Net Zero:

The Countdown Has Begun

WORLD GOVERNMENTS SUMMIT 2023

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1.0 Introduction

The world is nearing the point of no return.
The Intergovernmental Panel on Climate Change (IPCC) and other agencies have been issuing the warnings:
the 1.5-degree Celsius scenario is growing increasing out of reach[1] and despite a COVID-induced dip in 2020 when emissions fell 5.6% compared to 2019,[2] ground was lost once more as emissions rose by 6% the following year.[3] From a carbon budget perspective, the world has less than 400 billion tonnes of carbon dioxide equivalent (CO_2e) left to spend[4] until 2050. Simply put, the outlook is grim.

But there is hope. By the end of 2022, 70 countries that account for 90% of global GDP[5] and 76% of total emissions[6] had pledged to reach net zero, and out of COP27 in Sharm El Sheikh came a much sharper focus on implementation. Looking to the near future, COP28, which will take place in the UAE in December 2023, will be a global stock take, and the world can expect real progress, not just good intentions.

With all eyes looking to the December horizon, it is not just governments pushing to fulfil their net zero pledges. To date, 702 of the world's largest publicly traded companies have committed to the same goal,[7] with 18,700 businesses sharing their 2022 climate, forest, and water security impacts with non-profit global disclosure system, CDP.[8] Meanwhile, more than 2,200 companies that constitute over one-third of global market capitalization have been working with the Science Based Targets Initiative (SBTi) to have their targets validated[9].

Across geographies, the extent and type of decarbonization commitments that companies are making vary widely, but there is one thing that unites all businesses around the world: Every company on the net zero journey will have to dig deep into their organization and engage with the entire ecosystem to deliver on their promises.

2.0 The Transformation Challenge

Delivering on the promise of net zero is a leadership challenge for companies. While the magnitude and complexity of this challenge is generally well accepted, there is no standardized or uniform approach for companies to build upon. As such, company leaders are now presented with critical strategic choices and must make bold decisions to accelerate the delivery of much-needed net zero results.

As a starting point, company leaders should be asking the following key questions to chart and accelerate their net zero journeys:

Bold leadership:

How bold and encompassing should the emissions reduction ambition be?

- Should the company commit to the 'Scope 1,2,3' method of categorizing greenhouse gas (GHG) emissions, as set out by the GHG Protocol corporate standard? Scope 1 emissions are direct emissions from company-owned and controlled resources, Scope 2 emissions are the result of the generation of energy purchased from a utility provider, and Scope 3 emissions include all other indirect emissions that occur along a company's value chain.
- Should the company set aggressive 2030 and 2050 targets relating to these scopes? Currently, companies are obliged to report Scope 1 and Scope 2 emissions, while reporting on Scope 3 is voluntary and more challenging.
- Will the company make dramatic portfolio moves, pursue new business models, and reallocate resources accordingly?
- Should the company proactively help shape a green ecosystem around its own business scope and boundaries?

Emissions technology:

Which portfolio of technologies should the company deploy to accelerate and deliver the emissions reduction pathways?

- Which available technologies should the company adopt and implement widely across the enterprise?
- Should the company seek to lead the way by investing in specific technologies, or should it follow the lead of others?
- Which emerging technologies should the company help catalyze?

Funding:

What can be done to unlock funding for major technology-led net zero projects?

- How should the company prioritize and allocate funding across its net zero initiatives?
- What are the key issues or roadblocks that prevent the lending community from funding large scale, technology-driven projects?
- What future funding models need to be developed to bring tailored funding solutions?

Enabling capabilities:

What capabilities does the company need to build to future-proof its competitive position?

- How should the company set up and orchestrate a company-wide transformation program, including operating models and KPIs?
- What mindset is needed and what people, data management, and measurement capabilities will be required?
- How should the company manage risk and different conflicting trade-offs?

Bold leadership

Pre-COP27, the momentum was around building commitment. Pre-COP28, the focus is now on accelerating actions and delivering results. This calls for bold leadership actions from companies worldwide.

Start from the top

Bold decision making starts with the company board. Yet, a recent joint study[10] from INSEAD business school and global leadership advisory company, Heidrick and Struggles, identified areas of concern. Specifically, while 75% of surveyed board members indicated climate change was important to the strategic success of the company, 50% were not satisfied with the company's reporting on the issue to the board.

This drives home the importance for company boards to set the right purpose and objectives for the organization and to encourage strong communication company-wide. Within the environmental, social, and governance (ESG) context, climate change should now be an integral part of business strategy and boards must stay abreast of progress. This requires company boards to ask their management teams if they are being aggressive enough in their emissions reduction plans, similar to the way in which they may scrutinize wider company strategy and performance outcomes.

Company boards should also be aware of the growth opportunities that net zero can offer. Like all economic transitions, the current energy shift presents a wealth of profit pools waiting to be tapped. For example, hydrogen will not only create opportunities for producers, but it will also present opportunities such as fuel cells for transportation, feedstock for chemicals, heating applications, related infrastructure services, and many more.

Here, once again, boards should be asking the right questions of their CEOs and management teams. Namely, is the company uncovering tech-driven future growth opportunities and devising strategies to seize them?

In order to ask the right questions and provide robust guidance to their organization, the board must include members who understand the wide spectrum of technological possibilities and who possess knowledge of related areas. Where such expertise is absent, it may be necessary to onboard external capabilities. For instance, some organizations have started to institute ESG/sustainability committees to provide targeted insight and support.

Think scenarios

Despite unprecedented headwinds, uncertainty, and challenges in the global operating environment, renewables are expected to grow at a much faster rate than before. In fact, the International Energy Agency (IEA) forecasts that renewables will account for 35% of the global energy mix by 2025[11] .

As the energy transition picks up pace, companies must now consider different scenarios as they chart their course to net zero. To do so, it is important to model scenarios that (i) reflect the specific requirements of sustainability decision making, (ii) add granularity to the implications of sustainability drivers for decision making at the portfolio level, and (iii) factor in the sense of urgency and timing.

Key here will be the ability to act fast in developing net zero actions, milestones, and signposts that relate to each scenario. And of course, transparency regarding progress will be essential in ensuring stakeholder confidence along the way.

Make bold moves

Leading companies need to demonstrate that they are making bold decisions relating to emissions reduction targets, portfolio moves, product decisions, and R&D investment. Just as importantly, they must also put in place resource allocations to activate these decisions.

Emissions:

- In terms of emissions, leaders are expected to go all the way:
- Include Scope 1, 2, and 3 in their emissions reduction commitments
- Ensure company targets are aligned with SBTi
- Pursue aggressive reduction strategies in the lead up to 2030

Business models:

- When it comes to portfolio moves and business model changes, bold leaders should take decisive action, such as:
- Retiring energy and asset capacities that are not environmentally
- Identifying and committing to new areas of business

Resource allocation:

- Leading companies need to allocate resources/funding to 'dial moving' decarbonization programs and initiatives. Such allocations can be reflected differently, depending on the company context. For instance, it could be reflected as capex share for decarbonization, or in the R&D budget

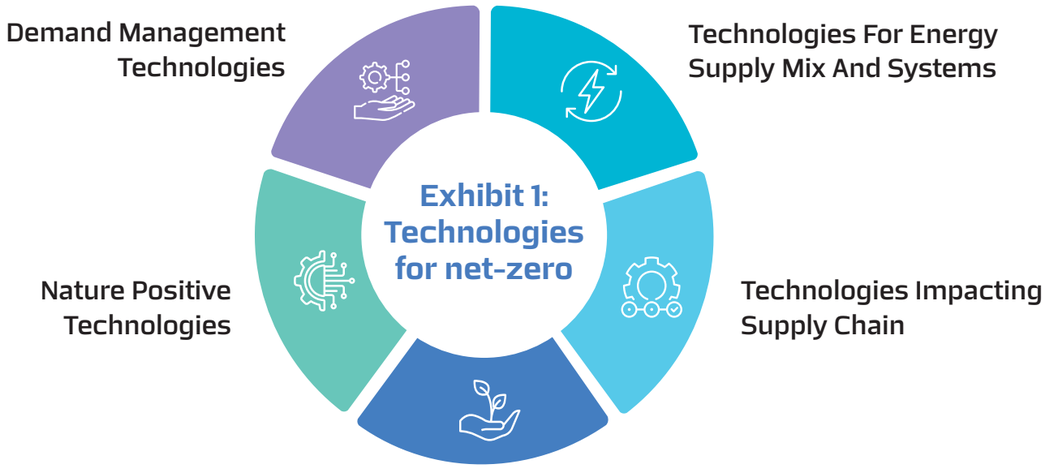
While there is no single definitive study that provides a summary of all companies' bold moves, indications suggest that a significant number are pushing the boundaries and trying to accelerate decarbonization. For example, more than 220 companies have included Scope 1,2 and 3 in their emissions reduction commitments[12] and multinationals such as Shell, Nestle, and Ford have pledged to reduce their emissions by 40% to 50% by 2030, ultimately aiming for net zero by 2050.

Other leading companies have decided to shift their portfolio mix and embark on new businesses to capitalize on opportunities that will arise from a decarbonized world. For instance, Australian energy company, Origin, has taken the decision to shut down its coal plants by 2025,[13] while Reliance Industries in India has embarked on a major program to decarbonize its operations.[14]

Technology choices

Technologies are the major levers for companies to drive down emissions, yet choosing the right ones amidst market, technological, and regulatory uncertainties is a formidable task.

Exhibit 1: Technologies for net-zero



- Renewable energy (e.g. solar, wind, hydro energy)
- Nuclear energy
- Hydrogen (e.g. as energy source, fuel)
- Carbon capture and storage (or CCS)
- Energy storage (e.g. battery storage, pumped hydro, flow batteries)environmentally
- Identifying and committing to new areas of business

- EV
- eFuels (e.g. sustainable airline fuels) and bio-fuels (e.g. bio-methane, bio-methanol, bio-ethane)

- Digital (e.g. IoT, drones, cloud, digital twins)
- Data (e.g. AI, data analytics)

- Landfill-to-X (e.g. gas, solar)
- Reforestation (e.g. mangrove)
- Farming (e.g. regenerative, organic)
- Land and water management
- Waste management (e.g. waste-to-energy, waste-to-chemicals, thermal treatment)

- Energy efficiency (e.g. efficient HVAC systems, new generation motors, pumps, compressors, energy efficient lighting and appliances)
- Circularity (e.g. bio-based raw materials, mechanical and chemical recycling)

One challenge for corporate decision makers is the existence of multiple technology sub-categories. For example, hydrogen can be categorized by color, (e.g.: green, blue, or grey) with multiple technical parameters and several choices of electrolyzer and compressor technologies also in the mix. Technology maturity levels and commercial viability can also vary, adding further layers of complexity. Navigating this maze of technologies and selecting the most appropriate solutions to deliver the desired emissions reduction pathways is not easy.

Making the right choice vis-à-vis the portfolio of technologies to reduce emissions requires leaders in a company to take into consideration many factors. For example:

- Technology maturity and trends
- Commercial viability
- Long-term cost competitiveness
- Investment required
- Emissions reduction potential
- Capability of the organization to adopt the technology

From an organization's perspective, herein lies the main internal challenge, and addressing it often requires the creation of a cross-functional team. No single function—be it corporate sustainability, group strategy and planning, or tech R&D—can work through this strategic issue alone; the task demands a collaborative and orchestrated approach.

Develop strategic technology foresight

To select the most suitable portfolio of technologies, companies need to develop strategic technology foresights [15]— a process that typically takes leading companies 15 to 30 years. A best practice technology foresight process considers all potential technologies in various stages of maturity.

To select the most suitable portfolio of technologies, companies need to develop strategic technology foresights[15]— a process that typically takes leading companies 15 to 30 years. A best practice technology foresight process considers all potential technologies in various stages of maturity. It also identifies the breakthrough innovations and incremental technology developments that can fill gaps or address unmet needs. The resultant output then highlights to decision makers where to focus and – just as importantly – where not to lead.

The technology landscape is moving rapidly, so it is imperative for companies to have a finger firmly on the pulse of the latest developments. Many leading organizations have internal technology scouting functions and technology collaboration platforms that often involve startups to keep abreast of developments.

Some companies also have corporate venture capital facilities with specific mandates that facilitate strategic investments in low-carbon, emissions reduction technologies. For example, General Motors, through its venture arm, GM Ventures, targets software and hardware startup companies with attractive emerging technologies that, when matured, can help GM achieve its net zero objectives. Such is the faith in the startup ecosystem, investments into carbon and emissions startups reached $13.8 billion across 734 deals by the end of 2022.[16]

Reset priorities

To achieve net zero, companies will need to take a hard look at their existing and planned technology portfolios. Leading companies rigorously assess their portfolios, bring in external talent to inject new capabilities and challenge legacy technology projects, and follow a proven, technology funneling and decision-making process.

Once this process is complete, it is important to make clear and sometimes difficult decisions. For instance, a company may want to own all relevant technologies in-house, yet this may no longer fit within the accelerated energy transition or a decarbonized world where ecosystem play becomes the norm.

Companies leading the net zero charge also focus on outcomes or results by adopting a technology agnostic approach. To catch up, companies at all stages of maturity need to ramp up their investments in clean technologies and bring about a step change in their future emissions profiles.

Assess the Economics with MACC

Marginal abatement cost curves, or MACC, have long been used to assess the economics associated with climate change mitigation options. Many of these MACCs have been developed at a sector level, and companies at the forefront of the energy transition have used them as the basis of selection, prioritization, and resource allocation for net zero initiatives.

However, there are challenges with the development and use of MAC curves. The 'curves' are often the result of a tedious one-off process, requiring significant effort on the part of companies and involving internal and external resources. What's more, MACCs are dynamic beasts, with many variables that can change over time and significantly alter the shape of a curve.

For instance, significant impact can result from:

- Changes to a country's regulatory regime
- Incentives such as the Inflation Reduction Act in the USA, which has the potential to reduce the cost of green hydrogen production by almost 50%
- Rapid developments in technology, such as the potential of lithium-air batteries to replace lithium-ion batteries for long-range electric vehicle (EV) applications
- Macroeconomic conditions, such as high inflation impacting input costs
- Consumer behavior, including rapid adoption of low carbon technologies like rooftop solar

With this in mind, companies need to move away from static MAC curves and build capabilities to develop dynamic curves that inform technology choices on a continuous basis.

Net Zero Transformation: Sector Focus

3.0 Utilities

3.1 Utilities

Riding the net zero wave

As the world makes strides towards decarbonization, utilities are actively looking to invest in cleaner energy sources and making strategic long-term investments designed to meet decarbonization goals. Yet, while focusing on their own carbon footprint, utilities must also evolve their transmission and distribution capabilities, as well as their products and services, to stay in sync with the wider green transition. For instance, utility companies will have to plan their infrastructure programs to complement the expansion of EVs[17] and smart home devices.

