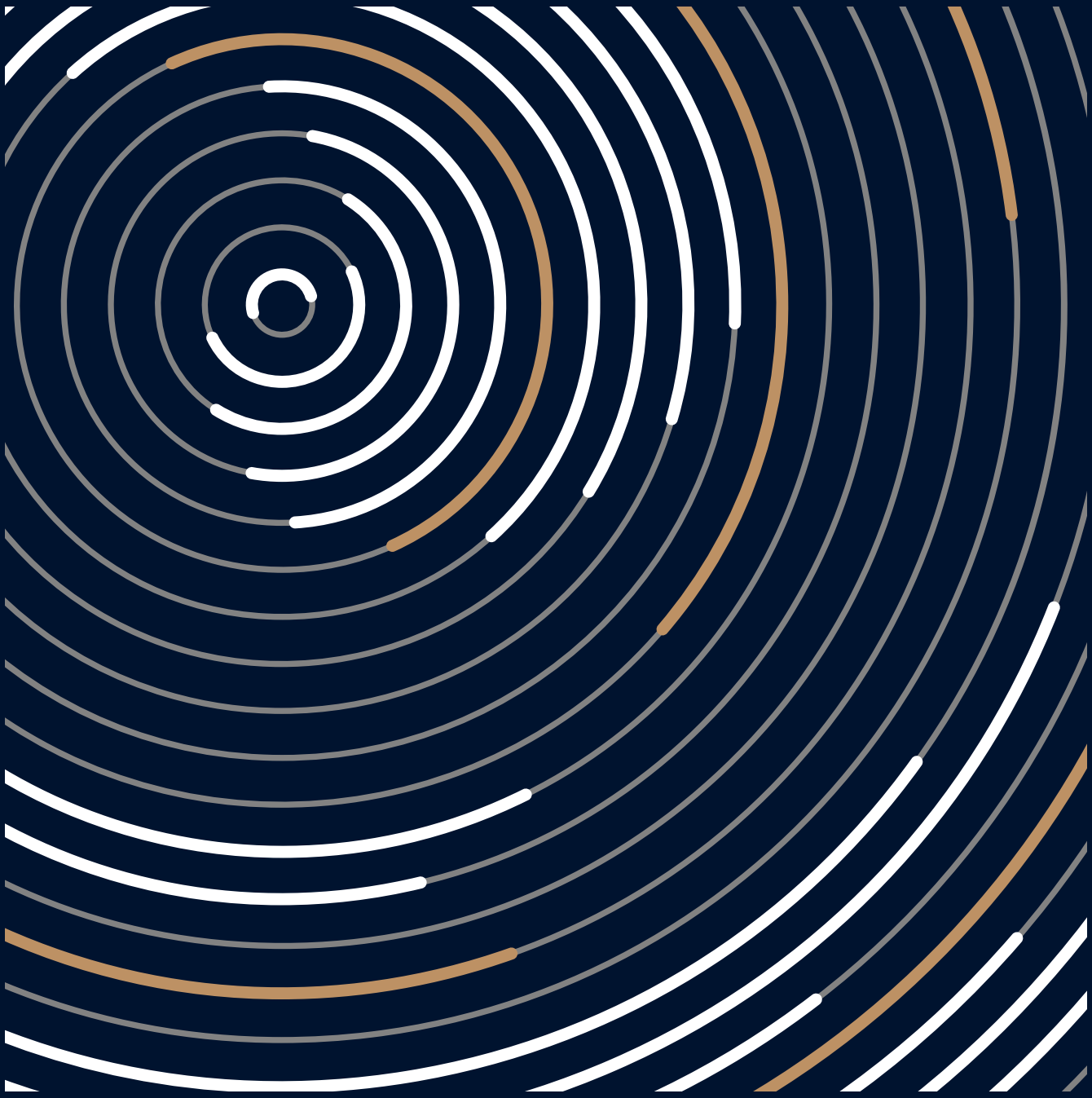

THE PARIS EFFECT

HOW THE CLIMATE AGREEMENT IS RESHAPING THE GLOBAL ECONOMY

December 2020

SYSTEMIQ

ENDORSEMENTS

"We know that inadequate action translates into massive and costly climate risk. The Paris Effect makes it clear that it also puts economies at risk of falling behind the next wave of the creation of prosperity. That wave is already gathering pace and will become a dominant force in growth and transformation over this decade. Wise policy makers and investors will aim for the opportunities, jobs, and resilience that can be delivered only through a net-zero economy."

Pr. Nicholas Stern, Professor of Economics, Chair of the Grantham Research Institute on Climate Change and the Environment, London School of Economics

"The Paris Agreement has inspired net zero pledges from countries, companies and citizens. This report shows that we can transform very quickly and that recovery from economic crisis must prioritise the delivery of these pledges. The net zero future is not a far off vision; we are ready to make the transition now."

Christiana Figueres, Former Executive Secretary of the UNFCCC, now co-founder of Global Optimism

"As the report shows, the global economy has seen positive changes since the Paris Agreement: low-carbon industry is developing rapidly, climate finance and green finance are becoming increasingly mainstream. A number of economies, including China, have set the vision to reach carbon neutrality by mid-century. China's 2060 commitment represents a huge green investment opportunity. Furthermore, achieving carbon neutrality requires a green finance system which can provide the incentives and the regulatory framework to accelerate the low-carbon transition. A post-COVID world needs to recover the economy and at the same time, transition to a green future – these two tasks can never be separated."

Dr. Ma Jun, Director of Center for Finance and Development at Tsinghua University, Chairman of China Green Finance Committee

"It is clear the global long-term goal of Paris - net zero GHG emissions by midcentury - is now the reference point for governments and financial actors. World leaders started a journey in 2015 and now is the time to accelerate. We know global temperatures and emissions are rising but this assessment should give us hope that the Paris Agreement is working."

Laurence Tubiana, CEO, European Climate Foundation

"The Paris Agreement was a watershed moment for the global economy– and it is both exhilarating and reassuring to see that technological and economic trends over the past five years are indeed propelling us towards a carbon-emissions free future. This is despite the fact that a global peaking of carbon emissions is yet to occur; and suggests that these positive trends need to be converted into action as soon as possible, if not sooner."

Dr Ajay Mathur, Director General, TERI and a member of the Prime Minister's Council on Climate Change

"This excellent and hopeful paper shows us that with the astonishing progress being made across a wide range of clean energy technologies and business models, we can deliver global economic transformation at the speed and scale needed to meet the Paris climate goals but only if political leaders do their part with the right kind of policy support. It reaffirms that we can win the fight of our lives for a safer, cleaner, more prosperous world. And now the US is about to be fully back in the fight, where it belongs."

Todd Stern, Former United States Special Envoy for Climate Change

"The Paris Effect is a timely reminder to us all of the importance of the Paris Climate Agreement, and how the scale of multi-stakeholder collaboration it has helped to trigger across business, finance and governments is key to delivering a net zero emissions economy by 2050 or sooner. The report shows how much has been achieved since 2015, but also how much there is still to do. Looking ahead to COP26, the World Economic Forum will be fully engaged to help business and government leaders raise ambitions and deliver the actions required for a net zero, nature-positive economy, as a key dimension of the post-COVID global recovery."

Prof Klaus Schwab, Founder and Executive Chairman, World Economic Forum

"The Paris Effect report reiterates that the move towards a cleaner, decarbonised economy has gained unstoppable momentum. The transition is being pushed along no longer solely by regulators, but by markets themselves, as the costs of technologies are falling and green businesses are beginning to outcompete incumbents. This means that the move to a net zero economy is becoming an inevitability, and will be hastened along by more countries and companies committing to net zero targets."

Hubert Keller, CEO, Lombard Odier

"Decarbonisation of the global economy is accelerating despite some of the headwinds we have seen. With concerted and focussed effort we can make this the growth story of the century and create resilient and inclusive societies."

Paul Polman, Co-founder and Chair, IMAGINE

"The Paris Agreement has brought the world together in increased global ambition for climate action. Clear political ambition and commitment to decarbonization is key for the industrial deployment of renewable energy, and for an accelerated decarbonization of our societies, which is now also building speed through green hydrogen in hard-to-abate sectors. The Paris Effect highlights that in just 5 years, the transition to low-carbon solutions has been happening much faster than many realise, as the costs of renewable energy continue to fall and more countries and businesses seize this opportunity."

Thomas Thune Andersen, Chairman of the Board, Orsted

"Transformational change is possible – and it is happening. The Paris momentum continues to be a driving force behind the protection of our Global Commons. While recognising the scale of our environmental challenges, I salute the progress made over the past 5 years and trust that it will propel Governments into near-term action for a stronger, healthier and fairer world in the long term."

Naoko Ishii, Executive Vice President and Director, Center for Global Commons, UTokyo

"The past 5 years have confirmed the exponential nature of the transition to a net zero economy. The right policy signals are coming now. There is a vast opportunity if we get this right. But those who join the race too late may never catch up. It is very hard to chase an exponential curve."

Nigel Topping, UK High-Level Climate Action Champion

ENDORSEMENTS

"The last five years have shown that stability in the climate system is key to avoiding instability in the financial system. The Paris Effect demonstrates that investors are already helping drive economy-wide shifts to net zero as smart capital moves away from carbon- and resource-intensive players towards companies whose business models are based on sustainable value creation."

Rhian-Mari Thomas, CEO, Green Finance Institute

"The climate crisis is developing even faster than we feared; but as this important and clearly written report sets out, the zero carbon technologies we need to limit future damage are already far more competitive than we expected. We must now seize the opportunity to accelerate the energy transition and emissions reductions."

Lei Zhang, CEO, Envision

"The world is not yet on track to avoid potentially disastrous climate change. But this clear, compelling and important report sets out a case for optimism. In the 5 years since the Paris climate agreement , faster than anticipated technological progress has given us the tools to cut emissions rapidly at low cost, and an ever growing number of countries, companies and sectors have committed to reduce their emissions to zero. In this new reality, countries and companies which fail to grasp the economic opportunities will be left with stranded assets and unsustainable jobs."

Adair Turner, Chair, Energy Transitions Commission

"The Paris Effect report underlines the opportunities to build forward together. The role of the private sector in attaining transformative tipping points as we recover from COVID-19 and transition to a greener more inclusive future is critical. This transition has to be just and inclusive. Low carbon technologies, sustainable food security systems and nature-based solutions are all opportunities for Africa. Critically, this report recognises that we need to innovate and upscale financing to build forward effectively."

Vera Songwe, United Nations Under Secretary-General and Executive Secretary of the Economic Commission for Africa

"Over the last 5 years since the Paris Agreement, progress on low-carbon solutions and markets has been much faster than many realize, with rapidly falling costs for wind, solar and batteries. This is already causing fundamental disruption in our energy systems, and this disruption will only accelerate as clean energy costs continue falling relentlessly. Governments, investors and other global leaders should review The Paris Effect to better understand and get ahead of clean energy cost curves."

Jules Kortenhorst, CEO, Rocky Mountain Institute

"The Paris treaty not only raised global awareness around the urgency to act; it also set in motion an unstoppable train. This report makes it clear that joining the movement to build resilient and clean economies is not only the right thing to do, it is the private sector's best path towards return on investment."

Feike Sijbesma, Honorary Chairman, DSM

"Financial market participants are beginning to focus on the serious risk management problem posed by worsening climate change, but this report calls attention to the many parallel areas of opportunity, where cost tipping points and growing incentives to reduce emissions mean real economic benefits can be gained through investing in low carbon sectors and technologies. There has been a growing embrace of the concept of a rapid transition to a "net zero" future since the Paris Agreement came into effect 5 years ago. Countries and investors that turn a blind eye to that will only worsen the risks they face while missing the opportunities to benefit from the low carbon transition."

Bob Litterman, Chairman of the Commodity Futures Trading Commission's Climate-Related Market Risk Subcommittee, former head of risk management at Goldman Sachs

"The Paris Effect report summarises very well the momentum generated by the Paris Climate Agreement across the globe. The understanding of the climate crisis and commitment to the Paris Climate Agreement have made countries aware of the speed and actions needed to mitigate climate change impact. The desire to scale up innovations and new decarbonisation technologies have come to the forefront faster than expected. The probability of a scaled and accelerated implementation of new ideas and technologies motivated Dalmia Cement to pioneer a carbon negative roadmap and become net zero by 2040."

Mahendra Singhi, MD and CEO, Dalmia Cement (Bharat) Limited

"Paris changed the game. It stated the path for a low-carbon economy and called for the world to step up to the climate crisis. 5 years later, in some ways, that promise has not been met. But in more ways than we realise, it has. The Paris Effect shows how different nations, institutions and businesses are transforming parts of our energy, transport, industry and agriculture systems even faster than we had anticipated – and with benefits that no government can afford to turn down."

Izabella Teixeira, Former Minister of the Environment, Brazil

"Paris brought forth unprecedented alignment across the world, and a sea change in mindsets and innovation from finance to boardrooms, policies to indigenous communities and youth. We need a shift from ego system to eco system with net-zero, resource-efficient and nature-positive economies – which can bring 35 million direct jobs by 2030. Better business Better World is worth pursuing now more than ever."

Cherie Nursalim, Vice Chairman Giti Group and International Chamber of Commerce

"The Paris Agreement promised to leave no one behind, and an inclusive, just energy transition is pivotal to deliver this vision. Renewable energy solutions are now the cheapest and fastest way to reach vulnerable populations and achieve universal energy access – all while we accelerate climate action. Simply put: we cannot achieve net-zero emissions by 2050 if we do not achieve sustainable energy for all by 2030."

Damilola Ogunbiyi, CEO and Special Representative of the UN Secretary-General for Sustainable Energy for All and Co-Chair of UN-Energy

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ABOUT THIS REPORT

Developed by SYSTEMIQ, *The Paris Effect: How the climate agreement is reshaping the global economy*, examines how progress towards a zero-carbon economy has accelerated in the past five years since the Paris Agreement, and the opportunities that this creates for governments that join this transition.

The new assessment shows that although greenhouse gas emissions and global temperatures are rising, progress on low-carbon solutions has been faster than many realise: in 2015, zero-carbon technologies and business models could rarely compete with legacy high-carbon businesses. Today, zero-carbon solutions are competitive in markets representing around one quarter of emissions. By 2030, these solutions could be competitive across sectors representing nearly three quarters of emissions. The report highlights how key shifts across the general public, corporates, finance and government are propelling this progress, creating the opportunity to scale zero-carbon industries in the 2020s.

The Paris Effect draws on research and analysis from hundreds of sources to highlight economic, social and political trends over the past five years. Countries that create the right enabling policy environments to harness these trends stand to capture the benefits of millions of jobs, resilient economies, and simultaneously reduce emissions. Finance ministers and other key economic decision-makers can accelerate investments into low-carbon industries with greater confidence that this will deliver compelling returns. The case for enlightened self-interest has never been stronger.

About SYSTEMIQ

SYSTEMIQ was founded in 2016 to drive the achievement of the Paris Agreement and the UN Sustainable Development Goals by transforming markets and business models in three key economic systems: regenerative land use, circular materials, and clean energy. A certified B-Corp, SYSTEMIQ combines purpose-driven consultancy with high-impact, on-the-ground work, and partners with business, finance, policy-makers and civil society to deliver transformative change. SYSTEMIQ has offices in Brazil, Germany, Indonesia, the Netherlands and the United Kingdom.

Learn more at **www.systemiq.earth**
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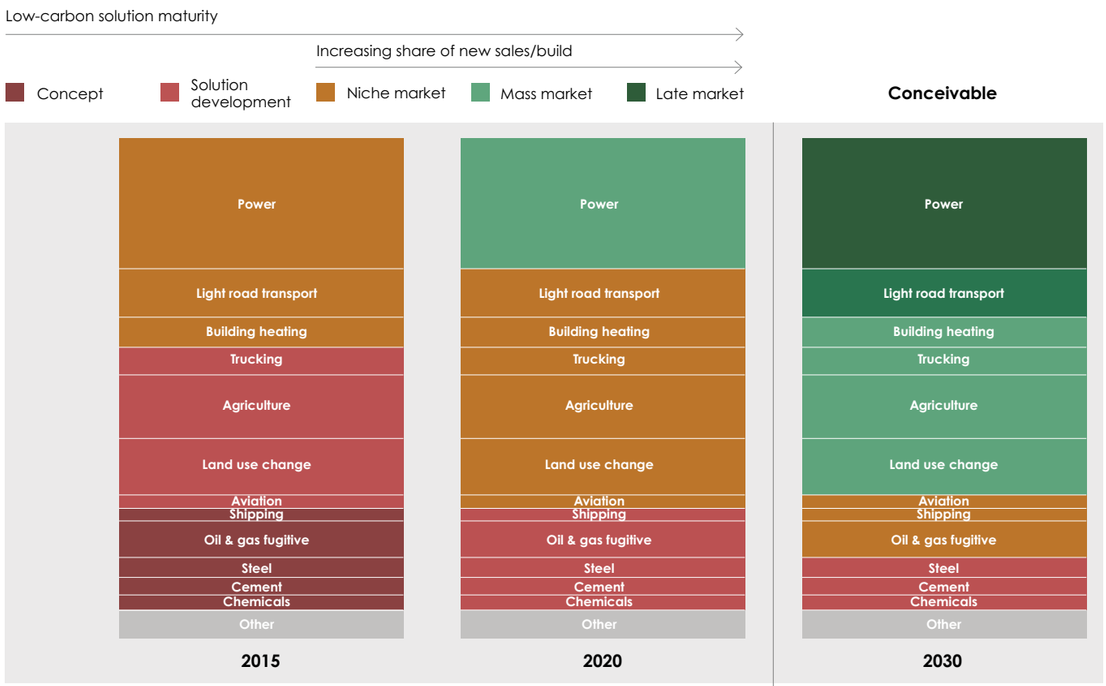
EXECUTIVE SUMMARY

In the years since the Paris Agreement, emissions have risen from 53 billion tonnes CO_2e in 2015[1] to 55 billion tonnes.[2] Even a severe COVID-driven contraction of the economy has barely changed this trajectory. The world is not on track to avoid dangerous, irreversible climate change. That is a key reality on which we need to act urgently and collectively. But it is not the whole story.

Since Paris, progress on low-carbon solutions and markets has been much faster than many realise. In 2015, low-carbon technologies and business models could rarely compete with incumbent high-carbon solutions. Today in 2020, low-carbon solutions are competitive in sectors representing around 25% of emissions. By 2030, these solutions could be competitive in sectors representing 70% of global emissions. (See Exhibit 1.) A stealth revolution is today propelling us towards a zero-carbon, digital future.

It has been estimated that building towards net-zero economies by 2030 stands to add over 35 million net new jobs globally, with growth in sectors like renewable power, energy-efficient buildings, local food economies and land restoration.[3] These are needed more than ever in the context of the post-COVID recovery. The net-zero transition should generate tens of millions of jobs over the coming decade. The same transition would also result in jobs being displaced - albeit fewer in number - in declining industries. Workers in affected sectors deserve strong support to help them adjust. As low-carbon solutions combine with digitisation to restructure economies, late movers will not only miss out on the multiple gains from the transformation, but also risk slower growth, lower productivity and job creation, and a loss of competitiveness. **Countries, companies and investors now have a once-in-a-generation opportunity to scale zero-carbon industries in the 2020s, creating prosperous growth, millions of jobs and more resilient economies.**

Exhibit 1: Low-carbon solutions by sector – progress since Paris and look forward to 2030



Note: sectors sized according to 2019 emissions impact

Source: SYSTEMIQ analysis; CO_2e emissions breakdown informed by International Energy Agency, Energy Transitions Commission; Food and Land Use Coalition; World Resources Institute; Climate Watch.

SETTING THE CONDITIONS FOR A NEW ECONOMY TO EMERGE

The dynamics set in train since the Paris Agreement have created the conditions for dramatic progress in low-carbon solutions and markets over the last five years. The agreement – with its in-built 'ratchet' mechanism – laid out a clear pathway for 195 countries to steadily cut their reliance on fossil fuels. This shared direction of travel increased the confidence of leaders to provide consistent policy signals. In turn, these have created the conditions for companies to invest and innovate, and for the markets for zero-carbon solutions to start scaling – from electric vehicles to alternative proteins to sustainable aviation fuels.

Countries, cities and regions accounting for over 50% of GDP now have net-zero targets (See Box 1).[4] Paris-aligned low-carbon policies are emerging with the potential for widespread impact. For example, the realistic possibility of carbon border tax adjustments by the EU[5], the UK[6], and by US President-elect Joe Biden[7] (in markets which together account for over 30% of global imports by value[8]) is already nudging behaviour in commodities such as steel and aluminium. The same is true in soft commodity markets, where the credible prospect of stricter requirements on food companies to prove that their supply chains are deforestation-free is changing behaviour.

Over 1,500 companies with combined revenues of $12.5 trillion have set or pledged to set net-zero targets.[9] The finance community has begun to integrate climate as a meaningful factor into mainstream investment. The value of global ESG assets (broadly defined) has almost doubled in four years, hitting $40.5 trillion this year.[10] Institutional investors representing $5 trillion assets under management have now committed to align portfolios with a 1.5°C scenario by 2050 via the Net-Zero Asset Owner Alliance (launched a year ago).[11] In 2020, the Bank of England announced that it will conduct climate stress tests on lenders and insurers from 2021.[12] **France,[13] the UK[14] and New Zealand[15] have either made climate risk disclosure mandatory or committed to do so. Others are beginning to follow.**

ZERO-CARBON SOLUTIONS AND MARKETS ARE GROWING FASTER THAN EXPECTED

These trends have created the conditions for sectors to move towards market tipping points where low-carbon solutions can out-compete legacy, high-carbon businesses. Once new solutions find an early market to serve, investment cycles can speed up, enabling performance improvement; costs often fall much faster than expected. The faster they improve, the more investment flows. Once solutions reach market tipping points – beating incumbents on cost, quality, convenience, regulatory alignment or social acceptance – they can take off on an "S-curve" trajectory. In parallel, legacy businesses often spiral downwards faster than expected as they lose market share, economies of scale and regulatory support. Once markets smell that a sector or technology has peaked, the dynamics of value destruction can be brutal.

In 2014, the IEA forecast that average solar prices would reach $0.05/kWh by 2050, 36 years later.[16] In fact, it took only 6 years.[17] Solar and wind are the cheapest form of new generation in countries covering over 70% of global GDP;[18] this will be the case everywhere by the late 2020s. These sources of power generation captured two-thirds of new power capacity added in 2019; including hydropower, renewables captured a full three-quarters of new capacity.[19] Solar/wind + batteries are also increasingly competitive as dispatchable power (for example, India's "round-the-clock renewables auction"[20]) benefiting from battery price declines propelled by the electric vehicles market. As solar, wind and battery costs continue to fall precipitously, this is creating economic pull for solar/wind + batteries to serve up to 75-90% of power systems.[21] Who would have believed that Texas would become one of the world leaders in wind power generation, with wind power accounting for nearly one-fifth of the state's electricity generation in 2019?[22]

In 2016, industry analysts forecast that internal combustion cars would still account for 60% of cars sold in the 2050s.[23] Today, it is hard to imagine them capturing anything beyond a shrinking minority of sales by the 2030s. Before 2024, **electric vehicles (EVs) will beat internal combustion on cost and**

almost every other purchase criterion: sticker price parity[24], a fraction of the maintenance, unparalleled acceleration, and near-equal range.[25] Since 2015, when the first few fully electric vehicle models were available, numbers have grown to 230 in 2019 and we are set to see over 500 models on the market by 2022.[26] These not only offer consumers more choice, but also more affordable, mainstream options. As more countries roll out charging infrastructure, who will buy outdated combustion engines? They will likely go down the road of DVDs, which saw sales decline by 86% in 13 years (2008-2019) after streaming services disrupted the market.[27] Countries from Norway to China are building out charging infrastructure and using EV subsidies to scale the market, boost domestic manufacturing and ensure their citizens have cleaner air.

This is the case for public transport fleets, too. Uganda has committed nearly $39 million to establish an e-bus plant with initial manufacturing capacity of 5,000 vehicles a year from 2021.[28] The government hopes that 90% of the e-bus parts could eventually be made in Uganda.[29] Further, the emergence of "mobility as a service" since 2015 will both reduce aggregate demand for personal vehicles and accelerate the transition to EVs. **Roughly a third of the expected increase in vehicle sales from urbanisation and macro-economic growth will likely not happen because of shared mobility.[30]**

The same market dynamics that delivered advances in the leading net-zero sectors will likely be replicated in other sectors, bringing them closer to market tipping points across the next 5-10 years. Widespread availability of clean electrons will further accelerate the change, given the central role that electrification (either directly or via hydrogen) plays in total system decarbonisation.

In 2015, it was broadly assumed that heavy industry (steel, cement, plastics) and heavy transport (shipping, aviation, trucking) would only partly decarbonize, even by 2050, and might never reach zero carbon within their own operations. With net zero by 2050 becoming the new norm, it is now clear that these sectors will need to get to net zero - and that they can. Today, there are 66 zero-emission shipping pilots and demonstrations.[31] The production of Sustainable Aviation Fuels grew twentyfold between 2013-15 and 2016-18.[32] 200 electric airplanes are in development.[33] Once electric aviation is commercial (likely by the mid-2020s for smaller planes, 2030s for 100+ seaters), **short-haul flights could be cost competitive with jet-fuelled planes**, with better engine efficiency and lower maintenance.[34] This will reshape the industry. Large-scale pilots are launching in zero-emissions cement and steel (such as Baowu Group in China).[35] The cost of green hydrogen production (a key technology to decarbonise these sectors) is set to fall to less than $2/kg before 2030, supported by the continued dramatic fall in renewable energy costs.[36] At this point, the cost increase to consumers of products linked to green shipping and green steel (for example, cars made with green steel) will be less than 1%.[37] Countries already recognise the opportunity for growth, exports and jobs. Chile, Morocco, Australia and many other countries are developing plans and infrastructure to become green hydrogen super-hubs for the clean energy era.

And across almost every resource-intensive sector, companies are exploring ways to become more circular, reducing the demand for primary resources. Increased recycling rates could mean that virgin plastic demand growth will fall sharply from 4% a year before 2020 to below 1% a year between 2020 and 2027, triggering the shift from an investment to a capital reallocation logic.[38]

A growing appreciation of the value of nature is giving rise to new ways of growing food and managing land. The alternative proteins industry (which includes plant-based meat, single-cell and insect-based proteins, and cultured meat) has grown **29% in the past two years to $5 billion.[39]** Major fast food chains are launching meat-free burgers, bringing this trend into the mainstream. By 2030, the market is projected to grow more than eighteenfold to $85 billion.[40] Both public and private sectors are increasingly engaging in schemes and mechanisms to pay for ecosystem services and public goods. The UK's Environmental Land Management scheme will reward farmers for undertaking environmental measures on their land.[41] From 2017 to 2019, the market for forestry and land-use credits more than doubled in value to $160 million.[42] **If properly managed with high standards of governance and environmental integrity, terrestrial carbon investments could grow to become a $50 billion market by 2030.[43] This would bring us closer to the point where thriving forests are worth more alive than dead**, generating resources for tropical forest nations to invest in their natural capital, build forest-positive value chains and improve livelihoods for their rural and indigenous communities. Rising consumer consciousness of environmental issues, most notably triggered by the 2017 *Blue Planet* series in the case of single-use plastics, has the potential to further reinforce the shift towards nature-positive value chains.

Underlying forces at work in the macro-economy favour this industrial revolution. The digitisation of the economy enables business models that increase resource efficiency (for example, "as-a-service" models). A more connected world generates multiple sources of innovation worldwide, with emerging economies not only acting as early adopters of new, clean technologies but also driving their development and rapid diffusion. Smart policies are spreading faster as countries learn from each other, with growing climate policy convergence across close trading partners.[41] Ultra-low interest rates are well suited to clean technologies, which often have high upfront capital requirements and low running costs. With costs of capital (WACC) down at 5%, solar has a levelized cost of energy ~25% lower than if WACC was 10%.[45] The COVID-19 pandemic has prompted new (often digital) ways of working and entertaining. **This has the potential to permanently re-shape transport, commercial real estate and consumer spending habits.**

NEW SOURCES OF WEALTH CREATION AND DESTRUCTION ARE EMERGING

The financial markets can read the writing on the wall. The smart money is already moving into clean technologies and solutions. And it is getting out of old economy assets. As these industries decline, they lose economies of scale, cost of capital increases and it becomes harder to attract talent. Coal has been hit first: US coal stocks lost over half their value in 2019.[46] Coal capacity under development is down 62% globally since 2015.[47] Even under a Trump presidency, US coal production and consumption declined 16% and 40% between 2016 and 2020.[48] **Reflecting their own assessment of shortening industry life, oil and gas players are pulling back on long-life projects:** since 2014, the average lifetime of major industry projects has declined from 50 to 30 years and the trend is accelerating.[49] Any dollar spent into old economy industries is increasingly at risk of being a dollar that investors might not get back.

Some incumbents have understood the S-curve and are pivoting fast to build new renewable energy businesses. Danish utility company Ørsted A/S has transformed into a global offshore wind provider since listing publicly in 2016. Its share price has tripled in the last two years and market capitalisation now stands at ~$76 billion.[50] Others refused to read the tea leaves and suffered massive value destruction, estimated at over $500 billion in European utilities markets since 2008.[51] ExxonMobil's value is now rivalled by that of rising US renewables giant NextEra Energy.[52] Big Oil is being replaced with green giants in the clean energy industry. While those with cheapest oil or other fossil resources may leave it too late to adapt, the economic torch is being passed to the next generation. **The window for long-lived fossil fuel investments is closing very fast.**

A NARROWING WINDOW OF OPPORTUNITY

However, there is no guarantee that these market tipping points will be reached fast enough. The balance sheets and lobbying power of old economy players enable them to continue investing and influencing politicians to provide the regulation that keeps them on life-support. Inconsistent policy support for growing industries can also create false starts. For example, retroactive changes to Spain's solar feed-in tariff in 2013 created massive investor risk and stalled the industry's development.[53]

Given the science, we cannot afford another decade of delay. In the last five years, emissions have gone up. The world is not on track to avoid dangerous levels of global warming and irreversible climate tipping points are being triggered. **On climate, in the words of Bill McKibben, winning slowly is the same as losing.**

Many countries are beginning to move, bolstered by an electorate that is prioritising climate and the emergence of industry players lobbying for regulations to support zero-carbon solutions. Since 2019, elections in the EU, UK, New Zealand and US were all won by leaders with strong climate platforms.[54]

Countries that see the opportunity are taking steps to harness the power of reinvestment cycles to establish globally competitive players in new industries. South Korea's New Deal directs $95 billion into green and digital technology investments.[55] The UK Government's £100 billion national infrastructure strategy outlines plans to invest in green infrastructure to create a net zero economy by 2050,[56] with up to 68% emission cuts by 2030.[57] One third of France's COVID stimulus package – around $30 billion – is allocated to green measures (including $9 billion to green industry).[58] These countries will reap the rewards of millions of good jobs, reduced fossil imports, scaled-up clean exports, cheaper power and transport, lower health costs, enhanced resilience, and greater energy and food security. If enough countries use their COVID recovery programmes to scale zero-carbon industries, these shifts will reshape the economy over the coming 10 years.

However, most countries are not moving fast enough. Government decisions to support existing industries – while understandable, given this is where jobs are today – are ultimately unwise. **By failing to predict the pace of change, countries are making poor policy and investment decisions and wasting taxpayers' money.**

To capture this opportunity, countries need to deliver decisive action over the coming year, leading up to COP26 in Glasgow. Individually, countries can send unambiguous policy signals into the real economy through consistent, ambitious targets, regulation and fiscal incentives. Collectively, greater international cooperation sector-by-sector will accelerate shifts, aligning global supply chains and driving cost and performance improvements. Real economy actors need to act swiftly to stay relevant, including corporates (especially in the carbon- and nature-intensive sectors) and the finance community. **The case for enlightened self-interest has never been stronger. Those countries, companies and cities that act decisively today will strengthen their own competitive prospects and will drive a real economy transformation that can deliver high-quality, lower-risk growth, jobs and returns.**

COUNTRIES THAT SEE THE OPPORTUNITY ARE TAKING STEPS TO HARNESS THE POWER OF REINVESTMENT CYCLES TO ESTABLISH GLOBALLY COMPETITIVE PLAYERS IN NEW INDUSTRIES.

Box 1

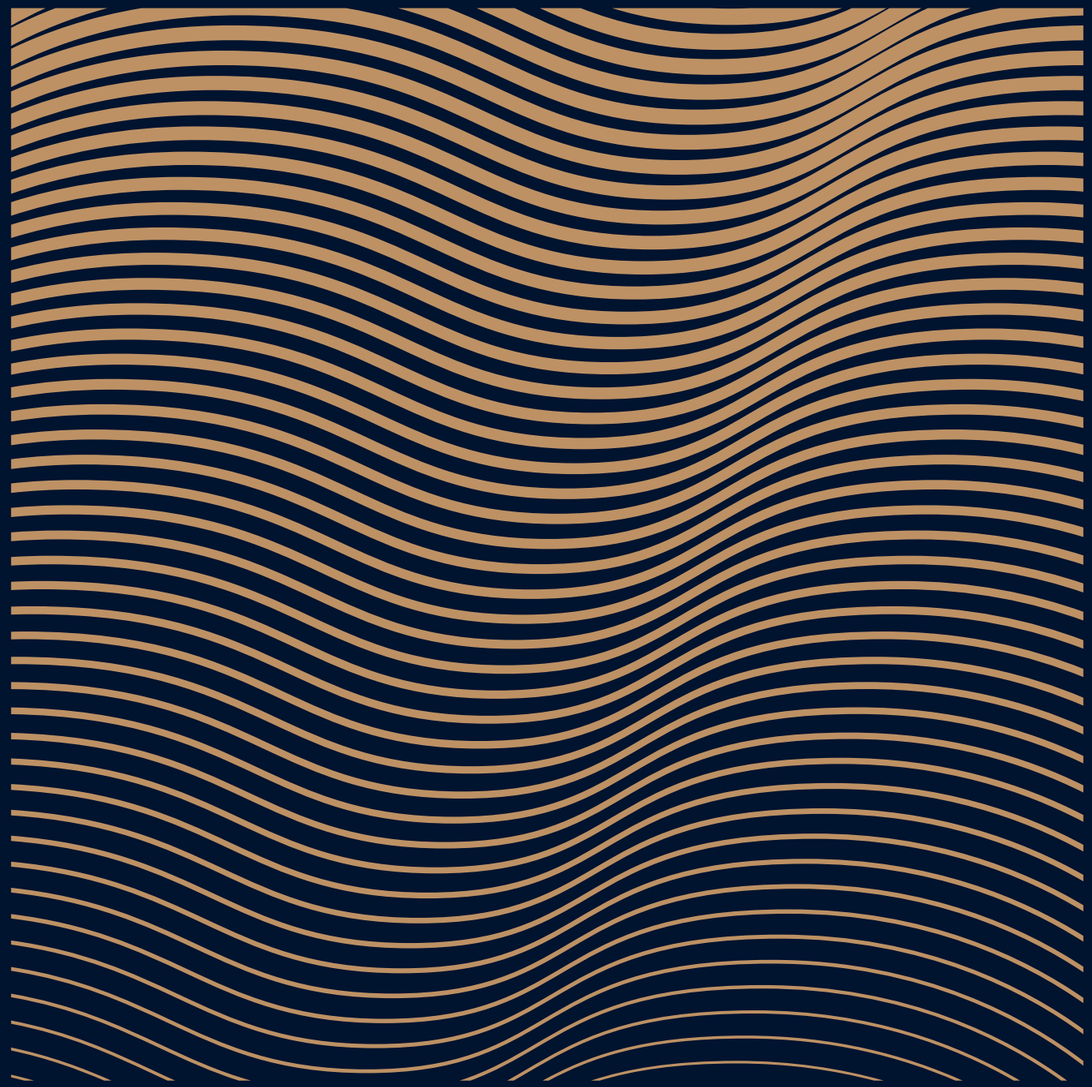
Ambition has stepped up across key actors

- Countries, cities and regions accounting for over **50% of GDP now have net-zero targets** in place.[59]
- **20 countries and the EU** have a net-zero commitment and **more than 100 others** are considering adopting one.[60] 118 states and regions are committed to keeping temperature rise to well below 2 degrees Celsius, with efforts to reach 1.5 degree Celsius. Many of these are increasingly setting net-zero targets for 2050 or earlier.[61]
- **China has committed to carbon neutrality by 2060**[62] and US President-elect **Joe Biden has committed to re-engage** on climate.[63] The two global superpowers account for around 40% of global emissions.[64]
- The EU[65], U.K.[66] and US President-elect Joe Biden[67] are considering **carbon border tax adjustments,** in jurisdictions which account for 30% of global imports by value.[68]
- Over **1,500 companies** with combined revenues of $12.5 trillion have set **net-zero targets.**[69]
- 460 companies have approved science-based targets and a further ~500 are engaging in the **Science-Based Targets initiative (SBTi).**[70]
- 1,500 organisations (with a market capitalization of over $12.6 trillion) and financial institutions with $150 trillion AUM have made clear their support for implementing the recommendations of the **Task Force on Climate-related Financial Disclosures (TCFD).**[71]
- Institutional investors representing **$5 trillion** assets under management have now committed to align portfolios with a 1.5˚C scenario by 2050 via the **Net-Zero Asset Owner Alliance** (launched 2019).[72]
- **France,[73] the UK[74] and New Zealand[75] have each either made climate risk disclosure mandatory or committed to do so.** In 2020, the Bank of England announced that it would be conducting climate stress tests on lenders and insurers from 2021.[76]
- **34 central banks have joined the Network for Greening the Financial System**, through which they are working to ensure a smooth transition to a low-carbon economy.[77]

Sector leaders are betting on a zero-emission future

- **Over ten carmakers (including Volvo, Renault and Fiat) have committed to EV sales targets** for the period between 2020 and 2025.[78] VW Group alone plans to invest $66 billion by 2024.[79]
- Shipping giants **Maersk and CMA CGM** have committed to **net zero by 2050.**[80]
- Since 2018, **IAG**[81]**, One World Alliance**[82] and others representing **>15% global air passengers** have issued net-zero commitments.
- **European steel makers representing 13% of global production** have set 2030-50 net-zero targets.[83]
- **40 companies** representing one-third of global cement production capacity have committed to be carbon neutral by 2050, through the Global Cement and Concrete Association. **Dalmia Cement**[84] and **Heidelberg Cement**[85] have separately committed to carbon neutrality by 2040 and 2050, respectively.
- **General Mills**[86]**, Cargill**[87] **and Walmart** have each committed to regenerative agriculture. Walmart has pledged to protect, manage or restore 50 million acres by 2030 (an area the size of Ohio and Indiana).[88]
- 200 companies, covering 20% of the global plastics packaging market, have transformative **circularity commitments**, up from just one in 2015.[89]

SECTOR PROGRESS ON S-CURVES



In 2014, the IEA forecast that average solar prices would reach $0.05/kWh by 2050, 36 years later.[1] In fact, it took only six years.[2]

Today, solar and wind are the cheapest form of new generation in countries covering over 70% of global GDP.[3] This will be the case everywhere by the late 2020s.[4] As solar has declined in cost, deployment targets have increased, bringing more investment in scale manufacturing and innovation. This has propelled performance improvements and yet further cost declines.

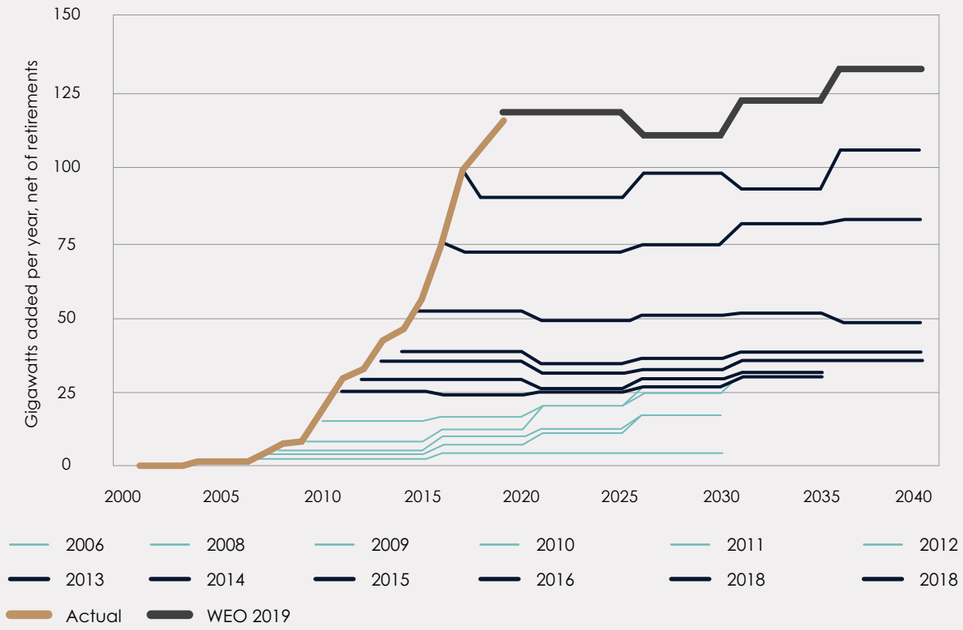
As a result, deployment of solar energy has grown exponentially – faster than anyone could have predicted.[5] (See Exhibit 2.)

Only we could have. New markets often grow on exponential curves. From the motorised car to colour TVs, disruptive solutions can scale from 2-3% market share to over 80% share within 10-15 years.[6](See Exhibit 3.)

Once a solution finds an early niche market to serve, returns can be reinvested into the business to improve solution performance and cost at rates faster than expected, which drives early market growth and more investment.

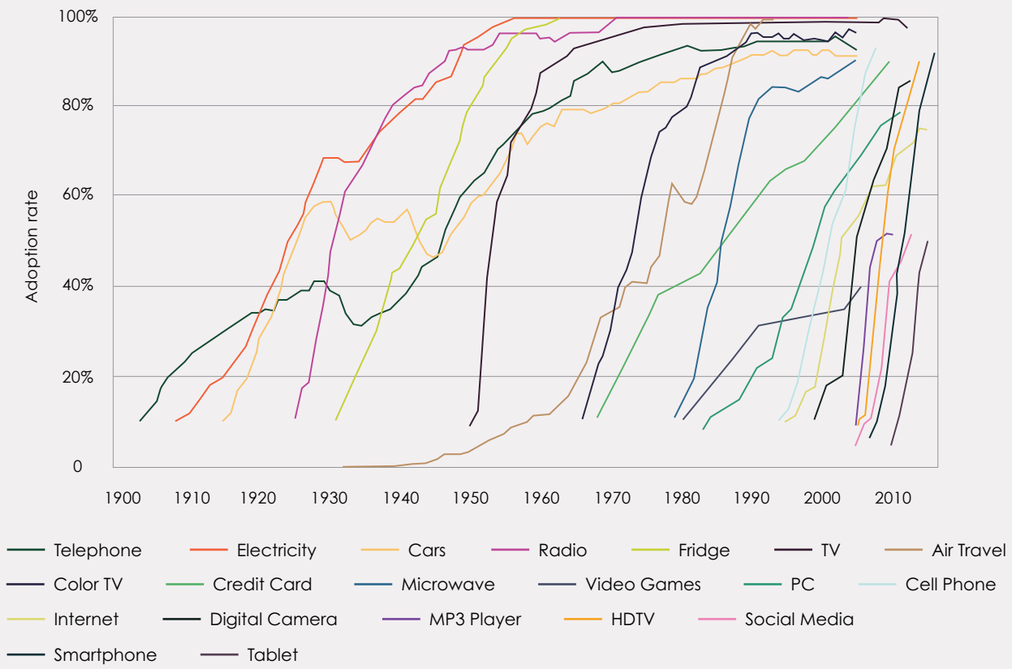
As performance improves and costs decline, the solution can often find market tipping points – for example, beating the incumbent solution on cost, quality, convenience, regulatory support, or social acceptance – after which its **share of market can take off on an "S-curve" trajectory.** In only a short number of years, a disruptive solution can move from small share of market (e.g., 2-5%) to capturing a majority of new sales and investment.

Exhibit 2: Not anticipating the positive feedback loops, actual solar markt growth has consistently outstripped forecasts



Source: CarbonBrief (2019)

Exhibit 3: Market inflection points in consumer products have led to incredibly fast adoption (1900-2010, USA)



Source: Blackrock Investment Institute, Asymco (2014)

Failure to appreciate the potential for rapid solution improvement and market uptake can result in governments and corporates – often stuck in linear thinking – to invest unwisely. We are already seeing the negative consequences among owners of coal plants, many of whom have come to realise they are holding a stranded asset that is unable to cover its debt, as it has been disrupted by low-cost renewables.

Stages of solution maturity

It can help to think about solution development and market growth across five stages:

i. **concept stage**, when an idea is formulated to address a problem or fill a market gap

ii. **solution development stage**, when initial investments are made to develop a solution but it is not yet serving a market

iii. **niche markets**, in which market growth may be slow but improvements in solution performance and cost can be swift

iv. **mass markets**, accessed once certain tipping points are reached, when market share can rapidly scale on an S-curve trajectory, and

v. **late markets**, in which growth slows, as adoption of the solution reaches saturation point, regulations and actors are fully re-organised around the new solution.

As a solution is progressing from stages (i) to (iii) it will not capture meaningful share of market. However, it still makes meaningful progress in solution development, towards market tipping points that facilitate its entry into mass market.

