# Scaling the Industrial Transition: Hard-to-Abate Sectors and Net-Zero Progress in 2025

December 2025

**IESR Webinar, 29 January 2026 – Hard-to-Abate Sectors and Net-Zero Progress**

Centre for Energy and Materials

# Our role



The World Economic Forum is the trusted platform for public-private cooperation. **Our mission is to improve the state of the world.**

At the Forum, we connect leaders from business, government, civil society, international organizations, academia, and the next generation to make sense of global challenges and move the world forward together.

We create trusted spaces where diverse and divergent voices can engage openly, work across sectors and regions and build lasting relationships. Through dialogue and trust building, we support partners in turning shared understanding into meaningful solutions that address the issues that matter most to people and the planet

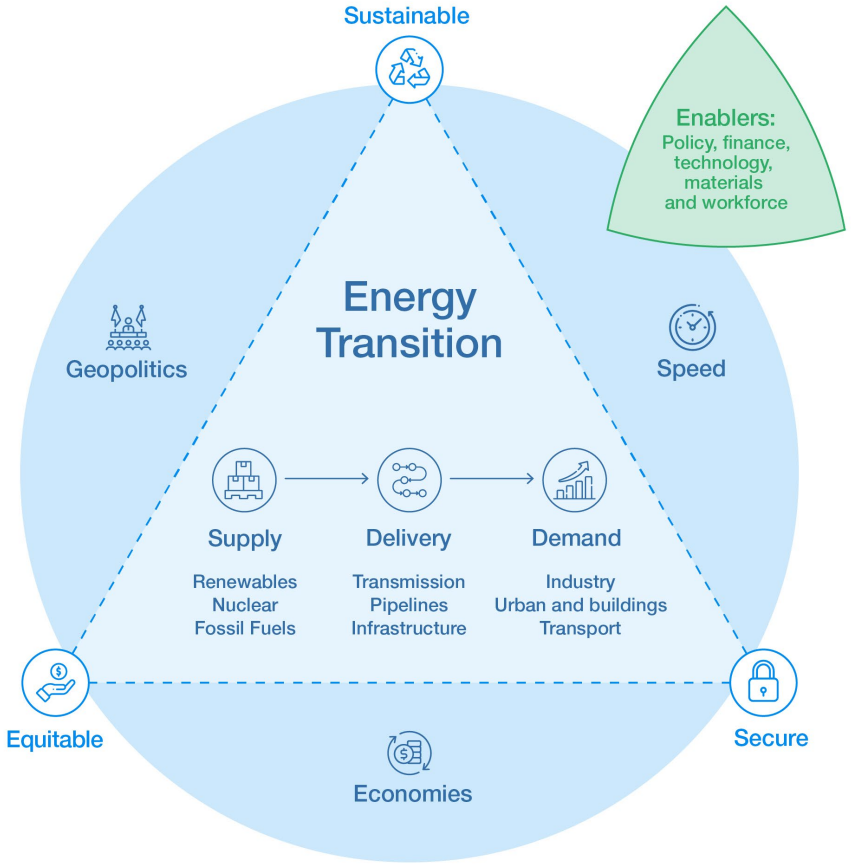
# Shaping the future of energy and materials

## Our Vision

To accelerate the transition to secure, sustainable, and equitable energy and materials systems that enable positive economic and social development.

## Our Mission

Bring together leaders from companies and countries to create insights, shape solutions and engage in high impact collaboration to accelerate energy and material transitions.



# Overview of Centre Programs

## Shaping the Future of Energy

Driving transitions towards a world enabled by secure, sustainable, and affordable energy systems that drive opportunity for all.

Initiatives:

- Future of Clean Fuels
- Future of Power Systems
- Responsible Renewables Infrastructure
- Coal to Clean
- Energy Transition Index
- Net-Zero Industry Tracker
- AI Energy Impact

## Transforming Industrial Ecosystems

Shaping the transformation of industrial ecosystems to drive economic growth, employment and reduce CO2e emissions.

Initiatives:

- Transitioning Industrial Clusters

## Advancing the Future of Materials

Driving a future where material systems transition toward optimal accessibility, sustainability, and productivity, fostering societal, economic, and environmental prosperity.

Initiatives:

- Securing Minerals for the Energy Transition
- Transitioning Materials Systems*

Deploying our work at the regional level through multi-stakeholder meetings, engaging 4IR Centres and conducting regional deep dives

* in development

# ETI – A framework for effective energy transition

**Country-level snapshot of energy systems:** Benchmarking countries holistically on energy **system performance** across security, sustainability, Equity and **transition readiness.**

| 118 | 10 | 43 |
|---|---|---|
| Countries | Years | Indicators |

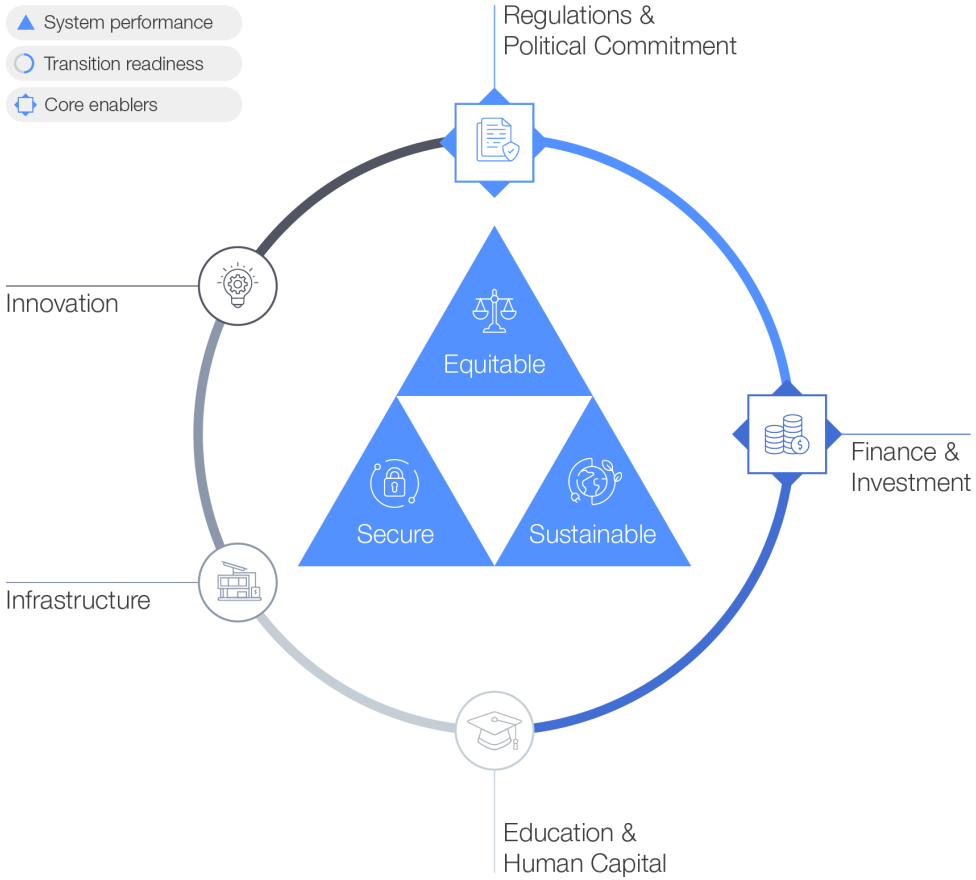
01 Improved data recency (+1.2 years), granularity, and source reliability

