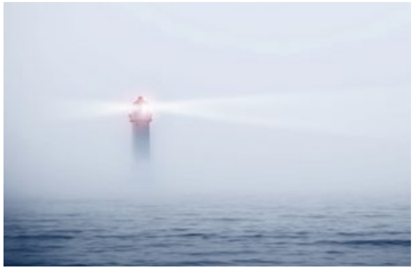
Leading the way to net-zero

Global Greentech investment opportunities

20 October 2021
Chief Investment Office GWM
Investment research

UBS

Content



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Editorial

"The climate we experience in the future depends on our decisions now."

Intergovernmental Panel on Climate Change (IPCC)

Earth is transforming into a high-risk zone, with extreme climate events like heat waves, heavy rainfall, and droughts becoming more frequent and severe. Driven by the emission of record levels of greenhouse gases such as carbon dioxide (CO_2) into the atmosphere, the past five years were the hottest ones on record (Fig. 1). Climate models suggest global warming will intensify until the world reaches net-zero emissions, hopefully around the year 2050.

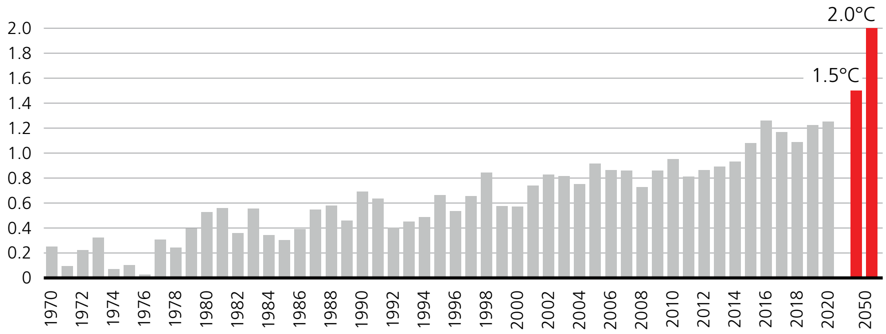
Global momentum to tackle the climate crisis has been building in the last decade. Progress has been made on many fronts, including huge strides in renewable energy generation, which is increasingly cost competitive with fossil fuel alternatives. Advances both in electric vehicle technology and in energy efficiency, coupled with societal pressure on governments and politicians to embrace a more environmentally friendly agenda, are helping to shift the Earth's course toward a net-zero future. Nevertheless, much more remains to be done, and speed will be of the essence.

The trajectory to net-zero will be key, though, as warming will continue to escalate until we reach net-zero. While the difference between a 1.5°C and a 2°C (or more) rise in average global temperatures may not seem like much, even a 0.5°C shift higher would have a significant impact on our way of life, posing humanitarian and economic risks alike. And since global warming is not evenly distributed, some regions will face much more severe consequences. In November 2021, the 26th Conference of the Parties (COP26) of the UN Framework Convention on Climate Change will take place, the most important such gathering since the Paris Agree-

Figure 1

Annual global mean surface temperature change (°C)

increase over pre-industrial era; two possible 2050 climate scenarios for illustration purposes



Note: Pre-industrial period defined as the years 1850–1900

Source: Copernicus Climate Change Service, ERA5; UBS; as of October 2021

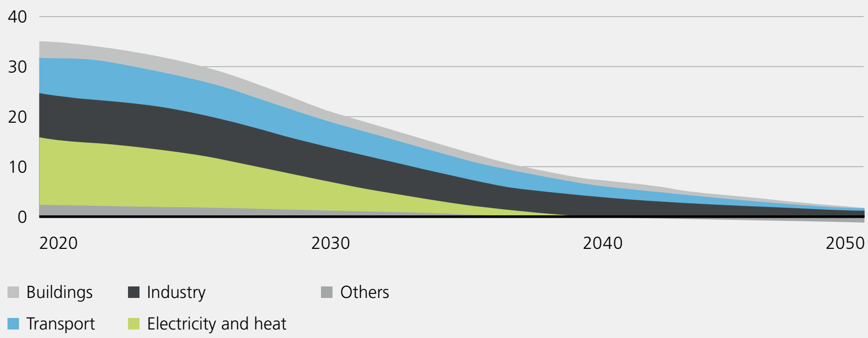
Net-zero

Every ton of carbon released stays in the atmosphere and traps heat, unless it can be absorbed by nature (oceans, soil, and plants), or emerging carbon capture technology. Reaching net-zero – where all carbon emitted can be absorbed – will be necessary to stop further global warming. The broad consensus amongst climate researchers is that this could be achieved by around 2050, assuming that immediate, rapid and large-scale reductions in CO_2 emissions will be taken. From a sector perspective, electricity and heat production is the largest single source of global CO_2 emissions, accounting for more than 40%. Most of the reductions in global CO_2 emissions through 2030 will be driven by replacing fossil fuels with renewable energy. The path for other high CO_2 emitting sectors like industry, transport and buildings is likely to be much more gradual.

Figure 2

Sector view of CO_2 mitigation path +1.5°C scenario

in $GtCO_2$



Source: IEA (2021) Net Zero by 2050 – A roadmap for the global energy sector. All rights reserved; UBS

Statements

"Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach."

Intergovernmental Panel on Climate Change (IPCC), Sixth Assessment Report, August 2021

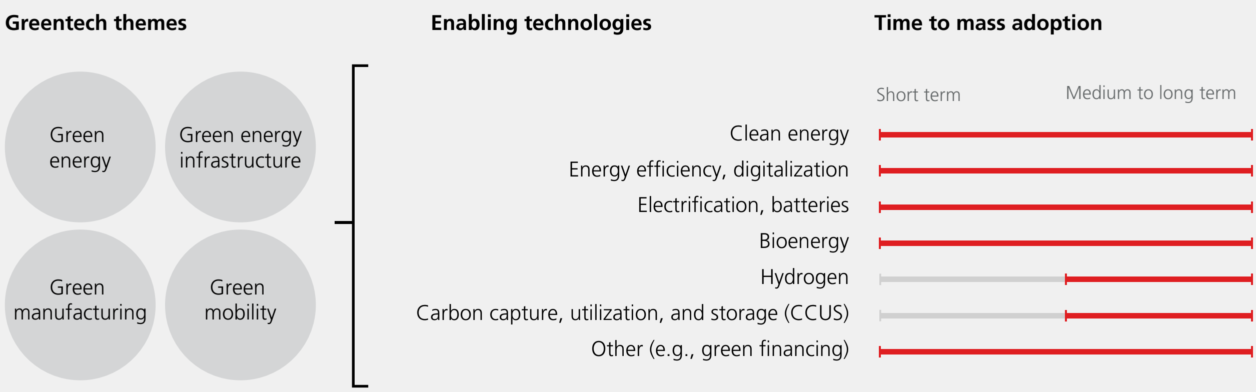
Greater national climate ambitions, accelerated by COP26, will be an important catalyst. Clean energy, energy efficiency, digitalization, electrification, batteries, bioenergy and intermediaries such as financials offer attractive investment opportunities.

UBS. Note: COP26 is the 2021 United Nations climate change conference taking place in November 2021 in Glasgow

Global investment opportunities: Up to USD 130tr expected to flow into global energy transition by 2050, about 40% of which between 2021 and 2030.

IRENA (2021), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi. Note: Investment opportunity in a 1.5°C scenario

Greentech opportunities



Source: UBS, as of October 2021

ment was signed in 2015. This meeting will likely prompt the adoption of significant regulations aimed at mitigating climate risks, public policies such as carbon taxes or pricing to incentivize change, massive infrastructure investments, and green subsidies. However, the biggest challenge will be closing the gap between rhetoric and action.

What does this mean for investors? Huge amounts of money will be mobilized and funneled into energy transition solutions in the coming decades, offering interesting investment opportunities. The International Renewable Energy Agency (IRENA) sees investment need ranging from USD 100tr to 130tr between now and 2050 under different scenario assumptions[1], funded by lending, debt, and equity investments (public and private). Investments will likely be front-loaded, with about 40% occurring in the years 2021–2030. Companies that provide technological solutions to climate change challenges can expect to benefit, whereas those that are too slow to adapt could see rising costs and a loss of competitiveness.

While information technology has underpinned economic growth for the past decade, action on climate change is poised to serve as a key global theme, politically and economically, for the coming decades.

We see the biggest short- to medium-term investment opportunities in five areas

- clean energy
- energy efficiency, digitalization
- electrification, batteries
- bioenergy
- green financing

Over the longer term, we expect new investment opportunities in technologies like

- hydrogen
- carbon capture, utilization, and storage

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1 IRENA (2021), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi. Note: Assumptions include a Planned Energy Scenario (governments' current energy plans and other planned targets and policies) and a 1.5°C scenario.

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Global regulation

The latest report from the Intergovernmental Panel on Climate Change (IPCC) issued a "code red for humanity." Without immediate action, it concluded that we are set to reach a tipping point by the end of this decade, and the goal to contain global warming to 1.5–2°C by 2050 will not be achieved.

This puts further emphasis on the UN's upcoming climate change conference (COP26) in November 2021, at which Paris Agreement (COP21) targets and progress will be reviewed. Currently, legally binding nationally determined contributions (NDCs) cover only 12% of the emission reductions required to meet Paris Agreement goals (Fig. 3). We expect additional action from policymakers and companies alike to support high-profile decarbonization commitments made over the past year.

What, precisely, would policy efforts focus on? According to the International Energy Agency (IEA), 80% of the emission reduction technologies required to get us to 2030 interim targets already exist and are already in use. These include renewables (e.g., solar and wind), energy efficiency solutions, electrification, and bioenergy. Here, the goal is driving massive scale and speed—renewable capacity additions must increase fourfold, and energy efficiency improvements must accelerate threefold compared with what has been achieved in the past two decades.

Policy tools will come from two angles. First, we will see regulations that enforce change. For example, the UK government has banned the sale of internal combustion engine cars from 2030 and trucks from 2035, and the country's national aviation sector has become the first to pledge to go "jet zero" (i.e., net-zero carbon emissions from the sector) by 2040. Second, the deployment of capital toward the energy transition should further accelerate, especially the leveraging of private capital.

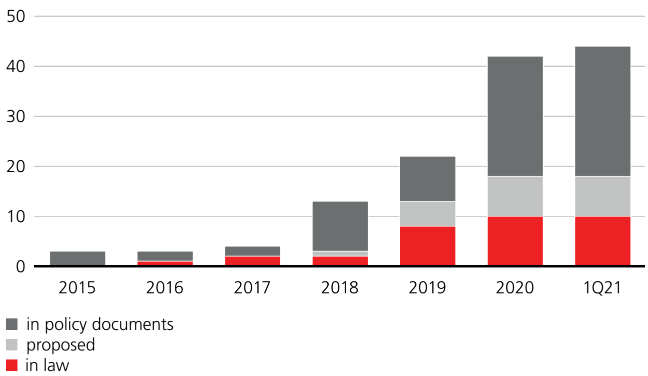
Carbon pricing will also increasingly come in focus, creating market-based incentives to cut emissions where it is easiest to do so and rewarding low-carbon technologies. The IEA calls for global carbon prices to reach USD 130/t by 2030, and USD 250/t by 2050 (recently, EU carbon prices have remained between USD 61/t and 74/t). Greentech-related companies may benefit not only from the potential sale of carbon credits, but also from additional revenue opportunities by selling additional goods and services. For example, the EU's "Fit for 55" package pushes member states to invest proceeds from carbon credits into climate and energy-related projects.