The first step can often begin with ambition, driven by governments or corporates setting a direction and targets. When governments set net-zero targets, this increases confidence in the future relevance of zero-carbon solutions, stimulating research and development (R&D) investment. Governments can also lead R&D investment directly in instances where the spend required to find a solution exceeds the amount a private company can afford (for example, large-scale projects in nuclear fusion).

With sufficient investment of money, ingenuity and time, attractive solutions can emerge. As solutions improve and demonstrate their potential for future growth, they attract further investment, which helps drive further improvement. For example, increased efforts around green hydrogen solutions for heavy transport and industry are leading to increased confidence that costs can be reduced to \$2/kg H_2 before 2030. This in turn is increasing investments.[7]

Finding an early market to serve is a critical step. As referenced, once this takes place, returns can be re-invested and new investments can be secured at greater scale. This accelerates a positive feedback loop, delivering solution performance improvement and cost declines faster than expected. For example, investments in Impossible Foods (including a raise of \$108 million in 2015[8]) enabled the company to invest in innovation, improving its product, driving down costs and bringing that product to market. As revenues have grown, this has generated increased investor interest: in March 2020, the company secured around \$500 million in a series F round[9], followed by a further \$200 million later in the year[10]. Government procurement and regulation can often prove critical to creating early markets for low-carbon solutions that are not yet competitive. Such government market creation can be designed to maximise innovation and competition, for example through contract-for-difference auctions, where a government commits to fund the gap between market prices and prices achieved through new technologies (the auction is for which new technology bidder is willing to accept the lowest "difference" payment).

Governments become increasingly willing to implement supportive policies as an industry becomes progressively more important to the country's socioeconomic performance. For example, the Chinese government's solar PV deployment targets strengthened over time, reflecting the growing alignment of solar deployment with the country's interests in global exports and low cost clean power.[11] Co-benefits can also become more evident and recognised as markets grow, strengthening buy-in from the government and the general public. With air pollution causing over 650,000 premature deaths and many more hospitalisations in China, the government is increasingly incentivised to support cleaner power and transport, which can help to address this issue.[12]

Ultimately, with solution improvement, regulatory alignment, social acceptance, or other factors, market tipping points can be reached and the solution can break into mass markets and **capture share faster than expected.**

In the late market stage, the previous technology that has been displaced can hang on in niche markets for a long time. In the case of the zero-carbon transition, it will be important to implement policies and regulations that actively drive down the remaining market shares held by high-carbon activities, even once low-carbon solutions have taken majority share.

A number (or frequently combination) of actions from actors drive these positive feedback loops of ambition, investment, solution development and market growth (see Exhibit 4). This includes the **general public** (e.g., by changing consumer preferences, applying pressure on governments or corporates to raise ambition or creating solutions themselves), **government** (e.g., by setting targets, providing consistent policy signals, introducing regulatory change and facilitating increased investment in solutions), the **finance community** (e.g., by facilitating changes in access to capital or the cost of capital) and **corporates** (e.g., by generating fresh or different demands from their suppliers and by pivoting political advocacy away from the old solutions and towards the new ones).

GOVERNMENTS BECOME INCREASINGLY WILLING TO IMPLEMENT SUPPORTIVE POLICIES AS AN INDUSTRY BECOMES PROGRESSIVELY MORE IMPORTANT TO THE COUNTRY'S SOCIOECONOMIC PERFORMANCE.

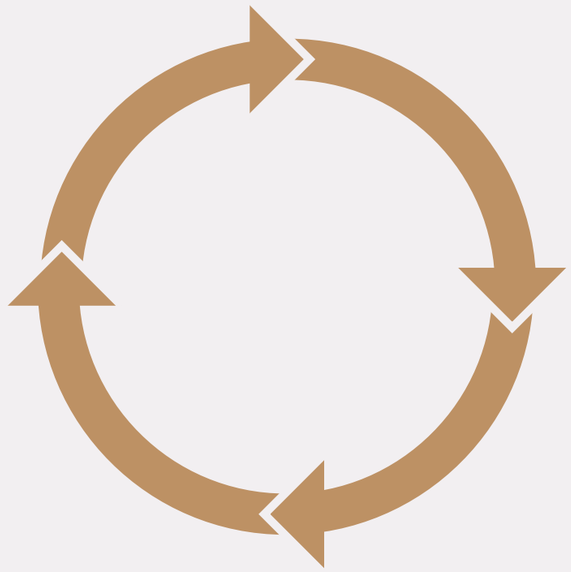
Exhibit 4: Actors set off positive feedback loops that deliver exponential growth

Access early market

- **Government:** stipulate or stimulate buying, e.g., contract for difference; government procurement
- **Corporate:** sustainable sourcing (e.g., to limit supply-chain risk) creates premium market
- **Public:** early adopters provide (premium) early niche market (e.g., electric vehicles, alternative proteins)

Scale to mass market

- **Government:** cut subsidies to "old" and provide to "new", regulations (e.g., pollution control), standards (e.g., emissions intensity or energy efficiency), bans (e.g., ICE), restrictions; de-risked contracts (e.g., long-term PPAs)
- **Public:** social tipping points can contribute (e.g., alternative proteins)



Ambition set and ratchets with every loop

- **Government:**
  - Net-zero commitments set direction, particularly for harder to decarbonise sectors with 20+ year asset-lives
  - Sector targets motivate suppliers to invest (e.g., solar/wind build-out targets encourage developers to establish local supply chains)
  - As expectations are exceeded and confidence grows, ability to ratchet ambition
  - International collaboration can align supply chains and collectively drive faster solution improvements
- **Corporates:** lobby Government to increase ambition. Influence scales as lobby power of new industries grows and old economy players switch to investing in the new economy, aligning interests.
- **Public:** Seeing the opportunity for them and their communities, voters create political space for raised ambitions; consumers and employees raise pressure.

Solutions improve in performance and cost

- **Government:** underwrite enabling infrastructure (e.g., EV charging infrastructure; transmission lines to areas of high renewable resource; satellites for forest cover monitoring)
- **Clusters of countries:** Supply chain co-ordination across countries, e.g., for electric vehicles, green fuels for shipping & aviation.
- **Corporates:** collaboration across new value-chains (e.g., renewables + hydrogen production + steel + auto manufacturer); supply chains mature and procurement practices improve
- **Finance:** enabling business model innovation (e.g., financing to avoid upfront capital outlay for businesses and consumers; supporting capital-heavy "as-a-service" business models)
- **Public:** entrepreneurial efforts focused on solving societal issues bring forward new solutions

Investments into innovation and scale manufacturing & supply chains

- **Government:**
  - RD&D investments in mission-driven innovation where investment scale or timelines exceed what is possible in private sector (e.g., fusion)
  - De-risk investments e.g., tax breaks, low interest rate loans possibly blended finance mechanism
  - Clusters of countries: shared investments in Government mission-driven innovation (R&D)
- **Finance:**
  - Increase access to capital & lower cost of capital to clean; e.g.: cleantech VC funding for early stage solutions; engage in blended finance solutions.
  - Lower access to capital & increase cost of capital to incumbent "old" economy
- **Corporates:** direct own capital (from balance sheets) to develop and scale zero-carbon solutions

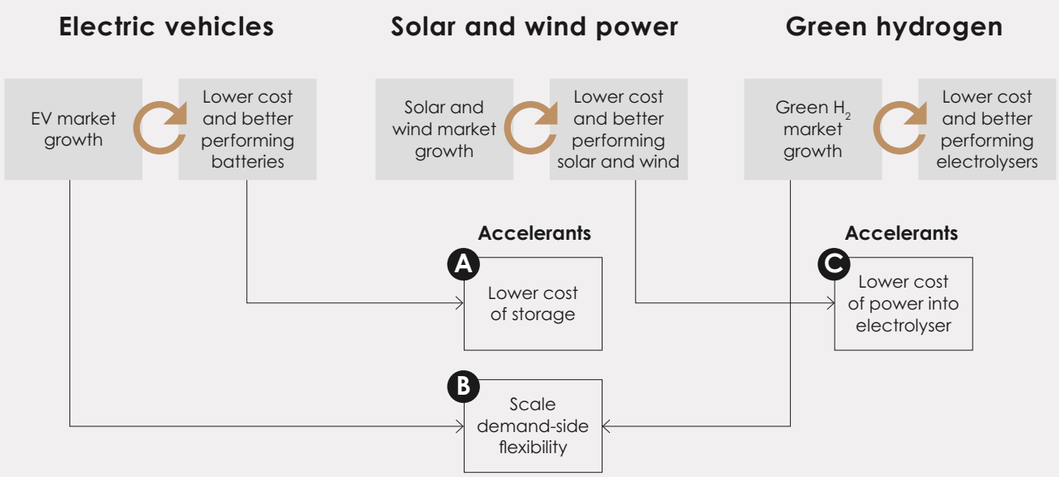
Interactions

Exponential trends can cascade into each other, one acting as an accelerant or trigger to the other. We can already spot areas where this is happening and will happen (see Exhibit 5.) For example, accelerated growth in the electric vehicle market will drive cost reductions and performance improvements in lithium-ion batteries; low-cost batteries play a critical role in enabling solar and wind to become the most cost competitive option for up to 75-90% share of power generation. In turn, as renewables scale and costs decline, ultra-low-cost clean power will deliver ultra-low-cost green hydrogen – a key technology for zero-emissions in select sectors (including aviation, shipping and steel). There are undoubtedly other such interactions we do not yet see coming.

While positive feedback loops can scale new solutions, legacy businesses often spiral downwards faster than expected as they lose market share, economies of scale and regulatory support. As the opportunities in new technologies and markets become clearer, companies see the opportunity for them to win in the new paradigm. At this point, they can very quickly redirect investments and political advocacy. For example, following the development of a car engine that made the use of leaded petrol unnecessary in the 1980s, automotive companies broke from a long-standing coalition with the oil and gas industry to advocate government for regulations on leaded petrol. This crashed the market for leaded petrol, with unleaded taking over faster than was expected. In 1988, unleaded petrol accounted for just 0.4% of petrol sales in the UK; by 2000 it accounted for 97%.[13] These industry pivots are a critical dynamic in the case of low-carbon solutions, given that in many cases these are replacing old carbon-intensive solutions, rather than creating a product or service that was not there before.

Once financial markets smell that a sector or technology has peaked, the dynamics of value destruction can be brutal. Coal has been the first to be hit: US coal stocks lost over half their value in 2019 alone and have continued to fall during 2020.[14] The same trends are beginning in the oil and gas sector, with recent write-downs of £14 billion by BP[15] and $22 billion by Shell.[16] Exxon Mobil has been exited from the 30-firm Dow Jones Industrial Average.[17] We outline declines in the fossil fuel industry in more detail in the Corporate Stakes section.

Exhibit 5: Positive feedback loops in building the zero-carbon economy cascade into each other, with one exponential helping to accelerate the other



Market tipping points across key emissions sectors

Low carbon solutions are improving on cost and performance, starting to serve niche markets and progressing towards mass markets where they will be able to rapidly capture share of new sales.

Market tipping points for low-carbon solutions in select emissions sectors include:

Power: solar/wind + batteries are cheaper than new fossil generation

Light road transport: electric vehicles surpass petrol and diesel vehicles in key customer criteria including cost, range and convenience

Agriculture, food and land use: (i) standing/protected natural ecosystems are valued more by the market than they are cut down, (ii) agricultural practices consistently deliver win-wins in terms of returns for the producer and returns for nature

Aviation: for short-haul flights, continued technology improvements will bring battery-electric and hydrogen-electric planes closer to technical feasibility. Once viable and certified, they could be cost competitive

Shipping: declining costs of sustainable fuels will combine with the emergence of premium markets for them (as set by regulation)

Many market tipping points described above will take place even with no cost of carbon placed on polluters (for example, the energy transition and rise of EVs). Tight regulations on polluters (which add to their costs) and/or explicit carbon prices can bring these tipping points forward and make the S-curves steeper. In other sectors where solutions will struggle to compete solely on cost, **market tipping points will require regulations to drive S-curve growth**, e.g., expansion of markets for low-carbon shipping and aviation fuels through ever increasing low-carbon fuel mandates.

Progress towards market tipping points across sectors

The dynamics set in train since the Paris Agreement have created the conditions for low-carbon solutions and markets to progress dramatically over the last five years. The agreement – with its in-built 'ratchet' mechanism – laid out a clear pathway for 195 countries to steadily cut their reliance on fossil fuels. This shared direction of travel increased the confidence of leaders to provide consistent policy signals. In turn, these have created the conditions for companies to invest and innovate, and for the markets for low-carbon solutions to start scaling – from electric vehicles to alternative proteins to sustainable aviation fuels.

These trends have created the conditions for sectors to move towards tipping points where low-carbon solutions can outcompete legacy high-carbon businesses. As illustrated in Exhibits 6 and 7 solar and wind power have already passed a market tipping point, now cheaper than new fossil generation; they are well into mass market adoption. Electric vehicles are set to reach cost parity within the next five years.

The same market dynamics that delivered advances in the leading net zero sectors will likely be replicated in other sectors, bringing them closer to market tipping points. The pace of progress and nature of market tipping points will differ across sectors.

Simultaneously, a set of external factors are accelerating the adoption of low-carbon solutions. The **digitisation of the economy** enables business models that increase resource efficiency (such as "as-a-service models"). A more connected world is causing smart policies to diffuse faster as countries learn from each other. The number of climate policies of trade partners have increased in line with one another since 2005. **Ultra-low interest rates** are well suited to clean technologies, which often have high upfront capital requirements and low running costs. With costs of capital (WACC) down at 5%, solar has a levelized cost of energy ~25% lower than if it were at 10%.

In the following pages, we describe how since 2015 trends across these sectors have progressed clean solutions towards early markets, and market tipping points. We also touch on threats to progress and describe how shifts by government, the general public, corporations and the finance can create (and in many countries, are creating) the conditions for progress to accelerate in the near-term. We indicate what this means for corporates and countries. And we indicate priorities for countries to capture this unprecedented opportunity.

Elements not covered: energy efficiency and heat pumps for building heating

This report does not cover the **critical element of energy efficiency**, for buildings and in industrial design. Energy efficiency is one of our most powerful levers to decarbonise. It is critical to enabling low-carbon solutions to capture large shares of energy demand. **Efficient design** (e.g., angular and wider piping to reduce pump/motor sizing) is one element that could end up playing a very meaningful role and can spread swiftly. Energy efficiency and other demand reduction levers can help to decouple inputs (e.g., energy) from GDP growth. This report focuses on select low-carbon supply-side solutions and their role in driving us to net-zero.

The report also does not tackle **electric heat pumps** in depth, as their progress in the past five years has not been quite as dramatic as we have seen in other sectors. Electrification of building heating is critical, and heat pumps are progressing with ever-improving coefficients of performance, including in cold climates. Further, reversible heat pumps are already cost competitive with a gas boiler and air-conditioner in many locations.[18] Continued progress, supportive regulation, and complementary building energy efficiency efforts could help this sector start to take strides in the next 10 years.

Other solutions on the horizon could become similarly unmissable opportunities, though are still in concept or solution development phase, or serving only very small markets at present. These include for example efforts to decarbonise primary plastic production and advances in the ocean economy, including the potential for seaweed to take off as a key input for a range of sectors.

Exhibit 6: As solutions progress and reach market tipping points, they break into mass markets and can rapidly capture increasing share of new sales / build.

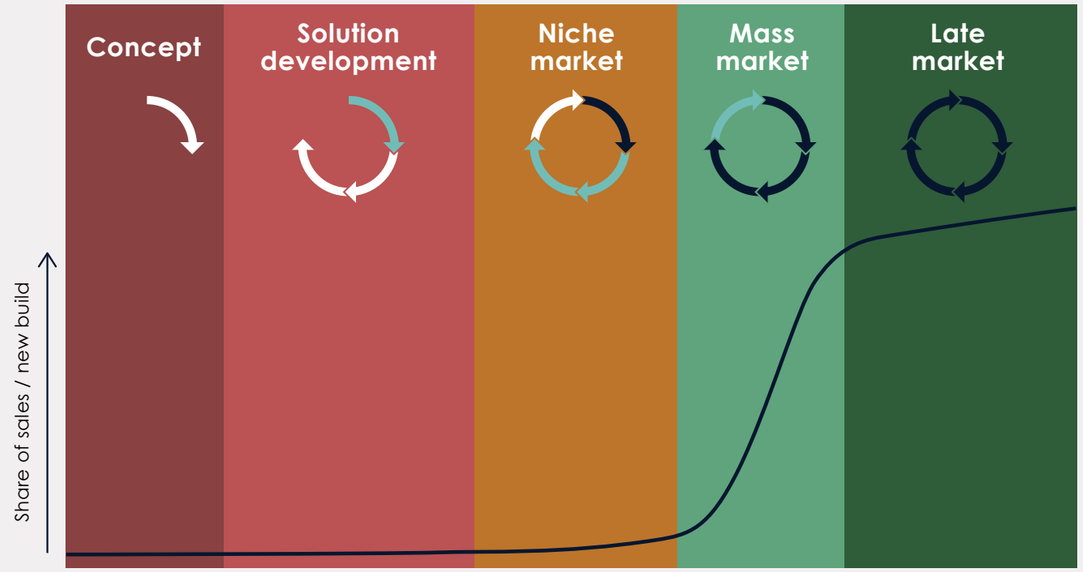
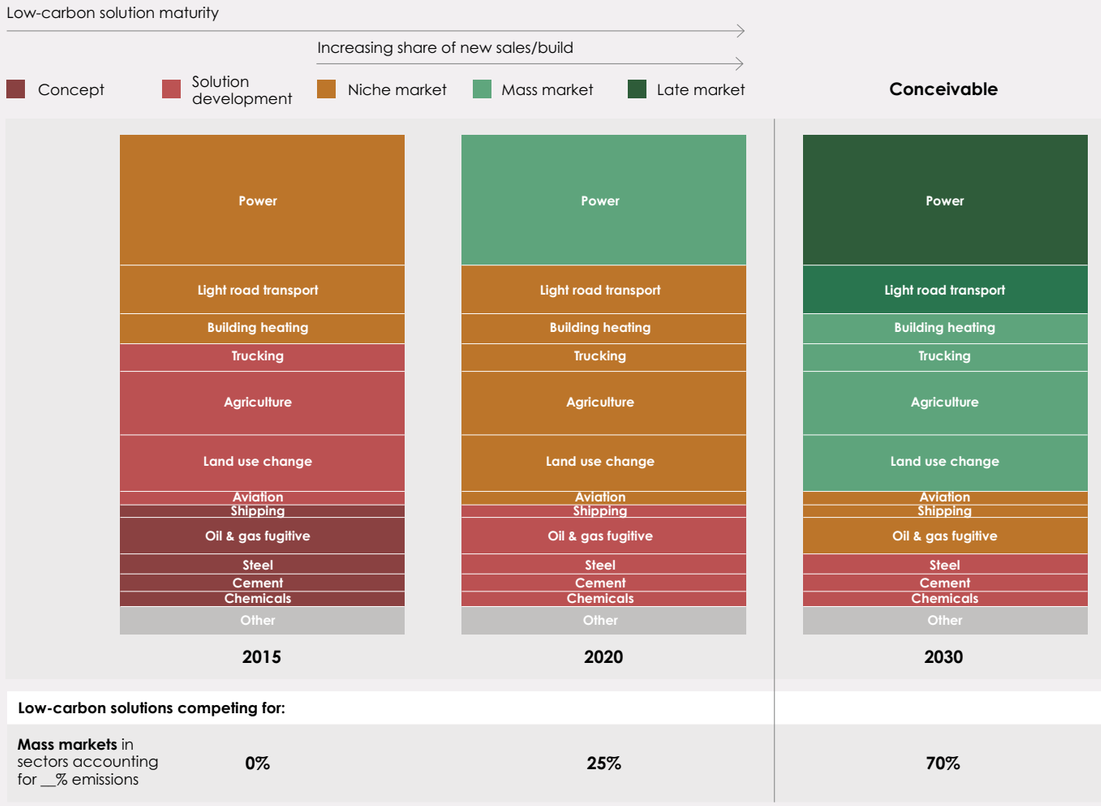


Exhibit 7: Zero-carbon solutions by sector – progress since Paris and look ahead to 2030



Note: sectors sized according to 2019 emissions impact

Source: SYSTEMIQ analysis; CO_2e emissions breakdown informed by International Energy Agency, Energy Transitions Commission; Food and Land Use Coalition; World Resources Institute; Climate Watch.

POWER GENERATION

We are crossing a number of cost tipping points – already and increasingly before 2030 – that are creating economic incentive for solar and wind to serve up to 75-90% of power systems (leveraging batteries and other flexibility levers).[19] The right enabling policy can capture this opportunity.

In 2015, solar and wind were expensive forms of generation. Today, just five years later, solar/wind are the **cheapest form of new generation in countries representing over 70% of GDP.[20]** By 2025, an estimated 73% of coal plants globally will have higher operating costs compared to the cost of building new solar/wind, thus **stranding coal.[21]**

This is driven by precipitous cost declines. **Since 2015, prices have fallen 50-65% for each of solar, wind and batteries.[22]** These declines will only continue with **projected falls of 30-60% across solar, wind and batteries in the next ten years.[23]** For solar, component parts will struggle to become considerably cheaper; however, innovation efforts now are focused on improving efficiency of mass market panels (i.e., electricity output per solar energy that hits the panel) from circa 20% today to closer to 30%.[24] Offshore wind costs – which have also already fallen considerably – will receive another immense market boost precipitating further cost declines, as the EU is considering a plan to increase offshore wind energy capacity five-fold by 2030, and twenty-five-fold by 2050 to deliver climate neutrality by mid-century.[25]

Solar and wind provide variable output, meaning the power system needs flexibility to integrate them. **There is enough flexibility in most power systems already (e.g., gas, coal or hydro plants that can ramp up and down, cross area balancing) to have solar/wind serve up to 30% (more in high-hydro systems), with limited-to-no additional cost of flexibility.** For this first 30% of the power system, the only cost metric that matters is cost of a kWh from solar/wind versus that from coal/gas.[32] As above, solar/wind has cleared this hurdle almost everywhere. The 30% mark can be considerably higher in systems with significant hydro and large dams, which provide immense flexibility. As flexible demand – electric vehicles and heat pumps – come onto the power system, this too will add flexibility (e.g., through smart charging and Vehicle-to-Grid). Increased transmission interconnection between adjacent power systems also adds considerable flexibility.

As much as **75-90% of all power use in a system can be met with the right mix of solar and wind, combined with a moderate amount of battery or other short-term storage.[26]** (See Exhibit 8). Solar/wind + storage solutions are also already beating out fossil generation today, as seen for example in India's "round-the-clock renewables" auction (see Case Study 1). As cost

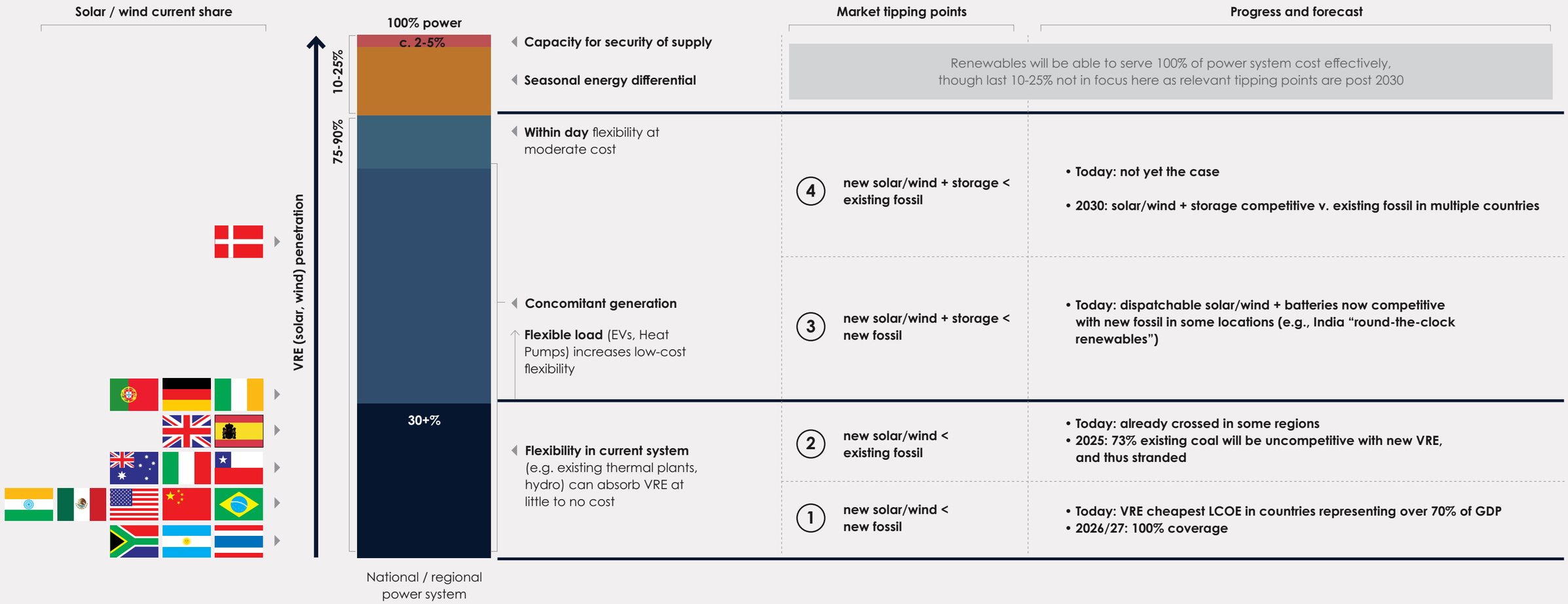
declines continue, new solar/wind + storage will even begin to beat out the operating cost of existing coal/gas plants; this is already the case for higher cost coal plants in India.

The solar/wind revolution is well progressed and only accelerating. **Solar and wind power captured two-thirds of new power capacity added in 2019; including hydropower, renewables captured a full three-quarters of new capacity.**[27] Countries are taking note and moving to capture this opportunity – in low cost power, jobs, reduced fossil imports, cleaner air – and are scaling from often very low starting points to considerable scale in a matter of a few short years, for example Taiwan which is moving fast in offshore wind (see Case Study 2).

As countries scale renewables rapidly to capture the opportunity, **coal plants can ramp down equally rapidly** as has been seen for example in the UK (see Case Study 3).

SOLAR AND WIND POWER CAPTURED TWO-THIRDS OF NEW POWER CAPACITY ADDED IN 2019; INCLUDING HYDROPOWER, RENEWABLES CAPTURED A FULL THREE-QUARTERS OF NEW CAPACITY.

Exhibit 8: Four market tipping points are being crossed already and increasingly so over the coming ten years; as they are crossed, this is creating strong economic pull for solar and wind to serve up to 75-90% power generation



Source: IEA, Climate Policy Initiative, Bloomberg New Energy Finance, Rocky Mountain Institute

CASE STUDY 1

India's "round-the-clock renewables" auction[28]

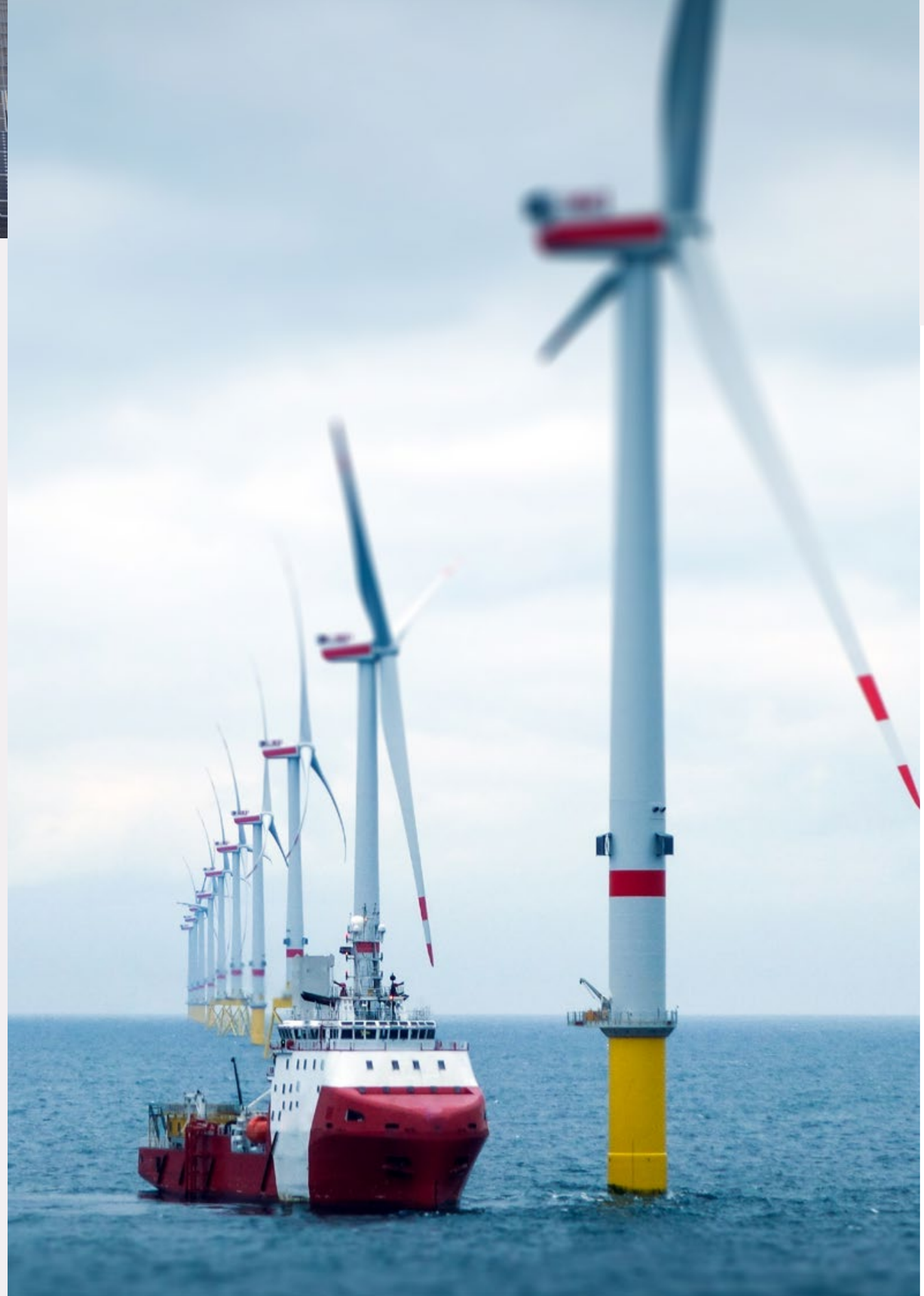
India ran an auction for 400MW renewable capacity, stipulating that the generator had to have availability 80% of the hours of the year (including overnight).

Renew Power won the auction at a price of $38/MWh and is expected to meet the requirements through a mix of storage and also oversizing the solar/wind resource such that even when producing below max capacity (e.g., when cloudy for solar) the site will still meet the required output.

CASE STUDY 2

Taiwan – from zero to 10GW by 2030[29]

Taiwan has set its sights on offshore wind. As an early-stage market, it implemented strong commitments, offshore wind-specific regulatory framework and consistent policy enablers. Recognising the investor risks in a new market it initially set a high Feed-in-Tariff to attract investment and begin to tackle supply chain and technical risks. It identified 36 potential sites for offshore wind development, set a target of 6GW by 2025, and ultimately allocated 6GW of capacity through a competitive selection round in 2018. Taiwan is now shaping to be the second-largest offshore wind market in Asia-Pacific after Mainland China. It is set to generate 20,000 local jobs and nearly $30 billion of inward investment by 2025. Large OEMs have made significant investments in domestic blade and nacelle manufacturing. Bolstered by success to date, Taiwan recently announced its future tender for a further 10 GW of offshore projects commissioned from 2026-2035.



CASE STUDY 3

UK coal from 40% to 5% in 6 years[30]

Over 6 years, 2012-2018, the UK went from coal providing 143 TWh (40% share) down to 17 TWh (5% share), **a decline of 88% over just 6 years.** In that same time period, generation for renewables came online to serve this gap, adding 70 TWh of power (scaling from 40 TWh to 110 TWh) and beating out gas which only added 30 TWh in this time.

Co-benefits

Jobs: Renewable energy creates **3x more jobs per dollar invested than fossil fuels.**[31] In fossil, much of the investment pays for access to the resource. Renewable resources are ubiquitous and the technology increasingly cheap, thus capital differentially pays for labour and thus creates more jobs.

There were already 12 million jobs in renewable energy in 2019.[32] Goldman Sachs estimates that an investment pathway in clean power consistent with a 2ºC pathway would **generate 7 million new direct jobs globally in renewable electricity before 2030.**[33]

The same Goldman report estimates that the 2ºC pathway would see **decline by 2030 of 1 million jobs** across coal mining (-0.3) and coal power generation (-0.6).[34] Early retirement packages, re-training to new industries (e.g., wind turbine technician) can help and these communities should be supported in a just transition. (See Case Study 4.)

Exports: Countries exporting to regions with zero-carbon targets that may implement carbon border adjustments (for example, the EU) will need to ensure their **goods are manufactured with low-carbon electricity to remain competitive.**

Reduced health costs: ramping down highly polluting coal plants can dramatically improve air pollution, which is a significant driver of health costs. (See Light Road Transport "reduced health costs" for key figures on health costs from air pollution).

CASE STUDY 4

Spain's just transition for coal miners

The Spanish Government for example is funding a just transition with €250 million between 2019-2023 (Plan del Carbón deal); ~60% of miners (aged 48 and older or with 25 years' service) will be offered early retirement, younger miners will receive a redundancy payment; certain funds are to be used for regenerating former mining sites and priority for this employment will go to former miners.[35]

Challenges and Priorities to driving S-Curve growth

In mature renewable energy markets, **uncertainty in future wholesale pricing** (as driven by tech cost uncertainties, demand growth uncertainties, etc.) means that **long-term energy contracts should continue to be used.** Long-term energy contracts serve to lower risk for investors, thereby drawing in large pools of low-cost capital. This low-cost capital is **critical to achieving lower energy costs** given the impact cost of capital has on levelised cost of energy for renewables. With costs of capital (WACC) down at 5%, solar has a levelised cost of energy ~25% lower than if it were at 10%.[36] These long-term auctions should also reflect system needs. Chile provides a good example to follow here with auctions for power by quarter of the year and by hour of the day.

Low-cost flexibility should be added to the system as a priority, to enable solar/wind to push well past 30% of power. This includes: interconnections between adjacent systems to expand balancing area; ensuring new sources of demand (electric vehicles, heat pumps) are flexible – e.g., smart charging controls for electric vehicles with ability for these to engage with grid services; adding utility-scale storage (batteries, pumped hydro) to the system, or auctioning for solar/wind + storage solutions as India has done.

Transmission and distribution networks need to be built out, in particular to connect in areas of high renewable resource to the grid. This can often have long lead times (5+ years) if land planning is complicated. Therefore It is critical to move early on this front. Distribution network investments will be driven both by generation increasingly connected at the distribution level, but more so by increases in load as transport and building heating are electrified. Network build out often will need to come ahead of generation ramp-up and scale-up of electrification of transport and heating, thus should be tackled very proactively; reactive approaches would risk considerable slow-down and energy system resilience issues.

Given the scale of variable renewable generation growth required (c. 4-7x today's build rate by 2030), one of the **key barriers to speed of deployment is permitting and planning** (for both generation and networks). Countries should look to tackle this, for example by centralising planning and permitting processes, enabling a "one-stop shop" and streamlined approach.

In emerging renewable energy markets, to get the market started **mechanisms to de-risk investments** for developers are paramount, e.g.: building transmission lines to areas of high renewables and securing land rights for developers (e.g., REDZ in South Africa, YEKA in Turkey). For countries not yet comfortable with **balancing a grid with meaningful volumes of renewables**, some of this responsibility can be shared with developers by including **storage and dispatchability requirements** in renewables auctions as India has done with the "round-the-clock renewables" auction. Still, establishing a supportive regulatory environment will be critical to attracting investment by developers. Certain hurdles can be cleared to a degree with use of **blended finance** to help de-risk early projects. Announcing a **pipeline of auctions** can also be critical to signal to potential developers considerable opportunity over many years to come and thereby encourage investment in local supply chains.

LIGHT ROAD TRANSPORT

Electric Vehicles (EVs) are on track to reach a market tipping point by 2024 when they will have surpassed petrol and diesel cars in almost every car buyer purchase criterion: equal on upfront cost and range, a fraction of the cost to run and maintain, and better acceleration.[37] (See Exhibit 9.)

Continued **battery price declines** will result in EVs reaching **sticker price parity with internal combustion engines by 2024.[38]** In 2015, the battery accounted for 60% of the cost of an electric vehicle.[39] Since then, the cost of batteries has fallen **60%** (from ~$370/kWh in 2015 to ~$150/kWh in 2019).[40] **Costs are set to fall a further 40% by 2024, at which point electric vehicles will reach up front cost parity** with internal combustion vehicles.[41]

Total cost of ownership parity has already been reached for fleets (which account for 25% of car registrations in Europe[42]) due to the greater distances they travel. This will be reached for personal cars in 1-2 years, depending on class, size and local petrol prices.[43]

At the same time, **battery range** is extending, with Tesla S already capable of a 600km range.[44] As battery technology continues to improve, ranges will extend for lower-cost EVs as well.

By the end of 2022, the choice of EV model for consumers will have more than doubled from 230 models in 2019 to **500 EV models** three years later.[45] In 2015 there were fewer than 20 pure electric models available in Europe and the US.[46]

Since 2015, **17 countries have set targets to phase out petrol and diesel cars by 2025-40,** creating the incentive for disruptors to scale and for incumbents to transition.[47]

As a result of these shifts, the **EV share of car sales has grown five-fold since 2015 and is growing exponentially.** (See Exhibits 10–11.) In Norway, where a government incentive programme has closed the cost parity gap, EV share of sales is already 50%.[48] Disruptive start-ups are finding ways for four-wheelers to enter sub-Saharan African markets, too. (See Case Study 5.)

Electric 2- and 3-wheelers (popular in emerging economies) are already cost competitive with petrol- and diesel-powered vehicles[49] and now **account for 25%** of 2- and 3-wheelers on the road.[50]

A set of developments indicate further EV growth across the 2020s.
Regulations linked to air pollution limit the areas that ICEs can access, increasing the appeal of EVs relative to their polluting counterparts. **Twenty cities (including Beijing, London and Rome) have announced plans to prohibit combustion-engine vehicles in "low-emission zones" by 2024-2030.[53]**

Public procurement and public transport contracts are increasing demand for electric vehicles and helping to drive down cost, while boosting local manufacturing. The Ugandan Government has committed nearly $39 million of funding to run an electric bus project from 2018 to 2022, supporting the construction of a plant with capacity to make 5,000 electric buses and other EVs per year.[54] **The government hopes that 90% of the e-bus parts could eventually be made in Uganda.[55]**

Financial markets are betting on an electric vehicle future, lowering the cost of capital for EV producers and creating a virtuous cycle of growth. With a market capitalisation of over $500 billion, Tesla will be the largest company to enter the S&P500 in December.[56] It is now valued at more than GM, VW and Toyota combined.[57]

Mobility-as-a-Service reducing car demand
Mobility-as-a-Service (MaaS, including ride-hailing, car sharing and micro-mobility) is scaling. (See Case Study 6.) In the coming years, **MaaS could become four times cheaper per mile than buying a new car and two to four times cheaper than operating an existing vehicle.[59]** This reduces demand for new cars, as shared cars see higher utilisation. By 2030, approximately one-third of the sales that would typically result from urbanisation and economic development will not happen as a result of MaaS.[60]

CASE STUDY 5

Nopea Ride[58]

An **EV taxi hailing service is scaling up operations in Kenya.** Nopea Ride imports used Nissan Leafs and leases them to drivers. They have set up three charging hubs in Nairobi. The start-up has 11 EVs on its platform and plans to expand to 50 by 2021. The **leasing model is proving a gamechanger** in the region by reducing the up-front capital needs for car use and reducing potential worries around range and/or battery lifetime.

CASE STUDY 6

Grab Mobility Services

Since its launch in 2012, mobility services app Grab has expanded to eight countries in South East Asia,[61] gaining over 187 million users (around one-third of the population in the countries within which it operates).[62] The company has secured $10.5 billion funding since its launch, enabling it to explore new business models (from grocery to fintech).[63]

Exhibit 9: Comparing consumer purchase criteria of EVs and ICEs once sticker price parity achieved (circa 2024)

Consumer purchase criteria	Electric Vehicle		Internal Combustion Engine
Low **upfront cost**	=	Electric vehicles' upfront cost on par with ICE at battery cost of c.$100/ kWh; expected by 2024	=
Low **recharging / refuelling cost**	✓	Electric vehicles are 3-4 times cheaper to fuel per kilometre	✗
Limited **maintenance**	✓	EV maintenance costs ~50% those of ICE (4-wheelers)	✗
Good **range**	=	Tesla S can already achieve over 600 km/ charge	=
Convenient **recharging / refuelling**	=	Charge EVs overnight and avoid regular fill-ups; 20%-80% recharge in 30 mins with fast-charger	=
Good **acceleration**	✓		✗
Can freely enter **low-emission zones**	✓	20 cities (incl. Beijing, Rome) to prohibit combustion vehicles in "low-emissions zones" by 2024-30	✗
Does not **pollute local air**	✓		✗

Source: SYSTEMIQ collation based on buyacar.com (2020), The Mobility House (2020), Cleantechnica (2020)

Co-benefits

Jobs: protecting jobs in auto-manufacturing will require transitioning to meet global demand for EVs and avoid significant jobs at risk as demand for ICE declines. Volkswagen employs 200,000 people directly globally (120,000 in Germany).[64] It is investing $35 billion to pivot to EVs to ensure relevance in vehicle markets in the near future.[65] Equally, building out the necessary charging infrastructure (including grid connections, civil and road works) is estimated by Goldman Sachs to potentially add 6 million jobs by 2030.[66]

Export opportunities: by transitioning from ICE vehicles, automotive manufacturing companies can capture share in a growing global EV market. Failure to do so will result in stranded assets.

Reduced health costs: shifting to EVs and reducing the total number of cars on the road can dramatically improve air pollution, which is a driver of significant health costs. Increased **annual health care costs as a result of air pollution** are estimated at **$3 trillion globally**, accounting for over 5% of GDP in China, India, Bangladesh, Serbia, Romania and Hungary, among others.[67] A minimal increase in pollution has been found to lead to an 11% increase in a country's mortality rate related to COVID-19.[68] (See Case Study 7.)

Cost savings for citizens: EV owners will save money due to the lower costs of total ownership. As mentioned above, MaaS will become cheaper than individual ownership as the market scales.[69]

Challenges to setting off S-curve growth

Manufacturers: if manufacturers don't move fast enough, there could be an extreme imbalance between supply and demand in the mid-2020s. This would lead to counter-productive outcomes such as dealers increasing the cost of auto-loans on EVs.

Charging infrastructure: Public sector investment in charging is moving in many countries. Those who do not move now may be caught out. Charging infrastructure at scale can take years to install (including new grid connections). If not completed in advance of the likely EV adoption wave, negative driver experiences (e.g., extensive wait times) will slow EV adoption.

The predominance of secondhand markets will slow adoption. Yet a key source of secondhand EVs will grow as corporate fleets become electrified. Today, 92 companies across 80 markets worldwide have committed to switch their fleets to EVs and/or install charging for staff and customers by 2030.[73]

Consumer concerns around battery life can deter them from purchasing EVs both due to fears of this causing inconvenience as an owner and compromising resale value.

Priorities to capture the opportunity

Introduce ICE phase-out dates to send a signal to manufacturers.

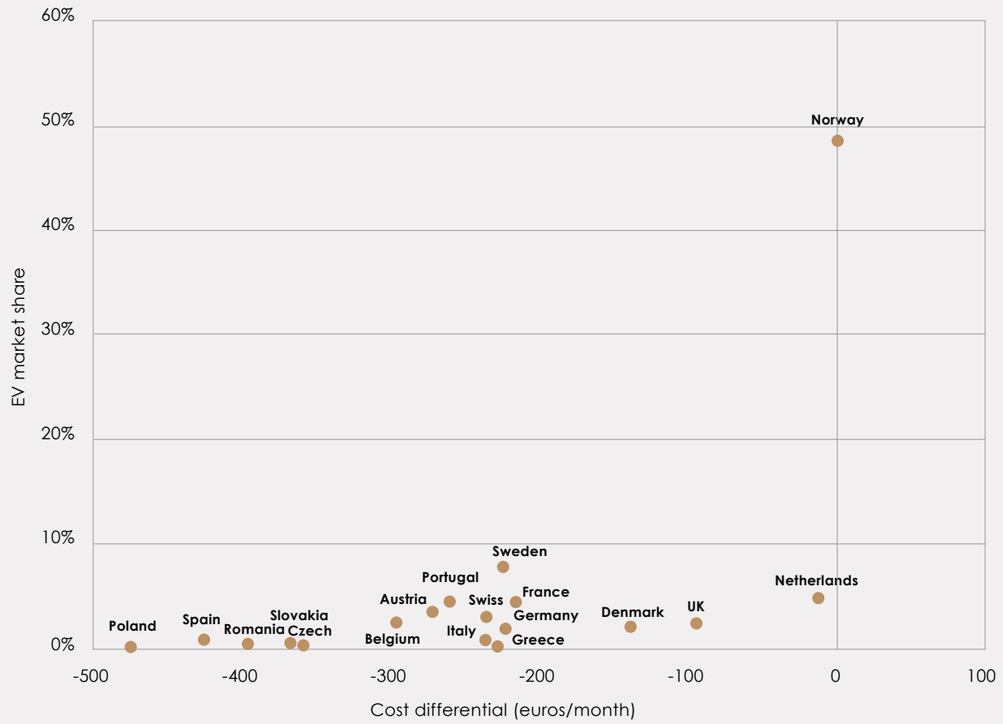
Introduce Low-Emissions Zones to improve air quality in cities.