02 Removed redundant or low-impact indicators

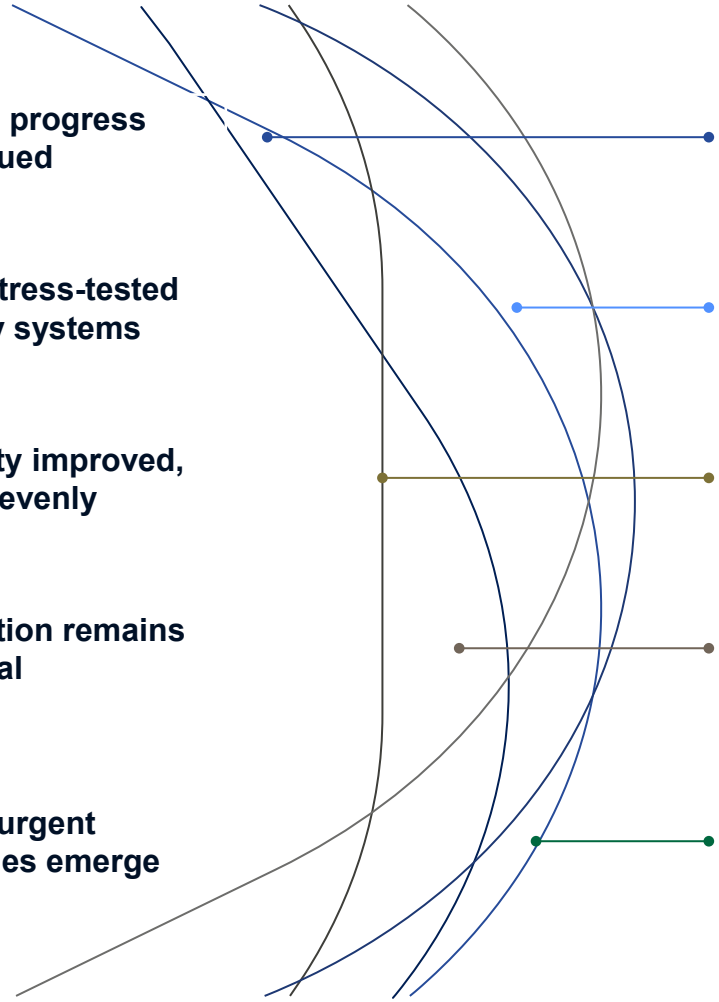
03 Introduced more targeted metrics (e.g. economic freedom)

04 Incorporated methodological feedback from advisory board members

05 Incorporated careful assessment of today's shifting geopolitical and economic landscape



# ETI 25: Executive summary




ETI 2025 shows modest but broad progress in energy transition (+1.1% YoY), led by gains in equity and clean energy adoption

Record energy demand (+2.2%) and supply chain disruptions exposed systemic vulnerabilities; $CO_2$ emissions hit a new high; investment slow down

65% of countries improved their scores, mainly advanced economies; only 28% advanced across all energy dimensions

Advanced economies still lead but face delivery gaps; Emerging Europe and Asia gained momentum; capital flows remain misaligned

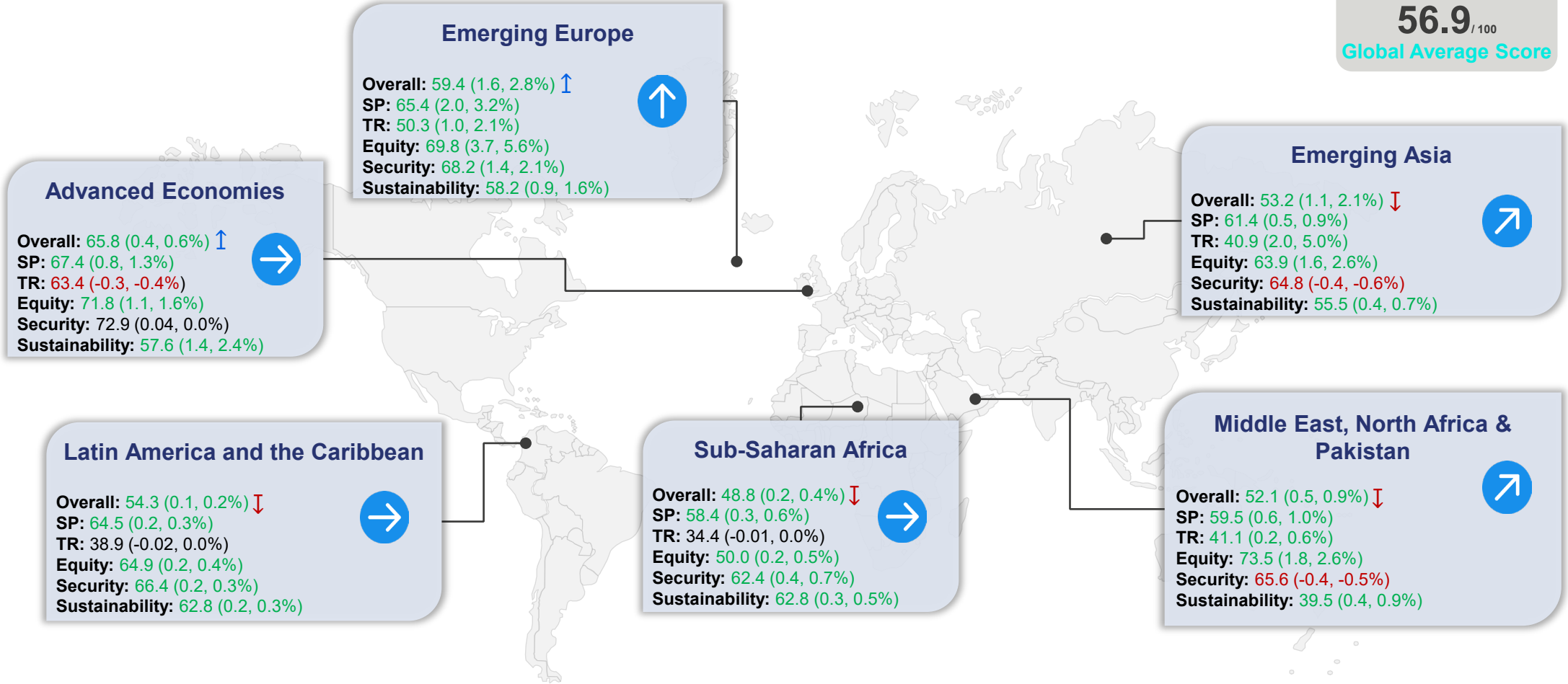
- Redefine energy security (grids, minerals, digital resilience)
- Bridge investment gaps, especially in emerging markets
- Unblock delivery bottlenecks in infrastructure, permitting, and workforce

