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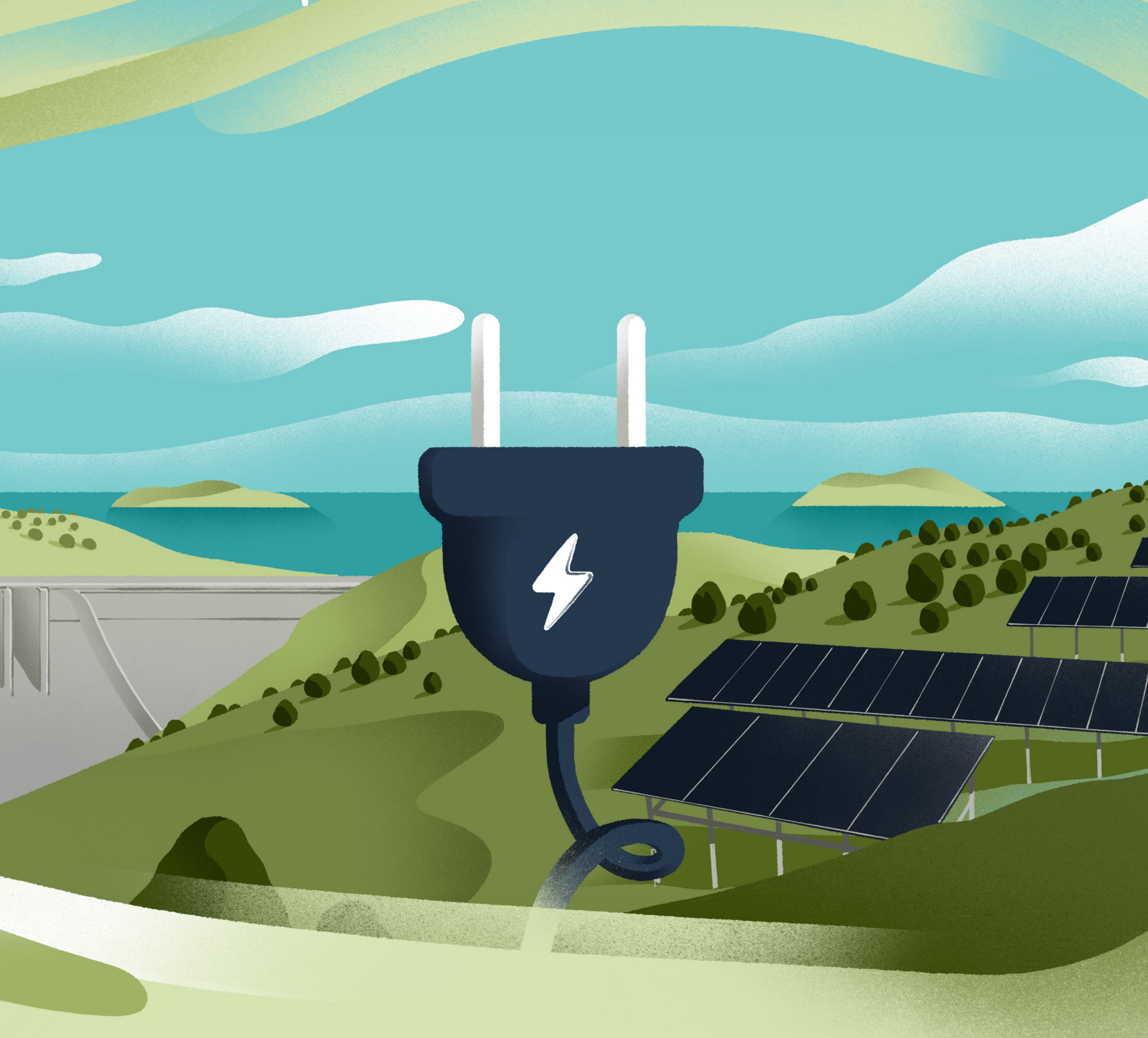

Energy Transition

The quest for emissions-free energy

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Introduction and key takeaways

This report explores a central challenge for the world today – how we produce and use energy in a more sustainable way that is less destructive for the world around us. The usual emphasis here is on switching sources of energy production to sources that do not involve CO_2 emissions. But, as we argue, this energy transition will also involve changing the ways in which we distribute, store and consume energy. We identify greater electrification as one central theme here for the consumption of energy, while emissions free energy sources will remain center stage for energy production.

