

The Choreography Needed for Net-Zero Industry Transition

WHITE PAPER

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Preface

Despite net-zero targets covering 85% of the world's population, energy-related emissions rose during 2021. We are still nowhere near a 1.5°C pathway. We need to create more compelling incentives for energy-intensive industries to embrace the rapid transition the Earth urgently needs.



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If the global community has been working on climate action for over 30 years, why is the pace of progress still so slow? Despite warnings that we are moving from a slow-burning crisis to a full-blown climate emergency, public and private responses continue to be incremental in nature and we are not seeing the rapid action required to trigger systemic change. Meanwhile, Russia's invasion of Ukraine and the impact on Europe's energy supplies has further heightened calls to push for more renewable energy generation and to cut dependence on fossil fuels. However, eight years out from 2030, when emissions must be cut in half, we are left with the sobering realization that we are nowhere near a 1.5°C trajectory.

Today, over 136 countries have announced net-zero targets representing 116 regions and covering 85% of the global population. On the corporate side, more than 1,000 companies have made Paris-aligned commitments representing over \$23 trillion in market capitalization.¹ Despite these efforts and despite the economic case for transitioning to a net-zero economy,² emissions are still going up. The International Energy Agency (IEA) reported that global energy-related CO₂ emissions rose by over 2 billion tonnes in 2021 to their highest level in history.³

Leaders across all business sectors and from all countries are tasked to navigate an unprecedented

global transformation, moving from a global energy system relying for 80% on fossil fuels towards one that is net-zero by mid-century. For businesses, the path to net zero means successfully transforming their competitive strategies, operations, business portfolio and organization. For leaders from government and international organizations, it means understanding which policy solutions and financial interventions will have the greatest impact on achieving greener and more inclusive societies.

However, the current lack of progress begs the question whether we have sufficient incentives for companies, particularly in energy-intensive industries, to innovate towards a net-zero future, and whether we have the right mechanisms that are “fit for purpose” and sufficiently agile to achieve faster and more efficient responses to climate change. These challenges are compounded by the fact that many traditional carbon-intensive businesses remain highly profitable, while net-zero alternatives remain uncertain in terms of return on investment. We run the risk of bearing both the

cost of inaction and the cost of delayed action – the slower we go, the more expensive it gets.

In considering the widening “ambition to implementation” gap, this paper outlines analysis, ideas and recommendations from the World Economic Forum’s Global Future Council on the Net-Zero Transition across three themes:

- Getting a more detailed understanding of the gaps to 2030 in the energy production, consumption and heavy industry sectors, so that the scale of the challenge is brought into clear view
- Identifying the obstacles that still prevent us from bridging these gaps and taking the breakthrough action needed
- Highlighting innovative models and mechanisms that could enable companies, countries and financial players to achieve faster and more efficient progress towards building the net-zero economy



The price tag for achieving a net-zero carbon economy has been estimated at around 2% to 3% of annual global GDP. Conversely, the costs from unmitigated climate change are estimated to amount to 10-12% by 2100, with the IMF even forecasting a loss of 25% in its worst-case scenario.

Executive summary

Gaps to 2030 – realizing the scale of the challenge

The gap between net-zero ambition and implementation is widening. Industry accounts for 30% of global greenhouse gas emissions. To reach net zero by 2050, we need the heaviest-emitting sectors to deliver:

- **Steel:** 70-113 (near-) zero-emission steel plants producing 280 million tonnes of steel a year
- **Trucking:** Between 6 and 12 million zero-emission (ZE) trucks, with a sales share of 30-80% of long-haul and 60-80% for urban and regional duty cycles; between 1.4 and 2.4 million overnight depot chargers and 200,000-600,000 public high-speed chargers for battery electric trucks; between 1,000 and 10,000 H₂ refuelling stations for fuel-cell electric trucks across key markets
- **Aviation:** 250-350 Sustainable Aviation Fuel (SAF) plants globally, producing between 30 and 50 million tonnes of SAF to achieve, respectively, a 10% to 15% share of SAF in global jet aviation fuel supply
- **Shipping:** At least 200 deep-sea ZE ships; 10 large trade ports covering at least three continents to supply ZE fuels; 5% scalable ZE fuel in international shipping
- **Concrete:** 20+ fully operational commercial-scale on-site Carbon Capture, Usage and Storage (CCUS) facilities, delivering more than 160 million m³ concrete

A stocktake of the action needed to limit warming to 1.5 degrees reveals some sobering statistics:

- By 2030, we must be adding 630 GW of solar power and 390 GW of wind power every year
- Annual clean energy investment must top \$4 trillion by 2030 (it was \$750 billion in 2021)
- Subsidies for fossil fuels (80% of the world's energy) total \$6 trillion per year
- Two-thirds of global companies lack net-zero targets; 99% need a climate action plan
- By 2030, electric vehicles must grow from 5% to over 60% of global car sales
- Emerging technologies need \$90 billion of R&D funding by 2030 (today we spend \$25 billion)
- Emerging markets need additional investments of \$1 trillion to get on track for 2030
- Global circularity needs to double every decade (from 9% of global economic activity today)

Obstacles preventing net-zero progress

Obstacles preventing more rapid progress include lack of incentives, failing policies and unproven technologies. Companies in energy-intensive industries still lack incentives to abandon fossil-based business-as-usual in favour of innovation, especially given the record profits booked by oil companies in Q1 this year. Despite widespread recognition by industries of the effects of climate change, a company's bottom line remains the main driver for its strategy.