Source(s): (1) IEA, (2) BNEF

GEOGRAPHIC VIEW

# Global energy transition scores in 2025

**56.9**/100
Global Average Score



## Emerging Europe

**Overall:** 59.4 (1.6, 2.8%) ↥
**SP:** 65.4 (2.0, 3.2%)
**TR:** 50.3 (1.0, 2.1%)
**Equity:** 69.8 (3.7, 5.6%)
**Security:** 68.2 (1.4, 2.1%)
**Sustainability:** 58.2 (0.9, 1.6%)

## Advanced Economies

**Overall:** 65.8 (0.4, 0.6%) ↥
**SP:** 67.4 (0.8, 1.3%)
**TR:** 63.4 (-0.3, -0.4%)
**Equity:** 71.8 (1.1, 1.6%)
**Security:** 72.9 (0.04, 0.0%)
**Sustainability:** 57.6 (1.4, 2.4%)

## Emerging Asia

**Overall:** 53.2 (1.1, 2.1%) ↧
**SP:** 61.4 (0.5, 0.9%)
**TR:** 40.9 (2.0, 5.0%)
**Equity:** 63.9 (1.6, 2.6%)
**Security:** 64.8 (-0.4, -0.6%)
**Sustainability:** 55.5 (0.4, 0.7%)

## Latin America and the Caribbean

**Overall:** 54.3 (0.1, 0.2%) ↧
**SP:** 64.5 (0.2, 0.3%)
**TR:** 38.9 (-0.02, 0.0%)
**Equity:** 64.9 (0.2, 0.4%)
**Security:** 66.4 (0.2, 0.3%)
**Sustainability:** 62.8 (0.2, 0.3%)

## Sub-Saharan Africa

**Overall:** 48.8 (0.2, 0.4%) ↧
**SP:** 58.4 (0.3, 0.6%)
**TR:** 34.4 (-0.01, 0.0%)
**Equity:** 50.0 (0.2, 0.5%)
**Security:** 62.4 (0.4, 0.7%)
**Sustainability:** 62.8 (0.3, 0.5%)

## Middle East, North Africa & Pakistan

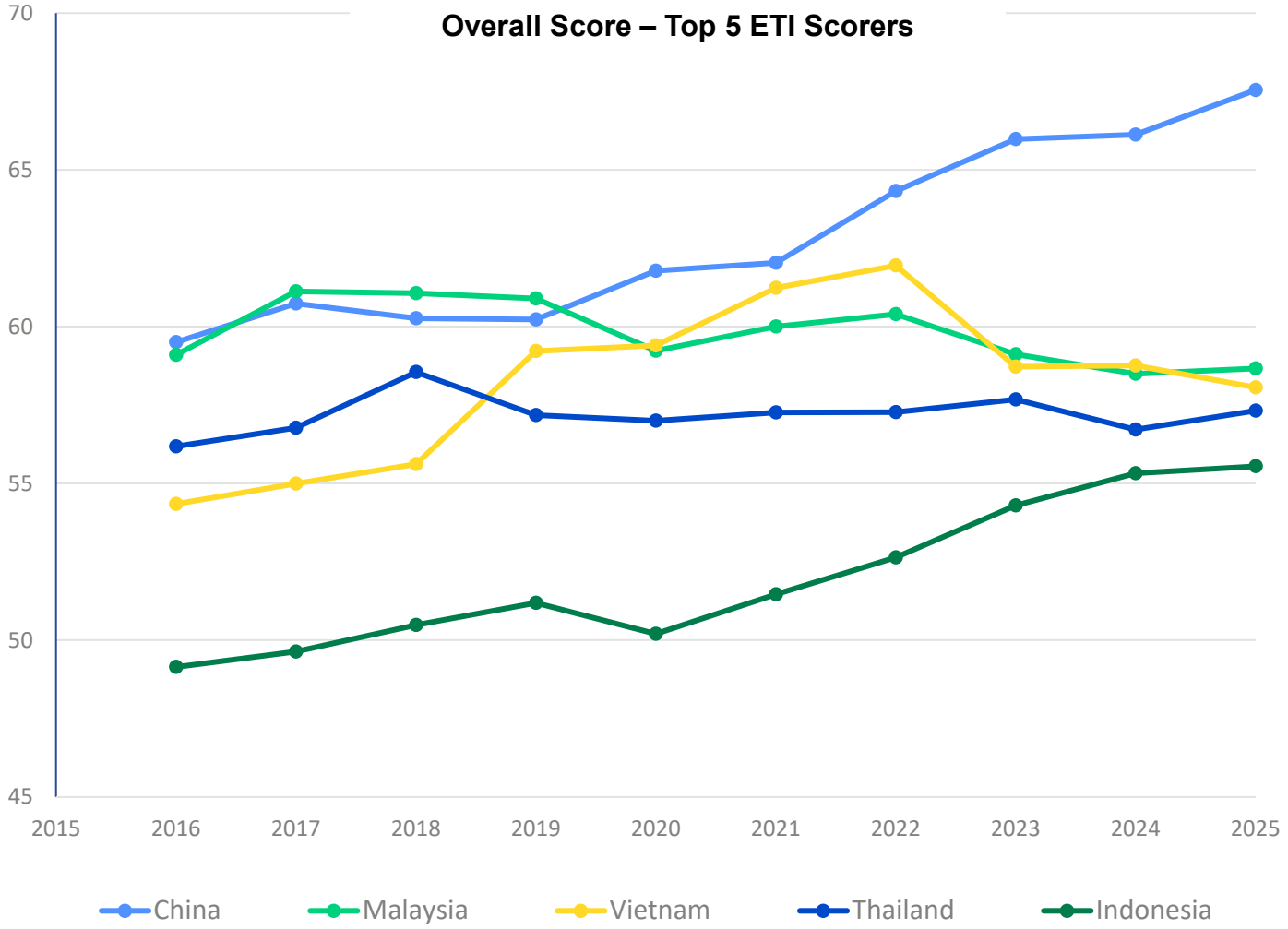
**Overall:** 52.1 (0.5, 0.9%) ↧
**SP:** 59.5 (0.6, 1.0%)
**TR:** 41.1 (0.2, 0.6%)
**Equity:** 73.5 (1.8, 2.6%)
**Security:** 65.6 (-0.4, -0.5%)
**Sustainability:** 39.5 (0.4, 0.9%)

