Washington Industrial Decarbonization Pathways, EITEs, and Related Policy

May 29, 2025

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AGENDA

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About RMI

Transforming the global energy system to secure a clean, prosperous, zero-carbon future for all.

BY Targeting Key Sectors

- Electricity
- Buildings
- Transportation
- Industry

USING Powerful Market Catalysts

- Policy
- Technology
- Climate Aligned Finance
- Climate Intelligence
- Education & Capacity Building
- Communications

Project Review

- Objective: Identify decarbonization pathways for Washington's emissions-intensive, trade-exposed (EITE) industries and explore market and policy opportunities to support industrial decarbonization and regional clean tech development.
- Scope and Project Recap:
  - Identify feasible, cost-effective technical decarbonization pathways for EITE industries.*
  - Assess the projected impact on greenhouse gas emissions and electricity demand from decarbonization pathways.
  - Produce market and policy recommendations to support industrial decarbonization in Washington, including recommendations on future no-cost allowance allocations.

* Initial analysis for select EITE industries presented to EITE Industry Advisory group in November 2024.

Key Takeaways From Stakeholder Interviews

RMI conducted 25 stakeholder interviews (including a majority of EITE advisory group members*)

EITE No-Cost Allowances	• Interviewees stressed changes to no-cost allowances and emissions baselines should acknowledge industries' varied needs and the feasibility of deploying decarbonization technologies. • No interviewees gave estimates or specific proposals for no-cost allowance allocation levels, methods, or benchmarks post-2034.
Technical Pathways	• Industry members indicated efficiency improvements are a top priority for most industrial facilities and are already being implemented. • Most interviewees expressed that limited clean energy capacity on Washington's grid complicates and/or limits interest in facility electrification, a key decarbonization method. • Many interviewees provided input on the technologies and timelines included in RMI's preliminary decarbonization pathways.
Policy	• Several industry interviewees indicated that a lack of certainty about project approvals or rejections in the permitting process hinders desire to invest in decarbonization efforts. • Most interviewees expressed support for the idea of using Cap-and-Invest funds or other state financial supports to aid industrial decarbonization projects.

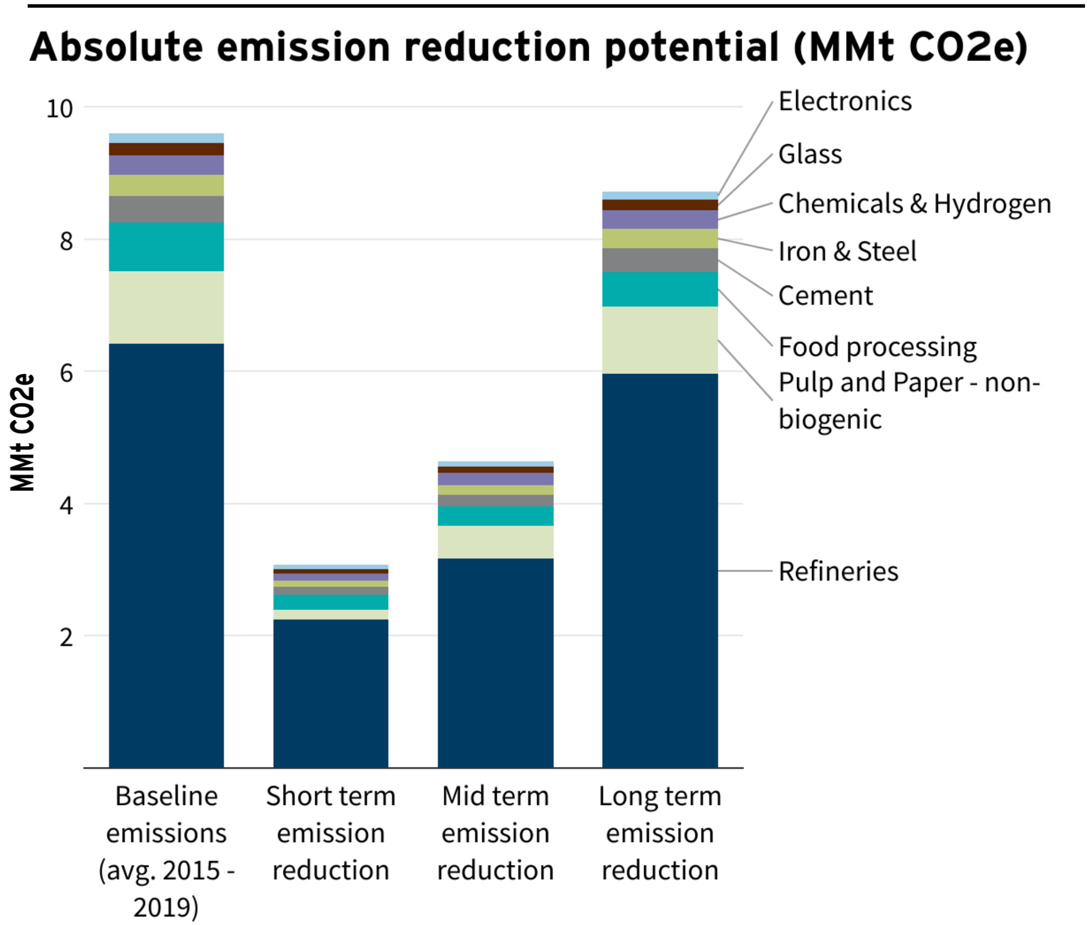
*Some members declined to be interviewed and/or did not wish to be directly referenced in our report. Interviews were conducted between December 2024-April 2025. More information about stakeholder interviews will be included in RMI's final report.

Decarbonization Pathways for Washington's Industries

Updated from the initial analysis presented in November 2024

Pathway Overview: Abatement Potential

49% emissions reduction can be achieved 2035 and 89% by 2050 on average across all sectors



Cross-cutting pathways: Energy efficiency, electrification, alternative fuels, and CCUS were evaluated alongside sector-specific technologies.

Short-term: Energy and material efficiency measures across all EITE sectors, delivering 10–30% emissions reductions with net cost savings.