Investors also need incentives. While \$130 trillion of assets are subject to net-zero pledges, actual deployment of this capital is hampered by risks

including long investment horizons, high upfront costs and an unwillingness to invest in helping high-emitters transition because their near-term carbon intensity will blacken investor portfolios.

The situation is compounded by a lack of policies to favour first movers in the transition. Governments should create incentives, de-risk investments, reward climate action and implement punitive measures for those who fail to comply with net-zero goals. Carbon-pricing and other mechanisms could plug carbon leakage while policies sending demand-side signals could incentivize low-carbon technologies.

An efficient transition is also hampered by uncertainty around the availability of key components, such as technology (e.g. CCUS, green hydrogen, SAF, e-ammonia), materials (e.g. to manufacture batteries) and infrastructure (e.g. to produce clean energy, store

and transport CO₂, produce and transport hydrogen). More innovation is needed – not just sectoral approaches, but also circular economy initiatives and upstream/downstream value chain collaborations to bridge supply and demand.

Creating coalitions to accelerate net-zero technologies

The green premium of low-carbon technologies is a barrier to growth. We need coalitions of public and private actors to share the costs of developing these technologies, proving they work and making them market-ready within the next decade. Technologies such as sustainable fuels, low-carbon steel and green hydrogen need to demonstrate proof-of-concept before 2030, to stand any chance of being commercializing at sufficient scale to deliver net-zero by 2050. Beyond trial projects, the goal is to create a self-sustaining pipeline of commercial projects and infrastructure needed for industry decarbonization.

Coalitions are needed to choreograph a critical mass of leaders from industry, government, finance and philanthropy to work together towards systemic change, by:

- Building coalitions of countries to implement the climate policies and concessional finance necessary to attract investment in low-carbon infrastructure
- Sending the market strong private and public demand signals, through green offtake agreements, buyers' alliances and public procurement commitments – this in turn will give industry confidence to invest in transitional technologies

- De-risking the process through public and philanthropic financing
- Designing policies to promote the transition – e.g. fuel standards, green public procurement standards, carbon pricing, tax breaks and grants for R&D, investing in renewable-based power infrastructure

Examples already exist of such public-private collaboration. For example, the HYBRIT initiative is a joint venture of SSAB, Vattenfall and LKAB to manufacture fossil-free steel, and brings a larger set of stakeholders around the shared purpose of leading the low-carbon transition, a goal that the Swedish government actively backs. The project also received support from the European Union Innovation Fund. Importantly, the initiative is starting to get offtake signals and agreements from purchasers, such as Volvo, which represents an important step towards establishing a completely fossil-free value chain. Another area of collaboration is in forming low-carbon clusters and green corridors to scale-up net-zero technologies by aggregating demand within captive markets. Only by orchestrating collaborative action across diverse sets of stakeholders are we likely to achieve the goal of net-zero emissions by 2050.

1 Gaps to 2030 - realizing the scale of the challenge

The gap between net-zero ambition and implementation is widening. We know what the most energy-intensive industries need to do – more zero-emission trucks and ships, more green steel and aviation fuel. The numbers, however, are daunting: \$100-150 trillion of investment in clean energy is needed to achieve global net-zero by 2050.



1.1 Deliverables needed from heavy-emitting sectors by 2030

From ongoing sectoral analysis conducted by the [Mission Possible Partnership](#) into the seven harder-to-abate sectors responsible for 30% of global greenhouse gas emissions (aviation, shipping, trucking, steel, aluminium, concrete and chemicals), we know that the following deliverables in these heavy industry and mobility sectors will be needed by 2030 to stay on track for net zero by mid-century:

- Between [70 and 113 \(near-\) zero-emission steel plants](#)⁴ producing 280 million tonnes of primary steel a year.
- Between 6 and 12 million zero-emission (ZE) trucks, with a sales share of 30-80% of long-haul and 60-80% for urban and regional duty cycles; between 1.4 and 2.4 million overnight depot chargers and 200,000-600,000 public high-speed chargers for battery electric trucks; and between 1,000 and 10,000 H₂ refuelling stations for fuel-cell electric trucks across key markets.⁵
- Between 250 and 350 Sustainable Aviation Fuel (SAF) plants built around the world, with the aim to produce between 30 and 50 million tonnes of SAF to, respectively, achieve a 10-15% share of SAF in global jet aviation fuel supply⁶; and first market entry of hydrogen, battery-electric and hybrid aircraft.
- At least [200 deep-sea ZE ships](#), as well as 10 large trade ports covering at least three continents to supply ZE fuels and [5% scalable ZE fuel in international shipping](#). As key enablers to get there: by 2025, [at least six green corridors](#) and [50 small-scale ZE fuel facilities](#) in leading countries.
- 20+ fully operational commercial-scale on-site Carbon Capture, Usage and Storage (CCUS) facilities, delivering more than 160 million m³ concrete⁷

Please note that these milestones should not be regarded as a final set of data points for sectoral alignment with a 1.5°C trajectory. Rather, these data points remain subject to ongoing analysis by Mission Possible Partnership and are intended to offer a snapshot of the headway we need to make in this decade to get on track for net-zero by 2050 in five of the seven harder-to-abate sectors.