Utilities will also need to maneuver their way to offset carbon emissions while simultaneously dealing with a climate crisis that is testing the resilience of systems and pressure from customers relating to energy affordability, availability, and price volatility.

To support companies on this costly and complex journey, governments and financial institutions are introducing policies to ease the transition to net zero. For example, the Indian government is working on various policies relating to green hydrogen , offshore wind, electric vehicles, green energy procurement, and the faster clearance of green projects. Meanwhile, banks such as the Asian Development Bank have stopped financing coal powered projects in Southeast Asia.[18]

Leading the charge

Utilities in developed countries have set ambitious net zero targets, with many European companies aiming to achieve Scope 1 and Scope 2 goals well before 2045. In fact, companies, such as Portuguese energy supplier, Gás Natural, Eletricidade e Serviços Energéticos (EDP) , have set net zero targets for as early as 2030. Meanwhile, 2050 is the target year for companies in the US, with notable exceptions including PSEG and Eversource – both of which have their sights set on 2030. As for Scope 3, utilities across the globe are yet to address these emissions, except for outliers such as Engie and Duke Energy.

Engie

Europe-based Engie, has identified decarbonization levers across its value chain. These include reducing its own footprint emissions, offsetting residual emissions, and the decarbonization of customers.

To reduce its own footprint emissions, Engie is developing solar and wind capacity and increasing renewable energy generation from 31 GW in 2020 to 80 GW in 2030. It is also adding capacity in low-carbon distributed infrastructure such as district heating and cooling and distributed solar and low-carbon on-site utilities. Furthermore, the company plans to phase out coal by 2025 in Europe and 2027 in the rest of the world,[19] and is working towards progressive reduction in gas unit load factors to accommodate intermittent generation of renewables.

One of Engie's strategies is to ensure gas units are fueled by green gas (e.g., biomethane and hydrogen) or equipped with carbon capture usage and storage (CCUS)[20]. The company has set a preference for suppliers with science-based targets for 2030 and is actively seeking collaborative projects to meet decarbonization goals.

To offset residual emissions, Engie is favoring carbon offset projects such as nature-based solutions and CCUS, which are close to the company's core activities. As for the decarbonization of customers, the energy player has developed self-governing principles, highlighting the emissions avoided by using Engie's products and services. It has also included decarbonization of customers as a criterion in the company decision-making process where investment is concerned.

Duke Energy

To reach net zero, there is no one-size-fits-all approach. While Engie has identified levers across value chain, US-based Duke Energy aims to clean up the supply chain using a three-pronged approach: identifying emissions, reporting, and undertaking actionable steps.

Duke Energy plans to use a mix of solar, onshore wind, offshore wind, and energy storage in the short term, while its longer-term plans include the replacement of gas-fired capacity with green hydrogen or CCUS.

The company is also striving to double down on its renewables portfolio, growing it to 16,000 MW by 2025 through large scale solar deployment, and it aims to shut down its coal-fired power plants by the end of 2030. Further demonstrating its decarbonization ambitions, Duke Energy intends to cover Scope 2 and aspects of Scope 3 emissions in its net zero target, and is conducting research into long duration storage technologies.

Orsted

Another example of ambitious net zero targets is Orsted – the largest energy company in Denmark and one of the early adopters of decarbonization. It plans to achieve net zero in Scope 1 and 2 emissions by 2025 and Scope 3 emissions by 2040. It is also working closely with suppliers to ensure the use of 100% renewable electricity in manufacturing, installation, and transportation in line with its 2020 supply chain decarbonization program. Furthermore, the company is set to meet its 100% electric car fleet target by 2025. Orsted is using a mix of efficiency initiatives, such as route optimization and sailing at fuel- saving speed, as well as breakthrough technologies including hybrid service operation vessels

Technology choices

Utilities can leverage a number of decarbonization technologies depending on the underlying business model and operations. These technologies broadly target three strategies:

Efficiency increase

Fuel shift (hybrid approach)

Deep decarbonization

Companies may use these strategies one after another in a phased approach or undertake a multi-pronged approach using levers simultaneously to reach the net zero target. Either way, they must drive decision making based on timeline, feasibility, and cost considerations, while planning a decarbonization roadmap. This will allow companies to prioritize decarbonization investments, achieve the highest reduction in carbon emissions, and manage risk and cost levels.

Exhibit 2: Green technologies in the utilities sector

Current status	Efficiency increase	Fuel shift (Hybrid)	Deep decarbonization	Net zero target
	▪ Plant performance optimization ▪ Off-shore and marine energy and efficiency solutions ▪ Waste heat recovery ▪ Plant flexibility solutions ▪ Brownfield engine exchange ▪ Eco-design transformer ▪ Heat recycle solutions ▪ Sea float ▪ Highly efficient turbines, compressors, and plants ▪ Heat recycle Solutions ▪ Highly efficient high voltage direct current ▪ Turbine/compressor/ generator upgrade	▪ Coal to gas shift ▪ Thermal storage integration ▪ Coal to biomass shift ▪ Transmission for PV and wind power ▪ Low carbon gas turbine fuels ▪ Power from shore and subsea grid ▪ Integrated low-carbon hybrid solutions ▪ Biomass/geothermal ▪ Pipeline upgrades ▪ Grid stability ▪ H_2 gas turbines (co-firing) ▪ Power from shore and subsea grid ▪ Power to heat	▪ Caron capture ▪ Solar PV ▪ Green energy storage ▪ H_2 gas turbines (100%) ▪ Hydro power ▪ Zero carbon hybrid solutions ▪ New energy carriers ▪ Electrolyzers ▪ Wind power ▪ Concentrated solar power ▪ Offshore and marine net zero operations ▪ Concentrated solar power ▪ Hydrogen compressors ▪ Fuel cells ▪ Power to X

Challenges and risks to implementation

Decarbonization is a breakthrough opportunity, however, it does present many risks that must be mitigated for successful implementation:

- Current renewables capacity will have to increase significantly to support full decarbonization, and this will lead to supply chain limitations in the form of raw material scarcity
- Solar and wind as resources are intermittent, and reliability of these technologies remains in question. Moreover, current networks are not adapted to serve renewables
- Digitized smart grids are better suited to handle renewables, yet digital technologies are also more vulnerable to cyber-attacks

Utilities also face several business challenges around the lack of talent, lack of adequate sustainable financing options, variability in decarbonization targets across the value chain, and poor integration of emissions data in investment and business decisions.

Adding to the pressures, utilities must also handle customer dissatisfaction concerning increasing prices sparked by geopolitical crises. Here, regulatory support is more important than ever as utilities battle supply chain disruptions and high price volatility. Such is the severity of the situation, utilities face the risk of failing to deliver affordable and resilient energy solutions, and many have been forced to put their green transition targets on hold, delaying coal phase out past IEA's 2030 deadline.

Ultimately, it is the utilities that manage to strike a balance between providing uninterrupted supply of low-cost energy and meeting their net zero commitments that will succeed in the long term.

4.0 Industrials

Many heavyweights in the industrials sector have embarked on the journey to decarbonization, with frontrunners setting bold emissions reduction targets, taking an ecosystem-wide approach, and driving new business growth. Among the sector's standout companies are French multinational, Schneider Electric, and German industrial manufacturing giant, Siemens.

4.1 Industrials

Leading companies

Schneider

Schneider Electric, one of the leading global digital automation and energy management companies, has long made sustainability a core business priority and has been reaping the benefits of early strategic orientation. The company witnessed 5.3% YOY growth between 2021 and 2022 with 72% of impact revenue coming from green sources in 2022. It is also rated 73/100 according to ESG criteria, and by the end of 2022, the company's share price had appreciated by more than 2.3X, compared to 2013.

Schneider has committed to becoming net zero by 2050 across the whole value chain, covering all Scope 1,2 and 3 emissions, and has also pledged to slash Scope 3 emissions from both suppliers and customers.

Internally, the tone at Schneider has been set from the top. At the board level, there is oversight of the company's sustainability strategy, priorities, and outcome, while company executives have KPI targets related to sustainability. The focus on sustainability in fact percolates throughout the organization and is the basis of the culture of the organization.

Beyond the boundaries of its own business, Schneider claims that it plans to mobilize its entire ecosystem to act for a climate positive world. As part of that ambition, the company aims to train one million people in energy management and provide 50 million people with access to green energy.

Siemens[21]

Siemens is aiming for carbon neutrality in all production facilities and buildings globally by 2030. In addition, it plans to reduce absolute Scope 3 GHG emissions from its products by 28% by 2030, from a 2019 base year.

Already, Siemens has reduced CO_2 emissions in its own operations by 36% over the last two years and has invested €65 million (over $70 million) in energy efficiency projects, resulting in annual savings of approximately €13 million (around $14 million). It has also succeeded in supplying 78% of its electricity demand with renewables.

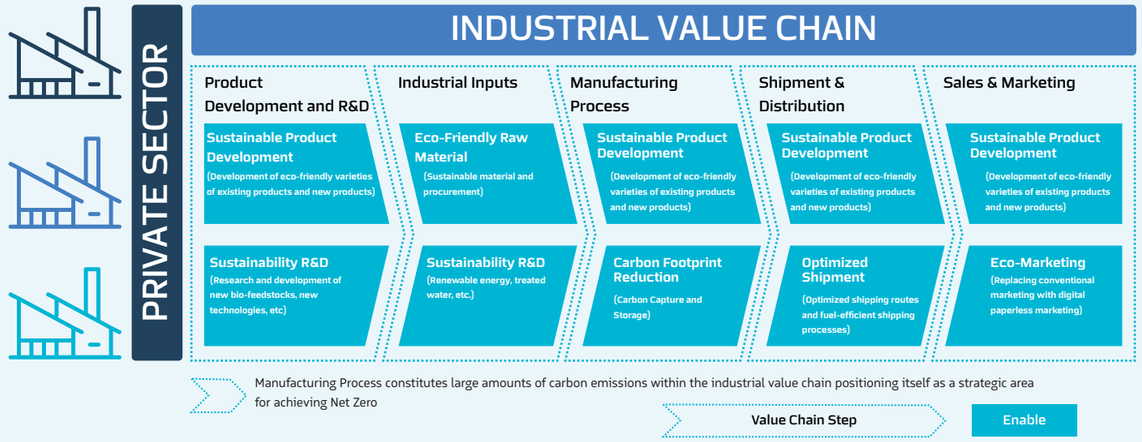
Siemens has been active in several collaborative projects to help consumers achieve their emissions targets. For example, Siemens and Volkswagen are exploring the potential of e-mobility to transform how people travel throughout Africa's cities. A pilot project has been launched in Rwanda where the two companies will offer car-sharing and ride-hailing services in its capital city, Kigali. In addition, the company is working with Coca-Cola Austria to leverage energy management and smart condition monitoring systems to improve energy efficiency and reduce waste generation and water consumption.

Siemens is also working with partners around the world to develop green technologies to meet its ambitious emissions targets. For example, Siemens and BASF are investigating the possibility of building a proton exchange membrane (PEM) water electrolysis system with a capacity of 50 MW for CO_2-free production of hydrogen from water and electricity.

Technology choice and challenges

The adoption of the right technologies across the industrial value chain is critical to meeting the net zero commitments set by manufacturing players. In particular, operational excellence and carbon footprint reduction technologies are key to reducing greenhouse gas emissions in manufacturing processes, which account for about 23% of the sector's total GHG output.[22]

Exhibit 3: Industrial sector sustainability measures



Multiple technologies are used inmanufacturing processes, and the top solutions for carbon footprint reduction and operational excellence within manufacturing plants include:

Carbon footprint reduction:

- Carbon capture and storage (CCS)
- Smart energy systems

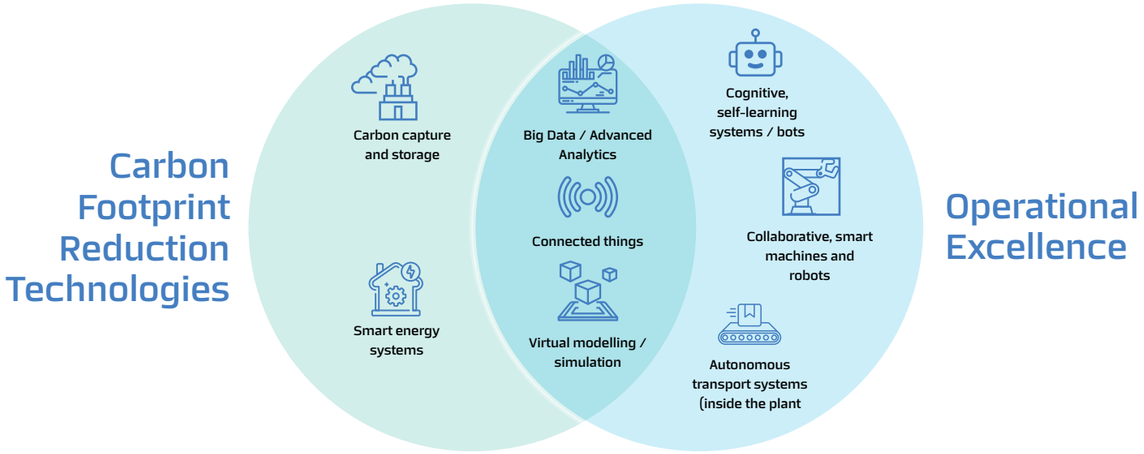
Operational excellence:

- Autonomous transport systems (inside the plant)
- Collaborative intelligent machines and robotics
- Self-learning cognitive systems

Carbon footprint reduction and operation excellence:

- Big data
- Connected things
- Virtual modelling and simulations

Exhibit 4: Key technologies adopted in the industrial sector



Big companies in the manufacturing sector are striving to achieve net zero through technology-based sustainability plans, and in many cases the impact of the adopted technologies has already been realized. For instance, BMW's manufacturing plant in Dingolfin, Germany, uses innovative manufacturing techniques such as automation, robotics, artificial intelligence, and smart control systems to reduce its carbon footprint. This has resulted in a 30% decrease in resource consumption and emissions over the past decade.

However, the adoption of new technologies by manufacturing players comes with several challenges:

01
Lack of skilled workforce

Moving from traditional operations to next-generation manufacturing requires a highly skilled workforce that can adapt to continuous improvements in systems and processes. This requires ongoing training and up-skilling of the existing workforce, changes in the hiring process, and a revamping of the educational curriculum.

02
Technology awareness limitation

Technological advancements and breakthroughs have been happening at a very fast pace and many organizations are struggling to keep up. To address this, companies need to establish strategic partnerships with technology vendors and raise organizational awareness to facilitate internal technology ideation and the development of requirements.

03
Outdated infrastructure and ICT systems

Adopting new technologies requires state-of-the-art infrastructure. For example, many Fourth Industrial Revolution (IR4.0) technologies require the establishment of high-speed and wide-area data transmission networks, cloud solutions, and cybersecurity.

