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Key Trends & Growth Opportunities in Global Decarbonisation

Key Technologies & Solutions at the Heart of the Energy Transition

The Growth Pipeline™ Company Powering clients to a future shaped by growth

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FROST & SULLIVAN – WHO WE ARE

A LEADING RESEARCH AND ADVISORY FIRM WITH OFFICES IN <u>30 COUNTRIES</u>, WHO HAS PARTNERED WITH CORPORATIONS, CITIES, GOVERNMENTS, AND INVESTOR COMMUNITIES OVER THE PAST 60 YEARS TO IDENTIFY, PRIORITIZE, AND EXECUTE OPPORTUNITIES THAT POWER CLIENTS TOWARD A FUTURE SHAPED BY GROWTH.



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OUR INDUSTRY EXPERTISE: OVER 40 PROGRAM AREAS SERVING A WIDER RANGE OF SECTORS

Mobility F&S has a long track record (avg. 15Y+) in having industry analysts Aftermarket & and consultants **Digital Retail** tracking valuechains of each of Commercial these markets Mobility and submarkets. Leasing and



Centers

Digital Media

POWER & ENERGY AREAS OF COVERAGE



Power Generation

- Conventional Power Gas, Nuclear, Oil
- Renewable Energy Solar PV, Onshore Wind, Offshore Wind, Bioenergy and Geothermal
- DER Residential and C+I PV, Gensets, Industrial Turbines
- Combined Heat & Power
- Fuel Cells
- Power Services
- Digital Twins



Grid Modernisation & Flexibility

- HV/MV Equipment
- Substation Automation
- Customer Information Systems
 & Billing
- Grid Asset Management
 Solutions
- VPPs/DERMS
- Microgrids
- Advanced Metering Infrastructure
- Grid, Res & C&I Battery
 Storage
- Non-Battery Storage
- Advanced Grid Intelligence
 Solutions



Critical Power

- Gensets
- UPS
- Inverters
- DC Power Systems
- PDUs & Transfer Switches
- Datacentre Services
- Cooling Solutions
- DC Infrastructure
 Management Solutions
- Modular & Prefabricated
 Datacentres
- Batteries



Deep Energy Decarbonisation

- Renewable Hydrogen
 (Electrolysers)
- Blue Hydrogen (CCUS)
- Methane Pyrolysis
- Hydrogen Use Cases
- Hydrogen Storage
- Electrification of Industrial Processes, Buildings and Transportation
- Carbon Capture, Utilisation & Storage
- Emissions Management
- Alternative Gases & Synthetic Fuels

AGENDA



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GLOBAL GROWTH SLOWDOWN FROM 3.2% IN 2024 TO 2.8% IN 2025 EXPECTED UNDER A BASELINE TARIFF SCENARIO

GDP Growth – 2025 Visioning Scenarios

FARIFF WAR

BASELINE

INTENSIFICATION

FARIFF WAR

EASING

- US Tariff Policy: Reduces blanket tariffs to 5-10%, signs trade deals with Japan and Korea; Phases
 out tariffs on autos and steel; introduces limited quotas instead; relaxes enforcement on
 USMCA¹ non-compliant goods.
- Retaliatory Tariffs on US: reduction to ~30% from China; EU shelves retaliatory measures and commits for a new transatlantic trade framework.
- Early advanced market growth recovery; US growth resilience; APAC stronger rebound
- US Tariff Policy: Standardized reciprocal 10% tariff regime maintained through 2025; continuing 25% tariffs on Canada and Mexico on non-USMCA compliant goods; 25% on global auto and metals; 145% tariffs on China maintained
- Retaliatory Tariffs on US: China keeps 125% (exemptions for semiconductor products and certain pharma exports); EU delays or staggers retaliatory tariffs; Canada retains 25% on auto
- Weak China growth (3.8%), growth pullback in Americas, and slower growth in APAC and EU
- US Tariff Policy: Escalations vs China continue. Maintains high tariffs across APAC and non-USMCA nations (e.g., 46% Vietnam, 26% India, 24% Japan); 100% Taiwan chip imports, 5-15% semiconductors and pharmaceuticals
- Retaliatory Tariffs on US: China escalates beyond 125% and removes current exemptions; full
 retaliatory packages from EU including a 25% tariff on US aerospace, spirits, and cars; Canada
 maintains retaliatory tariffs on US car exports and other select goods.
- China steep slowdown (3.5%), Japan near-recession (0.0%); <1.0% advanced economy growth
- Lower oil demand to hamper GCC growth prospects