37%

The industrial sector accounted for 37% of total global final energy use in 2018.

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GT CO₂ Industrial emissions represent 30% of GHG emissions globally.



Fossil fuels still supply 80% of the world's energy and receive \$6 trillion of subsidies per year

1.2 Critical gaps between us and the pathway to 1.5 degrees

These milestones in the harder-to-abate sectors reveal a daunting challenge. Meanwhile, a stocktake of other key areas where progress needs to be

made reveals some critical gaps between where we are and the path we need to take to limit warming to 1.5 degrees:

Corporate net-zero targets

Only one third of global companies have announced net-zero targets (Scope 1 and 2) and out of those a majority is based in Europe

or the US.⁸ While some companies have set 2030 targets, fewer than 1% have a climate action plan.⁹

Fossil fuel supply and subsidies

Fossil fuels currently supply around 80% of the world's energy – as they have over the last 30 years. Global fossil fuel subsidies stand at around \$6 trillion per year (about 7% of global GDP)¹⁰ and

G20 countries continue to commit around half of all energy spending to fossil fuels, which includes billions of dollars of support to fossil-fuel energy as part of COVID-19 recovery spending.¹¹

Clean energy technologies deployment

Between now and 2030, we need to rapidly scale up the deployment of all available clean energy technologies. For electric vehicles (EVs) this means growing today's 5% of global car sales to more than 60% by 2030.¹² For solar power, we need annual

additions to reach 630 GW by 2030 – equivalent to installing the world's current largest solar park roughly every day.¹³ For wind we need to add 390 GW by 2030, which is almost four-times the record levels set in 2020.¹⁴

Clean energy investment

To achieve the above stated clean energy deployment, annual clean energy investment will need to be significantly scaled up by 2030 to around \$4 trillion.¹⁵ Between \$100 trillion and \$150 trillion of

investment will be required to achieve global net-zero by mid-century.¹⁶ We are far away from reaching this ambition, with \$500 billion invested in clean energy in 2020 and around \$750 billion invested in 2021.¹⁷

R&D funding for emerging technologies

Up to half of the emissions reductions required by 2050 must come from technologies currently under development. Lining up the pilots and demonstration projects by 2030 to

bring these technologies to commercial scale by mid-century will require around \$90 billion, significantly higher than today's spending of around \$25 billion.¹⁸

The transition gap between Global North and South

Emerging markets face several challenges to their transition, including urbanization, rising energy demands and legacy assets and infrastructure.

Getting emerging markets on track for 2030 requires additional investments of \$1 trillion in public and private finance.¹⁹

Our industrial system is at risk of linear lock-in

Between 2015, when the Paris Agreement was adopted, and COP26 in Glasgow in 2021, 70% more virgin materials were extracted than the amount the Earth can safely replenish.²⁰ To decarbonize the economy, we need to go beyond energy alone to undertake a radical transformation of how we use materials, towards sustainable global

value chains. Yet, the circular economy decreased from 9.1% of total global economic activity in 2018 to 8.6% in 2020, with barriers to scaling circular solutions including uncertain feasibility, fragmented supply chains and a lack of economic viability. To get on track for a net-zero future, we need to double global circularity every decade.

Below:
@Tsvetan Ivanov/
Gettyimages



We need annual additions of solar power to reach 630 GW by 2030 – equivalent to installing the world's current largest solar park roughly every day



2

Obstacles preventing net-zero progress

To design a framework capable of delivering decarbonization breakthroughs requires an honest assessment of the obstacles preventing more rapid progress on the net-zero pathway. Creating the right incentives for business will prove critical.



2.1 Lack of incentives for energy-intensive industries to innovate

A vital part of steering energy-intensive industries towards a net-zero track is to recognize the enormity of what we are asking them to do. Unlike ongoing transitions in the transport and electricity sectors, we are expecting incumbents in longstanding industries that are integral parts of industrialized society to innovate at an unprecedented speed. It is hard to imagine a historic example of incumbent players having to create the level of disruption to their business practices that is needed today to move energy-intensive industries towards a Paris-aligned trajectory.

There are several explanations for why the pace of industry transition is lagging. Most notable is the “fossil path dependency” of many actors in this space, driven by technical and economic needs and inflexible institutional frameworks. As of today, there is no clear, compelling incentive for industry players to commit to disruptive decarbonization pathways. While the macro-economic and company-level risks of failing to act or of transitioning too late are coming into clearer focus, it is also true that many companies are struggling to assess climate-related

risks because of their complexity and long-term effects. Other companies may fully realize the climate impact of business-as-usual but choose to maximize current practices for profit until their business is forced to change due to tightened regulations (even with existential risk to the enterprise).