04
Resistance to change

Technology adoption requires a fundamental shift in how work gets done and how decisions are made. As a result, employees fear that their skills or entire roles may become obsolete, and that more work will be required from them to adapt to the new changes.

05
Limited access to finance

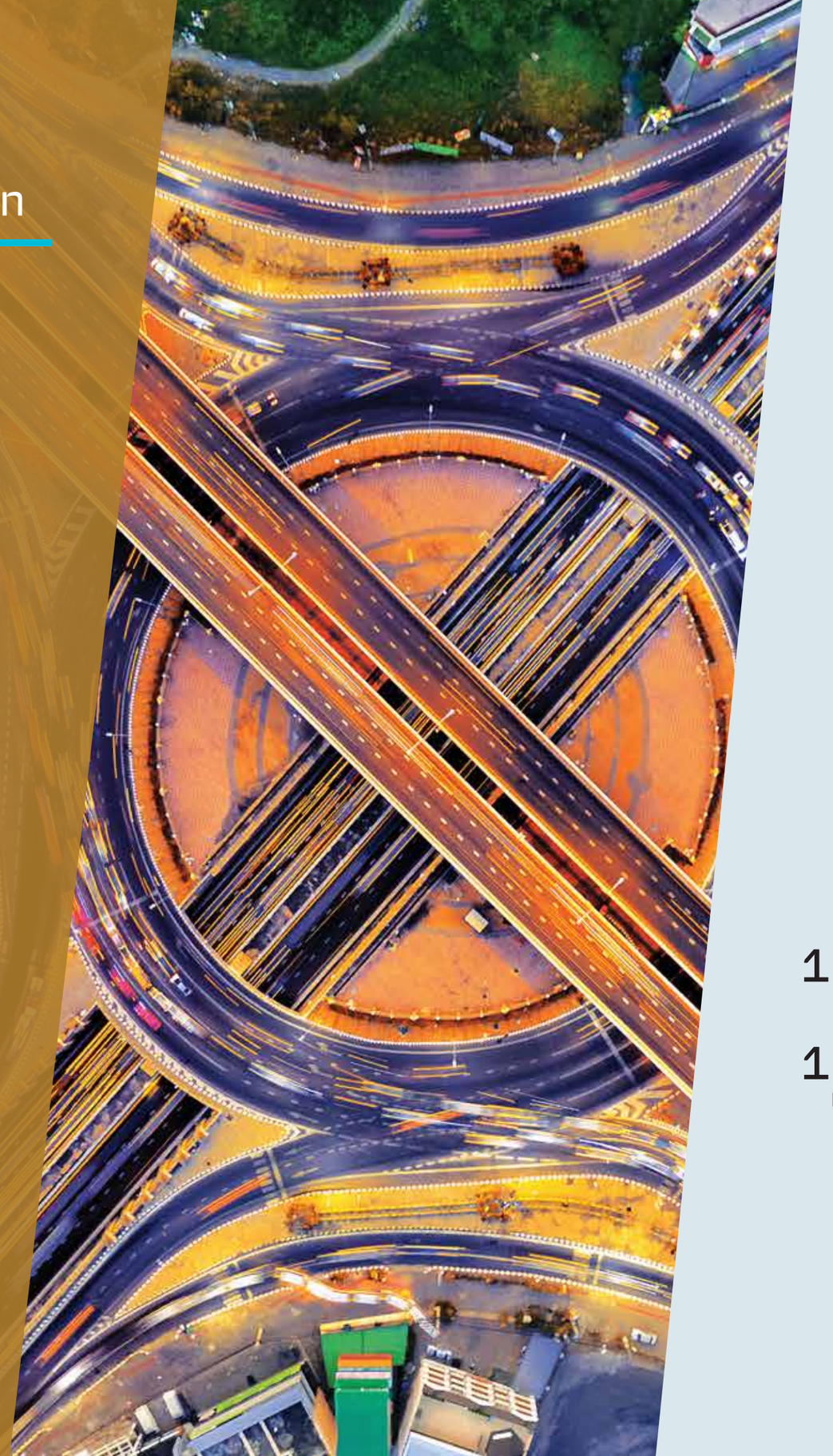
Organizations often struggle to access funding for their technology-related initiatives and sometimes rely on government incentives and IR4.0 and CCS technology funds.

The identified challenges are often magnified in the case of small and medium enterprises (SMEs), which constitute the majority of the manufacturing sector in the Middle East. A key success factor in driving technologies in the manufacturing sector in the region will be to accelerate and enable the adoption of technologies by SMEs.

In order to address the challenges faced in adopting new technologies, manufacturing companies should consider:

- Training and developing their current workforce to implement new technologies
- Hiring the required talent for effective IR4.0 adoption, such as AI, machine learning specialists, and big data specialists
- Designing and executing effective change management and communication campaigns to raise awareness surrounding the benefits of adopting these technologies to secure buy-in across their organizations
- Educating company leadership on the application and benefits of new technologies in order for them to act as champions of change
- Putting in place the necessary ICT infra structure to enable the use of advanced technologies

5.0 Transportation



5.1 Transportation

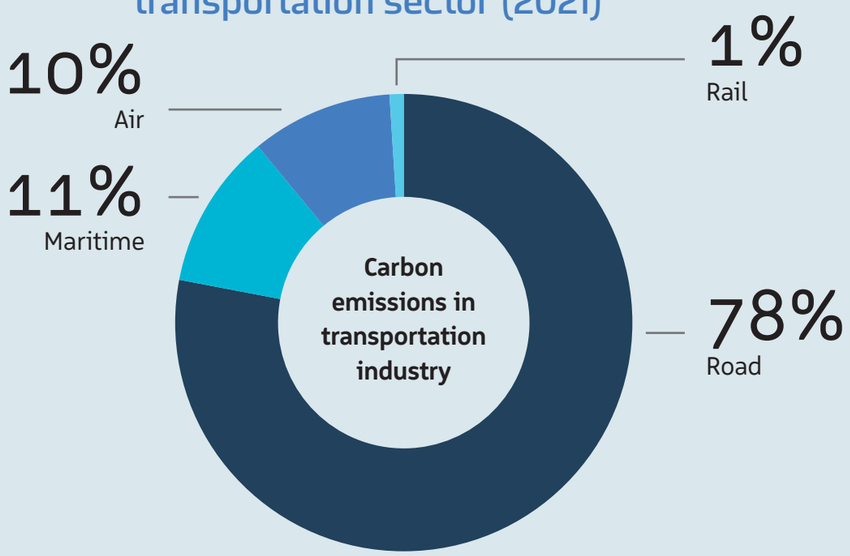
GHG emissions

The transportation industry is responsible for 16.2% of the global greenhouse gas emissions, mainly generated from burning fossil fuels to power transport activities[23]. What's more, the sector continues to rely on oil products for 91% of its final energy, down only three percentage points from the early 1970s.

During the COVID-19 pandemic there was a brief reprieve, but in 2021, the IEA reported[24] that global CO_2 emissions from the transportation sector had grown by 8% to nearly 7.7 gigatonnes CO_2, up from 7.1 gigatonnes CO_2 in 2020. Of the total emissions, 78% are attributed to road transport, with 65% coming from passenger travel and 35% from road freight. For its part, the aviation industry contributes 9.5% of the total emissions in the industry, with 81% stemming from passenger travel and 19% from freight. Maritime and rail transport are responsible for 11.2% and 1.2% of emissions, respectively.

Aggressively bringing down the emissions from road, maritime, and air segments for the transportation sector will be key to reaching net zero targets.

Exhibit 5: Emissions mix in the transportation sector (2021)



Bold moves by transportation companies

To get on track with the net zero emissions by 2050 scenario, CO_2 emissions from the transportation industry must fall by approximately 3% per year to 2030[24]. But the challenge is significant given that aviation, shipping, and heavy-duty trucking are some of the hard-to-abate segments within the sector.

According to CDP, only 30% of 872 major transportation sector companies have disclosed their carbon emissions, and just 23% have set any form of emissions reduction target. Painting an even grimmer picture, many of the pledges that do exist are not aggressive enough and less than 40% of the companies with a stated aim of reducing emissions have actually done so in the last year. Despite the slow progress, however, leading companies have been making decisive moves

Toyota[25]

As part of its net zero ambition, Japanese automaker, Toyota, has committed to halving Scope 1 and 2 emissions by 2031 , on a 2014 baseline[26] and has undertaken the Life Cycle zero CO_2 Emissions Challenge to reduce global CO_2 emissions from new vehicles by 90% compared by 2050, on a 2010 baseline[27]. Scope 3 emissions contribute to 98% of Toyota's total emissions, with category 11 'use of sold goods' making up over 90%.[25]

In addition, Toyota has conducted numerous environmental initiatives continuously since the 1960s. For example, the company created the Toyota Earth Charter in 1992, which was revised in 2000. Based on this charter, Toyota has formulated its long-term sustainability initiatives as the Toyota Environmental Challenge 2050. The challenge covers all Toyota operations and strives to achieve six bold objectives around CO_2 emissions reductions from new vehicles, operations, suppliers and dealers, as well as water conservation, recycling, and nature positive solutions.

To target its Scope 3 emissions originating from category 11 'use of sold goods', Toyota aims to expand its portfolio of sustainable vehicles including plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs), and hybrid electric vehicles (HEVs). The automaker has also pledged to invest $70 billion in carbon-neutral vehicles, which includes $35 billion in BEV-related R&D and capital investment, and $35 billion in HEVs, PHEVs, and FCEVs. It aims to achieve global sales of 3.5 million BEVs per year and roll out 30 BEV models by 2030. This will enable the company to reduce CO_2 emissions by 35% compared to 2010 levels.

DHL

Deutsche Post DHL Group (DHL) has established itself as a leader in the logistics sector through its green initiatives and commitment to promoting sustainability. It also became the first logistics company to commit to net zero transformation when it unveiled its ambitious Mission 2050 in 2017, and SBTi has confirmed that DHL's climate targets are in line with its criteria.

DHL has committed to spending €7 billion ($7.6 billion) by 2030 to reduce its emissions from 36 million tonnes of CO_2e in 2020 to 29 million tonnes in 2030,[28] while at the same time growing the business. It plans to electrify 60% of its last-mile delivery vehicle fleet by 2030 compared to 18% in 2020 and cover at least 30% of its fuel requirements in aviation and line haul with sustainable energy. It also aims to become a leader in sustainable aviation fuel (SAF) and design all new buildings to be carbon neutral. Overall, DHL intends to reduce its absolute Scope 3 emissions from fuel- and energy-related activities, transportation services, and internal travels.

Through its GoGreen initiative, DHL has been empowering customers to incorporate sustainable logistics practices into their business models. It also provides customers with emissions information and helps them optimize their carbon footprint. Internally, by 2025 DHL aims to train 80% of its workforce to become certified GoGreen experts and actively involve them in environmental and climate protection initiatives. Already, the company has over 70,000 GoGreen specialists.[29]

5.2 Transportation

Deutsche Bahn

Germany's national rail company, Deutsche Bahn (DB), is leading the transition to green energy in the country by setting lofty targets and committing to achieving climate neutrality by 2040. This is an accelerated target compared to its initial 2050 pledge.

Using renewable energy for all Deutsche Bahn's electricity consumption is one of the key catalysts in the green transition. In the short-term, the rail giant plans to use 100% renewable energy in all depots, office buildings, and stations in Germany by 2025. From there, the energy mix is to be transitioned entirely to renewables 2038. Energy efficiency is also being optimized by utilizing regenerative braking across the company's fleets and by adopting efficient driving techniques.

Additionally, the DB leadership is rapidly transitioning away from using diesel to power fleets and is focusing instead on alternative fuels such as hydrotreated vegetable oil (HVO). Meanwhile, the company is also exploring retrofitted systems and battery alternatives that would help the fleet operate without emissions, while reducing and eventually stopping the usage of fossil fuels for heating purposes.

Going even further, DB is influencing the sustainability of the wider customer journey by providing green mobility offerings, such as on-demand shared shuttles or bike rental, to reduce the overall customer carbon footprint.

By taking bold decisions and leading the curve on the green transition in mobility across Germany and Europe, DB is setting the pace for others to follow.

United Airlines[30]

United Airlines has been acknowledged as a leading figure in promoting sustainable aviation. In 2022, the company made a bold commitment to be 100% green, aiming to achieve carbon neutrality by 2050 without relying on conventional carbon offsets. United plans to achieve this goal by:

- Enhancing fuel efficiency
- Utilizing sustainable fuels that are both cost-efficient and environmentally responsible
- Reducing emissions through technological and process innovations
- Employing carbon capture and sequestration technology that can extract CO_2 from the ambient air
- Investing in innovative technology that can help reduce GHG emissions

United has invested over $70 million in SAF development, electric vertical takeoff and landing (eVTOL) aircraft, and carbon capture and sequestration technology. As of 2020, the company had also allocated $24.3 billion in capital commitments to modernize and replace its older, less efficient aircraft. Additionally, United works in close collaboration with different departments and with air traffic control providers to optimize fuel efficiency and support the ecosystem by encouraging the adoption of industry best practices and providing relevant training and tools to pilots and dispatchers.

Maersk[31]

In 2022, Maersk revealed an ambitious plan to bring forward its net zero emissions target year to 2040, instead of 2050. This goal pertains to all three emissions scopes, and it aligns with the climate commitments of its customers. Furthermore, by 2030, Maersk aims to cut its carbon intensity by half, compared to 2020, and employ green fuels to transport at least 25% of company cargo.

Maersk has a comprehensive approach to sustainability that extends beyond reducing carbon emissions. The company actively works with its customers to promote responsible business practices across all areas of sustainability. It also engages in multi-stakeholder forums like Smart Freight Centre, Clean Cargo, the First Movers Coalition, and Road Freight Zero. Maersk collaborates with other industry players too, to improve standards and develop joint concepts that can accelerate the development and scaling of green solutions.