Energy transition will continue to have multiple policy dimensions. Changing energy sources and consumption will continue to be encouraged by the "carrot" of policy subsidies as well as technological change reducing costs. But markets can also be used to provide a "stick" for reform, in conjunction with policy. Carbon pricing, carbon taxes and the development of voluntary carbon markets provide an obvious example of markets in action and where they can fall short.

Energy transition will require some compromises. Greater electrification, for example, will have many benefits but will also create new demands on our natural capital – for example, through a higher demand for mineral resources build electronic devices.

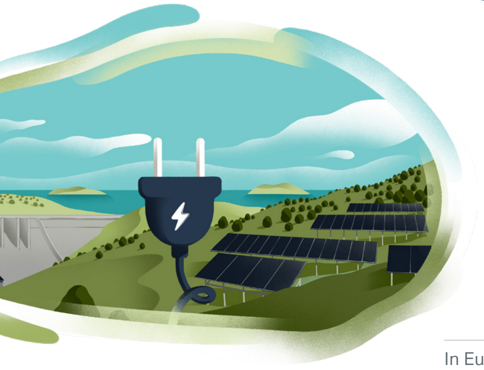
But it will also create many opportunities for improvement. For example, the decentralised nature of renewable power may add resilience to overall power systems and benefit local economics. Changing energy systems may also provide an opportunity to rebalance the global energy system, giving greater opportunities to the so-called Global South. Energy transition is not just a matter for the developed economies: the needs of emerging economies need urgently to be addressed too.

The world needs to meet an expected increase in energy demand in the least destructive way possible. The bulk of greenhouse gas emissions come from energy.

Increased electricity output from renewables, extending electrification into new sectors, and improved electricity distribution and storage systems are top priorities.

Annual global investments in low carbon power and sustainable transition strategies are expected to rise exponentially over the next decade.

Public and commercial sector priorities will probably increasingly converge, helped by technological change. Change could help boost energy system resilience and give a stronger voice to the Global South.



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Why?

Electrification is key to ensuring reliable and sustainable energy supply while reducing greenhouse gas emissions.

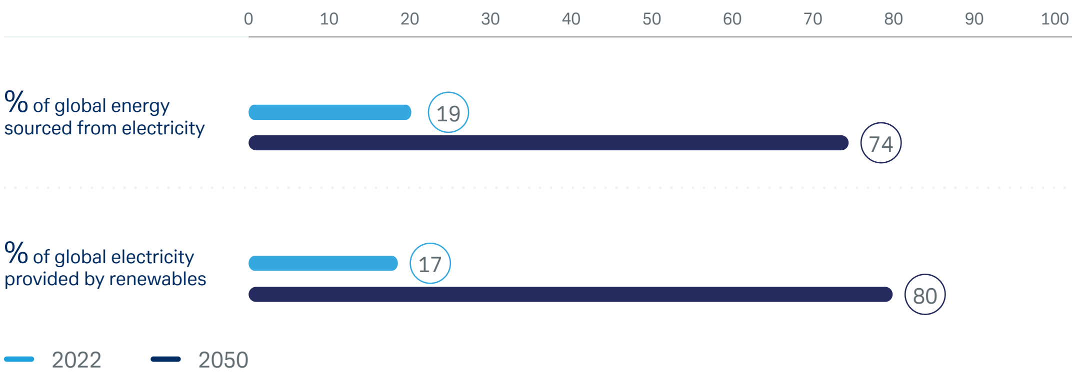
The bulk of greenhouse gas emissions come from energy. But income and population growth will continue to drive energy demand upwards. Current annual energy use per capita is over 10,000 kWh in the U.S., compared to less than 1,000 kWh in much of Africa[1] – suggesting that we should be prepared for substantial growth.