Strategic capital must also chase longer-term technologies. The IEA cautions that 50% of emission reductions required to meet 2050 goals would have to come from technologies that

Figure 3

Number of national net-zero pledges

countries with pledges

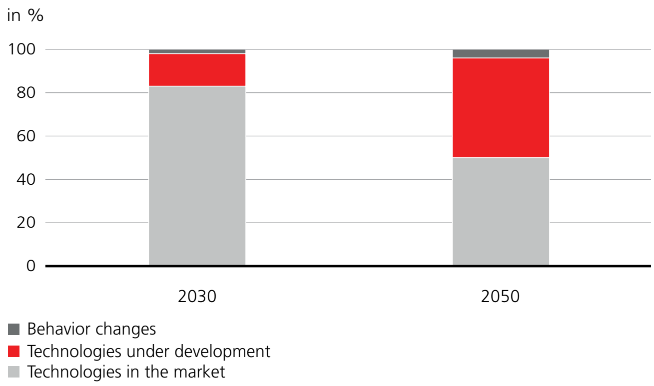


Source: IEA (2021) Net Zero by 2050 – A roadmap for the global energy sector. All rights reserved; UBS

Figure 4

Annual CO_2 emissions savings in the net-zero pathway relative to 2020

in %

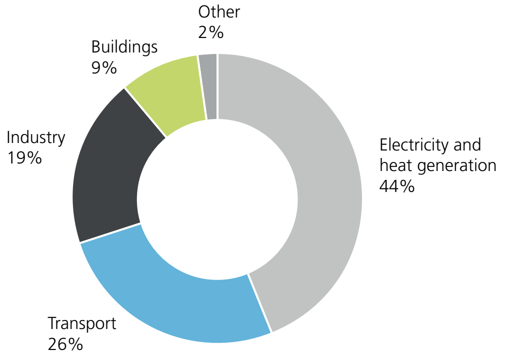


Source: IEA (2021) Net Zero by 2050 - A roadmap for the global energy sector. All rights reserved; UBS do not currently exist or are not widely used (Fig. 4). The focus will be on hydrogen, which should grow fivefold by 2050, and carbon capture, utilization, and storage (CCUS).

But building climate resilience goes beyond just mitigation strategies that reduce emissions. With the expectation of more frequent and severe climate events, we may also see heightened policy emphasis on adaptation strategies. This includes climate-proofing cities, businesses, and countries, and investing in areas ranging from physical infrastructure to insurance. According to the reinsurance company *Munich Re*, just 40% of natural disaster losses in 2020 were insured, and that figure stands at only 2% in China.[1] This underscores the need for the development and application of technologies across different industries to deliver scale and speed. The opportunity cost of inaction will be the largest in emissions-intensive sectors (Fig. 5).

Figure 5

Global CO_2 emissions by sector, 2019



Source: IEA (2021) Global CO_2 emissions by sector, https://www.iea.org/data-and-statistics/charts/global-co2-emissions-by-sector-2019

Regional developments

United States

The US has proposed ambitious targets to decrease emissions, including goals to reach 80% clean electricity and 50% electric vehicle sales by 2030. With about 60% of the US power sector still dominated by fossil fuels, these targets indicate significant growth from current levels in renewable energy sources such as solar and wind.

In mid-August, the US Senate approved a bipartisan USD 1tr infrastructure bill that includes spending on electric grid and power infrastructure, water systems, electric vehicles, and water remediation projects. The bill has not been signed into law yet, and the scale of spending is smaller than originally announced on the campaign trail, but we view the potential incremental spending as positive for greentech industries. The budget reconciliation plan to be finalized in the weeks ahead could provide another avenue for Congress to weave climate-related initiatives into federal spending plans, but we don't believe the fate of the US greentech market rests solely on these bills. Demand has remained healthy despite pandemic headwinds, with renewable energy capacity additions breaking records year-to-date, according to the American Clean Power Association. This is further supported by the outlook for rising global demand for clean energy, in part driven by policy support outside the US.

Europe

The European Union has been a frontrunner in developing and implementing climate-driven policies. In reducing greenhouse gas emissions, growing renewable energies, introducing an emissions trading system, and supporting energy efficiency measurements, it has proven itself a leader in global efforts to mitigate climate change.

The EU goes "Fit for 55"

Introduced in December 2019, the European Green Deal set a goal for Europe to become the world's first climate-neutral continent by 2050. In the meantime, other major countries and markets have followed. In July 2021, the European Commission laid out the path to net-zero emissions and presented plans for more ambitious targets to reduce greenhouse gas emissions in this decade, including a series of legislative proposals (Fig. 6). According to this "Fit for 55" package, emissions should decline by at least 55% by 2030 (compared with 1990 levels).

1 Munich Re, "Record hurricane season and major wildfires – The natural disaster figures for 2020," January 2021

Figure 6

Fit for 55 overview

Energy
– produce 40% of energy from renewable sources by 2030
– set more ambitious energy efficiency targets
– sustainability criteria for the use of bioenergy are strengthened

Buildings
– initiate renovation wave
– public sector should renovate 3% of its buildings each year

Transport
– accelerate the transition to zero-emission mobility
– average emissions to be lowered by 55% from 2030 (compared with 2021 levels)
– all new cars to be zero-emission as of 2035
– install a tighter network of charging (electric) and fueling (for hydrogen) points
– shipping emissions to be included in the EU Emissions Trading System (ETS)

Land use, forestry, and agriculture
– set an overall EU target for carbon removals by natural sinks
– plant three billion trees by 2030 to improve the quality, quantity, and resilience of EU forests

Source: European Commission; UBS; as of October 2021

Offshore renewables to grow

Boosting offshore renewable energy is another key focus area of the European Commission, particularly given the global dominance of the EU's offshore wind energy leaders and its vast basins. Here, European Union's offshore wind capacity is proposed to surge from the current 15 GW capacity to at least 60 GW by 2030 and to 300 GW by 2050. While the potential for offshore wind is great, new technologies like wave, tidal, and floating solar should also be advanced. Floating solar is a solar power production installation mounted on a structure that floats on water. Offshore renewable energy investments are estimated to reach EUR 800bn by 2050.[1]

Asia Pacific

Asia Pacific (APAC) accounts for about half of the world´s energy consumption, with most of that regional consumption coming from fossil fuels. However, this dependence on oil, coal, and natural gas is likely to change, and we expect APAC to become the key destination for renewable energy development and investment in this decade. The region is supported by rising populations, strong economic growth, and substantial potential due to the low market penetration of renewables there. While China recently announced net-zero carbon pledges by 2060, Japan and South Korea plan to reach this target already by 2050. Solar and wind are expected to attract the most attention from governments across the region. In fact, APAC is expected to become one of the biggest, if not the biggest, offshore wind market by 2030, with the top markets in China, South Korea, Japan, and Vietnam.
Already today, China is the global leader in renewables production and will accelerate its transition away from traditional fuels as the country aims to reach peak emissions before 2030 and net-zero emissions by 2060. To decarbonize its massive coal industry, China's new green infrastructure hydrogen deal will transform its major coal mining region into a hydrogen production facility, turning Inner Mongolia into one of the largest renewable energy hubs in Asia. China has also launched the first phase of its national carbon emissions trading scheme (ETS), which aims to deploy market mechanisms to regulate carbon output while incentivizing high-emission industries to pivot toward renewable energy sources.

While Asia Pacific is not taking a one-size-fits-all approach to get to net-zero, major countries like India and Japan are also making progress. Japan has announced its intention to accelerate its transition to renewable energy, targeting 36–38% of power production by 2030. As one of the major carbon emitters globally, India is aiming for a total of 450 GW of renewable energy and to meet 40% of its electricity needs from non-fossil fuel sources by 2030, with solar power at the forefront. A milestone was achieved in August 2021 when the country successfully crossed the threshold of a total of 100 GW of renewable energy production capacity.

2022 Beijing Winter Olympics

China has plans in the works to demonstrate its development of nationwide green transportation during the 2022 Beijing Winter Olympics. Over 200 hydrogen fuel cell shuttle buses will transport competitors, staff, and visitors within the Yanqing competition zone. All electricity supplied during the winter games would come from renewable sources, generated with the help of wind and solar plants from the co-host city, Zhangjiakou. Refrigerants used within ice venues would be produced using natural carbon dioxide, instead of the chemical Freon used in previous winter Olympics, to further curb carbon emissions.

1 European Commission (press release), "Boosting offshore renewable energy for a climate neutral Europe," 19 November 2020

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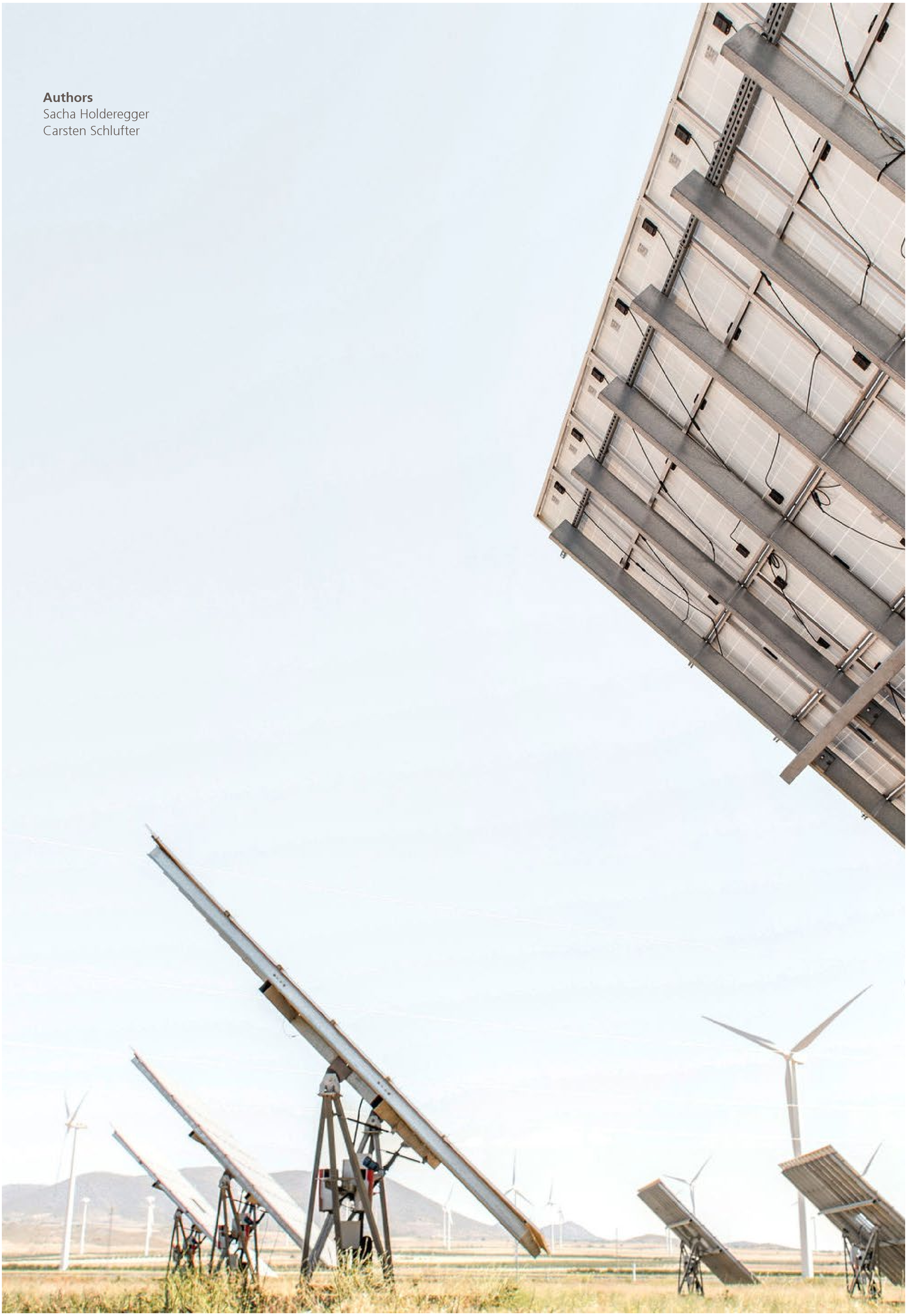