Generally, there are not enough incentives for companies in energy-intensive industries to innovate towards a net-zero future, while there are plenty of incentives to stick to business-as-usual – especially when fuel scarcity due to the war in Ukraine has made some traditional business models even more profitable. In fact, due to soaring oil and gas prices, Shell’s profits in the first quarter of 2022 almost tripled to \$9.1 billion, compared to the first quarter of 2021, while BP’s profits more than doubled during the same period to \$6.2 billion.²¹ Collectively, Shell, BP, ExxonMobil, Chevron and ConocoPhillips earned \$35 billion in the first three months of 2022,²² at profit margins these companies haven’t seen in years. But this hasn’t necessarily translated into increased investments in the energy transition – and it’s not a given it will.²³



Despite widespread recognition of the effects of climate change by industries, a company’s bottom line remains the main driver for its strategy and the dominant decision-making factor in boardrooms

Ideally, every private sector company would establish realistic decarbonization strategies and roadmaps, which would result in tangible company-level action with transparent metrics for Scope 1, 2 and 3 emissions that could be monitored and evaluated by third parties. However, these strategies are often associated with high abatement costs that lead to less profitability or a high green premium for downstream actors. Despite widespread

recognition by industries of the effects of climate change, a company’s bottom line remains the main driver for its strategy and the dominant decision-making factor in boardrooms. This undermines the business case for net zero. Creating value for multiple stakeholders – the idea of [stakeholder capitalism](#) championed by the World Economic Forum and others – is still not mainstream. Value creation is still measured by maximizing returns to shareholders and investors.

2.2 Policy and regulation still failing to level the transition playing field

The lack of incentives problem is compounded by the fact that policy and regulation continue to fail in levelling the transition playing field. This needs to change. We must create a level playing field for the first movers that are charting a course towards net zero. Governments must step up and provide faster, more targeted policy action. Regulators should create incentives, de-risk investments, reward climate action and, to a certain extent, implement punitive measures for those who fail to comply or are not aligned with net-zero goals.

This suite of measures is not always effective as electoral cycles prevent the creation of incentives that will yield benefits and results further down the line, while long-term regional and national competitiveness often gets prioritized. In other instances, while industry players might be keen to commit to building low-carbon assets and, to that effect, negotiate deals with governments, antitrust and competition regulation and enforcement and trade policy might thwart progress or scupper deals and initiatives.

2.3 Barriers preventing acceleration of clean technologies

The new business models and shifting operations required to deliver net-zero pathways bring levels of risk and uncertainty that could impede an efficient

transition. This risk arises in large part from the uncertain availability of key components, such as technology, materials, infrastructure and policy:

Availability of technology

Key technologies that have been identified as critical for the net-zero transition are carbon capture and storage, hydrogen deployment, development of alternative fuels such as Sustainable Aviation

Fuel, e-methanol and e-ammonia. However, the development and deployment of such technologies by 2030 are not guaranteed without strategies to accelerate their progress.

Availability of materials

To reach net zero, value chains such as those for EVs and battery storage need to grow exponentially over the next decade. Supply chain

risks such as material scarcity or shortage and trade risks could slow down the implementation of net-zero strategies.²⁴

Availability of enabling infrastructure

Deep decarbonization requires reliable and abundant clean energy supplies to electrify heavy industries, infrastructure for CO₂ storage

and transport, and infrastructure for hydrogen production, transport and consumption.

Availability of policy signals

There are insufficient carbon-pricing and other mechanisms to plug carbon leakage and not enough policies to generate demand-side signals to incentivize low-carbon production processes and substitutes. In addition, while the policy landscape

is more mature for some sectors (e.g. renewable energy and light transport), that is not the case for heavy industries, where decision-making is fragmented across departments focused on different sectors.

2.4 Insufficient value chain innovation and collaboration

Sectoral approaches, including those orchestrated by initiatives such as the [Mission Possible Partnership](#), [First Movers Coalition](#), the [Race to Zero](#) campaign and the [Leadership Group for Industry Transition](#) (LeadIT), are incredibly valuable in rallying industry players and other stakeholders around a common goal and fostering agreement on how collaboration can unlock progress. However, alternative business models, circular economy approaches and collaboration along value chains are equally vital to amplify the impacts of those sectoral efforts.

Bridging the gap between supply and demand is particularly important. For example, Volvo Cars recently initiated a collaboration with steel producer SSAB and renewable energy company Vattenfall to produce “fossil-free” cars using steel made with hydrogen rather than coal. For these types of upstream/downstream collaborations to multiply, governments and financial institutions must work together to create the right enabling environment and agree on how each of these public and private partners can share the risk of developing low-carbon assets.

2.5 Unlocking investment for the net-zero transition

Many banks, asset owners and asset managers have made net-zero commitments – to date, over \$130 trillion of assets under management are

subject to such pledges.²⁵ However, challenges remain in actually deploying this capital towards decarbonizing the global economy.