2025 GDP Growth, by Country Group & Visioning Scenario







1. US-Mexico-Canada Agreement (USMCA); 2. Emerging Market and Developing (EM&D) Economies; Analysis stands updated as of 5th May 2025; Source: Frost & Sullivan

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TARIFF WARS 2.0 TO FURTHER DRIVE DIVERSIFICATION AND DECENTRALIZATION OF SUPPLY CHAIN STRATEGIES

10% blanket tariffs; 145% on China imports 🗸 Successful USMCA review paving way for Certain reduced tariffs on Mexico & Canada US-EU, US-India, 125% retaliatory tariffs by China (lowered to US-Japan, 10% till Aug); Up to 25% EU tariff retaliation 25% auto & negotiations (paused for 90-days) metals; 25% Waiver on select goods based on US and China slashed Global 1 tariffs on quota-limit agreement for EU, Moderately tariffs for 90 days in reciprocal non-USMCA Canada, Korea, Australia de-escalation move tariffs above Certain compliant US-UK trade deal: POLICY LIKELIHOOD (145% to 30%) 🗸 10% blanket goods auto tariffs scaled (paused for back to 10% 90 days) Moderately including: Uncertain 20% EU 100% tariffs on chip imports from **US-Indonesia critical** Taiwan; 25% tariffs on EU industrial minerals focused trade goods; 5-15% tariffs on pharmaceutical agreement & semiconductors Uncertain Q1'25 Q2'25 Q3'25 Q4'25 H1'26 H2'26 TIMELINE OF IMPLEMENTATION Positive impact Negative impact Implemented Bubble size represents size of economic impact

Trump 2.0 Policy Likelihood and Risk Impact Mapping, 2025-2026

GLOBAL GROWTH SLOWDOWN TO 2.8% AVOIDING A RECESSION IN 2025; WEAKER CHINA TO WEIGH ON ASIA PACIFIC GROWTH



Note: The data and analysis stand updated as of 5th May 2025. Data for India is presented for fiscal years. For example, India's 2024 data refers to the fiscal year from April 2024 to March 2025. 2024 figures for UAE are estimates and 2025 figures are forecasts for all countries unless otherwise noted. Sources: IMF; Frost & Sullivan

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EVOLUTION OF CARBON MARKETS

As of 2023, 25% of global GHG emissions were covered by carbon pricing instruments such as carbon taxes of trading schemes. This will increase over the next decade as more countries implement schemes and existing countries expand the number of industries covered

Canada has a flexible approach where each jurisdiction can design its own pricing system according to its needs.

The United States lacks a nationwide carbon market, but 12 states on the East and West Coast have implemented effective carbon pricing.

In Latin America, there are mainly carbon taxes, with Mexico launching the first ETS in 2023. While there are others considering similar approaches, if implemented, a Brazilian ETS can potentially become a global leader with about 20% of the total carbon credits from natural sources. **Europe** has the longestrunning and most extensive ETS world in terms of sectors covered, and it is expected to keep growing.

China represents the world's largest ETS, encompassing an estimated 4 billion tCO2, which is over 40% of the country's total carbon emissions.

Carbon Markets: Revenue Forecast, Global, 2023 and 2030

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and regulations differ widely between jurisdictions. However, the region is a key catalyst for growth with the launch and development of new initiatives in India, Indonesia, Japan, and Malaysia.

In **APAC**, key policies

Ongoing reforms in **Australia and New Zealand's** carbon markets are expected to increase decarbonization targets.



Carbon Tax Implemented

ETS Implemented

Carbon Tax Under Consideration

With only a few schemes implemented, Africa

is an exception to the standard with regards to

growing rapidly with the Africa Carbon Markets

compliance markets. However, the VCM is

Initiative (ACMI), launched in late 2022.