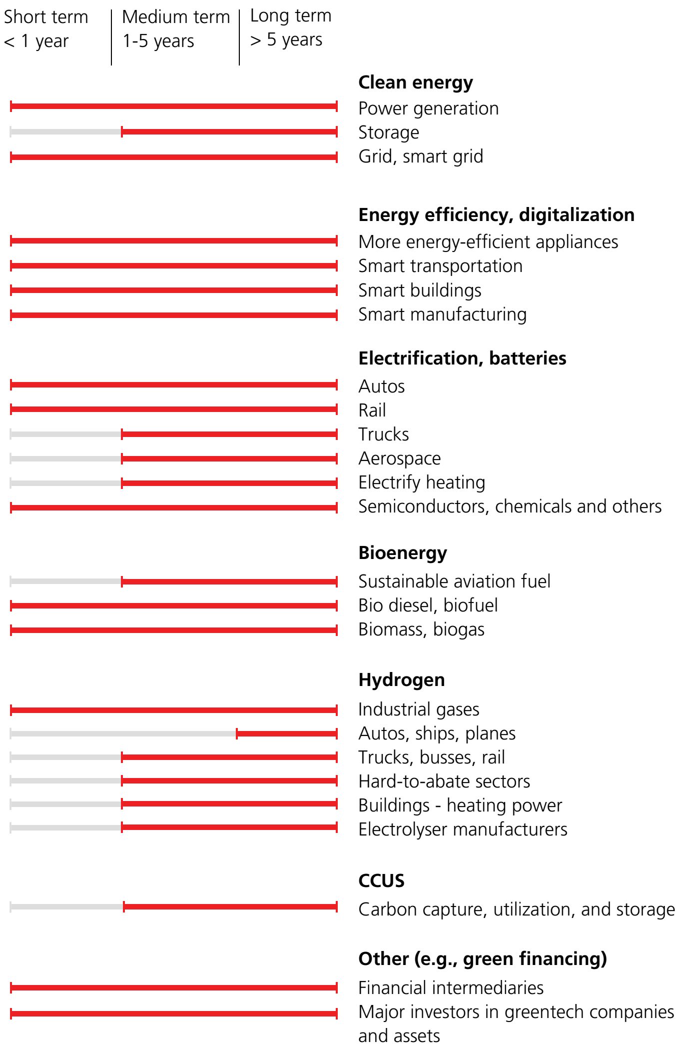
Enabling technologies

Global climate goals can only be reached with green technologies as an important enabler, in our view. While most of the technologies needed to achieve the required deep cuts in global emissions by 2030 already exist (e.g., renewable energy, significant energy efficiency improvements), the net-zero emissions path in the following decades will rely on the widespread use of new technologies that are not commercially available or in use yet.

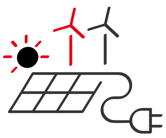
This sets the scene for investment opportunities both in the short-to-medium term, including in listed (Fig. 7) and private equity, and in the longer term. A major acceleration in clean-energy innovation must occur over this decade to bring these new technologies to market in time (Fig. 4). The development and deployment of these new technologies has the potential to create major new industries with commercial opportunities. We focus on the most promising new technologies in the areas of electrification; batteries; bioenergy; hydrogen; and carbon capture, utilization, and storage.

Figure 7

Investment opportunities



Source: UBS, as of October 2021



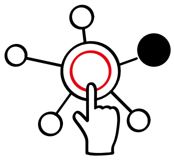
Clean energy

Clean electricity will play a key role across all sectors—from transport and buildings to industry—and is essential to producing low-emission fuels such as green hydrogen. To achieve this, total electricity generation is expected to increase over 2.5 times between today and 2050.[1] Decarbonizing the production of electricity is therefore the largest opportunity for reducing CO_2 emissions. In its net-zero pathway, the IEA expects that 90% of electricity generation should come from renewable sources by 2050, up from 25% in 2018, with wind and solar PV together accounting for nearly 70%. Falling costs for renewable technology have been one of the key growth drivers for installations in the past years. While wind and solar energy have already become cost competitive with fuel-based or nuclear power electricity generation in many countries, expected further cost declines should soon make them the cheapest way to produce electricity. Significant investment in

1 IEA (2021) Net Zero by 2050 – A roadmap for the global energy sector. All rights reserved.

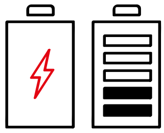
electricity storage to compensate for the intermittency of wind and solar will be required to maintain electricity reliability, though as discussed below, significant progress is being made with batteries and other storage technologies.

Energy efficiency, digitalization



Reducing carbon emissions at a time when global energy demand is rising means that increased energy efficiency will be essential. Many efficiency measures in industry, buildings, appliances, and transport can be put into effect and scaled up very quickly. These will be crucial to curbing emissions until other new technologies have a more meaningful impact. Examples of key energy efficiency measures are more efficient pumps, boilers, air conditioners, motors, and other appliances. The IEA expects that 2–2.5% of existing residential buildings will have to be retrofitted each year through 2050.[1] Further, digitalization will also play an important role in the energy transition as the renewable energy landscape will be much more fragmented and decentralized, with production closer to the point of energy consumption. In the future, renewable power generation will likely still be dominated by the traditional energy providers, as well as by many companies and households that produce, consume, and sell renewable energy to the grid. This means larger amounts of data and an increasingly complex system that will have to match changing levels of supply and demand. New digital technologies like artificial intelligence, big data, and distributed ledgers will likely be critical in supporting that transition. In manufacturing, new technologies like the Industrial Internet of Things (IIoT) and digital twins (i.e., the virtual representation of a product, production process, or performance) will be key to increasing connectivity and automation, and to finding more efficient energy solutions.

Electrification, batteries

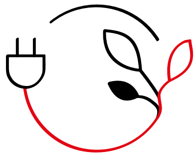


Electric vehicles (cars, SUVs, and pickup trucks) have become increasingly popular, especially as battery costs have fallen and are likely to continue to fall sharply. Quickly declining battery costs, coupled with faster charging times and a rapid rollout of electric vehicle charging infrastructure, weaken the case for alternative fuels (biofuels) and technologies (e.g., hydrogen-powered fuel cells[2]). Once these investments are made, batteries are expected to benefit from a first-mover advantage and a superior cost position. Significant progress has been made in battery technology over the past decade. Current lithium-based batteries will remain dominant in the near term, but evolving changes in the field of chemistry will likely result in higher energy density batteries, with new battery technologies like sodium-ion also just around the corner. That said, the future may belong to solid-state batteries (see also our "Smart mobility" Longer Term Investments report) that boast even greater energy density, higher safety, and better end-of-life recycling characteristics, which make them appealing for transportation purposes.

Meanwhile, in many instances, the economics involved in using batteries for stationary purposes are not compelling enough currently. However, we believe this will change. The more decentralized and less reliant power generation becomes, thanks to renewables, the more batteries will be needed. Technologies enabling the storing of the electricity generated by households' photovoltaic (PV) systems or, on a much larger scale, by PV farms will gain ground, in our view. They will be a complementary enabling technology for large-scale applications alongside pumped storage hydro (where applicable) and hydrogen technology.

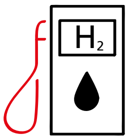
1 IEA (2021) Net Zero by 2050 – A roadmap for the global energy sector. All rights reserved.
2 Fuel cells are devices that convert the chemical energy of a fuel (usually hydrogen) into electricity with an electrochemical reaction.

Bioenergy



Bioenergy is a form of renewable energy including solid biomass (e.g., crop waste, wood waste, food waste, microalgae), biogas, and liquid biofuels. It can be used to produce transportation fuels, heat, and electricity. Bioenergy technologies enable the reuse of carbon from biomass and waste streams. If biomass is coupled with carbon capture, utilization, and storage (CCUS) in the power sector and some industrial sectors, it can even achieve negative emissions, removing CO_2 from the atmosphere.

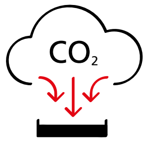
Hydrogen



Hydrogen has a key role to play in the global energy transition. It balances short-term variations in renewable electricity supply and demand and acts as an option for long-term storage to help offset renewable variability across seasons. It's also the preferred solution for achieving net-zero in energy-intensive, hard-to-decarbonize sectors like steel, chemicals, long-haul transport, and shipping. As an energy carrier, hydrogen is very similar to electricity in that it can be produced by various energy sources and technologies. Efforts are ongoing to evaluate the transportation of hydrogen in existing fossil fuel infrastructure such as natural gas networks. Hydrogen can be produced from fossil fuels, biomass, and water (through water electrolysis). Today, the production is 95% based on fossil fuels, mainly brown hydrogen from coal or lignite or grey hydrogen from natural gas. Naturally, this does not further the net-zero aim, which is why the future is green (renewables energy) or blue hydrogen (fossil fuel combined with CCUS). Today almost all hydrogen is used at the location of production, but this is set to change. The Hydrogen Council estimates that by 2030 about 30% of the production capacity will be transported by ships or pipelines from countries with ample renewable energy resources such as Australia, Saudi Arabia, and Chile.[1]

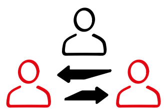
1 Hydrogen Council, "Hydrogen Insights – An updated perspective on hydrogen investment, market development and momentum in China," July 2021

Carbon capture, utilization, and storage (CCUS)



Carbon capture, utilization, and storage (CCUS) is a set of technologies that involve the capture of CO_2 either at the point of emission (the "tailpipe") from power generation or industrial facilities that use fossil fuels or biomass for fuel, or directly from the air ("direct air capture"). If not being used on-site, the captured CO_2 is compressed and transported by pipeline, ship, rail, or truck to be used in a range of applications, or it's injected into deep geological formations such as depleted oil and gas reservoirs, coalbeds, or deep saline aquifers where it's trapped for permanent storage. Given the need to significantly reduce greenhouse gases in the atmosphere over the next several decades to achieve net-zero, CCUS technologies will have a significant role to play, at least in some major markets. The US and China could be attractive markets for CCUS technology if the cost to build and operate facilities can be reduced. Even the new hydrogen economy stands to benefit, and the so-called blue hydrogen (based on fossil fuels combined with CCUS) could be an attractive way to pursue decarbonization in select regions. Many large companies are actively working to reduce the cost of CCUS technologies, and if they're successful, there could be a significant growth opportunity for these technologies globally. With several new CCUS projects underway across the world, we believe breakthroughs are likely over the next several years.