Roll-out charging infrastructure and strengthen distribution networks ahead of EV demand. The Chinese government increased the number of public charging points from 0.05 million to 0.5 million between 2015 and 2019, and has plans for 4.8 million by end of 2020.[74; 75]

Stimulate market development by providing financial support to consumers and manufacturers (e.g., tax exemptions, purchase rebates), implementing public procurement mandates for government and public transport fleets, and supporting manufacturers to establish local supply-chains (for example, tax breaks to support construction of battery gigafactories). Battery s**wap/rental programs for 2- and 3-wheelers** are also a good way to reduce upfront cost and deliver a better customer experience.

Countries with meaningful automotive manufacturing will need to transition their plants to produce electric vehicles swiftly to avoid the risk stranded manufacturing plants and lost jobs. For those jobs that cannot be retained, support will be needed in the form of retraining and social safety nets.

Exhibit 10: EV market share relative to cost differential of EVs and ICE, Europe[51]



Source: Sharpe, S. & Lenton, M., T. (2020)

Exhibit 11: Electric vehicle share of sales scaling across markets[52]

Source: IEA (2020), Society of Motor Manufacturers & Traders (2020)

CASE STUDY 7

China's air quality and electric vehicle push

Air pollution causes over 650,000 premature deaths in China each year, and many more hospitalisations. The two largest sources of pollution are coal-power and petrol cars.[70]

In a drive to combat this issue, China has become a leader in electric transit, owning 99% of the world's 385,000 electric buses.[71] Beijing has made a particular push. It saw an average improvement in air quality of 54% by end of 2017 compared to the previous year.[72]

TWENTY CITIES (INCLUDING BEIJING, LONDON AND ROME) HAVE ANNOUNCED PLANS TO PROHIBIT COMBUSTION-ENGINE VEHICLES IN "LOW-EMISSION ZONES" BY 2024-2030.

AGRICULTURE, FOOD AND LAND USE

Since 2015, efforts to halt and reverse deforestation and biodiversity loss have been insufficient. Annual tree cover loss rose from 2018 to 2019, reaching the third-highest levels since record-keeping began in 2001.[76] Between 2019 and 2020, deforestation rates in the Brazilian Amazon were at their highest since 2008.[77]

Yet conditions are coming together that bring solutions closer to the point where natural ecosystems are worth more standing than cut down. A growing appreciation of the value of nature is giving rise to disruptive ways of growing food and managing land that could fundamentally shift incentives in nature's favour.

Increased appreciation of the value of nature

General understanding of the value of nature has increased in recent years. The IPCC Climate Change and Land Report (2019), commissioned in April 2016, helped to raise awareness of the importance of land sinks in tackling climate change.[78] The report made clear that without tackling unsustainable land use and protecting nature, it would not be possible to deliver on ambitious climate scenarios. **This in turn has driven demand for natural climate solutions among governments and corporates.**

Policy action: at least two-thirds of Paris Agreement signatories include Nature-Based Solutions[1] in some form in their NDCs.[79] More robust targets and regulations are urgently needed. But increasing numbers of countries are introducing targeted policies, such as China's Forest Law which includes a nationwide ban on the sale, production or transport of illegally procured timber.[80]

Corporates: in the last few years, initiatives have ramped up that could help to address challenges in translating deforestation commitments into action. Companies have largely struggled to deliver on deforestation commitments made to-date.[81] Yet greater supply-chain collaboration, investment and policy advocacy could help to address this. In 2020, more than 600 companies with a combined revenue of $4.1 trillion (including Walmart, Citigroup, Google, Microsoft and Unilever) have urged governments to adopt policies to reverse nature loss this decade.[82] Seventeen multinational consumer goods firms with a collective market value of $1.8 trillion (including Nestle, Mars and Unilever) have committed to tackle deforestation, forest degradation and land conversion in supply chains through the **Forest Positive Coalition of Action.[83]**

Investors are starting to factor the risks associated with deforestation and land degradation into investment decisions. In 2020, 29 financial institutions managing $4 trillion in total assets demanded the Brazilian government to rein in surging deforestation.[84] The same year, Nordea Asset Management, which controls

[1] Nature-based Solutions (NbS) are actions that work with and enhance nature to help address societal challenges. They are win-win solutions that involve protecting, restoring and sustainably managing ecosystems, including forests, peatlands, mangroves, wetlands, savannahs, coral reefs and other landscapes.

a €230 billion fund, dropped JBS, the world's biggest meat producer, from its portfolio.[85]

Rising consumer consciousness of environmental issues has the potential to further reinforce the shift towards nature-positive value chains by applying pressure on corporates to act. In 2014-15, 49% of UK adults were aware of and concerned about biodiversity loss.[86] By 2018-19, the proportion had risen to 62%.[87]

Ease pressure on natural resources and reduce emissions from agriculture and food

Advances in farming, food production and waste reduction have the potential to ease pressure on resources and free up land for restoration and afforestation projects. **Tipping points will be reached when the cost and appeal of diversified protein sources create new dietary norms;** and when improved farming practices and reduced food loss and waste enable producers to grow sufficient food without encroaching on nature.

More productive, regenerative and efficient ways of growing food have emerged and scaled in recent years.

- **Precision agriculture** can improve yields and reduce inputs by using data and technology to optimise conventional farming practices. Nigerian start-up Zenvus collects and analyses soil data to offer tailored advice to farmers on what, when and how to plant.[88] CRISPR-related technology is creating the opportunity to develop more nutritious, abundant, resilient and less input-intensive foods.[89] **As precision farming takes off in diverse geographies, the market value is set to triple over the next five years to $12 billion in 2025.[90]**

- **Regenerative agriculture** offers a way to make a positive impact on nature while boosting productivity and yield resilience. A recent study of meta-analyses found that in 63% of cases, agricultural diversification (which involves regenerative practices) delivers a win-win for crop yields and ecosystem services such as restoring degraded soils, fixing carbon and improving the water cycle.[91] Since 2015, Danone,[92] General Mills,[93] Cargill[94] and Walmart[95] have each committed to regenerative farming practices at-scale. This represents an important mindset shift among key leaders in the sector. In 2020, Walmart pledged to protect, manage or restore at least 50 million acres of land by 2030 (roughly the size of Ohio and Indiana combined).[96] Public sector interventions are also driving growth – for example in Andhra Pradesh (see Case Study 8.)

- **Vertical farming** can increase yields per unit area compared with conventional farming.[97] It could help cities to grow fresh vegetables and greens 365 days of the year, reducing pressure on land, air freight and energy-intensive greenhouses. As renewable energy costs decline, the economics of vertical farming will dramatically improve. **Since 2015, investment into vertical farming has increased sixfold.[98] The market is expected to double in size by 2030.[99]**

The alternative protein industry (which includes plant-based meat, single-cell and insect-based proteins, and cultured meat), has grown 29% in the past two years to $5 billion.[101] Venture capital investment flows have increased sixfold since 2017.[102] As investment has flowed in, the costs of cultured meat have dropped from hundreds of dollars per kilogram to $25 in recent years, without the benefit of economies of scale.[103] Overall, **alternative proteins could be five times cheaper than existing animal proteins by 2030.[104]**

Whether consumers will adopt cultured meat en-masse remains to be seen, but attitudes to meat consumption are changing. Nearly 30% of Brazilians are either vegetarian or moving towards reducing consumption.[105] Two-thirds of American consumers are consciously cutting down on meat.[106] Plant-based restaurants are launching across sub-Saharan Africa's cities (albeit alongside a growing number of Western-inspired, meat-heavy food haunts).[107] **By 2030, alternative protein markets are projected to grow eighteenfold to a projected $85 billion industry.[108]**

Food loss and waste: around a third of food is wasted across the value-chain globally.[109] In 2015, reducing food loss and waste was formally enshrined as Sustainable Development Goal 12.3.[110] Since then, solutions and technologies to build more efficient food systems have experienced significant growth.

- **Countries constituting 49% of the world's population have set targets for reducing food loss and/or waste.[111]** Eleven countries include these in their NDCs, including Cote d'Ivoire, Honduras and Bhutan.[112] Several countries (including France, Argentina and Ghana) have passed legislation and tax incentives.[113]

CASE STUDY 8

Andhra Pradesh[100]

The Indian state of Andhra Pradesh is training 6 million farmers to transition to zero-budget natural farming practices by 2024. The programme intends to reduce farmers' input costs while increasing their incomes, restoring ecosystem health and supporting the production of a more diverse range of crops.

- **32 of the world's 50 largest food companies** (by revenue) across the food supply chain are involved in programmes that have set a food loss and waste reduction target consistent with SDG 12.3.[114] Ten of the world's leading food retailers and providers have engaged 200 major suppliers to reduce food loss and waste through the 10x20x30 initiative.[115]

- **Technological advances have the potential to dramatically enhance the efficiency of food systems.** Improved processing, packaging, market linkages and even gene editing can help to reduce food loss and waste across the value-chain. Gene editing can extend the shelf life of fleshy fruits[116] and vegetables.[117] Kenyan cold storage provider Solar Freeze provides solar-powered mobile cold rooms for farmers, reducing post-harvest losses by 40-60% among its users.[118] **Technology is also being used to redistribute surplus food and optimise menus to reduce waste in hospitality.** (See Case Study 9.)

Challenges to setting off S-curve Growth

Insufficient R&D (including in new biological inputs) and/or knowledge sharing platforms slows the spread of disruptive solutions and practices, including alternative proteins and regenerative agricultural practices

Perverse incentives: government subsidies often support more input-intensive forms of agriculture. There is little or no regulation to penalise unsustainable and inefficient practices.

Farmers face transition risk and lack confidence that shifting to regenerative agricultural practices will not result in yield decreases due to a lack of familiarity with the practices.

If not well managed, technological innovation could increase inequality and fail to create the conditions for nature-positive growth. There is a risk that companies will benefit disproportionately from technological advances due to their ability to invest in these, while the most vulnerable in society will be locked out of opportunities to benefit.

Priorities to capture the opportunity

Increase R&D spending for public knowledge to scale the emergence of **alternative proteins, precision agriculture** technologies and **regenerative farming** inputs and practices.

Use public finance to **incentivise regenerative farming:** governments can leverage public procurement to create premium markets for regenerative produce and levy payments on emissions.

Redirect agricultural subsidies to promote sustainable land management. Governments could repurpose agriculture subsidies as payments for ecosystem services for farmers who increase soil carbon – a good proxy for soil health.

Support the growth of alternative protein markets by (i) working with the private sector to build public trust and confidence and (ii) **redirecting public food procurement** towards diverse protein products to help develop the market.

Support the **meat industry workforce to transition** by providing re-skilling and social safety nets.

Invest in infrastructure (including irrigation, machinery and roads) to improve access to farming technologies and consumer markets that equip and incentivise farmers to boost productivity. This could also help to reduce food loss and waste.

Leverage policy tools including **reform of safety regulations, reporting requirements and bans** to reduce retailer-generated food loss and waste.

Increasing the value attributed to nature

The last few years has seen an increase in the transfer of large-scale payments for ecosystem services (PES) schemes.[119] Perverse incentives currently dwarf schemes that reward sustainable practices.[120] But pioneering governments are rewarding land owners and producers with **payments for public goods.** In Colombia, a proportion of proceeds from the country's carbon tax are earmarked for rural development and deforestation-reduction programmes in conflict-affected areas.[121] This can generate jobs and growth in related sectors like ecotourism (which accounts for 6% of Costa Rica's GDP, following the country's pioneering use of PES over two decades ago).[122]

Trade policies play a critical role in creating market standards that incentivise the production of nature positive products. Importing countries can implement trade policies that treat sustainable land management practices as standard market access requirements and actively support tropical countries to adjust to this standard. In 2018, France introduced a National Strategy against Imported Deforestation through which it committed to implement public purchasing policy and tools to promote sustainable imports (among other plans).[123] The UK Government is considering a law that would prohibit large companies from using products grown on land that was deforested illegally.[124] By requiring businesses to carry out due diligence on their supply chains, the hope is that this will be more effective than previous regulations.

Against this context, innovative business models are emerging that protect forests and create alternative sources of income for local communities. These include models that create value from standing forest, like the COOPAVAM cooperative (see Case Study 10) and models that generate value from forest regrowth, such as a partnership between PT Bumi Agrindo Sejahtera and PT BIS in Indonesia to grow productive Kemiri Sunan trees in degraded lands to produce kernels for biofuels.[125] As outlined above, agricultural production-protection models can also reduce pressure on and regenerate nature. **These regenerative business models point to the potential emergence of a new economic sector – and a new asset class of investment opportunities – that complements public interventions to protect tropical forests.[126]**

A growing number of commitments to carbon neutrality are creating demand for voluntary carbon offsets. Since 2017, the market for forestry and land-use credits has more than doubled in value to $160 million.[128] Together with public funding, an average of $823 million of annual forest funding has flowed since 2010.[129] Nature-Based Solutions are referenced by 24 out of the 42 companies announcing net-zero targets in 2019 to 2020, reflecting a greater appreciation of the value of nature.[130]

If properly managed with high standards of governance and environmental integrity, terrestrial carbon could grow to become a $50 billion market by 2030.[131] More needs to be done to built trust and credibility of projects and commitments. Yet efforts are emerging to enhance integrity on supply- and demand-sides, including the Science-based Targets Initiative's development of standards for net-zero targets (to be launched ahead of COP26)[132] and the recent launch of the Architecture for REDD+Transactions (ART) framework (a voluntary initiative that offers a rigorous standard and comprehensive process to transparently register, verify and issue REDD+ emission reduction credits) which lays the groundwork for companies to ethically buy offsets from a nation state.[133]

With rising demand, actors are coordinating to scale up financial markets. For example, the Task Force on Scaling Voluntary Carbon Markets (launched in 2020) seeks to build consensus on how best to scale up voluntary carbon markets.[134]

Technological advances could accelerate and scale many of these solutions. Precision and vertical agriculture use data analysis to deliver more judicious inputs and better land management. Digital innovations enable real-time monitoring of land use changes from afar. For example, MapBiomas combines remote sensing, GIS and the Google Earth

CASE STUDY 9

Winnow

Tech-start up Winnow helps chefs and catering businesses across 40 countries to reduce food waste by using artificial intelligence techniques to adjust menus and correct portion sizes. The company claims that kitchens using Winnow typically halve food waste in 12 months, saving its customers $33 million.

CASE STUDY 10

COOPAVAM

The COOPAVAM smallholder cooperative provides global brands like The Body Shop with deforestation-free Brazil nuts, mainly sourced from indigenous communities in the northwest of Mato Grosso, where deforestation rates are high. COOPAVAM is supporting the livelihoods of 4,000 people and has brought 1.4 million hectares of forest into sustainable use.[127]

Engine platform to equip a network of experts and communities to **track deforestation of the Amazon rainforest.**[135] Technology can also provide solutions to affordably restore nature. For example, BioCarbon Engineering uses drones to reforest hard to access areas, planting trees 150 times faster and ten times cheaper than current methods.[136] **However, technology in and of itself is not good for nature – in fact, it can increase the efficiency with which we deplete it.** The right innovation ecosystem is needed to ensure that technology supports a nature-positive economy. For example, promoting inclusive forms of social innovation and sharing knowledge equitably and openly.[137]

Co-benefits

Jobs: an estimated 70 million jobs could be created over the next decade if sustainable business models were to scale across all aspects of food and land use.[138] **Restoration and sustainable forest management** can generate an estimated **40 jobs per $1 million investment** (direct and indirect).[139]

Resilience: an estimated **$44 trillion of economic value** generation is moderately or highly **dependent on nature** and its services, including construction, agriculture, food and beverages, and utilities.[140] Sustainable land management practices are essential to protect against mounting climate impacts. Forest fires in Indonesia in 2015 cost at least **$16 billion** due to the impact on agriculture, environment, forestry, trade, tourism and transportation – more than double the reconstruction cost following the Aceh tsunami.[141]

Population health: unsustainable land management practices can generate significant health problems. The Indonesia forest and peat fires of 2015-16 caused over one million respiratory illnesses and 100,000 premature deaths.[142]

Challenges to setting off S-curve Growth

A radical scale-up of finance is needed for forest protection and restoration. The ~$823 million of average annual forest funding today represents a fraction of the $50 billion a year investment that is needed to protect and restore forests.[143]

Perverse incentives dwarf rewards for sustainable behaviour. Of the $700 billion of public support for agriculture and fisheries, only 15% targets public goods.[144]

A consistent and accepted framework is needed to integrate carbon offsetting into decarbonisation strategies. The work of the Science-based Targets initiative is critical.

Priorities to capture the opportunity

All countries, including non-tropical forest rich countries can scale up and regulate carbon and PES markets, in partnership with the private sector.

All countries can redesign public finance, in particular agricultural subsidies, to avoid perverse incentives.

Tropical forest rich countries can strengthen national spatial planning capacity. China's Forest Law is underpinned by extensive use of spatial planning tools.[145] This provides a platform to introduce regulations, strict sustainable use regimes and grant indigenous peoples' groups legal title to their traditional lands.

IF PROPERLY MANAGED WITH HIGH STANDARDS OF GOVERNANCE AND ENVIRONMENTAL INTEGRITY, TERRESTRIAL CARBON INVESTMENTS COULD GROW TO BECOME A $50 BILLION MARKET BY 2030.

HEAVY TRANSPORT AND HEAVY INDUSTRY

In 2015, heavy transport (trucking, aviation, shipping) and heavy industry (e.g., steel, cement) assumed they would not play a significant role in the energy transition. It appeared to cover broader prevailing targets across the economy of 80% reductions by 2050,[146] and these sectors felt they would fall in the remaining 20%. The focus was on incremental solutions and offsets.

In the past 2–3 years, however, with the pivot to net-zero commitments, the **need for heavy transport and heavy industry to fully decarbonise has become clear.** Furthermore, industry leaders are increasingly committing to more ambitious goals as confidence has grown around the technological and economic feasibility of solutions. The recent **Making Mission Possible** report (2020) attests to this shift, demonstrating how all sectors can achieve net-zero energy and process emissions by 2050.[147]

Recently, a third shift has raised ambitions further: the **projected cost of green hydrogen** has plummeted as confidence has grown over the role green hydrogen can play in select sectors (including shipping, long-haul aviation and steel), and as people have increasingly understood the learning curve benefits achievable.

As a result of these shifts, a range of decarbonisation solutions are being developed across "harder to abate" (HTA) sectors. In some areas, breakthrough technologies are emerging with the potential to reach commercial scale in the coming years. (See Exhibit 12.)

Decarbonisation of heavy transport and industry, as with other sectors, will involve a combination of:

1. Reducing energy demand via:

- **end-product demand management**, including: substitution, such as cross-laminated timber in place of steel; recycling, reuse and resale; and general reduction in end-user demand (for example, video conference instead of flying)
- **energy efficiency** enhancing the rate at which energy inputs are converted to useful energy and other outputs. For example, higher performance engines and better airplane designs.

2. Decarbonisation of supply: clean production and use of virgin materials or fuels.

In this section, we focus on **decarbonisation of supply solutions** due to their role in driving emissions all the way to zero. Demand management – discussed in part in the Circular Economy section – and energy efficiency remain critical and can deliver much of the necessary reductions at competitive costs.

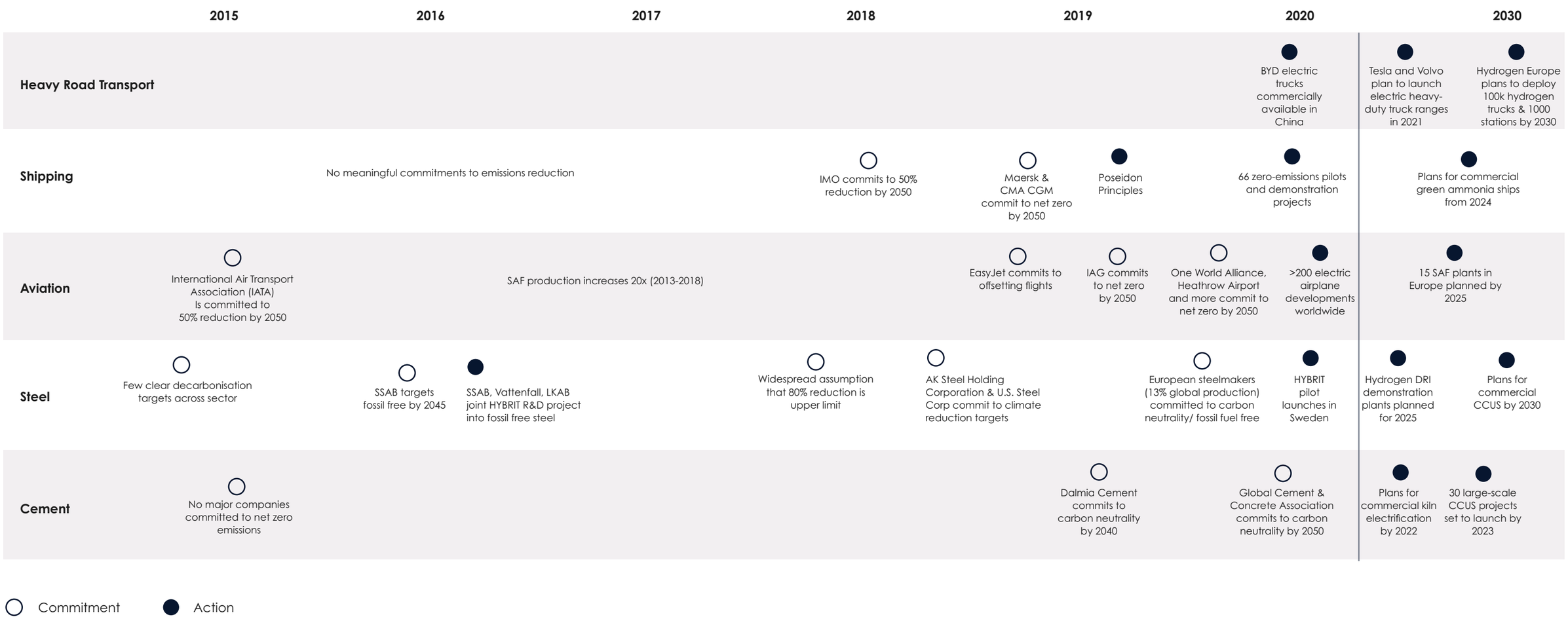
We spotlight Shipping, Aviation, Steel and Cement.

It should be noted that **Heavy Road Trucking is set for solutions to be cost-competitive before 2030 in many geographies (including the EU), and others shortly thereafter.**[148] Tesla[149] and Volvo[150] plan to launch electric heavy-duty trucks in 2021. China's BYD already offers commercial electric trucks.[151] If advances in battery technology and truck design move faster than expected – as we have seen before – the timeline for cost competitiveness could be pulled forward. The prospects for trucking decarbonisation benefit from battery improvements driven by light-road transport (cost declines and increased energy density), and re-design that reduces weight impact of large batteries, ensuring the weight available for cargo of the truck is only minimally (or not at all) impacted by battery weight. Overhead catenary wires and hydrogen-electric solutions are also being explored and may find a niche in heavy-duty long-haul trucking, if straight battery-electric does not outcompete here as well.

Before stepping through each sector, we touch briefly on green hydrogen, given its central role in low-carbon solutions for select sectors, in particular for shipping, aviation, and steel.

HEAVY ROAD TRUCKING IS SET FOR SOLUTIONS TO BE COST COMPETITIVE BEFORE 2030 IN MANY GEOGRAPHIES (INCLUDING THE EU), AND OTHERS SHORTLY THEREAFTER.

Exhibit 12: Industry commitments and actions to low-carbon solutions



Source: SYSTEMIQ collation

GREEN HYDROGEN

There is increasing confidence that hydrogen will be central to low-carbon solutions in shipping, aviation and steel, and can potentially provide high-temperature industrial heat and reliable/seasonal power balances in the longer term.

Hydrogen has certain drawbacks: it is a quarter of the volumetric density of natural gas and is expensive to compress or liquify (hence limited global trade as pure hydrogen). However, it has key benefits as well: **200-times the gravimetric energy density of batteries**; creates very high heat on combustion; can produce electricity via fuel-cell (at c.60% efficiency); and can combine with other sustainably sourced molecules to **make low-carbon e-fuels** (e.g., green ammonia or synthetic jet-fuel).

Green hydrogen can be produced with zero-carbon electricity and water.

While many of the discussed use-cases are uncertain, particular sectors benefit immensely from the energy density of hydrogen or related e-fuels (shipping, aviation), or its chemical properties (as a reducing agent for steel). Clean hydrogen may also play a role in high-temperature industrial heat, fertilizer and for reliable power supply (via gas plant or fuel-cell) in 100% clean power systems.

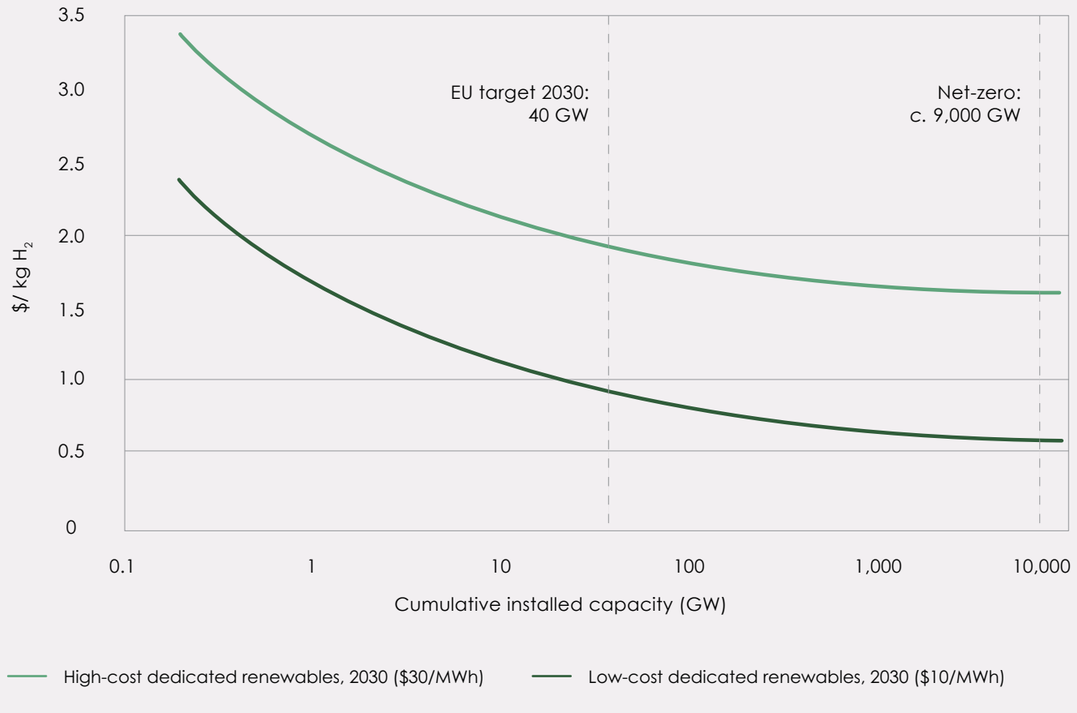
The three key determinants of cost of green hydrogen are: electrolyser cost; electrolyser utilisation; and electricity price. Once electrolyser cost is low enough (e.g., <$300/kW) and utilisation is high enough (e.g., >30%), electricity price becomes the dominant cost determinant.[152] **Therefore, as renewable power becomes cheaper, it enables ever-cheaper green hydrogen.**

Right now, the cost of electrolysers is high (except in China), though at a learning rate of 18% (cost decline per doubling cumulative capacity) will drive swift cost reductions as economies of scale and innovations come through. **As the cost of green hydrogen declines from c. $3–6/kg H2 today to less than $2/kg H_2** or below by 2030, the cost premium for goods produced with green hydrogen compresses. This will create **more investment, further propelling cost declines.** (See Exhibit 13.)

While the premiums are meaningful at the commodity level (e.g., green steel), they will play through to only **marginal cost increments at end-consumer level.** An electric vehicle made with green steel would cost <1% more in terms of the cost of the car. In aviation the impact will be higher (+10–20% on ticket price), but not excessive.[153]

Countries with **very good solar and wind resources** are well positioned for **cheap green hydrogen.** Wind and

Exhibit 13: Increased cumulative deployment leads to lower-cost electrolysers, lower cost hydrogen, making H2-solutions more compelling and in turn, leading to more deployment



Premium to be covered vs. fossil solution – for products produced with hydrogen

Premium to be covered (e.g., with contract for difference)	**Cost of hydrogen** ($/kg H_2) **$2**	**$1**	**$0.5**
Synthetic jet-fuel $/kg jet fuel v. kerosene costs at 0.65 $/kg jet	+0.9 $/kg jet	+0.4 $/kg jet	+0.2 $/kg jet
Green ammonia premium as % HFO cost v. HFO cost 0.39 $/kg	+160%	+70%	+30%
Green steel $/ton v. fossil-steel at 373$/ton	+150 $/ton	+87 $/ton	+55 $/ton

Source: SYSTEMIQ analysis, McKinsey (2020)
Note: The LCOE for input power is shown under two scenarios: 30 $/MWh (high-case) and 10 $/MWh (low-case). The cost decline was calculated based on a 18% learning rate of electrolyser CapEx (starting cumulative capacity and CapEx in 2020: 200 MW and 1200 $/kW). Further parameters: 66% alkaline electrolyser efficiency, 45% load factor, 6.5% interest rate, 3% OPEX (of CapEx), 30 year electrolyser lifetime with 50% stack replacement costs and 0.004 $/kg costs for water. H_2 storage cost is not included. For Synthetic jet-fuel production. Cost of CO_2 feedstock assumed at $66/t$CO_2$. [*] Note: if cost of CO_2 feedstock can be reduced to $0, this eliminates the cost premium (in scenario where cost of hydrogen is at $0.5/kg H2).

solar can lift utilisation of electrolysers (e.g., to 50–70%) and thereby limit the need for H2 storage as a way to enable high utilisation of downstream processes (e.g., ammonia production).[154] Some estimates point to the green hydrogen **export market scaling to $300 billion yearly by 2050.[155] Chile,[156] Morocco,[157] Australia and others are also positioning themselves as possible hubs for zero-emission fuel production.** While hydrogen itself is not as well-suited for long-distance transport (except by pipeline), goods produced with green hydrogen (e.g., green ammonia, synthetic jet-fuel, green steel) can be plugged into global supply chains.

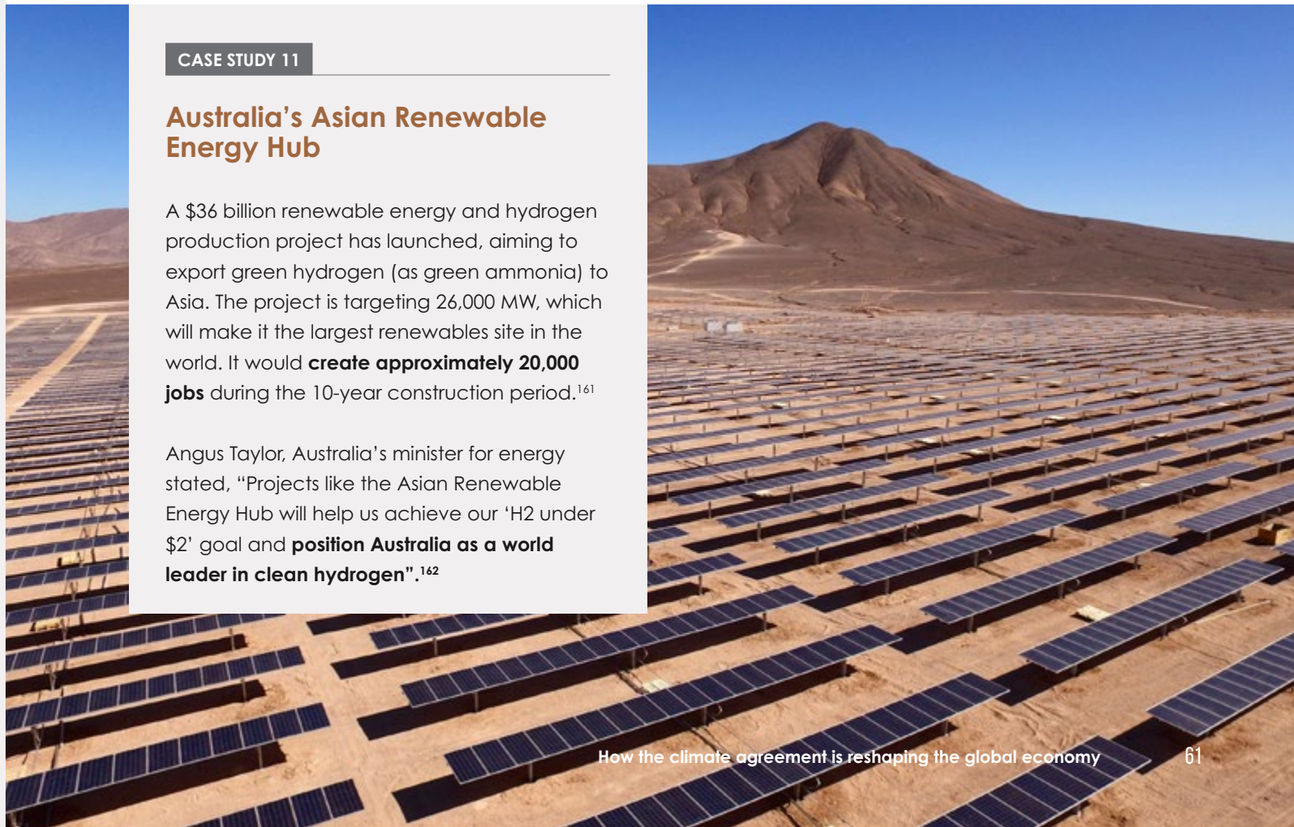
In the past two years at least **17 countries and regions** (e.g., the EU, China, Australia, Germany) have released or are preparing to release hydrogen strategies. Others are supporting demonstration projects and advancing policy.[158]

Globally, **$40–60 billion of public funding is being made available** to support hydrogen (including grants, subsidies for R&D, scale-up project support, demand subsidies*).[159]

Projects are ramping up. One of the largest, the Asian Renewable Energy Hub (see Case Study 11) was recently granted "major project" status by the Government of Australia.[160]

AS THE COST OF GREEN HYDROGEN DECLINES TOWARDS 2030, THE COST PREMIUM FOR GOODS PRODUCED WITH GREEN HYDROGEN COMPRESSES. THIS WILL ATTRACT MORE INVESTMENT, FURTHER PROPELLING COST DECLINES.

* In some cases, hydrogen projects compete against other technologies in broader funding pot, hence the low-high range.



CASE STUDY 11

Australia's Asian Renewable Energy Hub

A $36 billion renewable energy and hydrogen production project has launched, aiming to export green hydrogen (as green ammonia) to Asia. The project is targeting 26,000 MW, which will make it the largest renewables site in the world. It would **create approximately 20,000 jobs** during the 10-year construction period.[161]

Angus Taylor, Australia's minister for energy stated, "Projects like the Asian Renewable Energy Hub will help us achieve our 'H2 under $2' goal and **position Australia as a world leader in clean hydrogen".[162]**

SHIPPING

A range of low- and zero-emission solutions have emerged in the shipping sector in the last 2–3 years, some with the potential to enter commercial production before 2025.

A market tipping point will be reached when declining costs of sustainable fuels will combine with the emergence of premium markets for them.

Decarbonising shipping requires a shift from heavy fuel oil (HFO) to alternative fuels or engines. Long-haul routes (roughly 70% of total shipping emissions) could be powered by green ammonia and biofuels.[163] Battery-or hydrogen-based electrification and the use of hydrogen as an alternative fuel may be best suited to short-haul routes.

Raised ambition

Since 2019, the shipping industry has undergone a step change in ambition, creating a platform for large-scale investment and innovation to decarbonise the sector.

Net zero commitments: as recently as 2018, a net zero commitment was not on the table for the shipping industry. The International Maritime Organisation (IMO) confirmed this in 2018, when it committed to at least halving emissions by 2050.[164] Since then, **industry leaders have ramped up ambition. In 2019, shipping giant Maersk committed to net zero by 2050,**[165] **followed by CMA CGM.**[166]

Breakthrough solutions emerging

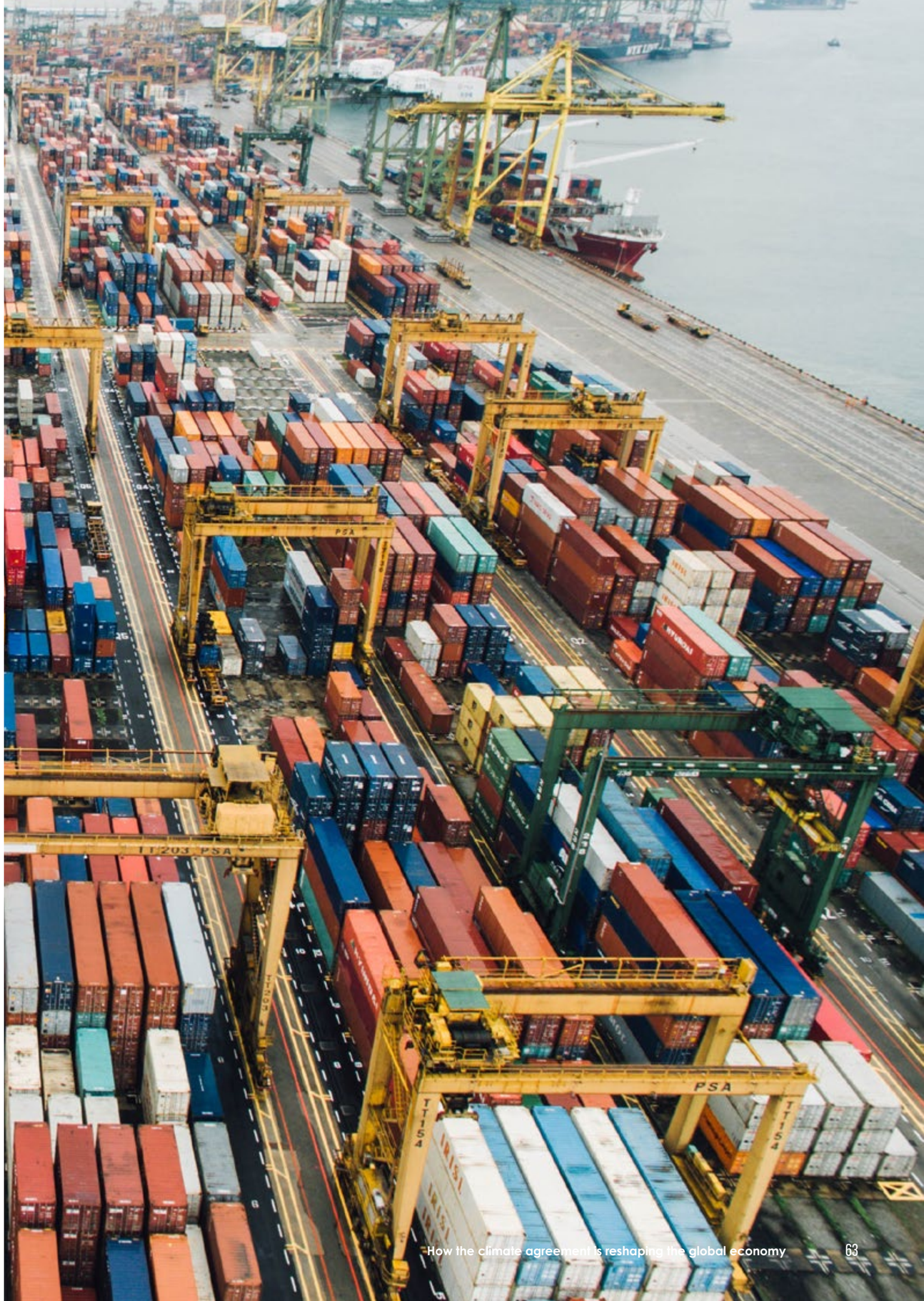
66 zero-emissions pilot and demonstration projects have launched in recent years, advancing technologies with the potential to scale in the next 5–10 years.[167] (See Exhibit 14.)

Green Ammonia

Green ammonia is gaining traction as a potential leading solution. It has twice the energy density of hydrogen,[168] and nine times that of lithium-ion batteries.[169] Ammonia is already produced and thus infrastructure already exists, including 120 ports that are equipped to deal with its import and export.[170] (See Case Study 12.)

In 2018, green ammonia projects were limited in number and focused on theoretical and laboratory work.[171] Two years later, advances in green ammonia production and engine design (to enable ships to run on ammonia) have made **dramatic leaps, bringing the prospect of green shipping forward to as close as 2024.** Japan's Green Ammonia Consortium (launched April 2019) aims to build a value-chain CO_2-free ammonia from supply to use-stage.[172]

Similar projects in engine design point to commercial vessels running on ammonia before 2024. Once



engines are developed to run on ammonia, installing and/or retrofitting ship engines is relatively straightforward and therefore feasible soon after 2024.[174] (See Case Study 13.) Norwegian shipping company Eidesvik plans to install ammonia fuel-cells on the Viking Energy vessel by late 2024.[175] The Viking will sail solely on clean fuel for 3,000 hours annually.[176]

Hydrogen

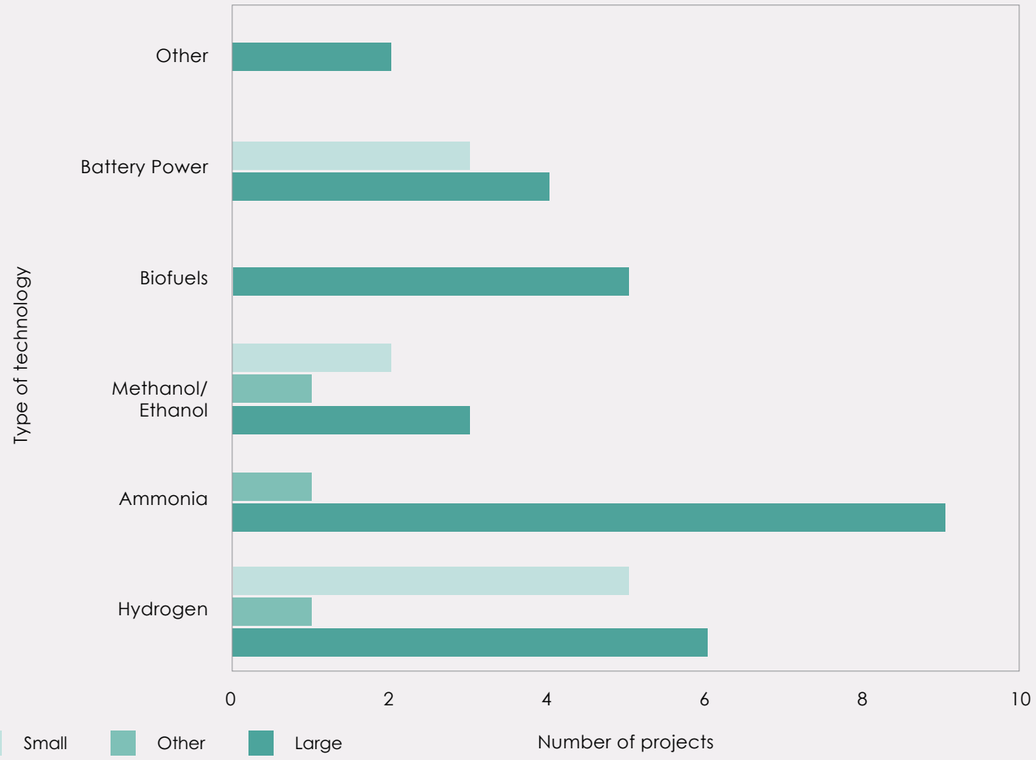
Hydrogen development projects and pilots are also taking off. In 2018, it was assumed that hydrogen fuel-cells would be limited to short-haul vessels for at least the medium-term.[178] By 2020, a study by the International Council on Clean Transport (ICCT) found that **99% of transpacific voyages made by container ships in 2015 could have been powered by hydrogen and fuel-cells.[179]**

Banks are creating incentives for corporates to act. In 2019, 11 banks representing $100 billion established the **Poseidon Principles to assess and disclose the climate alignment of ship finance portfolios.**

Industry is investing, too. In late 2020, the IMO confirmed that it will give further consideration to an innovative proposal for an **industry-financed $5 billion R&D programme into zero-emission solutions for shipping,** which has been spearheaded by industry figures for the past year.[180]

Leading companies are articulating clear policy asks. Norwegian shipping company Torvald Klaveness Group has publicly voiced support for the EU Emissions Trading Scheme applying to shipping. Ship charterer Trafigura is pushing for a global carbon levy through the IMO to boost the competitiveness and uptake of alternative fuels. This could be used to subsidise zero-emission vessel and fuel projects.[183]

Exhibit 14: Pilots and demonstrations in recent years for zero-emissions shipping – ammonia leads the way for large ships; hydrogen options are being explored for both small and large ships



Source: Søgaard, K. & Bringham, C. (2020)
Note: Some projects involving hydrogen have been double-counted as they combine hydrogen production with the production of other fuels, such as ammonia or methanol

CASE STUDY 12

Green Ammonia Fuel

In 2020, NYK Line, Japan Marine United and Nippon Kaiji Kyokai signed an R&D agreement to develop an ammonia-fuelled ammonia gas carrier, floating storage and regasification barge. The barge will provide new possibilities for supplying and storing ammonia, acting as an alternative to land facilities.[173]

CASE STUDY 13

Green Ammonia Engine

In 2020, MISC Berhad, Samsung Heavy Industries, Lloyd's Register and MAN Energy Solutions announced a joint development project for an ammonia-fuelled tanker. If successful, the vessel will be commercial by 2024.[177]

Concept design of an ammonia carrier fuelled by its own cargo created by Niels de Vries, C-Job Naval Architects.

