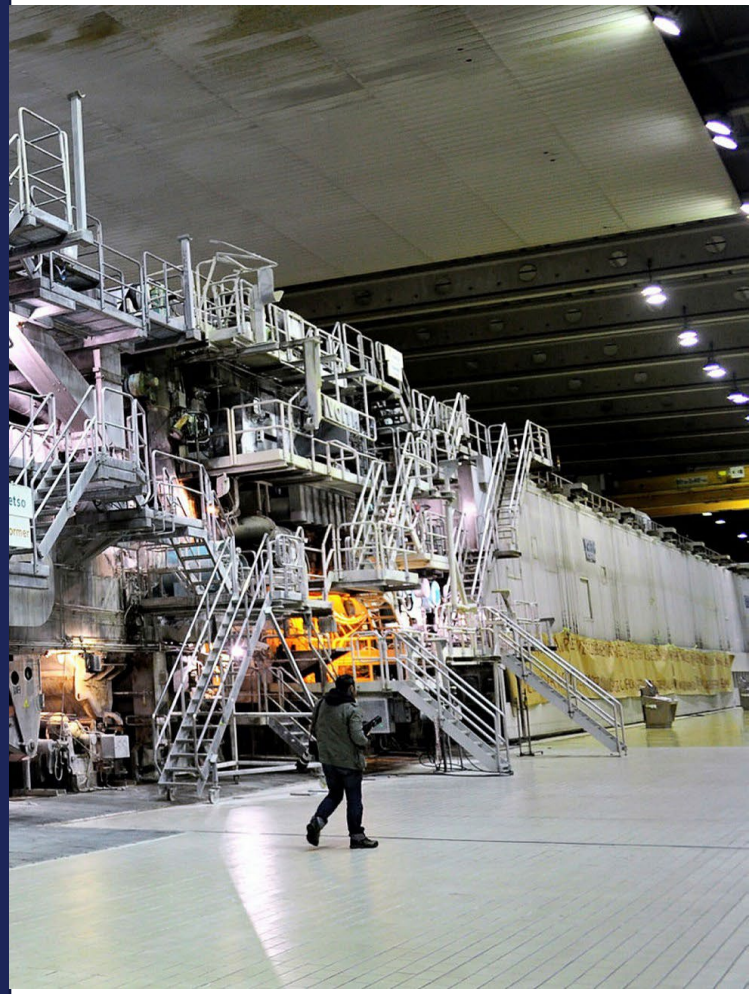


Industrial Electrification: Implications for State Regulators

NARUC CPI Innovation Webinar
May 25, 2023

Sara Baldwin
Senior Director, Electrification

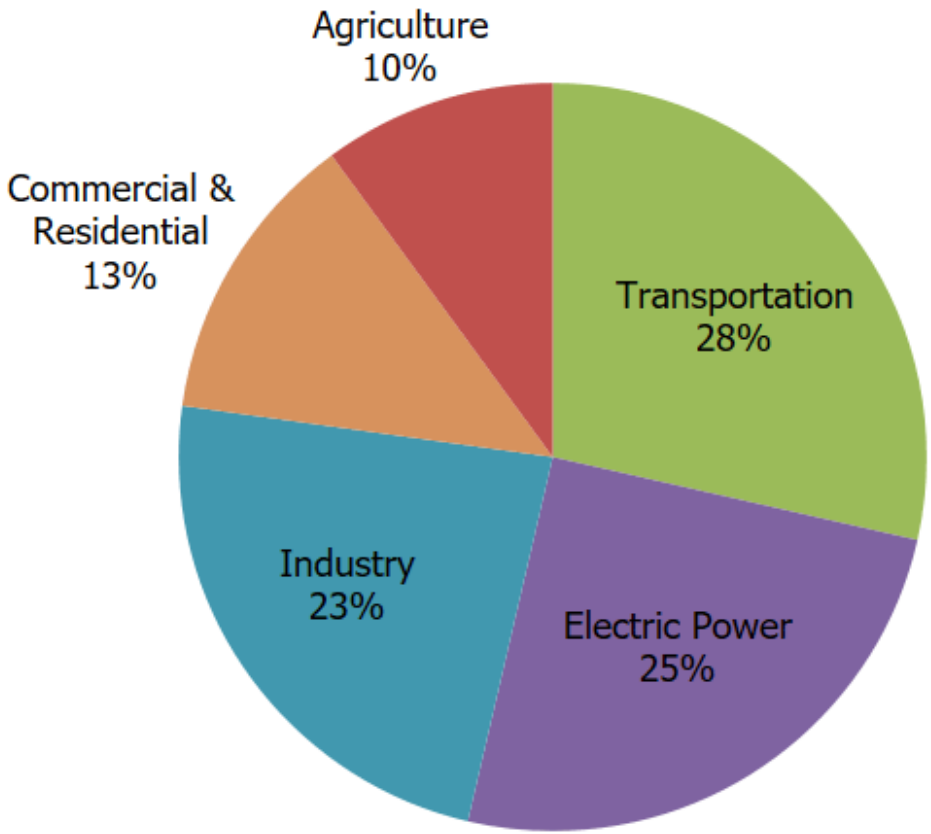
ENERGY INNOVATION
POLICY & TECHNOLOGY LLC®