Mid-term: Higher-CAPEX, more complex deployments; key levers include partial or full electrification of heat and processes.

Long-term: Transition to low-carbon fuels and deployment of CCUS, which today remain costly and complex, pushing full-scale rollout to a 10-year horizon.

Highest-impact sectors: Refineries, pulp & paper, and food processing offer the highest reduction potential (2035/2050):

- Refineries: Emissions are highly concentrated in 5 facilities, 3.2/5.9 MMt CO_2e reduction
- Pulp & Paper: 11 mills, 0.5/1.02 MMt CO_2e reduction (non-biogenic)
- Food Processing: 13 plants totaling 0.6 MMt CO_2e/yr, but smaller per-site scale with 0.3/0.52 MMt CO_2e reduction

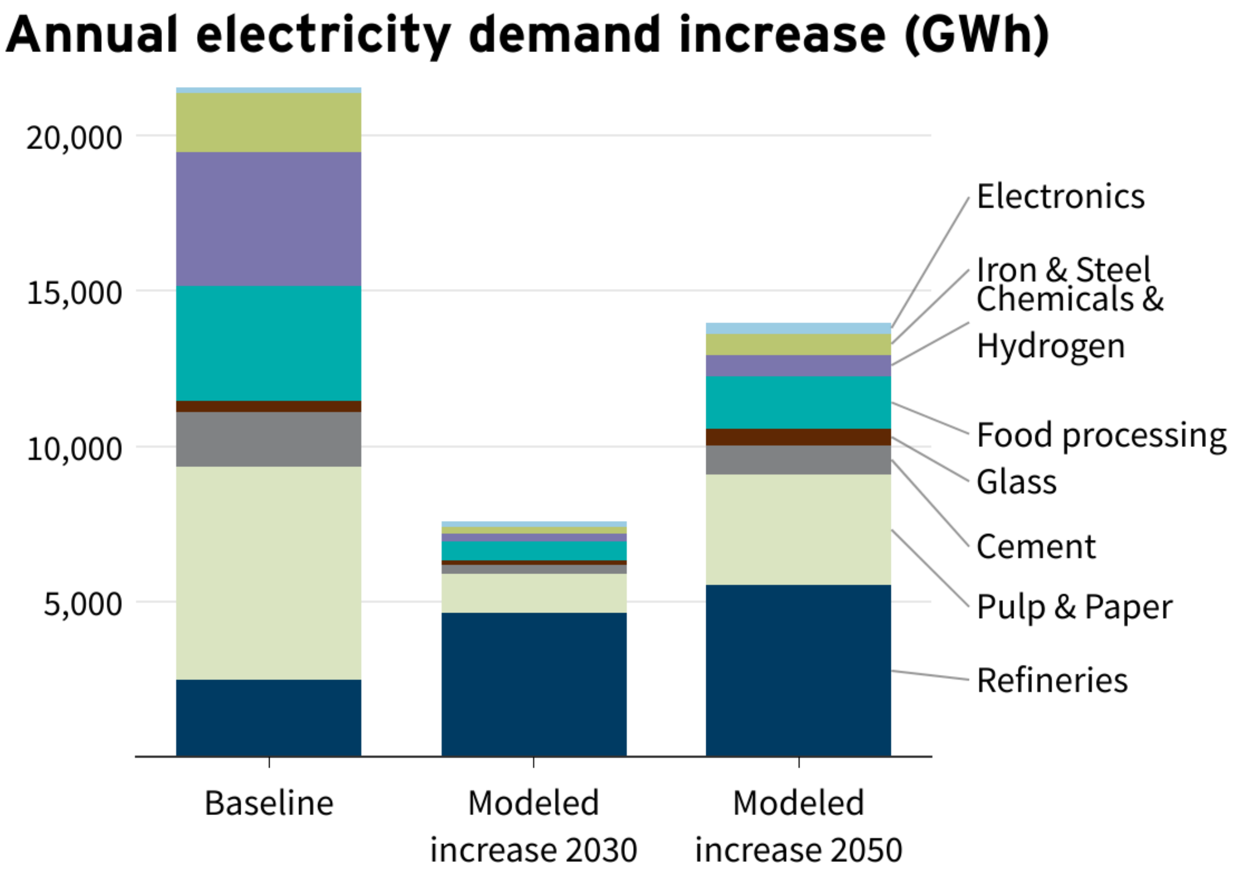
CCUS feasibility In diffuse, small-scale sectors (e.g., food processing, glass manufacturing) CCUS is not currently viable; focus remains on large, concentrated sources including refineries, cement and chemicals.

Grid constraints: Transmission capacity and the need for firm, low-carbon power can delay electrification projects or raise costs.