Challenges to setting off S-Curve Growth

Lack of premium markets: green shipping fuel is likely to remain more costly than conventional fuel. Policy incentives are needed to create premium markets.

Priorities to capture the opportunity

Provide public funding for R&D to achieve cost reductions in green shipping fuels.

Launch public-private partnerships and/or blended finance instruments to reduce CapEx and cost of capital for green ammonia production and fuel infrastructure.

Impose regulatory standards and green fuel mandates to create premium markets. Can start with domestic and regional shipping, river freight, coastal and shorter-distance freight and cruise ships to make these sectors the drivers of innovation and early adoption.

Carbon pricing can also be used to create premium markets for green shipping fuel and certainty for those investing in solutions. For major ports serving long-haul ships, align with others to ensure regulations do not result in avoidance strategies

INDUSTRY LEADERS HAVE RAMPED UP AMBITION. IN 2019, SHIPPING GIANT MAERSK COMMITTED TO NET ZERO BY 2050, FOLLOWED BY CMA CGM.

AVIATION

In 2015, green aviation was not a serious prospect, with limited if any pilots in process. Today, solutions undergoing pilots have the potential to become commercial before 2025. An expansion of policies, including blending mandates, could help to scale solutions for the aviation industry in the next 5–10 years.

Regional and short-haul flights account for 28% of aviation emissions; electric airplanes (incl. hydrogen-electric) and hydrogen-propulsion can serve this segment. Sustainable Aviation Fuels (SAFs) are most likely to decarbonise medium- to long-haul flights, which account for 72% of emissions.[184]

Raised ambition

Until recently, the aviation industry's official target of a 50% reduction in emissions intensity by 2050 went largely unchallenged.[185] Since 2019, however, **a number of net-zero commitments have come through from industry** including: IAG (which owns British Airways and Iberia, among others)[186]; the UK Sustainable Aviation Coalition; and One World Alliance (13 airlines, including British Airways, Qantas, Japan Airlines and Finnair).[187] These commitments reflect growing confidence in decarbonisation pathways. **For the first time, the International Air Transport Association (IATA) is arguing that net zero emissions by 2060 are possible globally.[188]**

Breakthrough solutions emerging

In 2015, electric airplanes were an ambitious idea. Today, over 200 developments are live worldwide.[189]

Advances in battery energy density (increased 42% in recent years and could double, going forward) are enabling electric flight, as are hydrogen-electric solutions (see Case Study 14).

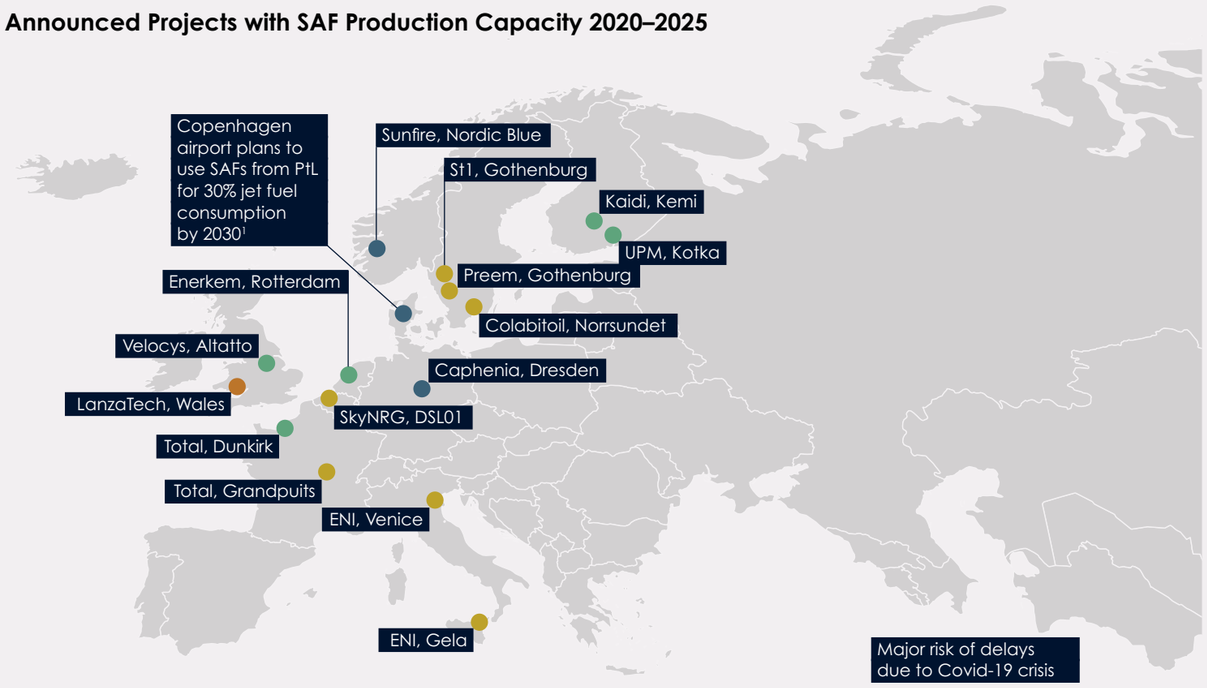
Once electric aviation is commercial (mid-2020s for smaller planes, 2030s for 100+ seaters), **short-haul flights could be cost competitive with jet-fuelled planes,** with better engine efficiency and lower maintenance.[190]

Sustainable Aviation Fuels (SAFs) are on the verge of a major ramp-up in Europe and North America in the 2020s. Global production increased more than twentyfold between 2013–2015 and 2016–2018.[193] The number of airports supplying SAFs has grown sevenfold from 2 to 14 in that period.[194] Plans launched in recent years include 15 new plants with SAF output potential in Europe alone by 2025 (See Exhibit 15).[195] Among these is DSL-01, which if delivered will be the first dedicated SAF production plant (scheduled to open 2022).[196] If all are completed, capacity would more than double in the next five years.[197]

Advances are driving growth in three categories of SAF (HEFAs, advanced biofuels and synfuels), which have the potential to reduce fuel emissions by 70%

Exhibit 15: Total SAF capacity could more than double in Europe in the next 5 years if all projects are completed on time

Announced Projects with SAF Production Capacity 2020–2025



Source: Energy Transitions Commission, McKinsey, IRENA (2017) Maersk, Neste, press releases.

Companies have announced plans to open 15 new plants with SAF output potential in Europe by 2025, but all need major policy support

Supplier	Location	Tech	Start Year	Total Fuel Capacity (Mt./yr.)
Eni	Italy	HEFA	2021	0.8
Enerkem	Netherlands	G+FT	2021	<0.1*
Colabitoil	Sweden	HEFA	2021	0.5
Eni	Italy	HEFA	2021	0.2
St1	Sweden	HEFA	2022	0.2
Kaidi	Finland	G+FT	2022	<0.1*
SkyNRG	Netherlands	HEFA	2023	0.1
Preem	Sweden	HEFA	2023	0.8
Sunfire	Norway	Synfuels	2023	<0.1*
Caphenia	Germany	Synfuels	2023	<0.1*
Total	France	G+FT	2024	0.2
Total	France	HEFA	2024	0.34
Neste	TBD[2]	HEFA	2025	1
Velocys	UK	G+FT	2025	0.1
LanzaTech	UK	AtJ	2025	0.4
UPM	Finland	UPM	2025	0.5

* Pilot/demo plans. 1 This project is a partnership between Copenhagen Airports, A.P. Moller - Maersk, DSV Panalpina, DFDS, SAS and Ørsted to trial-scale production facility to produce sustainable fuels for road, maritime and air transport in the Copenhagen area. 2 Final investment decisions expected in 2021.

to100%, respectively. HEFA costs have declined tenfold since 2012.[198] They will likely remain the most cost-competitive option in the near-term until other pathways reach technological and commercial maturity and significant scale. Advanced biofuels provide compelling near-term opportunities to reduce emissions by 85–94% and can be produced from sources of sustainable biomass from wastes and residues.[199] Given declining input costs, **synthetic fuel could become the most cost-competitive SAF in the longer term** as green hydrogen costs decline (accounts for 70% cost of synfuel).[200]

Policy advances are helping to catalyse market growth. **Since 2015, Norway, Sweden, the Netherlands and Denmark have either implemented or are considering implementing SAF blending mandates.**[201] The European Union (EU) leads the way and is currently debating the possibility of implementing an EU-wide mandate.[202] Six other European countries have policy roadmaps and strategies for SAFs.[203] Air France's recent €7 billion bailout came with "climate conditions", including a fuel mandate and requirements to improve fleet efficiency.[204]

Challenges to setting off S-Curve Growth

Electric and hydrogen-fuelled aviation

Certification systems: even with technological maturity, new planes can only enter the market with certification, which can be slowed by the processes of government-funded certification agencies.

Major changes to airport infrastructure and airline fleets may be needed to accommodate hydrogen/-electric planes.

Sustainable Aviation Fuels

SAFs are likely to remain more expensive than fossil-based jet fuel for many years to come. **Policy to create premium markets** is needed (for example, blending mandates, development capital and loan guarantees for first-of-a-kind projects).

Negotiating stumbling blocks: a global solution is needed, given the global nature of aviation. Yet negotiations conducted through ICAO have been slow.

COVID-19 places delays on SAF projects: companies may hold off investments in production plants until greater market certainty returns.

Priorities for capturing the opportunity

Provide public support for R&D to drive down the cost of core technologies.

Provide sufficient resources to certification agencies to develop standards in parallel with technology maturation.

Expand green fuel and blending mandates to provide incentives for SAFs; provide gradual increase in SAF fuel % to enable supply to scale steadily.

A global regulatory solution to ensure the transition to net-zero in the sector will eventually be required to resolve competitive distortions between different regions. Within this framework, it should be recognised that emerging markets have the opportunity to develop air travel industry, as was the case in developed economies.

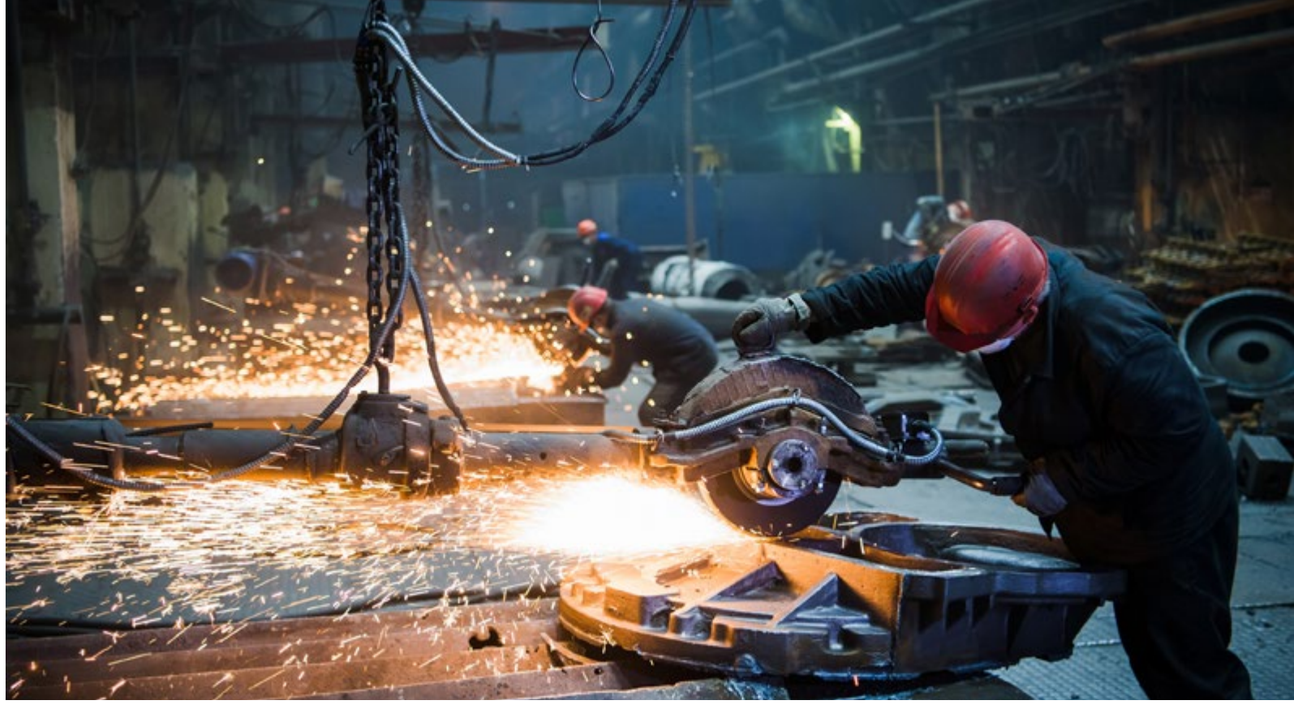
CASE STUDY 14

ZeroAvia[3]

In late 2020, US and UK-based company ZeroAvia completed the first hydrogen fuel-cell powered flight of a commercial grade aircraft.[191] The company plans to have hydrogen-powered commercial planes taking off by 2023.[192]

[3] Note, SYSTEMIQ is an investor in Zero Avia

STEEL



Industry ambition has stepped up dramatically since 2015. Increased investment and resources are being channelled into developing new low-carbon solutions and strengthening existing technologies.

A market tipping point will be reached when a carbon price is introduced and/or a differentiated market emerges that offers a premium for low-carbon steel. This is essential, given low-carbon steel will likely remain more expensive than high-carbon steel in the medium- to long-term (although with less than a 1% impact on consumer prices in some applications).[205] Nonetheless, continued declines in the cost of low-carbon production remain important to help bring about the tipping point, by reducing the level of carbon price or premium required for low-carbon steel to compete against high-carbon steel.

Demand-side measures can play a considerable role in decarbonising the steel sector, for example through substitution (such as, material efficiency or swapping steel for timber[206]), increased recycling of scrap steel and the development of circular business models (see Circular Economy section). However, demand for steel is likely to increase as emerging economies develop their infrastructure and steel-intensive low-carbon technologies are rolled out (for example, offshore wind). Even when recycling and circular efforts are applied in combination, they cannot full decarbonise the sector. (See Exhibit 16.)[207] Similarly, energy efficiency will play a critical role but is estimated to only reduce emissions by 15–20%.[208] **Therefore, it is necessary to decarbonise primary steel production.**

Raised ambition

Industry ambition has stepped up. In 2015, there were few clear decarbonisation targets across the steel sector. In 2016, SSAB launched a joint R&D project into zero carbon steel with Vattenfall and LKAB.[209] Today, **European steel makers representing 13% of global production have set ambitious emissions reduction targets.[210]** Liberty Steel Group has committed to be net carbon neutral by 2030; SSAB will be fossil fuel free by 2045;[211] Tata Steel[212] and ThyssenKrupp[213] have committed to carbon neutrality by 2050. In September 2020, the world's biggest steel producer, ArcelorMittal, extended its net zero commitment to cover global operations.[214] Voestalpine[215] has committed to 80–95% reduction by 2050, while Salzgitter[216] has stated that a 95% reduction is possible with green hydrogen by 2050, respectively.

National net zero commitments as of 2020. China, Japan, South Korea and the EU (which cumulatively account for 70% of global steel production and 67% of consumption) have each set a net zero target by 2050–2060.[217] This makes decarbonisation of the sector an industrial imperative.

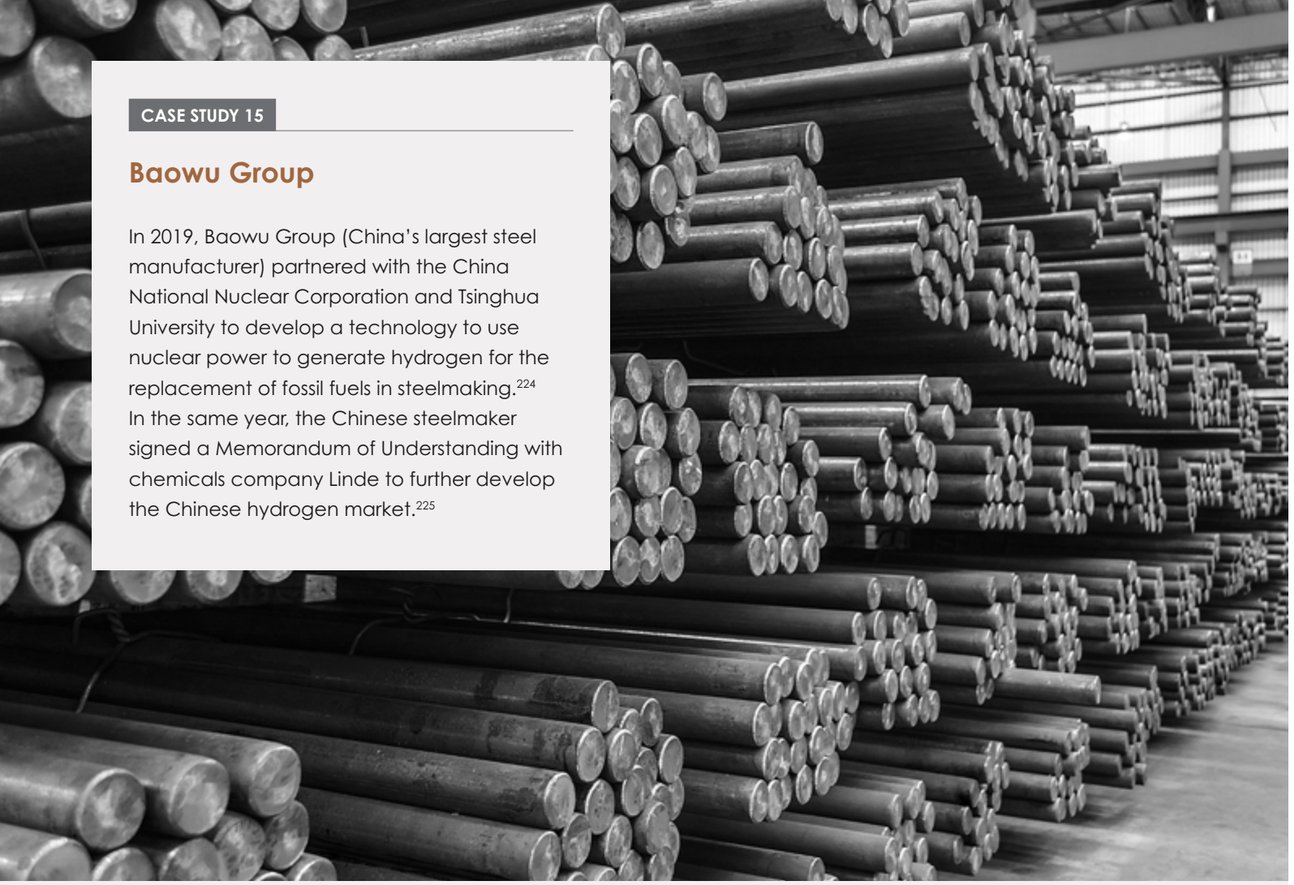
Solutions in development

The sector is increasing R&D investments and testing the feasibility of a range of potentially transformative technologies to reduce emissions.

Hydrogen-based Direct Reduction Iron (DRI) could reduce emissions in primary ore production by 100%.[218] The process uses hydrogen as a reducing agent (producing H_2O as a by-product rather than CO_2), followed by the use of an electric arc furnace (which can be run on renewable energy). While industry actors like Tenova have tested hydrogen-based DRI technology since the 1990s,[219] efforts have not previously been mainstream. Since 2018, **however, this technology has advanced from pre-feasibility stage (Technological Readiness Level 2–3) to large prototype (TRL of 5).[220]** A range of pilot programmes are launching, with plans for demonstration plants by 2025. These include Sweden's HYBRIT pilot plant (announced in 2016, launched in 2020 and set to reach commercial scale in the 2030s[221]); an ArcelorMittal plant in Hamburg (announced in 2019[222]); and projects led by HBIS and Baowu Group in China.[223] (See Case Study 15.)

Carbon Capture, Use and Storage (CCUS) can reduce emissions in primary ore production by 90%.[226] The technology for its application to the DRI step in steel production has existed since 2000 and has a TRL of 9.[227] Yet recently, efforts have ramped up. In 2016, a plant launched in Abu Dhabi with significantly greater capture capacity (0.8 Mt/ year of CO_2) than previous projects in the iron and steel sectors.[228] **CCUS technologies applied to the blast furnace step** (in which coal reduces ore to pig iron in a high carbon process) are less advanced, at large prototype level (TRL of 5).[229] A range of pilots have launched in recent years, aiming for commercial deployment by 2030.[230] These include COURSE 50 in Japan, which aims to reach commercial scale by 2030.[231]

Policies under consideration by the EU could help to create a level playing field for zero-emissions steel to compete with high-emissions steel. The European Commission's commitment to 55% emissions reduction by 2030 has led to projections of an €80/ tonne CO_2 carbon price by 2030.[232] A carbon border tax adjustment would be essential to ensure a carbon price or other forms of regulation are effective in creating a level playing field due to the international competitive markets for steel. The realistic possibility of carbon border tax adjustments by the EU,[233] UK[234] and by US President-elect Joe Biden[235] (which together account for over 14% of steel imports[236]) could help to tip the balance.



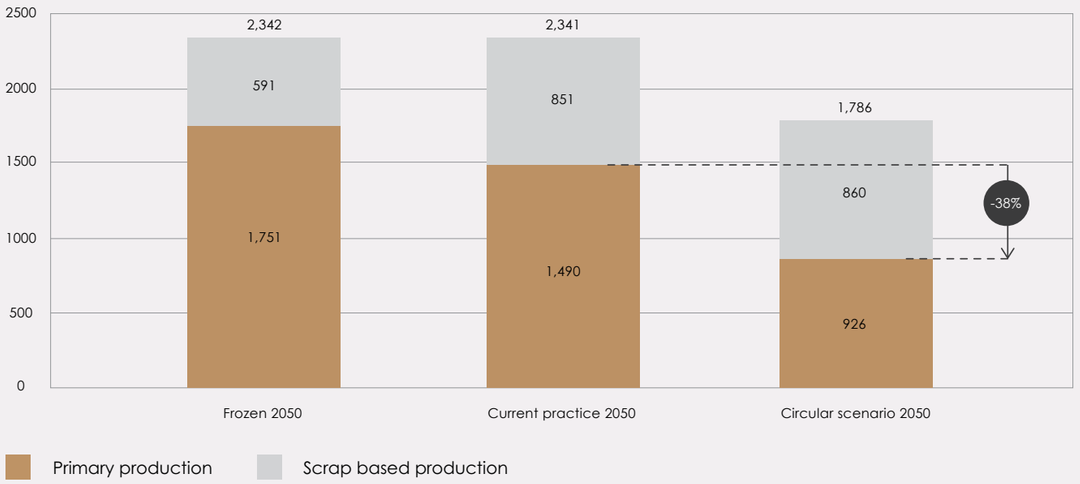
CASE STUDY 15

Baowu Group

In 2019, Baowu Group (China's largest steel manufacturer) partnered with the China National Nuclear Corporation and Tsinghua University to develop a technology to use nuclear power to generate hydrogen for the replacement of fossil fuels in steelmaking.[224] In the same year, the Chinese steelmaker signed a Memorandum of Understanding with chemicals company Linde to further develop the Chinese hydrogen market.[225]

Exhibit 16: significant primary steel production will still be required even if scrap-based production is maximised

Global steel production by route
Mt steel per year, 2015–2100



Source: Material Economics (2018; 2019)

The European Commission has developed a set of policies and proposals that could compel both construction and automobile sectors to commit to net-zero emissions steel.[237] Given the importance of EU automotive and fuel standard regulation in shaping global standards, this could have global implications.

Pioneering governments are also using public procurement mandates to create premium demand signals for low-carbon steel. Examples include the building and infrastructure sectors (which account for half of global steel consumption[238]). In 2017, the **Buy Clean California Act** was introduced, requiring state agencies to consider the carbon footprint of building materials used in their construction projects – a world first.[239]

The finance sector is increasingly creating incentives for corporates to act. In 2019, the Institutional Investors Group on Climate Change (a network of over 250 investors with over $30 trillion in AUM) encouraged members to engage company management on climate-related risks.[240]

Challenges to setting off S-Curve Growth

Limited opportunities for greening production: the steel industry suffers from overcapacity, and this situation is not likely to improve in the next decades as steel demand from China decreases. As a result of this overcapacity, substantial greenfield investments in the coming years are unlikely. At the same time, many blast furnace facilities have been constructed in the last 10–20 years (particularly in China), meaning they still have another ~20 years before they are decommissioned, which also limits natural opportunities for major brownfield investments Meanwhile, ageing plants increasingly require renovation or substitution. This raises the risk of lock-in to investments in high-carbon solutions before low-carbon technologies are mature.

Lack of premium markets: green steel fuel is likely to remain more costly than high-emissions steel. In addition, as a globally traded commodity, there is a risk that green steel produced in countries with regulatory measures that require low/zero-carbon production will be undercut by steel produced in countries without such measures. Without policy incentives, it therefore will not be possible for low/ zero-carbon solutions to compete in global markets.

Access to investment: in the absence of premium markets, steel producers face a challenge to secure the investment required to decarbonise. While movements regarding a carbon price are promising (particularly in the EU), stronger signals are needed to provide investors with the certainty of future markets to invest meaningfully in steel.

Priorities for capturing the opportunity

Provide support for R&D and pilots into CCUS and hydrogen-based reduction. Funding should: target efforts to drive down the cost and increase the efficiency of electrolysis equipment; pilot and drive down the cost of hydrogen-based reduction; and ensure the feasibility and drive down the cost of innovative BF-BOF designs, which would reduce the cost of CCUS.

Establish a deployment strategy and support investment in carbon transport and storage infrastructure to facilitate the development of CCUS for steel (and other heavy industries).

Collaborate with industry actors to provide start-up capital and subsidies for initial investments in green steel production plants to compensate for the CapEx requirements of the technological shift.

Leverage public procurement to create premium markets for green steel and create certainty of demand. Governments can require a rising percent of low/zero-emission steel to be used in all publicly funded construction and set clear targets for this increase over the long-term.

Introduce policies to reduce the price of renewable energy, to lower the cost of green steel production.

Expand carbon pricing to create premium markets for green steel and create certainty about the future price trajectory. Complementing carbon pricing with **carbon border adjustments** will be essential given the international competitive markets for steel.

CEMENT

2020 is a watershed moment for the cement sector. Strong industry-wide commitments to decarbonise have reinforced initiatives to deliver on these targets. Although early stage, a range of solutions are emerging.

Pilots set to launch across the 2020s may be applied at commercial scale by the mid- to late-2030s, driven by technological advances and economic incentives.

Demand-side measures can be considerable in decarbonising the sector. Still, cement production volumes are set to increase; decarbonising production is therefore critical. A number of promising solutions are being explored; **market tipping points will occur when one or two solutions break through and premium markets for zero-carbon cement emerge.**

Raised ambition

In 2015, no major cement companies had committed to net zero emissions reduction. **Five years on, in September 2020, the Global Cement and Concrete Association, which includes 40 companies representing one-third of global cement production capacity, committed to be carbon neutral by 2050.**[241] Dalmia Cement has targeted carbon neutrality by 2040.[242] The HeidelbergCement group aims to achieve carbon neutral concrete by 2050.[243]

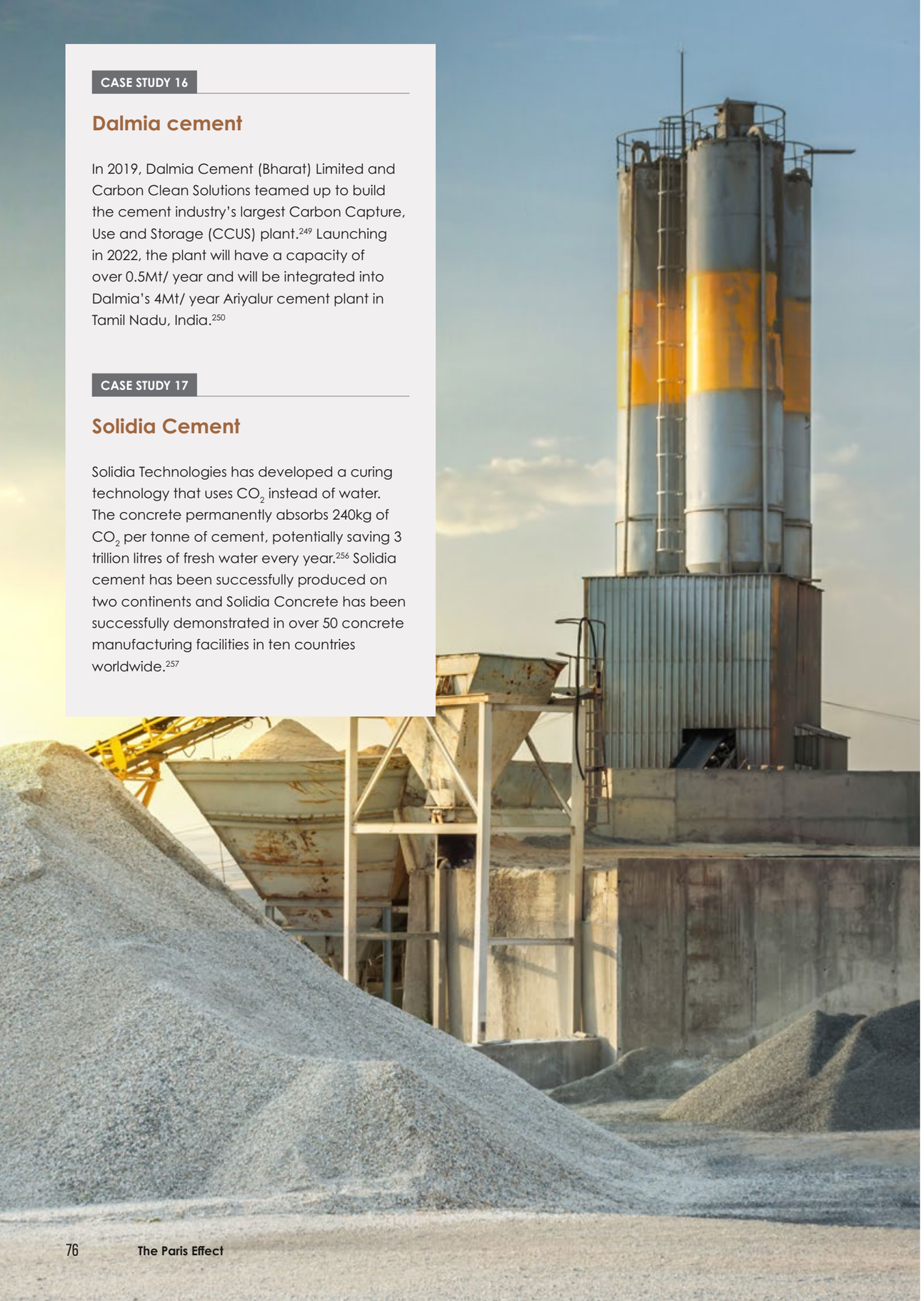
A month after the September 2020 announcement, the **UK Concrete and Mineral Products Association launched a roadmap to become net negative by 2050**, pointing to potential solutions to deliver on this goal.[244]

Solutions in development

The sector is deepening R&D and testing the feasibility of a range of potentially transformative solutions that reduce emissions. These include:

Carbon Capture, Use and Storage (CCUS) could reduce emissions from cement production processes by 90%.[245] In 2018, CCUS technology was being applied only in pilot sites.[246] **Today, over 30 large-scale projects are scheduled to launch worldwide by 2023, including not just pilots but commercial plants.**[247] Dalmia's large-scale demonstration plant in India (see Case Study 16); a Lehigh cement plant in Canada currently undergoing feasibility study; and a full-scale Norcem plant in Norway that could become operational in 2023–24.[248]

Heat generation accounts for about 35% of emissions from cement production.[251] Since 2015, a range of **industry pilots and projects have launched or have been announced,** and are beginning to show positive results.



CASE STUDY 16

Dalmia cement

In 2019, Dalmia Cement (Bharat) Limited and Carbon Clean Solutions teamed up to build the cement industry's largest Carbon Capture, Use and Storage (CCUS) plant.[249] Launching in 2022, the plant will have a capacity of over 0.5Mt/ year and will be integrated into Dalmia's 4Mt/ year Ariyalur cement plant in Tamil Nadu, India.[250]

CASE STUDY 17

Solidia Cement

Solidia Technologies has developed a curing technology that uses CO_2 instead of water. The concrete permanently absorbs 240kg of CO_2 per tonne of cement, potentially saving 3 trillion litres of fresh water every year.[256] Solidia cement has been successfully produced on two continents and Solidia Concrete has been successfully demonstrated in over 50 concrete manufacturing facilities in ten countries worldwide.[257]

- **Since 2018, kiln electrification has moved from the subject of research to pilots and even plans for commercial plants.[252]** CEMEX and Synhelion have partnered to develop cement produced with solar, with plans for a commercial plant as early as 2022.

- **Hydrogen-based heat generation is being piloted.[254]** The £6 million Hanson project in the UK, due to be completed in 2021, will use hydrogen as a partial replacement for natural gas in the kiln combustion system.[255]

Since 2018, a range of research and feasibility studies have advanced understanding of low-carbon chemistry options for cement. Research efforts involve replacing Portland cement with fire ash (Rice University, USA, 2018) and developing cementless concrete using alkali-activated industrial waste products (Kaunas University of Technology, Lithuania). Private sector disruptors like Solidia are developing potentially transformative technologies. (See Case Study 17.)

Challenges to setting off S-Curve Growth

Innovation: a range of innovations will need to be pursued to decarbonise the cement sector, with different options better suited to certain geographies. Sustained support for innovation is critical, including creation of early markets.

Lack of premium markets: green cement is likely to remain more costly than high-emissions cement. Policy incentives (e.g., standards) are required.

Infrastructure: CCUS solutions require CO_2 transport and storage facilities.

Priorities for capturing the opportunity

Provide support for R&D and large-scale demonstration projects and pilots into CCUS, zero-carbon heat generation and low-carbon chemistry.

Reform regulation to increase the availability of traditional clinker substitutes. Countries can ban waste disposal of fly ash, sewage sludge and concrete waste in landfills to encourage producers of these waste materials to collaborate with cement companies to reintegrate them into production. China and India in particular are projected to have large fly ash and blast furnace slag supplies.[258]

Leverage public procurement to create premium markets for green cement and guarantee certainty of demand. Governments can require a rising percent of low/zero-emission cement to be used in all publicly funded construction.

Introduce an embedded carbon standard for the construction industry to use a rising percent of low/ zero-emission cement in projects.

Establish a deployment strategy and support investment in carbon transport and storage infrastructure to facilitate the development of CCUS for cement (and other heavy industries). For example, the Northern Lights CO_2 storage project, led by Equinor, Shell and Total will develop a network of capture facilities across Europe, including four cement factories and a steel plant. By 2024, the project would offer the potential to transport, inject and store up to 1.5 million tonnes of CO_2 per year.[259]

Employ carbon pricing to create a market for green cement. A price of ~$100 / tonne CO_2 would drive cement decarbonisation.[260] The local nature of cement production and distribution means that a carbon price would not result in significant competitiveness issues or the relocation of production.

CIRCULAR ECONOMY

Since 2015, public awareness and concern for the environmental impact of materials has increased, placing pressure on governments and businesses to act.

This has created the conditions for increased political and corporate support for "circular economy"[4] technologies and business models. Breakthrough solutions are emerging in key materials. Circular economy solutions can reduce carbon emissions and other environmental impacts substantially by reducing total demand for new products and materials (e.g., primary production steel, metals for batteries, textiles, plastics).

Policy action is critical for the promotion of this shift, given linear models are baked into current economic systems. The implementation of smart policy and the development of solutions by pioneering corporates will ensure improved full life-cycle management of products and materials. **This will lead to market tipping points when circular models outcompete linear models on convenience, cost and quality of service provided** (e.g., cost of battery cheaper via circular model).

Increasing awareness and ambition

Public concern has risen, notably triggered by the 2017 Blue Planet II documentary series and civil society action. Government and businesses have begun to respond with increasingly ambitious plans and targets.

Public support is creating political space for action. 92% of EU citizens approve of action to reduce single-use plastics.[261] Twelve countries and the EU now have a circular economy policy, up from only one in 2015.[262] In addition, many governments (including the EU, South Korea and Canada) are considering or implementing Extended Producer Responsibility policies.[263] From 2021 onwards, the EU Taxonomy on Sustainable Finance (in force since 2020)[264] will include Circular Economy criteria in its requirements for investors, companies and financial institutions to define their environmental performance.[265] These policy interventions are not perfect, nor are they at critical mass. Nonetheless, their positive reception from the general public demonstrates that **there is political space for governments to continue implementing more meaningful circular economy principles.**

Today, 200 companies covering 20% of the global plastics packaging market have committed to 100% recyclable, compostable or reusable packaging by 2025 through the Ellen MacArthur Foundation's Global Commitment circularity commitments, up from just one in 2015.[266] The number of private market funds with a circular economy focus has grown tenfold since 2016.[267] (See Exhibit 17.)

[4] A circular economy moves away from traditional linear models of making, using and disposing. Instead, it extracts the maximum value from products while in use, minimizes harmful leakage into the environment, recovers products and materials at the end of each service life and regenerates natural capital.

Solutions emerging

Promising innovations in technology and business models are emerging across **plastics, electronics, textiles, battery systems and mineral mining,** among others.

Solutions for plastic waste are beginning to emerge across the value-chain. These centre on reducing (eliminating and reusing), substituting and recycling plastics. Increased recycling rates could mean that virgin plastic demand growth will fall sharply from 4% a year before 2020 to below 1% a year between 2020 and 2027, triggering the shift from an investment to a capital reallocation logic.[268]

- **Refill solutions are already matching linear models on price.** For example, Algramo delivers Nestlé and Unilever refill products door-to-door to Chilean customers at 30–40% lower cost than disposably packaged options. (See Case Study 18.)

- **Small-scale disruptors are developing plastic substitutes** from sugar and carbon dioxide[269] to waste frying oil.[270] If larger players engage and more investment is poured into innovation, breakthrough technologies could emerge.

- **The Alliance to End Plastic Waste** has activated 14 projects across six countries in South-East Asia, India and Africa to tackle plastic waste. Members of the Alliance are leading 55 projects worth $400 million worldwide[271] from corporates to invest in recycling in the Global South. In 2019, Unilever committed to help to collect and process more plastic packaging than they sell by 2025.[272] **Increased recycling rates could mean that virgin plastic demand growth will fall sharply from 4% a year before 2020 to below 1% a year between 2020 and 2027,** triggering the shift from an investment to a capital reallocation logic.[273]

Circular electronics systems can already compete with linear models on price and convenience. Since 2016, companies including Philips, Cisco, HP, Dell and Samsung have scaled "as-a-service" models. These reduce up-front cost and maintenance for consumers, while enabling companies to retain ownership of valuable technology. Philips' share of revenues from circular models rose from 10% to 12% in one year (2017–2018)[278] and they are targeting 25% by 2025.[279] Platforms that facilitate sharing models are growing and securing investment, too. In 2020, Back Market, a marketplace for refurbished consumer electronics founded in 2014, raised $120 million from Goldman Sachs, Aglaé Ventures, and Eurazeo Growth.[280]

Circular battery models are becoming more appealing and profitable as concerns around the volatility and provenance of lithium and cobalt supplies rise. The sector is growing rapidly (in line with EVs), enabling economies of scale.[281] Batteries account for roughly half of EV production emissions, and EVs will account for ~80% of global battery materials demand by 2030. By that year, around 10% of key battery materials demand could be provided by recyclates.[282] Circularity goes beyond recycling: by linking EV batteries with power grids via smart or bi-directional charging during use, and in "second life" applications in stationary power storage after their "first life", significant cost and CO_2 savings can be unlocked.[283] Battery recycling and repurposing is an established practice in China. Automaker NIO's swappable EV batteries make them 20% cheaper for customers (see Case study 19). Other geographies are catching up: the European Commission aims to mandate high quality circularity to support the Union's goal to become 80% self-sufficient in lithium by 2025.[284]

There is a growing business case for circular metals, with some of the world's largest corporate consumers looking to make the switch to secondary metals. Urban mining (the targeted reclamation of raw materials in urban and municipal areas) can prove more economical than primary production, given that electrical and electronic waste has up to 50 times higher concentration of valuable metals and minerals than the ores extracted from mines.[287] Other promising models include metals-as-a-service and closed loop recycling, whereby material producers retain ownership and control over their product, helping them reap benefits from efficiency measures and circular management. Industry leaders are getting on board. Since 2016, ArcelorMittal has offered a rental business model for steel sheet piles for the construction industry.[288]

Circular fashion models are scaling and securing investment. Circular fashion models can reduce the sector's emissions by at least 9% by 2030, with the potential for far greater reduction if these replace linear models.[289] Digital resale business models have experienced ~15% growth p.a. in the US over the past ten years.[290] In 2020, Rent the Runway raised $540 million in investment and achieved a $1 billion valuation.[291] Larger brands like H&M[292] and Selfridges[293] are beginning to integrate circularity into their businesses. Significant questions remain about the strength of the industry's commitment to dismantling fast fashion models. But there is increasing evidence that circular models can meet consumer demands and drive growth. If these trends continue, **the fashion resale market could exceed that of fast fashion by 2029.[294]**

Advances in digital technology are expanding the opportunities for circular models, driving down costs and enhancing convenience relative to linear models. Digital traceability tools enable closed loop solutions by tracking the location and characteristics of key materials. For example, tech start-up Circulor maps supply chains to provide responsible sourcing and accurate product carbon footprints both before and after point of sale, making it easier to manage the flow of materials across the economy.[295] (See Case Study 20.) The European Union is planning to legislate the creation of digital "product passports", starting in batteries, to underpin effective life-cycle management including recycling and reverse logistics.[296] Robotics can disassemble electronics more efficiently, such as Apple's "Daisy" robots, which can each disassemble 1.2 million iPhone devices per year.[297]

Co-benefits

Jobs: Scaling up the circular economy could result in the net growth of 6 million jobs globally by 2030 in roles including the delivery of new service models, repair and redesign, reverse logistics and waste collection.[300] Waste collection systems can generate over 700,000 net direct employment in middle and low income countries by 2027.[301] **Processing recyclables can sustain ~20 times more jobs than landfill,** and plastic manufacturers making use of recycled materials, ~100 times more.[302]

Savings: a transition to a circular economy could generate annual net material cost savings of $380 billion (in transition) and up to $630 billion if a fundamental economic shift is achieved.[303]

Reduced import dependency for raw materials: this can both avoid shortages and relieve companies from volatile prices of products and raw materials, such as cobalt and lithium.

CASE STUDY 18

Algramo

Chilean company Algramo dispenses food staples "by the gram" to low-income customers through vending machines installed in 2,000 almacén (family food shops),[274] cutting down on packaging and reducing the end price by 30-40%.[275] In 2020, the start-up partnered with Nestle and Unilever to deliver refill products door-to-door.[276] The same year, the company has expanded to the US, launching refill vending machine pilots in New York City.[277]

CASE STUDY 19

NIO Circular Batteries

Chinese EV manufacturer NIO's Battery as a Service (BaaS) program lowers vehicle prices by roughly 20% for customers.[285] Batteries are swapped in dedicated stations instead of charged. Leveraging circular models has helped the company to grow. By 2025, it is projected to dominate upward of 30% of the Chinese premium EV market.[286]

CASE STUDY 20

Circulor

Start-up Circulor tracks battery metals such as cobalt across the value-chain for large manufacturers like Volvo Cars and Daimler.[298] This can lower the risk of human rights abuses, map life-cycle carbon emissions and facilitate the management of materials in closed loop systems (by tracking where they are, to better re-integrate them into the value-chain). This technology could be applied to other extractive industries, including plastic waste and recycling, agriculture and forestry and electronic waste.[299]

Challenges to setting off S-Curve Growth

While many consumers express an intention to waste less, unsustainable consumption behaviours continue to grow. The growth of low-quality, low-cost items reduces incentives for consumers to waste less. Consumers buy 60% more clothes than they did in 2000[304] and discard the lowest-priced garments after just 7–8 wears.[305]

High labour costs in developed markets penalize models that require labour inputs, such as repair, resale and recycling. This is further amplified by high labour taxation rates.

Weak collection systems: circular models require strong reverse logistics, collection and waste management systems to facilitate the circulation of goods. These are lacking in many geographies, particularly emerging economies.