Technology choice and challenges

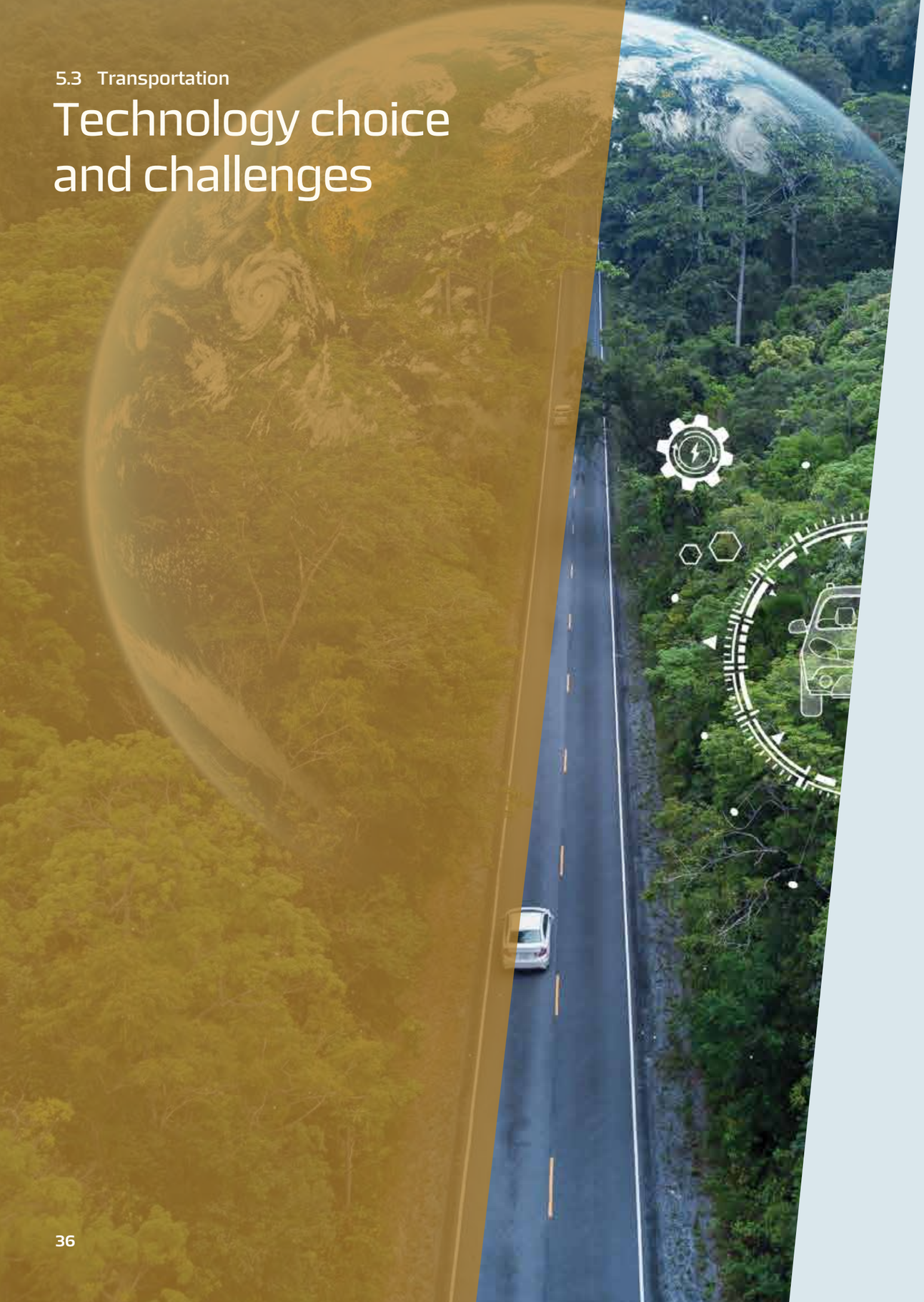


Exhibit 6: Sustainable technologies in the transportation sector

Road Transport	▪ Electrification ▪ Flexible fuel ▪ Green hydrogen combustion cars	▪ Hydrogen fuel cells ▪ Alternate fuel technology CNG, LNG ▪ Internet of vehicles
Rail Transport	▪ Electrification ▪ Anti-idling system	▪ Rugged mobile inspection devices ▪ Acoustic monitoring for equipment defect prediction
Air Transport	▪ Sustainable aviation fuel (SAF) ▪ Bio-fuel based propellants ▪ Hydrogen based engines	▪ Hybrid and eVOTLs ▪ Al to help ATC and reduce navigation time
Maritime Transport	▪ No ballast system ▪ Sulfur scrubber system ▪ Sail and kite propulsion system	▪ Sandwich plate system (SPS) ▪ Advanced rudder and propeller system ▪ Greener fuel alternatives NH3, etc

Research for the development and deployment of technologies to facilitate sustainable transportation has been ongoing around the world. Electrification, the shift to greener fuels, and increasing popularity of AI models for faster navigation and for reducing idle time are key trends across different modes of transport.

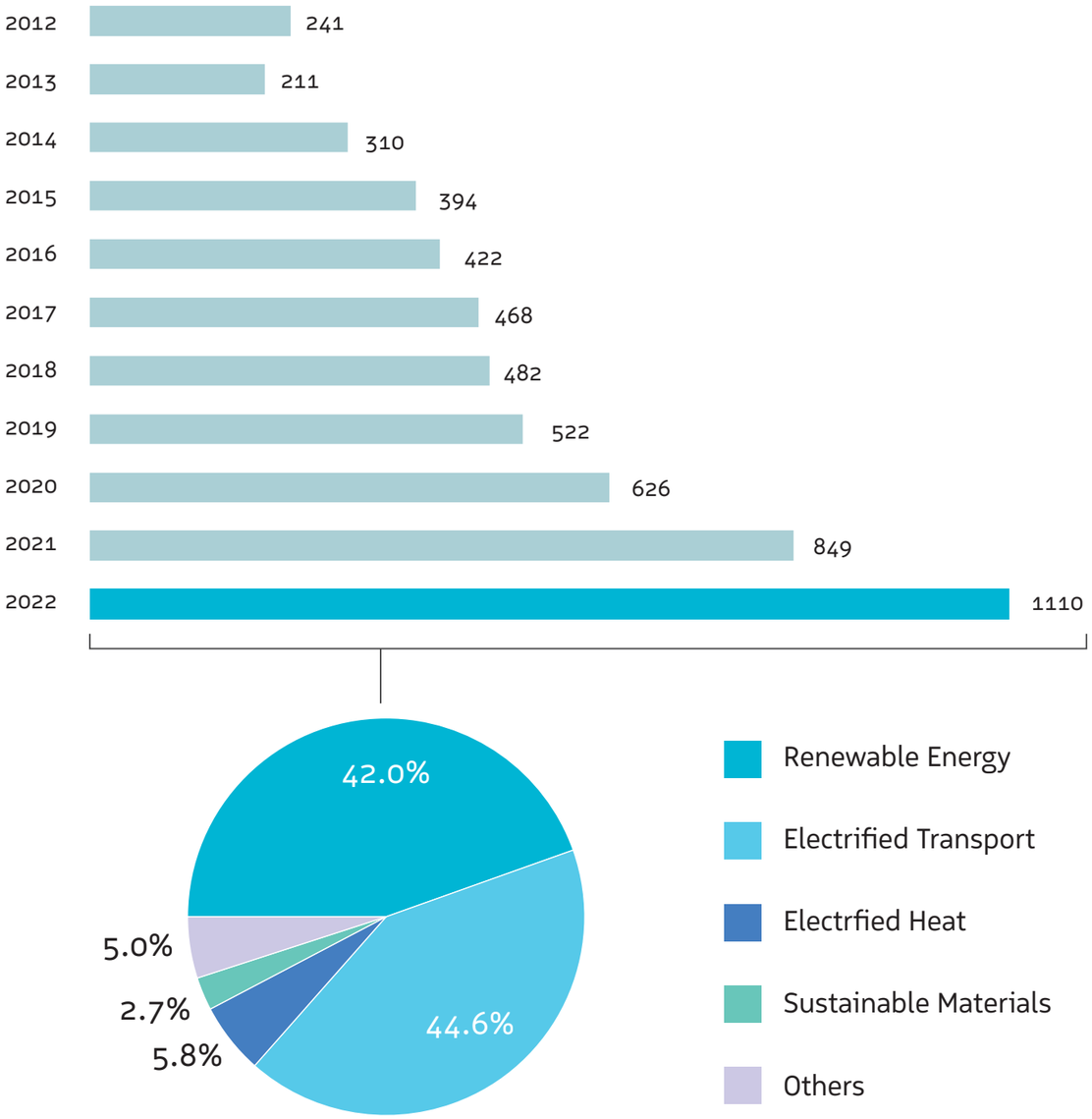
Another key trend is the rise of electric vehicles. The plethora of sustainable technology we see today varies in commercial viability, maturity, and emission impact, but EVs stand out as a mature and commercially viable option. Sales of EVs doubled in 2021 from the previous year to a new record of 6.6 million. This brings the total number of electric cars on the world's roads to about 16.5 million, which is triple the number in 2018. What's more, nearly 10% of global car sales were electric in 2021, four times the market share in 2019.[32]

Alongside EVs, sustainable aviation fuel is another emerging technology that is expected to see a rise in uptake. To date, over 450,000 flights have taken to the skies using SAF and more than 50 airlines now have experience with the fuel.[33] Meanwhile, the technology to make ammonia (NH_3) usable as a green fuel in maritime transportation is still at the development stage but is expected to account for 25% of the maritime fuel mix by 2050.[34]

From ammonia to SAF, technology is a key driver of sustainable growth in the transportation industry and there is increasing investment in the mobility sector today. Strategic research provider, BloombergNEF, reported that global investments in the low-carbon energy transition amounted to an estimated $1.1 trillion in 2022.[35] The renewable energy sector received the largest share of investment, amounting to $495 billion, or 45% of the total.

Here, it is important to note that electrified transport, which includes investments in electric vehicles and infrastructure, saw a massive funding increase of 54% year-on-year, with a total investment of $466 billion. However, this figure still falls short if the sector is to reach net zero CO_2 emissions by 2050. In fact, for that goal to become a reality, investments need to triple in size.

Exhibit 7: Investments in energy transition technologies (in $B)



Priorities for execution

The implementation of transport solutions aimed at reducing carbon emissions and minimizing environmental impact faces significant challenges across various modes of transportation:

Air transportation

Developing and deploying sustainable aviation technologies, such as electric or hydrogen-powered aircraft, is challenging due to the limitations of current technology and infrastructure. Building a robust charging or refueling network for electric or hydrogen-powered planes is necessary but requires substantial investments and innovation.

The energy density of batteries for electric aircraft and the range of sustainable fuels are lower compared to traditional aviation fuels, which poses challenges for long-haul flights. Advancements in battery technology and sustainable fuel options are needed to overcome these limitations.

Establishing international standards and regulations for sustainable aviation fuels and emissions reduction is essential. Collaboration among governments, airlines, and regulatory bodies is also necessary to facilitate the adoption of low-carbon solutions in the aviation sector.

Rail transportation

Expanding electrification in rail transport requires significant investment in infrastructure, including overhead lines and substations. Developing renewable energy sources to power trains is crucial for reducing the carbon footprint of rail systems and overcoming reliance on fossil fuels.

Ensuring efficient connectivity between different rail networks and increasing capacity to meet growing demand are challenges that involve infrastructure upgrades, improved scheduling, and better integration with other modes of transport.

Land transportation

Driving demand away from using private cars towards public transport or other micro mobility services has significant benefits, including reducing carbon footprint, but it requires improvements to public transport networks, integration of transport modes, affordability, and incentives, as well as good passenger experience and high safety standards.

Expanding charging infrastructure for electric vehicles and hydrogen refueling stations is crucial for widespread adoption. Ensuring sufficient coverage and capacity in urban and rural areas is a challenge that requires substantial investments and coordination between public and private entities.

Enhancing consumer acceptance of EVs and other low-emission vehicles requires addressing concerns about range anxiety, charging times, and upfront costs. Education, incentives, and improved battery technology are key to overcoming these barriers.

Integrating various modes of land transport, such as buses, cars, bicycles, and pedestrian infrastructure, presents challenges in terms of connectivity, ticketing systems, and seamless travel experiences. Coordinated planning and investment are necessary to create integrated sustainable transport networks.

Maritime transportation

Developing and adopting sustainable fuels like biofuels, hydrogen, and ammonia is essential for reducing emissions in the maritime sector. However, challenges exist in terms of availability, scalability, and infrastructure for these alternative fuels.

Establishing international regulations and standards for emissions reduction in maritime transport is a complex task that requires collaboration among countries, shipping companies, and international organizations. Achieving consensus and enforcing compliance can be challenging.

Retrofitting existing vessels or building new ships with cleaner technologies, such as hybrid propulsion or wind-assisted systems, can be costly and require significant investment from the maritime industry.

Addressing these challenges demands a comprehensive and collaborative approach involving governments, industry stakeholders, research institutions, and consumers.

On the latter, consumer choices and changes in behavior can have a significant impact on the transport sector. For example, behavioral trends such as shifting from using cars to public transport for short trips or opting for rail travel over short haul flights can make a positive difference in the net zero campaign. However, bringing consumers onboard with the green transition requires an integrated ecosystem that delivers a positive experience and clear incentives through government actions.

Beyond the individual level, enterprise customers, such as city councils, are also critical stakeholders for transportation companies. For example, in order for EVs to successfully take off in any given city, the right infrastructure first needs to be in place, and responsibility for its roll out rests with local authorities – albeit with private-sector involvement.

From city councils to the national leadership, government at every level has a role to play in enabling the acceleration of emissions reduction programs. In the case of land transportation, federal, state, and local government must work together to develop consistent policies, regulations, and incentives to implement green public transportation networks – and to encourage passengers to use them.

6.0 Oil & Gas

6.1 Oil & Gas

Oil & Gas companies' commitment to net zero

It is well known that the oil and gas industry is a major contributor to GHG emissions. In fact, a recent IEA estimate suggested that Scope 1 and 2 emissions from the production, transportation, and processing of oil and gas, accounted for 5.1 billion tonnes of CO_2e in 2022.[36] Just as concerning, indirect greenhouse gas emissions from oil and gas operations currently amount to approximately 5,200 million tonnes (Mt) of CO_2e, which represents about 15% of the total GHG emissions from the energy sector[37].

To achieve net zero, emissions from the oil and gas industry must decrease by a huge 45% to 50% by 2030. The challenge is immense, but several decarbonization initiatives are underway shaped by different strategic approaches:

Aggressive decarbonization of existing operations

Some oil and gas companies have focused on aggressive decarbonization of existing operations while sticking to their core business.

ExxonMobil:

ExxonMobil has committed to net zero GHG emissions for its operated assets by 2050 while its 2030 plans expect a 20% to 30% reduction in corporate-wide greenhouse gas intensity, including reductions of 40% to 50% in upstream intensity, 70% to 80% in methane intensity, and[38] 60% to 70% in flaring intensity. In addition, ExxonMobil plans to grow its new low carbon solutions business.

Revamping the integrated business model

Other oil and gas companies have started by revamping their integrated business model and building the foundations of a non-oil and gas portfolio to meet the needs of a decarbonized future. These new businesses range from solar and wind energy generation, to EV charging infrastructure, low-carbon biofuels, and hydrogen.

Total Energies:

Total Energies[39] is aiming for a 40% reduction in its Scope 1 and 2 emissions by 2030 compared to 2015 and intends to reduce emissions related to sales of petroleum products (Scope 3 oil) by more than 30% by 2030, compared to 2015 levels. By 2050, Total plans to achieve net zero and produce 50% of its energy from renewable electricity, 25% from new decarbonized biofuels, hydrogen, or e-fuels. The remaining 25% will be produced from hydrocarbons, with the residual Scope 3 emissions from its customers fully captured, recycled, or offset.