REVENUE FORECAST BY INDUSTRY APPLICATION OF CARBON CAPTURE

Market revenues stabalising in 2035 as average costs should be stable and some industries already starting to reach saturation



CARBON CAPTURE MARKET.....INDUSTRY APPLICATION SPLIT BY REVENUE (2030 & 2040)



Direct air capture is forecast to be the largest application by 2040, assuming that cost reductions can be achieved, ahead of hydrogen production and bioenergy





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KEY GROWTH OPPORTUNITIES FOR CCUS



Key to higher deployment is to have a range of solution offerings to cater to the diverse sub-set of customer industries

CCUS as a Service Business Models	Modular CCUS	CCUS Clusters/Hubs	Upcycling & Utilization of Captured Carbon	Digital Technology in CCUS
 Integrated value proposition with client paying per tonne of CO2 removal Carbon neutrality as a service 	 Standardized plant structure to minimize costs Remote and automated operations 	• Shared infrastructure and transportation costs enable higher deployments	 Upcycling into plastics, building materials fuels etc. Generating revenues or environmental benefits to offset carbon capture costs 	 Help in managing the CCUS assets effectively Process optimization to improve capture efficiency

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EMISSIONS MANAGEMENT SOLUTIONS, PLATFORMS AND SERVICES BY APPLICATION

Market opportunity & innovation highest for oil & gas, but significant opportunities in other sectors. A tightening of emissions regulations in Europe and other leading global markets creates a medium-term need to act



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ESTABLISHED PLAYERS HAVE THE LEAD, BUT PLENTY OF INNOVATION IN THE INDUSTRY

The usual suspects feature strongly, with well-developed offerings and strong relationships in the sector. But there is also a strong appetite for the offerings of new companies driven by digital solutions



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DECARBONIZING INDUSTRIAL HEAT: THE GLOBAL OPPORTUNITY



Decarbonisation of electricity production still leaves huge amounts of fossil fuels being used within the global economy



Global Industrial Heat Demand, 2022 (TWh)

WHAT ARE THE HEAT REQUIREMENTS OF INDUSTRIES?



Electricity has many advantages as a source of energy for industry. It is faster, safer, more efficient and capable of powering any industrial heat process. There is no limit on the temperatures electricity can generate



Source: Industrial Heat Demand, Frost & Sullivan

WHAT ARE THE KEY BENEFITS TO THE CUSTOMER OF ELECTRIFICATION?



Electrification can deliver real benefits for industrial companies



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INVESTMENT DRIVING HEAT TECHNOLOGIES UP THE TRL SCALE



In the next 5-10 years, partnerships and collaborations between OEMS and industrial partners will establish pilot and demonstration projects for testing and validating new industrial electrification technologies





Legend: Technology Readiness Level - TRL9: Full commercial application. Technology is available for customers. - TRL8: First of a kind commercial system. Manufacturing issues solved. - TRL7: Demonstration system operates in space environment at pre-commercial scale. - TRL6: Prototype system tested in relevant environment close to expected performance. - TRL5: Large scale prototype tested in intended environment. - TRL4: Small scale prototype built in lab environment. - TRL3: Performing basic and applied science.

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HEAT PUMPS A KEY FOCUS FOR INDUSTRIAL ELECTRIFICATION



An established technology for lower temperatures, the drive is now on to reach higher temperatures and be commercially competitive

Temperatures	Current Opportunity Fit for IHP	Technology Readiness	Process Industry and Type
<80°C	High	9 Future Proof solutions	 Paper: De-inking Food: Concentration Chemical: Bio-reactions
80°C to 100°C	High	9 Commercial and Competitive, limited large scale deployment	 Paper: Bleaching Food: Evaporation Chemical: Concentration
100°C-140°C	High	8 First-of-a-kind commercial application	 Paper: Drying Food: Evaporation Chemical: Concentration
140°C-160°C	Medium	8 First-of-a-kind commercial application	 Paper: Pulp boiling Food: Drying Chemical: Distillation Various Industries: Steam Production
160°C-200°C	Medium/ Low	6 First-of-a-kind commercial application/Early to large prototype	 Various Industries: High Temperature Steam Production
>200°C	Low	4 Early to large prototype	 Various Industries: High Temperature Processes

INDUSTRIAL HEAT PUMP MARKET OPPORTUNITY – KEY REGIONS



Market size will close to double in decade. Lower temperatures dominate, but significant potential for higher temperatures – innovation will be the key



INDUSTRIAL HEAT PUMP MARKET OPPORTUNITY – KEY COUNTRIES



China, United States and Japan the leading country markets. Italy just ahead of France in Europe, despite relatively high electricity costs



Key: The list only represents key countries and is not exhaustive.