Investors need incentives to direct capital towards greening high-emitting assets as well as high-risk early-stage net-zero technologies

There are a number of reasons why we are not seeing the growing level of investment required to green industrial assets and develop new low-carbon technologies:

- Investment horizons for these assets tend to be longer than the timescales investors are traditionally used to
- Many of the low-carbon solutions required for decarbonizing our economy have high upfront capital costs and risk profiles that deter many investors
- Investors looking to decarbonize their portfolios are deterred from buying high-emitting assets, which they could help transition from grey to green, because that transition takes time – during which the carbon intensity of their overall portfolio will increase

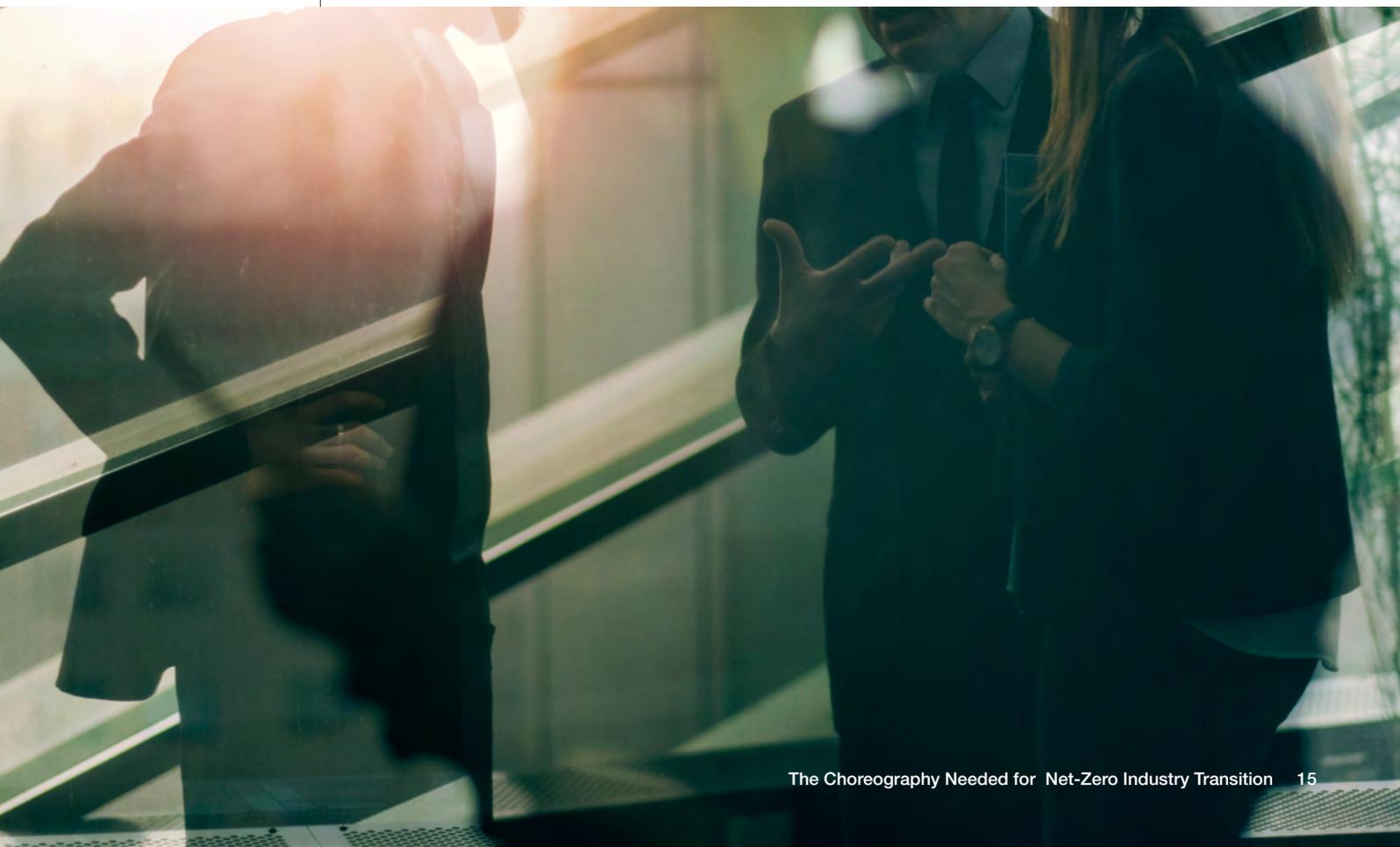
To unlock investment for the net-zero transition, incentives need to be put in place for investors to direct capital towards opportunities at both ends of the transition spectrum:

- High-emitting assets starting their transition pathway from grey-to-green (a transition which will take longer and could therefore appear on investors’ books as carbon-intensive for some time)
- Early-stage net-zero technology and infrastructure, which are critical for the transition but have high capital intensity and come with higher risks

3

Coalitions to choreograph radical action on accelerating net-zero technologies

The green premium of low-carbon technologies is a barrier to growth. We need coalitions of public and private actors to share the costs of developing these technologies, proving they work and making them market-ready within the next decade.



3.1 New technologies need proof-of-concept before 2030

The previous chapter on key obstacles raises a problem of alignment. We need businesses and industries to start integrating low-carbon solutions to their products and processes. Yet today's competitive marketplace at best fails to reward them sufficiently for this transition and at worst could expose their profitability and business model to a set of risks and disadvantages. To compound matters, we lack the enabling policy environment to support the transition.

This leads to the conclusion that unlocking the pace and scale of the transition hinges on brokering agreements between policy-makers, industry players, public and private demand-side actors, financial institutions and philanthropists on how the green premiums attached to these low-carbon products and processes can be shared out, so that innovative projects can be tested and commercialized.