Prominent industry leaders such as Shell and BP have also made bold net-zero commitments, driving a transformation from their conventional business models to diversified ventures in new energy. However, some of these players has opted to recalibrate their emissions reduction goals, redirecting their attention towards their core oil and gas operations as a means to generate quality earnings.

Dual strategies from national oil corporations (NOCs)

NOCs have been focusing on both decarbonization of existing operations and expansion of their portfolios to include low-carbon energy. By sheer definition, NOCs will need to continue to be the custodians of their respective countries' oil and gas assets, and many have committed to the goal of net zero.

Aramco:

Aramco[40] announced its ambition to achieve Scope 1 and 2 net zero by 2050 and to halve these emissions by 2035, from a 2018 baseline. The net zero deadline set by the company comes a decade earlier than that of its home country, Saudi Arabia. Aramco aims to reduce its absolute emissions to 67 million metric tonnes of carbon dioxide equivalent (MMt CO_2e) by 2035. This comes despite the projected increase in business-as-usual Scope 1 and Scope 2 GHG emissions for its wholly owned operated assets to 119 Mm CO_2e, due to the growth strategy in oil and gas production and development of new businesses.

As part of the net zero plan, Aramco has identified five key areas and set specific reduction targets 2035 covering (i) energy efficiency, (ii) renewables, (iii) CCUS, (iv) methane and flaring, and (v) NBS and offsets. In addition, it has embarked on a wide range of low-carbon fuel and transportation technologies, and hydrogen. Aramco's Hawaiyah CCUS facility has captured and processed 45 million cubic feet of CO2 and the company has also produced the world's first shipment of blue ammonia – a carrier for blue hydrogen – and delivered it to Japan.[41]

PETRONAS:

Malaysia's NOC PETRONAS has committed to net zero by 2050. It plans to reduce GHG emissions from Scope 1 and Scope 2 by 20% by 2030 (from a 2020 baseline) and by 80% by 2040. PETRONAS has also recently launched Gentari – a new, independent entity working on cleaner energy solutions that will capture opportunities in the energy transition and generate non-oil and gas revenue for the company. Gentari is focusing on three core segments: renewables, hydrogen, and mobility. It aims to expand its offering of renewable and clean energy to between 30 GW and 40 GW, generate up to 1,200,000 tonnes per annum of clean hydrogen, and build 25,000 EV charging points across key markets in the Asia Pacific region.[42]

With the recent geopolitical conflict, energy crises, and societal challenges such as the increased cost of living, there is no doubt that oil and gas companies face huge pressure to be part of the solution in making energy affordable, while continuing to accelerate progress towards the decarbonized world.

Technologies and key challenges

Leading oil and gas companies have started deploying various decarbonization technologies to reduce carbon emissions and achieve net-zero targets. Some of these technologies are outlined below:

Selected technologies used by upstream companies

Flaring and methane management:

For oil and gas companies, flaring and fugitive methane are major sources of GHG emissions. Encouragingly, many companies have been able to reduce flaring and methane intensity from their operations and there are also global initiatives that have brought together players to collectively address the issue, such as the World Bank's Zero Routine Flaring Initiative and the Oil and Gas Climate Initiative (OGCI).

Moving forward, companies should aspire to have zero routine flaring and openly share best practices with industry players. Aramco for example, has a flare minimization plan and invests into new technologies, such as innovative flare gas recovery systems, high integrity pressure protection systems, and zero discharge technology, to reduce intermittent flaring. Meanwhile, companies like BP, Shell, and ExxonMobil have committed to reducing fugitive methane emissions to near zero by 2030.

To address fugitive methane emissions, companies can consider using drones to measure and monitor methane leaks and

satellite images to identify them in the first place. They can also install vapor recovery units.

Carbon Capture Usage and Storage:

CCUS is the process of capturing waste carbon dioxide, transporting and depositing it in a storage site that will not allow for leakage into the atmosphere, and subsequently utilizing the carbon dioxide to produce meaningful outputs. ExxonMobil, Shell, Equinor, Total Energies Aramco, ADNOC, and PEMEX count among the companies pursuing CCUS projects.

Electrification:

Solar and wind are good candidates for the electrification of certain assets, depending on the geographical, locational, and operational contexts. Geothermal energy is also an enormous source of renewable energy, yet the high cost of drilling wells for geothermal installations means it is underutilized. One solution to make geothermal installations economically viable is to convert existing oil wells for geothermal production. Indonesia's Pertamina has been investing in geothermal energy and the UAE's Masdar has made strategic investments in Pertamina Geothermal Energy company.

Selected technologies used by downstream companies

Energy Efficiency:

Energy efficiency technologies can deliver the low hanging fruit for companies, helping to reduce costs as well as emissions. There are numerous ways in which downstream/refining operations can reduce energy usage:

- Optimize steam production systems through real time optimization and boiler purge automatization, and optimize steam distribution processes through reducing steam line losses and insulating networks
- Optimize compressed air usage by minimizing leakage and implementing early detection programs.
- Motor: Adopt higher efficiency motors and install variable speeds on motors
- Optimize oven usage by revamping heat insulation and recovery, metering, and digital
- Improve vacuum usage by using vacuum pumps, replacing vacuum production systems

There are numerous other energy efficiency and energy management opportunities that can be identified and applied for downstream/refining operations. This will require working through operating units, equipment, and processes to uncover hidden gems, which are often easy to implement.

Cleaner inputs:

Downstream/refining operations can benefit from the use of cleaner inputs. These can range from cleaner fuel for energy and steam, to bio-feedstock or feeds with biogenic CO_2.

Green hydrogen:

Refineries use hydrogen in the de-sulfurization of crude oil to make petrol, diesel, and other chemicals. Green hydrogen is produced by splitting water into hydrogen and oxygen using renewable energy. This requires the use of electrolyzers or small modular reactor (SMR) technologies. Green hydrogen does not emit any polluting gases during combustion or production, is easy to store, and can be transformed into electricity or synthetic gas, which can be used for several purposes.

High temperature electric cracking:

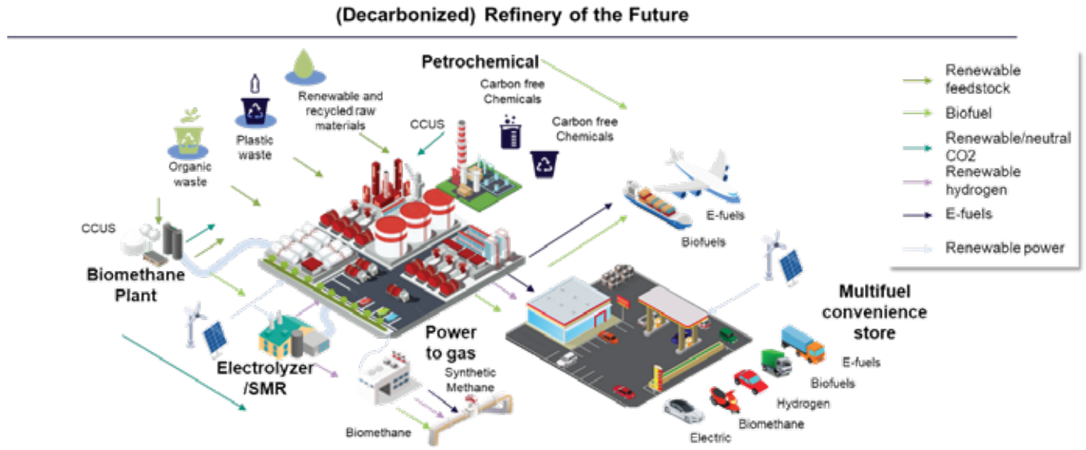
Steam cracking is a large contributor to CO_2 emissions. This process can be electrified by using renewable energy sources instead of fossil fuels, which can help reduce CO_2 emissions significantly. However, this technology is in its early stage of maturity.

Cleaner outputs:

Downstream/refining operations can generate cleaner, greener products, which will then help to reduce Scope 3 emissions. E-fuels, synfuels, and biofuels are examples of such greener products.

With the use of existing, new, and emerging technologies, refinery of the future has the potential to be much greener, and with a lower emissions footprint. However, there are numerous challenges when it comes to deploying, scaling, and sustaining use of technologies in the oil and gas industry.

Exhibit 8: Potential use of technologies to decarbonize downstream refineries



Economic challenges:

Large, upfront capital investment is required to deploy decarbonization technologies, and while projects may be ready to adopt them, the technologies are often not mature or commercially viable yet. Executives are thus required to meet net-zero targets while simultaneously handling short-term profitability and cash flow challenges and pressure from customers and investors regarding sustainability.

Limited support from regulators:

Some initiatives are difficult to execute due to limited regulatory support. In some cases, there is no clear business model for adopting decarbonization technologies due to lack of regulatory certainty. To address this, clear government incentives, such as those introduced by the United States through the IRA, are required, and high operation standards need to be established to facilitate adoption of necessary technologies.

Logistical and supply chain challenges:

Deploying certain decarbonization technologies will require oil and gas companies to rethink their operational models and adopt different processes, necessitating the creation of partnerships with relevant stakeholders and fresh supply chains. This is particularly true for large projects involving hydrogen, CCUS, green inputs, and green products.

Technology adoption and scale-up:

Given the highly safety conscious culture and conservative nature of the industry, there is often a reluctance to adopt new technologies and stakeholders often seek proof before considering a change. Once a new technology is adopted, it must be sustainable for the long term, as change-over down the track may not be possible. Such barriers need to be addressed in order for oil and gas companies to drive their decarbonization execution agendas.

6.3 Oil & Gas

Deep dive in CCUS

Carbon capture, utilization, and storage is a technology that captures carbon dioxide emissions from industrial processes, such as power generation and manufacturing. It then stores the CO_2 underground or uses it for other applications. CCUS has proved to be an effective decarbonization technology and is gaining momentum as a means to help reduce GHG emissions and mitigate climate change.

The IEA estimates that 4 Gt of CO_2 per year must be captured by 2035 and 7.6 Gt by 2050 in its Sustainable Development Scenario. Under this scenario, global CO_2 emissions from the energy sector fall to zero on a net basis by 2070, with CCUS accounting for nearly 15% of the cumulative reduction in emissions, compared with the Stated Policies Scenario.

Current status and progress

Currently, there are nearly 40 commercial facilities utilizing CCUS for industrial processes, fuel transformation, and power generation, with a combined annual capture capacity of roughly 45 Mt CO_2. The US has seen the biggest investments in CCUS capacity so far, with ExxonMobil, Chevron and others leading in terms of current and announced projects.

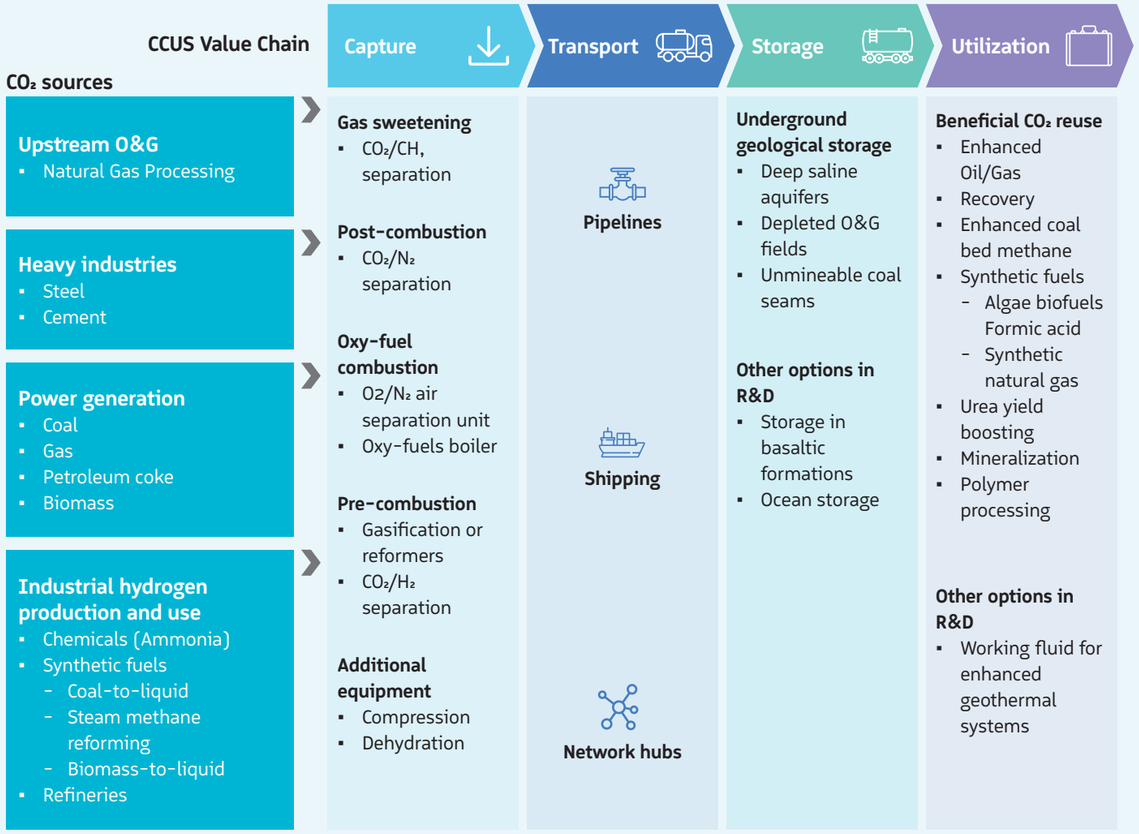
While CCUS deployment had previously fallen short of expectations, the momentum has significantly increased in recent years. Presently, there are roughly

500 projects in various stages of development throughout the value chain[43] and leading companies across the globe are collaborating to further develop their CCUS strategies.