RMI analysis, GHG Reporting Program Publication

Pathway Overview: Electricity Demand

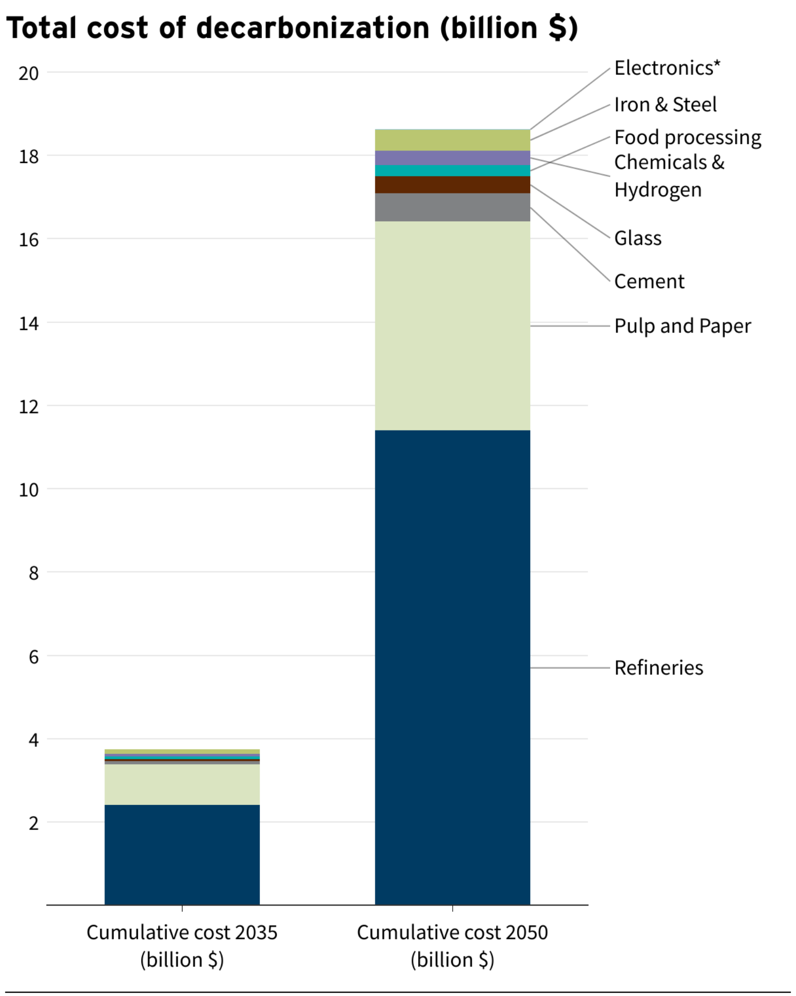
Relative increase by 35% in 2030 and 65% in 2050



- Access to grid with clean electricity can become a bottleneck for at-scale introduction of electrification, green hydrogen and CCUS
- Additional annual electricity demand is modeled with RMI-developed model
  - Full electrification of low temp heat processes (<100°C)
  - Combination of electrification, green hydrogen and CCS for high-temp applications
- Total additional demand in 2050: 13,975 GWh
- Sectors with the highest expected increase (2050):
  - Refineries: ~5,523 GWh
  - Pulp & Paper: ~3,574 GWh
  - Food Processing: ~1,704 GWh
- Current total industrial demand: 21,462 GWh
- State's net generation (2023): 102,960 GWh

RMI analysis, EPA FLIGHT, NW Power & Conservation Council, U.S. Energy Information Administration

Pathway Overview: Cost Estimates



- Methodology cost calculation:
  - Summed each technology's marginal abatement cost (MAC) ($/tCOe) × its sector-specific emission reduction (tCOe)
  - MAC data sourced from DOE Liftoff reports, peer-reviewed literature, and case studies
  - Values vary by technology and project
  - Average values were used to avoid extreme outliers
- Total investment:
  - 2035: $3.75 B
  - 2050: $18.63 B
- Total value of EITE no-cost allowances:
  - 2035: $5.4 B
- Top 3 Sector investments (2035/2050):
  - Refineries: $2.41 B / $11.40 B
  - Pulp & Paper: $0.98 B / $5.01 B
  - Cement: $0.07 B / $0.68 B

Determining allocations of no-cost allowances to EITEs post-2034

Projection Under Current Law

Annual Emissions Cap Projections Under WA Cap-and-Invest (MT CO2e)

Total annual Cap-and-Invest program allowance budgets through 2050, based on set total program budget allowance decreases relative to total program baseline values for the 2023-2026 compliance period.

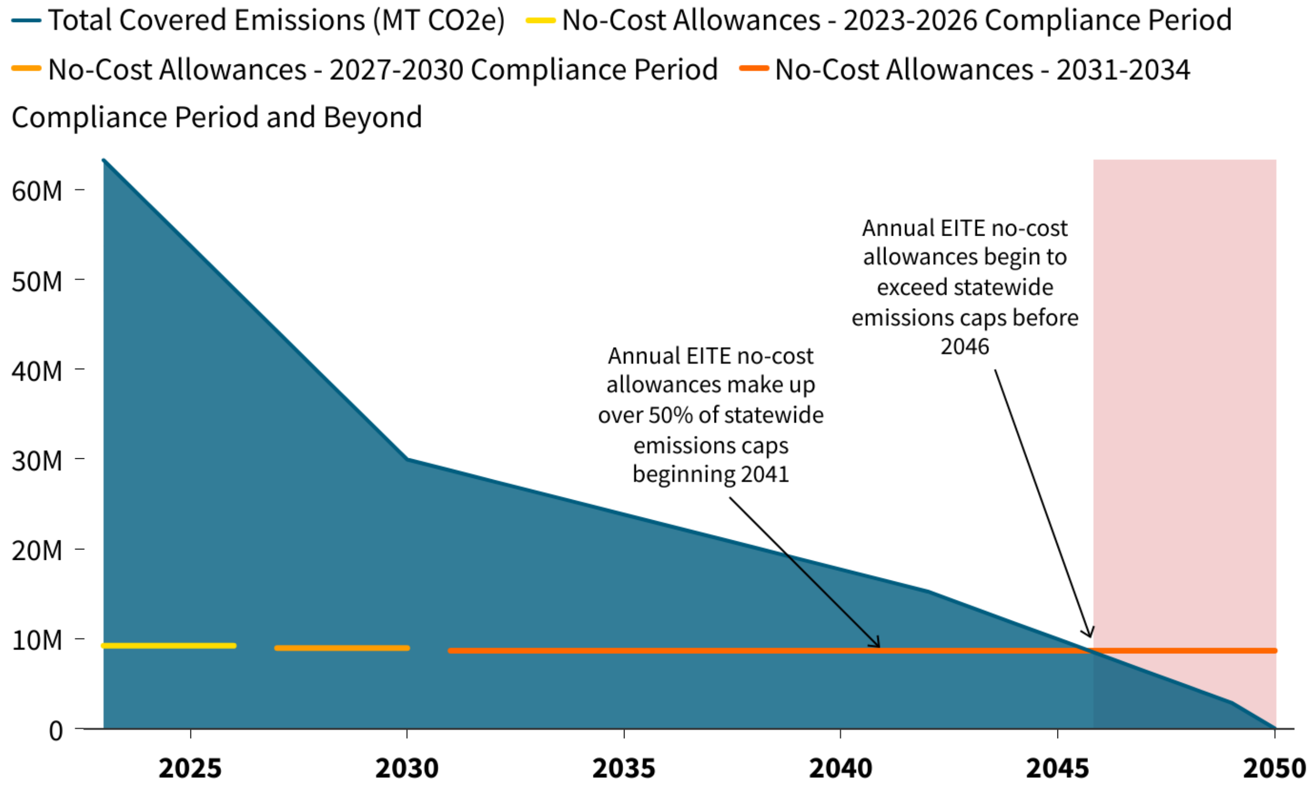


Chart: RMI • **Source:** Washington Department of Ecology

See RCW 70A.65.110 Allocation of allowances to emissions-intensive, trade-exposed industries.