**Emerging Europe leads regional progress in 2025, followed by Emerging Asia**

↑ ↗ → shows whether the region's score rose or fell compared with last year

↧ ↥ indicates whether the region's average score sits above or below the global average

# Geographic profile: Emerging Asia




## Top Scorer Reasoning

- **China:** High readiness for the energy transition backed by leading clean energy and industrial infrastructure, human capital, innovation and investment. China accounted for nearly 40% of the world's clean energy investment in 2024.
- **Malaysia:** Scores high on Equity and Security due to near universal access, strong diversification and reliable grid infrastructure
- **Vietnam:** Vietnam has achieved near-universal energy access, strong grid reliability, and leads the region in energy use per capita.
- **Thailand:** Thailand scores high on energy security, supported by very few and short electricity outages, reflecting strong grid reliability.
- **Indonesia:** Indonesia stands out for its self-reliance, with minimal energy imports, a well-diversified energy mix, and dependable grid performance.

# Net Zero Industry Tracker

Accelerating the speed and scale of industrial and company transitions by corporate leaders, policy makers and civi society with insights and fact-based frameworks for dialogue, collaboration and sector progress tracking.

## OUR INITIATIVE

The Net-Zero Industry Tracker monitors the pace of decarbonization of eight hard-to-abate industry sectors, which account for approximately 40% of global greenhouse emissions (Scopes 1 and 2).

## OUTCOMES

- Foster greater understanding of the state and readiness for transition of heavy industrial sectors by establishing a disseminating a fact-based framework and knowledge framework.
- Support the adoption of best practices to accelerate transition efforts by sharing case studies from global peers and our expert community.
- Support the creation of energy transition roadmaps by curating and facilitating public-private collaboration.

## VALUE FOR MEMBERS

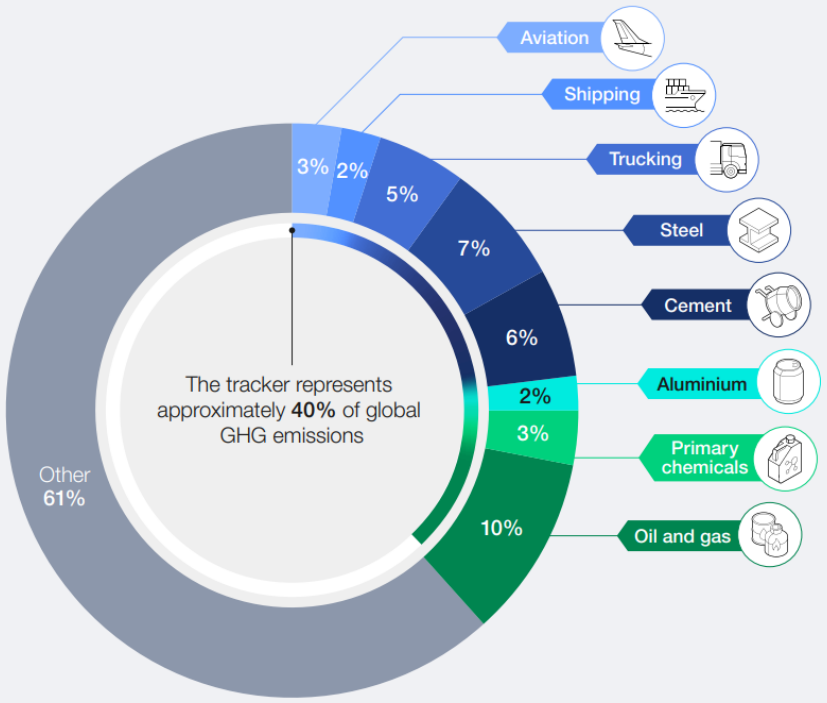
- Timely and Consistent Monitoring: Essential for assessing progress in these sectors and identifying areas of opportunity in industrial and heavy transport decarbonization.
- Comprehensive Approach: A standardized and consistent methodology to unlock cross-sectoral synergies.
- Collaboration Opportunities: The Tracker facilitates collaboration by offering a unified platform for diverse stakeholder groups.
- Latest Information Consolidation: Developed in consultation with industry sustainability leaders, expert organizations, and industrial associations, the Tracker consolidates the most current and relevant data.
- Cross-Cutting Insights: Providing cross-cutting insights on issues that cut across different hard to abate sectors

# Framework

The Net Zero Industry Tracker analyses the progress of eight hard-to-abate sectors in achieving net-zero emissions by 2050.