Energy Innovation Policy & Technology LLC®

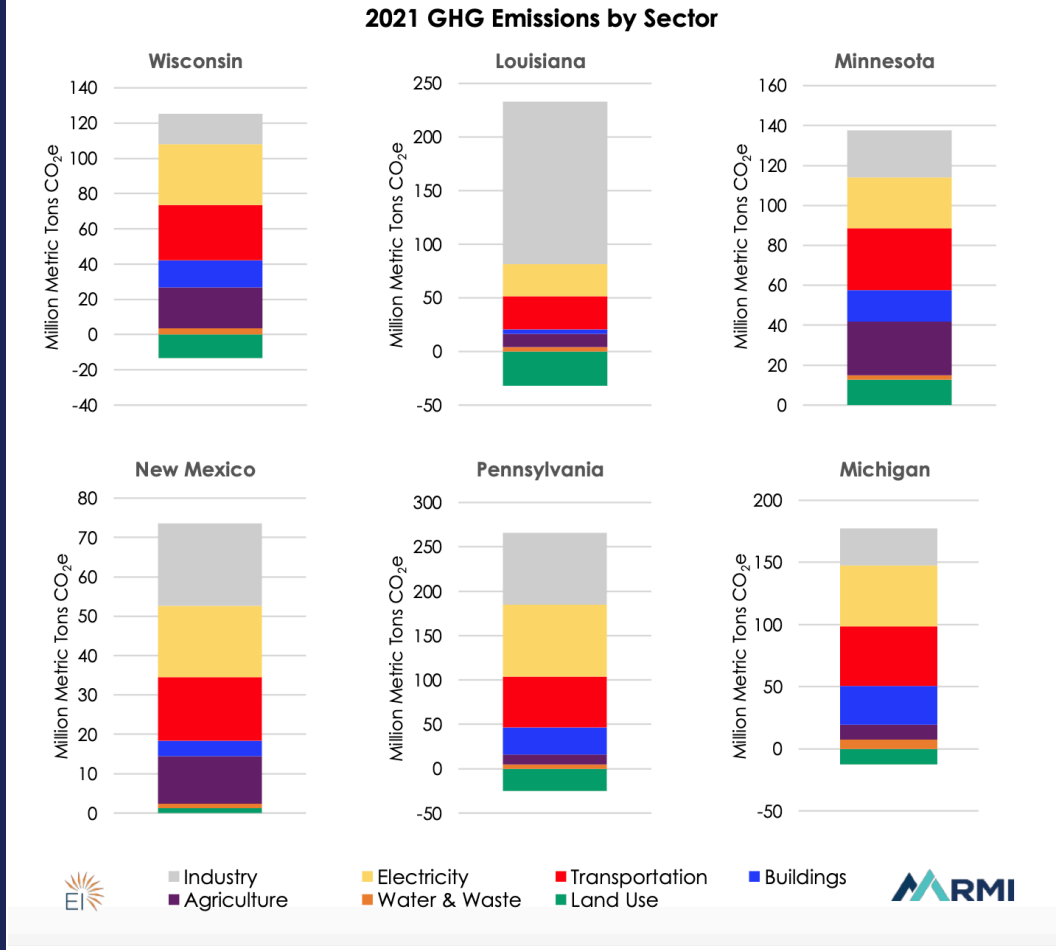
- Non-partisan climate policy think tank working towards a climate safe future where people and the planet thrive with economic, security, and equity benefits.
- We provide objective research based on scientific assessments to identify **the most effective economywide emissions reduction policies.**
- We prioritize the largest emitting nations and sectors, focusing on policies that accelerate technology-neutral zero-carbon solutions at the speed and scale necessary to fight climate change.
- Our policy recommendations are grounded in data, driven by our open-source and peer-reviewed Energy Policy Simulator model and our book *Designing Climate Solutions*.