Approaches to consider

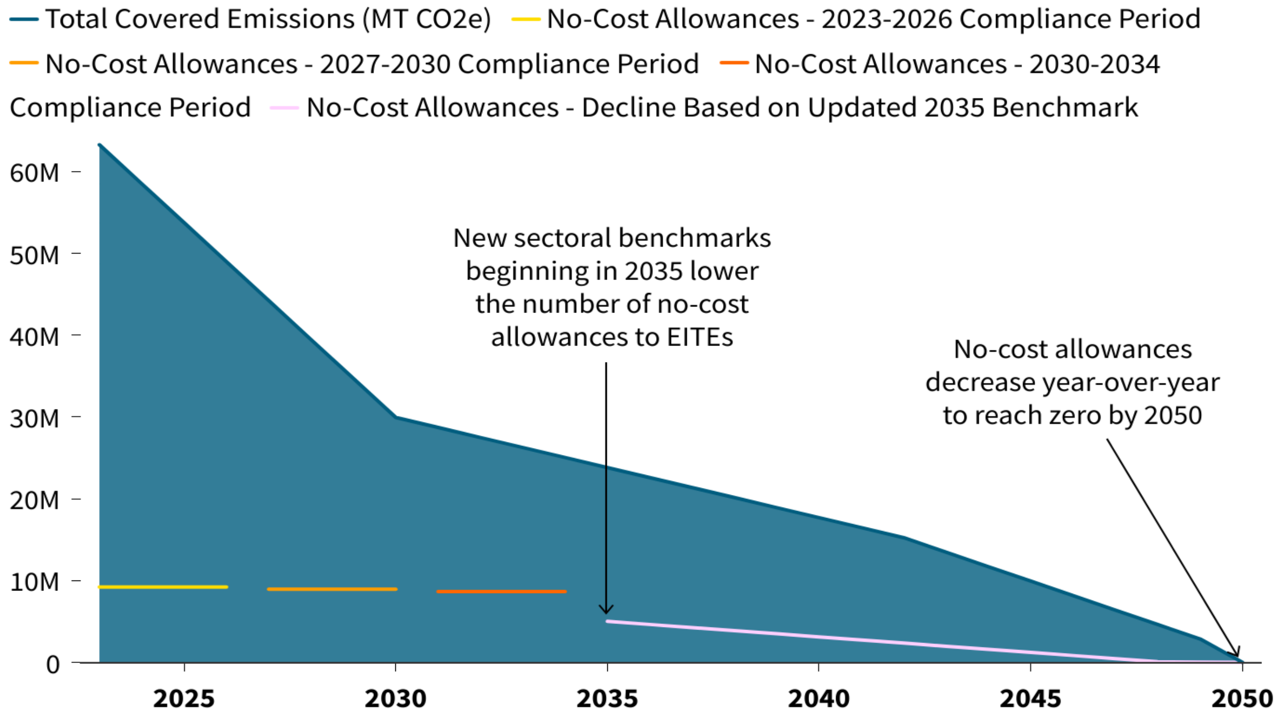
Least favored approach	No change to law. EITEs continue to receive allowances equivalent to 94% of their 2015-2019 baseline in the 2035-2050 compliance periods.
	Exempt EITEs from compliance with the Cap-and-Invest program after 2034.
	Issue more allowances to EITEs in the 2040s so that the level of no-cost allowances required to be allocated to EITEs never exceeds the overall cap.
	Cease no-cost allowance allocation to EITEs after 2034.
	Economic value basis using each EITE subsector's contribution to state GDP per ton of GHGs to prioritize distribution of no-cost allowances.
	Uniform and gradual reduction of no-cost allowance allocation post-2034 in alignment with the overall emissions cap.
Most favored approach	Sector-specific benchmarking taking into account pre-2035 technical ability to reduce emissions and post-2034 sector-specific no-cost allowance reduction schedules.

Note: Not an exhaustive list of possible approaches.

Sector-specific benchmarking and reduction

Projected Annual Emissions Cap and EITE No-Cost Allowances Projections with Estimated New 2035 Sectoral Benchmarks (MT CO2e)

New EITE sectoral 2035 emissions benchmarks, estimated based on emissions reduction potential, would see EITE no-cost allowances adjusted between 2034 and 2035 before declining steadily through 2050.



Total annual Cap-and-Invest program allowance budgets through 2050, based on set total program budget allowance decreases relative to statutory total program baseline values for the 2023-2026 compliance period through 2034. Updated 2035 emissions benchmark and 2035-2050 values based on RMI estimates.

Chart: RMI • **Source:** Washington Department of Ecology, EPA FLIGHT, RMI estimates.

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New Policy Opportunities

Why new policies?

- Existing opportunities, especially given likely upcoming changes to federal policy that removes or diminishes incentives, will not be sufficient to ensure effective decarbonization of Washington's industrial sector.
- Complement and strengthen the incentives already built into the Cap-and-Invest program.
- 18 new policy ideas considered in our analysis, all additional to determination of post-2034 no-cost allocation of allowances to EITEs.

