Modernizing Industry in Pennsylvania

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Key takeaways

1. The **Keystone State's manufacturing sector** heavily **relies on chemicals** and **steel** production. Pennsylvania's chemicals industry recently experienced 2.6% employment growth, and the state employs 2.1 times more steelworkers per capita compared to the national average.

2. As demand for chemicals and steel shifts to low-emissions products, **Pennsylvania can** leverage its specialized workforce and existing infrastructure to **establish an early-mover advantage in green markets.**

3. The **strategies with the greatest potential** for reducing manufacturing emissions in Pennsylvania are **electrifying thermal processes across facilities** and **converting coal-based steel facilities to hydrogen**.

4. States with this kind of industrial profile can **support modernization and economic competitiveness through enabling policy,** such as a production tax credit for clean manufacturing and public procurement of low-carbon products.

Pennsylvania shows economic momentum and strength in the chemicals and steel sectors; it's among the top five states with the greatest concentration of chemical manufacturing facilities, and it's responsible for 5% of all US crude steel production.

The Keystone State has a specialized workforce in these sectors. Chemical manufacturing experienced 2.6% employment growth in the last five years, and the state employs 2.1 times more steelworkers per capita than the national average.

But global changes necessitate a new strategy to keep Pennsylvania competitive. Chemical markets are shifting to low-emissions products. Global demand for green steel is forecast to equal 35% of current crude steel production by 2050. As the chemicals and steel markets transition, Pennsylvania has significant assets it can leverage to establish an early-mover advantage.

Supporting industrial modernization will also reduce climate pollution. For Pennsylvania to achieve its economy-wide goals of a 26% emissions reduction by 2025 and 80% by 2050 from 2005 levels, it must reduce pollution from leading sources of industrial emissions, which are chemicals, iron and steel, and miscellaneous manufacturing.

In 2024, Pennsylvania's manufacturing sector collectively released 34.5 million metric tons (MMT) of carbon dioxide equivalent (CO_2e), according to data from the Energy Policy Simulator.

Health impact from Pennsylvania's iron and steel, chemicals, food and beverage, and refining facilities

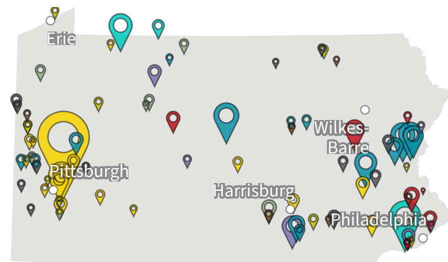
Current levels of air pollution from Illinois' manufacturing facilities adversely impact public health and economic activity.

Health Event	*Estimated Annual Incidents from Facilities*		
	Chemicals	**Iron and steel**	**Total**
Premature deaths	13-22	57-111	70-133
ER visits, respiratory	19	58	77
Asthma symptoms	8,330	28,954	37,284
Work loss days	997	5,615	6,612
School loss days	3,021	5,749	8,770
Total health costs*	$200M-330M	$0.9B-$1.6B	$1.3B-$1.7B
Lost economic activity**	$6.2M	$15.7M	$21.9M

**Includes health costs incurred from additional incidents not listed like cardiac arrests, stroke, and hospital admits*
***Includes economic impact of minor restricted activity days, in addition to school and work loss days*

Source: EPA CO-Benefits Risk Assessment (COBRA)

Pennsylvania's industrial facilities



Facilities by industry

- Iron and steel
- Cement and other nonmetalic minerals
- Refined petroleum and coke
- Chemicals
- Other metals
- Other manufacturing
- Glass products
- Pulp and paper
- Food and beverage

Metric tons CO_2e

400K 1.5M 4M

Source: US EPA

If the state does not take action, by 2050, the manufacturing sector is forecast to emit similar levels of pollution. However, if the state incorporates the strategies outlined below, it could reduce manufacturing emissions to 13.5 MMT CO_2e.