U.S. Greenhouse Gas (GHG) Emissions by Economic Sector, 2021

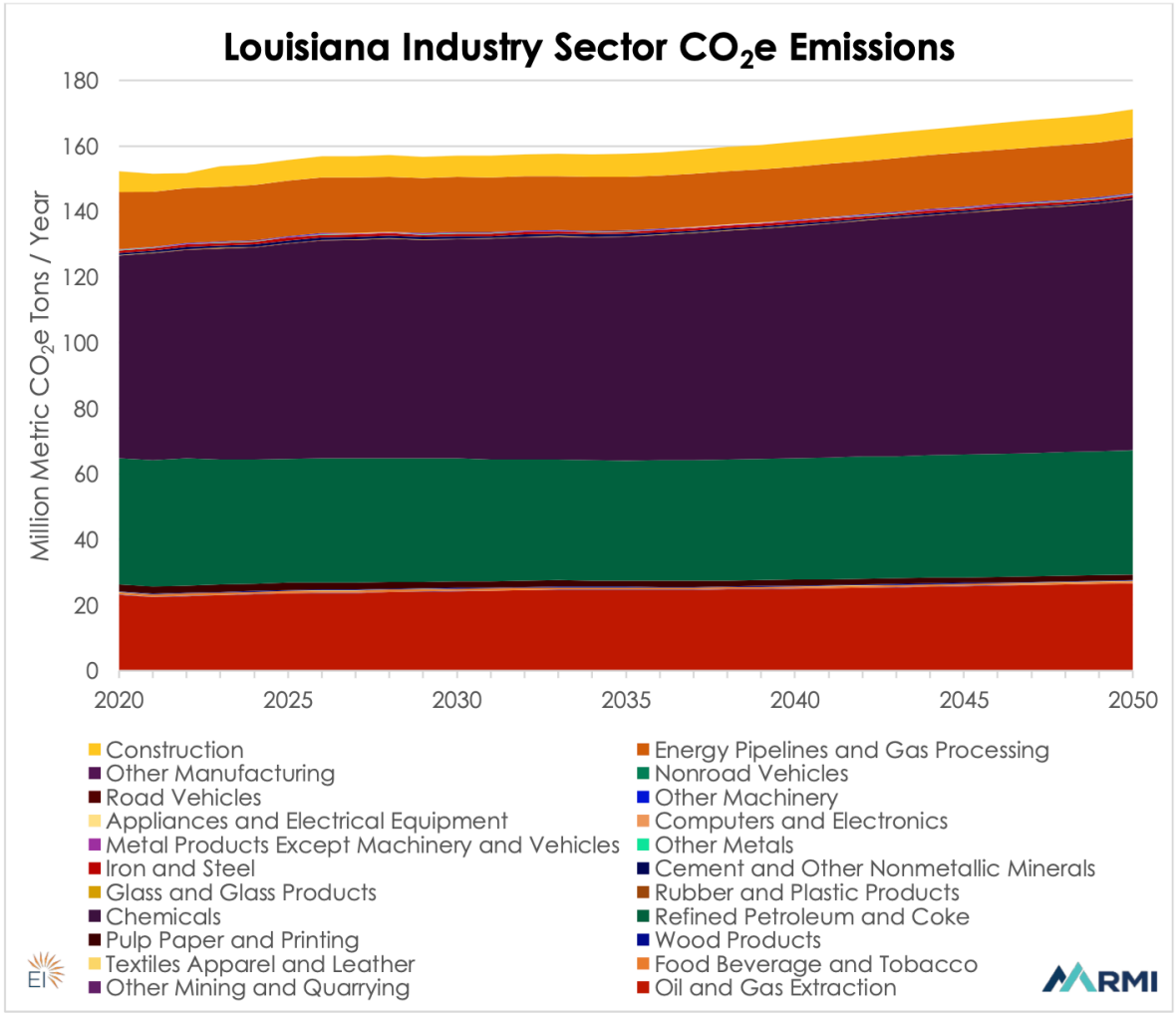


Source: U.S. Environmental Protection Agency

Industrial Sector GHG Emissions Vary Across States



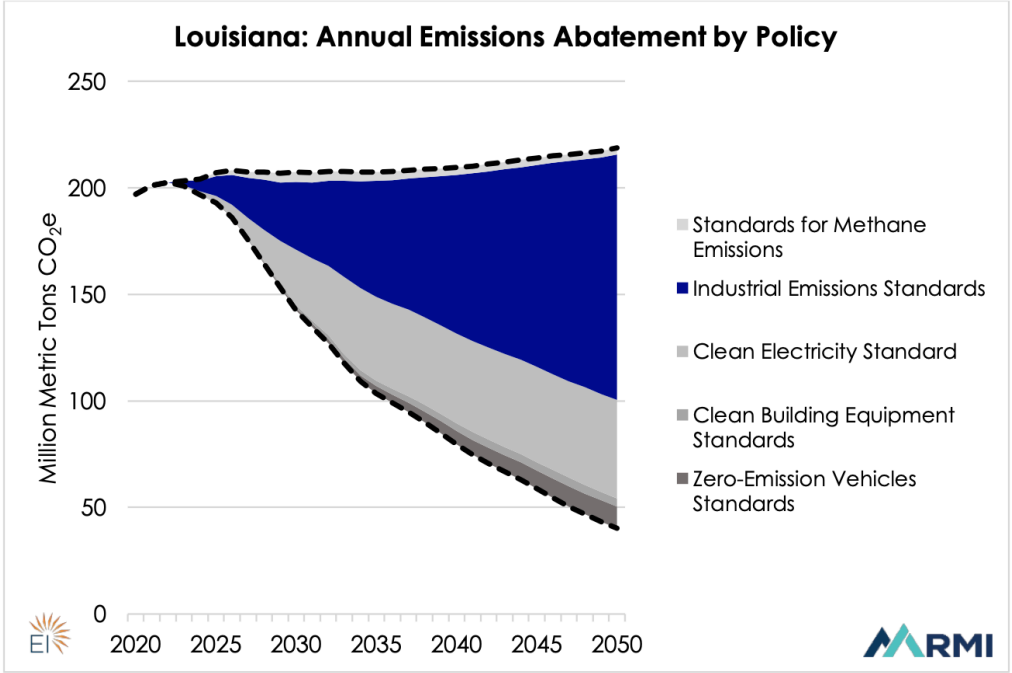
Source: Energy Innovation & RMI, *Top State Energy Policies to Cut Carbon Emissions*, February 2023.



Source: Energy Innovation & RMI, *Top State Energy Policies to Cut Carbon Emissions*, February 2023.

Modeled Policies for Industrial Decarbonization (example)

- Electrification for low- and medium-heat processes
- Other electric technologies and decarbonized fuels, such as green hydrogen, for high-temperature processes and feedstocks
- Energy efficiency upgrades