Perverse incentives subsidise linear models, making it harder for circular models to compete on price. These include higher taxes on labour which penalize reuse, repair and recycling models (which add more labour), and and value-added tax on upcycled products, which require paying twice for the same product.[306]

Business risks – associated for example with retaining product liabilities over their lifetime for product-as-a-service business models, capital costs for new developments, and long lead times until realization of returns at a product's end of life – disincentivise industry action.[307]

Priorities for capturing the opportunity

Introduce regulation and standards to support the emergence of markets for circular business models. For example, governments can mandate that all products are collected and recycled through high quality processes. Where there is sufficient recycled feedstock, countries can encourage the use of reused and recycled inputs when producing goods.

Implement Extended Producer Responsibility schemes for all materials on a global scale to create the incentives for producers to reduce life-cycle environmental impact.

Develop and commit to a global treaty on plastics, recognising the international nature of the challenge

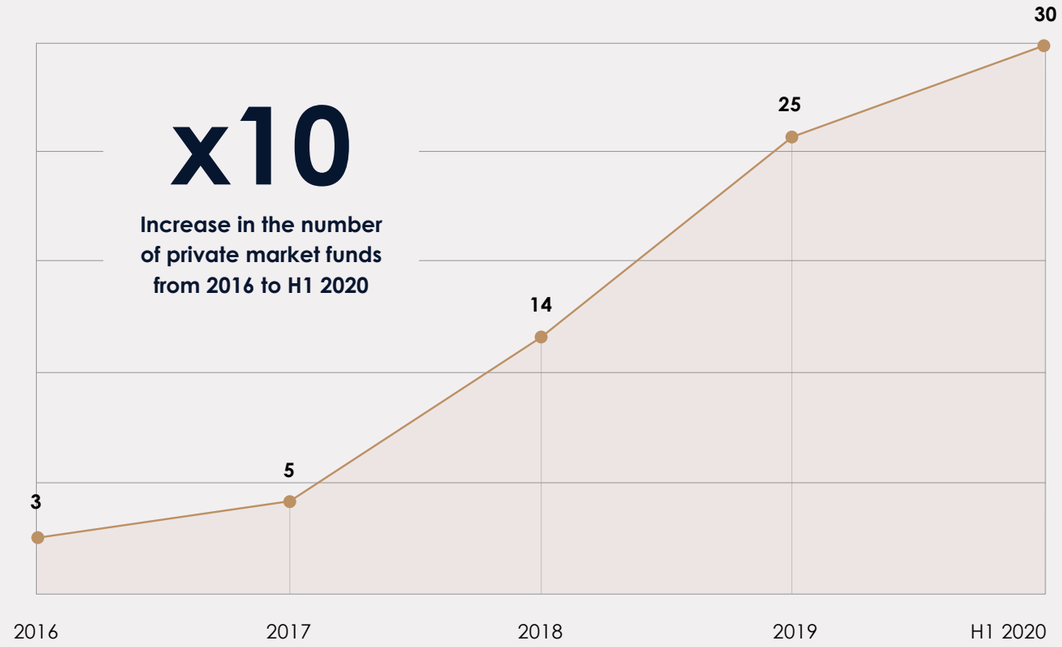
Support R&D to develop innovative circular technologies and materials

Engage internationally and allocate funds for countries in the Global South to support collection systems

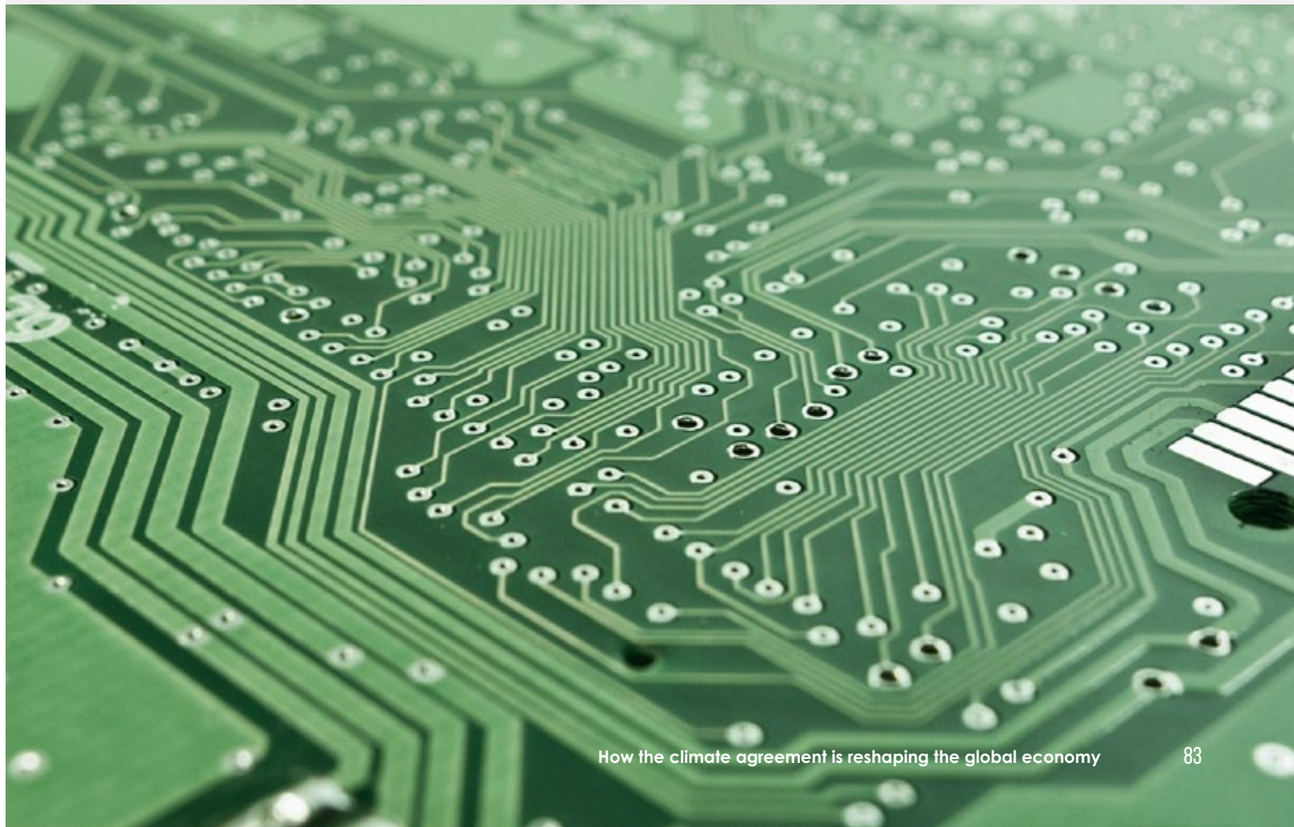
Strengthen reverse logistics systems: work with the private sector to develop and invest in waste management systems, including through blended finance.

CIRCULAR FASHION MODELS ARE SCALING AND SECURING INVESTMENT. CIRCULAR FASHION MODELS CAN REDUCE THE SECTOR'S EMISSIONS BY AT LEAST 9% BY 2030, WITH THE POTENTIAL FOR FAR GREATER REDUCTION IF THESE REPLACE LINEAR MODELS.

Exhibit 17: Number of private market funds with circular economy focus including venture capital, private equity and private debt funds



Source: Ellen MacArthur Foundation (2020)



CORPORATE STAKES

These macro-trends will create winners and losers within and across industries. This dynamic is already at play in some sectors and is imminent in others.

For the trends that are already delivering market penetration, the finance community is moving, downgrading yesterday's business models and driving up the value of those industries and businesses set for growth. Within the above trends, for those that are not yet delivering market penetration but are imminent, the financial community's reaction will come soon, as it always precedes the shift in the market itself.

New corporate winners

As these trends take hold, we will see the rise of new industry giants. As noted above, the power sector is furthest along. In October 2020, the stock market value of clean energy group NextEra surpassed that of ExxonMobil, once the world's biggest public company and a byword for Big Oil.[308] Alongside NextEra stands a series of renewable future supermajors, including Ørsted A/S, a previously tiny Danish utility that has been transformed into a global offshore wind provider worth ~$76 billion.[309] The automotive sector is seeing shifts, too. With a market capitalisation pushing over $500 billion in late 2020,[310] Tesla is now worth more than Toyota, Volkswagen, Hyundai, General Motors and Ford combined.[311] New industry giants will be born in other sectors as well, as they pass market inflection points and scale. Hydrogen and alternative proteins – to pick two – are already minting multi-billion dollar companies and growing. Other clean industries will follow suit.

Old industries in decline

As these new industries scale, old industries and old solutions decline, often in "death spirals". A loss of social license, investor appeal, and mounting regulation make it increasingly difficult for disrupted old-economy industries to attract capital and talent.

Coal is the first to be hit: Coal capacity under development is down 62% globally since 2015.[312] Not only is the pipeline shrinking fast, countries are bringing coal off-line early; Germany recently ran a tender to take 4.8 gigawatts of coal plants out of the market in 2021.[313] Coal generation fell a full 8% in the first half of 2020 compared to the first half of 2019, as a result of COVID-19, combined with rising wind and solar.[314]

Continued declines prompted BNEF to **bring forward their forecast for peak coal generation from the 2040s to 2019.**[315] Unsurprisingly, this has been reflected in company valuations: US coal stocks lost over half their value in 2019 alone and have continued to fall during 2020.[316] Investors are turning away. In 2019, Standard Chartered pulled out of three coal projects worth an estimated $7 billion in South-East Asia, as part of a broader policy to stop financing fossil fuels.[317]

Oil and gas can see the decline coming too: In 2012, three of the top five most valuable public firms were oil companies.[318] By mid-2019, none were.[319] This trend is being accelerated by investor commitments to phase out fossil fuels. In late 2019, the European Investment Bank (EIB) announced it would phase out lending for all fossil fuel projects by the end of 2021.[320] The cost of capital is increasing for the sector. Between 2006 and 2018, the cost of equity capital for the fossil-fuel sector rose by 3 percentage points; by contrast, for the renewables sector it fell by 3 percentage points.[321] Oil and gas investments are paying up to10–20% for capital, compared to 3–5% for renewables.[322] Long-term demand forecasts are increasingly being revised down, particularly as the reality of electric vehicle dominance sets in, contributing to a long-term picture of lower oil prices (on average, accepting there may be spikes). As a result, an increasing number of oil and gas companies are having to write-downs their assets: BP and Shell had write downs of $17 billion and $22 billion respectively in 2020.[323]

As oil and gas majors face mounting costs of capital and come to realise that value in their industry is increasingly focused in the near-term, they are investing in shorter-term projects. Since 2015, CapEx commitments in new long-cycle oil projects have fallen by >60%, versus the period 2010–2015.[324] This has taken a toll on the **resource life of Top Projects** (recoverable resources/production), which has fallen to 30 years in 2020 from c.50 years in 2014, **a c.20-year reduction since 2014.**[325]

While some industries will rise and fall, there are other industries which will transition from polluting ways of doing business, to clean solutions. This is the case in many of the heavy industry and heavy transport sectors. Though there is set to be increased substitution (e.g., timber instead of steel), there will remain a substantial steel industry. In such sectors, forward-looking incumbents can leverage their considerable financial, operational and human resources to position to win in these transitions. We are seeing this as steel, cement and shipping giants start to invest in pilots and projects to position themselves for green markets. As the economy is realigned, opportunities also emerge for companies in adjacent sectors. For example, fertilizer companies with their existing use of ammonia have an opportunity to get a head start in green ammonia – applicable across possibly many sectors (e.g., shipping, early use-cases in co-firing in thermal plants). Norwegian fertilizer company Yara has recognized this – it has launched a series of partnerships with energy providers to develop green ammonia.[326] **Those who fail to transition fast enough will be left locked out from certain markets, with stranded assets and a vicious cycle of divestment and falling revenues.**

Countries whose economies rest on declining industries risk seeing waves of volatility and defaults. These industries will have ever-shortening lifetimes and ever-increasing paces of decline. Long-term corporate debt, and equity, will become increasingly risky with highly questionable terminal values.

Conversely, countries that harness these trends and support their industries in positioning to win will provide their economies with **resilience and growth for decades.** Tens of millions of well-paying jobs and strong export-industries can be captured, as outlined in the 'Country Opportunities' section below. Furthermore, countries that import fossil fuels will be able to drive down these costly imports.

WHILE SOME INDUSTRIES WILL RISE AND FALL, THERE ARE OTHER INDUSTRIES WHICH WILL TRANSITION FROM POLLUTING WAYS OF DOING BUSINESS, TO CLEAN SOLUTIONS.

COUNTRY OPPORTUNITIES

All countries can position to benefit from the transition. Countries that do well to harness these trends stand to: gain millions of well-paying jobs; build and protect industries; establish new export industries; build resilience in their economies; and reduce health costs for their countries.

Failing to participate in these shifts means missing out on huge opportunities, and continuing reliance on increasingly volatile and risky old-economy industries. **Further, certain geographies are naturally well positioned to play a key role in global value chains.** These include:

Countries with high levels of renewable resources, and thus potential for world-leading low-cost renewable electricity, can **scale up green hydrogen production and export-associated derivatives such as green ammonia** (e.g., Chile, Australia, Morocco, parts of China, Middle East). These products can be plugged into global supply chains and thus sold to high-income countries willing to pay the initial cost premiums (e.g., green steel sold to German auto-makers who are seeking to deliver low-embedded carbon electric vehicles).

- Those located near major sources of hydrogen demand (e.g., North Africa, Spain) can take a lead role in **hydrogen production and export via pipeline** as the market matures.

- **Ports in particular hold a strategic position** for many reasons, including: ship re-fueling (i.e., with green ammonia); possible existing ammonia storage tanks (for fertilizer import/export); green steel export; often near airports as coastal transport hubs. **Countries with major ports can leverage their strategic advantage.** Royal Dutch Shell has partnered with the Port of Rotterdam to create a hydrogen network, using renewable energy from a nearby offshore wind farm to produce green hydrogen, with plans for this to be in operation as early as 2023.

Metal and mineral rich countries: to build the low-carbon economy, there will be increased need for metals and minerals, including copper, lithium and others. Countries rich in deposits of these metals and minerals can **scale their mining sectors and potentially also downstream sectors** (for example, lithium refining, battery manufacturing). It is critical to ensure that any mining activities are conducted in a way that ensures human rights are protected, avoids environmental destructuction and lifts the prosperity for local communities. This requires transparent and traceable supply-chains. Scaling circular models can also help to reduce the need for extraction.

Countries with high levels of renewable resources, situated near large economies (for example, Mexico, windy Midwestern US states, Turkey) can differentiate in **clean manufacturing producing low-cost goods with low embedded carbon**

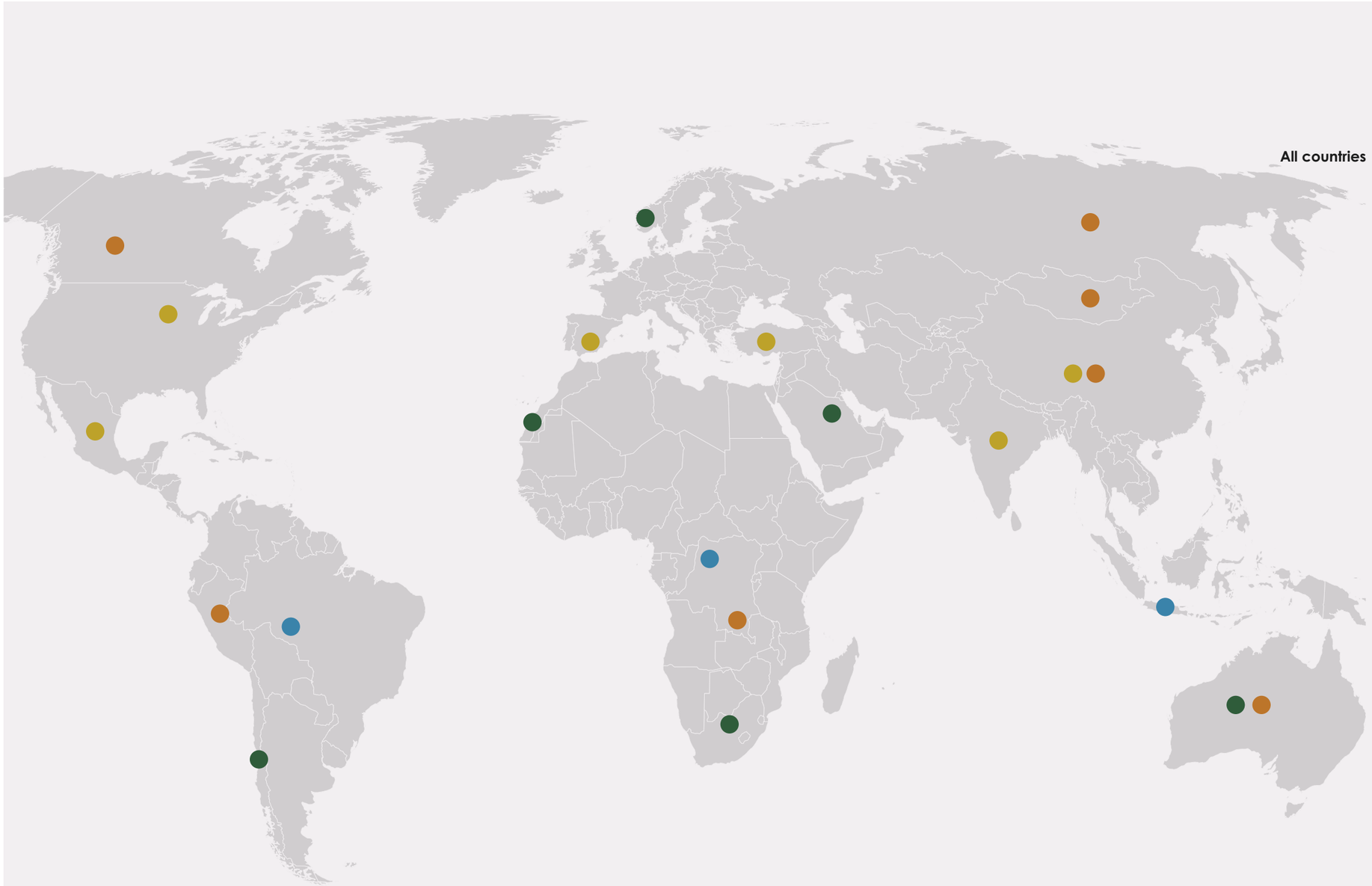
Tropical forest rich countries (including Brazil, Colombia, DRC and Indonesia) stand to gain from creating an enabling environment for regulated, verifiable projects to meet growing demand for sustainably-produced commodities, payments for ecosystem services, carbon markets and to benefit from enhanced resilience.

Exhibit 18 indicates select examples of countries and regions that can position for growing global value chains.

CERTAIN GEOGRAPHIES ARE NATURALLY WELL POSITIONED TO PLAY A KEY ROLE IN GLOBAL VALUE CHAINS.

Exhibit 18: Compelling country opportunities

Markers highlight select compelling examples, not exhaustive

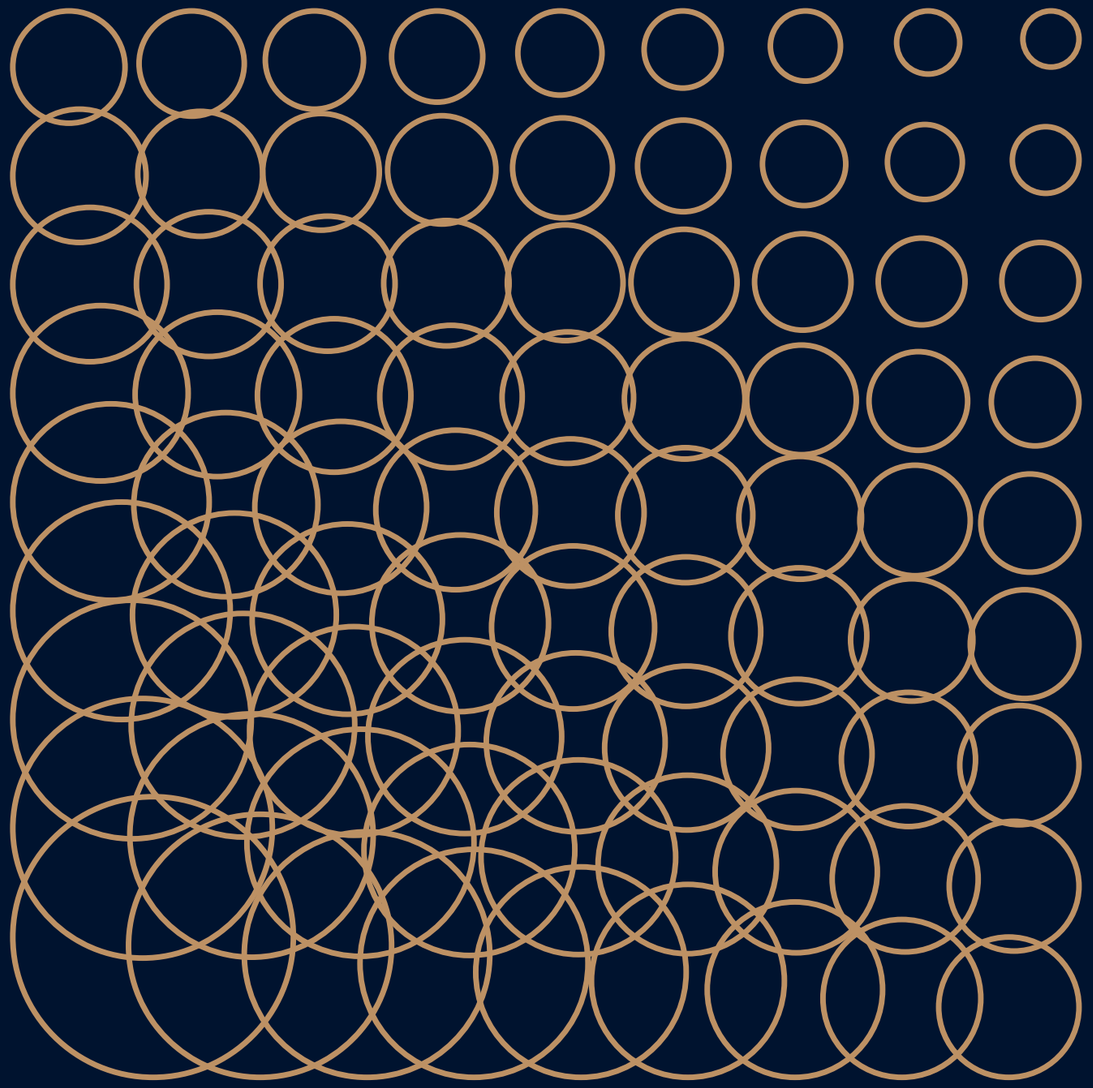


Country opportunities available to be captured 2020–30

- Lower-cost power
- Lower-cost vehicles / mobility
- Productive & resilient **agricultural systems** tailored to local context
- Competitive **export of green hydrogen products** (e.g., green ammonia, green steel)
  World-leading low-cost power, ideally both wind & solar[1] (or low-cost hydro), located on major shipping routes; ports hold strategic position (e.g., for fertiliser as well)
- Source of **metals & minerals** required to build low-carbon economy solutions (e.g., electricity networks, batteries)
- Competitive low-cost power for **low-carbon manufacturing** (e.g., batteries, heat pumps)
  Competitively low-cost power; near large economy (in particular EU given carbon border adjustment)
- High-carbon (+high biodiversity) **existing forest** to earn value for nature, or good location for **reforestation**[2]
  Standing forest (in particular rrainforest); land previously forest, peatland or wetland which can be returned to this state

Source: [1] **Note:** Ammonia production or steel production require a fairly consistent flow of hydrogen to maximise utilisation of ammonia or steel plant. Hydrogen production occurs when power supply to the electrolyser (solar or wind farm) is active. Hydrogen storage can be used as a buffer between the two processes, though it is expensive (except salt / rock caverns). However, with *both* good wind and solar resources, a high utilisation factor (e.g., 50–70%) can be achieved in hydrogen production, limiting the need for hydrogen storage. Low-cost power may also result from hydro. [2] **Note:** planting forest in northern Canada may not for example have net benefit given reduced albedo effect of trees relative to snow

KEY SHIFTS AMONG ACTORS



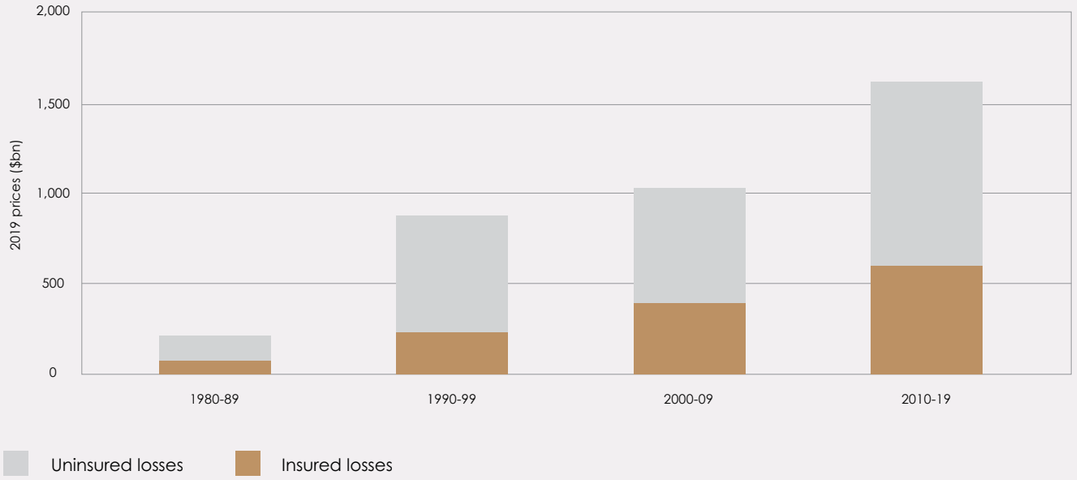
Since 2015, significant, sustained shifts among key ecosystem actors have helped to create the conditions for new markets and existing markets to scale along rapid S-curve trajectories.

Continued and growing engagement from these actors will **help propel markets for low-carbon solutions even more quickly in coming years.**

As climate impacts mount, many of these actors are moving with increasing urgency. Exhibit 19 illustrates the increase in weather-related losses since the 1980s, scaling from c. $0.2 trillion to over $1.5 trillion in the 2010s, only part of which can be explained by increased asset values.[327] As these impacts continue to mount, actors across sectors are likely to increasingly take steps to mitigate both physical and transition climate risk. (See Exhibit 20.)

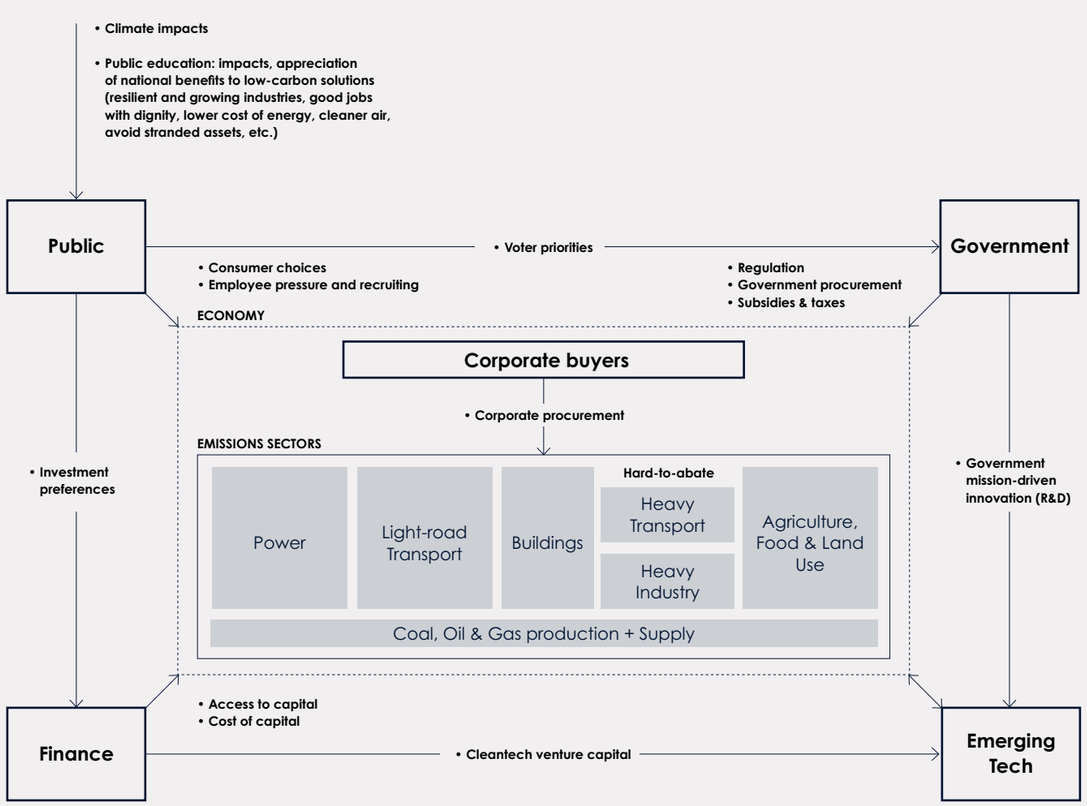
In addition, extreme heat can be dangerous to individuals, in particular older people, and is on the rise. In 2019, annual heat-related deaths stood at near 300,000, up from ~150,000 in 2000.[328] As costs and impacts mount, pressure from the public – on governments, corporates and financial services – will also increase.

Exhibit 19: Global economic losses resulting from weather-related catastrophes



Source: Swiss Re (2020) cited by Financial Stability Board (2020)

Exhibit 20: Ecosystem of actors create conditions for zero-carbon markets



PUBLIC

Since 2015, the proportion of adults who say that climate change is a very serious problem has grown, from 33% to 56% in Russia, 44% to 52% in Malaysia and 48% to 71% in South Korea.[329]

Newspaper, radio and television reports on climate change have doubled since mid-2018.[330] (See Exhibit 21.) As climate impacts mount, activism helps to raise popular awareness and prioritisation of the issue, and as an engaged young population comes of age (as voters, consumers and employees), **political candidates and corporations that fail to act on climate will increasingly struggle to gain traction.**

Voters

Voter support for climate action – especially scaling zero-carbon industries – is growing across the political spectrum, and is set to widen as **young people begin to vote.** In the US, 80% of "Millennial" and "Gen Z" Republicans (18–39 years old) believe the government should prioritise the development of alternative energy sources, compared to 55% of "Baby Boomer" Republicans (56 years and above).[331]

This is creating political space to support climate solutions. Since 2019, elections in the EU,[332] UK,[333] New Zealand[334] and US[335] were all won by leaders with strong climate platforms. In late 2020, Japan's conservative Liberal Democratic Party updated the country's climate ambition to net zero by 2050, citing economic growth as a key factor in the decision.[336]

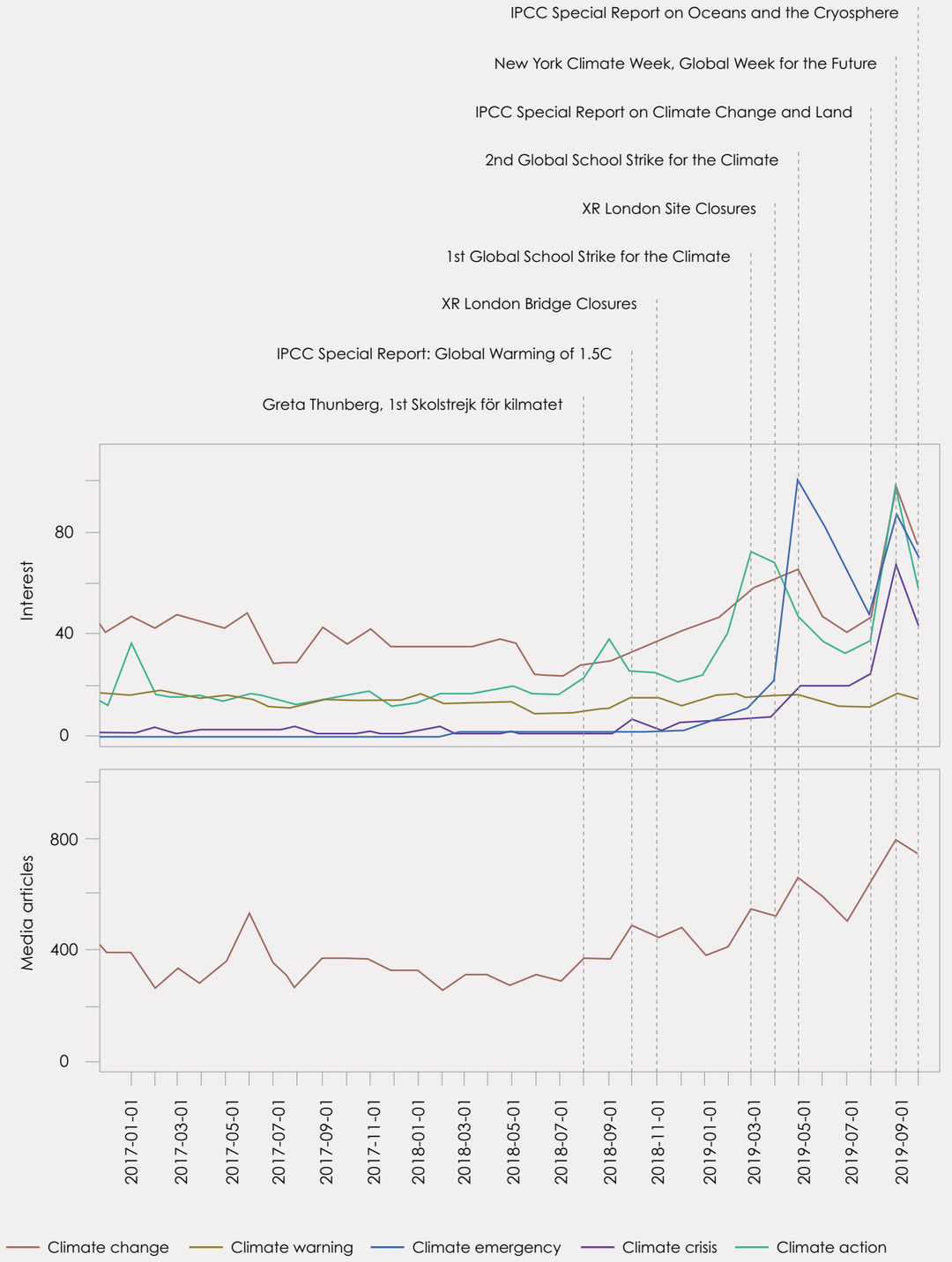
Consumers

Consumers are increasingly unwilling to back businesses without strong environmental records, creating a business opportunity in bringing forward low-carbon solutions and leading the transition. **Two-thirds of adults across 28 countries say they have made changes to their consumer behaviour out of concern about climate** in the past few years.[337] The reputational and financial damage that can result from public scandals can badly impact entire industries. The Volkswagen emissions scandal of 2015 dented US sales of other German auto-manufacturers (BMW, Mercedes-Benz and Smart) by nearly 500,000 units, valued at $26.5 billion in 2016.[338]

Employees

In 2015, no major instances of employee activism on climate were reported. **By 2019, thousands of employees conducted walk-outs and strikes on climate,** prompting companies including Amazon and Microsoft[339] to respond with stronger action. At the same time, **companies with weak records on climate are finding it increasingly difficult to recruit talent.** The number of UK graduates going into oil and gas exploration fell by 61% between 2012 and 2017.[340] Almost 90% of those working in oil and gas say that skills shortages are damaging productivity, with gaps widening in every sector of the industry.[341]

Exhibit 21: Media articles and Google searches about climate terms increased from mid-2018



Source: Thackeray J.,S. et al. (2020)

CORPORATE BUYERS

The private sector is starting to take a leadership position on climate not previously seen before.

Recognising the need to meet consumer demands and manage reputational, regulatory and physical climate risks, companies are committing to action, developing and scaling clean solutions across their value-chains and increasingly engaging with partners across sectors to maximise impact.

Committing to action

Over 1500 companies have pledged to reach net zero emissions.[342] Over 1000 companies spanning 60 countries and 50 sectors (with a combined market capitalisation of $16 trillion) are working to set and deliver on science-based targets through the Science-based Targets initiative.[343]

These commitments have been followed by **large-scale investments by leading players.** For example, IKEA plans to invest €200 million to meet its target of becoming climate positive by 2030.[344] Microsoft aims to spend $1 billion over the next four years. It has launched an investment fund targeting early-stage clean energy technologies.[345]

Developing and scaling solutions across value-chains

Leading figures are driving change across the value-chain through procurement and partnerships like RE100 (through which 268 companies have committed to 100% renewable electricity)[346] and **EV100** (through which 92 multinationals have committed to switch their fleets to EVs and/or install charging for staff or customers by 2030).[347]

Greater commitment to radical transparency is helping companies to identify and address issues in the value-chain, in response to growing pressure from consumers. In 2018 Unilever was the first consumer goods company to publicly disclose the suppliers and mills it sources palm oil from.[348] Within a year, Mars and Nestlé had made similar commitments.[349]

Partnering across sectors

Corporates who see their opportunity to benefit from the new dynamic are **engaging in policy advocacy to secure an environment that enables** a race to the top. Analysis shows that strategic and positive lobbying by private sector renewable energy users has **increased significantly since the Paris Agreement.**[350] Within this trend, utilities like Enel, Iberdrola, SSE and National Grid are pushing strategically for more ambitious climate policy.[351] Increased engagement with government on pro-climate policies indicates both the private sector's confidence in the direction of the economy and a willingness to drive that shift.

Since 2015, businesses have grasped the power of collective action to drive industry-wide change that could not be achieved alone. Initiatives launched in the last five years include: One Planet Lab; Fashion Pact; the Global Maritime Forum's Getting to Zero Coalition; and the Mission Possible Platform. These bring together the weight of collective action, and the expertise of multiple players to create new value chains. Doing so can address systemic barriers to progress. For example, Indonesia's Food Loss and Waste Action Partnership (led by the Food and Land Use Coalition) brings together government ministries with private sector and civil society partners (including Olam, Yara, Syngenta and Rabobank) to develop practical plans to reduce food loss and waste in the country.[352] Elsewhere, Ørsted, Maersk, SAS and others have joined forces on an ambitious sustainable fuel project which would fuel Maersk ships and SAS airplanes.[353]

SINCE 2015, BUSINESSES HAVE GRASPED THE POWER OF COLLECTIVE ACTION TO DRIVE INDUSTRY-WIDE CHANGE

FINANCE AND INVESTOR COMMUNITY

The financial system is nearing a tipping point as mainstream investors start to actively integrate climate risk into their portfolio decisions. The latest data is proving that the new economy is increasingly bankable.

Research[354] confirms that ESG funds have outperformed the wider market over 10 years: once seen as a constraint on portfolio performance, ESG has become a quality assurance signal. This has been reflected in rapid market growth – global ESG assets (broadly defined) are now worth around $40.5 trillion, having almost tripled in value in less than a decade.[355] This will only get bigger as access to finance improves and the cost of low-carbon, regenerative solutions all over the world continues to plummet. But the financial system is slow-moving and still needs to overcome significant barriers before long-term portfolios are truly "Paris-aligned".

Integrating climate risk

The finance community is increasingly under pressure to address its exposure to climate risk and apply pressure to investee companies to do the same. Investors, shareholders and regulators are committing to better integrate physical and transition risk into their investment decisions, channel capital into Paris-aligned portfolios and develop the tools to measure the impact of this shift.

Financial industry commitments are building momentum and resources for the new economy. These are often driven by coalitions like ClimateAction 100+[356] – an investor initiative launched in 2017 to ensure the world's largest corporate greenhouse gas emitters take necessary action on climate change. ClimateAction 100+ is said to be responsible for miners like Glencore committing to cap coal production in 2019.[357] Another investor coalition is the Net Zero Asset Owner Alliance, through which 30 of the world's largest asset owners have agreed on concrete portfolio decarbonisation targets.[358] Tools from individual investors are also shaking things up: Legal & General Investment Management has made climate ratings for over 1,000 companies publicly available; voting and investment sanctions are applied to "laggard" companies.[359] Globally, financial institutions with cumulative assets of at least $47 trillion under management (representing 25% of global financial market) have set climate-related targets for their portfolios.[360] These range from setting specific investment targets (e.g. Goldman Sachs pledged $750 bn for sustainable finance by 2030[361]), to phasing out coal (e.g. BNP Paribas[362] and Crédit Agricole[363]), to net zero commitments (e.g. Barclays and HSBC announced plans to get to net zero by 2050, not just in their own operations but also for emissions that they finance.[364]

Shareholders are increasingly applying pressure. The number of climate-related shareholder resolutions has almost doubled since 2011 while the percentage of investors voting in favour has tripled over the same period, exceeding 30% in 2020.[365] In 2019, investor pressure compelled Royal Dutch Shell to link executive compensation to meeting GHG reduction targets.[366] Even losing resolutions sends a clear message: a preliminary vote on whether JP Morgan should disclose its full carbon footprint and reduce fossil fuel lending was defeated by only 0.4% this year;[367] signalling that almost half of the bank's investors are displeased with its approach to fossil fuel investment. Despite the economic impacts of COVID-19, this trend has remained strong through 2020.[368]

Disclosure is key to shifting capital out of high-carbon, high-risk assets. Financial institutions with a combined $150 trillion assets under management, and more than 1,500 organisations with a combined market capitalisation of $13 trillion have signed up to the Task Force on Climate-related Financial Disclosures (TCFD), voluntarily committing to improve and increase reporting of climate-related financial risk.[369] While this represents significant progress, it still only captures 15% of the market capitalisation of the world's major stock exchanges,[370] confirming the need for mandatory disclosure as seen in France, followed by the UK and New Zealand.[371] The EU, Australia, Hong Kong, Japan and South Africa are also considering TCFD-aligned disclosure mandates.[372] And in a world first, Canada tied COVID-19 bailouts to TCFD disclosure.[373]

Regulators and central banks are raising ambition. The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) (launched 2017) is helping the financial system to better manage risks and mobilise capital for low-carbon investments.[374] The Dutch National Bank[375] and the Bank of England[376] are pioneering stress tests to assess financial institutions' vulnerabilities to different temperature rise scenarios. Meanwhile, for the first time, the US Federal Reserve formally highlighted climate change as a potential threat to financial stability this year – a critical first step to integrating climate risk for US investors.[377]

Financial policy signals matter. The EU's new taxonomy on sustainable finance will help public and private investors assess whether investments are meeting robust environmental standards that are consistent with the Paris Agreement. The Coalition of Finance Ministers for Climate Action brings together members from over 50 countries to secure a just transition towards low-carbon development.[378]

Better data, new climate modelling tools and high-integrity impact measurement are accelerating change. Forward-looking analytics are transforming the investment universe when it comes to assessing physical climate risk. Solutions like Jupiter's ClimateScore Global[379] predict climate impacts like flood, fire and extreme heat, informing capital investment decisions and facilitating TCFD disclosure. Other initiatives tackle transition risk: Orbitas Finance modelling looks at how it could impair investments in the tropical commodities sector through changes in key financial metrics. Better reporting and metrics are also critical to improve transparency and measure the impact of investor commitments with initiatives like Net Purpose and the PRIME Coalition part of a growing industry.

All of this is creating top-down pressure throughout the financial system: forcing investors to scrutinise exposure to physical and transition risk and accelerating capital shifts out of the old economy and into the new.

Moving out of old industries

Despite positive momentum, there are still major barriers which lock-in traditional models of capital allocation and prevent trillions of dollars from flowing out of the old economy and into the new one. This has seen over $2.7 trillion invested in the fossil fuels sector since 2015.[380] In 2019 alone, the world's largest banks invested around $2.6 trillion (roughly the GDP of Canada) into sectors which are primary drivers of biodiversity destruction.

Fortunately, a growing number of investors are actively transitioning their portfolios out of fossil fuels as they realise the inherent risks in environmentally unsound investments.

In the last three years, the number of financial institutions committing to phase out coal has grown significantly. Banks like Standard Chartered have been particularly important given their footprint in emerging markets: in 2018 it prohibited direct financing for new coal-fired power; the following year the bank committed to restrict general corporate support to coal clients by 2030.[381] This is critical as a significant share of coal finance happens at the company not project level.[382]

Going beyond coal, the World Bank was the first to ban upstream oil and gas finance.[383] The European Investment Bank (EIB) has gone even further, committing to phase out coal along with all unabated oil and gas projects by the end of 2021.[384] It is set to become the EU's "climate bank": it will spend a €1 trillion green investment package by 2030, end funding for all fossil fuels and airport expansions by the end of 2022 and target more than half of its funding activities to climate action by 2025.[385] In general, it is becoming **harder to finance oil and gas assets** with the cost of borrowing becoming more expensive (~10-20%) compared to renewable projects (down to 3-5% for regulated investments in Europe).[386] **Investors have made similar moves out of companies and commodities linked to deforestation and biodiversity loss** (see Agriculture, Food and Land Use).

Banking on the new economy

Funding for clean, sustainable solutions is growing. New indices, ETFs and debt instruments that facilitate sustainable passive trading are emerging, including a new index for ESG credit default swaps that started trading in 2020 with a tighter spread than the benchmark.[387]

Green bonds issuance surpassed the $1 trillion landmark earlier this year,[388] with more than $200 billion issued in 2020 alone (as of November 2020).[389] These bonds support a range of projects from clean energy to sustainable agriculture, waste and water.[390] To be a credible source of transition and low-carbon finance, it is critical that these instruments maintain environmental integrity, avoid "greenwashing" and are standardised. The work being done by the EU Commission on a sustainable finance taxonomy and green bond standard[391] will help to ensure the effectiveness, transparency and standardisation of the green bond market.