Other



Intermediaries such as the financial sector have a key role to play in the transition to a more sustainable economy. The sector will be critical in facilitating the financing needed to get to net-zero by 2050 through channeling funds away from fossil fuels and into the energy transition. Nascent technologies will be especially dependent on the supply of enough risk capital if they are to stand a realistic chance of getting through the initial "valley-of-death" stage and becoming market competitive. Innovative lending, investing (private and public markets), corporate finance, and insurance solutions are expected to support companies in adopting and developing low-carbon solutions. Recent UN-convened initiatives such as the Net Zero Banking Alliance and the Asset Managers' Alliance highlight these intentions and could become a catalyst in the next development phase of climate finance.

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Greentech focus areas

Decarbonization represents the next great transformation. Markets and businesses are likely to undergo fundamental and rapid change in the future. We see attractive investment opportunities in four areas:

- **Green energy**
- **Green manufacturing**
- **Green mobility**
- **Green energy infrastructure**

IRENA expects offshore wind capacity should grow by a factor of ten times by 2030

Green energy

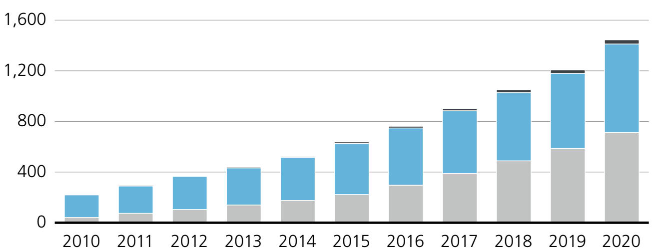
The year 2020 welcomed a record number of new global renewable energy installations. According to the International Renewable Energy Agency (IRENA), total renewable energy capacity grew to around 2,800 GW, an increase of 10%, demonstrating its resilience throughout the pandemic. Growth was strongest in solar energy (+22%) and wind energy (+18%).

Robust growth of solar and wind power
Boosting renewables for clean electricity generation and hydrogen production both will be critical to achieving net-zero emissions, in our view. Although hydroelectric power is still the renewable with the highest capacity worldwide, we believe solar and wind energy has the greatest growth potential (Fig. 8) and is poised to become the backbone of electricity production in many countries, far exceeding hydroelectric power. To reach net-zero, the IEA estimates that solar and wind capacity must grow exponentially to 5,000 GW of solar (33% of global electric capacity) and more than 3,000 GW of wind capacity (21%) by 2030. Political support for renewable growth is strong, and costs have fallen at a faster pace than experts had anticipated some years ago, thanks to economies of scale and technical innovations. While 95% of today's wind power capacity is onshore, we think offshore wind has enormous potential in many regions.

Figure 8

Global renewable capacity (wind and solar)

in GW



Source: IRENA (2021), Renewable capacity statistics 2021, International Renewable Energy Agency, Abu Dhabi; UBS

Huge potential for offshore wind power
Boasting almost 75% of global capacity, Europe has been the dominant offshore wind power market (Fig. 9), with the UK and Germany contributing to half of the global capacity of 34 GW at the end of 2020. However, China installed half of the new global offshore wind capacity with 6 GW last year, and it should soon become the largest offshore wind market. We expect offshore wind growth to be exponential in the coming years. With capacity factors (i.e., the ratio of an electricity output to the maximum possible output, 365 days or 8,760 hours per year) of up to 60%, offshore wind provides more reliable electricity generation potential than onshore wind and solar energy. To contain global warming to the 1.5°C Paris Agreement target, IRENA expects offshore wind capacity should grow by a factor of ten times to 380 GW by 2030 (Fig. 10). But the world's energy needs do not stop there, as the European Commission expects that 240–450 GW of offshore wind power will be needed in the EU alone by 2050.

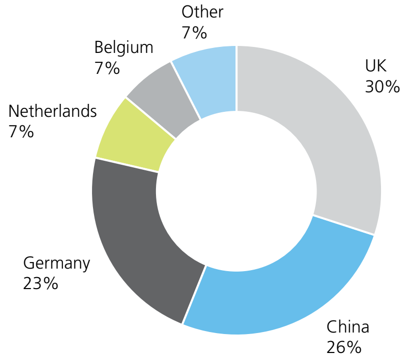
Technology improvements and cost declines have been impressive over the past several years, and they could continue to surprise. At 10–15 MW today, the average offshore wind turbine capacity has improved by a factor of 4–5x since 2010, and it's projected to double to 20 MW by 2030. This will improve capacity factors and the security of electricity supply. While the manufacturers of offshore wind turbines are limited to a small number of companies, several oil majors have recently entered the market; they've presented their investment plans and are competing with the traditional large utility and infrastructure funds. Given rising investment, the IEA expects the offshore wind power market to become a USD 1tr business by 2040.[1]

Rapid cost reductions should make offshore wind cost competitive with fossil fuel and nuclear power production within this decade. The IEA expects investment costs, which were about EUR 1bn for a 250 MW offshore wind project in 2018 (including transmission), to fall 40% over this decade. Outside Europe, large-scale projects are planned in China, the US, and Japan. While offshore wind projects have grown in size and total investment costs over the past decade, floating offshore wind is a technology that enables the building of wind farms in deep water. Floating technologies are not economically attractive yet, but the EU is supporting new projects as part of its EUR 1.8tr Next Generation EU recovery plan.

1 Source: IEA (2019) Offshore Wind Outlook 2019, https://www.iea.org/reports/offshore-wind-outlook-2019. All rights reserved.

Figure 9

Share of global offshore wind energy capacity

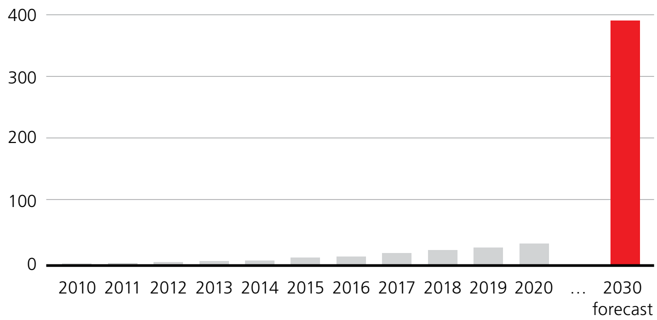


Source: IRENA (2021), Renewable capacity statistics 2021, International Renewable Energy Agency, Abu Dhabi; UBS

Figure 10

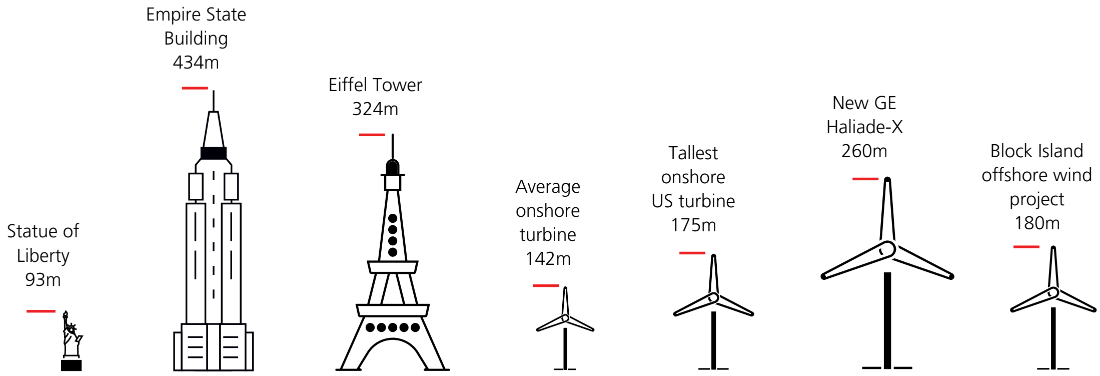
Global offshore wind energy capacity and forecast for 2030

in GW



Source: IRENA (2021), Renewable capacity statistics 2021; IRENA (2021), Offshore Renewables: An action agenda for deployment, International Renewable Energy Agency, Abu Dhabi; UBS

Dimensions



Source: UBS

Deep Dive

Dogger Bank Wind Farm

Located in Europe's North Sea, 130km off the northeast coast of England and in water depths between 20m and 60m, the Dogger Bank Wind Farm is the world's largest offshore wind farm with a total generation capacity of about 5 GW. Dogger Bank is an isolated sandbank that consists of four offshore wind farms, each with a capacity from 1.2 to 1.4 GW and up to 600km^2 in size.

The Dogger Bank is an attractive location because it is far away from shore, shielding it from complaints about the visual impact of wind turbines, yet the water depth is shallow enough for traditional fixed foundation wind turbine designs. First power is expected in the summer of 2023, with full completion of the project targeted for 2026. Dogger Bank will be the UK's largest single source of renewable energy in the coming years.

The four offshore wind farms (Dogger Bank A, B, and C, and Sofia wind farm) are owned and operated by various energy companies such as the Scottish renewable developer *SSE*, Norway's oil and gas major *Equinor*, Italian multinational oil major *ENI*, and *RWE*, a German utilities company.

GE will provide the 190 wind turbines for Dogger Bank A and B (13 MW) and 87 wind turbines (14 MW) for Dogger Bank C. The turbines will have a height of about 260 meters, 107 meter blades, and a 220-meter rotor. For the Sofia wind farm, *Siemens Gamesa* will provide 100 wind turbines (14 MW).

One spin of such a wind turbine can generate enough electricity to power a UK household for more than two days

Global energy and fuel production from biomass has grown sharply in the past several years

Deep Dive

Bioenergy

Bioenergy is a renewable energy source and accounts for about 10% of the world's total primary energy supply. Global bioenergy production from biomass (organic material like organic waste, agricultural crops, and forest residues), as well as the production of biofuel, has grown sharply in the past several years.

Since our earliest days, humans have used biomass energy, and it remains an important fuel in many (developing) countries for cooking and heating today. Biomass is converted to energy through various processes, including direct combustion (burning) and chemical/biological conversion to produce fuels.

The most common types of biofuels are bioethanol, which is mainly produced from maize (60%) and sugarcane (25%), and biodiesel, which is mainly produced from palm oil (30%), soybean oil (25%), rapeseed oil (20%), and cooking oils (20%).

Biofuels play an important role in, for example, Latin America, where they are the largest source of clean transport fuels. Global biofuel production has been growing quickly in the past several years, with the US and Brazil— the largest producers by far—having a 48% and 27% share in ethanol production, respectively, while the EU is the largest producer of biodiesel with a 32% share.

Green manufacturing

According to the IEA, the manufacturing sector accounts for the second-highest share of final energy consumption, behind the transport sector. The subsectors with the highest CO_2 emissions are cement, iron and steel, chemicals, and petrochemicals (Fig. 11). We believe that the adoption of more resource-efficient processes is resulting in more sustainable industrial practices thereby reducing the environmental footprint of the manufacturing sector, especially resource-intensive industries. In the US, for instance, energy efficiency improvements had a big impact on manufacturing intensity, which decreased by 44% between 2000 and 2018, primarily because of improvements in the basic metals and chemicals industry.[1]

Industrial companies have always had big incentives to save energy since energy costs directly affect their profitability. As a result, life-cycle costs of new equipment are key to consider when making purchasing decisions. In our deep dive section, we present an example (variable speed drives, or VSDs) that shows what a powerful, positive impact energy efficiency can have both on the environment and on businesses. We regard the current economic environment as very supportive for energy efficiency investments because energy prices are relatively high and funding costs are low, making the return on investment attractive.

Some of the most promising opportunities for improving efficiency in the manufacturing sector—while also having a positive environmental impact—include smart automation; the usage of hydrogen in the production process; carbon capture, utilization, and storage (CCUS); and the recycling of plastics.