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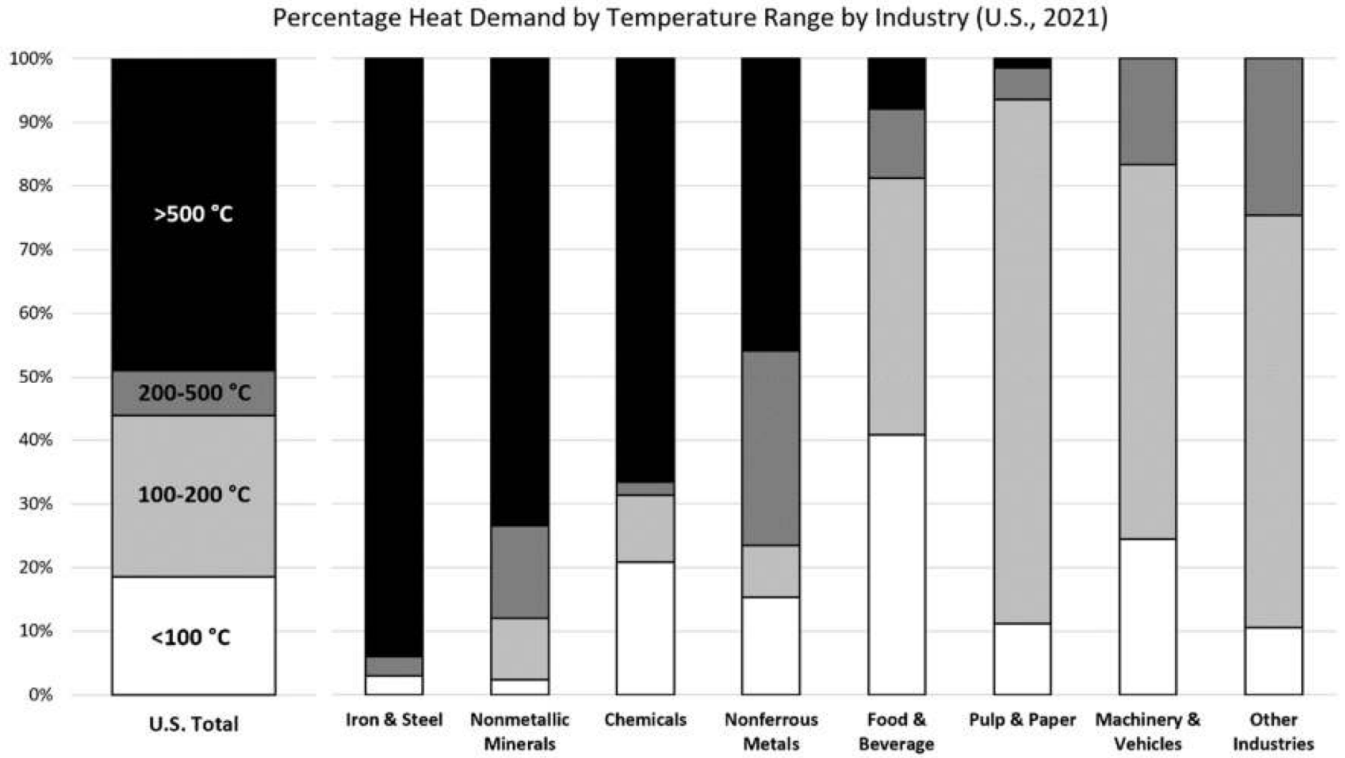


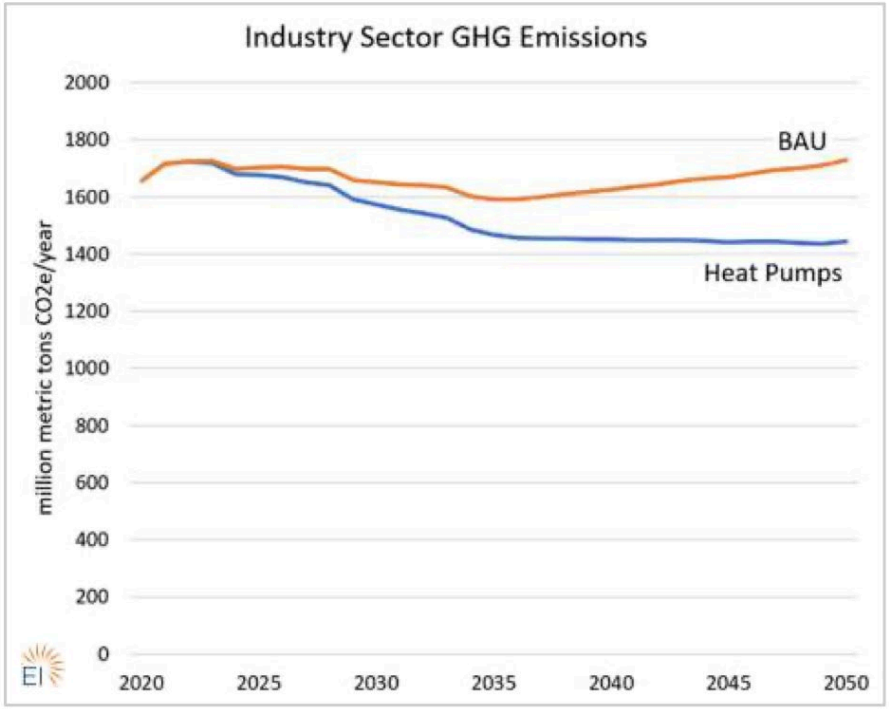
Figure 2. U.S. industrial heat demand by temperature range by industry in 2021. "Nonmetallic minerals" include cement, lime, glass, brick, tile, etc. Excludes heat for non-process uses, such as HVAC services for the comfort of workers.[4,5]