Categorizing and prioritizing potential new policy

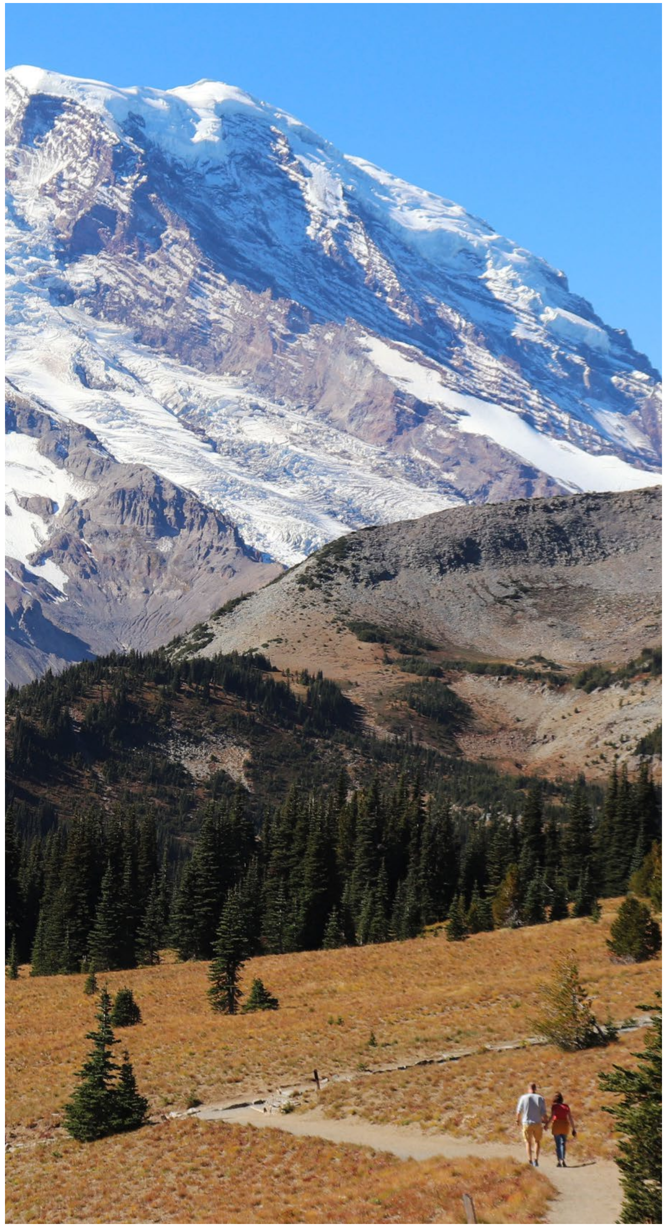
- Categories:
  - Updating Standards and Regulations refers to potential changes to state decision-making processes and rules, standards, or regulations governing issues relevant to industrial decarbonization.
  - Cap-and-Invest Program Evolution and EITE Treatment refers to actions affecting the future of compliance pathways and allowance allocations for EITE industries.
  - State Support refers to financial mechanisms Washington could leverage to aid industrial decarbonization.
- Prioritization:
  - Essential changes are those fundamentally necessary to enable technical decarbonization measures to be implemented.
  - Recommended changes are those highly likely to enable implementation of the technical measures and realistically achieve emission reduction targets.
  - Changes worth consideration are policy opportunities likely to improve the pace of Washington's industrial decarbonization, but which require additional study to effectively implement in Washington.

New Policy Opportunities categorized & prioritized

	Updating Standards and Regulations	Cap-and-Invest Program Evolution and EITE Treatment	State Support
Essential	Expedite electrical grid enhancements for industrial electrification		
	Accelerate permitting procedures for critical decarbonization projects		
Recommended	Reform industrial electricity tariffs and ratemaking	Consign EITE no-cost allowances at auction	Set up an industrially focused Green Bank
	Update existing rules on oil refinery 2025 goals	Require additional criteria to qualify as an EITE	Increase funding for the Hard to Decarbonize Sector Grants Program
Worth Consideration	Introduce a clean heat standard	Allow opt-in EITE entities to receive no-cost allowances	Augment technical assistance planning grants for decarbonization
	Expand methane regulations	Develop additional offset protocols	Strengthen state procurement requirements
			Introduce tax credits for emission reducing equipment
			Introduce tax credits for clean manufacturing production
			Invest in common carrier infrastructure for the transportation of green hydrogen
			Incentivize transitions of refineries to other functions

Conclusion & Next Steps

- Conclusion
  - Washington's Cap-and-Invest program is effective but faces challenges in the treatment of industrial emissions.
  - Deep industrial decarbonization by 2050 is achievable through the technical pathways we have identified.
  - Achieving Climate Commitment Act targets will require legislative action, regulatory changes, and dedicated industrial funding.
  - Coordinated efforts among government, industry, and the public can reduce emissions, prevent leakage, and attract clean industry to Washington.
  - "If it's difficult we do it immediately. If it looks impossible, it may take a bit longer." – Choose Washington
- Next steps
  - If you wish, send feedback by June 2nd to dveysey@rmi.org
  - Final report will be published by the end of June



Pictured: Mount Rainier National Park

Questions?

Contact for follow-ups:
dveysey@rmi.org

Emission reductions overview (MMt CO_2e)

	Baseline emissions (2015-2019)	Short term emission reduction	Mid term emission reduction	Long term emission reduction	Cumulative emission reduction (2035)	Cumulative emission reduction (2050)
Refineries	6.411617	2.24406595	3.173750415	5.96280381	21.3595187	100.900154
Pulp and Paper - Total	6.9035984	0.966503776	3.072101288	6.42034651	20.3693322	104.373925
Pulp and Paper - non-biogenic	1.0977264	0.153681696	0.488488248	1.02088555	3.23888389	31.8340656
Food processing	0.74342	0.223026	0.297368	0.520394	1.17186537	11.3422823
Cement	0.3921906	0.11765718	0.174524817	0.35297154	0.63756907	5.16891588
Iron & Steel	0.33111	0.099333	0.1489995	0.297999	1.94708481	8.68002945
Chemicals & Hydrogen	0.2927016	0.099518544	0.181474992	0.2751395	0.96376296	4.63879065
Glass	0.1787392	0.07149568	0.092944384	0.16086528	0.98935656	4.86705522
Electronics	0.1476388	0.069390236	0.08120134	0.12549298	0.43837687	2.10153801

RMI analysis

Refineries

Sector snapshot

Lower tech & permit risk, GHG cuts → **Higher tech & permit risk, GHG cuts**

Marginal Optimization and Efficiencies

Lowering emissions without major capital investments. Options could include lighter and/or lower sulfur crudes, HEFA biofeed co-processing (S3)*, targeted equipment upgrades, better maintenance, automation, and less fugitives and flaring

Electrification

Replacing fossil fuel-based systems with electric technologies, focusing primarily on condensing/venting steam turbines (e.g., pumps and compressors) and process heating (e.g., boilers and fired heaters).