We need to meet this increase in demand in the least destructive way possible. Around three quarters of global CO_2 emissions are related to energy use.[2] Achieving a net-zero economy therefore involves radical change in the way we produce and use energy. Efficiency gains will have only a limited impact.

As shown in Figure 1 below, to achieve a 1.5°C compatible pathway, the percentage of global energy sourced from electricity will likely need to triple to more than 70%, while the percentage of electricity provided by renewables will need to rise from 17% in 2022 to 80% in 2050.[3]

Figure 1: Current global electricity mix and electricity supplied by renewables vs 2050 forecasts

Source: IRENA, Deutsche Bank AG. Data as of March 2022.



Improved carbon free electrification offers a multi-pronged approach to this problem.

1 Electricity is a form of energy that can be produced in a less CO_2-pollution emitting form.

2 (Given appropriate technology and price), the use of electricity can be extended into new sectors of the economy that are currently dependent on CO_2-generating fossil fuel power, like the heavy industry and transportation sectors.

3 Electricity can itself be used to generate other non-destructive energy sources, e.g. hydrogen, which will be instrumental in ensuring a reliable and sustainable energy transition.

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Route ahead

A clean energy transition is likely to involve five key elements:

- Reducing the absolute amount of fossil fuel-based energy production
- Increasing renewables' share of electricity production
- Extending electricity use into new (fossil fuel-dependent) sectors
- Creating and maintaining reliable electricity distribution and storage systems to meet changed distribution patterns
- Developing carbon capture and storage systems for remaining carbon emissions

One estimate is that total global electricity supply could rise by around 3.5-5 times from current levels in the next 30 years. This would potentially increase it to 130,000 TWh by 2050, including that used for the production of hydrogen.[4] In order to provide a reference point, consider that today the annual electricity consumption of the U.S. is around 4,000 TWh, while the average annual electricity consumption for a U.S. residential utility customer was 10,632 kWh (1.0362×10^{-5} TWh).[5] New sources of electricity demand will come (directly or indirectly) from sectors keen to decarbonise. The transport sector offers obvious opportunities for the greater use of electricity – technology and cost permitting. Electricity will also be needed to produce new energy sources such as hydrogen.

Meeting this increased demand for electricity will be challenging. The problem lies in developing balanced electricity distribution systems that can reliably supply new patterns of demand, based on high penetration level of renewable energy production. On the first instance, this requires gradually phasing out fossil fuels and increasing renewable energy generation from a supply perspective.

Today fossil fuels account for two-thirds of all electricity generated worldwide (Coal 36%, Natural Gas 23%, Oil 3%).[6] In many developed economies, energy production patterns are already changing: notwithstanding a recent increase due to the geopolitical situation in 2022, coal's share of total generation is already falling, and across much of Europe clear end-dates for coal phase-out have been established. However, the situation is different in developing economies.

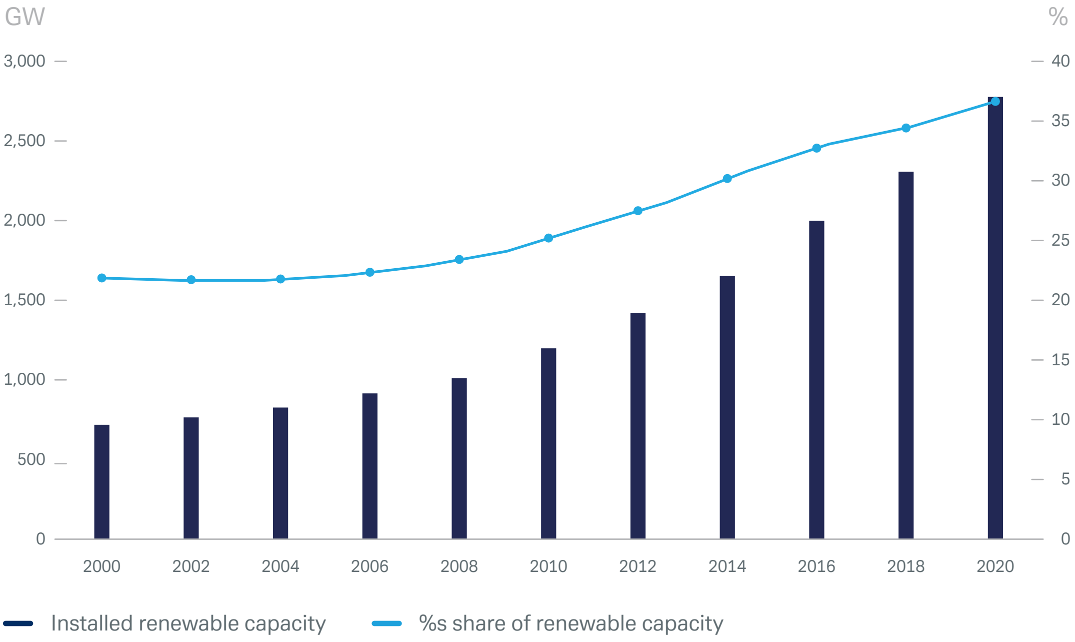
In China and India coal now accounts for over 60% of total generation. Investment is still substantial, with around 80% of capacity in both countries added in the last 15 years.[7] Reduction of natural gas consumption will however depend more on developed economies. 34% of current global gas generation is in the U.S.: China and India combined account for only 7% of global gas-based electricity generation.[8]

