# THE ROLE OF CHP IN THE INDUSTRIAL DECARBONIZATION ROADMAP

*The Department of Energy (DOE) recognizes the substantial benefits that combined heat and power (CHP) provides in the industrial sector and continues to support further development and utilization of the technology through the Advanced Manufacturing Office (AMO) R&D projects and its CHP Deployment Program.* ***This factsheet cites CHP-specific language from the DOE Industrial Decarbonization Roadmap[1] published in September 2022.***

**Within its Industrial Decarbonization Roadmap, DOE identified four key "pillars" of industrial decarbonization:**

1. **Energy Efficiency**
2. **Industrial Electrification**
3. **Low-carbon Fuels, Feedstocks, and Energy Sources (LCFFES)**
4. **Carbon Capture, Utilization, and Storage (CCUS)**

## CHP ROLE IN ENERGY EFFICIENCY

- "CHP replaces both a separate onsite thermal system (furnace or boiler) and purchased power with a single, integrated system, efficiently producing both thermal energy and electricity at the point of use." (p. 14)
- "Industrial CHP systems, through both topping and bottoming cycles, can provide needed energy services for some subsectors with overall energy efficiencies of 65%–85% compared to separate production of heat and power, which collectively averages 45%–55% system efficiency." (p. 14)
- "Industrial CHP can provide significant greenhouse gas emissions reductions in the near- to mid-term as marginal grid emissions continue to be based on a mix of fossil fuels in most areas of the country." (p. 14)

## CHP ROLE IN INDUSTRIAL ELECTRIFICATION

- "CHP is prevalent in chemicals, pulp and paper, refining, primary metals, and food industries, but can also be found in crop production, nonmetallic minerals, and other industrial uses." (p. 14)
- "In 2019, AMO began funding research that could enable electrified process heating and would couple CHP systems with clean energy sources; both topics were meant to increase the use of low-carbon energy sources in manufacturing." (p. 174)

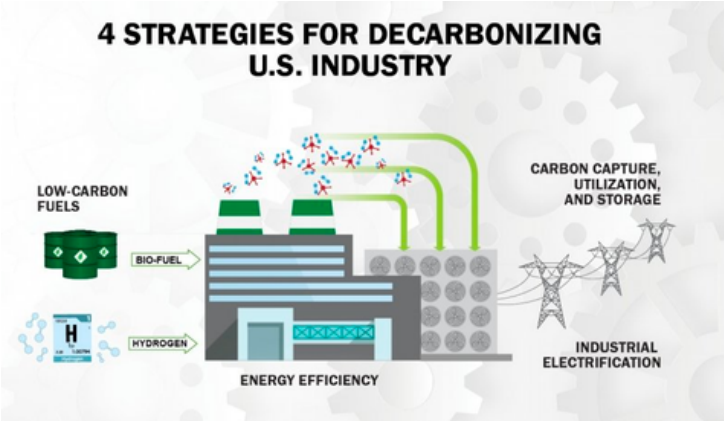


**Figure 1**: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

## CHP ROLE IN LOW-CARBON FUELS AND ENERGY SOURCES

- "CHP systems utilizing clean fuel sources can enhance energy security and resilience for industrials and distributed microgrids.[2] The use of nuclear energy for electricity and heat, renewable and synthetic fuels, and clean sources of energy as the prime movers for CHP systems can avoid the use of fossil fuels, which will support the integration of CHP into a fully decarbonized energy economy." (p. 14)
- "CHP has long used digester and biogas as fuel sources,[3] and systems deployed today can operate on increasing percentages of RNG as availability increases." (p. 14)
- "Engine and gas turbine manufacturers are currently testing and operating CHP systems on high percentage hydrogen fuels, in preparation for increasing use of RNG and hydrogen in the future." (p. 14)
- "RNG and hydrogen-fueled CHP systems can be a long-term path to decarbonizing industrial thermal processes resistant to electrification because of technology or cost barriers, and for critical operations where dispatchable onsite power is needed for resilience and reliability." (p. 14)

## CHP ROLE IN CARBON CAPTURE, UTILIZATION, AND STORAGE

- "Many refineries export excess CHP-generated electricity to their local grid and recognize that they could become a net exporter of decarbonized electricity by adding carbon capture to their CHP capacity." (p. 116)
- "Key learnings, needs and RD&D opportunities include...building information infrastructure, deploying smart manufacturing technologies, and improving CCUS and CHP, energy intelligence, and scale-up assistance..." (p. 86)

## RESEARCH, DEVELOPMENT & DEMONSTRATION NEEDS FOR FUTURE CHP APPLICATIONS (p.15)

- Prime mover development (e.g., reciprocating engines, gas turbines, and microturbines) to maintain high efficiency.
- High reliability and low criteria air pollutant emissions on biofuels and high levels of hydrogen.
- Options for new cycles/working fluids.
- Controls and control schemes for integrating with a dynamic smart grid and distributed microgrids.
- Conversion of natural gas infrastructure to operate on high levels of RNG and hydrogen.
- Heat exchangers to deal with "dirty" but hot streams.
- Considering solar/thermal integration for lower-grade heat.

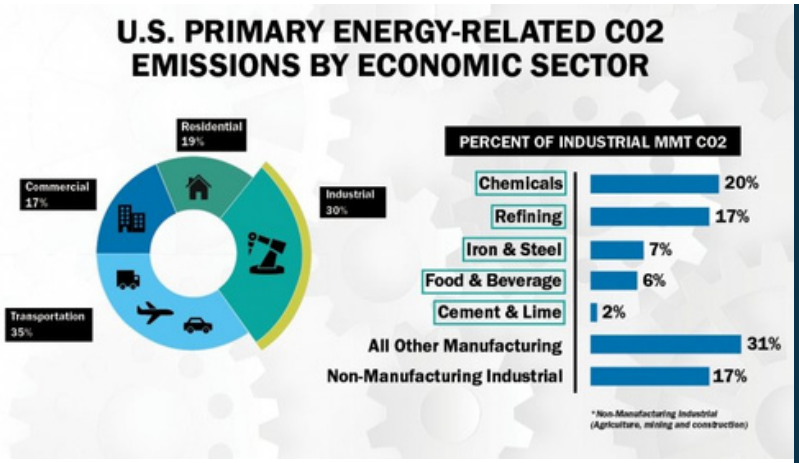


**Figure 2**: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

### REFERENCES

1. "Industrial Decarbonization Roadmap," U.S. Department of Energy, September 2022, https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf.
2. Net emissions for a CHP system are based on the fuel chargeable to power defined as the incremental fuel for the CHP system, relative to the fuel needs of a heat-only system divided by the net electrical power produced by the system.
3. DOE's CHP Installation Database lists 608 CHP systems with a total of 538 megawatt operating on digester gas and landfill gas utilizing reciprocating engines, gas turbines, microturbines and fuels cells. "CHP Installations," U.S. Department of Energy, last modified October 31, 2021, https://doe.icfwebservices.com/chpdb/.