## Scope

Covers 8 sectors across heavy industry and heavy transport, covering ~40% of global GHG emissions

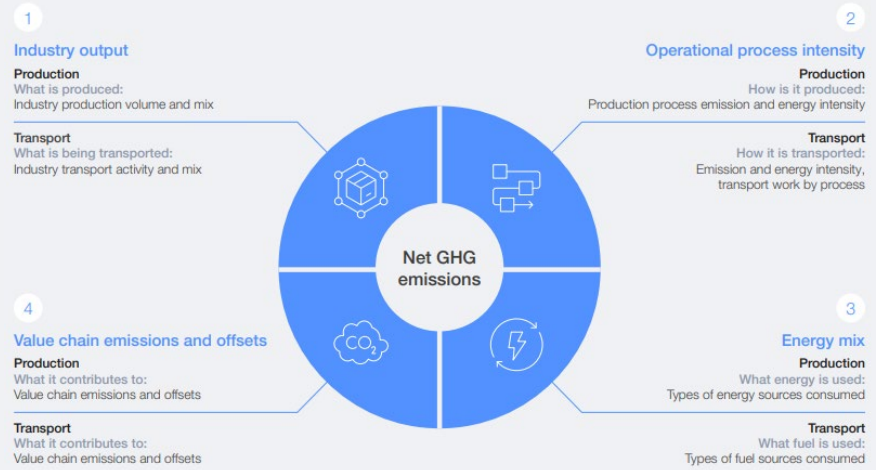



Sources: IEA and IAI.

Net-Zero Industry Tracker: 2024 Edition

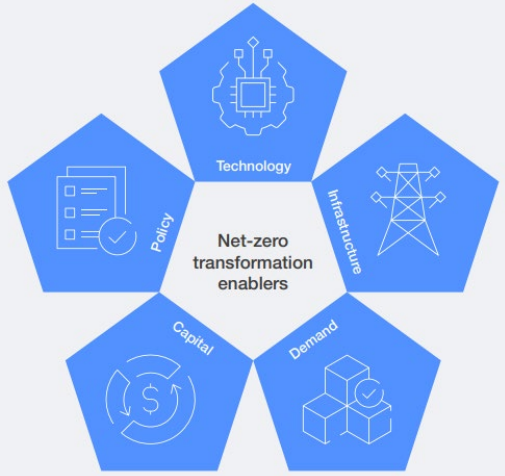
## Performance

Assesses emission performance in recent years and compares to targets




## Readiness

Provides an assessment of how ready a sector is to transform across 5 dimensions



# 2025 context – The year in review

| | |
|---|---|
| Emissions are rising despite pockets of sectoral progress | ▪ Global CO2 emissions hit a new record in 2024 (+ 0.9% to 38 Gt)[1] – most sectors saw emissions rise, while small declines in steel and cement were driven by lower output<br>▪ Demand surged 2.2% in 2024[2], well above the decade's average, driven by rapid electrification and the explosive rise of AI and data centers, and industrial electricity demand grew 4%[3]<br>--> **Activity growth is outpacing decarbonization** |
| Technology progress is real, but scaling is held back by economics and system constraints | ▪ Renewables expanded rapidly (92% of new capacity additions)[4], SAF production doubled, and hydrogen/CCUS pilots progressed<br>▪ Yet cost inflation, volatile interest rates, grid congestion and slow permitting limited deployment, whilst clean energy investment remained high, but growth slowed (11% vs 24-29% in previous years)<br>--> **The limiting factor is no longer technology but the systems that deploy it** |
| Geopolitics and supply chains are reshaping the cost and pace of the transition | ▪ Tariffs, regional carbon prices, and export controls are regionalizing trade and tech flows, fragmenting access to critical materials and advanced manufacturing capacity<br>▪ Industrial competitiveness is exposed to volatility in energy prices, interest rates and exchange rates<br>--> **Industrial transition is happening in a more fragmented, more competitive world** |

**2025: Progress under pressure – emissions rising, technologies advancing, systems lagging**

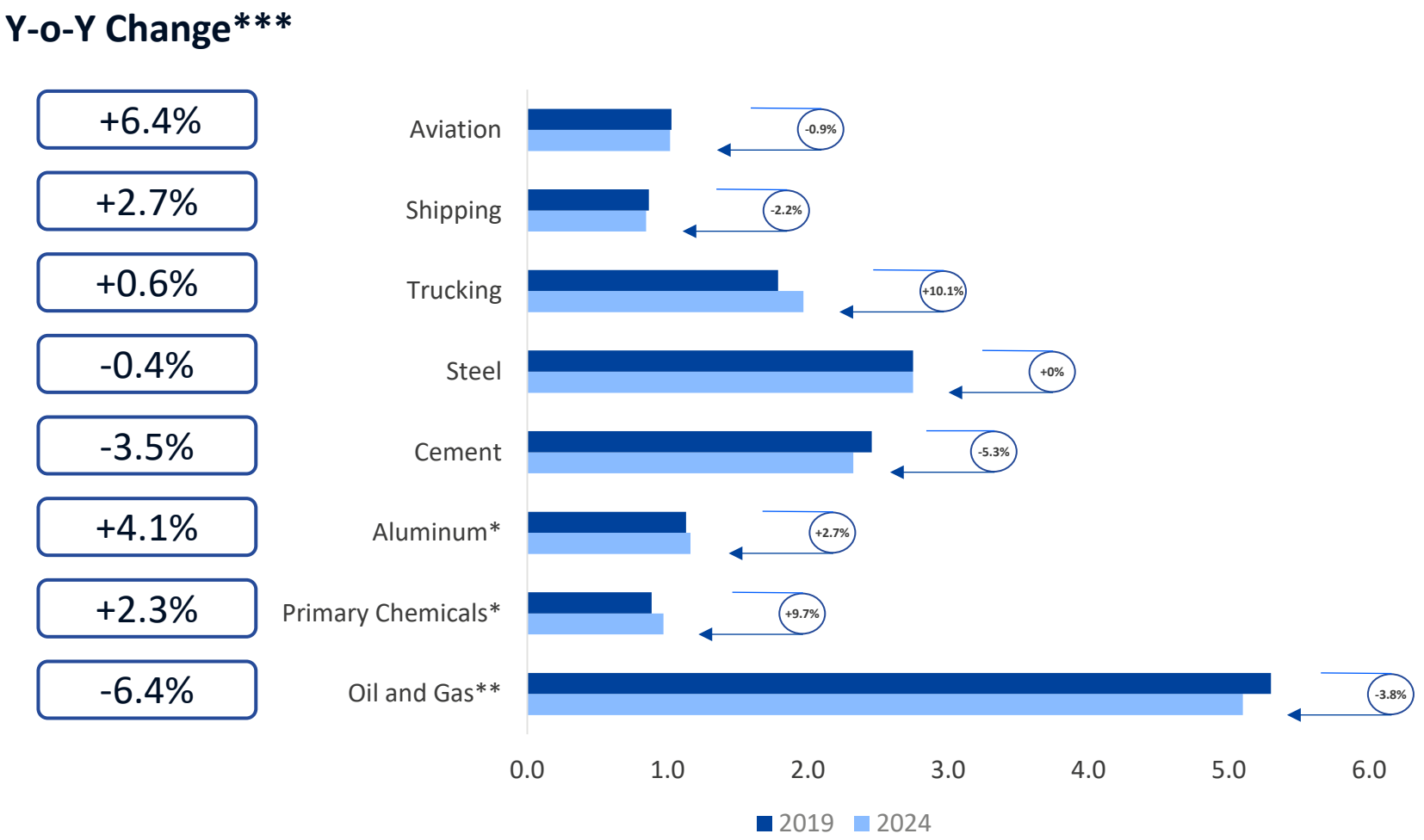
Source(s): (1) IEA WEO 2025 (2) IEA (3) IEA (4) IRENA