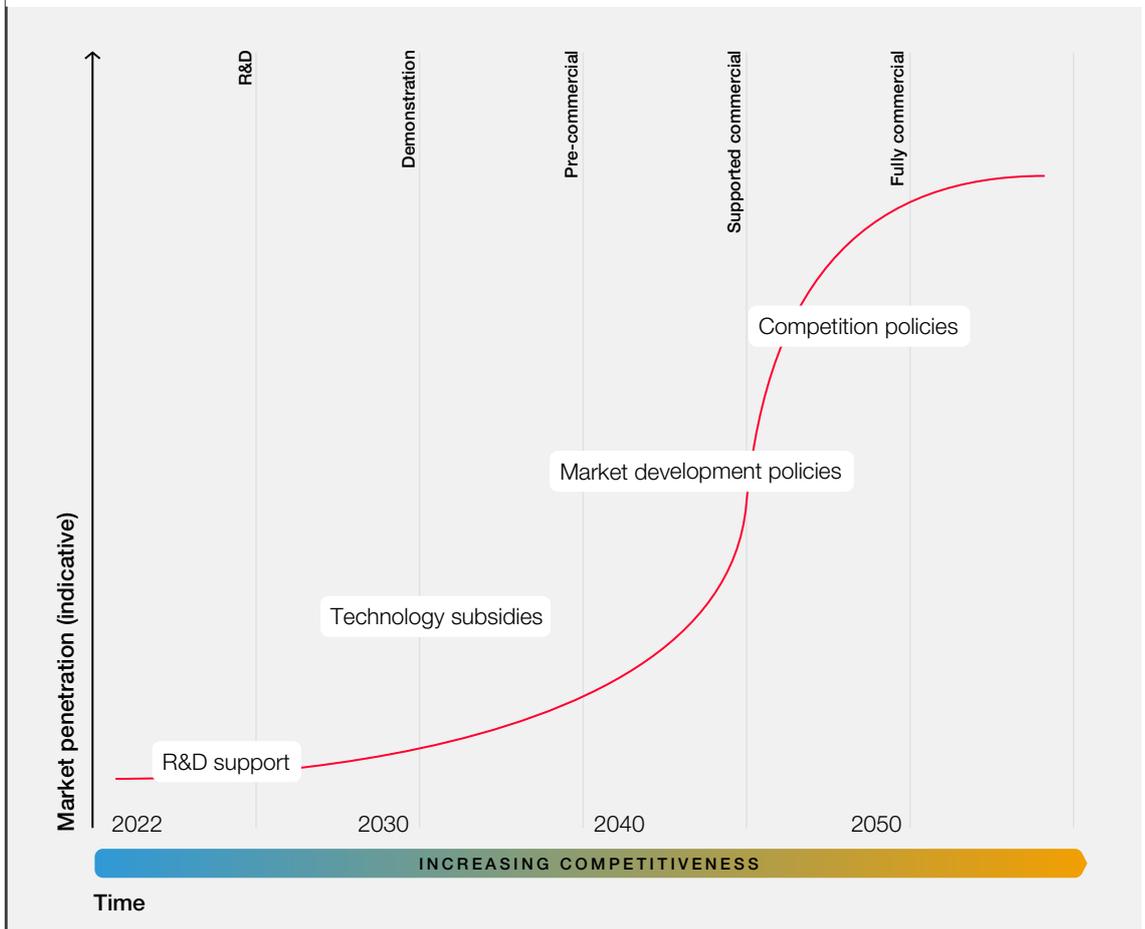


Accelerating the transition hinges on brokering agreements between policy-makers, industry players, financiers and philanthropists on how to share the cost of the green premiums attached to low-carbon products and processes

One urgent near-term objective is demonstrating proof-of-concept for some of the most promising and significant low-carbon technologies, such as sustainable fuels, low-carbon steel and green hydrogen. Deploying a range of trial projects using these technologies would generate critical learning for subsequent efforts to commercialize them. Such projects would also demonstrate to the rest of the world that the actors involved

in these domains are serious about delivering on their net-zero pledges. However, the logic of the "S-curve" of new technology development and deployment (see Figure 1) demands that this proof-of-concept phase needs to happen before 2030, if we are to stand any chance of commercializing and deploying low-carbon technologies at the scale required to deliver net-zero by 2050.

FIGURE 1 S-curve of new technology development and deployment



Source: Hammond et al

Note to Figure 1: The S-curve represents the progress of new technologies, which starts with a gentle incline during the R&D and testing stages, before steepening into more widespread commercialization and adoption of the technologies. In the case of the low-carbon transition, it is vital that the R&D and testing phase happens before 2030. Otherwise it will be considerably harder to deploy sufficient low-carbon assets in the 2030-2050 period, when the S-curve needs to "accelerate" to deliver net-zero.

The enormity of the challenge raises two important issues:

- First, tough choices will have to be made around which assets to prioritize. For example, even if we can scale up green hydrogen production, it is unlikely to deliver sufficient decarbonization across all industrial materials, such as steel, cement and aluminium.
- Second, although the near-term priority is to prove the viability of new technologies on a trial-project basis, the goal should be to

create a self-sustaining pipeline of commercial projects and infrastructure needed for industry decarbonization.