The broader sustainable debt market (which includes social and sustainability bonds, sustainability-linked loans and green loans) has generated an estimated additional $1 trillion worth of transactions over the past few years.[392] Instruments such as transition bonds are also being explored by market players to facilitate investment in sectors where low-emission solutions are still in development. Of course, these instruments still only represent a fraction of the $100 trillion bond market.[393] There is still a long way to go.

Although momentum is building, the financial system is not moving fast enough. Barriers still remain which make it easier to finance business as usual. The most important lever to tackle these barriers will always be real economy policy signals (including carbon pricing, deforestation-free supply chains, or commitments to phase out petrol and diesel cars), since these will feed through into investment models. Policies which require long-term pools of capital – like pension funds – to consider climate risk in investment decisions are critical to future-proofing portfolios. Most importantly, mandatory disclosure of climate related financial risks, better and more transparent data, high-integrity impact measurement, standardised green investment products and accountability in climate commitments will all be key to Paris-aligning the financial system. **Building on leading examples from the past five years, these solutions are all within reach.**

THE FINANCE COMMUNITY IS INCREASINGLY UNDER PRESSURE TO ADDRESS ITS EXPOSURE TO CLIMATE RISK AND APPLY PRESSURE TO INVESTEE COMPANIES TO DO THE SAME.

GOVERNMENT

Governments have a critical role to play in accelerating the progress of low-carbon solutions towards market tipping points.

Barriers to overcome

To capture this opportunity, countries need to take action to combat the adverse effects of uncertainty and incumbency. These include:

Consumer influence is limited in reshaping mass markets. Price remains a key purchase criterion for most consumers and polluting products often outperform low-carbon options (certainly initially) on price. Governments seeking to encourage consumers to bias their spending to support clean industries will need to keep this front of mind.

Incumbents who are keen to maintain the old economy have current returns at their disposal to continue investing in high-carbon assets, they do not need to turn to financial markets for capital in many instances. In addition, the dominant position of incumbent companies – even if short-lived – grants them significant political leverage.

The financial system can only go so far without the right enabling policy. Even though capital markets are supposed to look to future cash-flows, the combination of discounting methodologies, short-term incentives, lack of confidence around key enabling climate policies means that many market actors will respond at scale too late, with assets and investments already exposed.

Progress since Paris

Governments in leading countries are beginning to establish the enabling environment for new systems to emerge. They are doing so through a combination of policy carrots, sticks and investments to scale the new economy, while also withdrawing perverse incentives that prop up the old economy. These help to accelerate progress towards market tipping points by contributing to the positive feedback loops of ambition, investment, solution development and market growth outlined in the opening section. Such actions include:

Raising ambition: since the Paris Agreement, governments have stepped up ambition on climate. A growing number of countries have committed to net zero emissions targets and are implementing sector-specific targets where necessary.

Countries, cities and regions accounting for over 50% of GDP have adopted a net zero commitment.[394] Before 2015, few countries had emissions reduction targets and those that did largely targeted 80% reductions rather than 100%.[395] Five years on, **over 120 countries and the EU have adopted or are considering a net zero commitment.**[396] 118 states and regions have committed to net zero via the Under 2 Coalition.[397] **291 US cities and 10 states** have committed to net zero via 'We Are Still In'.[398] If President elect Biden commits the US to net zero, this would bring two-thirds of the world's economy under net zero targets.[399]

These commitments have direct impacts on key emissions sectors. For example, recent commitments to net zero by China[400], Japan[401], South Korea[402] and the EU[403] have profound significance for the steel sector, given they cumulatively account for 70% of global steel production and 67% of consumption.[404]

They also provide a platform for legislation and policy interventions that create **the enabling environment** for solutions to emerge, and for niche markets to grow and transition into mass markets. **China's Five-Year Plan 2016–2020** includes three times as many sustainability-related terms as the previous Five-Year Plan (from 27 to 81).[405]

As ambition has ramped up, the shared direction of travel has increased the confidence of leaders to provide consistent policy signals and investment support for low-carbon solutions. These are creating the conditions for companies to invest and innovate, and for markets for low-carbon solutions to begin to scale.

Investment – direct support and de-risking: some countries have begun to provide direct support to those developing new solutions and creating the incentives for the private sector to invest. Across both, greening COVID-19 recovery plans and attaching proper strings to any industry support represents a huge opportunity to build back better, reshaping national economies and setting them on a new path. Countries that implement carbon prices and taxes can use these revenues to fund investments in R&D, technology scaling and clean infrastructure that underpin low-carbon solutions.

Greening the Recovery: one third of France's COVID-19 stimulus package – around $30 billion – is allocated to green measures (including $9 billion to green industry).[406] Unfortunately at the same time, over $200 billion of G20 COVID-19 recovery stimulus packages has been committed to fossil fuel industries.[407] With fossil industries becoming increasingly volatile, these funds are adding risk into national economies.

Direct investment: South Korea's New Deal directs $95 billion into green and digital technology investments.[408] The UK Government's £100 billion national infrastructure strategy outlines plans to invest in green infrastructure to create a net zero economy by 2050[409], with up to 68% emission cuts by 2030.[410] Since 2015, members of Mission Innovation – a group of 24 governments and private sector leaders – have raised R&D spending by 38% to support the acceleration of clean energy

technology innovation. While members did not hit their target of doubling spend in this period, nearly all countries increased spending.[411]

Fiscal policy: governments are finding new ways to incentivise private sector investment in low-carbon solutions. For example, the renewed Canadian Income Tax Act of 2019 enables businesses to take advantage of accelerated capital cost allowance (CCA) rates for investments in specified clean energy generation and conservation equipment.[412] Since 2018, the Government of Malaysia's Green Technology Financing Scheme has used rebates and a 60% loan guarantee to encourage 28 banks and financial institutions to participate in 319 projects (approximately $1 billion in loans).[413]

Over 40 countries have adopted a carbon price, including Canada, Mexico and Argentina.[414] These can help to shift investment and push out remaining high-carbon practices where the zero-carbon solution is already more mature (for example, driving out coal from the European power sector). They can also generate tax revenues to invest in the clean transition. For example, in 2019, British Columbia established the CleanBC Industry Fund, which invests carbon tax revenues of $13 million in projects that support clean development opportunities.[415]

Solutions – enabling infrastructure: ensuring that the linkages and networks necessary to support new systems are in place, from charging infrastructure for EVs to transmission networks connecting areas of high renewable resource into the national power system. Increasing numbers of countries are building out EV charging infrastructure to enable the market to scale, alongside policy support (for example, tax breaks). For example, rates of EV sales have increased fourfold in China since 2015, just as charging points per capita have risen tenfold from 0.05 million to 0.5 million (2015 to 2019).[416]

Markets: since 2015, countries have begun to put in place incentives for low-carbon solutions to scale and new markets to emerge. Policy carrots and sticks can help to create a level playing field for innovations to compete. Key interventions include:

Regulations and standards can create incentives for incumbents to improve performance and protect consumers from unsustainable products. In the last two years, regulations and standards to avoid deforestation-linked commodities have begun to ramp up. In 2018, France introduced a National Strategy against Imported Deforestation through which it committed to implement public purchasing policy and tools to promote sustainable imports (among other plans).[417] The UK Government is considering a law that would prohibit large companies from using products grown on land that was deforested illegally.[418] (See Agriculture, Food and Land Use Section.)

Feed in tariffs (FIT) provide support for early-stage solutions to scale from niche markets to larger, mass markets. For example, Chinese FIT policies introduced in 2011 successfully stimulated PV domestic market. New installations increased thirtyfold to 33 GW by 2016 (accounting for around 40% of global new installations).[419]

Reforming fiscal incentives can help to avoid perverse incentives that reward polluting practices. $400 billion of public subsidies continue to pour into fossil fuel and other polluting industries rather than into low-carbon solutions.[420] Of the $700 billion spent on public support for agriculture and fisheries, only 15% is targeted at public goods.[421] Countries that recognise the opportunity in a net-zero economy can redirect these subsidies to support the investments in sustainable low-carbon solutions.

The realistic possibility of carbon border tax adjustments by the EU,[422] U.K.[423] and by US President Elect Joe Biden[424] (in jurisdictions which together account for 30% of global imports by value[425]) is already nudging behaviour in markets for commodities such as steel and aluminium.

Public procurement: almost all OECD countries have developed green public procurement strategies or policies. These provide certainty of demand and premium markets for solutions that are not yet competitive with incumbents on price to access an initial market and grow, improving performance and driving down costs through economies of scale.[426] In many countries, the public sector represents a significant proportion of demand for construction materials and could be a major driver of low-carbon heavy industry products.[427] California, the Netherlands and New Zealand are among countries introducing requirements for state agencies to consider the carbon footprint of building materials used in their construction projects.[428] (See Steel Section.)

Phase-out dates for sunset industries can accelerate the scale-up of new mass-markets by reducing the power of incumbents to hold back change. **17 countries worldwide have set phase out dates for petrol- and diesel- cars.[429]** Eight EU countries plan to phase out coal by 2030.[430]

Built-in ratcheting mechanisms provide companies with clear policy signals and reset expectations for investors. This can include tightening regulations in specific sectors (e.g., power, auto, aviation fuels) or predictably increasing carbon pricing across a number of sectors. The continued commitment of governments to the Nationally Determined Contribution (NDC) process has helped to increase momentum and provide the private sector with confidence in the direction of travel.

Financial regulations and policies: financial authorities and governing bodies are beginning to integrate climate risk and realign incentives in the finance system for a more rapid reallocation of capital away from fossil fuel and polluting investments towards more stable low-carbon solutions. This includes sending clear policy signals on disclosure and stress testing; for example, and the UK[431] and New Zealand[432] have joined France[433] in committing to make TCFD mandatory.

Much more needs to be done. To ensure properly informed decisions are being made, it is also important to incorporate climate risk and resilience into macro-fiscal and financial frameworks. There are currently disincentives to invest in infrastructure in emerging markets, which need to be tackled. While introduced to safeguard the stability of the system, current requirements on liquidity, reserves and capital provisioning for banks (Basel III[434]) and other financial institutions (e.g. Solvency II for European insurers[435]) make it harder to invest in the low carbon real economy. One option is to have a differentiated capital weighting system that assigns a higher or lower risk weight for capital provisioning based on sustainability, anticipating sudden negative price developments in the future. Further detail on progress in financial regulations and policies is outlined in the Finance Section, above.

International collaboration: governments and international industry bodies can accelerate progress across sectors by coordinating on investments, policy signals and regulation to cultivate markets. This can help to overcome first mover disadvantages. It can also help to create and scale the niche for first deployment in competitive sectors where low carbon

technology is significantly more expensive than fossil fuel options (for example, in global markets such as shipping, aviation and steel).

Support a just transition: the new jobs generated by the transition to a zero-carbon economy considerably outnumber those that will be displaced as old industries decline. Yet there are workers in declining industries, and they deserve support in the transition. Governments are beginning to demonstrate how a just transition can be assured. These centre on direct funding (e.g., for early retirement packages), retraining and relocation support, and the provision of social safety nets. Spain has established a €250 million fund to support the coal mining workforce.[436] (See Power Section.) In 2019, Chile and Germany established the Chilean-German Energy Partnership to exchange best practices on energy policies, including how to support a just transition through business models for energy transition, capacity-building and public awareness raising.[437]

These climate policy signals are increasing and becoming more reliable, making it harder for companies and investors to discount today's policies. They should be keenly aware that more policies to enable thriving low-carbon industries and to penalise pollution are on their way.

The NDCs set since Paris play a critical role in this, with the number of countries committed to ramping up ambition at critical mass. As has been shown in this report, a series of additional factors mean that governments increasingly recognise that climate action is in their country's interest. These include mounting climate impacts, which are more costly and more near-term than previously understood; increasing public concern for climate change and support for government action; growing confidence in the technological and economic availability of low-carbon solutions; and increasing evidence that a shift to a low-carbon economy is a superior growth pathway than supporting old industries. **It is becoming politically and financially riskier for policymakers to delay action than to take action.**

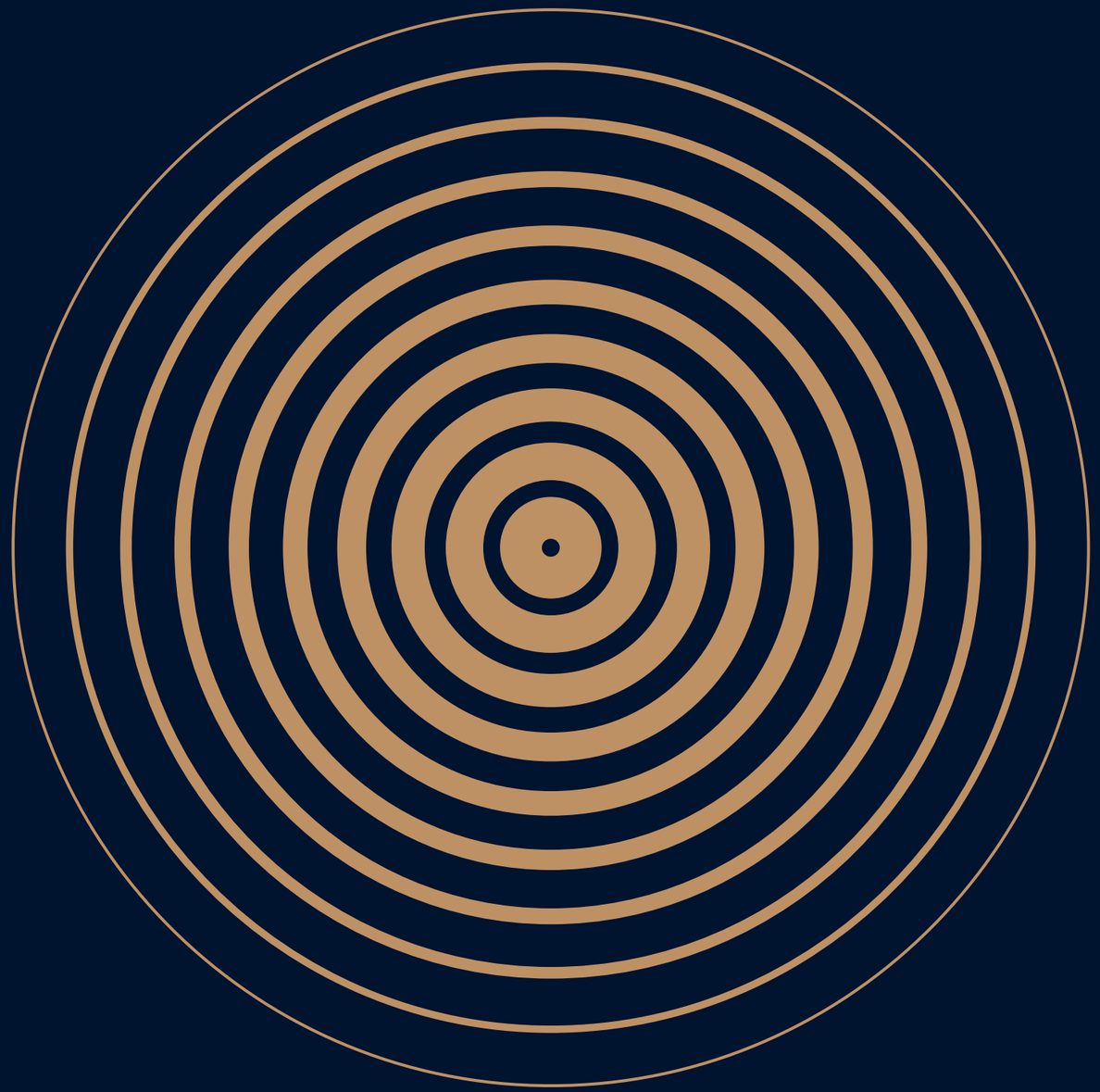
CONCLUSION

The conditions are set for exponential shifts across the economy. These have the potential to unlock huge social and economic opportunities

by generating good jobs, improving population health and livelihoods, and enhancing the resilience of the economy and driving growth in capital (manufactured, financial, social, human, natural). Countries can also choose to explore metrics other than GDP that capture these benefits. Those who act decisively will capture this decade and establish themselves in pole position in a global race to the top.

Governments can lead these shifts confident in the political and economic dividends. Policymakers can champion low-carbon industries, knowing that this will deliver competitive and resilient industries at scale, delivering good stable jobs. In many countries and sectors, this is already happening.

The case for enlightened self-interest has never been stronger. Those countries, companies and cities that act decisively today will strengthen their own competitive prospects and drive a real economy transformation that can deliver high-quality, lower-risk growth, jobs and returns.



APPENDIX A

Defining the stage of solution maturity
For the first three stages of solution development, the definition of what constitutes each stage is similar across sectors (see table to right).

For the next two stages, what is considered to be "mass market" and "late market" differs. Generally it is as follows.

- Mass Market: solution is serving >5% (differs by sector, depending on sector dynamics) of new sales/ build and a market tipping point has been crossed that is pulling the share served by the solution upward at an accelerating pace. This is the case across a majority of relevant countries.
- Late Market: regulations are spreading in many countries that will drive the high-carbon incumbent solutions towards 0% market share over time.

Concept	Solution Development	Niche Market
Solution has been conceived but no substantial investments yet put into solution development	Investments are being made in solution, technologies and/ or projects are being deployed even at commercial scale but limited to few instances. No consistent market as yet.	Solutions have found a market to serve, even if early niche market, e.g., supported by public procurement or considerable minority of buyers willing to pay a premium.

	Mass Market	Late Market
Power - Solar & wind	First market tipping point • New solar / wind cheaper than new fossil Second market tipping point to further accelerate • New solar / wind + batteries (@20% capacity) cheaper than new fossil	• Coal early closure dates & mechanisms to facilitate this (e.g., financing mechanisms) • Carbon pricing on electricity sector to limit use of gas
Light road transport -Electric vehicles	• Electric vehicles have cheaper total cost of ownership than internal combustion • Electric vehicles have cheaper upfront cost than internal combustion + • Sufficient electric vehicle charging infrastructure (e.g., 1 chargepoint per 10-20 EVs)	• Internal combustion sales bans
Building heating -Heat pumps	• Total cost of heating with electric heat pump is less than heating with gas boiler and sufficiently attractive in other purchase criteria that heat pumps are penetrating >5% sales of replacement heating systems in existing buildings.	• Ban on the sale of new gas boilers or considerable tax on fossil fuels for home heating, combined with funds for heating to low-income households to avoid energy poverty.
Trucking -Electric trucks	• Electric (or hydrogen-electric, option for catenary) lower cost per ton of cargo delivered per kilometer. • Electric trucks capturing >5% of new truck sales	• Ban on sales of internal combustion trucks.
Agriculture - Precision agriculture - Regenerative agriculture - Alternative proteins	Below trends spreading across countries • Precision and regenerative agriculture: being used in 5+% of markets and scaling • Alternative proteins: seized 5+% of market share from animal proteins and scaling	Below measures spreading across countries. The ultimate configuration of sustainable agriculture will differ from place to place, due to the highly local nature of production and consumption patterns. • Public incentives reformed and/ or redirected in majority of countries to support transition • Knowledge-sharing tools scaled-up to accelerate diffusion
Land use change - NBS revenue stream through value for nature	• 30-50% of trade in soft commodity markets covered by effective net-zero deforestation commitments • 30-50% of members of FT500 setting net-zero nature positive science-based targets • Countries that represent 30-50% of the world's tropical forests have made net-zero nature positive commitments	• 80%+ of trade in soft commodity markets covered by effective net-zero deforestation commitments • 80%+ of members of FT500 setting net-zero nature positive science-based targets • Countries that represent 80%+ of the world's tropical forests have made net-zero nature positive commitments
Aviation - Sustainable aviation fuels - Electric planes	• Sustainable Aviation Fuels: serving over 5% of jet-fuel market and blending mandates spreading and scaling rapidly across countries. • Electric planes: over 5% of new planes built for ~100-seaters and smaller, and providing cheaper passenger-km travel v. kerosene planes	• Sustainable Aviation Fuels: blending mandates approaching 100% in plurality of countries (or complete offsets of aviation emissions) • Electric planes: bans on sales of kerosene-fuelled planes for ~100-seaters and below.
Shipping - Sustainable shipping fuel	• Zero-carbon fuels serving 5% of shipping fuel and mandates in place (e.g., from IMO) to drive this share upwards at pace.	• Regulations in place to ultimately drive carbon-emitting shipping fuels out of the market
Oil & gas fugitive emissions - Tracking, premium market	• Certifications, tracking, markets and regulations in place that have incentivized reductions of fugitive emissions by >5% and are rapidly scaling (e.g., towards 40%). Note: this could be possible by 2030, but it is hghly uncertain because the market is very immature at the moment.	• All major importing countries and major self-consumers of natural gas have measures in place to considerably constrain fugitive emissions.
Steel - H2 reduction	• >5% of primary production steel served by "green steel" made using low-carbon method (e.g., H2 DRI + EAF); regulations creating premium green steel markets are rapidly spreading, supported by carbon border adjustments putting price on embedded carbon in steel at import.	• All majorf steel consuming countries have sufficient regulations (e.g., carbon pricing on steel) to drive remaining high-carbon steel production processes out of the market in due time.
Cement	• >5% of cement market served by low-carbon cement and climbing.	• Regulations being implemented in majority of countries to phase out high-carbon cement.
Chemicals	• Low-carbon feedstocks capturing >5% share and scaling.	• High-carbon feedstocks being banned in majority of countries.

APPENDIX B

Indicators informing categorisation of low-carbon solution maturity	2015	2020	2030 Conceivable
Power - Solar & wind	Solar & wind expensive versus gas & coal	Solar & wind cheapest new generation in 70% countries by GDP ; 2/3 new generation in 2019.	Solar/wind cheaper than gas/coal everywhere. Solar/ wind + batteries cheaper in more and more countries.
Light road transport -Electric vehicles	Electric vehicles luxury buy; few models	Nearing cost parity; over 230 models	EVs surpassed ICE on upfront cost & other buyer criteria. By 2030, approximately one-third of the sales that would typically result from urbanisation and economic development will not happen as a result of MaaS.
Building heating -Heat pumps	Heat pumps not cost competitive with gas boiler	Reversible heat pumps cost competitive with gas boiler + air conditioner in some locations ; heat pumps serving only 5% of global building heating	Potential for heat pumps to improve efficiency (e.g., raising heat pump seasonal performance factor to 4.5-5.5 by 2030) and reach sufficient cost advantage to be highly attractive option, including for replacement in existing buildings.
Trucking -Electric trucks	Short-haul competitive in some locations on Total Cost of Ownership (TCO)	Short-haul and medium-haul possibly competitive on TCO in some locations	Short-, medium- and long-haul possibly competitive on TCO in many locations by 2030
Agriculture - Precision agriculture - Regenerative agriculture - Alternative proteins	- Growing recognition of potential for precision agriculture – but limited roll-out; - Niche alternative protein market; Beyond Meat US operations; Impossible Foods not yet launched	~$4 billion precision agriculture market; major companies committed to regenerative agriculture (Walmart, Cargill, General Mills) and evidence of benefits (63% of cases deliver win-wins); sixfold increase of investment in vertical farming since 2015 - $5 billion alternative proteins market (has grown 30% in two years)	- Regenerative agriculture could be rolled out across millions of hectares of land through company value-chains (50 million acres by Walmart by 2030); precision agriculture to reach market value of $12 billion and vertical agriculture $7 billion by 2025 - Alternative proteins $85 billion market and potentially 5x cheaper than existing animal proteins by 2030; estimates for share of total protein market range from 3% by 2025 to 60% by 2040.
Land use change - NBS revenue stream through value for nature	- Limited global coordination/ country commitments on deforestation-free supply-chains, let alone policies - Limited trust in forestry and land use credits; lack of clarity on role in decarbonisation journey	- Two-thirds of countries have Nature Based Solutions in Nationally Determined Contributions (NDCs) - Governments increasingly implementing policies to reward sustainable practices/ penalise unsustainable practices, e.g., 2018 France introduces policy re imported deforestation (UK and EU considering); UK ELM scheme rewards farmers for public goods Carbon markets -$160m forestry & land use credits (double value in 2017); average $823m annual forest funding since 2013 (incl public funding) - Corporate demand at-scale: >1500 companies committed to net zero, will require offsetting - Processes in place to begin to address supply- (e.g., technological advances) and demand-side (e.g., Science-based Targets for Nature, Task Force on Scaling Voluntary Carbon Markets) integrity issues	Potential for $50billion market by 2030. A $50 billion market is the estimated investment opportunity for tropical forests and peatlands by 2030, based on reaching the goal of close to zero gross deforestation, accompanied by significant restoration. With players like IKEA and others committing to large-scale investments in nature, in line with science-based targets, if these trends continue we could see over 30% of FT500 (or equivalent volume of interest in investments in nature) by 2030. Beyond revenue streams from the private sector, public sector investments in nature (which constitute the majority of investments in nature today), could also see considerable growth between now and 2030.
Aviation - Sustainable aviation fuels - Electric planes	Limited if any pilot projects. Very limited use of SAFs	-200,000 SAFs produced globally – less than 0.1% of total ~300 million tons of jet fuel used - 200+ electric plane developments.	SAF capacity in Europe to double in next 5 years. Blending mandates scaling, 2-30% across countries in Western Europe by 2030 . Smaller electric planes commercial (100+ seater commercial in 2030s).
Shipping - Sustainable shipping fuel	Net-zero not discussed	66-zero emissions pilot and demonstration projects	Scale green-fuelled ships on the water as soon as 2024; (green) ammonia engines by 2024 ; larger-scale pilots possible by 2025
Oil & gas fugitive emissions - Tracking, premium market	Limited awareness of issue	Broad awareness among key actors; recognition that reductions can be achieved cost effectively; independent certification systems coming forward; legislative plans ; satellites, and other monitoring (planes, sensors) increasingly being deployed for tracking & monitoring.	Could deliver 40% fugitive emissions reductions by 2030. Many challenges present and solutions not yet mature, though considerable progress underway. This is on the border of niche / mass market by 2030.
Steel - H2 reduction	Net-zero not discussed	Green primary production plants in development (e.g., HYBRIT, Baowu Group)	First green virgin steel plants online.
Cement	Net-zero not discussed	30 large-scale CCUS projects set to launch by 2023 Industry pilots in clean heat generation + low-carbon chemistry.	Plans for some projects to go commercial in early 2020s, but trajectory of technology is uncertain.
Chemicals	Net-zero not discussed	Mechanical recycling accounts for <14% total; chemical recycling accounts for <0.1% total	Alternative low-carbon (non-fossil) feedstocks offer potential alternatives to conventional plastic (TBC not yet cost competitive) Up to 40% plastics are recycled and/or re-used.

See relevant sections of the report for further information and references.

Executive Summary Endnotes

1. United Nations Environment Programme (UNEP). (2017). The Emissions Gap Report 2017. https://www.unenvironment.org/resources/emissions-gap-report-2017.

2. UNEP. (2017). The Emissions Gap Report 2019. https://www.unenvironment.org/resources/emissions-gap-report-2019.

3. New Climate Economy (2018). Unlocking The Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times. https://newclimateeconomy.report/2018; Lamy, P., Pons, G., Borchers-Gasnier, A., Leturcq, P., Delair, M., Magdalinski, E., & Pellerin-Carlin, T. (2020). Greener After - A Green Recovery Stimulus for a post-COVID-19 Europe.; Goldman Sachs. (2020).Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf; ILO (2018), World Employment Social Outlook 2018: Greening with jobs, Geneva: International Labour Organization, https://www.ilo.org/wesogreening/documents/WESO_Greening_EN_web2.pdf

4. NewClimate Institute & Data-Driven EnviroLab. (2020). Navigating the nuances of net-zero targets. https://newclimate.org/wp-content/uploads/2020/10/NewClimate_NetZeroReport_October2020.pdf.

5. European Commission (EC). (2020). Commission launches public consultations on energy taxation and a carbon border adjustment mechanism. https://ec.europa.eu/taxation_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism_en, accessed December 1, 2020.

6. Government U.K. (2020). Carbon Emissions Tax – closed consultation. https://www.gov.uk/government/consultations/carbon-emissions-tax, accessed December 1, 2020.

7. Green, M. (2020). U.S. could adopt carbon tax under a Biden presidency, ex-Fed Chair Yellen says. Reuters. https://uk.reuters.com/article/us-usa-climate-tax/u-s-could-adopt-carbon-tax-under-a-biden-presidency-ex-fed-chair-yellen-says-idUKKBN26T23L, accessed December 1, 2020.

8. For percentage of global imports in 2019 (EU 14%, US, 16.5%;), see: Eurostat. (2020). Share of European Union EU27 (from 2020) in the World Trade. https://ec.europa.eu/eurostat/databrowser/view/EXT_LT_INTROEU27_2020__custom_274611/default/table?lang=en, accessed November 23, 2020.

9. NewClimate Institute & Data-Driven EnviroLab. (2020).

10. Baker, S. (2020). Global ESG-data driven assets hit $40.5 trillion. Pension & Investments. https://www.pionline.com/esg/global-esg-data-driven-assets-hit-405-trillion#:~:text=The%20value%20of%20global%20assets,to%20%2440.5%20trillion%20in%202020, accessed November 30, 2020.

11. United Nations-Convened Net-Zero Asset Owner Alliance. (2020). Institutional investors transitioning their portfolios to net zero GHG emissions by 2050. https://www.unepfi.org/net-zero-alliance/, accessed November 30, 2020.

12. Sim, B. (2020). Bank of England to roll out climate stress tests in June 2021, says Bailey. Financial News. https://www.fnlondon.com/articles/bank-of-england-to-roll-out-climate-stress-tests-in-june-2021-says-bailey-20201109, accessed November 20, 2020.

13. Mazzacurati, E. (2017). Art. 173: France's Groundbreaking Climate Risk Reporting Law. Four Twenty Seven. http://427mt.com/2017/01/16/impact-french-law-article-173/, accessed November 23, 2020.

14. Elliot, L. (2020). UK to make climate risk reports mandatory for large companies. The Guardian. https://www.theguardian.com/environment/2020/nov/09/uk-to-make-climate-risk-reports-mandatory-for-large-companies, accessed November 13, 2020.

15. Ministry of the Environment New Zealand (MfE). (2020). Mandatory climate-related financial disclosures. https://www.mfe.govt.nz/climate-change/climate-change-and-government/mandatory-climate-related-financial-disclosures, accessed November 30, 2020.

16. International Energy Agency (IEA). (2014). Technology Roadmap Solar Photovoltaic Energy – 2014 edition. https://webstore.iea.org/download/direct/421.

17. IEA. (2020). Solar Energy Mapping the road ahead. https://webstore.iea.org/download/direct/2890?fileName=Solar_Energy_Mapping_the_road_ahead.pdf, accessed December 2, 2020.

18. BloombergNF. (2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

19. BNEF. (2020). Solar and wind reach 67% of new power capacity added globally in 2019, while fossil fuels slide to 25%. https://about.bnef.com/blog/solar-and-wind-reach-67-of-new-power-capacity-added-globally-in-2019-while-fossil-fuels-slide-to-25, accessed December 2, 2020.

20. News reports, including Renewable Energy Magazine, 'ReNew Power Wins India's First Round-the-Clock Renewable Energy Tender', https://www.renewableenergymagazine.com/pv_solar/renew-power-wins-indiaa-s-first-roundtheclock-20200526#

21. SYSTEMIQ analysis based on BNEF (2020), Rocky Mountain Institute (RMI). (2020). How to retire early. https://rmi.org/insight/how-to-retire-early/, accessed December 1, 2020; Climate Policy Initiative (2017). Flexibility: the path to low-carbon, low-cost electricity grids. https://www.climatepolicyinitiative.org/publication/flexibility-path-low-carbon-low-cost-electricity-grids/ ; Pierpont (2017). Mind the Storage Gap. https://www.greentechmedia.com/articles/read/mind-the-storage-gap-how-much-flexibility-do-we-need-for-a-high-renewables, accessed December 1, 2020

22. Mercure, M. (2020). Texas Leads the Way in Wind Power. North American Windpower. https://nawindpower.com/texas-leads-the-way-in-wind-power, accessed November 30, 2020.

23. International Energy Agency (IEA). (2016). Global EV Outlook 2016. https://webstore.iea.org/download/direct/347.

24. UBS Group (2020). Tearing Down the Heart of an Electric Car Lab 2: Cost Parity a Closer Reality? https://www.ubs.com/global/en/investment-bank/in-focus/2020/heart-of-electric-car.html, accessed December 1, 2020

25. Tesla. (2020). Model S Long Range Plus: Building the First 400-Mile Electric Vehicle. https://www.tesla.com/blog/model-s-long-range-plus-building-first-400-mile-electric-vehicle, accessed December 1, 2020.

26. SYSTEMIQ analysis, 2015 data based on Longo et al. (2015). How is the spread of the Electric Vehicles? In 2015 IEEE 1st International Forum on Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI). https://doi.org/10.1109/RTSI.2015.7325137.; 2020/2022 data based on McKinsey & Company (2020). McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/mckinsey-electric-vehicle-index-europe-cushions-a-global-plunge-in-ev-sales, accessed December 1, 2020.

27. Whitten, S. (2019). The death of the DVD: Why sales dropped more than 86% in 13 years. https://www.cnbc.com/2019/11/08/the-death-of-the-dvd-why-sales-dropped-more-than-86percent-in-13-years.html#:~:text=Since%202008%2C%20DVD%20sales%20have,caused%20DVD%20sales%20to%20plummet.v, accessed November 30, 2020.

28. Lombrana, L.M. & Ojambo, F. (2020). Africa's First Electric Bus Plant Will Industrialize Uganda While Fighting Pollution. Bloomberg. https://www.bloomberg.com/news/articles/2020-08-11/africa-s-first-electric-bus-plant-industrializes-a-region, accessed November 30, 2020.

29. Ibid.

30. McKinsey & Company. (2017). How shared mobility will change the automotive industry. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-shared-mobility-will-change-the-automotive-industry, accessed November 30, 2020.

31. Søgaard, K. & Bringham, C. (2020). Mapping of zero emission pilots and demonstration projects. Global Maritime Forum. https://www.globalmaritimeforum.org/news/mapping-of-zero-emission-pilots-and-demonstration-projects/, accessed November 30, 2020.

32. International Civil Aviation Organisation (ICAO). (2020). Sustainable Aviation Fuels (SAF). https://www.icao.int/environmental-protection/pages/SAF.aspx, accessed December 1, 2020.

Executive Summary Endnotes

33. Roland Berger. (2020). Electrically Propelled Aircraft Developments Exceed 200 For The First Time. https://www.rolandberger.com/en/Point-of-View/Electric-propulsion-is-finally-on-the-map.html, accessed November 30, 2020.

34. European Regions Association. (2020). Green and Sustainable Connectivity: ERA's first sustainability report. https://www.eraa.org/era-sustainability-report-confirms-need-governments-invest-regional-aviation.

35. Moore, A. (2019). Hydrogen market in China to receive boost from Linde and Baowu Group partnership. https://www.hydrogenfuelnews.com/hydrogen-market-in-china-to-receive-boost-from-linde-and-baowu-group-partnership/8538996/, accessed December 7, 2020.

36. SYSTEMIQ analysis based on Hydrogen Council (2020). Path to hydrogen competitiveness - A cost perspective. https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/.

37. Energy Transitions Commission (ETC). (2018). Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC_MissionPossible_FullReport.pdf.

38. SYSTEMIQ & The PEW Charitable Trusts. (2020). Breaking the Plastic Wave. A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution. https://www.systemiq.earth/breakingtheplasticwave/

39. The Good Food Institute (GFI). (2020). Plant-Based Market Overview. https://www.gfi.org/marketresearch, accessed November 12, 2020.

40. UBS Group. (2019). Is mock meat the future of food? https://www.ubs.com/microsites/wma/insights/en/investing/2019/meat.html, accessed November 13, 2020.

41. Department for Food, Environment and Rural Affairs. (2020). The Environmental Land Management scheme: an overview. https://www.gov.uk/government/publications/the-environmental-land-management-scheme-an-overview

42. Ecosystem Marketplace. (2020). State of the Voluntary Carbon Markets 2020: Voluntary Carbon and the Post-Pandemic Recovery. https://www.forest-trends.org/publications/state-of-the-voluntary-carbon-markets-2020/, accessed December 1, 2020.

43. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

44. Dolphin, G. & Pollitt, M. (2019). Climate policy diffusion. Judge Business School, University of Cambridge and Energy Policy Research Group (EPRG). EPRG Winter Seminar. https://www.eprg.group.cam.ac.uk/wp-content/uploads/2019/12/G.-Dolphin_Winter2019.pdf, accessed November 30, 2020.

45. SYSTEMIQ analysis.

46. Kuykendall, T. (2020). US coal stocks continue sharp decline into 2020. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-coal-stocks-continue-sharp-decline-into-2020-56940158, accessed November 30, 2020.

47. Shearer, C. (2020). Guest post: How plans for new coal are changing around the world. CarbonBrief. https://www.carbonbrief.org/guest-post-how-plans-for-new-coal-are-changing-around-the-world, accessed November 26, 2020.

48. Jones, C. (2020). Trump's Coal Resurgence Promise Has Gone Underground. Forbes. Data based on U.S. Energy Information Administration (EIA). (2020). https://www.forbes.com/sites/chuckjones/2020/08/26/trumps-coal-resurgence-promise-has-gone-underground/?sh=581c92c856d8, accessed November 30, 2020.

49. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

50. Bloomberg. (2020). Oersted:DC. https://www.bloomberg.com/quote/ORSTED:DC.

51. McKinsey & Company. (2014). Beyond the storm – value growth in the EU power sector. https://www.mckinsey.com/~/media/mckinsey/featured%20insights/europe/beyond%20the%20storm%20value%20growth%20in%20the%20eu%20power%20sector/beyond_the_storm_value_growth_in_the_eu_power_sector.pdf.

52. Eckhouse, B. & Wade, W. (2020). NextEra Now More Valuable Than Exxon as Clean Power Eclipses Oil. Bloomberg Quint. https://www.bloombergquint.com/business/nextera-now-more-valuable-than-exxon-as-clean-energy-unseats-oil#:~:text=(Bloomberg)%20%2D%2D%20NextEra%20Energy%20Inc,billion%2C%20topping%20Exxon's%20%24142%20billion, accessed November 30, 2020.

53. Robinson, D. (2013). Pulling the Plug on Renewable Power in Spain. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/12/Pulling-the-Plug-on-Renewable-Power-in-Spain.pdf.

54. Climate Action. (2019). Climate change now a priority in European election results. http://www.climateaction.org/news/climate-change-now-a-priority-in-european-election-results, accessed December 3, 2020; Summers, J. (2020). The UK's Climate Election. Climate Institute. http://climate.org/the-uks-climate-election/, accessed December 3, 2020; International Institute for Sustainable Development. (IISD). (2020). New Zealand's Prime Minister Expected to Address Climate Crisis During Recovery. https://www.iisd.org/sustainable-recovery/news/new-zealands-prime-minister-expected-to-address-climate-crisis-during-recovery/, accessed 03 December 2020; Dolsak, N. & Prakash, A. (2020).Forbes. Will The Biden Administration Transform U.S. Climate Policy? https://www.forbes.com/sites/prakashdolsak/2020/10/16/will-the-biden-administration-transform--us-climate-policy/?sh=3e890eef4d4c, accessed December 3, 2020.

55. Kirk, D. (2020). Korea Reveals 'New Deal' Designed To Boost Jobs, Revive Sagging Economy. Forbes. https://www.forbes.com/sites/donaldkirk/2020/07/14/koreas-reveals-new-deal-designed-to-boost-jobs-revive-sagging-economy/?sh=7702f80c3250, accessed November 30, 2020.

56. Ambrose, J. (2020). Rishi Sunak sets out £100bn investment in infrastructure. The Guardian. https://www.theguardian.com/politics/2020/nov/25/rishi-sunak-sets-out-100bn-investment-in-infrastructure, accessed November 30, 2020.

57. Hook, L., Pickard, J. (2020). UK challenges other nations with emissions upgrade. Financial Times. https://www.ft.com/content/5e7979df-2013-42e8-84e8-460fba14fdda, accessed December 7, 2020.

58. Henley, J. (2020). France's 'big green recovery plan' not big enough for campaigners. The Guardian. https://www.theguardian.com/world/2020/sep/03/france-launches-big-green-recovery-plan-part-100bn-stimulus-covid, accessed November 30, 2020.

59. NewClimate Institute & Data-Driven EnviroLab (2020).

60. Energy & Climate Intelligence Unit. (2020). Net Zero Carbon Tracker. https://eciu.net/netzerotracker, accessed November 30, 2020.

61. Under2 Coalition. (2020). https://www.theclimategroup.org/under2-coalition, accessed November 30, 2020.

62. McGrath, M. (2020). Climate change: China aims for 'carbon neutrality by 2060'. BBC News. https://www.bbc.com/news/science-environment-54256826, accessed November 30, 2020.

63. Biden, J. (2020). https://joebiden.com/climate-plan/, accessed November 30, 2020.

64. Ge, M. & Friedrich, J. (2020). 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors. World Resource Institute (WRI). https://www.wri.org/blog/2020/02/greenhouse-gas-emissions-by-country-sector, accessed November 30, 2020.

65. European Commission (EC). (2020). Commission launches public consultations on energy taxation and a carbon border adjustment mechanism. https://ec.europa.eu/taxation_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism_en, accessed December 1, 2020.

Executive Summary Endnotes

66. Government U.K. (2020). Carbon Emissions Tax – closed consultation. https://www.gov.uk/government/consultations/carbon-emissions-tax, accessed December 1, 2020.

67. Green, M. (2020). U.S. could adopt carbon tax under a Biden presidency, ex-Fed Chair Yellen says. Reuters. https://uk.reuters.com/article/us-usa-climate-tax/u-s-could-adopt-carbon-tax-under-a-biden-presidency-ex-fed-chair-yellen-says-idUKKBN26T23L, accessed December 1, 2020.

68. Eurostat. (2020).

69. NewClimate Institute & Data-Driven EnviroLab. (2020).

70. Science Based Targets Initiative (SBTi). (2020). https://sciencebasedtargets.org/news/science-based-targets-initiative-launches-process-to-develop-first-science-based-global-standard-for-corporate-net-zero-targets, accessed November 30, 2020.

71. Task Force on Climate-related Financial Disclosures (TCFD). (2020). More than 1,000 Global Organizations Declare Support for the Task Force on Climate-related Financial Disclosures and its Recommendations. https://assets.bbhub.io/company/sites/60/2020/02/PR-TCFD-1000-Supporters_FINAL.pdf, accessed November 30, 2020.

72. United Nations-Convened Net-Zero Asset Owner Alliance. (2020).

73. Mazzacurati, E. (2017).

74. Elliot, L. (2020).

75. MfE. (2020).

76. Sim, B. (2020).

77. Network for Greening the Financial System (NGFS). (2020). https://www.ngfs.net/en, accessed November 30, 2020.

78. Woodward et al., (2020). Electric Vehicles – setting a course. Deloitte Insights. https://www2.deloitte.com/uk/en/insights/focus/future-of-mobility/electric-vehicle-trends-2030.html, accessed November 30, 2020.

79. Rauwald, C. (2019). VW Challenges Rivals With $66 Billion for Electric Car Era. Bloomberg. https://www.bloomberg.com/news/articles/2019-11-15/vw-boosts-new-technology-spending-to-66-billion-through-2024, accessed November 30, 2020.

80. Skydsgaard, N. (2020). Maersk heads zero-carbon drive in shipping sector with $60 million research center. Reuters. https://uk.reuters.com/article/uk-shipping-climatechange-maersk/maersk-heads-zero-carbon-drive-in-shipping-sector-with-60-million-research-center-idUKKBN23W0PV, accessed November 30, 2020.

81. International Airlines Group (IAG). (2020). IAG Backs Net Zero Co2 Emissions By 2050. https://www.iairgroup.com/en/newsroom/press-releases/newsroom-listing/2019/net-zero-emissions#:~:text=International%20Airlines%20Group%20(IAG)%20is,global%20warming%20to%201.5%20degrees, accessed November 30,2020.

82. One World Alliance. (2020). oneworld member airlines commit to net zero carbon emissions by 2050. https://www.oneworld.com/news/2020-09-11-oneworld-member-airlines-commit-to-net-zero-carbon-emissions-by-2050, accessed November 30, 2020.

83. SYSTEMIQ analysis based on World Steel Association (2020). World Steel in Figures 2020. Companies include ArcelorMittal, Tata Steel, Thyssenkrupp and SSAB. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

84. Cemnet. (2019). Dalmia Cement sets carbon neutrality target for 2040. https://www.cemnet.com/News/story/167365/dalmia-cement-sets-carbon-neutrality-target-for-2040.html, accessed December 2, 2020.

85. GreenBiz. (2019). Cement giant Heidelberg pledges carbon neutral concrete by 2050. https://www.greenbiz.com/article/cement-giant-heidelberg-pledges-carbon-neutral-concrete-2050, accessed December 2, 2020.

86. General Mills. (2020). Regenerative Agriculture. https://www.generalmills.com/en/Responsibility/Sustainability/Regenerative-agriculture, accessed December 2, 2020.