# Industrial transition dynamics in 2025

**2025 marks a shift from invention to execution – scaling now hinges on viable economics, enforceable accountability and integrated systems**

| | Trend 1 | Trend 2 | Trend 3 |
|---|---|---|---|
| | Global climate policy is shifting from voluntary ambition to enforceable accountability | Economic viability has always mattered but its importance has sharpened and it's now the key barrier to scale | The transition is not constrained by invention alone, but integration scale will determine success |
| | Voluntary markets aren't enough, but neither are mandates alone – the emerging model is a hybrid of blending incentives, carbon pricing, and verified data | High energy costs, supply bottlenecks, and weak green premium demand are stalling competitiveness | Deployment is advancing – yet the pace is set by policy, capital, and infrastructure, not isolated tech breakthroughs |
| Key Message | Progress depends on pragmatic combinations of carrots and sticks | The question is no longer "can we build it?" but "can we afford to build, run, and sell it competitively?" | Top-level commitments are no longer the limiting factor; system enablers are |

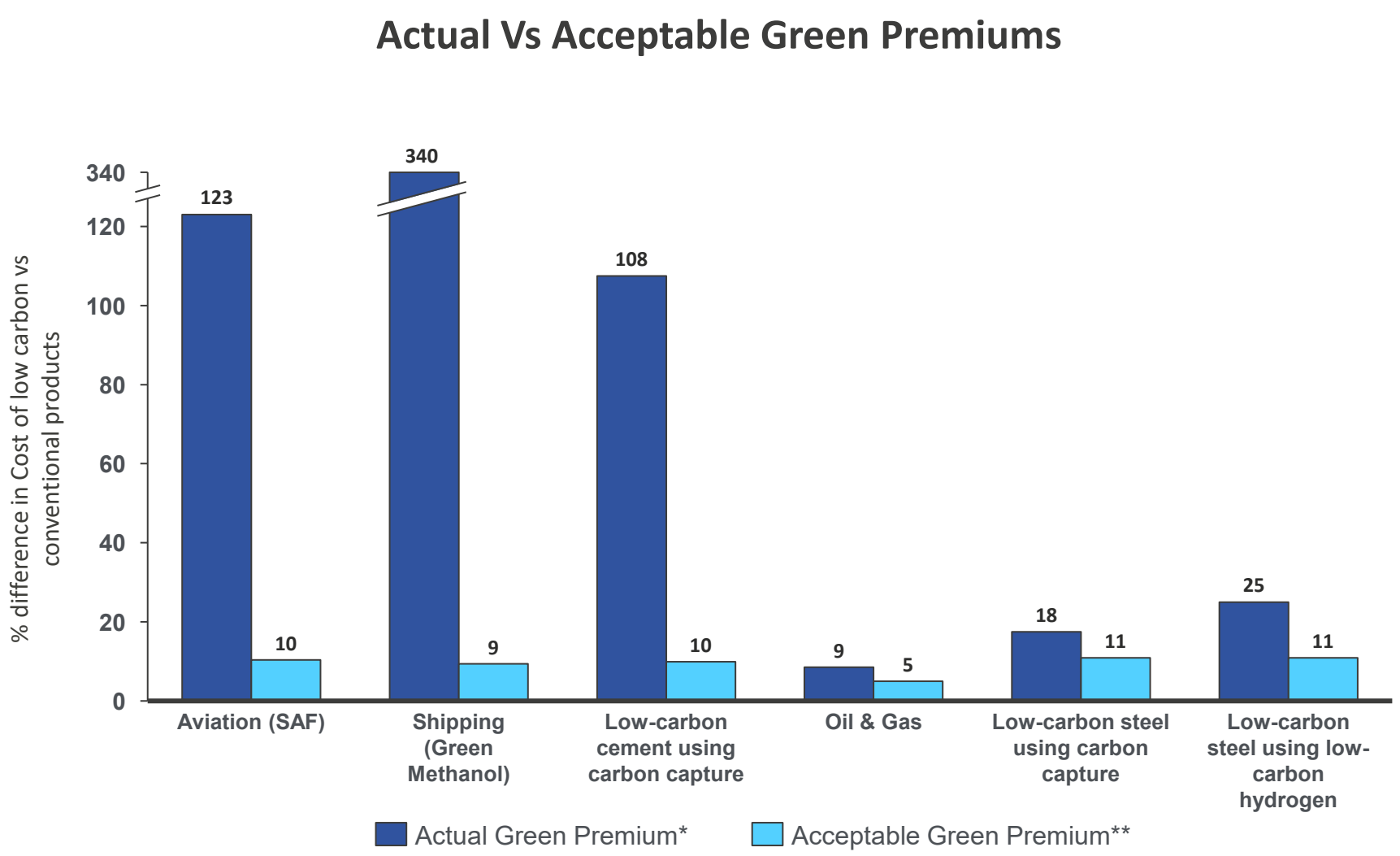
# Figure 1: CO2 emissions in hard-to-abate sectors in gigatonnes (Gt) $CO_2e$, 2019 vs. 2024