Where there is public-private cooperation around specific low-carbon assets, a balance will need to be struck between publicly-covered risks (e.g. publicly funded R&D, subsidies etc.) or publicly-created markets (e.g. sufficient offtake²⁷ commitments to spur on production and privately funded innovation) and attempts to gear private competition and other market forces towards deploying low-carbon solutions.

3.2 Progress requires coalitions of public and private actors

What is needed are coalitions to choreograph a critical mass of leaders from industry, government, finance and philanthropy with the shared aim to accelerate the development of enough trial

projects in each sector to generate a self-sustaining pipeline of market-ready projects and infrastructure to decarbonize heavy industry.

FIGURE 2 Industry decarbonization flywheel



In practice, such public-private coalitions should collaborate in specific sectors to assemble the various moving parts necessary to create systemic change. This means public policy, transition finance, demand-side commitments and supply-side innovation

working together to create a “flywheel” effect towards industry decarbonization (see Figure 2).

Tangible examples of this collaboration could include the following:

Build coalitions of countries with shared interest in hosting low-carbon infrastructure

Bring together a group of ambitious countries with associated interests, which would agree to implement the necessary climate policy and concessional finance (e.g. loans, reimbursable advances, grants and equity investments) to

attract the inward investment associated with hosting sector-specific low-carbon infrastructure or projects (e.g. green steel plants, sustainable aviation fuel plants etc.).

Send the market strong private and public demand signals

Such a commitment would be underwritten by strong private and public demand signals through green offtake commitments from purchasers (e.g. through the First Movers Coalition (See Box 1), buyers’

alliances, aggregated demand signals and public procurement commitments), based on analysis around what the tipping point in a demand signal for the technology in question is for it to be able to scale up.

Give industry confidence to invest in transitional technologies

This demand-side commitment would give industry leaders the confidence to invest in innovative net-

zero technologies and transition towards low-carbon operations.

De-risk process through public and philanthropic financing

The process could be further de-risked and accelerated through public and private financing,

underwritten by philanthropic support (targeted, nimble, risk-tolerant and patient capital).

Design policies to shift niche green technologies to mainstream

This collective initiative could be incentivized by policy frameworks designed to enable nascent green technologies to shift from niche, premium markets to the wider economy. Such policy frameworks should cover five key areas for unlocking investment and scaling up transition technologies:

1. Create demand for low-carbon assets and services (e.g. fuel standards, green public procurement standards, lifecycle carbon product standards)
2. Support the formation of profitable markets (e.g. establishing trading platforms for low-carbon commodities)

3. Level the playing field between high-carbon and low-carbon technologies (e.g. carbon pricing, carbon border adjustment schemes)
4. Support R&D and first-in-kind projects (e.g. tax incentives for R&D, direct grants for R&D, intellectual property reform)
5. Build the common infrastructure for these technologies (e.g. investing in renewable-based power systems; grid extension; hydrogen production, transportation and storage; and key technologies for decarbonizing some sectors, such as carbon capture, storage and utilization)

First Movers Coalition

The First Movers Coalition (FMC) was created through a partnership between the World Economic Forum and the US State Department, through the office of the Special Presidential Envoy for Climate, John Kerry. It was formally launched at COP26 in Glasgow in November 2021.

This demand-side coalition leverages the collective purchasing power of companies globally to send a clear demand signal to scale-up critical clean energy technologies essential to the industrial sector's net-zero transition. FMC will address the seven heaviest-emitting sectors: aluminium, aviation, chemicals, concrete, shipping, steel and trucking – which represent more than 30% of global emissions – as well as carbon removal.

At COP26, 35 founding member companies committed to meet sector-specific procurement commitments by 2030 in aviation, shipping, trucking and steel. At the World Economic Forum's Annual Meeting in May 2022, FMC launched two additional sectors – aluminium and carbon removal. At COP27, the last two FMC sectors will be launched – chemicals and concrete. Governments have realized the

benefits of engaging in FMC, either to support the transition of their existing industries or as a path towards new net-zero growth opportunities. Norway, Sweden and Japan joined FMC in May with other countries expected to join by COP27.

By signing onto FMC's procurement commitments, members accept they will incur a green premium on a small proportion of their overall procurement. As a result of this ramp-up in supply, catalysed in part by FMC commitments, the green premium should fall over time. This in turn will accelerate the growth of the clean energy technologies critical for achieving net zero by 2050.

In this vital decade, the coalition will undertake a range of activities to help companies achieve their FMC targets and strengthen their sustainability efforts. It expects to align sectoral value chains to help members deliver on commitments, for example by developing innovative frameworks to demonstrate FMC member progress, and facilitating engagement with existing and new suppliers to deliver and benefit from new financing mechanisms that address the risks of first-mover procurements on the demand-side.

Source: @ zhaojankang/Gettyimages

3.3 Scaling-up through collaborative projects and green clusters

We are already seeing collaboration between public and private stakeholders in several low-carbon projects and initiatives. For example, the HYBRIT (Hydrogen Breakthrough Ironmaking Technology) initiative is manufacturing steel using green hydrogen instead of coal and is getting the all-important offtake signals and agreements from purchasers, such as Volvo, which represents an important step towards establishing a completely fossil-free value chain (see Box 2).