CCUS value chain and technologies

CCUS has distinct steps in the value chain, which can create many opportunities for players to participate in this growing sector. These steps range from CO_2 capture and transportation to storage and utilization, as illustrated below:

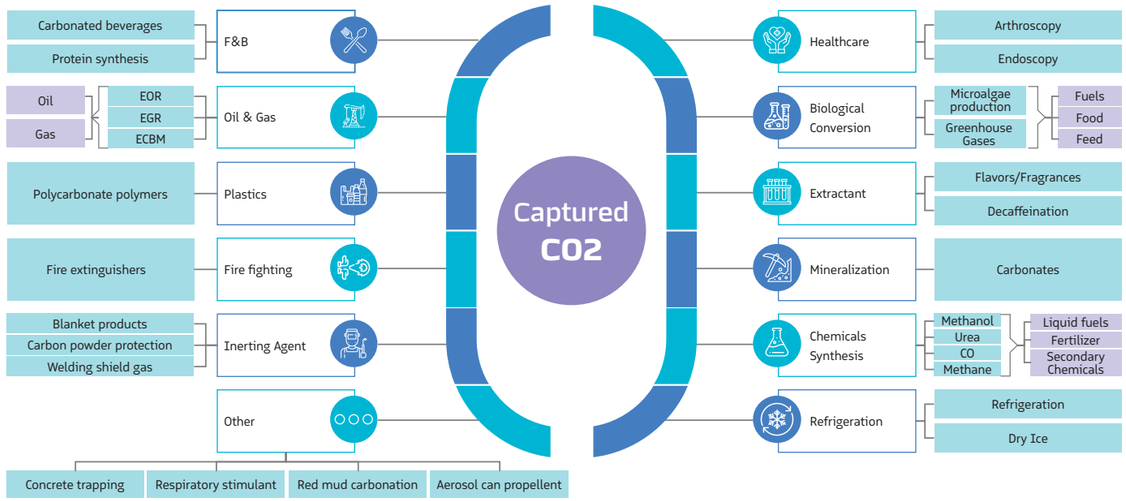
Exhibit 9: CCUS value chain



CCUS applications and market potential

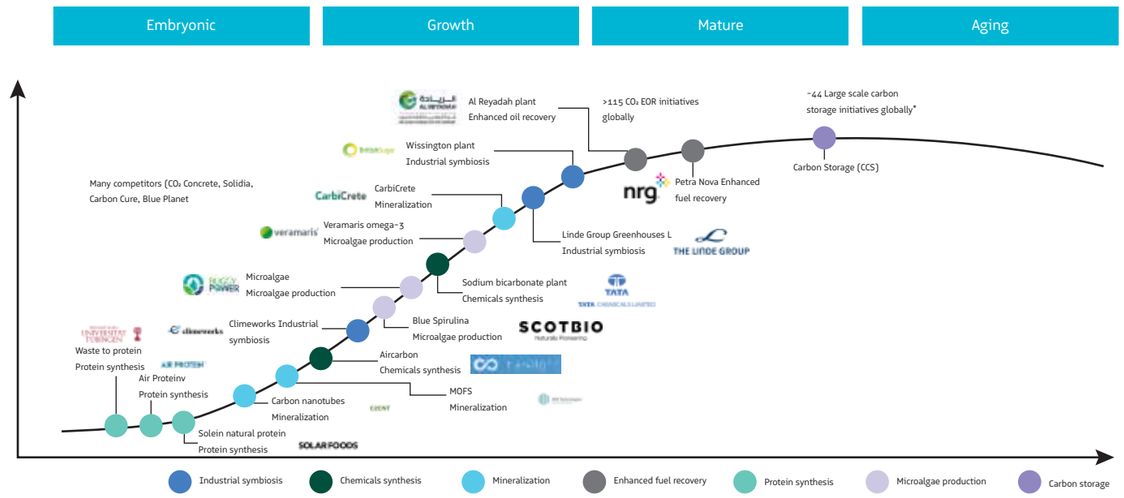
The CCUS market was estimated to be worth $1 billion last year and is expected to grow at a CAGR of between 30% and 50% up to 2030. The underlying drivers of this accelerated growth will be the overriding need of industries to decarbonize, increased incentives and support from government, technology development resulting in lower costs, and benefits from the economics of scale from the likes of CCUS hubs and clusters.

Exhibit 10: CCS - use of captured CO_2



From a sector perspective, CCUS is still predominantly used by oil and gas firms for enhanced oil recovery, but other sector-specific applications will continue to emerge. Meanwhile, on the technology front, while captured CO_2 is widely used for industrial symbiosis and chemical synthesis, growing technologies like microalgae production and mineralization have seen increasing implementation across multiple companies. The use of CO_2 to synthesize proteins, foods and feeds for human and animal consumption is another technology that is expected to grow in the days to come.

Exhibit 11: Utilization technology examples and maturity levels



Challenges with CCUS

CCUS technology has the potential to significantly reduce greenhouse gas emissions, but it also faces various challenges, with economic feasibility and a lack of regulatory incentives prime among them. Other key challenges include:

Public support:

Development of a large-scale CCUS infrastructure requires public support for initial costs and project risks, like tax incentives and subsidies. Safety of CCUS is also a public concern. As such, companies and governments must engage in awareness raising campaigns and encourage wider acceptance

Storage:

CCS relies on geological storage where the availability is limited, while CCU requires transportation infrastructure and optimal proximity to CO_2 consumers

Policy:

CCUS development is highly dependent on policy support including carbon pricing or government funding through emissions trading schemes (ETS)

Tech intensity:

CCUS is a technology intensive process, with different technologies needed along the value chain. More R&D work is clearly needed and can be achieved in collaboration with global ecosystem partners

6.4 Oil & Gas

Priorities for execution

Given the magnitude of the net zero challenge, companies in the oil and gas sector must set out a clear roadmap that highlights the key priorities for execution as they work towards a decarbonized future. These priorities should include:

Tackle the low hanging fruit

Reducing methane emissions can have tremendous impact as it is estimated to be over 80 times more potent than CO_2 over a period of 20 years. According to the IEA, companies can achieve a 75% reduction in methane emissions using existing technologies, with almost half of the improvements coming in at a zero net cost. Thus, initiatives such as phasing out or upgrading pneumatic equipment, improving leak detection and repair (LDAR), and eliminating routine flaring can contribute significantly to the decarbonization journey.

Prioritize initiatives and develop a robust capex plan

Executives need to take into consideration a variety of factors such as areas of operations, current portfolio mix, and local policies and systems when prioritizing decarbonization initiatives. A robust capex plan also needs to be established with clear short-term and long-term targets and effective progress monitoring mechanisms.

Execute operational improvements

Oil and gas companies can undertake several operational initiatives to reduce the intensity of Scope 1 and 2 emissions. These initiatives include improving logistics networks by using the sharing economy principle, optimizing production and operation management through digital tools such as Internet of Things (IoT) sensors, and increasing reuse or employing additive manufacturing to reduce waste.

External communication and stakeholder engagement

The oil and gas industry is a key player in pushing for a decarbonized world. While the industry often receives bad press, the world will continue to need oil and gas to ensure energy security and affordability. Thus, industry leaders must continuously work to enhance public opinion as they aggressively deliver on their decarbonization plans.

7.0 Scope 3 – The Holy Grail

Reducing Scope 1 and Scope 2 emissions is a vital and courageous endeavor, yet without tackling Scope 3, achieving net zero will be rendered a pipedream. Such is their significance, Scope 3 emissions can account for between 70% and 90% of total emissions for some companies.

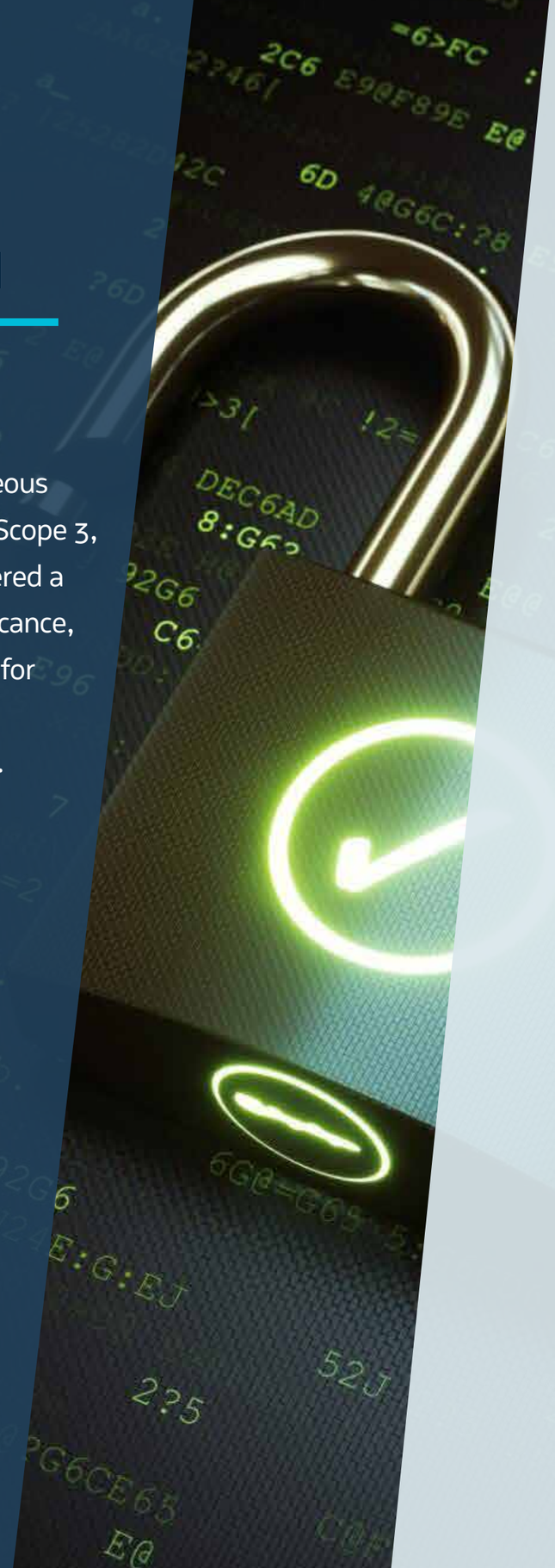
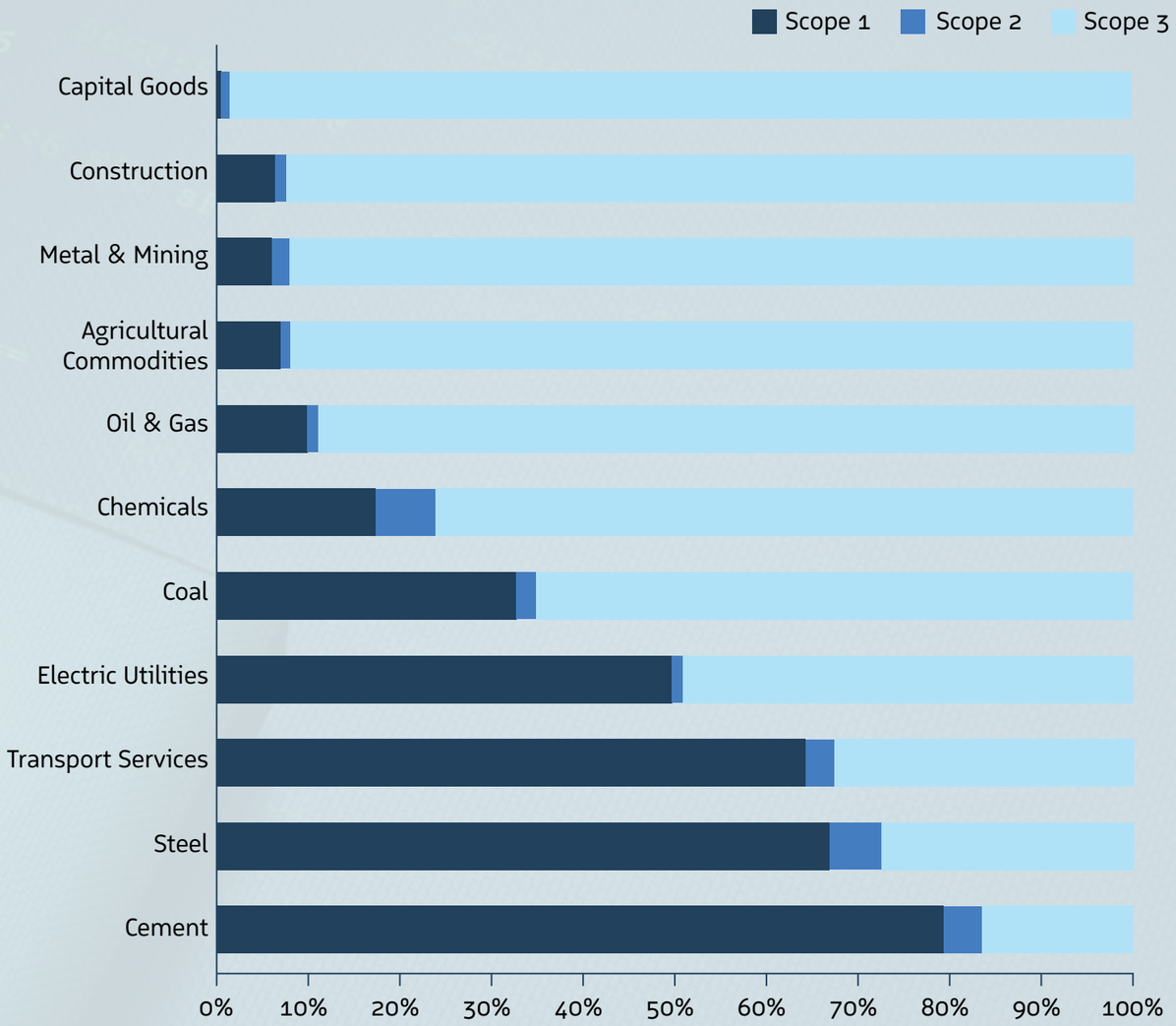
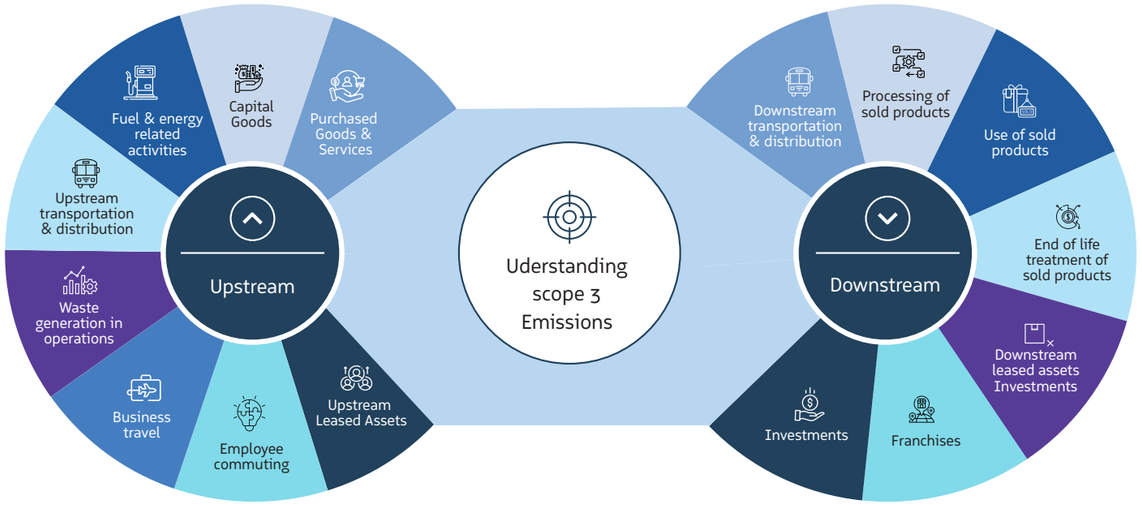


Exhibit 12: Emissions profile by sector (scope 1,2 and 3 emissions as % of total)[44]



The key categories of Scope 3 are well understood, yet challenges abound when it comes to baselining and reducing these emissions. Among the main obstacles are: (i) drawing a clear boundary for Scope 3 emissions (e.g., from the supply chain), (ii) gathering accurate emissions data, (iii) setting appropriate reduction targets, and (iv) addressing the current lack of standards.