*Hard-to-abate emissions remain stubborn: most sectors rose, and small declines in steel, cement and oil & gas reflect lower output – not real decarbonizati on*

** Aluminum and Primary Chemicals 2024 data based on Accenture Analysis*
*** Oil & Gas data for 2018-2022 since data onwards 2023 not available*
**** Y-o-Y Change represents 2024 vs 2023 (except for Oil & Gas which is 2022 vs 2021)*

# Figure 3: Green premium gap across hard-to-abate sectors




**A large disconnect persists between actual and acceptable green premiums – especially in aviation, shipping, and cement – highlighting why low-carbon alternatives struggle to scale without major cost reductions or policy support**

** Actual Green Premium = Difference in cost between clean/low carbon product versus conventional alternative*
***Acceptable Green Premium = Green premium that organizations are willing to pay*

# Table 1: 2025 in review – what has changed?

| Topic | 2024 snapshot | 2025 update | Momentum |
|---|---|---|---|
| **Net zero** | Strong policy momentum and expanding corporate net-zero pledges;<br><br>some efficiency and emissions improvements, though progress remains insufficient | Progress steady but uneven; corporate ambition continues to rise, yet regional policy momentum diverging (EU, Middle East, India positive; US rollback); companies shifting towards commercially driven decarbonization strategies | ⇔ |
| **Economic/capital** | High interest rates made capital availability a binding constraint | Rates eased slightly, but bottlenecks shifted to project economics/bankability with exchange-rate volatility raising costs in emerging markets | ⇔ |
| **Tariffs and trade policy** | Limited policy attention; marginal to analyse | Now central, with new tariffs and policy uncertainty straining supply chains, raising costs and driving self-reliance | ⇑ |
| **Green technology** | Strong policy support for emerging solutions such as hydrogen, biofuels, and CCUS; early pilots showing promise | Deployment remains uneven: mature technologies (renewables, electrification and storage) are scaling rapidly, while hydrogen progress remains subdued amid cost pressures and demand uncertainty | ⇑ |
| **AI–energy nexus** | Nascent technology with speculative benefits | Now fully operational, driving a surge in electricity demand and a race for green electrons and grid access, while also opening new opportunities to optimise energy assets and systems | ⇑ |

**2025 shifts the transition from policy momentum to system strain – capital, trade, technology gaps and AI-driven demand now shape its pace**

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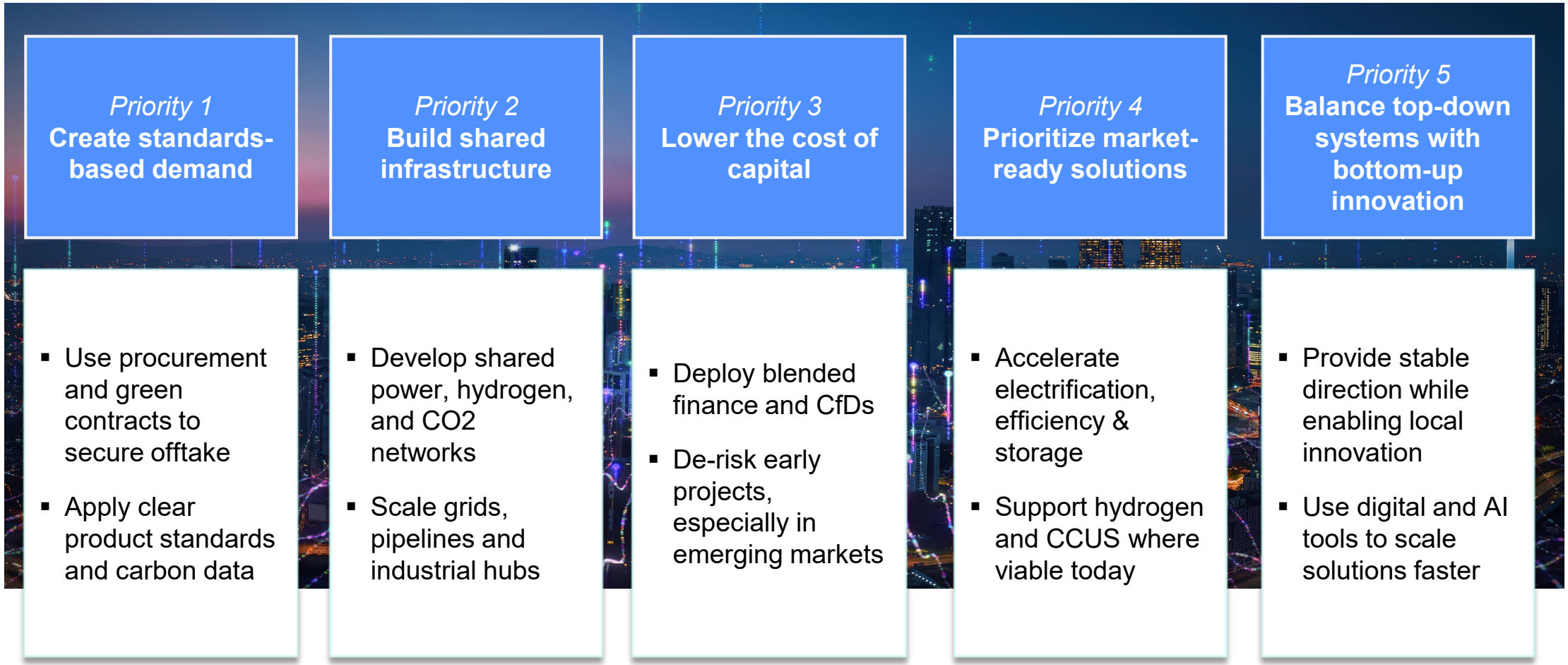
# Table 3: Carbon reduction progress in 2025 across hard-to-abate sectors