Renewables power-generation capacity is growing faster than non-renewables. As shown in Figure 2, renewables capacity has increased by 130% over the last ten years, much faster than non-renewables growth of 24%.[9] But globally, wind and solar generation still only account for 10% of electricity generation.[10]

One forecast suggests they will need to grow to around 40% of electricity generation by 2030 and over 75% by 2050,[11] with parallel deployment of other zero-carbon generation, flexibility, storage and networks, to deliver zero-carbon energy systems at scale.

Figure 2: Annual installed renewable energy capacity and renewables' share of total capacity

Source: IRENA, Deutsche Bank AG. Data as of March 2023.



This means a sharp speed-up in renewables' implementation rates: the IEA reckons that solar and wind implementation each year must be 10-15 times current levels (i.e. rising from 170 GW to 2,500 GW per year. Solar capacity would have to grow faster (650 GW to 26,000-35,000 GW by 2050) than wind (640 GW to 14,000-16,000 GW).[12]

The reduced cost of renewable energy sources has played an important role in encouraging their implementation so far: the UN's Intergovernmental Panel on Climate Change (IPCC) for example reckons that the cost of solar energy has fallen by 85% over the last decade. It is difficult to predict how much costs will fall in future, but pressure for change may come from other sources: the Russia/Ukraine war, for example, has already accelerated renewable energy adoption.

Nonetheless, renewable energy sources are more abundant in some regions of the world (sunny places, ideally near the equator, and windy regions), while being almost absent in some others. This will mean that, in order to allow for 100% clean energy production, there will be a need for transmission lines connecting cloudy and windless regions, often crossing national borders. Moreover, output from renewable energy sources can vary unpredictably and between seasons, thus creating the risk of major outages in some periods and overgeneration during others. To provide an example, the Energiewende programme in Germany set a goal of 60% renewable energy by 2050. Solar power capacity rose sharply in response. As a result, Germany generated 10 times as much solar energy in June 2018 as it did in December 2018.[13] But Germany's solar and wind power plants occasionally produce so much electricity that the nation is unable to use it all.

Intermittency and variable renewable energy (VRE) are therefore likely to remain a focus of attention. Systems with high VRE penetration rates will have to make complex choices and decisions on the best scale, mix, and interconnectivity of VRE resources. VRE capacity could have to be sufficient to cope with predictable seasonal demand peaks - meaning overcapacity at times of lower demand.

In this context, there is currently a discussion around the role for other zero-carbon sources, including nuclear, providing dispatchable generation alternatives in case of predictable and unpredictable variations. One source argues that nuclear power is now the second-largest source of low-carbon electricity. 10% of the world's electrical demand is thought to be met by around 450 operational reactors.[14]

But major, perhaps insuperable, challenges remain around many aspects of nuclear power, not just waste management. We should not rely on a future expansion of nuclear power generation to meet our changing energy needs.