In addition to having a negative climate impact, industrial emissions harm public health. Certain industrial processes can release pollutants like particulate matter, nitrogen oxides, and sulfur dioxide, which are linked to adverse health conditions, ranging from asthma exacerbation to premature death and disease.

Curbing emissions from facilities is particularly critical to the health of local communities, which are disproportionately impacted by exposure to air pollution.

Strategies for emissions reduction

Modernizing facilities can support competitiveness in emerging markets while reducing air and climate pollution. Based on the [Energy Policy Simulator](), an open-source model for estimating the impacts of energy policies, the strategies with the greatest potential for reducing emissions in Pennsylvania are electrifying thermal processes across facilities, especially those requiring heat below 400°C, and converting coal-based steel facilities to hydrogen direct reduction.

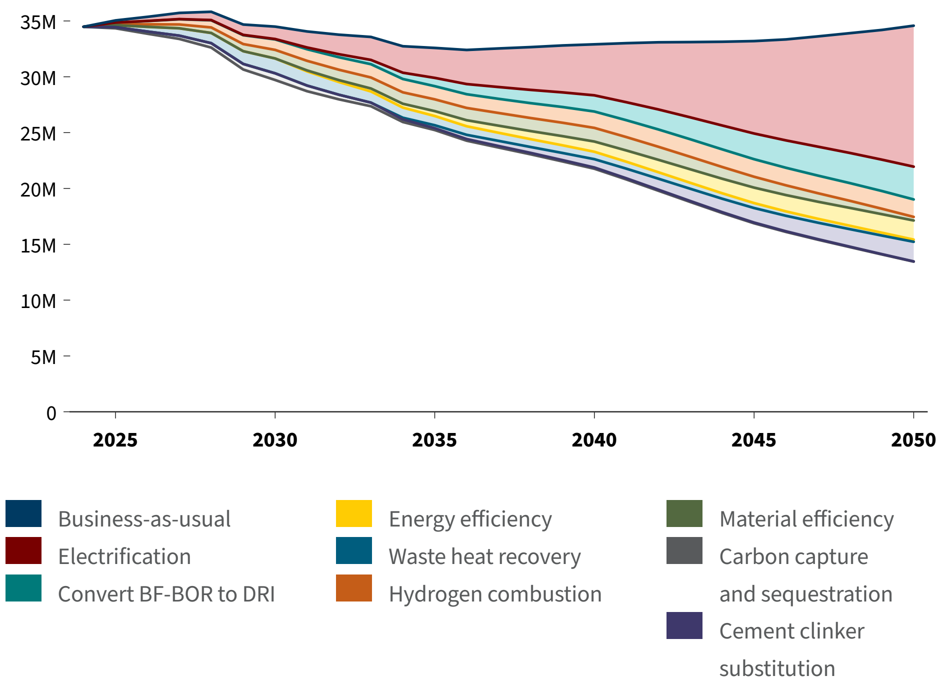
If nearly all industrial processes below 400°C are electrified by 2050, Pennsylvania can reduce emissions from manufacturing by a cumulative 121 MMT CO_2e, or 46% of overall potential emissions reductions from the set of strategies. Electrification of thermal processes is an immediate opportunity to reduce emissions from on-site combustion of fossil fuels. Direct electrification for low- to medium-temperature heat has the greatest potential in [light industries](), including food and beverage, pulp and paper, and certain [chemicals]().

Pennsylvania can also shift to direct reduced iron (DRI) facilities in lieu of relining blast furnace–basic oxygen furnace (BF-BOF) steel plants. If the transition begins promptly, this is expected to result in cumulative emissions reductions of 0.119 MMT CO_2e by 2030 and 31.4 MMT CO_2e by 2050. DRIs operating on natural gas can produce 50% fewer emissions than BF–BOF steel plants, and DRIs operating on clean hydrogen can produce 90% fewer emissions.[1]

[1] Estimates of relative emissions reductions are based on a global warming potential factor of 100, which understates the short-term impacts of methane.