| Sectors | Current progress | Core transition lever | Main barrier to scale |
|---|---|---|---|
| Aviation | Gradual SAF uptake and aircraft efficiency gains as mandates in Europe come into effect and new aircraft is delivered | SAF and operational efficiency | High SAF fuel cost and commercial viability |
| Shipping | Pilots in ammonia ($NH_3$) and early commercial scale in methanol as regional regulation like EU Emissions Trading System (ETS) come into effect while dual-fuel new builds enter the fleets | Efficiency upgrades and low-carbon fuels ($NH_3$, $H_2$) | IMO's delay on global regulation, supply chain alignment, fuel-infrastructure gaps |
| Trucking | Electrification in short-haul, $H_2$ pilots for heavy freight | Dual-tech approach (battery/$H_2$) and integrated ecosystem (grid, charging) | Refuelling and charging infrastructure gaps, fleet turnover cost and limited fleet readiness |
| Steel | Early adoption of $H_2$, electrification, recycling, CCUS pilots | Redesign of core production processes | High capital intensity, reliable clean energy supply, cost verification and premium |
| Aluminum | Gradual use of low-carbon electricity and recycling, with early pilots in inert-anode and energy efficient smelting technologies | Electrification and recycling, supported by breakthrough smelting technologies (inert anodes) and low carbon power sourcing | Electricity costs, limited access to reliable low-carbon power, mobilizing recycling logistics and slow commercial readiness of next generation smelting technologies |
| Cement | Early-stage pilots in low-clinker materials and CCUS integration | CCUS integration and redesign of core production processes | Lack of clear demand signal from buyers, absence of regulation and public procurement favouring low-emission cement, limited financing for decarbonized Production |
| Petrochemicals | Moving from fuel-based to materials-based growth, early CCUS and $CO_2$-based feedstocks | CCUS integration and circular economy models | Weak demand and uncertain pricing for low-carbon products |
| Oil and gas | Expanding CCUS and $H_2$ hubs, methane-abatement efforts | Clustered CCUS and storage networks, methane reduction technologies | Asset decarbonization economics, volatile carbon prices and slow policy alignment |

# Strategic priorities 2025 onwards



| *Priority 1* **Create standards-based demand** | *Priority 2* **Build shared infrastructure** | *Priority 3* **Lower the cost of capital** | *Priority 4* **Prioritize market-ready solutions** | *Priority 5* **Balance top-down systems with bottom-up innovation** |
|---|---|---|---|---|
| ▪ Use procurement and green contracts to secure offtake<br>▪ Apply clear product standards and carbon data | ▪ Develop shared power, hydrogen, and CO2 networks<br>▪ Scale grids, pipelines and industrial hubs | ▪ Deploy blended finance and CfDs<br>▪ De-risk early projects, especially in emerging markets | ▪ Accelerate electrification, efficiency & storage<br>▪ Support hydrogen and CCUS where viable today | ▪ Provide stable direction while enabling local innovation<br>▪ Use digital and AI tools to scale solutions faster |

**Industrial decarbonization now depends on aligning demand, infrastructure, finance and innovation to scale proven solutions**

# Transitioning Industrial Clusters

The Transitioning Industrial Clusters initiative aims to improve collaboration and develop a shared vision among co-located companies and public institutions, with the goals of driving economic growth, employment and reducing CO2e emissions.

## OUR INITIATIVE

Industrial clusters are geographic areas where co-located companies and public institutions, representing either a single or multiple industries, provide opportunities for scale, sharing of risk/resources, aggregation and optimization of demand. The Transitioning Industrial Clusters initiative supports the world's leading companies at various stages of ambition and development to align on components required to competitively apply for funding, gain regulatory support and launch full-scale development activities to transition industrial clusters.

## OUTCOMES

- Bring together co-located companies and public institutions to develop plans to protect and create jobs, drive economic growth and reduce carbon emission at an industrial cluster level through the development of a cohesive governance structure
- Support the world's leading companies at various stages of ambition and development to align on components required to competitively apply for funding, gain regulatory support and launch full-scale development activities to transition industrial clusters.
- Protect and create jobs, improve GDP contribution and reduce CO2e at an industrial cluster level

## VALUE FOR MEMBERS

- Access learnings and best practices from the global community: Replicate successful approaches undertaken by other industrial clusters
- Participate in projects with the community: Involvement in projects, workshops and demos targeting advancement of cluster impact
- Strengthen your cluster reach and influence: Amplify visibility on efforts and progress made by the cluster towards GDP, jobs and emissions

## HOW TO GET INVOLVED

The Transitioning Industrial Clusters initiative is seeking partners, policymakers, investors and industry leaders to:

- Identify which industrial clusters they operate in and would like to engage in the initiative
- Engage in the sub-group on Governance: improve collaboration and common vision of industrial clusters
- Engage in the sub-group on Infrastructure: create a community of multi-fuel network infrastructure in relation to the energy transition of transport and heavy industry
- Engage in the sub-group on Digitalization: identify synergies and improve energy efficiency by leveraging data, digital and common targets

Contact
Charles Pacini
Manager, Transforming Industrial Ecosystems
Charles.Pacini@weforum.org

# ASEAN

## Transitioning Industrial Clusters in ASEAN

Driving collaboration and shared action among co-located industrial players to foster economic growth, protect jobs, and reduce CO2e emissions. Industrial clusters from the region formalize their governance and define their path towards industrial transition.

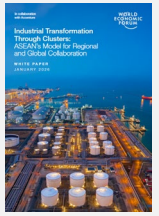
How to engage: Onboard industrial cluster to the WEF global Network and join the next regional in-person events: Kuching, Malaysia (April), Jakarta, Indonesia (June)

## Malaysia's Green Energy Future: Power Sector Decarbonization

Surfacing actionable policy, technology, and financing options to accelerate the decarbonization of Malaysia's power sector, notably, identifying practical pathways to transition its power generation through scaling up clean energy and phasing down its coal-power fleet. Co-hosted by Malaysia's Ministry of Energy Transition and Water Transformation (PETRA).

How to engage: 11 February (virtual), 28 April (virtual), 27 May (in-person, Kuala Lumpur, Malaysia)

**Recent Centre Publication**



Industrial Transformation Through Clusters: ASEAN's Model for Regional and Global Collaboration

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# Thank you

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