Gasoline Unit & Fuel-Grade Coker Shutdowns

Shutting down key processing units can reduce emissions as road fuel demand drops. Naphtha (paraffinic or aromatic) and short resid can be repurposed as a higher-sulfur non-fuel feedstock for other industries, preserving some product value.

Biorefinery Conversion

Includes conversion of smaller refineries or select secondary units to produce biofuels like Sustainable Aviation Fuel (SAF). Ideal for lower-capacity sites like U.S. Oil/PAR Pacific in Tacoma.

Low-Intensity Hydrogen

Production of green hydrogen via electrolysis (preferred) or "turquoise" via methane pyrolysis. Green can be eligible for 45V tax credits for dedicated processing. The wide range of WA refinery sizes (>5x) can support commercial scale-up of these technologies.

Fluid Catalytic Cracking Waste Gas Carbon Capture

Captures CO_2 from FCC waste gas, potentially converting it to methanol. Eligible for 45Q tax credits, this method provides a bridge to cleaner production options - particularly relevant in the long-term for advanced SAF and low-emissions chems.

- 5 facilities, 6.4 MMt CO_2e p.a.
- Emission reduction potential (2035/2050): 3.2 MMt CO_2e/5.96 MMt CO_2e
- Cumulative cost (2035/2050): $2.1 B/$11.4 B
- Electricity demand increase (2030/2050): 4,639 GWh/5,522 GWh

RMI analysis

Pulp and paper

Sector snapshot

Short term | **Mid term** | **Long term**

Energy Efficiency/Waste Heat Recovery

Improving energy efficiency, particularly in steam systems, represents a significant immediate opportunity for emissions reductions and cost savings. Other technologies include advanced process control (APC) systems, enzyme-assisted refining and impulse drying.

Electrification

Includes electrification of the auxiliary boilers for production of steam used in the pulp mills and paper production processes, especially relevant for non-integrated paper mills.

Low Carbon Fuels and Hydrogen

The most probable source for Low Carbon Fuels (LCFs) for this subsector are forest residues, sawmill chips or pellets. LCFs particularly relevant for integrated and pulping mills due continued access to biomass. Green hydrogen can be used as a cleaner fuel for steam generation

Carbon Capture Utilization Storage

Applied to address CO_2 residual process emissions, such as those from boilers that burn biomass residue leftover after pulping, and from lime kilns used in the Kraft chemical recovery process.

Black Liquor Gasification/ Biorefinery

Converting black liquor into syngas for generating electricity and steam more efficiently or using it in biorefineries for biofuels and hydrogen production. In combination with CCUS contribute to negative emissions.

13 facilities, 6.9 MMt CO_2e p.a, 1.1 MMt – non biogenic focus for emission reduction

Emission reduction potential (2035/2050): 0.48 MMt CO_2e/ 1.02 MMt CO_2e

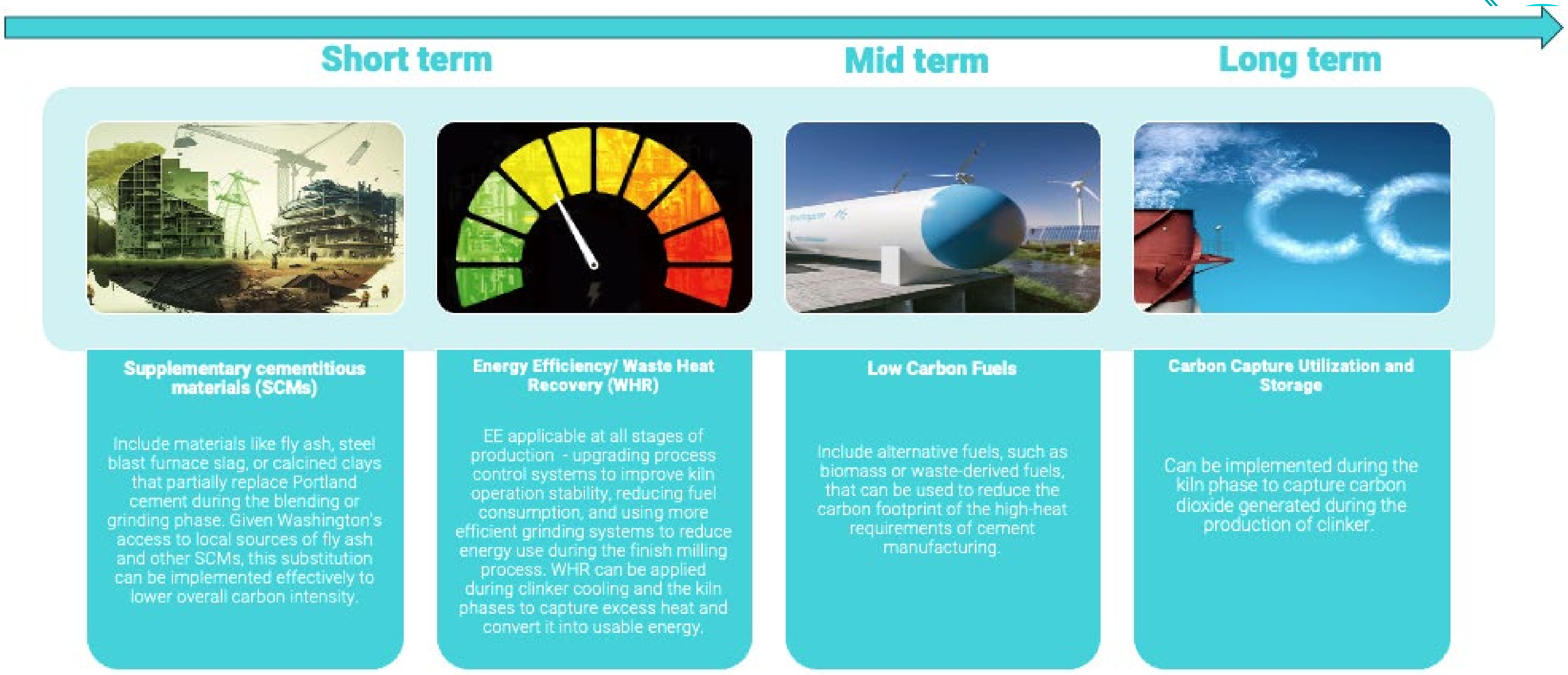
Cumulative cost (2035/2050): $0.98 B/ $5.01B