Exhibit 13: Scope 3 emissions categories



To address Scope 3 emissions, companies need to take a collaborative and holistic ecosystem approach, factoring in the perspectives of both upstream suppliers and downstream customers. Any successful Scope 3 program will also need clear strategy and prioritization, and careful orchestration over time. Towards this end, there are several key questions that companies should consider:

- Which Scope 3 categories are most pressing and most relevant to the company's business and operations?
- What is the current situation with respect to gathering emissions data or estimating emissions to create a robust baseline?
- Which calculation methodology should the company adopt for baseline estimates and the calculation of their Scope 3 emissions, and where does the potential for error lie?
- What Scope 3 reduction opportunities may exist? Which of these can be easily aligned and have the biggest impact?
- What kind of collaboration across the supply chain ecosystem will be needed to deliver on the Scope 3 reduction opportunities?
- How can the company maintain the focus, coordination, and influence with ecosystem partners over multiple years to drive down emissions?

As these questions indicate, Scope 3 emissions reduction can be a major undertaking for a company and the effort needed should not be underestimated. The challenges outlined below further illustrate the scale of the task ahead:

Reporting requirements

Different companies have different Scope 3 emissions profiles. As such, while 15 categories have been indicated by the GHG Protocol, companies may choose to report on some, but not all.

Emissions data and calculation methodology

Lack of data availability and reliability makes emissions estimation difficult. Apart from primary data collection, secondary data collection, extrapolation, modelling, and proxy data sets are used to estimate total emissions. There are also different quantitative assessment methodologies developed by different organizations to calculate Scope 3 emissions, such as ISO standards and GHG protocol. Identifying which calculation methodology suits best can therefore be challenging.

Data management and sharing

Given the collaborative nature of activities for Scope 3, data management, privacy, confidentiality, security, and sharing protocol very quickly become major issues and can be key stumbling blocks for Scope 3 initiatives. However, ecosystem collaboration can be enabled through data sharing, for which a transparent regulatory framework will be needed.[45]

Capability

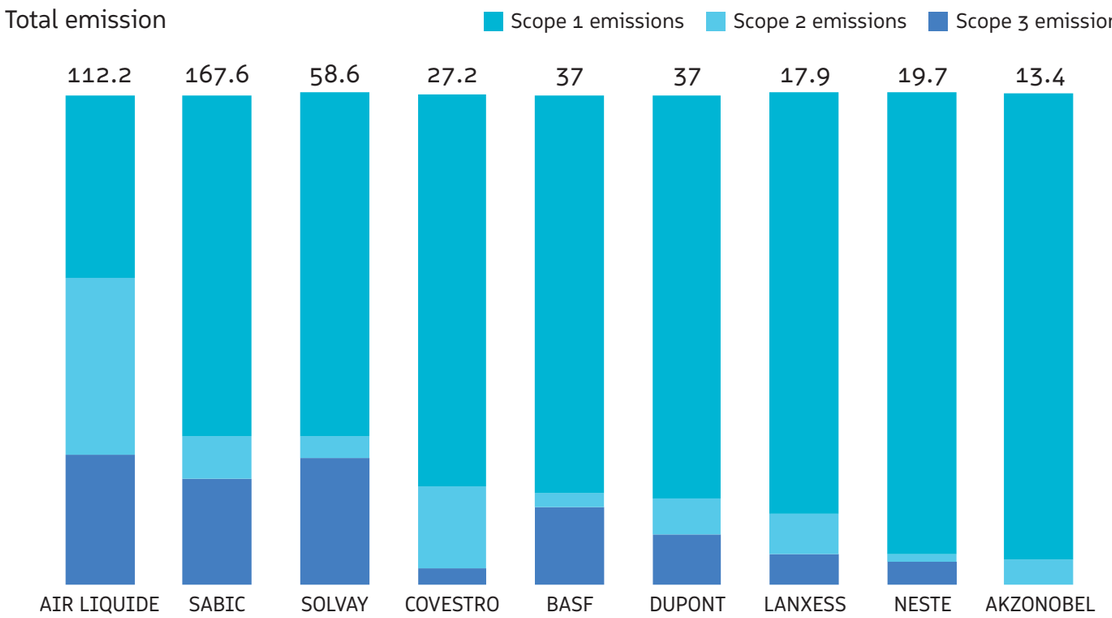
The capability to assess and act on reducing Scope 3 emissions is not the same for all companies. Internal employees, supply chain partners, and the extent of reach and control over them vary widely. This affects the emissions estimation as well as the implementation of any initiative to reduce Scope 3 emissions. Here, a digital platform may be useful in addressing the related challenges.

Scope 3 emissions in chemical companies

The chemical industry stands as the largest consumer of energy in the industrial sector and the third largest emitter of direct CO_2 emissions, primarily due to the fact that approximately half of its energy input is utilized as feedstock rather than a source of energy. In 2021, primary chemical production resulted in direct CO_2 emissions of 925 Mt, representing a 5% increase on the previous year, and surpassing the levels seen in 2019.

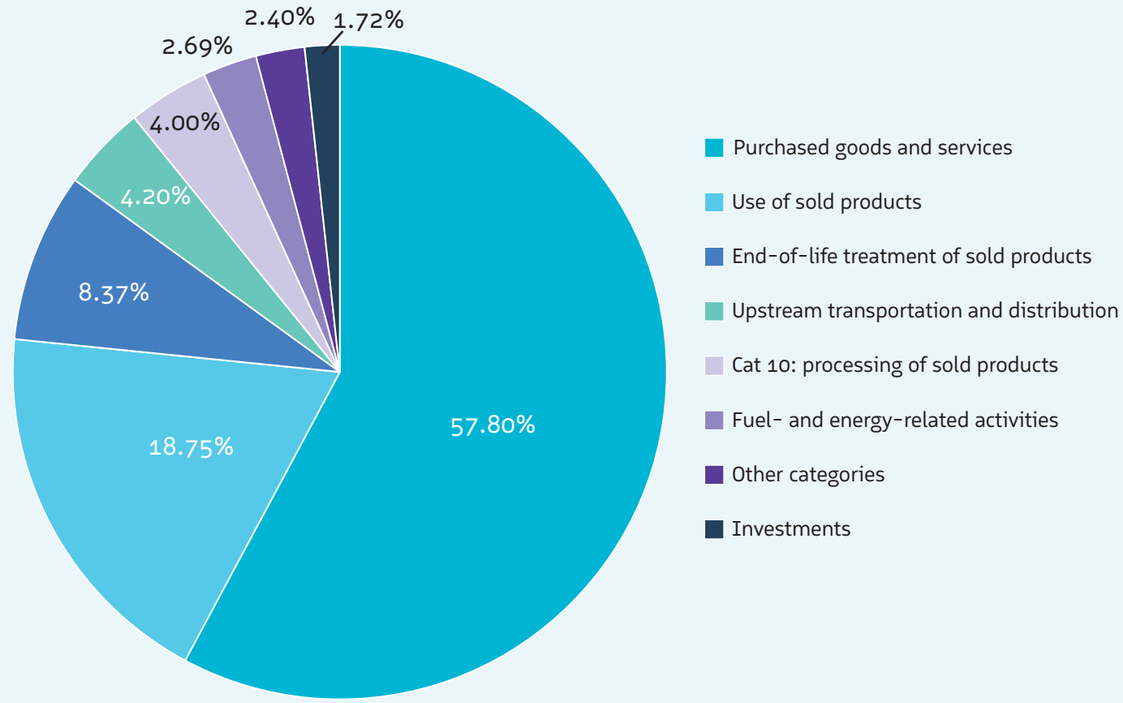
Companies may use these strategies one after another in a phased approach or undertake a multi-pronged approach using levers simultaneously to reach the net zero target. Either way, they must drive decision making based on timeline, feasibility, and cost considerations, while planning a decarbonization roadmap. This will allow companies to prioritize decarbonization investments, achieve the highest reduction in carbon emissions, and manage risk and cost levels.

Exhibit 14: CO_2 emissions in the chemical industry (in million metric tons)



According to CDP, over 76% of the chemical industry's total emissions are generated by Scope 3 sources, with Scope 1 and Scope 2 emissions accounting for ~17% and ~7%, respectively. Category 1 Scope 3 emissions, which are associated with purchased goods and services, represent around 58% of total Scope 3 emissions, followed by the use of sold products at ~19% and end of life treatment of sold products at ~8%.

Exhibit 15: Scope 3 emissions in the chemical industry[46]



The ratio of emissions across different Scope 3 categories varies significantly among chemical companies due to differing supply chains, product portfolios, business models, and energy mixes. Still, many leading chemical companies are united in their determination to make positive change.

AkzoNobel

Purchased goods and services contribute 47% and processing of sold products contributes 42% of the total Scope 3 emissions of Akzo Nobel. The company's Paint the Future collaborative ecosystem approach involves working with suppliers and customers across the value chain to collectively find solutions to the challenge of cutting carbon emissions by 50%.

Supplier collaboration

AkzoNobel conducts supplier assessments, audits, and capacity-building programs to help suppliers improve their environmental performance. To date, the company has engaged with over 200 suppliers to improve their sustainability practices using programs and partners provided by Together for Sustainability (TfS).

Customer collaboration

AkzoNobel invests in R&D to develop and promote more sustainable products across its portfolio, in conjunction with its customers across various coating segments. The company has developed coating technologies with lower volatile organic compound (VOC) content, reduced energy consumption during production, and improved durability, which can lead to lower emissions during product use. These sustainable product innovations are aimed at helping AkzoNobel customers reduce their own emissions when using the company's products.

BASF

Category 1 'purchased goods and services' contributes 52% of BASF's total Scope 3 emissions, and category 12 'end of life treatment of sold products' contributes 26%.

Supplier collaboration

In 2021, BASF introduced a global supplier CO_2 management program to create transparency, help steer net zero efforts, and reduce upstream emissions over the long term. The company has set up sustainability criteria for supplier selection, which includes evaluating suppliers' environmental performance and sustainability practices. BASF also conducts audits and provides guidance on sustainable practices to its suppliers to help them improve their environmental performance and reduce their emissions.

Customer collaboration

As part of its corporate sustainability strategy, BASF aims to help customers shed 250 million metric tonnes of CO_2 equivalents annually by 2030 through its products and solutions. In 2021, the company achieved a reduction of two million metric tons, primarily using new blowing agents in polyurethane (PU) foams. BASF has also developed lightweight materials for the automotive industry that can help reduce vehicle weight, resulting in lower fuel consumption and emissions. Furthermore, the company has developed catalysts and technologies for the renewable energy sector, such as wind energy and battery materials for EVs, which can help reduce GHG emissions.

Covestro

Supplier collaboration

Category 1 contributes 75% of total Scope 3 emissions at Covestro. The company is actively engaging with its suppliers to promote sustainability and reduce Scope 3 emissions in its supply chain. As one of the founding members of Together for Sustainability (TfS), the company prepared the guidelines for product carbon footprint (PCF) calculations for suppliers.

All Covestro suppliers with recurrent annual spending exceeding €100,000 (~$109,000) are audited and have to be compliant with sustainability requirements. These audits evaluate suppliers' emissions management, resource efficiency, waste management, and other environmental aspects. Covestro also provides feedback and recommendations to suppliers on areas for improvement.

Reducing Scope 3 emissions through procurement

The procurement function of any company has a unique opportunity to create strategic impact for the whole of the organization where decarbonization is concerned. This is due to the fact that a large share of Scope 3 emissions comes from purchased goods and services.

The procurement functions of leading companies, which are in the top quartile in their performance and capabilities, are masters of developing and executing category-specific sourcing strategies to deliver cost reduction and service level improvements. They are also skilled at implementing category management practices to sustain this delivered value.

Companies that have pursued excellence in strategic procurement practices should be in good positions to build on their extended reach into the supply chain and work jointly with their suppliers to reduce Scope 3 emissions. Sustainable sourcing, emissions transparency from suppliers, circularity in materials, and product design are some of the levers available for companies to explore.

From the 'purchased goods and services' perspectives, companies can consider

Adding/linking emissions data into the company spend cube

By collecting emissions data and integrating it into (or linking it with) the spend cube, companies can identify the areas responsible for high emissions and act to reduce them. This approach not only helps companies reduce their environmental impact, but also improves supplier relationships, reduces supply chain risks, and increases visibility.

Taking a category-by-category approach

Category strategy and management is a well embedded methodology for value creation for the procurement function. Procurement category managers can add the dimension of supplier emissions while developing sourcing strategies and making purchasing decisions by considering the environmental impact of their suppliers. By working with suppliers who have lower emissions and encouraging existing suppliers to adopt sustainable practices, category managers can reduce their category's carbon footprint.

Leveraging supplier relationship management (SRM)

Leading procurement functions use SRM methodologies to develop long-term value creating relationships with high priority suppliers. There are also specific SRM tools that companies use to this end. By integrating supplier emissions data into SRM, companies

can encourage their suppliers to adopt more sustainable practices, reduce their environmental impact, and strengthen supplier relationships. This approach can help companies achieve their sustainability goals while reducing supply chain risks and improving transparency.

Depending on the extent of change, this can be a large-scale undertaking. Importantly, in the case of public or government-linked companies, existing policies need to be relaxed to allow strategic collaboration between government bodies and their suppliers to reduce Scope 3 emissions.

Using technology

In addition to capability building in their procurement teams, companies can use technologies to further enhance their efforts to reduce Scope 3 emissions. Sustainable procurement platforms like EcoVadis, SAP Ariba, and Higg Index include sustainability features such as tracking supplier sustainability metrics and enabling procurement to set sustainability goals.

The rapid advancement of technology also means that AI can now be used to predict the complex and changing Scope 3 emissions profiles of a chemicals company and its suppliers. Meanwhile, blockchain can be used for emissions traceability purposes across the supply chain. These technologies create significant potential for chemicals companies to enhance their sustainability and reduce Scope 3 emissions.[47]

Revamping procurement policy

At the end of the day, companies' procurement policies and procedures need to be revamped to include many of the potential changes that will need to be adopted, such as sourcing strategy, supplier selection, tendering and contracting, and SRM.

8.0 Funding

The funding challenge

Out of the $6,500 billion annual investment needed to fund the transition to net zero until 2050, 55% is to come from private finance, with commercial banks being the largest contributors, according to the Net Zero 2050 scenario from the Network for Greening the Financial System (NGFS). It is believed that less than 5% of this amount has been deployed today, and even the most optimistic scenarios are planning for only 70% of the required financing to be deployed at all.