Note: All figures are rounded. The base year is 2023. Source: Frost & Sullivan

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ELECTRIFICATION OF INDUSTRIES—ROADMAP



Governments need to create a fair regulatory framework and incentive schemes and develop nation-wide programs that enable cutting edge research, development, and demonstration projects, as these are crucial for increasing the adoption of electrification technologies across all industrial segments



Increase in investment for

and design and heating

Policy support for wider

processes.

technologies

innovations related to materials

implementation of electrification

Partnerships between OEMs

and industries to test and

validate heating processes.



Modest growth for commercial & industrial heat pumps



Greater support for deploying electric solutions within strategic industries



Greater industry attention toward supporting industrial heat solutions



Rollout of pilot projects related to heating technologies with TRL up to 7.



Partnerships between OEMs and industries to test and validate heating processes.













Improved economics for electricity vs. gas



Technological innovations to bring down the costs associated with heating technologies as they scale up.



- Commercialization of complex electrification technologies across potential industrial segments across all temperature ranges.
- Withdrawal of support for certain electrification technologies when cost parity is reached, specially heat pumps.

Policies mandating complete replacement of fossil fuel-based heating processes by the end of 2050 across a majority of industries.



ELECTRIFICATION TECHNOLOGIES ECOSYSTEM



Source: Frost & Sullivan

INNOVATIONS IN ELECTRIFICATION



Multiple innovations focused on taking fossil fuels out of the process in leading fossil fuel using industries

Electrowinning for Steel

Electrolysis for Cement

electra **SSAB**

Iron-ore is dissolved in a chemical cocktail – a process called electrowinning. Produces sheets of iron that are fossil free

Backed by Amazon and BHP

Sublime Systems

Using electrolysis to replace the traditional kiln in the cement process

\$40 million from Siam Cement

COOLBROOX[®]

Electricity for Chemicals

Using a high-speed rotors powered by electricity to break down chemicals needed by the industry

Backed by Braskem, Cemex and SABIC

1,500C for Industry





Both companies can reach temperatures in excess of **1,500C**

Rondo has received **\$60 million** from investors such as SABIC, Microsoft, Aramco and Rio Tinto.

Antora has received **\$80 million** from investors such as Breakthrough Ventures & Shell

WASTE HEAT UTILIZATION GAINING MORE PROMINENCE



Waste heat recovery has gained in prominence in the past five years as policy makers and regulators have become aware of the potential impact implementing waste heat recovery could have on global emissions. High emission industries such as oil & gas and iron & steel dominate overall investment, but the market potential for all forms of heat recovery, including low temperature is seeing strong growth.



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WASTE HEAT RECOVERY TECHNOLOGIES CONTINUE TO INCREASE



Waste heat recovery has significant potential to impact global emissions. High emission industries such as oil & gas and iron & steel dominate overall investment, but the market potential for all forms of heat recovery, including low temperature is seeing strong growth



Solutions that can monitor, reduce and capture waste heat generated in commercial and industrial processes.



Utilising waste heat internally to boost operational efficiency or selling it to other industries or public heating networks.



Funding opportunities arising from efficiency- related stimulus programs that boost demand.



Deployment of smart industrial metering solutions so that end users can better understand their usage patterns.

HIGHEST BIOFUEL GROWTH RATES FOR BIOMETHANOL & SAF

Demand for renewable diesel and SAF will almost double by 2030, reaching 80 MTPA, with the United States and Europe accounting for 80% of the increase



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BIOMETHANE THE GROWTH; BIOGAS THE MATURITY

The biomethane industry, with 7.3 MTPA global production, is gaining interest because of its potential for a clean, cost-effective, and versatile alternative to natural gas, suitable for chemical and fertilizer production and competitive with other clean energy options

Revenue Forecast by Biogas, Global, 2022–2030





EFUELS THE KEY GROWTH AREA

More than 200 eFuel projects are in early stages globally, requiring governments to increase demand for low-emission alternatives. Achieving economies of scale through predictable demand is crucial to maximizing decarbonization opportunities without affecting consumer prices

Revenue Forecast by eFuels, Global, 2022–2030







eFuels: eFuels Revenue

KEY TAKEAWAYS



Emissions control – watch this space: Progression of the past few years has been the drift of more countries adopting measures – now uncertain



Carbon capture could gain in more hostile green climate: Significant support in the US, possible movement in Europe



120 ^o**C** – **200** ^o**C** the early priority: Commercially viable solutions to this temperature brings another 25%~ of heat into play



Alternative fuels a mix of maturity and growth: Biogas, bioethanol, biodiesel more mature, eFuels strong growth from a low base

Source: Frost & Sullivan



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