Electricity demand increase (2030/2050): 1,242 GWh/ 3,574 GWh

RMI analysis

Cement

Sector snapshot



1 facility, 0.39 MMt CO_2e p.a,

Emission reduction potential (2035/2050): 0.17 MMt CO_2e/0.36 MMt CO_2e

Cumulative cost (2035/2050): $0.07 B/$0.68 B

Electricity demand increase (2030/2050): 278 GWh/931 GWh

RMI analysis

Glass production

Sector snapshot

Short term | **Mid term** | **Long term**

Material Efficiency and Recycling

Includes increasing the use of recycled glass (cullet), which has a lower melting temperature compared to raw materials, thus requiring less process heat. Utilizing cullet also avoids both energy-related and process CO_2 emissions.

Energy Efficiency/ Waste Heat Recovery

Efficiency measures, such as the use of oxyfuel furnaces, reduce energy consumption by optimizing combustion in the glass melting process - widely applied in the U.S. due to low capital cost and ease of retrofit, used alongside with WHR from the exhaust gases for preheating the combustion air.

Electrification

Includes electrifying specific heating processes using electric melting furnace technologies, such as submerged electrodes, microwaves, and plasma.

Low Carbon Fuels / Hydrogen

Replacing fossil fuels with low-carbon alternatives, such as biogas, synthetic methane, biomass, or green hydrogen. This substitution can provide the high temperatures needed for melting glass materials while significantly reducing carbon emissions

Carbon Capture Utilization and Storage

CCUS technologies to capture and store CO_2 emissions from the melting process. Feasibility for the glass industry remains uncertain due to challenges such as the presence of acidic compounds and high cost.

- 2 facilities, 0.178 MMt CO_2e p.a,
- Emission reduction potential (2035/2050): 0.09 MMt CO_2e / 0.16 MMt CO_2e
- Cumulative cost (2035/2050): $0.05 B/$0.41 B
- Electricity demand increase (2030/2050): 163 GWh/526 GWh

RMI analysis

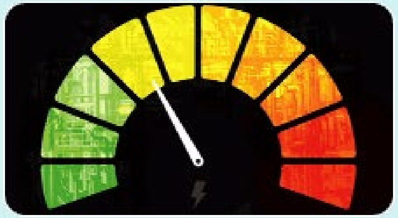
Food processing

Sector snapshot

Short term | **Mid term** | **Long term**

Material Efficiency

Includes optimizing the use of raw materials, reducing waste, and maximizing product yield, e.g., reducing waste in peeling (steam pealing, optical peeling control systems), sorting, and blanching (counter-flow) steps can significantly cut energy use and emissions.



Energy Efficiency/Waste Heat Recovery

Incudes efficient lighting, chillers, freezers, fryers with advanced control systems, variable speed drives for washing and peeling processing. Heat recovery from fryers, water vapors, steam peelers can be used to e.g., pre-heat blanching water, air or heating.

Electrification

Involves replacing gas-fired boilers or fryers with electric ones. Heat pumps can be used to electrify the provision of low- to medium-temperature (up to 200°C) heat for preheating and drying.

Low Carbon Fuels/ Hydrogen

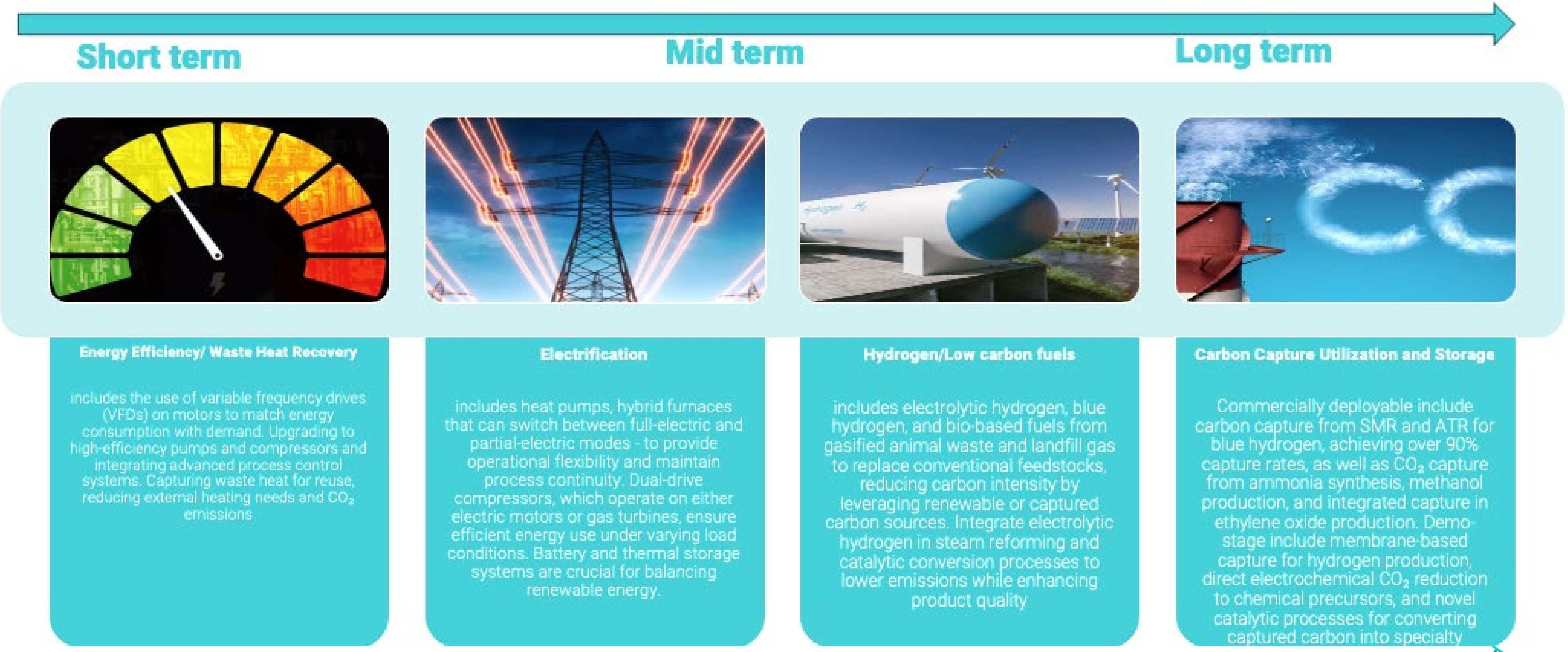
Includes switching from conventional fossil fuels to low carbon alternatives, such as biogas, biomethane, or renewable natural gas for high-temperature processes (e.g. frying, roasting, drying). Hydrogen can also be used as a fuel for steam boilers and burners, replacing natural gas.