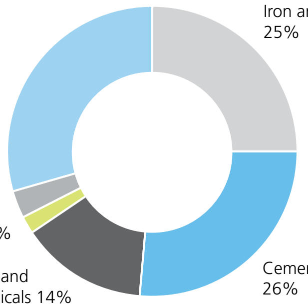
Smart automation
More efficient production processes are a key driver for green manufacturing, helping to reduce CO_2 in the manufacturing sector. Over the last few years, several factors have accelerated the digital transformation and increased the usage of automation equipment in the manufacturing sector, supporting this trend. The Industrial Internet of Things (IIoT), 5G communication networks, and industrial software are all key enablers of the transition to smart and more sustainable manufacturing. The COVID-19 crisis has further boosted the trend toward "contactless" production. We expect an increasing focus on connected devices and their use of the IIoT (Fig. 12). Under the IIoT system, smart machines are connecting everything from manufacturing processes to transport networks with cloud systems, giving unprecedented real-time control and transparency to businesses and customers. These developments will help reduce the energy consumption in the industrial production process and support the decarbonization of the manufacturing sector.

The IIoT will also be critical to the success of digital twin technology (i.e., the virtual representation of a product, production process, or performance). This technology includes, among other applications, the use of sensor data, machine-to-machine communication, and big data technology (cloud-

Energy efficiency improvements have a big impact on manufacturing intensity

Figure 11

Global industry direct CO_2 emissions in 2018



Source: IEA (2020) Industry direct CO_2 emissions, https://www.iea.org/data-and-statistics/charts/industry-direct-co2-emissions-in-the-sustainable-development-scenario-2000-2030. All rights reserved; UBS

1 Source: IEA (2020) Energy Efficiency Indicators: Overview, https://www.iea.org/reports/energy-efficiency-indicators-overview. All rights reserved.

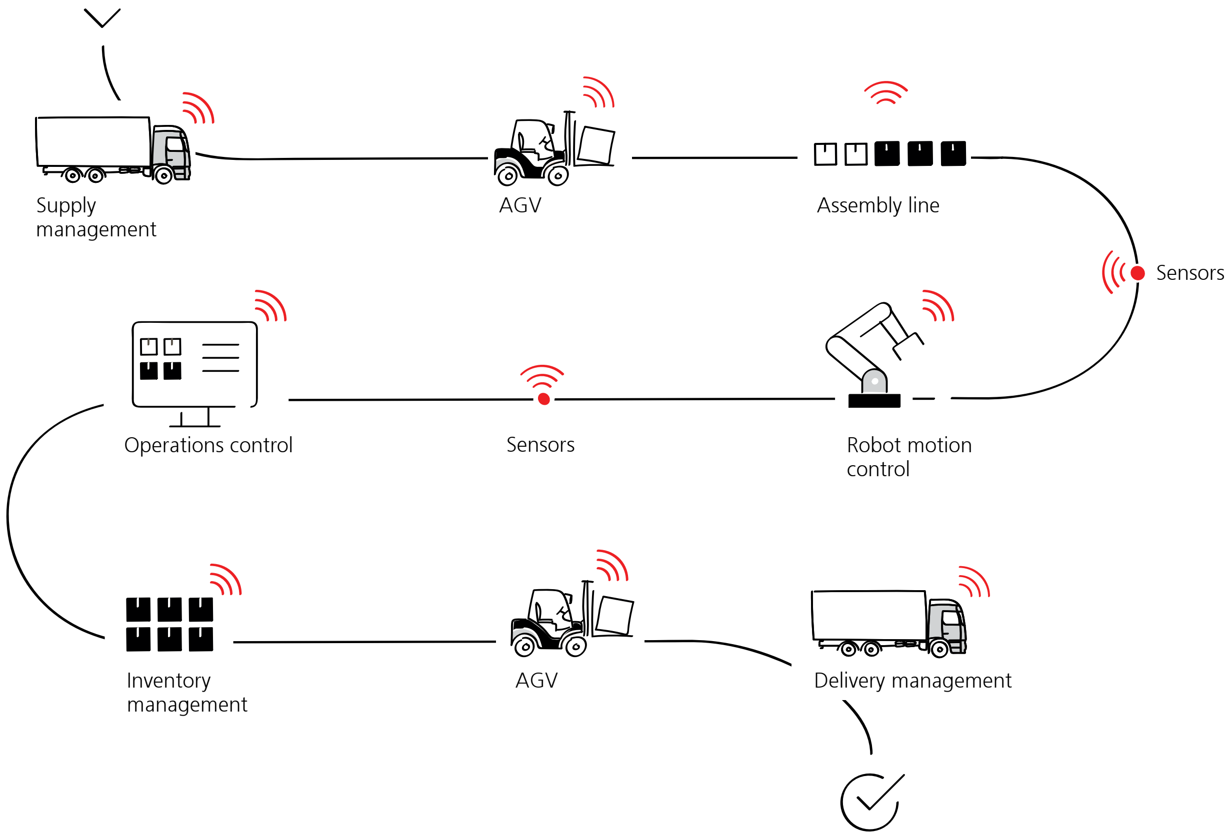
based platforms) to monitor equipment and analyze data in real time. Digital twins and IIoT technology will have a positive impact on the environment both by eliminating inefficiencies and by saving resources through better management of production processes and predictive maintenance, leading ultimately to a longer product life.

We estimate the size of the global automation market at USD 183bn in 2020. Following the strong post-pandemic rebound, we expect the smart automation industry to grow its average revenue in the mid- to high-single-digit rates in the medium term.

The adoption of this technological transformation is happening across the world. In China, for instance, the State Council in November 2017 revealed guidance for the country's IIoT development, indicating that Beijing seeks to enhance China's manufacturing sector through information technology. Against the backdrop of Beijing's fast rollout of 5G infrastructure, the government has supported the upgrade of the physical economy through digitalization. Given the US's threat to clamp down on technology transfers, Beijing is keen to define its own IIoT standards and to develop the supply chain to help China achieve self-sufficiency in advanced technology applications. In addition, Beijing's decarbonization target and the nation's aging population have supported local firms in accelerating the pace of manufacturing automation. The robot density in manufacturing surged massively in the last decade, bringing the robot density per 10,000 employees in the manufacturing sector in China to a higher level than the global average (Fig. 13).

Figure 12

Sample application areas of 5G in the factory of the future



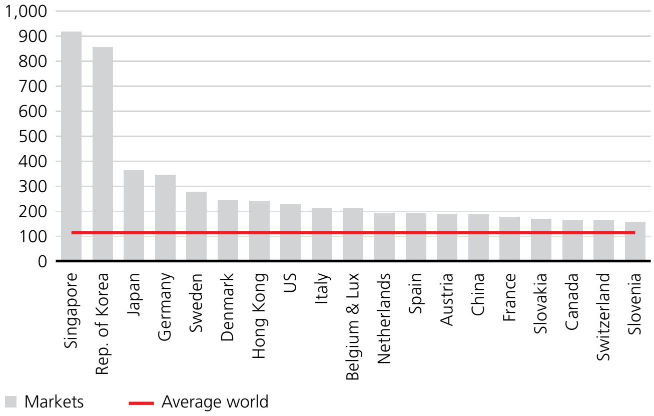
Note: AGV = automated guided vehicle
Source: ZVEI (5G for Connected Industries and Automation); UBS

But this trend is not isolated to China, as other Asian countries, Europe, and the US are also upgrading their automation equipment. Europe is home to many of the market leaders in the global factory, process, and warehouse automation industry. In the aftermath of the pandemic, we expect certain industries to diversify their supply chains and bring production closer to end-customers in Europe and North America. This would be an acceleration of a trend that had already begun in the wake of the US-China trade tensions that rapidly increased tariffs between the two countries. Prime evidence of this trend can be found in the semiconductor industry where we have seen around USD 50bn in new US semiconductor plant investments announced over the past year, a significant amount relative to the current rate of spending. Recent regulatory crackdowns by China on industries such as technology could also increase reshoring. The net result of these developments will be a greening of manufacturing as companies pursue more highly automated and efficient manufacturing plants and techniques.

Figure 13

Robot density in manufacturing (all industries) by geography

Robots per 10,000 employees, 2019



Source: International Federation of Robotics, "World Robotics 2020"; UBS; as of 24 September 2020

Promising technologies:
CCUS, hydrogen, and recycling

Another way companies can significantly green their manufacturing processes is through better carbon management to reduce overall polluting emissions. Companies have been pursuing processes such as carbon capture, utilization, and storage (CCUS) to help decarbonize their manufacturing. Several regions, including the US and Europe, have already launched supportive regulation or the funding of projects aimed at capturing carbon emissions and storing them underground. The European cement industry, for instance, has announced a roadmap to become carbon neutral along the value chain by 2050. CCUS will account for 42% of the reduction in cement and concrete value chain-related CO_2 emissions, according to the European Cement Association (CEMBUREAU).[1]

The use of less polluting alternatives such as hydrogen will also play an important role in reducing manufacturing's carbon footprint. Green hydrogen is a cleaner burning fuel than natural gas or coal, and it can be produced totally free of emissions. Highly carbon-intensive industries like steel are currently exploring using hydrogen to reduce CO_2 emissions. The European Parliamentary Research Service (EPRS) estimates that the usage of hydrogen instead of coal would increase the price per ton of steel by about one-third in Europe, but in the long term the higher prices for carbon emissions, lower prices for renewable electricity, and large-scale production of hydrogen support this alternative.[2]

Finally, another important area for advancing emission reductions is in circular economy processes, which recycle waste products back to virgin chemicals. In the US, several companies are building plants that focus on converting waste plastic back into its core molecular building blocks, which can then be used for feedstock as new plastic, fuel, or other petrochemicals. Other countries are also testing using plant-based feedstocks that would generate much less pollution.

1 The European Cement Association (CEMBUREAU), "Cementing the European Green Deal – Reaching climate neutrality along the cement and concrete value chain by 2050," May 2020. For more details please see: www.cembureau.eu
2 EPRS I European Parliamentary Research Service (C. Kurrer): The potential of hydrogen for decarbonising steel production, December 2020.

Deep Dive

Variable-speed drives

The IEA has published a working paper about the energy efficiency opportunities of electric motor-driven systems (EMDS), and in that report, they estimated EMDS consumes around 43–46% of all electricity worldwide.[1] Based on the latest estimates from industry experts, only 23% of all motors worldwide are equipped with variable-speed drives (VSDs) that enable them to adjust their speed.[2] In other words, 77% of all motors run the entire time at full tilt, regardless of how much output is required. With VSDs, the energy consumption could be reduced materially.

Pumps can also use this technology. The initial cost of a standard pump represents just 5% of the total cost of ownership; the primary cost is energy (85%) and the rest is maintenance (10%). A VSD and maximum diameter impeller save up to 10% of energy versus a pump that operates at a constant speed. This technology can also be installed in existing pumps. Another option is the replacement of an old pump with a modern high-efficiency pump, which reduces the energy consumption by 3–20% and could achieve up to 50% in same cases.[3] VSDs serve as just one example of how energy efficiency savings can be achieved in industrial applications. They also nicely illustrate that energy efficiency offers major service-life cost-reduction potential and is an important tool for reducing CO_2 emissions.