The blunt reality is that less than one third of the net zero transition technologies to be financed have been identified, and given the limited capability of banks to finance high-risk innovation, the overall result is not so surprising.

Based on Arthur D. Little client discussions, developing net zero financing appears to be a defensive move to protect business. Due to the scarcity of ‘green’ clients and their ability to select banks for their net zero projects, banks are often experiencing lower margins on net zero business, without necessarily having the possibility to pass on this cost to ‘brown’ clients. The incentive measures provided by central banks, such as cost of capital discounts for green financing, do not materially move the needle and will not be sustainable if applied to the entire market.

To balance this gloomy picture, it is important to consider that required net zero financing is expected to represent close to 30% of bank financing revenue by 2050 – and even more for sectors such as energy or transport. In reality, companies cannot absorb that much additional debt, which means that the non-net zero financing market will shrink. In this context, financing net zero is not a debate for banks, but a question of figuring out how best to do it.

The following examples explore how banks might adapt their models to fit the emerging net zero reality.

8.2 Funding

Funding options

For some companies, funding decarbonization initiatives with their own cash flow could be an option, with positive and quick business cases relating to energy efficiency and freight network improvement, among others. In particular, for many large and global oil and gas companies, much of the 'super profit' generated in recent years could be deployed into major decarbonization or energy transition-related initiatives.

However, other initiatives may be more challenging to fund with cash flow, due to the high cost of technology, the availability and costs of raw materials, and supply chain constraints. Or it may simply be too difficult to establish a business case – for instance, in the case of certain nature-based solutions.

Thus, funding allocation becomes a complex decision-making exercise. On the latter, it is important to weigh up the ambition to implement decarbonization initiatives with the judiciary duty to deliver shareholder returns for the capital deployed. Nevertheless, leaders wanting to be bold and push boundaries will need to find balanced solutions that satisfy both shareholders and decarbonization ambitions.

Tap into sustainable financing

Sustainable finance is booming, with increasing funding opportunities for companies. The volume of global sustainable debt instruments reached a staggering $1.47 trillion in 2021, which is more than double the figure for 2020. Green bonds alone brought in more than $480 billion. Looking ahead, broadly, a report from Bloomberg Analysis notes that the ESG market is on track to exceed $50 trillion by 2025.

NRG Energy was the first North American company to issue sustainability-linked bonds or SLB, setting a direct emissions reduction target for Scopes 1,2 and 3 with the bond's condition. Meanwhile, green issuances from countries across the MENA region are outpacing global growth. In 2021, the region generated $24.55 billion in green and sustainable finance, an impressive 532% increase on 2020's figure of $3.8 billion.

Build strategic partnerships

For large scale decarbonization projects, companies will increasingly need to consider financing strategy at the onset of developing the project business case, along with commercial strategies and partnership models. Certainty of offtake, viability of the end-to-end supply chain, and scalability of technology are examples of major elements that financiers want to understand as different funding options are explored. Here, it is critical to have consortia partners that bring these elements into the project and underwrite the perceived or actual risks.

One good example is the Neom Green Hydrogen Company (NGHC), which is an equal joint venture (JV) between NEOM, ACWA Power and Air Products. The existence of Air Products in the JV provided the company a 30-year offtake guarantee for green ammonia, which helped secure project financing from 23 local, regional, and international banks and financial institutions.

Leverage blended or hybrid finance models

Blended or hybrid finance is a mechanism through which public and/or philanthropic capital can be brought together to catalyze private investment for a project. The model has been used for development projects by multilateral agencies, with public and philanthropic investors enhancing the risk-return profile.

Similar blended finance models can be applied in the context of decarbonization initiatives, where there may be significant social impact, like improved air quality, increased vegetation/forestation, or improved water management. Public-private partnerships (PPPs), for example, can help to unlock new sources of capital for decarbonization projects and help reduce financial risk, increase access to capital, and tap into a wider pool of knowledge.

Such hybrid funding schemes can help bridge the gap between the public and private sectors, allowing for the sharing of resources and risk management during a transitional period where the market is maturing, and data reporting is being deployed. However, the success of PPPs depends on careful planning and execution, including the establishment of clear roles and responsibilities, risk allocation mechanisms, and effective governance structures.

Collaborate

Financial institutions are increasingly looking to work with their corporate clients during the development and activation phases of net zero plans. They are starting to provide advisory services while also gaining an understanding of the nature of their clients' net zero plans, which helps them to tailor financing packages down the line.

Leading companies can also involve insurance companies in this process to develop bespoke insurance products to meet project needs. In fact, there is a significant opportunity for companies, financiers, and insurance firms to co-create financing solutions for major decarbonization projects.

8.3 Funding

Data, reporting, and ESG

A robust net zero plan, realistic yet ambitious decarbonization initiatives, and demonstrable progress all help a company to improve its ESG rating. This, in turn, can reduce borrowing costs and improve the organization's attractiveness to potential investors.

To enable lenders to make informed decisions on financing large-scale ESG projects, standardized data reporting is key. This enables lenders to assess the risks and opportunities associated with different ESG projects and structure financial products that reflect the specific needs of each project.

To achieve standard reporting, companies should deploy the right data catalogue and KPI management framework to fully leverage their operations and maximize their access to green finance. The catalogue acts as a centralized repository that logs all ESG-related data points, offering transparency without disrupting the existing data landscape of the company. The ESG data catalogue uses a top-down structure, with data clustered into use cases. This fosters a targeted approach to identifying and structuring data points, from the requirement to the application, while ensuring that prioritized use cases are completed first.

Data governance is also essential to ensure that ESG data is properly collected, validated, and managed. This helps to build trust between lenders and borrowers, making it easier to secure financing for ESG projects.

As data goes through its lifecycle of creation, storage, usage, archiving, quality control, and destruction, it needs a process to designate a clear alignment of responsibility and ensure quality across the ESG use cases. Therefore, identifying the ESG data owner is key. The data owner serves as a manager who is responsible for quality control of specific data points as they are being used for different ESG use cases. The development of a data governance framework should be scalable, flexible, and tailored to the specific company's structure and ESG requirements.

9.0 Transformation Enablers

Many companies underestimate the sheer size and complexity of the transformation required to deliver on the net zero promise. Decarbonization is not a program on the side that can be managed via a classic project management office (PMO). Nor can it be delivered simply by appointing a chief sustainability officer. To realize net zero ambitions, companies will need to have the right operating and governance mode in place, as well as the right capabilities, from people to data.

Operating model

Depending on the context, companies can adopt several types of operating models to achieve their net zero ambitions, as outlined below

The decentralized approach

A decentralized operating model would be suitable where operating companies (OpCos)

i. Are vastly different in the nature of their business,
ii. Do not have much synergistic potential from a decarbonization initiative perspective, and
iii. Can fund and execute decarbonization programs without much support from the group.

The centralized model

A centralized approach is suitable for companies that can harness significant synergies across the OpCo. Such an approach is also suited to companies that may need to pull in scarce cross-functional resources and drive change from the corporate center while letting the OpCos run their initiatives.

The hybrid way

A hybrid model enables companies to drive certain major initiatives from the corporate center (e.g., CCUS or hydrogen) and have the OpCos drive their business- and operations-specific initiatives, such as Scope 3-related supply chain and customer-specific programs.

Alongside an appropriate operating model, companies will need effective and often multi-layered governance mechanisms in place to oversee transformation. For example, establishing specific board committees, management committees, and an overall transformation management office are all mechanisms that can help companies drive change.

In addition, aligning the KPIs of the CEO and executive leadership with the decarbonization goal is a must. These KPIs then need to be cascaded down to middle management and front-line teams to ensure the whole organization's purpose, decisions, and actions are aligned.

9.2 Transformation Enablers

Capabilities and mindset

As companies embark on major programs to decarbonize, develop new sustainable products and services, and create new business models, the need for talent and resources in this space will continue to grow. As such, it is important for companies to put in place capability building programs, which can range from upskilling the whole workforce where ESG and sustainability are concerned, to investing in the right systems for data capture, management, and monitoring.

Workforce capabilities

Companies may need to undertake wholesale education and up-skilling on topics related to climate change and the environment, as only a handful of employees are likely to have experience or expertise in these areas. In addition, many of the new technologies and levers that are available for decarbonization require in depth understanding. Therefore, companies wishing to adopt these technologies will need to upskill their workforces accordingly.

Mindset change

Changing mindsets is going to be critical in the quest for net zero, particularly where individual decision making is concerned. For instance, an industrial company may want to consider how it uses electricity in the office, select the optimal outbound mode of freight transport, or optimize maintenance activities in the plant.

Depending on a company's cultural fabric, it may be appropriate to add the dimension of climate action within its day-to-day activities to keep the topic of net zero front and center – and this will require a significant change management effort.

Data sharing and management capabilities

In addition to people-related capabilities, companies will also need to develop new data capabilities to facilitate both internal and external collaboration on emissions data. This will become increasingly important as new reporting requirements become clear in different jurisdictions. For example, the U.S. Securities and Exchange Commission will be requiring companies to disclose GHG emissions related to their Scope 1,2, and 3 commitments as part of their overall climate-related disclosure.

Some companies may already have well-configured data storing, sharing, and management platforms as part of their digital transformation, so emissions data can simply be added on. Alternatively, companies can explore the possibility of buying a new data platform or developing one in-house. There has been a rise in emissions data solutions providers in recent years, and this trend is expected to continue.

Data sharing with external parties, however, is something that will take some time to mature, given the issues around security, intellectual property (IP), liability, and competitive advantage. While these issues are likely to persist, companies will have to find a way to share emissions data and adopt common data sharing platforms, as collaboration will become increasingly critical to reducing Scope 3 emissions.

10.0 Call for Action

As the world pushes for net zero, the tasks at hand are formidable, but they are not insurmountable. Already, leading companies have made their commitments, developed high-level net zero pathways, and are in the process of executing their programs of activities. Now, to accelerate their initiatives and move the decarbonization dial, company leaders should focus on five high-impact actions

01 Drive a bold and holistic net zero transformation

- Continuously revisit the scope and magnitude of the emissions target. In particular, look for ways to frontload and accelerate the interim milestones and increase Scope 3 targets
- Execute an integrated, technology-led, whole-of-company transformation program, ensuring all major emissions reduction opportunities and the enablers needed are covered in the plan and work in harmony, thus creating a feedback loop
- Take stock of decarbonization progress on a regular basis, and course correct to remain on the path to net zero

Exhibit 16: ADL's net-zero transformation framework

Net-Zero Transformation Ambition
Scope 1, 2 and 3, Science-Based Targets And Timing Investor And Stakeholder Pressures

Levers

Scenarios and portfolio mix	Leverage technologies					New business models
	Energy supply mix and systems	Demand management	Supply chain	IR4.0 and Digital	Nature-based	
Scenarios Business mix Levers Product sustainability	Renewables, nuclear, hydrogen, CCUS and energy Storage	Energy efficiency and circularity	EV and e-fuels	Digital and data	Landfill-to-X, reforestation, farming, land and water management, and waste management	Carbon neutral offerings e.g., Offsetting mobility, telecom

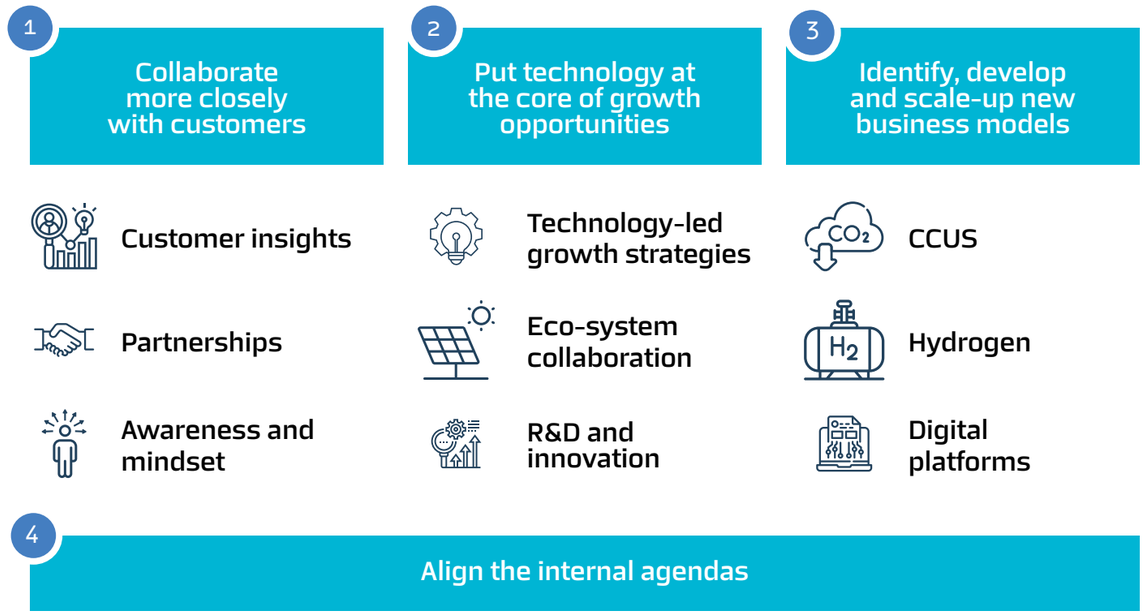
Enablers

Funding and capital management	Operating model	Culture and capability	Innovation and partnerships	Advocacy
Green finance Resource allocation	Governance Org model Metrics and processes	Ways of working Mindset Capability	Innovation model Partnership	Government policy and regulations Stakeholder advocacy

02 Address emissions reduction and capture future growth opportunities:

- Explore, position for, and capture future profit pools resulting from the energy transition, while driving down own emissions
- Work jointly with customers to uncover new growth opportunities, look for ways to leverage technology and innovation to create new propositions, and pursue new business models

Exhibit 17: ADL's growth under net zero framework



03 Put people at the heart of the net zero transformation

- Focus on upskilling/reskilling the current workforce (e.g., through formal education, on the job training)
- Think long-term, develop a focused talent development strategy, and explore all avenues to train and bring in fresh talents
- Capitalize on the energy transition and sustainability as the compelling value proposition/purpose to attract young talent

04 Focus on ensuring supply chain is keeping up

- Collaborate inside and outside of siloed organizational boundaries to anticipate, plan for, and bring together supply chain initiatives that need to be in place to get major decarbonization projects off the ground (e.g., grid modernization, transmission expansion, and EV infrastructure network)
- Proactively identify and work with supply chain partners to be on top of Scope 3 emissions

05 Bring stakeholders along for the journey

- Work with different categories and levels of stakeholders, from the board to front line leaders to external government agencies, so that there is a common understanding of the plan and actions
- Involve and work with the funding organizations to find innovative solutions to some of the more pressing funding challenges for net zero programs

The world is watching. Now is the time for corporate leaders to deliver on their net zero promise and accelerate emissions reduction while charting for green, sustainable growth.

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