- 10 facilities, 0.74 MMt CO_2e p.a,
- Emission reduction potential (2035/2050): 0.3 MMt CO_2e / 0.52 MMt CO_2e
- Cumulative cost (2035/2050): $0.06 B/ $0.26 B
- Electricity demand increase (2030/2050): 625 GWh/ 1,704 GWh

RMI analysis

Chemicals and hydrogen

Sector snapshot



4 facilities, 0.29 MMt CO_2e p.a,

Emission reduction potential (2035/2050): 0.18 MMt CO_2e / 0.27 MMt CO_2e

Cumulative cost (2035/2050): $0.07B/$0.36B

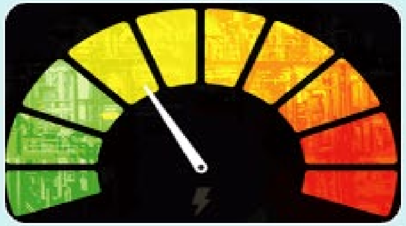
Electricity demand increase (2030/2050): 232 GWh/686 GWh

RMI analysis

Iron and steel

Sector snapshot

Short term — **Mid term** — **Long term**



Material efficiency

includes maximizing the use of high-quality prime scrap minimizing the need for energy-intensive primary iron production. By optimizing the charge mix with low-carbon DRI/HBI as a supplement, mills can overcome limitations in scrap availability while maintaining production quality. Adopting advanced sorting and recycling techniques help preserve material purity

Electrification

includes Electric Arc Furnace to melt and refine iron. Integrating onsite renewable energy sources, such as solar or wind power, along with energy storage solutions, ensures a stable and clean power supply, while smart process controls and waste heat recovery systems further enhance operational efficiency and sustainability.

Hydrogen

Green hydrogen used as a reducing agent in the direct reduction of iron ore (DRI) process. Instead of relying on carbon-based fuels like natural gas, hydrogen reacts with iron ore to produce direct-reduced iron while generating water as a byproduct also includes electrolytic hydrogen for rolling and casting

Carbon Capture Utilization and Storage

Primarily beneficial for Blast Furnace – Basic Oxygen Furnace (BF-BOF) mills– due to their high CO_2 emissions from coke combustion,, the technology is also being investigated for integration into natural gas-based DRI/HBI. In the EAF route, CCS may be applied to off-gas streams or to residual emissions from DRI production

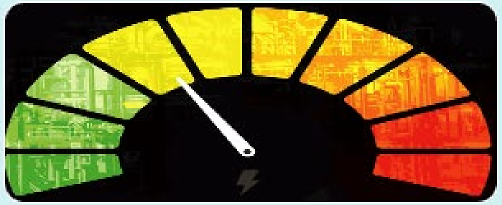
- 1 steel facility, 0.33 MMt CO_2e p.a,
- Emission reduction potential (2035/2050): 0.15 MMt CO_2e / 0.3 MMt CO_2e
- Cumulative cost (2035/2050): $0.1 B/$0.49 B
- Electricity demand increase (2030/2050): 224 GWh/683 GWh

RMI analysis

Electronics

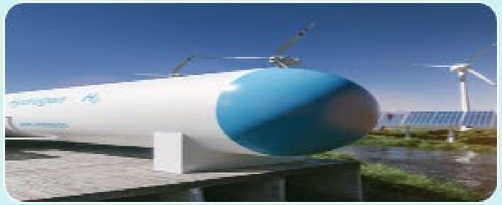
Sector snapshot

Short term | **Mid term**



Energy Efficiency

includes integration of real-time process control systems in cleanroom environments, which optimize HVAC and lighting operations to reduce energy waste, energy-efficient lighting and cooling systems



Sustainable materials

employing sustainable materials—such as recycled silicon feedstock and low-VOC solvents during chemical processing—further enhances sustainability by minimizing resource consumption and reducing waste throughout production.

Electrification

Electrification measures include transitioning from fossil fuel-based backup generators to grid-connected renewable systems—such as on-site solar installations—to power high-energy processes like photolithography and etching

- 2 facilities, 0.15 MMt CO_2e p.a,
- Emission reduction potential (2035/2050): 0.08 MMt CO_2e /0.125 MMt CO_2e
- Cumulative cost (2035/2050): $0.004 B/$0.02 B
- Electricity demand increase (2030/2050): 161 GWh/347 GWh

RMI analysis