87. Cargill. (2020). Cargill to advance regenerative agriculture practices across 10 million acres of North American farmland by 2030. https://www.cargill.com/2020/cargill-to-advance-regenerative-agriculture-practices-across-10, accessed December 2, 2020.

88. McMillon, D. (2020). Walmart's Regenerative Approach: Going Beyond Sustainability. Walmart. https://corporate.walmart.com/newsroom/2020/09/21/walmarts-regenerative-approach-going-beyond-sustainability, accessed November 30, 2020.

89. Ellen MacArthur Foundation. (2020). The New Plastics Economy Global Commitment 2019 Progress Report. https://www.ellenmacarthurfoundation.org/assets/downloads/Global-Commitment-2019-Progress-Report.pdf, accessed November 30, 2020.

Main Report Endnotes

1. International Energy Agency (IEA). (2014). Technology Roadmap Solar Photovoltaic Energy 2014 edition. https://webstore.iea.org/download/direct/421

2. IEA. (2020). Solar Energy Mapping the road ahead. https://webstore.iea.org/download/direct/2890?fileName=Solar_Energy_Mapping_the_road_ahead.pdf, accessed December 2, 2020.

3. BNEF. (2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

4. BNEF.(2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

5. CarbonBrief. (2020). Solar is now 'cheapest electricity in history', confirms IEA. https://www.carbonbrief.org/solar-is-now-cheapest-electricity-in-history-confirms-iea, accessed December 7, 2020.

6 Blackrock Investment Institute, Asymco. available at: https://www.businessinsider.com/blackrock-topic-we-should-be-paying-attention-charts-2015-12?r=US&IR=T#1-adoption-of-technology-in-the-us-1900-to-present-1, accessed December 7, 2020.

7. BNEF. (2020). 'Hydrogen Economy' Offers Promising Path to Decarbonization. https://about.bnef.com/blog/hydrogen-economy-offers-promising-path-to-decarbonization/, accessed December 7, 2020.

8. Climate Action. (2015). Impossible Foods announces $108m funding for plant-based burger. http://www.climateaction.org/news/impossible_foods_announces_108m_funding_for_plant_based_burger, accessed December 4, 2020.

9. Bloomberg News. (2020). Beyond Meat's $4 Billion Rival Is in Fresh Funding Talks. https://www.bloomberg.com/news/articles/2020-05-02/beyond-meat-s-4-billion-rival-is-said-in-fresh-funding-talks, accessed December 4, 2020.

10. Businesswire. (2020). Impossible Foods Closes $200 Million in Funding to Accelerate Growth. https://www.businesswire.com/news/home/20200813005733/en/Impossible-Foods-Closes-200-Million-in-New-Funding-to-Accelerate-Growth, accessed December 4, 2020.

11. Estimation based on IRENA Renewable Cost Database and Auctions Database. (2020). https://www.irena.org/Statistics/View-Data-by-Topic/Costs/Global-Trends, accessed December 7, 2020 and expert input

12. China Dialogue. (2020). China releases 2020 action plan for air pollution. https://chinadialogue.net/en/pollution/10711-china-releases-2-2-action-plan-for-air-pollution/, accessed December 7, 2020.

13. Culmer, K. (2020). Unleaded fuel is now an inevitability – sooner or later, we will all be filling our cars with it," Autocar wrote in its 11 January 1989 issue. Autocar. https://www.autocar.co.uk/car-news/anything-goes-throwback-thursday/throwback-thursday-1989-switchover-unleaded-petrol, accessed December 4, 2020.

14. Kuykendall, T. (2020). US coal stocks continue sharp decline into 2020. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-coal-stocks-continue-sharp-decline-into-2020-56940158, accessed November 30, 2020.

15. Bousso, R. (2020). BP wipes up to £14 billion from assets with bleaker oil outlook. https://uk.reuters.com/article/uk-bp-writeoffs-idUKKBN23M0N3 , accessed December 7, 2020.

16. Bousso, R. (2020). Shell to cut asset values by up to $22 billion after coronavirus hit. Reuters. https://www.reuters.com/article/us-shell-outlook-idUSKBN2410OQ, accessed December 7, 2020.

17. Domonske, C. (2020). Exxon Mobil Exits: The Dow Drops Its Oldest Member. NPR. https://www.npr.org/2020/08/25/905818004/exxon-mobil-exits-the-dow-drops-its-oldest-member?t=1607326577348, accessed December 7, 2020.

18. IEA. (2020). Heat Pumps. https://www.iea.org/reports/heat-pumps.

19. SYSTEMIQ analysis based on BNEF (2020), Rocky Mountain Institute (RMI). (2020). How to retire early. https://rmi.org/insight/how-to-retire-early/. Accessed December 1, 2020; Climate Policy Initiative (2017). Flexibility: the path to low-carbon, low-cost electricity grids. https://www.climatepolicyinitiative.org/publication/flexibility-path-low-carbon-low-costelectricity-grids/. Pierpont (2017). Mind the Storage Gap. https://www.greentechmedia.com/articles/read/mind-the-storage-gap-how-much-flexibility-dowe-need-for-a-high-renewables. accessed December 1, 2020.

20. BNEF. (2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

21. Rocky Mountain Institute (RMI). (2020). How to retire early. https://rmi.org/insight/how-to-retire-early/, accessed December 1, 2020.

22. Energy Transitions Commission (2020). Making Mission Possible. https://www.energy-transitions.org/wp-content/uploads/2020/09/Making-Mission-Possible-Full-Report.pdf . Charts draw from Bloomberg New Energy Finance

23. Estimation indicated in IRENA. (2019). Future of Solar Photovoltaic. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Nov/IRENA_Future_of_Solar_PV_2019.pdf; IRENA. (2019). Future of Wind. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf; BNEF. (2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

24. Example initiative seeking to bring higher efficient cells to mass market is Oxford PV: AZO Materials. Oxford PV and the Latest Solar Power Breakthrough. https://www.azom.com/article.aspx?ArticleID=19575. Accessed December 4, 2020.

25. Abnett, K. (2020). EU eyes huge increase in offshore wind energy to meet climate goals: draft. Reuters. https://www.reuters.com/article/us-eu-energy-offshore-idUSKBN27M1IX, accessed December 4, 2020.

26. Based on Pierpont et al.(2017). Flexibility - The path to low-carbon, low-cost electricity grids. Climate Policy Initiative. https://www.climatepolicyinitiative.org/wp-content/uploads/2017/04/CPI-Flexibility-the-path-to-low-carbon-low-cost-grids-April-2017.pdf, accessed December 4, 2020; Mind the Storage Gap. https://www.greentechmedia.com/articles/read/mind-the-storage-gap-how-much-flexibility-do-we-need-for-a-high-renewables, accessed December 1, 2020.

27. BNEF. (2020). Solar and wind reach 67% of new power capacity added globally in 2019, while fossil fuels slide to 25%. https://about.bnef.com/blog/solar-and-wind-reach-67-of-new-power-capacity-added-globally-in-2019-while-fossil-fuels-slide-to-25, accessed December 2, 2020.

28. Based on news reports, including Renewable Energy Magazine. ReNew Power Wins India's First Roundthe- Clock Renewable Energy Tender. https://www.renewableenergymagazine.com/pv_solar/renewpower-wins-indiaa-s-first-roundtheclock-20200526#, accessed December 3, 2020.

29. Global Wind Energy Council (GWEC). 2020. Global Offshore Wind Report 2020. https://gwec.net/global-offshore-wind-report-2020/, accessed December 4, 2020.

30. Gabbatiss, J. (2019). UK primary energy use in 2018 was the lowest in half a century. CarbonBrief. https://www.carbonbrief.org/analysis-uk-primary-energy-use-in-2018-was-the-lowest-in-half-a-century, accessed December 4, 2020.

31. Garrett-Peltier, H.(2017). Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model. https://doi.org/10.1016/j.econmod.2016.11.012. Study finds that $1m spending can generate 7.5 FTE jobs in renewables and 7.72 FTE jobs in energy efficiency, in contrast to 2.65 FTE jobs in fossil fuel industries with the same investment.

32. IRENA.(2020). Renewable Energy and Jobs Annual Review 2020. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Sep/IRENA_RE_Jobs_2020.pdf, accessed December 4, 2020.

33. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

34. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

Main Report Endnotes

35. Industrial Global Union. (2018). Spanish coal unions win landmark Just Transition deal. http://www.industriall-union.org/spanish-coal-unions-win-landmark-just-transition-deal, accessed December 4, 2020.

36. SYSTEMIQ analysis.

37. For example the BMW i3 is 3.8 times cheaper to fuel than the BMW 318i (equivalent ICE): Evans, J. (2020). Cost of running an electric car. Buyacar.com.https://www.buyacar.co.uk/cars/economical-cars/electric-cars/650/cost-of-running-an-electric-car, accessed December 7, 2020; Similarly, the Hyundai IONIQ (EV) is 3 times cheaper to fuel than the Hyundai i30 1.4 T-GDI Trend DCT (ICE): The mobility house. (2020). Electric vs. Combustion – Which Car Pays Off? https://www.mobilityhouse.com/int_en/knowledge-center/cost-comparison-electric-car-vs-petrol-which-car-costs-more-annually#consumption, accessed December 7, 2020; Hanley, S. (2020). It's Official — Consumer Reports Confirms EV Owners Spend Half As Much On Maintenance. Cleantechnica. https://cleantechnica-com.cdn.ampproject.org/c/s/cleantechnica.com/2020/09/26/its-official-consumer-reports-confirms-ev-owners-spend-half-as-much-on-maintenance/amp/, accessed December 7, 2020.

38. UBS Group (2020). Tearing Down the Heart of an Electric Car Lab 2: Cost Parity a Closer Reality? https://www.ubs.com/global/en/investment-bank/in-focus/2020/heart-of-electric-car.html, accessed December 1, 2020.

39. BNEF. (2019). Bullard: Electric Car Price Tag Shrinks Along With Battery Costs. https://about.bnef.com/blog/bullard-electric-car-price-tag-shrinks-along-battery-cost/, accessed December 4, 2020.

40. 2019: 156$/kWh – Keen, K. (2020). As battery costs plummet, lithium-ion innovation hits limits, experts say. S&P Global. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/as-battery-costs-plummet-lithium-ion-innovation-hits-limits-experts-say-58613238, accessed December 7, 2020; 2015: 373$/kWh - Goldie, S. (2019). A Behind the Scenes Take on Lithium-ion Battery Prices. https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/, accessed December 7, 2020.

41. UBS Group.(2020). Tearing Down the Heart of an Electric Car Lab 2: Cost Parity a Closer Reality? (UBS). https://www.ubs.com/global/en/investment-bank/in-focus/2020/heart-of-electric-car.html, accessed December 1, 2020; BNEF. (2019). A Behind the Scenes Take on Lithium-ion Battery Prices. https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/#:~:text=This%20means%20that%20for%20every,and%20%2462%2FkWh%20by%202030, accessed December 4, 2020.

42. Global Fleet. (n.d.). untitled. https://www.globalfleet.com/en/financial-models/europe/analysis/europeans-lease-and-rent-more-cars-ever?a=BUY03&t%5B0%5D=Dataforce&curl=1, accessed December 4, 2020.

43. RethinkX. (2017). Rethinking Transportation 2020-2030. https://www.wsdot.wa.gov/publications/fulltext/ProjectDev/PSEProgram/Disruption-of-Transportation.pdf, accessed December 4, 2020.

44. Tesla. (2020). Model S Long Range Plus: Building the First 400-Mile Electric Vehicle. https://www.tesla.com/blog/model-s-long-range-plus-building-first-400-mile-electric-vehicle, accessed December 7, 2020.

45. McKinsey & Company. (2020). Electric Vehicle Index: Europe cushions a global plunge in EV sales. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/mckinsey-electric-vehicle-index-europe-cushions-a-global-plunge-in-ev-sales, accessed December 1, 2020

46. Longo et al. (2015). How is the spread of the Electric Vehicles? In 2015 IEEE 1st International Forum on Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI). https://doi.org/10.1109/RTSI.2015.7325137.

47. The Climate Center. (n.d.). Actions by countries to phase out internal combustion engines. https://theclimatecenter.org/actions-by-countries-phase-out-gas/, accessed December 4, 2020.

48. IEA. (2020). Global EV Outlook 2020. https://webstore.iea.org/download/direct/3007.

49. Kumar, P. & George C., T. (2020). Busting the cost barrier: Why electric three-wheelers make business sense. World Resource Institute(WRI) India. https://www.wricitiesindia.org/content/busting-cost-barrier-why-electric-three-wheelers-make-business-sense, accessed December 4, 2020.

50. IEA. (2020). Electric Vehicles. https://www.iea.org/reports/electric-vehicles, accessed December 4, 2020.

51. Sharpe, S. & Lenton, M., T. (2020). Upward-scaling tipping cascades to meet climate goals – plausible grounds for hope. University of Exeter, Global Systems Institute. https://www.exeter.ac.uk/media/universityofexeter/globalsystemsinstitute/documents/202001briefingnote.pdf, accessed December 4, 2020.

52. Based on IEA. (2020). Global EV Outlook 2020. https://webstore.iea.org/download/direct/3007; Society of Motor Manufacturers & Traders (SMMT). (n.d.). Electric Vehicle and Alternatively Fuelled Vehicle Registrations. https://www.smmt.co.uk/vehicle-data/evs-and-afvs-registrations/, accessed December 4, 2020.

53. International Council On Clean Transportation (ICCT). (2020). The end of the road? An overview of combustionengine car phase-out announcements across Europe. https://theicct.org/sites/default/files/publications/Combustion-engine-phase-out-briefing-may11.2020.pdf, accessed December 4, 2020.

54. Lombrana, L.M. & Ojambo, F. (2020). Africa's First Electric Bus Plant Will Industrialize Uganda While Fighting Pollution. Bloomberg.(2020). https://www.bloomberg.com/news/articles/2020-08-11/africa-s-first-electric-bus-plant-industrializes-a-region, accessed November 30, 2020.

55. Lombrana, L.M. & Ojambo, F. (2020). Africa's First Electric Bus Plant Will Industrialize Uganda While Fighting Pollution. Bloomberg.(2020). https://www.bloomberg.com/news/articles/2020-08-11/africa-s-first-electric-bus-plant-industrializes-a-region, accessed November 30, 2020.

56. Mackenzie, M. & Platt, E. (2020). Tesla's market value soars to $500bn ahead of S&P 500 debut. Financial Times. https://www.ft.com/content/97c5c50c-b00d-4031-bd15-1c5767c24242, accessed December 4, 2020.

57. Day, E. (2020). Tesla's S&P 500 Entry Has Market Seeking Next EV Cult Stock. Bloomberg. https://www.bloomberg.com/news/articles/2020-11-18/tesla-s-s-p-500-entry-has-investors-seeking-next-ev-cult-stock?sref=9caaYCoi, accessed December 4, 2020.

58. Nopea Ride. (n.d.). untitled. https://nopearide.com/, accessed December 6, 2020.

59. RethinkX. (2017). Rethinking Transportation 2020-2030. https://www.wsdot.wa.gov/publications/fulltext/ProjectDev/PSEProgram/Disruption-of-Transportation.pdf, accessed December 4, 2020.

60. McKinsey & Company. (2017). How shared mobility will change the automotive industry. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-shared-mobility-will-change-the-automotive-industry, accessed November 30, 2020.

61. Grab.(n.d.). Where We Are. https://www.grab.com/sg/locations/

62. https://www.cnbc.com/2020/06/16/grab-disruptor-50.html, accessed December 4, 2020.

63. Grab. (n.d.). Grab acquires wealth tech start-up Bento to bring retail wealth solutions to millions across Southeast Asia. https://www.grab.com/sg/press/business/grab-acquires-wealth-tech-start-up-bento-to-bring-retail-wealth-solutions-to-millions-across-southeast-asia/, accessed December 4, 2020.

64. Volkswagen. (n.d.). Personal und Organisation. https://www.volkswagen-newsroom.com/de/personal-und-organisation-3694, accessed December 4, 2020.

65. Volkswagen. (n.d.). Personal und Organisation. https://www.volkswagen-newsroom.com/de/personal-und-organisation-3694, accessed December 4, 2020.

66. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

67. Greenpeace. (2020). Toxic Air: The Price Of Fossil Fuels. https://www.greenpeace.org/static/planet4-southeastasia-stateless/2020/02/21b480fa-toxic-air-report-110220.pdf.

Main Report Endnotes

68. Jackson, J. & Hodges, K. (2020). How air pollution may influence the course of pandemics. Science Advances. https://doi.org/10.1126/sciadv.abf1897.

69. RethinkX. (2017). Rethinking Transportation 2020-2030. https://www.wsdot.wa.gov/publications/fulltext/ProjectDev/PSEProgram/Disruption-of-Transportation.pdf, accessed December 4, 2020.

70 Marsters, P. (2009). Electric Cars: The Drive for a Sustainable Solution in China. Wilson Center. https://www.wilsoncenter.org/publication/electric-cars-the-drive-for-sustainable-solution-china.

71. United Nations Environment Programme (UNEP). (n.d.). Beijing's battle to clean up its air. https://www.unenvironment.org/interactive/beat-air-pollution/, accessed December 4, 2020.

72. Heinrich Böll Stiftung (2019). Fighting Air Pollution: Mexico and China Show How to Do It. https://ba.boell.org/en/2019/01/30/fighting-air-pollution-mexico-and-china-show-how-do-it#_ftn7, accessed December 4, 2020.

73. Climate Group. (n.d.). Climate Group EV100. https://www.theclimategroup.org/ev100, accessed December 4, 2020.

74. Wu, S. & Yang, Z. (2020). Availability of Public Electric Vehicle Charging Pileand Development of Electric Vehicle: Evidence from China. Sustainability. https://www.mdpi.com/2071-1050/12/16/6369/pdf, accessed December 4, 2020.

75. Clover, C. & Fei Ju, S. (2017). Range anxiety powers China to invest in electric car-charging points. Financial Times. https://www.ft.com/content/f9aece28-d65f-11e7-8c9a-d9c0a5c8d5c9, accessed December 8, 2020.

76. Global Forest Watch (2019). untitled. https://cutt.ly/yhmGbV4. data based on: Hansen, M. C. et al. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53.

77. BBC.(2020). Brazil's Amazon: Deforestation 'surges to 12-year high. https://www.bbc.co.uk/news/world-latin-america-55130304, accessed December 4, 2020.

78. CarbonBrief. (2019). In-depth Q&A: The IPCC's special report on climate change and land. https://www.carbonbrief.org/in-depth-qa-the-ipccs-special-report-on-climate-change-and-land, accessed December 7, 2020.

79. Seddon, N. (n.d.). Nature-based Solutions in the NDCs: A synthesis and recommendations for enhancing ambition and action by 2020. Oxford University & International Union for Conservation of Nature. (IUCN). https://www.naturebasedsolutionsinitiative.org/wp-content/uploads/2018/12/NBSTalkforSideEvent.pdf, accessed December 7, 2020.

80. Chinese-English translation contracted by GIZ Forest Policy Facility to the Chinese Academy of Forestry.(2020). Forest Law. https://www.atibt.org/wp-content/uploads/2020/01/China-Forest-Law-Amendment-2020-20191228.pdf, accessed December 7, 2020.

81. Forest500. (2019). The companies getting it wrong on deforestation.https://forest500.org/publications/forest-500-annual-report-2019-companies-getting-it-wrong-deforestation, accessed December 7, 2020.

82. Business For Nature. (n.d.). untitled. https://www.businessfornature.org/advocate, accessed December 6, 2020.

83. IU energy. (n.d.). Consumer goods giants worth $1.8trn team up to tackle deforestation. https://iuenergy.co.uk/consumer-goods-giants-worth-1-8trn-team-up-to-tackle-deforestation/, accessed December 7, 2020.

84. Harris, B. (2020). Investors warn Brazil to stop Amazon destruction. Financial Times. https://www.ft.com/content/ad1d7176-ce6c-4a9b-9bbc-cbdb6691084f, accessed December 8, 2020.

85. Phillips, D. (2020). Investors drop Brazil meat giant JBS. The Guardian. https://www.theguardian.com/environment/2020/jul/28/investors-drop-brazil-meat-giant-jbs, accessed December 7, 2020.

86. Government of the United Kingdom. (2019). Monitor of Engagement with the Natural Environment – The national survey on people and the natural environment. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828552/Monitor_Engagement_Natural_Environment_2018_2019_v2.pdf.

87. Government of the United Kingdom. (2019). Monitor of Engagement with the Natural Environment – The national survey on people and the natural environment. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828552/Monitor_Engagement_Natural_Environment_2018_2019_v2.pdf.

88. Zenvus.(n.d.). untitled. https://www.zenvus.com/about-us/, accessed December 6, 2020.

89. Wang, T., et al. (2019). CRISPR technology is revolutionizing the improvement of tomato and other fruit crops. Hortic Res 6, 77. https://doi.org/10.1038/s41438-019-0159-x.

90. Agritech Tomorrow. (2019). Precision Farming Market to cross USD 12 billion by 2025. https://www.agritechtomorrow.com/story/2019/06/precision-farming-market-to-cross-usd-12-billion-by-2025-/11489/, accessed December 7, 2020.

91. Tamburini, G., Bommarco, R. (2020). Agricultural diversification promotes multiple ecosystem services without compromising yield. https://advances.sciencemag.org/content/6/45/eaba1715

92. Danone. (n.d.). Regenerative Agriculture. https://www.danone.com/impact/planet/regenerative-agriculture.html, accessed December 6, 2020.

93. General Mills. (n.d.). Regenerative Agirculture. https://www.generalmills.com/en/Responsibility/Sustainability/Regenerative-agriculture, accessed December 6, 2020.

94. Cargill. (2020). Cargill to advance regenerative agriculture practices across 10 million acres of North American farmland by 2030. https://www.cargill.com/2020/cargill-to-advance-regenerative-agriculture-practices-across-10, accessed December 6, 2020.

95. Walmart. (2020). Walmart Sets Goal to Become a Regenerative Company. https://corporate.walmart.com/newsroom/2020/09/21/walmart-sets-goal-to-become-a-regenerative-company, accessed December 6, 2020.

96. https://corporate.walmart.com/newsroom/2020/09/21/walmarts-regenerative-approach-going-beyond-sustainability

97. Banerjee, C. & Adenaeuer, L.(2014). Up, Up and Away! The Economics of Vertical Farming. Journal of Agricultural Studies, Vol. 2, No.1. https://doi.org/10.5296/jas.v2i1.4526.

98. Dealroom analysis cited in: Terazono, E. (2020). Vertical farming: hope or hype? Financial Times. https://www.ft.com/content/0e3aafca-2170-4552-9ade-68177784446e, accessed December 6, 2020.

99. Dealroom analysis cited in: Terazono, E. (2020). Vertical farming: hope or hype? Financial Times. https://www.ft.com/content/0e3aafca-2170-4552-9ade-68177784446e, accessed December 6, 2020.

100. Hillsdon, M. (2019). Innovative BNP Paribas loan helping 6 million Indian farmers go chemical-free. Reuters Events. https://www.reutersevents.com/sustainability/innovative-bnp-paribas-loan-helping-6-million-indian-farmers-go-chemical-free, accessed December 7, 2020.

101. The Good Food Institute (GFI). (2020). Plant-Based Market Overview. https://www.gfi.org/marketresearch, accessed December 7, 2020.

102. GFI. (2020). Record $824 million invested in alternative protein companies in 2019, $930 million already invested in Q1 2020. https://www.gfi.org/record-investment-in-alternative-protein-in-2019-and-q1-2020-media-release, accessed December 6, 2020.

103. World Economic Forum (WEF). (2019). Meat: the Future series
Alternative Proteins. http://www3.weforum.org/docs/WEF_White_Paper_Alternative_Proteins.pdf.

104. RethinkX. (2019). Rethinking Food and Agriculture 2020-2030. https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/5d7fe0e83d119516bfc0017e/1568661791363/RethinkX+Food+and+Agriculture+Report.pdf.

105. GFI. (2018). Consumer Research: Plant based market Brazil. https://www.gfi.org/images/uploads/2018/11/GFI_plant_based_market_brazil.pdf.

Main Report Endnotes

106. Grant, J. & Richter, H. (2020). 2020: The Year of the Flexitarian. Sustainalytics. https://www.sustainalytics.com/esg-blog/2020-the-year-of-the-flexitarian/, accessed December 7, 2020.

107. Pujol-Mazzini, A. (2020). How vegetarianism is going back to its roots in Africa. The Guardian. https://www.theguardian.com/global-development/2020/jan/15/how-vegetarianism-is-going-back-to-its-roots-in-africa, accessed December 7, 2020.

108. UBS Group (2019). Is mock meat the future of food? https://www.ubs.com/microsites/wma/insights/en/investing/2019/meat.html, accessed December 7, 2020.

109. United Nations Food and Agriculture Organisation (FAO). (n.d.). Food Loss and Food Waste. http://www.fao.org/food-loss-and-food-waste/flw-data)#:~:text=One%2Dthird%20of%20food%20produced,way%20to%20final%20household%20consumption, accessed December 6, 2020.

110. United Nations (2015). Goal 12: Ensure sustainable consumption and production patterns. https://www.un.org/sustainabledevelopment/sustainable-consumption-production/, accessed December 6, 2020.

111. Food and Land Use Coalition (FOLU). (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

112. O'Connor, C. (2019). Elements for national strategies on FLW International Workshop on Food Loss and Waste Prevention South East and East Asia. United Nations Environment. https://www.macs-g20.org/fileadmin/macs/Activities/S7_1_O_Connor_National_Strategies_FLW.pdf, accessed December 7, 2020.

113. Cited in: FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

114. WRI (n.d.). 32 Major Corporations Start "Measuring to Manage" Food Loss and Waste. https://www.wri.org/our-work/top-outcome/32-major-corporations-start-measuring-manage-food-loss-and-waste, accessed December 7, 2020.

115. WRI. (n.d.). Champions 12.3. https://champions123.org/10-20-30, accessed December 7, 2020.

116. Martín-Pizarro, C. & Posé, D. (2018). Genome Editing as a Tool for Fruit Ripening Manipulation. Front. Plant Sci. 9:1415. doi: 10.3389/fpls.2018.01415.

117. Khabbazi, D.,S. et al. (2020). Chapter eleven - Genetic engineering of horticultural crops contributes to the improvement of crop nutritional quality and shelf life. Plant Biotechnology. 247-272. https://doi.org/10.1016/B978-0-12-818632-9.00011-3.

118. Wanzala, J. (2019). Smart-Tech And Innovation. Solar freeze mobile cold storage units are reducing post-harvest loses among users by 40-60%. https://spore.cta.int/en/innovation/all/article/renewable-technology-confronts-kenya-s-food-waste-sid09b2243a5-60d3-4c9c-83b9-37553ee4b6c5, accessed December 7, 2020.

119. Salzman, J. et al. (2018). The global status and trends of Payments for Ecosystem Services. Nature Sustainability 1, 136-144. https://doi.org/10.1038/s41893-018-0033-0.

120. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

121. Price, K. (2020). Time for a tropical carbon tax, experts say. Conservation International. https://www.conservation.org/blog/time-for-a-tropical-carbon-tax-experts-say#:~:text=In%20the%20Amazon%20Basin%2C%20Colombia's,sources%20and%20combat%20climate%20change, accessed December 7, 2020.

122. OECD. (2018). OECD Tourism Trends and Policies 2018. https://doi.org/10.1787/tour-2018-46-en.

123. Government of France. (2018). Ending deforestation caused by importing unsustainable products. https://www.gouvernement.fr/en/ending-deforestation-caused-by-importing-unsustainable-products, accessed December 7, 2020.

124. The African Forest Landscape Restoration Initiative (AFR100). (n.d.). untitled. https://afr100.org/, accessed December 7, 2020.

125. FOLU. (2019). Prosperous Forests. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/11/FOLU-Prosperous-Forests_v6.pdf.

126. FOLU. (2019). Prosperous Forests. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/11/FOLU-Prosperous-Forests_v6.pdf.

127. FOLU. (2019). Prosperous Forests. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/11/FOLU-Prosperous-Forests_v6.pdf.

128. Ecosystem Marketplace. (2020). Voluntary Carbon and the Post-Pandemic Recovery. https://app.hubspot.com/documents/3298623/view/88656172?accessId=b01f32, accessed December 4, 2020; United Nations Principles for Responsible Investment (PRI). (2020). New investor guide to negative emission technologies and land use. https://www.unpri.org/news-and-press/new-investor-guide-to-negative-emission-technologies-and-land-use/6655.article, accessed December 7, 2020.

129. SYSETMIQ analysis based on (i) $83 million average annual voluntary carbon market REDD+ payments 2010-2019 (Ecosystem Marketplace report 2019); $740 million average annual "REDD+ readiness and implementation finance and REDD+ results-based finane 2010-17, from Climate Funds Update. (n.d.). https://climatefundsupdate.org/ and Forest Carbon Partnership (n.d.). https://www.forestcarbonpartnership.org/countries.

130. Vivideconomics. (2020). An investor guide to negative emission technologies and the importance of land use. https://www.unpri.org/download?ac=11980.

131. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and LandUse.https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

132. Science Based Targets Initiative (SBTi). (2020). Science Based Targets initiative launches process to develop first science-based global standard for corporate net-zero targets. https://sciencebasedtargets.org/2020/09/14/science-based-targets-initiative-launches-process-to-develop-first-science-based-global-standard-for-corporate-net-zero-targets/, accessed December 7, 2020.

133. Architecture for REDD+ Transactions. (n.d.). The REDD+ Environmental Excellence Standard. (TREES). https://www.artredd.org/trees/, accessed December 7, 2020.

134. Taskforce on Scaling Voluntary Carbon Markets (TSVCM).(n.d.) untitled. https://www.iif.com/tsvcm/, accessed December 7, 2020.

135. MapBiomass Initiative. (n.d.). untitled. https://mapbiomas.org/en, accessed December 7, 2020.

136. Du Besse, A. (2019). Drones Planting Trees: An interview with BioCarbon Engineering. Impakter. https://impakter.com/biocarbon-engineering/, accessed December 7, 2020.

137. WEF.(2020). The Future of Nature and Business Policy Companion. http://www3.weforum.org/docs/WEF_NNER_II_The_Future_of_Business_and_Nature_Policy_Companion_2020.pdf, accessed December 7, 2020.

138. The New Climate Economy (NCE). (2018). Unlocking The Inclusive Growth Story Of The 21st Century: Accelerating Climate Action In Urgent Times. https://newclimateeconomy.report/2018/.

139. Garrett-Peltier H. & Pollin, R. (2009). How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth, Political Economy Research Institute cited in: WWF & International Labour Organisation (ILO). (2020). Nature Hires:How Nature-Based Solutions can power a green jobs recovery. https://wwfeu.awsassets.panda.org/downloads/nature_hires_report_wwf_ilo.pdf. Growth, Political Economy Research Institute, January 2009.

140. WEF.(2020).Half of World's GDP Moderately or Highly Dependent on Nature, Says New Report. weforum.org/press/2020/01/half-of-world-s-gdp-moderately-or-highly-dependent-on-nature-says-new-report/, accessed December 7, 2020.

Main Report Endnotes

141. World Bank Group. (2016). The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis. http://pubdocs.worldbank.org/en/643781465442350600/Indonesia-forest-fire-notes.pdf.

1421. Koplitz, N. S. et al. (2016). Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. https://iopscience.iop.org/article/10.1088/1748-9326/11/9/094023.

143. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and LandUse.https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

144. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and LandUse.https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

145. ClientEarth. (2020). China introduces new law to safeguard forests and improve governance. https://www.clientearth.org/latest/latest-updates/opinions/china-introduces-new-law-to-safeguard-forests-and-improve-governance/, accessed December 7, 2020.

146. For example the 2008 Climate Change Act of the United Kingdom and the Roadmap to a low carbon economy in 2011 of the European Union included 80% reduction targets by 2050 compared to 1990, which were still valid in 2015.

147. Energy Transition Commission (ETC). (2018). Mission Possible. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC_MissionPossible_FullReport.pdf.

148. Heid, B. et al. (2017). What's sparking electric-vehicle adoption in the truck industry? McKinsey & Company. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/whats-sparking-electric-vehicle-adoption-in-the-truck-industry, accessed December 7, 2020.

149. Tesla. (n.d.). Semi. https://www.tesla.com/semi, accessed December 6, 2020.

150. Volvo Trucks. (n.d.). Driving Progress in Electromobility. https://www.volvotrucks.com/en-en/about-us/electromobility.html, accessed December 6, 2020.

151. BYD.(n.d.). Byd Trucks Hard At Work. https://en.byd.com/truck/, accessed December 6, 2020.

152. Hydrogen Council. (2020). Path to hydrogen competitiveness A cost perspective. https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf.

153. ETC. (2018). Mission Possible. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC_MissionPossible_FullReport.pdf.

154. IRENA. (2018). Hydrogen from Renewable Power. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Sep/IRENA_Hydrogen_from_renewable_power_2018.pdf.

155. Strategy&. (2020). The dawn of green hydrogen. https://www.strategyand.pwc.com/m1/en/reports/2020/the-dawn-of-green-hydrogen/the-dawn-of-green-hydrogen.pdf.

156. FuelCellsWorks. (2020). Chile: Government Presents the National Strategy for Chile to be a World leader in Green Hydrogen. https://cutt.ly/mhQSUyD, accessed December 7, 2020.

157. Smith, M. (2020). Morocco aims for global green hydrogen role. Petroleum Economist. https://www.petroleum-economist.com/articles/low-carbon-energy/energy-transition/2020/morocco-aims-for-global-green-hydrogen-role, accessed December 7, 2020.

158. World Energy Council & Ludwig Boelkow Systemchnik. (2020). International Hydrogen Strategies. https://www.weltenergierat.de/wp-content/uploads/2020/09/WEC_H2_Strategies_finalreport_200922.pdf.

159. World Energy Council & Ludwig Boelkow Systemchnik. (2020). International Hydrogen Strategies. https://www.weltenergierat.de/wp-content/uploads/2020/09/WEC_H2_Strategies_finalreport_200922.pdf.

160. Smyth, J. (2020). Australia backs desert project to export green hydrogen to Asia. Financial Times. https://www.ft.com/content/73505b3c-acd8-4bd5-b91a-fddfa2f331fb, accessed December 7, 2020.

161. Asian Renewable Energy Hub. (n.d.). untitled. https://asianrehub.com/about/. accessed December 4, 2020.

162. Smyth, J. (2020). Australia backs desert project to export green hydrogen to Asia. Financial Times. https://www.ft.com/content/73505b3c-acd8-4bd5-b91a-fddfa2f331fb, accessed December 7, 2020.

163. Fathom.world. (2020). Fourth IMO GHG Study – National governments found to have a much greater responsibility for shipping emissions than previously thought.https://fathom.world/fourth-imo-ghg-study-national-governments-found-to-have-a-much-greater-responsibility-for-shipping-emissions-than-previously-thought/, accessed December 7, 2020.

164. International Maritime Organisation (IMO). (2018). UN body adopts climate change strategy for shipping. https://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx, accessed December 7, 2020.

165. MAERSK. (2019). Towards a Zero Carbon Future. https://www.maersk.com/news/articles/2019/06/26/towards-a-zero-carbon-future, accessed December 7, 2020.

166. CMA CGM Group. (2020). The CMA CGM Group heads towards carbon neutrality by 2050. https://www.cma-cgm.com/news/3143/the-cma-cgm-group-heads-towards-carbon-neutrality-by-2050, accessed December 7, 2020.

167. Søgaard, K. & Bringham, C. (2020). Mapping of zero emission pilots and demonstration projects. Global Maritime Forum. https://www.globalmaritimeforum.org/news/mapping-of-zero-emission-pilots-and-demonstration-projects, accessed December 7, 2020.

168. ETC . (2018). Mission Possible: Sectoral Focus Shipping. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Shipping_final.pdf.

169. Middlehurst, C.(2020). Ammonia flagged as green shipping fuel of the future. Financial Times. https://www.ft.com/content/2014e53c-531f-11ea-a1ef-da1721a0541e, accessed December 8, 2020.

170. Bioenergy International. (2020). Ammonia "an attractive and low-risk marine fuel" – Ammonfuel report finds. https://bioenergyinternational.com/storage-logistics/ammonia, accessed December 7, 2020.

171. ETC.(2018). Mission Possible: Sectoral Focus Shipping. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Shipping_final.pdf.

172. Offshore Energy. (2020). NYK Exploring Ammonia as Carbon Neutral Marine Fuel. https://www.offshore-energy.biz/nyk-exploring-ammonia-as-carbon-neutral-marine-fuel/, accessed December 7, 2020.

173. Taylor, I. (2020). Asia Pacific: Nyk Line, Jmu And Classnk Join Forces For R&D On Ammonia As Marine Fuel. https://cutt.ly/8hQHe0q, accessed December 7, 2020.

174. Estimation based on expert input.

175. Equinor. (2020). The world's first carbon-free ammonia-fuelled supply vessel on the drawing board. https://www.equinor.com/en/news/2020-01-23-viking-energy.html, accessed December 7, 2020.

176. Middlehurst, C.(2020). Ammonia flagged as green shipping fuel of the future. Financial Times. https://www.ft.com/content/2014e53c-531f-11ea-a1ef-da1721a0541e, accessed December 8, 2020.

177. Middlehurst, C.(2020). Ammonia flagged as green shipping fuel of the future. Financial Times. https://www.ft.com/content/2014e53c-531f-11ea-a1ef-da1721a0541e, accessed December 8, 2020.

178. ETC . (2018). Mission Possible: Sectoral Focus Shipping. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Shipping_final.pdf.

179. Mao, X. et al. (2020). Refueling assessment of a zero-emission container corridor between China and the United States: Could hydrogen replace fossil fuels? International Council on Clean Transportation (ICCT). https://theicct.org/publications/zero-emission-container-corridor-hydrogen-2020, accessed December 7, 2020.

Main Report Endnotes

180. Manifold Times. (2020). Shipping industry welcomes IMO verdict on USD 5 billion fund to advance decarbonisation. https://www.manifoldtimes.com/news/shipping-industry-welcomes-imo-consideration-on-usd-5-billion-fund-to-advance-decarbonisation/, accessed December 7, 2020.

181. Chambers, S. (2020). Shipping urged to work with EU to develop new green framework. Splash 247. https://splash247.com/shipping-urged-to-work-with-eu-to-develop-new-green-framework/, accessed December 7, 2020.

182. Ovcina, J. (2020). Trafigura proposes carbon levy introduction to IMO. Offshore Energy.https://www.offshore-energy.biz/trafigura-proposes-carbon-levy-introduction-to-imo/, accessed December 7, 2020.

183. Sahu, S. (2020). Trafigura proposes carbon levy for shipping to hasten decarbonization. S&P Global. https://www.spglobal.com/platts/en/market-insights/latest-news/shipping/092520-trafigura-proposes-carbon-levy-for-shipping-to-hasten-decarbonization, accessed December 7, 2020.

184. WEF. (2020). Clean Skies for Tomorrow. Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation. http://www3.weforum.org/docs/WEF_Clean_Skies_Tomorrow_SAF_Analytics_2020.pdf, accessed December 7, 2020.

185. International Air Transport Association (IATA). (2015). IATA Sustainable Aviation Fuel Roadmap. https://www.iata.org/contentassets d13875e9ed784f75bac90f000760e998/safr-1-2015.pdf.

186. International Airlines Group (IAG). (2019). IAG backs net zero emissions by 2050. https://www.iairgroup.com/en/newsroom/press-releases/newsroom-listing/2019/net-zero-emissions#:~:text=International%20Airlines%20Group%20(IAG)%20is,global%20warming%20to%201.5%20degrees, accessed December 7, 2020.

187. Oneworld Group. (2020). oneworld member airlines commit to net zero carbon emissions by 2050. https://www.oneworld.com/news/2020-09-11-oneworld-member-airlines-commit-to-net-zero-carbon-emissions-by-2050, accessed December 7, 2020.

188. IATA. (2020). New analysis details aviation climate pathways. https://www.airlines.iata.org/news/new-analysis-details-aviation-climate-pathways, accessed December 7, 2020.

189. Roland Berger. (2020). Electrically Propelled Aircraft Developments Exceed 200 For The First Time. https://www.rolandberger.com/en/Point-of-View/Electric-propulsion-is-finally-on-the-map.html, accessed November 30, 2020.

190. European Regions Association. (2020). Green and Sustainable Connectivity: ERA's first sustainability report. https://www.eraa.org/era-sustainability-report-confirms-need-governments-invest-regional-aviation.

191. GreenCarCongress.com. ZeroAvia completes first hydrogen-electric passenger plane flight. https://www.greencarcongress.com/2020/09/20200929-zeroavia.html, accessed December 7, 2020.

192. Cairns, R. (2020). This aviation startup is soaring ahead with hydrogen-powered planes. CNN Travel. https://edition.cnn.com/travel/article/zeroavia-zero-emission-hydrogen-planes-spc-intl/index.html, accessed December 7, 2020.

193. International Civil Aviation Organisation (ICAO). (n.d.). Sustainable Aviation Fuels. https://www.icao.int/environmental-protection/pages/SAF.aspx, accessed December 7, 2020.

194. IATA. (2015). IATA Sustainable Aviation Fuel Roadmap. https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/safr-1-2015.pdf.

195. SYSTEMIQ collation based on ETC, McKinsey (2020), IRENA (2017), Maersk, Neste.

196. Boeing. (n.d.). Aviation Innovates To Connect the World in A Cleaner Future. https://www.boeing.com/global/boeing-in-europe/features/2019/aviation-innovates.page, accessed December 7, 2020.

197. ICAO. (n.d.). Sustainable Aviation Fuels. https://www.icao.int/environmental-protection/pages/SAF.aspx, accessed December 7, 2020.

198. Le Feuvre, P. (2019). Are aviation fuels ready to take off? IEA. https://www.iea.org/commentaries/are-aviation-biofuels-ready-for-take-off, accessed December 7, 2020.

199. WEF. (2020). Clean Skies for Tomorrow. Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation. http://www3.weforum.org/docs/WEF_Clean_Skies_Tomorrow_SAF_Analytics_2020.pdf, accessed December 7, 2020.

200. Dichter, A. et al. (2020). How airlines can chart a path to zero-carbon flying. McKinsey & Company. https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/how-airlines-can-chart-a-path-to-zero-carbon-flying, accessed December 7, 2020.

201. Argus Media. (2020). Europe makes legislative push for aviation transition. https://www.argusmedia.com/en/news/2145902-europe-makes-legislative-push-for-aviation-transition, accessed December 7, 2020.

202. Soone, J. (2020). Sustainable aviation fuels. European Parliament Research Service (EPRS). https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659361/EPRS_BRI(2020)659361_EN.pdf, accessed December 7, 2020.

203. WEF. (2020). Clean Skies for Tomorrow. Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation. http://www3.weforum.org/docs/WEF_Clean_Skies_Tomorrow_SAF_Analytics_2020.pdf, accessed December 7, 2020.

204. Transport & Environment (2020). Air France's bailout 'climate conditions' explained. https://www.transportenvironment.org/publications/air-frances-bailout-climate-conditions-explained, accessed December 7, 2020.

205. Energy Transition Commission (ETC). (2018). Mission Possible. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC_MissionPossible_FullReport.pdf.

206. The, H., S. et al. (2017). Replacement Scenarios for Construction Materials Based on Economy-wide Hybrid LCA. https://doi.org/10.1016/j.proeng.2017.04.177.

207. Exhibit informed by Material Economics. (2018). The Circular Economy - a powerful force for climate mitigation. https://materialeconomics.com/publications/the-circular-economy-a-powerful-force-for-climate-mitigation-1; Material Economics. (2019). Industrial Transformation 2050. https://materialeconomics.com/latest-updates/industrial-transformation-2050.

208. ETC. (2018). Mission Possible: Sectoral Focus Steel. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Steel_final.pdf.

209. SSAB. (2016). First in fossil-free steel. Using HYBRIT Technology. https://www.ssab.com/company/sustainability/sustainable-operations/hybrit, accessed December 7, 2020.

210. SYSTEMIQ Analysis based on: World Steel Association. (2020). World Steel in Figures 2020. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

211. SSAB. (n.d.). SSAB is taking the lead in decarbonizing the steel industry. https://www.ssab.com/company/sustainability/sustainable-operations/hybrit?utm_source=google&utm_medium=cpc&utm_campaign=communications_hybrit&utm_content=sem_dpt&gclid=CjwKCAiAn7L-BRBbEiwAI9UtkHAXRJYVsaHRJ6SraNRGjsUML8F-okgI6yC4nBtOdOpzmSY0593_DhoCrgMQAvD_BwE, accessed December 6, 2020.

212. Tata Steel. (n.d.). Tata Steel commitment to reducing emissions. https://www.tatasteelconstruction.com/en_GB/OurBrands/Colorcoat/Confidex-Sustain%C2%AE/Tata-Steel-commitment-to-reducing-emissions, accessed December 6, 2020.

213. Thyssenkrupp. (2019). Our climate goals: climate-neutral by 2050. https://engineered.thyssenkrupp.com/en/our-climate-goals-climate-neutral-by-2050/, accessed December 6, 2020.

214. ArcelorMittal. (2020). ArcelorMittal sets 2050 group carbon emissions target of net zero. https://corporate.arcelormittal.com/media/press-releases/arcelormittal-sets-2050-group-carbon-emissions-target-of-net-zero#:~:text=ArcelorMittal%20('the%20Company'),be%20carbon%20neutral%20by%202050, accessed December 6, 2020.