Another area where we see key stakeholders collaborating to get low-carbon assets and

processes off the ground is in the formation of low-carbon clusters. Green industrial clusters are formed in geographic areas that bring together companies representing one or more industries. The availability of multiple industrial energy consumers in close proximity creates opportunities to scale-up low-carbon technologies through aggregating demand and forming a captive market.²⁸ These clusters require an integrated risk- and resource-sharing approach and necessitate multi-stakeholder collaboration. The result can be a comprehensive framework of solutions and interventions around the shared aim of lowering emissions, increasing

resilience of industrial heartlands and offering other economic, environmental and societal benefits.

As these clusters proliferate, their combined emissions reduction commitments could put the decarbonization of the global economy back on track and through their learnings show the way for broader, cross-sectoral industry net-zero efforts. An [initiative](#) of the World Economic Forum, Accenture

and the US-based Electric Power Research Institute (EPRI) aims to sign up 100 industrial clusters by 2024.

Furthermore, there is scope for connecting clusters through green corridors, thereby amplifying their impact. This bottom-up, decentralized approach can meet and inform national-level industry transition and decarbonization policies and initiatives.

BOX 2

Making cars with fossil-free steel

In August 2021, the Scandinavian HYBRIT initiative produced the first-ever piece of fossil-free steel in the world. Volvo Cars, which took delivery of this steel, has committed to become climate-neutral by 2040 and has designed the world's first vehicle made of green steel, which it aims to start producing this year.

HYBRIT, which stands for Hydrogen Breakthrough Ironmaking Technology, is a joint venture between the Swedish state-owned utility Vattenfall, the state-owned mining company LKAB, and the Nordic/US-based steel company SSAB, aimed at co-developing a hydrogen-fuelled process to

manufacture fossil-free steel. With grants totalling €143 million from the EU Innovation Fund,²⁹ a large-scale demonstration plant will be constructed (among other demonstration projects). This plant is expected to produce about 1.35 million tonnes of fossil-free iron sponge annually to be used to produce crude steel, around a quarter of Sweden's total annual steel production.³⁰

Ample and reliable demand for such fossil-free steel (and other carbon-neutral materials) would further boost these efforts, which is why demand signals like the one sent by Volvo to develop cars using HYBRIT green steel are so important.³¹

Source: @Zephyr18/Gettyimages

Whether it is through projects such as HYBRIT or the work around accelerating industrial clusters, such collaborative initiatives help create prototype investment cases to reduce costs and share risks. They can also help define the integrated economics of developing and deploying low-carbon assets and processes, clarify the necessary public policy interventions to underpin the business case, and help develop terms of reference for multi-party value chain projects.

More importantly, these examples point to the need for coalitions of public and private partners that can choreograph targeted decarbonization action, to allow us to move from commitments, roadmaps and net-zero transition strategies to portfolios of practical, on-the-ground solutions. While orchestrating collaborative action across such diverse sets of stakeholders is challenging, it is only through integrated approaches of this kind that we are likely to achieve the goal of net-zero emissions by 2050.

Conclusion

We have the targets in place to take more than four-fifths of humanity to net zero by 2050. We need to halve greenhouse gas emissions within eight years. Yet they continue to rise. We are nowhere near the pathway to 1.5 degrees that scientists tell us we must follow to avoid the worst impacts of climate change.

This paper focuses on the role of carbon-heavy industries, which account for nearly one-third of all emissions. We know what needs to be done – more zero-emission steel plants, ships and trucks; more charging points, sustainable aviation fuel and green ammonia; more carbon capture plants; and a huge expansion in solar power, wind power and clean hydrogen supply.

So what are the obstacles preventing progress and how can we overcome them? Systemic change is needed and no single sector can make the difference. It requires a coalition of actors, choreographing their moves across a dance floor that, like the Titanic's, is beginning to tilt precariously.

The root of the problem remains creating sufficient commercial incentives to wean heavy-emitters and their shareholders off the lucrative returns of the fossil-fuel economy, which – with the ongoing war in Ukraine – has seldom seemed more profitable. Low-carbon fuel alternatives for the “harder-to-abate” sectors, and the infrastructure required to deliver that fuel, remain expensive.

Given that 80% of the world's energy still comes from fossil fuels and governments still subsidize those fuels to the tune of \$6 trillion each year, the system is currently rigged against newer, disruptive technologies. That needs to change. The inventors, entrepreneurs and businesses creating a sustainable future need support now – which means fairer rules and more finance.

Governments must shift fossil fuel subsidies into R&D funding for emerging technologies plus the infrastructure to roll it out. Public and philanthropic finance can de-risk the opportunities for more mainstream investors. This needs to happen before 2030, so that innovations such as green hydrogen, e-ammonia and carbon capture can move beyond proof-of-concept towards full commercialization by 2050.

Policy-makers need to frame new rules and norms around fuel standards, carbon-pricing, tax breaks and sustainability reporting. Meanwhile, to proceed at the pace required, nascent green technology companies need demand-side signals from government and industry, through green offtake agreements, buyers' alliances and public procurement commitments.

Changing the status quo is possible but it will require imaginative new collaborations, not just within sectors but up and down value chains and across national boundaries. The potential gains – both environmental and commercial – offered by seizing the low-carbon opportunity are matched only by the risks of failing to do so.

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