Industrial emissions in Pennsylvania

Emissions from manufacturing have the potential to decline by 21.1 million metric tons of CO_2e by 2050, compared to a business-as-usual scenario.



The wedges show each strategy's annual impact towards emissions reductions and was calculated using the Energy Policy Simulator (EPS). The conversion of BF-BOF to hydrogen-ready DRI facilities is estimated in the EPS by pairing the feedstock shifting and electrification levers. The business-as-usual scenario corresponds to the Federal Policy Repeal & Rollback scenario in the EPS, which is more representative of today's policy landscape, and assumes that Illinois does not take additional action on industrial emissions.

Source: RMI Analysis, [Energy Policy Simulator]()

Cumulative emissions reduction by strategy

Strategy	cumulative MMT CO_2e reductions through 2030	cumulative MMT CO_2e reductions through 2050	▼ % of cumulative industrial emissions reductions
Electrification	3.9	121.0	45.9%
Material efficiency	3.2	31.3	11.9%
Transition BF-BOF to DRI	0.1	31.4	11.9%
Energy efficiency	2.6	21.9	8.3%
Hydrogen combustion	0.0	18.9	7.2%
Waste heat recovery	4.6	17.5	6.6%
Carbon capture and sequestration	0.0	16.5	6.2%
Cement clinker substitution	2.1	5.0	1.9%

These values were calculated using the Pennsylvania Energy Policy Simulator (EPS), and they assume both stringent implementation and carbon capture and sequestration and hydrogen combustion reaching technological readiness by 2031. The conversion of BF-BOF to hydrogen-ready DRI facilities is estimated in the EPS by pairing the feedstock shifting and electrification levers.

Source: RMI Analysis, Energy Policy Simulator

Additional cross-cutting interventions that can be deployed in the near term include:

- **Using smarter design** to reduce demand for new steel, cement, and other manufactured goods – i.e., material efficiency.
- **Increasing the efficiency** of industrial equipment, including updating heat pumps and compressors, and integrating advanced process control systems. Energy efficiency is the quickest and most cost-effective mitigation strategy.
- **Recovering waste heat** using economizers and heat exchangers and converting it into usable energy.
- **Prioritizing the use** of low-carbon intensity methane in industries relying on high-heat processes while the infrastructure and supply for cleaner low carbon fuels is developed.

Supporting policies

With recent changes in federal policy causing market uncertainty, state leadership is critical to maintaining the interest and energy of its investors and project developers. Pennsylvania's policymakers can support industrial competitiveness and decarbonization through policies that establish certainty, which involves setting standards, and providing support, including reducing costs of technical interventions and increasing the value of low-emissions products.

There are several actions that Pennsylvania can take to modernize its industrial sector. Examples include:

Creating standards

- **State target setting** to direct the industry sector's transition to green products.
- **Material efficiency standards** — which involve using smart design to reduce the required amount of material in manufacturing — provide the same services with less material, thereby decreasing the energy demand for new production.
- **Improve transparency around upstream methane emissions** associated with the production and transmission of natural gas and petroleum by requiring measurement-informed, independently verified, facility-specific emission data.

Providing support

- **Develop hydrogen infrastructure,** including pipelines, storage facilities, and liquification plants. Transitioning to green hydrogen as a fuel source requires the availability of robust and resilient quality infrastructure.
- **Technical assistance grants** to assist facilities in transitioning to low-carbon production. Technical assistance can help facilities overcome financial barriers, capacity constraints or knowledge gaps in modernizing. This can complement the Reducing Industrial Sector Emissions in Pennsylvania (RISE PA) grants being offered for innovative projects.

Adding value

- **A production tax credit (PTC) for clean manufacturing** to increase the cost-competitiveness of clean production. A PTC rewards firms for shifting away from fossil-based inputs and helps bring new production methods in pilot and demonstration phases to scale.
- **Government procurement for low-emissions products** to create the offtake certainty required for capital expenditures, such as redevelopment of BF-BOF facilities.

For more information about industrial decarbonization, please email USAnalysis@rmi.org