215. Voestalpine (n.d.). Voestalpine climate protection strategy. https://www.voestalpine.com/group/en/group/environment/climate-protection-strategy/, accessed December 6, 2020.

Main Report Endnotes

216. Salzgitter AG. (2018). Non-financial Report 2018. https://www.salzgitter-ag.com/fileadmin/reports/2018/nfr/en/downloads/szag-non-financial-report-2018.pdf

217. World Steel Association. (2020). World Steel in Figures 2020. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

218. ETC. (2018). Mission Possible: Sectoral Focus Steel. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Steel_final.pdf.

219. IEA. (2020). Iron and Steel Technology Roadmap.https://aceroplatea.es/docs/Iron_and_Steel_Technology_Roadmap_IEA.pdf.

220. IEA. (2020). Iron and Steel Technology Roadmap.https://aceroplatea.es/docs/Iron_and_Steel_Technology_Roadmap_IEA.pdf.

221. IEA Clean Coal Center. (2020). SWEDISH STEELMAKER USES HYDROGEN INSTEAD OF COAL TO MAKE FOSSIL-FREE STEEL. https://www.iea-coal.org/swedish-steelmaker-uses-hydrogen-instead-of-coal-to-make-fossil-free-steel/, accessed December 7, 2020.

222. ArcelorMittal. (2020). ArcelorMittal to produce green Steel starting from 2020. https://corporate.arcelormittal.com/media/news-articles/arcelormittal-europe-to-produce-green-steel-starting-in-2020, accessed December 7, 2020.

223. IEA. (2020). Iron and Steel Technology Roadmap. https://webstore.iea.org/download/direct/4208.

224. Zhong, F. (2020). How hydrogen is gaining momentum in the Chinese steel industry. World Steel Association. https://www.worldsteel.org/media-centre/blog/2020/hydrogen-technology-momentum-Chinese-steel-industry.html, accessed December 7, 2020.

225. Moore, A. (2019). Hydrogen market in China to receive boost from Linde and Baowu Group partnership. https://www.hydrogenfuelnews.com/hydrogen-market-in-china-to-receive-boost-from-linde-and-baowu-group-partnership/8538996/, accessed December 7, 2020.

226. ETC. (2018). Mission Possible: Sectoral Focus Steel. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Steel_final.pdf.

227. IEA. (2019). Innovation Gaps. https://www.iea.org/reports/innovation-gaps/industry.

228. IEA. (2020).CCUS in Clean Energy Transitions. https://www.iea.org/reports/ccus-in-clean-energy-transitions/a-new-era-for-ccus#growing-ccus-momentum.

229. IEA. (2019). Innovation Gaps. https://www.iea.org/reports/innovation-gaps/industry

230. IEA. (2020). Iron and Steel Technology Roadmap. https://webstore.iea.org/download/direct/4208.

231. IEA. (2020). Iron and Steel Technology Roadmap. https://webstore.iea.org/download/direct/4208.

232. Poseidon, K. (2020). EU Climate Goals Accelerate Eastern European Decarbonization. BloombergNEF. https://assets.bbhub.io/professional/sites/24/BloombergNEF-Decarbonization-of-Eastern-Europe%E2%80%99s-Energy-Mix-Key-to-Higher-EU-Climate-Goals-Nov-2020.pdf, accessed December 8, 2020.

233. Government U.K. (2020). Carbon Emissions Tax – closed consultation. https://www.gov.uk/government/consultations/carbon-emissions-tax, accessed December 1, 2020.

234. European Commission (EC). (2020). Commission launches public consultations on energy taxation and a carbon border adjustment mechanism. https://ec.europa.eu/taxation_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism_en, accessed December 1, 2020.

235. Green, M. (2020). U.S. could adopt carbon tax under a Biden presidency, ex-Fed Chair Yellen says. Reuters. https://uk.reuters.com/article/us-usa-climate-tax/u-s-could-adopt-carbon-tax-under-a-biden-presidency-ex-fed-chair-yellen-says-idUKKBN26T23L, accessed December 1, 2020.

236. SYSTEMIQ analysis based on World Steel Association (2020). World Steel in Figures 2020. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

237. European Commission (EC). (n.d.). Levels - the European Framework for Sustainable Buildings. https://ec.europa.eu/environment/topics/circular-economy/levels_en, accessed December 5, 2020.; European Commission (EC). CO_2 emission performance standards for cars and vans (2020 onwards). https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en, accessed December 5, 2020.

238. World Steel Association (2020). World Steel in Figures 2020. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

239. Government of California. (n.d.). Buy Clean California Act. (BCCA) Department of General Services. https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act, accessed December 8, 2020.

240. Pfeuti, E. (2019). Investors turn on steel industry in push to slow climate change. Investors & Pensions Europe. https://www.ipe.com/investors-turn-on-steel-industry-in-push-to-slow-climate-change/10029564.article#:~:text=In%20a%20report%20entitled%20Investor,its%20impact%20on%20the%20environment., accessed December 8, 2020.

241. Global Cement and Concrete Association (GCCA). (2020). Concrete – the world's most widely used material – targets carbon neutral future. https://gccassociation.org/news/concrete-the-worlds-most-widely-used-material-targets-carbon-neutral-future/, accessed December 8, 2020.

242. Cemnet. (2019). Dalmia Cement sets carbon neutrality target for 2040. https://www.cemnet.com/News/story/167365/dalmia-cement-sets-carbon-neutrality-target-for-2040.html, accessed December 8, 2020.

243. Sauer, N. (2019). Cement giant Heidelberg pledges carbon neutral concrete by 2050. GreenBiz. https://www.greenbiz.com/article/cement-giant-heidelberg-pledges-carbon-neutral-concrete-2050, accessed December 8, 2020.

244. World Cement. (2020). UK concrete and cement sector sets out 'Roadmap to Beyond Net Zero'. https://www.worldcement.com/europe-cis/07102020/uk-concrete-and-cement-sector-sets-out-roadmap-to-beyond-net-zero/, accessed December 8, 2020.

245. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

246. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

247. IEA. (2020). World Energy Investment 2020. https://www.iea.org/reports/world-energy-investment-2020/rd-and-technology-innovation.

248. IEA. (2020). Cement. https://www.iea.org/reports/cement.

249. Global Cement. (2019). Dalmia cement commits itself to carbon negativity by 2040. https://www.globalcement.com/news/item/9873-dalmia-cement-commits-itself-to-carbon-negativity-by-2040, accessed December 8, 2020.

250. Global Cement. (2019). Dalmia cement commits itself to carbon negativity by 2040. https://www.globalcement.com/news/item/9873-dalmia-cement-commits-itself-to-carbon-negativity-by-2040, accessed December 8, 2020.

251. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

252. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

253. Cemex . (2020). CEMEX Looks To Use The Sun To Decarbonize Cement. https://www.cemex.co.uk/-/cemex-looks-to-use-the-sun-to-decarbonize-cement, accessed December 8, 2020.

254. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

255. Hanson. (2020). Leading the way in fuel-switching research project. https://www.hanson.co.uk/en/about-us/news-and-events/fuel-switching-research-

Main Report Endnotes

project, accessed December 8, 2020.

256. Solidiatech. (n.d.). untitled. https://www.solidiatech.com/solutions.html, accessed December 8, 2020.

257. Solidiatech. (n.d.). untitled. https://www.solidiatech.com/solutions.html, accessed December 8, 2020.

258. Chatham House. (2018). Making Concrete Change: Innovation in Low-carbon Cement and Concrete. https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete-0/3-overcoming-barriers.

259. Global CCS Institute. (2020). Norway's Flagship CCS Project Northern Lights Receives Green Light by Project Partners. https://www.globalccsinstitute.com/news-media/press-room/media-releases/norways-flagship-ccs-project-northern-lights-receives-green-light-by-project-partners/, accessed December 8, 2020.

260. ETC. (2019). Mission Possible : Sectoral Focus Cement. https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Cement_final.pdf.

261. ING (2020). Learning from consumers: How shifting demands are shaping companies' circular economy transition. https://www.ingwb.com/media/3076131/ing-circular-economy-survey-2020-learning-from-consumers.pdf, accessed December 8, 2020.

262. Chatham House. (n.d.). untitled. https://circulareconomy.earth/?year=2015, accessed December 5, 2020.

263. Product Stewardship Institute. (2020). Extended Producer Responsibility for Packaging and Paper Products: Policies, Practices, and Performance. https://cdn.ymaws.com/www.productstewardship.us/resource/resmgr/packaging/2020.03.17_PSI_EPR_for_PPP.pdf, accessed December 5, 2020.

264. European Commission (EC). (2020). Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Text with EEA relevance). Jounral of the European Parliament. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852.

265. Valero, J. (2020). Commission readies implementation of sustainable finance. Euractiv.com. euractiv.com/section/circular-economy/news/commission-readies-implementation-of-sustainable-finance/, accessed December 8, 2020.

266. Ellen MacArthur Foundation (EMF). (2020). Financing the Circular Economy. https://www.ellenmacarthurfoundation.org/assets/downloads/Financing-the-circular-economy.pdf.

267. EMF. (2020). Financing the Circular Economy. https://www.ellenmacarthurfoundation.org/assets/downloads/Financing-the-circular-economy.pdf.

268. The PEW Charitable Trusts, & SYSTEMIQ. (2020). Breaking the Plastic Wave. A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution. https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.

269. McKenna, J. (2017). Scientists have made biodegradable plastic from sugar and carbon dioxide. WEF. https://www.weforum.org/agenda/2017/10/scientists-have-made-biodegradable-plastic-from-sugar-and-carbon-dioxide/, accessed December 8, 2020.

270. Plastic Insight (2018). STU team develops second-generation Bio-plastics from waste Frying Oil. https://www.plasticsinsight.com/stu-team-develops-second-generation-bio-plastics-from-waste-frying-oil/, accessed December 8, 2020.

271. Alliance to End Plastic Waste. (2020). Progress Report 2020. https://endplasticwaste.org/en/news/alliance-to-end-plastic-waste-releases-2020-progress-report.

272. Unilever. (n.d.). Rethinking plastic packaging – towards a circular economy. https://www.unilever.com/sustainable-living/reducing-environmental-impact/waste-and-packaging/rethinking-plastic-packaging/, accessed December 8, 2020.

273. The PEW Charitable Trusts, & SYSTEMIQ. (2020). Breaking the Plastic Wave. A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution. https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.

274. Sustainable Brands. (2020). Algramo Brings Refillable, Waste-Free Cleaning Products to NYC. https://sustainablebrands.com/read/defining-the-next-economy/algramo-brings-refillable-waste-free-cleaning-products-to-nyc, accessed December 8, 2020.

275. HBS Digital Initiative. (2015). Algramo: The Value-add Vending Machine. https://digital.hbs.edu/platform-rctom/submission/algramo-the-value-add-vending-machine/, accessed December 8, 2020.

276. Finch & Beak Sustainability Strategies. (2020). Algramo Develops Refill Business With Unilever. https://www.finchandbeak.com/1578/algramo-develops-refill-business-with.htm, accessed December 8, 2020.

277. Sustainable Brands. (2020). Algramo Brings Refillable, Waste-Free Cleaning Products to NYC. https://sustainablebrands.com/read/defining-the-next-economy/algramo-brings-refillable-waste-free-cleaning-products-to-nyc, accessed December 8, 2020.

278. Philips. (2019). Philips on track to becoming carbon-neutral in its own operations by 2020. https://www.philips.com/a-w/about/news/archive/standard/news/press/2019/20190226-philips-on-track-to-becoming-carbon-neutral-in-its-own-operations-by-2020.html, accessed December 8, 2020.

279. Philips. (n.d.). Decoupling growth from resource consumption. https://www.philips.com/a-w/about/sustainability/circular-economy.html, accessed December 8, 2020.

280. TechCrunch. (2020). Back Market raises $120M for its refurbished device marketplace. https://techcrunch.com/2020/05/04/back-market-raises-120-million-for-its-refurbished-device-marketplace/, accessed December 8, 2002.

281. Pagliaro, M. & Meneguzzo, F. (2019). Lithium battery reusing and recycling: A circular economy insight. Heliyon. https://doi.org/10.1016/j.heliyon.2019.e01866.

282. Global Battery Alliance (GBA). (2019). A Vision for a Sustainable Battery Value Chain in 2030. http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf.

283. GBA. (2019). A Vision for a Sustainable Battery Value Chain in 2030. http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf.

284. European Battery Alliance (EBA). (2020). The European Battery Alliance to support EU's post coronavirus recovery. https://www.eba250.com/the-european-battery-alliance-to-support-eus-post-coronavirus-recovery/, accessed December 2018.

285. Green Car Congress. (2020). NIO launches Battery as a Service (BaaS) in China; battery swap system. https://www.greencarcongress.com/2020/08/20200821-nio.html, accessed December 8, 2020.

286. Fox, M. (2020). Nio will surge 85% as Tesla's China success is a 'rising tide lifts all boats' phenomenon, JPMorgan says. Markets Business Indiser. https://markets.businessinsider.com/news/stocks/nio-stock-price-upgrade-tesla-rising-tide-boats-buy-jpmorgan-2020-10-1029680089, accessed December 8, 2020.

287. Recupel. (n.d.). 7 reasons why urban mining is overtaking classical mining. https://www.recupel.be/en/blog/7-reasons-why-urban-mining-is-overtaking-classical-mining/, accessed December 8, 2020.

288. ArcelorMittal. (n.d.). ArcelorMittal's rental business model for steel sheet piles. https://europe.arcelormittal.com/newsandmedia/europenews/3170/Rental-business-model-for-steel-sheet-pil, accessed December 8, 2020.

289. McKinsey & Company & GFA. (2020). Fashion on Climate. https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.

290. Thredup. (2020). 2020 Resale Report. https://www.thredup.com/resale/static/thredup-resaleReport2020-42b42834f03ef2296d83a44f85a3e2b3.pdf.

291. Crunchbase. (n.d.). Rent the Runway. https://www.crunchbase.com/organization/rent-the-runway, accessed December 8, 2020.

Main Report Endnotes

292. H&M Group. (n.d.). Circularity and our value chain. https://hmgroup.com/sustainability/circular-and-climate-positive/circularity-and-our-value-chain.html, accessed December 8, 2020.

293. Hurr Collective. (n.d.). untitled. https://www.hurrcollective.com/, accessed December 8, 2020.

294. EMF. (2020). Financing the Circular Economy. https://www.ellenmacarthurfoundation.org/assets/downloads/Financing-the-circular-economy.pdf.

295. Circulor. (n.d.). untitled. https://www.circulor.com/, accessed December 8, 2020.

296. EC. (2020). Circular Economy Action Plan (CEAP). https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf.

297. Apple. (2019). Apple expands global recycling programmes. https://www.apple.com/uk/newsroom/2019/04/apple-expands-global-recycling-programs/, accessed December 8, 2020.

298. Volvo. (2019). Volvo Cars to implement blockchain traceability of cobalt used in electric car batteries. https://www.media.volvocars.com/global/en-gb/media/pressreleases/260242/volvo-cars-to-implement-blockchain-traceability-of-cobalt-used-in-electric-car-batteries, accessed December 5, 2020; Daimler. (2020). Blockchain pilot project provides transparency on CO2 emissions. https://www.daimler.com/sustainability/resources/blockchain-pilot-project-supply-chain.html, accessed December 5, 2020.

299. Circulor. (n.d.). untitled. https://www.circulor.com/, accessed December 7, 2020.

300. ILO. (2018). World Employment Social Outlook 2018: Greening with jobs. https://www.ilo.org/wesogreening/documents/WESO_Greening_EN_web2.pdf.

301. The PEW Charitable Trusts, & SYSTEMIQ. (2020). Breaking the Plastic Wave. A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution. https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.

302. Goldstein, J. & Electris, C. (2002). More jobs, less pollution: growing the recycling economy in the U.S.Tells Institute with Sound Resource Management. https://www.tellus.org/pub/More%20Jobs,%20Less%20Pollution%20-%20Growing%20the%20Recycling%20Economy%20in%20the%20US.pdf.

303. EMF (2013). Towards the Circular Economy – Vol.1. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf.

304. Ellen MacArthur Foundation (EMF).(2017). A New Textiles Economy: Redesigning Fashion's Future. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf.

305. McKinsey & Company. (2016). Style that's sustainable: A new fast-fashion formula. https://www.mckinsey.com/business-functions/sustainability/our-insights/style-thats-sustainable-a-new-fast-fashion-formula, accessed December 5, 2020.

306. R2piProject. (2020). Stakeholder Views Report Enablers and Barriers to a Circular Economy. http://www.r2piproject.eu/wp-content/uploads/2018/08/R2pi-stakeholders-report-sept-2018.pdf.

307. Ellen MacArthur Foundation (EMF). (2020). Financing the Circular Economy. https://www.ellenmacarthurfoundation.org/assets/downloads/Financing-the-circular-economy.pdf.

308. Meyer, G.(2020). Clean energy group NextEra surpasses ExxonMobil in market cap. Financial Times. https://www.ft.com/content/39a70458-d4d1-4a6e-aca6-1d5670bade11, accessed December 8, 2020.

309. Bloomberg. (2020). Oersted:DC. https://www.bloomberg.com/quote/ORSTED:DC, accessed December 8, 2020.

310. Bloomberg. (2020). Tesla nears half a trillion mark after soaring 525 this year. https://www.bloomberg.com/news/articles/2020-11-24/tesla-nears-half-a-trillion-mark-after-soaring-525-this-year, accessed December 8, 2020.

311. Cellan-Jones, R. (2020). Tech Tent: Is Tesla really worth $500 billion?. BBC News. https://www.bbc.co.uk/news/technology-55103706, accessed December 8, 2020.

312. Shearer, C. (2020). Guest post: How plans for new coal are changing around the world. CarbonBrief. https://www.carbonbrief.org/guest-post-how-plans-for-new-coal-are-changing-around-the-world, accessed November 26, 2020.

313. Eckert, V. (2020). German energy regulator awards first permits to close coal plants. Reuters. https://uk.reuters.com/article/uk-germany-hardcoal-idUKKBN28B4VO, accessed December 8, 2020.

314. Jones, D. et al. (2020). Wind And Solar Now Generate One-Tenth Of Global Electricity Global half-year electricity analysis. Ember. https://ember-climate.org/project/global-electricity-h12020/, accessed December 8, 2020.

315. BNEF. (2020). New Energy Outlook 2020. https://about.bnef.com/new-energy-outlook/#toc-download.

316. Kuykendall, T. (2020). US coal stocks continue sharp decline into 2020. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-coal-stocks-continue-sharp-decline-into-2020-56940158, accessed November 30, 2020.

317. Brock, J. (2019). StanChart exits three Southeast Asia coal plants worth estimated $7 billion. Reuters. https://www.reuters.com/article/us-stanchart-coal-idUSKBN1YM0KP, accessed December 8, 2020.

318. CNN Money. (2012). Fortune500. https://money.cnn.com/magazines/fortune/fortune500/2012/full_list/, accessed December 8, 2020.

319. Desjardins, J. (2019). A Visual History of the Largest Companies by Market Cap (1999-Today). VisualCapitalist. https://www.visualcapitalist.com/a-visual-history-of-the-largest-companies-by-market-cap-1999-today/, accessed December 8, 2020.

320. Fleming, S. & Hook, L. (2019). EIBto phase out lending to fossil fuel projects by 2021. Financial Times. https://www.ft.com/content/cc78d838-0720-11ea-a984-fbbacad9e7dd, accessed December 8, 2020.

321. IEA. (2019). World Energy Investment 2019. https://www.iea.org/reports/world-energy-investment-2019/financing-and-funding-trends, accessed December 8, 2020.

322. Financial Times editorial board. (2020). The slow death of Big Oil. Financial Times.https://www.ft.com/content/c343b958-63f4-44a4-9485-130d7740a843, accessed December 8, 2020.

323. Bousso, R. (2020). Shell to cut asset values by up to $22 billion after coronavirus hit. Reuters. https://uk.reuters.com/article/uk-shell-outlook/shell-to-cut-asset-values-by-up-to-22-billion-after-coronavirus-hit-idUKKBN2410SJ, accessed December 5, 2020; Buosso, R. (2020). BP wipes up to £14 billion from assets with bleaker oil outlook. https://uk.reuters.com/article/us-bp-writeoffs/bp-to-take-up-to-17-5-billion-writedown-lowers-oil-outlook-idUKKBN23M0QA, accessed December 5, 2020.

324. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

325. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

326. Yara. (n.d.). Green ammonia - carbon neutral fertiliser production. https://www.yara.co.uk/grow-the-future/sustainable-farming/green-ammonia/, accessed December 5, 2020.

327. Data based on Swiss Re. (2020). in: Financial Stability Board (FSB). (2020). The Implications of Climate Change for Financial Stability. https://www.fsb.org/wp-content/uploads/P231120.pdf.

328. Watts, N. et al. (2020). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. The Lancet. https://doi.org/10.1016/S0140-6736(20)32290-X.

329. Funk, C. et al. (2020). 3. Concern over climate and the environment predominates among these publics. Pew Research Center. https://www.pewresearch.org/science/2020/09/29/concern-over-climate-and-the-environment-predominates-among-these-publics/, accessed December 8, 2020.

Main Report Endnotes

330. Thackeray J.,S. et al. (2020). Civil disobedience movements such as School Strike for the Climate are raising public awareness of the climate change emergency. Open Change Biology. https://doi.org/10.1111/gcb.14978.

331. Tyson, A. & Kennedy, B. (2020). Two-Thirds of Americans Think Government Should Do More on Climate. Pew Research Center. https://www.pewresearch.org/science/2020/06/23/two-thirds-of-americans-think-government-should-do-more-on-climate/.

332. Climate Action. (2019). Climate change now a priority in European election results. http://www.climateaction.org/news/climate-change-nowa-priority-in-european-election-results, accessed December 3, 2020.

333. Summers, J. (2020). The UK's Climate Election. Climate Institute. http://climate.org/the-uks-climate-election/, accessed December 3, 2020.

334. IISD. (2020). New Zealand's Prime Minister Expected to Address Climate Crisis During Recovery. https://www.iisd.org/sustainable-recovery/news/new-zealandsprime-minister-expected-to-address-climate-crisisduring-recovery/, accessed 03 December 2020.

335. Dolsak, N. & Prakash, A. (2020). Will The Biden Administration Transform U.S. Climate Policy? Forbes. https://www.forbes.com/sites/prakashdolsak/2020/10/16/will-the-biden-administration-transform--us-climatepolicy/?sh=3e890eef4d4c, accessed December 3, 2020.

336. Vaughan, A. (2020). Japan steps up climate ambition with 2050 net zero emissions goal. New Scientist. https://www.newscientist.com/article/2258163-japan-steps-up-climate-ambition-with-2050-net-zero-emissions-goal/#ixzz6g2bNOA7T, accessed December 8, 2020.

337. IPSOS. (2019). Climate Change and Consumer Behavior. https://www.ipsos.com/sites/default/files/ct/news/documents/2020-01/global-advisor-climate-change-consumer-behavior.pdf.

338. Bachkmann, R. et al. (2019). Firms And Collective Reputation: A Study Of The Volkswagen Emissions Scandal. National Bureau Of EconomicResearch. https://www.nber.org/system/files/working_papers/w26117/w26117.pdf?utm_campaign=PANTHEON_STRIPPED&amp%3Butm_medium=PANTHEON_STRIPPED&amp%3Butm_source=PANTHEON_STRIPPED.

339. Newburger, E. (2019). 'Capitalism needs to evolve': Businesses close and employees walk out for global climate strike. CNBC. https://www.cnbc.com/2019/09/20/global-climate-strike-facebook-amazon-and-twitter-workers-walk-out.html, accessed December 7, 2020.

340. Spence, E. (2019). Oil Has a Millennial Problem as Talent Pipeline Trickles. Bloomberg Quint. https://www.bloombergquint.com/markets/the-oil-industry-s-talent-pipeline-slows-to-a-trickle, data based on Higher Education Statistics Agency (HESA).(2017). United Kingom.

341. Spence, E. (2019. Oil Has a Millennial Problem as Talent Pipeline Trickles. Bloomberg Quint. https://www.bloombergquint.com/markets/the-oil-industry-s-talent-pipeline-slows-to-a-trickle, data based on Higher Education Statistics Agency (HESA).(2017). United Kingom.

342. New Climate Institute & Data Driven EnviroLab. (2020). Navigating the nuances of net-zero targets. https://newclimate.org/wp-content/uploads/2020/10/NewClimate_NetZeroReport_October2020.pdf.

343. Science Based Targets Initiative (SBTi). (2020). The new normal: 1,000 companies are now setting science-based climate targets. https://sciencebasedtargets.org/blog/the-new-normal-1-000-companies-are-now-setting-science-based-climate-targets, accessed December 5, 2020.

344. IKEA. (2019). IKEA invests 200 million euros to speed up action to become climate positive by 2030. https://newsroom.inter.ikea.com/news/ikea-invests-200-million-euros-to-speed-up-action-to-become-climate-positive-by-2030/s/c3181331-23d9-473e-9d56-20e0c3db7c66#:~:text=27%2DNOV%2D2019-,IKEA%20invests%20200%20million%20euros%20to%20speed%20up%20action%20to,become%20a%20climate%20positive%20business, accessed December 5, 2020.

345. Roberts, D. (2020). Microsoft's astonishing climate change goals, explained. Vox. https://www.vox.com/energy-and-environment/2020/7/30/21336777/microsoft-climate-change-goals-negative-emissions-technologies, accessed December 8, 2020.

346. Climate Group. (n.d.). Climate Group RE100. https://www.there100.org/re100-members?page=8, accessed December 4, 2020.

347. Climate Group. (n.d.). Climate Group EV100. https://www.theclimategroup.org/ev100, accessed December 4, 2020.

348. Unilever. (2018). Taking a radical step on palm oil supply chain transparency. https://www.unilever.com/news/news-and-features/Feature-article/2018/we-take-a-radical-step-on-palm-oil-supply-chain-transparency.html, accessed December 8, 2020.

349. Malo, S. (2017). Nestle, Mars vow to clean up pet food supply chains. Reuters. https://de.reuters.com/article/nestle-mars-seafood-idUSL2N1GT140, accessed December 5, 2020.

350. PRI. (2018). Converging On Climate Lobbying. https://www.unpri.org/Uploads/g/v/q/PRI_Converging_on_climate_lobbying.pdf.

351. InfluenceMap. (n.d.). Corporate Lobbying. https://influencemap.org/climate-lobbying, accessed December 8, 2020.

352. Partnering for Green Growth and the Global Goals 2050 (P4G). (n.d.). Indonesia Food Loss and Waste Action Partnership. https://p4gpartnerships.org/partnership/indonesia-food-loss-and-waste-action-partnership, accessed December 8, 2020.

353. Maersk. (2020). Leading Danish companies join forces on an ambitious sustainable fuel project. https://www.maersk.com/news/articles/2020/05/26/leading-danish-companies-join-forces-on-an-ambitious-sustainable-fuel-project, accessed, December 5, 2020.

354. Riding, S. (2020). Majority of ESG funds outperform wider market over 10 years. Financial Times. https://www.ft.com/content/733ee6ff-446e-4f8b-86b2-19ef42da3824, accessed December 8, 2020.

355. Baker, S. (2020). Global ESG-data driven assets hit $40.5 trillion. Pensions & Investments. https://www.pionline.com/esg/global-esg-data-driven-assets-hit-405-trillion#:~:text=The%20value%20of%20global%20assets,to%20%2440.5%20trillion%20in%202020, accessed December 8, 2020.

356. Climate Action 100+ Global Investors Driving Business Transition. http://www.climateaction100.org/, accessed December 8, 2020.

357. Vinson & Elkins LLP. (2019). Glencore the Latest to Commit to Climate Action 100+ Initiative. lexology.com/library/detail.aspx?g=fce70c71-6527-41a7-838f-6879bd9eedc8, accessed December 8, 2020.

358. United Nations Environment Programme Finance Initiative. (2020). Net-Zero Asset Owner Alliance Sets Unprecedented 5-Year Portfolio Decarbonization Targets. https://www.unepfi.org/news/net-zero-asset-owner-alliance-sets-unprecedented-5-year-portfolio-decarbonization-targets/, accessed December 8, 2020.

359. Legal & General Group. (2020). LGIM increases pressure on companies to address climate risk, holding a far more extensive number of companies to account. https://www.legalandgeneralgroup.com/media-centre/press-releases/lgim-increases-pressure-on-companies-to-address-climate-risk-holding-a-far-more-extensive-number-of-companies-to-account/, accessed December 8, 2020.

360. Lütkehermöller, K. et al. (2020). Unpacking the finance sector's investment commitments. NewClimate Institute and Utrecht University. https://newclimate.org/wp-content/uploads/2020/09/NewClimate_Unpacking_Finance_Sector_Sept20.pdf, accessed December 3,2020.

361. Goldman Sachs. (n.d.). Sustainable Finance. https://www.goldmansachs.com/what-we-do/sustainable-finance/#:~:text=We're%20deploying%20%24750%20billion,to%20make%20a%20global%20impact., accessed December 8, 2020.

362. BNP Paribas. (2020). BNP Paribas is accelerating its timeframe for a complete coal exit. https://group.bnpparibas/en/press-release/bnp-paribas-accelerating-timeframe-complete-coal-exit, accessed December 8, 2020.

363. Institute for Energy Economics and Financial Analysis (IEEFA). (2019). France's Crédit Agricole to stop thermal coal investments in EU, OECD by 2030. https://ieefa.org/frances-credit-agricole-to-stop-thermal-

Main Report Endnotes

coal-investments-in-eu-oecd-by-2030/, accessed December 8, 2020.

364. HSBC. (2020). HSBC sets out net zero ambition. https://www.hsbc.com/who-we-are/hsbc-news/hsbc-sets-out-net-zero-ambition, accessed December 8, 2020; Barclays. (2020). Our ambition to be a net zero bank by 2050. https://home.barclays/society/our-position-on-climate-change/, accessed December 8, 2020.

365. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

366. Cronin, D. (2019). Activist Investors Force Change In The Oil Industry. Carbon Tracker. https://carbontracker.org/activist-investors-force-change-in-the-oil-industry/, accessed December 8, 2020.

367. Beals, K. R. (2020). JPMorgan Chase shareholders defeat call for greater climate-change disclosure at world's largest oil funder. Marketwatch. https://www.marketwatch.com/story/jpmorgan-chase-shareholders-defeat-call-for-greater-climate-change-disclosure-at-worlds-largest-oil-funder-2020-05-19, accessed December 8, 2020.

368. Mooney, A. (2020). Shareholder climate rebellions surge despite coronavirus crisis. Financial Times. https://www.ft.com/content/c10056af-306f-4d9d-8e97-5ffa112ddf49, accessed December 8, 2020.

369. TCFD. (2020). 2020 Status Report. https://www.fsb.org/wp-content/uploads/P291020-1.pdf.

370. TCFD. (2020). 2020 Status Report. https://www.fsb.org/wp-content/uploads/P291020-1.pdf.

371. http://427mt.com/2019/04/29/climate-risk-disclosure-france-paves-the-way/#:~:text=Climate%20risk%20disclosure%20is%20essential,and%20disclosure%20of%20climate%20risk.

372. TCFD. (2020). 2020 Status Report. https://www.fsb.org/wp-content/uploads/P291020-1.pdf.

373. Degnarain, N. (2020). What Canada Is Getting Right With Its Covid-19 Economic Response Plan. Forbes. https://www.forbes.com/sites/nishandegnarain/2020/05/19/what-canada-is-getting-right-with-its-covid-19-economic-response-plan/?sh=6658fa3a5357, accessed December 8, 2020.

374. Network for Greening the Financial System (NGFS). (2020). Origin and Purpose. https://www.ngfs.net/en/about-us/governance/origin-and-purpose, accessed December 8, 2020.

375. De Nederlandsche Bank. (2018). An energy transition risk stress test for the financial system of the Netherlands. https://www.dnb.nl/binaries/OS_Transition%20risk%20stress%20test%20versie_web_tcm46-379397.pdf.

376. Binham, C. (2019) Bank of England to set up tough climate stress tests. Financial Times. https://www.ft.com/content/bacdb162-217e-11ea-92da-f0c92e957a96, accessed December 8, 2020.

377. Guida, V. (2020). Fed formally calls out climate change as stability risk. Politico. https://www.politico.com/news/2020/11/10/fed-climate-change-risk-435685, accessed December 8, 2020.

378. Coalition of Finance Ministers for Climate Action (n.d.). Finance Ministers Hold The Keys To Unlocking Climate Action. https://www.financeministersforclimate.org/about-us, accessed December 8, 2020.

379. Jupiter. (n.d.). untitled. https://jupiterintel.com/about/, accessed December 8, 2020.

380. http://priceofoil.org/2020/03/18/report-banks-poured-2-7-trillion-into-fossil-fuels-since-paris-agreement/#:~:text=The%20latest%20version%20of%20the,since%20the%20Paris%20Climate%20Agreement.

381. Standard Chartered

382. Oil Change International, Rainforest Action Network, BankTrack, Indigenous Environmental Network, Reclaim Finance, & Sierra Club. (2020). Banking on Climate Change 2020: Fossil Fuel Finance Report Card. http://priceofoil.org/content/uploads/2020/03/Banking_on_Climate_Change_2020.pdf.

383. World Bank (2017). World Bank Group Announcements at One Planet Summit. https://www.worldbank.org/en/news/press-release/2017/12/12/world-bank-group-announcements-at-one-planet-summit, accessed December 8, 2020.

384. Fleming, S. & Hook, L. (2019). EIBto phase out lending to fossil fuel projects by 2021. Financial Times. https://www.ft.com/content/cc78d838-0720-11ea-a984-fbbacad9e7dd, accessed December 8, 2020.

385. European Investment bank (EIB). (2020). EU member states approve EIB Group Climate Bank Roadmap 2021-2025. https://www.eib.org/en/press/all/2020-307-eu-member-states-approve-eib-group-climate-bank-roadmap-2021-2025, accessed December 8, 2020.

386. Goldman Sachs. (2020). Carbonomics: the green engine of economic recovery. https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-green-engine-of-economic-recovery-f/report.pdf.

387. Linsell, K. & Marsh, A. (2020). Goldman, JPMorgan Among Banks Trading New ESG Credit Swaps Gauge. Bloomberg News. https://financialpost.com/pmn/business-pmn/goldman-jpmorgan-among-banks-trading-new-esg-credit-swaps-gauge, accessed December 8, 2020.

388. BNEF.(2020). Record Month Shoots Green Bonds Past Trillion-Dollar Mark. https://about.bnef.com/blog/record-month-shoots-green-bonds-past-trillion-dollar-mark/, accessed December 8, 2020.

389. Reuters. (2020). Green bond issuance surpasses $200 billion so far this year: research. https://www.reuters.com/article/us-greenbonds-issuance/green-bond-issuance-surpasses-200-billion-so-far-this-year-research-idUSKBN26Q21C, accessed December 8, 2020.

390. Climate Bonds Initiative. (2020). Sustainable Debt Global State Of The Market H1 2020. https://www.climatebonds.net/system/tdf/reports/cbi-sustainable-debt-global-sotm-h12020.pdf?file=1&type=node&id=54589, accessed December 8, 2020.

391. EC. (n.d.). EU Green Bond Standard. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-green-bond-standard_en, accessed December 8, 2020.

392. BNEF. (2020). Record Month Shoots Green Bonds Past Trillion-Dollar Mark. https://about.bnef.com/blog/record-month-shoots-green-bonds-past-trillion-dollar-mark/, accessed December 8, 2020.

393. Climate Bonds Initiative. (n.d.). untitled. https://www.climatebonds.net/about, accessed December 8, 2020.

394. NewClimate Institute & Data-Driven EnviroLab. (2020). Navigating the nuances of net-zero targets. https://newclimate.org/wp-content/uploads/2020/10/NewClimate_NetZeroReport_October2020.pdf.

395. Institute For Government. (2020). UK net zero target. https://cutt.ly/lhEWHXi, accessed December 8, 2020.

396. United Nations Framework Convention on Climate Change (UNCC). (2019). Climate Ambition Alliance: Nations Renew their Push to Upscale Action by 2020 and Achieve Net Zero CO2 Emissions by 2050. https://unfccc.int/news/climate-ambition-alliance-nations-renew-their-push-to-upscale-action-by-2020-and-achieve-net-zero, accessed December 8, 2020.

397. Under2 Coalition. (2020). https://www.theclimategroup.org/under2-coalition, accessed November 30, 2020.

398. We Are Still In. (n.d.). untitled. https://www.wearestillin.com/, accessed December 8, 2020.

399. MacGrath, M. (2020). Joe Biden: How the president-elect plans to tackle climate change. https://www.bbc.co.uk/news/science-environment-54858638, accessed December 8, 2020.

400. Varro, L. & Fengquan, A.(2020). China's net-zero ambitions: the next Five-Year Plan will be critical for an accelerated energy transition. IEA. https://www.iea.org/commentaries/china-s-net-zero-ambitions-the-next-five-year-plan-will-be-critical-for-an-accelerated-energy-transition, accessed December 8, 2020.

401. Vaughan, A. (2020). Japan steps up climate ambition with 2050 net zero emissions goal. New Scientist. https://www.newscientist.com/article/2258163-japan-steps-up-climate-ambition-with-2050-net-zero-emissions-goal/#ixzz6g2bNOA7T, accessed December 8, 2020.

Main Report Endnotes

402. IISD. (2020). South Korea Commits To Reaching Net-Zero By 2050. https://www.iisd.org/sustainable-recovery/news/south-korea-commits-to-reaching-net-zero-by-2050/, accessed December 8, 2020.

403. EC. (n.d.). 2050 long-term strategy. https://ec.europa.eu/clima/policies/strategies/2050_en, accessed December 8, 2020.

404. World Steel Association (2020). World Steel in Figures 2020. https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/

405. WEF. (2018). Emerging Market Consumers & Deforestation: Risks And Opportunities Of Growing Demand For Soft Commodities In China & Beyond. https://www.tropicalforestalliance.org/assets/Uploads/47530_Emerging-markets_consumers_and_deforestation_report_2018.pdf.

406. Henley, J. (2020). France's 'big green recovery plan' not big enough for campaigners. The Guardian. https://www.theguardian.com/world/2020/sep/03/france-launches-big-green-recovery-plan-part-100bn-stimulus-covid, accessed November 30, 2020.

407. G20 countries commmited at least $184b to oil and gas; $22 billion to coal; and $17 billion to multiple fossil fuels in: Energy Policy Tracker (2020). G20 countries. https://www.energypolicytracker.org/region/g20/, accessed December 8, 2020.

408. Kirk, D. (2020). Korea Reveals 'New Deal' Designed To Boost Jobs, Revive Sagging Economy. Forbes. https://www.forbes.com/sites/donaldkirk/2020/07/14/koreas-reveals-new-deal-designed-to-boost-jobs-revive-sagging-economy/?sh=7702f80c3250, accessed November 30, 2020.

409. Ambrose, J. (2020). Rishi Sunak sets out £100bn investment in infrastructure. The Guardian. https://www.theguardian.com/politics/2020/nov/25/rishi-sunak-sets-out-100bn-investment-in-infrastructure, accessed November 30, 2020.

410. Hook L. & Pickard, J.(2020). Johnson weighs pledging Britain to tougher emissions cuts target. Financial Times.https://www.ft.com/content/c2a2fc67-a590-45c3-bb5a-c026caef435a?accessToken=zwAAAXYjVwwgkdPCovxnpZBFw9O7WsAmyu9DWg.MEYCIQD50N0ER1PwdsNBlaxvz-Ub_B7BxNChkBbcWpJJO_r5rglhAOndOyCCJ-6_zVBcP1XdFD5YffFEAvLWgeSW4JWSLNL1&sharetype=gift?token=1099b9be-d57f-4247-b2b1-70a04cd55eea, accessed December 2, 2020.

411. Myslikova, Z. & Gallagher, K.S. (2020). Mission Innovation is mission critical. Nat Energy 5, 732–734. https://doi.org/10.1038/s41560-020-00694-5.

412. Natural Resources Canada (2020). Tax Incentives For Businesses. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/2019%20Tax-Incentives-Businesses__EN_v2.pdf, accessed December 8, 2020.

413. Hussain, I. F. (2020). Green loans: Financing the transition to a low-carbon economy. World Bank. https://blogs.worldbank.org/climatechange/green-loans-financing-transition-low-carbon-economy, accessed December 8, 2020.

414. Plumer, B. & Popovich, N. (2019). These Countries Have Prices on Carbon. Are They Working? https://www.nytimes.com/interactive/2019/04/02/climate/pricing-carbon-emissions.html, accessed December 8, 2020.

415. Electric Energy Online (2019). Government launches fund to support cleaner industry, reduce emissions. https://electricenergyonline.com/article/organization/14126/805379/Government-launches-fund-to-support-cleaner-industry-reduce-emissions.htm, accessed December 8, 2020.

416. Wu, S. & Yang, Z. (2020). Availability of Public Electric Vehicle Charging Pileand Development of Electric Vehicle: Evidence from China. Sustainability. https://www.mdpi.com/2071-1050/12/16/6369/pdf, accessed December 4, 2020.

417. Government of France. (2018). Ending deforestation caused by importing unsustainable products. https://www.gouvernement.fr/en/ending-deforestation-caused-by-importing-unsustainable-products, accessed December 7, 2020.

418. The African Forest Landscape Restoration Initiative (AFR100). (n.d.). untitled. https://afr100.org/, accessed December 7, 2020.

419. Ye, L.-C. et al. (2017). Analysis of feed-in tariff policies for solar photovoltaic in China 2011–2016. Applied Energy, 203, p. 496-505. https://doi.org/10.1016/j.apenergy.2017.06.037.

420. REN 21. (2020). Key Findings Of The Renewables 2020 Global Status Report. https://www.ren21.net/wp-content/uploads/2019/05/gsr_2020_key_findings_en.pdf.

421. FOLU. (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf.

422. EC. (2020). Commission launches public consultations on energy taxation and a carbon border adjustment mechanism. https://ec.europa.eu/taxation_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism_en, accessed December 1, 2020.

423. Government U.K. (2020). Carbon Emissions Tax – closed consultation. https://www.gov.uk/government/consultations/carbon-emissions-tax, accessed December 1, 2020.

424. Green, M. (2020). U.S. could adopt carbon tax under a Biden presidency, ex-Fed Chair Yellen says. Reuters. https://uk.reuters.com/article/us-usa-climate-tax/u-s-could-adopt-carbon-tax-under-a-biden-presidency-ex-fed-chair-yellen-says-idUKKBN26T23L, accessed December 1, 2020.

425. Based on Eurostat. (2020). Share of European Union EU27 (from 2020) in the World Trade. https://ec.europa.eu/eurostat/databrowser/view/EXT_LT_INTROEU27_2020__custom_274611/default/table?lang=en, accessed November 23, 2020.

426. OECD. (n.d.). Green Public Procurement. https://www.oecd.org/gov/public-procurement/green/, accessed December 8, 2020.

427. Cabinet Office United Kingom. (2011). Government Construction Strategy. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf, accessed December 8, 2020.

428. Based on: Government of California. (n.d.). Buy Clean California Act. (BCCA) Department of General Services. https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act, accessed December 8, 2020; Kadefores, A. et al. (2019). Procurement Requirements for Carbon Reduction in Infrastructure Construction Projects – An International Case Study. Volvo Construction Equipment. https://www.diva-portal.org/smash/get/diva2:1324140/FULLTEXT01.pdf.

429. Wappelhorst, S. (2020). The end of the road? An overview of combustionengine car phase-out announcements across Europe. ICCT. https://theicct.org/sites/default/files/publications/Combustion-engine-phase-out-briefing-may11.2020.pdf.

430. Energyworld from the Economic Times. (2019). Eight EU countries to phase out coal by 2030. https://energy.economictimes.indiatimes.com/news/coal/eight-eu-countries-to-phase-out-coal-by-2030/69851004, accessed December 8, 2020.

431. Elliot, L. (2020). UK to make climate risk reports mandatory for large companies. The Guardian. https://www.theguardian.com/environment/2020/nov/09/uk-to-make-climate-risk-reports-mandatory-for-large-companies, accessed November 13, 2020.

432. Ministry of the Environment New Zealand (MfE). (2020). Mandatory climate-related financial disclosures. https://www.mfe.govt.nz/climate-change/climate-change-and-government/mandatory-climate-related-financial-disclosures, accessed November 30, 2020.

433. Mazzacurati, E. (2017). Art. 173: France's Groundbreaking Climate Risk Reporting Law. Four Twenty Seven. http://427mt.com/2017/01/16/impact-french-law-article-173/, accessed November 23, 2020.

434. Bank for International Settlements (BIS). (n.d.). Basel III: international regulatory framework for banks. https://www.bis.org/bcbs/basel3.htm, accessed December 8, 2020.

435. Insurance Europe. (n.d.). A risk based regime for Europe. https://www.insuranceeurope.eu/solvency-ii, accessed December 8, 2020.

Main Report Endnotes

436. Industrial Global Union. (2018). Spanish coal unions win landmark Just Transition deal. http://www.industriall-union.org/spanish-coal-unions-win-landmark-just-transition-deal, accessed December 4, 2020.

437. IISD. (2019). Germany and Chile Share Concrete Examples of Just Transition. https://sdg.iisd.org/news/germany-and-chile-share-concrete-examples-of-just-transition/, accessed December 8, 2020.

Image Caption/Atul Loke for Panos Pictures/Food and Land Use Coalition
Women work on tissue cultured banana sapling at the Jain Irrigation facility in Jalgaon, India.

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