1 Waide, P. and C. Brunner (2011), "Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems," IEA Energy Papers, No. 2011/07, OECD Publishing, Paris, https://doi.org/10.1787/5kgg52gb9gjd-en.
2 Omdia, "Motor-driven Equipment Research Package," 2020
3 Sulzer, "Energy efficiency of pumping systems (Technical Article)," June 2020

Deep Dive

CCUS and hydrogen - one part of the solution

For countries to successfully meet their long-term decarbonization targets, the polluting emissions from heavy industries—particularly steel production—must be reduced. The making of steel is extremely carbon intensive, so techniques to green this process will have to become more widespread. Indeed, industry research predicts steel emissions will have to be cut by some 75% for countries to reach their decarbonization goals. Carbon capture, utilization, and storage (CCUS) is regarded as the preferred solution to this problem in the future. Since this process is still very expensive, however, countries will have to use tax incentives and regulation to encourage its widespread use and further development of the technology. New plants are currently in the planning stages, and they can capture and convert the carbon emissions to other products such as synthetic gas and biofuels, all while achieving a material decrease in overall greenhouse gas pollution.

Other less polluting steelmaking routes to follow are the use of green hydrogen produced from renewables and the increased use of electric arc furnaces (EAFs). EAFs use scrap steel as an input, so they're much less polluting than traditional steel furnaces that use coal and iron ore. Incentives will also be instrumental in discouraging coal use for steel production in terms of accelerating the shift to EAF plants. But as there is simply not enough scrap for the EAFs to replace the more polluting steel plants, carbon capture and hydrogen will still be necessary for countries to meet their decarbonization goals over time.

We estimate that by 2025, the annual addressable market of green mobility will have soared above USD 500bn

Green mobility

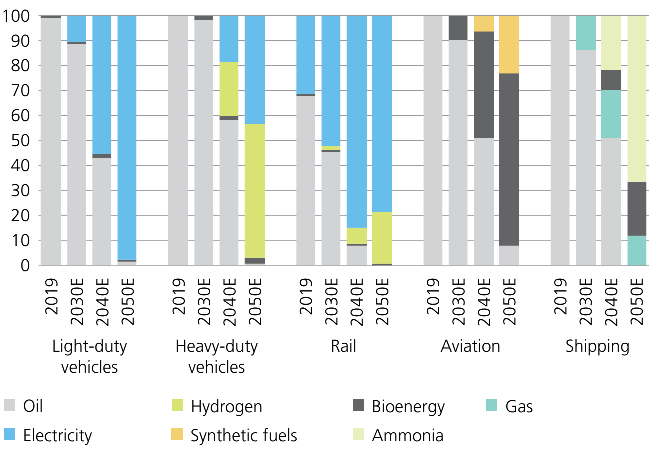
Green mobility has seen a strong push around the globe. The combination of regulatory changes, shifting consumer preferences, and technological advances should lead to less carbon- and other emissions-emitting mobility choices, but the speed with which the necessary technologies and fuels will be applied across the individual transportations sectors will vary greatly, in our view (Fig. 14).

Smart mobility was introduced as a CIO longer term investment theme some years ago, and it has focused on changes in the automobile industry. Smart mobility is a combination of smart powertrains (electrification to avoid burning fossil fuels), smart technology (autonomous driving to enable more fluid traffic flows and improving fuel efficiency per mile traveled, supported by artifical intelligence [AI]) and smart car use (car-sharing/car-hailing to reduce the number of vehicles needed). Green mobility goes a step further. It stretches across various segments: automobiles, commercial vehicles (trucks, buses, vans), aviation, shipping, rail, and bicycles. Together, smart mobility and green mobility will reshape the way we experience and use greener and more sustainable mobility, offering substantial growth in this decade for companies and investors alike. We estimate that by 2025, the annual addressable market of green mobility will have soared above USD 500bn. The strong anticipated growth should propel the addressable market by a factor of 4–5x by 2030. We see opportunities across all segments of green mobility, not only in makers of the end-product, but also in their parts suppliers, whose products includes batteries, and electronic components. Software companies should also help enable this shift. We recommend exposure through a broadly diversified stock selection across the whole green mobility value chain to minimize company- and technology-specific risks, with a substantial share of those companies based in Asia.

Figure 14

Electrification, bioenergy, synthetic fuels, clean hydrogen, and ammonia all play key roles in the transition

Fuel mix of energy consumption in different transport modes (%)



E= estimates

Source: Goldman Sachs Global Investment Research; UBS; as of October 2021

Looking at the **automobile** segment, the rollout of electric cars is well underway. Electric vehicle (EV) technology is progressing fast, with product offerings increasing by the day, while battery costs and charging times are coming down, and autonomous features are gaining speed. We expect growth, which started in 2020, to be exponential rather than linear. We think that by 2025 around 25% of new cars globally could be electrified, and we expect at least 15% will be battery powered full electric vehicles (BEV), with the rest plug-in and full hybrids. By 2030, in our view, electrified vehicles' share of new cars will likely be 60–70%, of which BEVs will represent more than 45% (Fig. 15). With car-sharing/car-hailing at the base, robo-taxis will ultimately be the icing on the cake, driven by a broad-based rollout of autonomous driving by the end of this decade. Overall, we're anticipating a USD 450bn market segment in 2025 (3–4x today's size), and a potential USD 2tr market in 2030 (see also our updated Longer Term Investments "Smart mobility" report published 17 June 2021). The auto industry is also taking a close look at adequate sourcing, the use of sustainable materials, and recycling via circular raw material usage at the end of vehicles' life cycles.

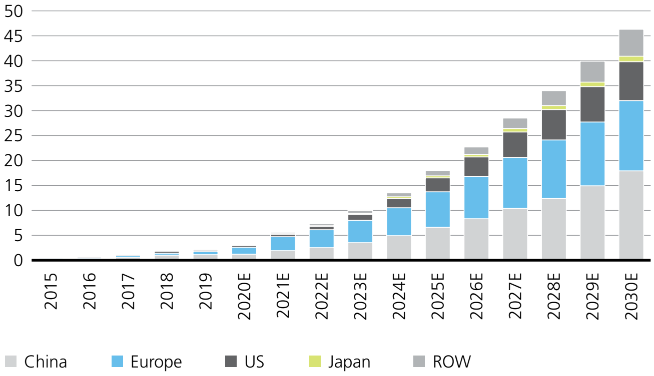
The path toward green mobility for **commercial vehicles (CV)** is also well paved. Emissions need to be drastically reduced via battery or fuel-cell electric technology (i.e., zero-emission vehicles, or ZEVs), and even more regulatory action has to be taken. In addition, the economics are also supportive of a shift. For commercial vehicles, the total cost of ownership (TCO)—which includes the purchase price and the running costs across the life of a CV—is important. ZEVs will enjoy a more attractive value proposition already in this decade, which bolsters the business case for replacing diesel-powered internal combustion engines. For urban delivery and inter-city commuting, BEV-powered vans, medium-size trucks, and buses will be the route to take, while for long-haul transportation of passengers and goods, hydrogen-powered fuel-cell technology will become a viable alternative, in our view. Looking at the plans of leading truck and bus manufacturers, we firmly believe that ZEVs' share will increase exponentially, resulting in a USD 80bn annual market by just 2030. And the van segment should easily add another substantial double-digit USD bn amount to that figure. We think all key markets—China, the US, and Europe—will power ahead, though the pace of uptake may differ. By segment, we expect the medium-duty segment to realize the greatest penetration, with ZEVs having a 40% market share by 2030, while heavy-duty should lag slightly behind at around 30%, still remarkable given the current levels of close to zero. To achieve a full carbon-free commercial vehicle fleet, however, one needs to consider the 10–15 year delay from purchase until the end-of-life of a commercial vehicle, indicating the longer-term nature of decarbonization efforts in this segment (Fig. 16).

Aviation is one sector for which decarbonization is not an easy goal to achieve. The average cost of reducing the carbon footprint here is the highest across all industries, and the percentage reduction we anticipate will be achieved over the next few years will also be the lowest. The reason for this disparity with other industries, first and foremost, is the long replacement cycle of aircraft, which run on average more than 20 years. Second, decarbonization will be an uphill battle against expected growth in aviation demand. **Rail** is regarded as the most advanced in decarbonization of all mobility choices. It is considered the cleanest form of transport given its emissions per passenger and freight, and it is already on the green agendas of many regions, countries, and markets. We expect to see more investment in rail's rolling stock and railroad infrastructure, as it enables the transport of large amounts of people and goods with a comparatively low environmental impact. But a lot still can—and must—be done in terms of upgrading trains, and also in electrifying the infrastructure. **Shipping** is recognized as one of the most efficient forms of commercial transport, but improvements in the industry are very long-term

Figure 15

Electrified cars – robust growth driven by China and Europe

EV unit sales (in million)



E= estimates

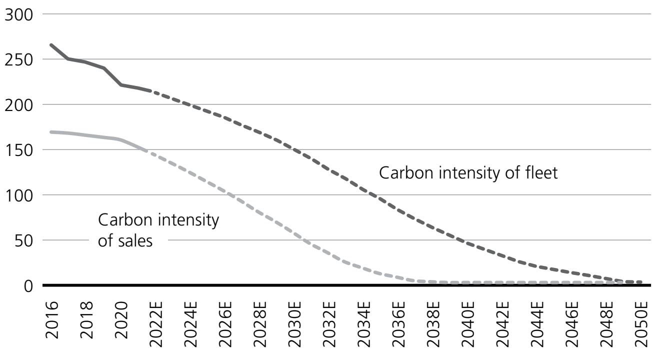
Note: Chart includes battery electric (BEV), plug-in-hybrids (PHEV), and fuel-cell vehicles; it excludes full-hybrids and mild hybrid vehicles.

Source: UBS, as of June 2021

Figure 16

Light-duty vehicles' (LDVs') CO_2 emissions per km traveled – carbon intensity of the fleet is tracking the carbon intensity of sales, with 10–15 year delay

in grams of CO_2 per km



E= estimates

Source: Goldman Sachs Global Investment Research; UBS; as of October 2021 endeavors due to the multi-year operational usage, which averages 25–30 years. Hence, removing carbon completely from shipping is unlikely to happen before 2050, in our view.

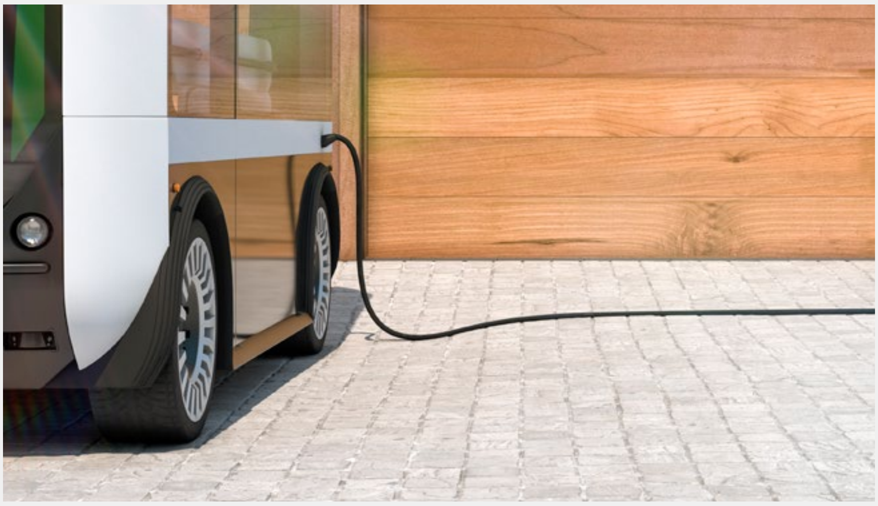
Looking at short-distance travel, the pandemic has also sparked a sharp rise in demand for **bikes**, and especially e-bikes, in many markets. Many cities in Europe have invested in bike infrastructure to cater to those needs. Bike superhighways ("autobahns") that enable fast and safe traveling have become more popular, and the positive effect on health is an additional argument in bikes' favor.

