A Roadmap for Industrial Decarbonization in Pennsylvania

Strategen Consulting and the Ohio River Valley Institute February 22, 2024



Background

One-third of Pennsylvania's current emissions come from the industrial sector.



Pennsylvania Total and Industrial Sector Greenhouse Gas Emissions (2019)



Methodology

In a base case scenario, industrial emissions are projected to increase despite new regulations to reduce fugitive emissions.

Pennsylvania's Industrial Sector Emissions - 2005, 2019, and projected



Sources: Pennsylvania's 2021 Climate Action Plan, 2022 GHG Inventory Report, 2023 Methane Reduction Strategy.

Methodology

The EPA's GHGRP was utilized as a complement to the PA GHG Inventory Report to characterize emissions.

- + Total emissions were kept constant from PA GHG Inventory.
- + Emissions from GHGRP were adjusted for subsectors where only largest facilities are required to report (assume 30% not reported). Kept constant for subsectors where all facilities report.
- + The remaining gap was attributed to a set of other industries based on the inventory's methodology.
- + Added emissions from new industrial facilities not yet considered in reports.





Methodology

Decarbonization levers were identified to reduce industrial emissions.

	2025		2030	>	2035		2040	>	2045	>	2050	
Energy Efficiency												
					Mater	rial Effi	iciency					
Electricification												
					Hydroge	n Fuel	Switching					
					Carbon Ca	pture a	and Storage	•				

Note: This figure excludes production ramp-downs and facility retirements, which were considered on a case-by-case basis.



This roadmap will reduce emissions by 21% in 2030 and 84% in 2050, compared to 2019.





The subsectors contributing the most to overall emissions reductions are fossil fuel extraction and delivery, low heat subsectors, and metals





Iron and Steel Decarbonization Pathway

12,000,000 10,000,000 GHG Emissions (Tonnes CO₂e) 8,000,000 6,000,000 4,000,000 2,000,000 0 2019 2025 2030 2035 2050 2040 2045 🔄 Remaining Emissions 🛛 Efficiency 🔄 Gas DRI-EAF 🗖 Scrap EAF 🔄 H2 DRI-EAF 🗶 Gas DRI-EAF w/ CCS Fabrication: Electrification Fabrication: Hydrogen --- BAU Emissions



Decarbonization Pathway for "Other Low Heat Subsectors"





This roadmap will lead to economic, equity, and environmental benefits.

- + Across all subsectors, Strategen calculates that the proposed industrial sector roadmap will cost approximately \$30-35 billion.
 - + Of the subsectors analyzed, minerals (primarily cement and lime production), iron and steel, and oil and gas are estimated to be the most expensive to decarbonize.
- + Failing to decarbonize Pennsylvania's industrial sector would result in \$16.88 billion in damages in 2050 alone.
 - + In contrast, Strategen's decarbonization pathway would reduce 2050 emissions by 68.6 MMT compared to business as usual, avoiding annual damages valued at just over \$14 billion by 2050.
- + Industrial efficiency, electrification, and fuel switching will have strong equity benefits by reducing disproportionate air pollution impacts of industrial facilities in Pennsylvania.
 - + The air quality impacts of hydrogen fuel switching and CCS in the industrial sector warrant further study.
- + National-level analysis from DOE suggests that industrial decarbonization efforts will create hundreds of thousands of direct and indirect jobs.
 - + Employment shifts will occur in fossil fuel production subsectors, which will need to be proactively managed.
 - + Industrial energy efficiency is particularly likely to have a strong, locally rooted economic impact in Pennsylvania.



Recommendations

The following enabling actions for both industry and state government can serve to drive forward industrial decarbonization in the commonwealth

	Advancing Decarbonization	Planning & Funding	Community Benefits
Near-Term Actions	 Focus on energy efficiency and electrification investments across all industrial subsectors. Develop a comprehensive approach to decarbonize the natural gas subsector. Accelerate decarbonization of the power sector. 	 Create broad incentive programs to which any subsector may apply. Focus subsidies on solutions that industrial actors would not have already implemented due to policy and economics. 	 Pursue community and worker engagement and benefits planning for decarbonization projects and policies. Invest in training and job placement programs that can channel existing workers' skills to growth industries.
Longer-Term Actions	 Conduct further study regarding the air quality impacts and infrastructure needs of clean hydrogen and carbon capture. Fully decarbonize the power sector. 	 Continue to seek and take advantage of federal funding opportunities and incentives. Explore additional funding opportunities for R&D 	 Explore options for state procurement of low-carbon industrial products to foster demand and in-state economic growth.



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