Source: Rissman, Jeffrey, Decarbonizing Low-Temperature Industrial Heat in the U.S., Energy Innovation, October 2022.

Activity	Temperature Range (°C)	Example Industries	Electrical Technologies
Melting metals	430-1650	Iron and steel, non-ferrous metals	Electric arc furnace, induction furnace
Producing steam, boiling, distillation	70-540	Chemicals, food processing	Heat pumps, electric resistance
Smelting (extracting metal from ore)	430-1650	Iron and steel, non-ferrous metals	Electrolysis, electric resistance, green hydrogen combustion
Calcining	800-1100	Cement, lime	Plasma torch, electric resistance, green hydrogen combustion
Melting non-conductive materials	800-1650	Glass, ceramics	Plasma torch, electric resistance, green hydrogen combustion
Welding	900-1500	Machinery, vehicles, construction, metal products	Electric arcs, lasers, electron beams
Cutting, drilling/boring	Very high	Machinery, vehicles, construction, metal products	Electric arcs, lasers, electron beams
Warming non-conductive, heat-sensitive materials	70-300	Food processing, plastic products, wood products	Dielectric heating, infrared heating
Curing adhesives and coatings	100-150	Vehicles, misc. products	UV light, infrared heating
Molding/forming	120-300	Plastic products	Electric resistance, dielectric heating
Sterilizing/pasteurizing	100-370	Food processing	Heat pumps, UV light, dielectric heating
Baking, thawing, drying	100-370	Food processing, rubber, some mineral and construction materials	Infrared heating, dielectric heating
Heat treating of metals (annealing, tempering, etc.)	100-800	Metal products, vehicles	Induction, infrared heating
Exceptionally high-temperature processes	2000-3000	synthetic graphite, specialty metals, vapor deposition coatings	Electric arcs, induction, lasers, electron beams