Overall, the combination of electrification, autonomous driving, and connectivity in automobiles will likely play a major role in establishing mobility as a service model (MaaS). Combined with trains for longer distances, trams, scooters, bikes, and e-bikes for the last mile should ensure we are well on our way toward low-carbon-emitting individual mobility. By deploying future technologies including software, MaaS will become a major force in this decade, in our view. Together with ZEV commercial vehicles and trains, it will be an important tool for achieving broader green mobility.

Deep Dive

Commercial vehicles going green

Two of the largest CV manufacturers globally, *Daimler Truck AG* and the *Volvo Group (trucks)*, announced in April 2020 the establishment a fifty-fifty joint venture (JV) for the development and large-scale production of fuel cells for applications in heavy-duty vehicles and other use cases. These fuel cells would enable long-distance travel of around 1,000km. At this stage, a fuel-cell electric CV would run at double the total cost of ownership of a diesel CV. But we believe the potential to reduce costs via technological advances and scale will substantially narrow the gap to diesel in this decade.



We think that technological advances and scale in fuel-cell electric CVs will substantially narrow the cost gap to diesel in this decade

The CV industry is also focusing on battery technology. In July 2021, *Daimler Truck AG*, the *TRATON GROUP*, and *Volvo Group* signed a non-binding agreement to install and operate a high-performance public charging network for battery electric heavy-duty long-haul trucks and coaches across Europe. With investment intentions of around EUR 500mn, the goal is to install and operate at least 1,700 high-performance green energy charging points close to highways, as well as at logistic and destination points, within five years from the establishment of the JV. While the European Automobile Manufacturers Association (ACEA) stated in May 2021 that around 15,000 high-performance public and destination charging points are needed by 2025, and 50,000 by 2030, the three companies sent a strong signal in support of the electrification of CVs in Europe. A Volvo-based 19 ton battery-electric truck (with a 680 kWh battery), which operates for Swiss-based logistics company *DPD*, set a world record in August 2021 when it traveled 1,099km without recharging, proving that BEVs for CVs are a viable alternative. According to *DPD*, the 80,000km annual usage results in around 72 fewer tons of CO_2 versus a diesel-powered version every year, making a strong case for the potential of green mobility for commercial vehicles.

Deep Dive

Aviation – fuel the way to go

We expect the main carbon reduction in aviation to come from sustainable aviation fuels (SAFs) and synthetic fuels

Based on current (and foreseeable) battery technology, we do not think that full electric powertrains are a near-term option beyond their use for very small airplanes and drone-like vehicles (eVTOL for vertical takeoff and landing) covering short distances such as from city centers to airports. So while the aviation industry will likely continue to make its aircraft more fuel efficient (tweaking engines, aerodynamics, shape, and weight), steps which may even include some partial electrification via hybrid systems, a more significant shift is needed. The main carbon reduction will come from so-called sustainable aviation fuels (SAFs), as well as from synthetic fuels, with hydrogen playing a role in the future. At this stage, however, current consumption (and production) of SAFs is negligible compared with the overall consumption of kerosine, and they're also far too expensive—but this must change.

The option to either "burn" hydrogen or to use hydrogen (or similar) in a fuel cell to produce electricity both are on the agenda. But a lot more volume is needed to carry hydrogen versus existing kerosine, so many adjustments to the overall body structure, including fighting against additional weight for fuel storage, are required. *Airbus* announced in September 2020 that hydrogen-fueled propulsion systems would be at the heart of a new generation of zero-emission commercial aircraft. The company presented three concept planes that it says could be ready for deployment by 2035. At this stage, we anticipate hydrogen will be mainly used for short- and medium-distance aircraft, while SAFs will need to increase in importance for long-distance travel. That said, the latter must overcome some barriers, including cost efficiency and the availability of supply (for an overview of applied aviation technologies, see Fig. 17).

Figure 17

Aviation technologies – fuel the way to go

Technology	Sustainable fuel (SAF)		Hybrid-electric	Fuel cells	LH_2 turbines
	Biofuel	Hydrogen synfuel			
Feedstock	Food crops	Syngas ($CO+H_2$)	Jet fuel + batteries	Liquid H_2 + O_2	Liquid H_2
Technology adoption horizon	Near-term	Medium-term	Medium-term	Medium-term	Long-term
Application type	Business / regional / large jets	Business / regional / large jets	Business / regional jets	Business / regional / jets	Business / regional / large jets
Changes in aircraft design	None	None	Limited	Limited	Meaningful

Source: UBS estimates.

Deep Dive

Shipping – all about the fuel

Given weight considerations, electrification for large vessels and cruise ships based on battery technology is not an option (with the exception of some smaller applications). Alternative low-carbon fuels such as liquified natural gas (LNG), hydrogen, ammonia, and forms of bioenergy are likely the way to go. We think that ammonia has the potential to make up a large part of the total energy in shipping by 2050, followed by biofuels, with the remaining energy provided by fossil fuels (LNG and oil). Ammonia burns CO_2-free and is a common, widely produced chemical. As a fuel, it can enable a circular economy in which it can be stored, shipped, used, and converted back into its constituent parts: nitrogen and hydrogen.

Looking at a recent example of Danish shipping company *A.P. Moeller-Maersk (MM)* offers a glimpse of optimism. In August 2021, the company announced it had placed an order with *Hyundai Heavy Industries* for eight large ocean-going vessels that would operate on carbon-neutral methanol (biofuel). The company claims additional costs will come in at around 10–15% of the total price. According to MM, this should reduce annual CO_2 emissions by around 1 million tons. To put this in context, the amount of CO_2 saved equates to the emissions of 500,000 cars, at roughly 7l/100km consumption, driving 10,000km per year. While this news was certainly encouraging, MM also warned that the supply of carbon neutral methanol would be challenging, indicating that the shipping industry will only contribute meaningfully to green mobility over the very long term. However, an immediate near-term positive contribution can be achieved when ships are docked in the harbor. Since a lot of energy is still needed to run the auxiliaries, using (renewable) electricity via shore power can make a big difference, and we've seen shipping companies take the first steps in this direction.

Deep Dive

Rail – electric and hydrogen

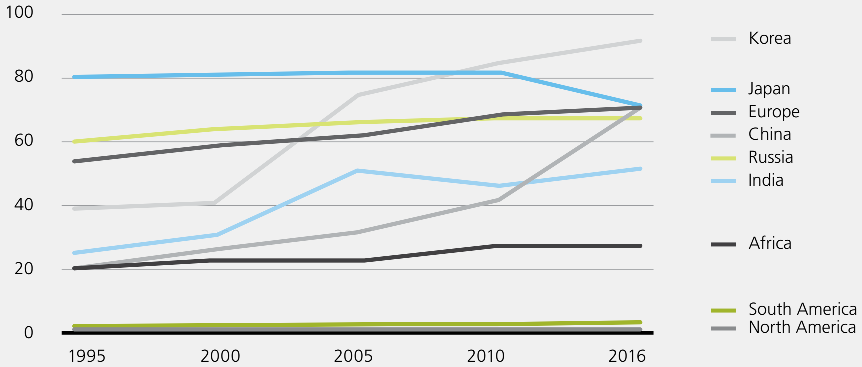
Electrification already plays an important role in the global rail sector today. According to the IEA, three-quarters of passenger rail transport activity and about half of the total tonne-kilometers of freight rail takes place on electric trains, with the rest of rail activity supported mainly by traditional carbon fuels. However, there is a large regional difference: While electrification in Switzerland is close to 100%, other countries like the US still offer significant opportunities in electrifying their railway systems (Fig. 18).

Besides the electrification of rail, we see hydrogen or fuel-cell electric as the most promising technologies for further decarbonizing rail transport. Batteries, on the other hand, should play an insignificant role, as they are not suitable for long distances. Several countries, including China, the US, the UK, and Germany, have announced hydrogen plans for their railway systems. In the last two years, European rail manufacturers have secured contracts to deliver zero-emission hydrogen-powered trains to Austria, Sweden, and the US. We estimate the current railway spending in Europe to be around EUR 150bn annually, with further allocations from the European Green Deal likely to follow. By 2050, the accumulated global investment in high-speed rail (HSR) or very high-speed trains (VHS) needed could exceed USD 10tr. Various initiatives and discussions advocating the replacement of domestic flights with HSR or VHS are bringing the development of trains and their infrastructure back into focus—exactly what green mobility is all about.

Figure 18

Share of electrified rail tracks

in %, based on electrified track-km



Source: IEA (2019) The future of rail – Opportunities for energy and the environment. All rights reserved; UBS

Green energy infrastructure

Green energy infrastructure connects energy producers to energy consumers, and it includes distribution grids, transmission lines, boiler plants, and pipelines for delivering heating or cooling. We think green energy infrastructure will play a key role in efficiently managing and distributing renewable energy from producers to storage and finally to end-users.

Growing electricity production from wind and solar presents a challenge to traditional electricity grids for two main reasons: 1) renewable plants can be smaller in size compared with traditional power plants; and 2) they can be more decentralized. This means tomorrow's electricity grid must be "smart" and provide much more flexibility so that it can accommodate changing weather conditions, as well as shifts in the average profile of energy producers and consumers alike. In the future, consumers may actually become so-called "prosumers," that is people who produce, store, and sell back their own energy produced for example through rooftop solar panels, using their own batteries as energy storage solutions (e.g., stationary batteries in the house or EV batteries; see Fig. 19). Significant infrastructure investment will be needed, as all these decentralized renewable assets must be connected to the grid and managed in an efficient way. We expect the number of new smart and traditional grid lines to increase because electricity demand will grow significantly in the coming decades. Europe is essentially leading the way in responding to the needs of electric grids. Monitor Deloitte estimates that EU27 and the UK's distribution grids need to be ramped up significantly. Around one-third of the EU's grids are over 40 years old, meaning they will require about EUR 400bn of investment by 2030.[1] This offers some perspective on the potential capital expenditures for grid operators in other regions, which will likely follow similar patterns.

Other green infrastructure investments include hydrogen networks, as well the massive rollout of electric vehicle charging stations. Contrary to the vast funding that has already been poured into the EV market, infrastructure development remains a key roadblock toward large-scale adoption within countries, though this may be changing.