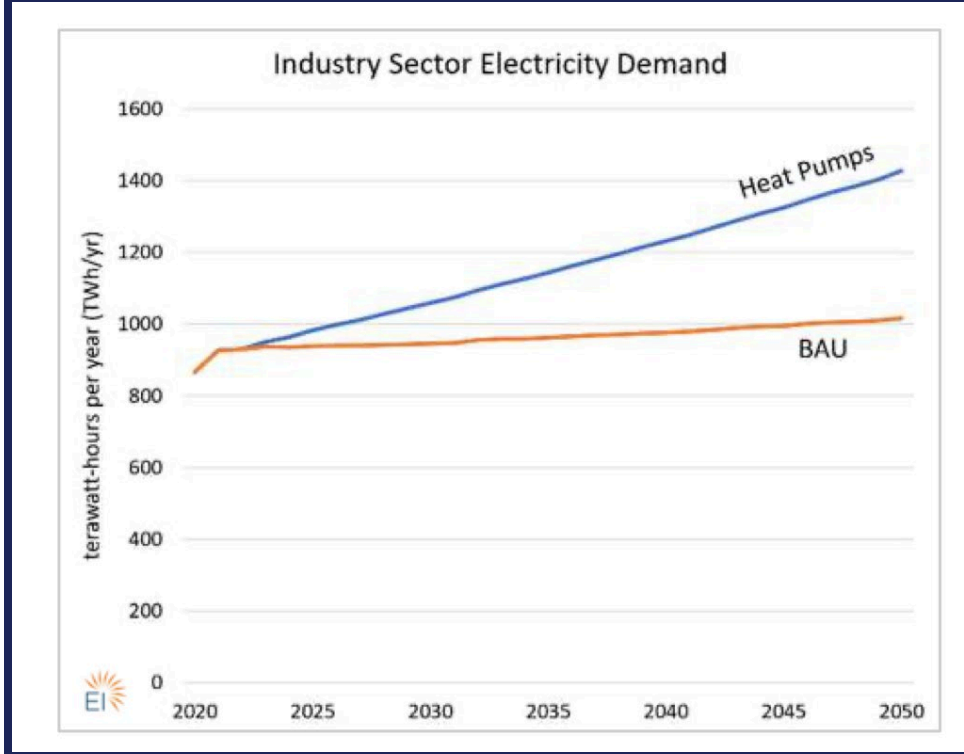
In the U.S., shifting to industrial heat pumps for low-temperature process heat would…

…reduce GHG emissions by 16% in 2050, relative to BAU.



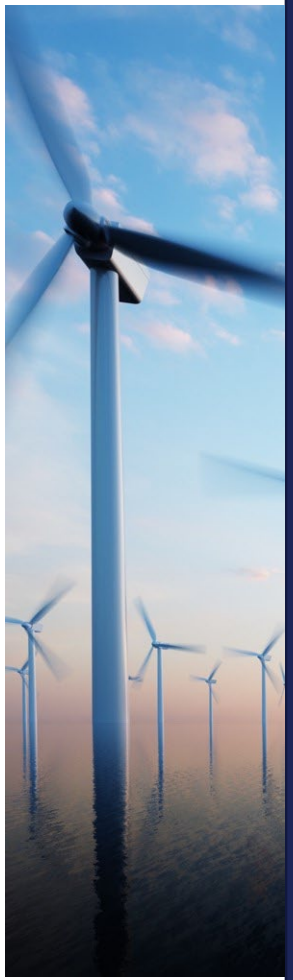
Source: Rissman, Jeffrey, Decarbonizing Low-Temperature Industrial Heat in the U.S., Energy Innovation, October 2022.

…increase electricity demand 12% in 2030 and 41% in 2050.



Regulatory Considerations for Industrial Electrification

- **Impact on utility forecasts, planning, and investment needs**
- **Implications for future demand of gas and electricity**
- **Opportunities to adopt or update energy efficiency programs**
- **Rate design to encourage energy efficiency and electrification**
- **Inflation Reduction Act support**
  - *$10 billion for the 48C Manufacturing Tax Credit that could be used to accelerate industrial heat pump adoption; eligibility for the tax credit includes re-equipping an industrial or manufacturing facility with equipment designed to reduce greenhouse gas emissions by at least 20 percent through the installation of... low- or zero- carbon process heat systems.*
  - *The Advanced Industrial Facilities Deployment Program authorizes $5.8 billion to support the purchase, installation, retrofits, or upgrades to industrial facilities to use "advanced industrial technology."*



Thank you!

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Industrial Electrification Technologies

Electrified heat

1. Heat pumps
2. Electrical resistance heating
3. Induction
4. Electric arcs / plasma torches
5. Dielectric heating (radio waves or microwave heating)
6. Infrared heating
7. Lasers
8. Electron beams

Heat storage

9. Thermal batteries

Heat replacement

10. Electrolysis
11. UV light

DISCUSSION AND Q & A

NARUC Innovation Webinar Series

One webinar most months

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Incorporating AI into Resilience-Informed Utility System Planning

June 20, 2023 | 3:00 – 4:00 PM EST

Topic TBD

July 27, 2023 | 3:00 – 4:00 PM EST

More webinar information will be added soon!

https://www.naruc.org/cpi-1/innovation-webinars/

NARUC thanks the U.S. Department of Energy for its support of this series.