Significant infrastructure investments will be needed, such as in electric grids, EV charging stations or hydrogen refueling stations

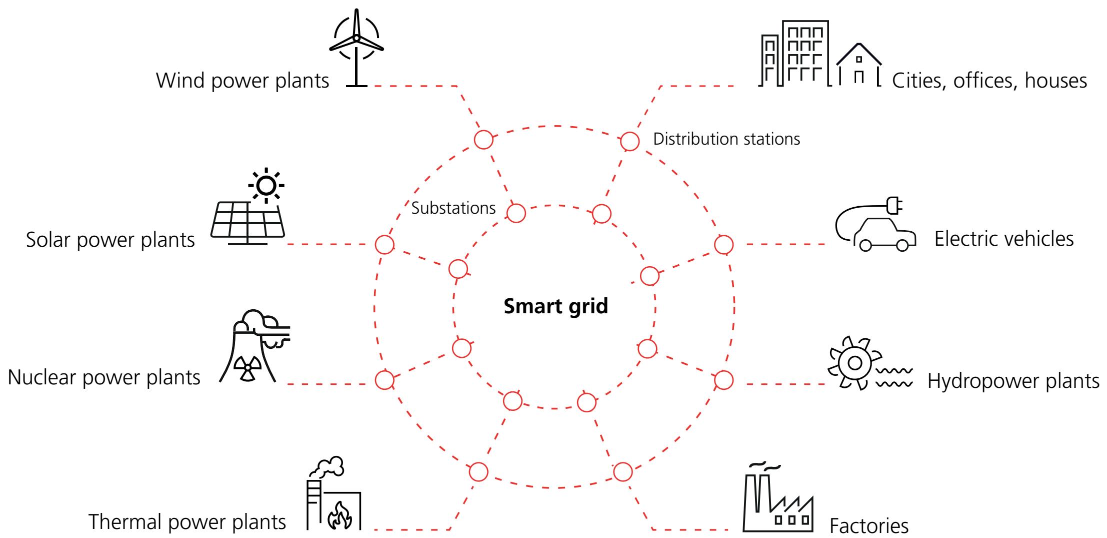
The UK has recognized the existing infrastructure gap will make it harder to capitalize on EV growth in the next decade. The ban on the sale of new petrol and diesel vehicles starting in 2030 was a major step in reaffirming the country's commitment to decarbonizing its economy while simultaneously overhauling the existing charging infrastructure. Roughly GBP 8–18bn of investment in charging stations is required to support the anticipated growth in EV usage, which translates into 30,000 charge points to be installed annually.[2]

Companies have forecast large numbers of electrified vehicles in the coming years, and many have taken the leap to expand their charging businesses across regions. The EV charging business is likely to gain traction from the massive public funding of green infrastructure. The concept of a hydrogen-powered economy has garnered some attention in certain parts of Asia Pacific, particularly in China, which is accountable for the majority of the world's energy consumption. China's aggressive plan to capture USD 15bn worth of the hydrogen value chain across its Beijing-Tianjin-Hebei industrial region is reflected in its 14th Five Year Plan (2021–25), with well-defined investments allocated to hydrogen infrastructure support. Although we are still at the dawn of a hydrogen economy, this renewable source will lead to the next significant transformation in the pursuit of a carbon-free economy, in our view.

1 Monitor Deloitte, "Connecting the dots: Distribution grid investment to power the energy transition," January 2021
2 Deloitte, "UK EV charging infrastructure update," 2021

Figure 19

Smart grid



Source: Swiss Federal Office of Energy; UBS

Deep Dive

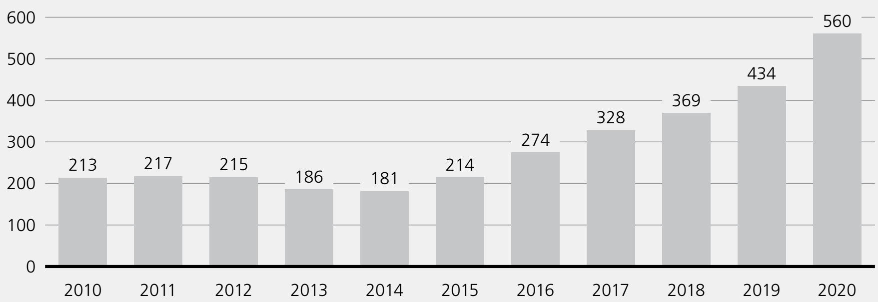
Hydrogen stations

Hydrogen stations have attracted global interest alongside the pursuit of a hydrogen economy (Fig. 20). China explicitly highlighted hydrogen as one of the six industries of the future in its 14th Five-Year Plan. While a national strategy has yet to be developed, several provinces and cities have already launched their own proposals. *Sinopec*, one of the largest oil companies in China, announced its plan to have 1,000 refueling stations equipped with hydrogen by 2025, up from 27 pilot stations at the end of 2020. This would be a major boost to China's hydrogen refueling infrastructure, which had around 100 refueling stations in operation at the end of last year. China also recently built its first underground hydrogen storage well in Chongqing, a storage facility 150 meters underground, which is safer and more compact compared with regular ones. Other Asian countries are also catching up and have announced plans to meaningfully increase the number of hydrogen refueling stations in the coming years. Japan intends to construct 1,000 hydrogen stations by 2030, and South Korea announced designs to build 450 stations by 2025.

Figure 20

Global hydrogen refueling stations

Number of all H2 refueling stations worldwide



Source: H2stations.org by LBST; UBS; as of 2021

Deep Dive

Charging infrastructure

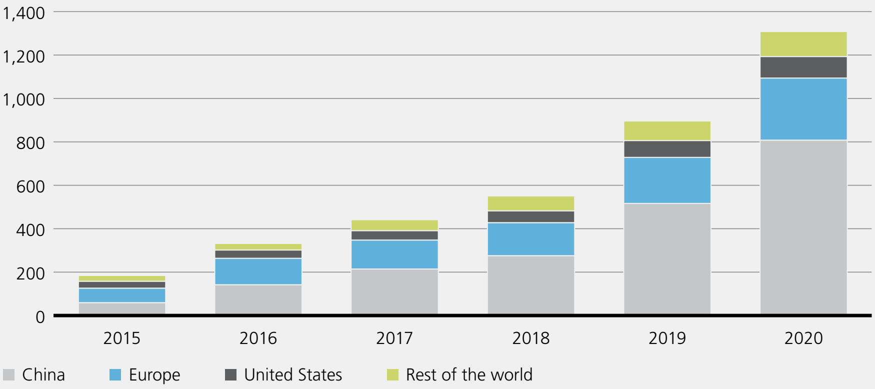
To meet the anticipated growth in EV usage, significant investments in charging infrastructure will be needed. Leading this development is China, which has over 800,000 public EV charging outlets or 60% of all global outlets installed by the end of 2020, followed by Europe (Fig. 21). Today, China has about one public EV charging point for every five EVs, but in light of the anticipated future EV growth, even this ratio is insufficient. This is why the New Energy Vehicle Development Plan (2021–35) and the Technology Roadmap 2.0 for energy-saving and new-energy vehicles both aim to shift support to the construction of charging infrastructure. But China is not alone in offering attractive opportunities. By 2030, BCG expects the number of public EV chargers in Europe to reach 1.8 million, which is nine times today's level and implies a CAGR of 25%.[1] While these two major regions are leading EV development, other regions are likely to follow suit soon. In Southeast Asia, Malaysia recently unveiled its plans to catch up to regional peers by extending its existing network of charging stations. It has committed to building 1,000 DC[2] charging stations by 2025, a large leap from its existing nine public DC fast-charging stations. But there are also other promising approaches to closing the charging infrastructure gap. China introduced a mobile recharging robot named "Mochi" that is fully powered by green electricity to perform automated refueling. Using the installed mobile application, drivers will be able to place an order to recharge their EV and the robot will rely on its navigation system to connect automatically with the vehicle. It takes roughly two hours to provide a full charge and is compatible with most EVs in the Chinese market. EV charger providers will continue to remain relevant given both the rapid green evolution and the infrastructure gap in the EV market globally.

To meet the anticipated growth in EV usage, significant investments in charging infrastructure will be needed

Figure 21

Stock of public electric light-duty vehicles chargers

in thousand



Source: IEA (2021) Global EV Outlook 2021, https://www.iea.org/reports/global-ev outlook-2021. All rights reserved; UBS

1 Boston Consulting Group, "Winning the battle in the EV charging ecosystem," April 2021
2 Batteries are charged using direct current (DC), which means that regular alternating current (AC) from the grid must be converted. DC charging stations enable fast charging thanks to their larger AC-to-DC converters than the built-in converters in vehicles.

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Sustainability considerations

Greentech innovations have the potential to transform the global economy, driving ongoing improvements in living standards while addressing climate challenges. But it's important to keep in mind that alongside these exciting developments, disruptions and risks could emerge as we undergo this transformation. Growing demand for energy and electricity mean reliability and power generation costs will be critical considerations going forward, especially in regions of the world with less favorable renewable economics. The potential for energy shortages or rapidly rising electricity costs could slow the transition. Some regions could choose to put economic development and energy stability above sustainability concerns.

There are also sustainability risks to consider both at the individual company level and with regard to the overall pace of the transition to a more sustainable global economy.

A thematic approach attempts to target companies providing products and services that will aid in the transition to net-zero, but the sustainability risks inherent in the operations of these companies should not be ignored. For example, mining for critical greentech inputs such as lithium and copper raises a number of sustainability considerations. The most pressing issues are the resource intensity of the mining and manufacturing processes, as well as possibly severe and difficult-to-identify human rights and labor issues in the supply chain. For lithium, specifically, the extraction and early-stage processing of these materials are water intensive and often occur in regions of the world where water is scarce, such as the "lithium triangle" spanning Chile, Argentina, and Bolivia. Human rights concerns include the usage of child and unpaid labor, the displacement of communities, and serious workplace safety violations.

For SI-focused investors, shareholder engagement strategies can be one way to gain exposure to these industries while working with company management to address some of these issues, including where materials are sourced and how supply chain operation problems are being addressed. This topic arguably stretches far beyond the scope of this report, but the risks bear monitoring.

These concerns represent more than just moral obligations for investors—companies face serious reputational and legal risks when these issues are mismanaged. In short, we see the value and the investment opportunity in critical input materials, but we are mindful of the sustainability risks that exist along the supply chain. We expect these topics to remain at the top of the agenda for human rights advocates and sustainable investors alike, especially as the transition to electrification becomes more widespread.

Conclusion

With the 26th Conference of the Parties (COP26) of the United Nations Framework Convention on Climate Change scheduled to take place in November 2021, we are approaching a decisive moment for international efforts aimed at tackling the climate crisis—probably one of the greatest challenges of our time. The number of countries that have pledged to reach net-zero emissions by mid-century or soon after continues to grow, but so too do global greenhouse gas emissions. This yawning gap between rhetoric and action needs to close if we are to have a fighting chance of reaching net-zero by 2050 and limiting the rise in global temperatures to below 2°C.

The achievement of these climate goals hinges on dramatically scaling up green technologies to reduce greenhouse gas emissions. And having those technologies ready in time depends, in turn, on a rapid acceleration in their deployment and in further innovation, both of which can be made possible only through significant investments. Based on IRENA calculations,[1] we expect about USD 40–50tr of global energy transition investments in the years 2021–30 alone, representing 40% of the total over the next three decades, funded by lending, debt, and equity (public and private). We believe this offers attractive investment opportunities for investors.

"We expect about USD 40–50tr of global energy transition investments in the years 2021–30 alone, representing 40% of the investments in the next three decades."

Some of the technologies and solutions we've examined in this report are proven but need rapid commercialization, while others are still in the laboratory stage or are not even conceptualized yet. This means that the full range of risk capital across all investment stages (private and public equity/debt) will be required to fund scientists, entrepreneurs, and established companies. In just over two business cycles, every sector of the global economy needs to transform and decarbonize.

In listed equity, we see the most attractive short- to medium-term investment opportunities in the ready-to-use technologies (i.e., clean energy, energy efficiency, and digitalization); advancements in technologies like electrification, batteries, and bioenergy; and intermediaries such as financials. And more investment opportunities, for example in hydrogen or CCUS, are likely to arise as these technologies become more mainstream in the coming years. Some of them might also be found in private equity. Across all business sectors, companies that can effectively capture and maximize the economic potential of adopting greentech—for example, by rapidly reducing operating costs and staying ahead of regulations such as carbon pricing—also stand to benefit, in our view.

1 IRENA (2021), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi. Note: Assumptions include a Planned Energy Scenario (governments' current energy plans and other planned targets and policies) and a 1.5°C scenario.

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