Nuclear power facilities could therefore in theory make an important contribution to the security of an electric grid. Nuclear power reactors can adjust to some extent their operations to respond to changes in supply and demand. As the share of variable renewables grows, so will the demand for such so-called dispatchable (i.e. on demand) power generation. Hence, especially within countries with well-established nuclear power generation, nuclear power facilities may be able to improve energy security by lowering reliance on imported fuels and limiting the effects of seasonal variations in renewable energy production.

Many governments are ramping up climate change mitigation efforts, including policy support for renewable energy adoption through tax credits, subsidies, and renewable project tenders and auctions. In the U.S., President Biden set a target for reaching a carbon pollution-free power sector by 2035.[15] At a corporate level, firms are already trying to develop their own renewable energy supply to meet sustainability targets. In 2021, corporations procured 31.1 GW of renewable energy globally via power purchase agreements (PPAs).[16]

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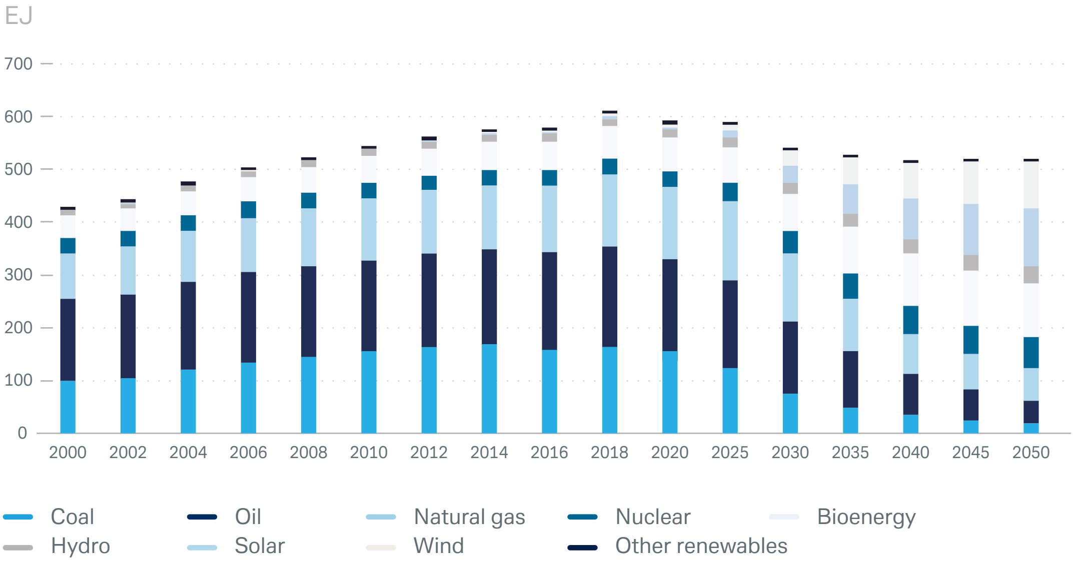
Development areas

Development areas should not be assessed simply on their immediate economic viability. We also always need to take into account the impact of any energy solution on nature and the ecosystem services that we depend on.

Solar photovoltaic (PV) installations. Various factors - principally large cost reductions, but also increased policy support, innovative finance and greater awareness have led to a more than 20-fold increase in solar capacity between 2010 and 2021.[17] By the end of 2021, installed global capacity of around 840 GW globally accounted for just below 10% of total installed energy capacity. The pace has accelerated, with a focus on Asia: this accounted for approaching 60% of the 133 GW capacity commissioned in 2021.[18] IEA scenarios for global energy generation in 2050 by technology are given in Figure 3. Solar could account for a very large share of global energy production at this date, with installations predicted to grow at a compound annual rate above 15%.

Figure 3: Global energy generation by technology

Source: IEA NZE forecasts, Deutsche Bank AG. Data as of March 2023.



Wind power has grown sharply too, with wind installations more than quadrupling between 2010 and 2021.[19] The installed capacity of onshore wind power rose to about 770 GW globally in 2021. The offshore wind market is still markedly smaller than that for onshore wind. Some 56 GW of capacity had been installed by the end of 2021.[20]

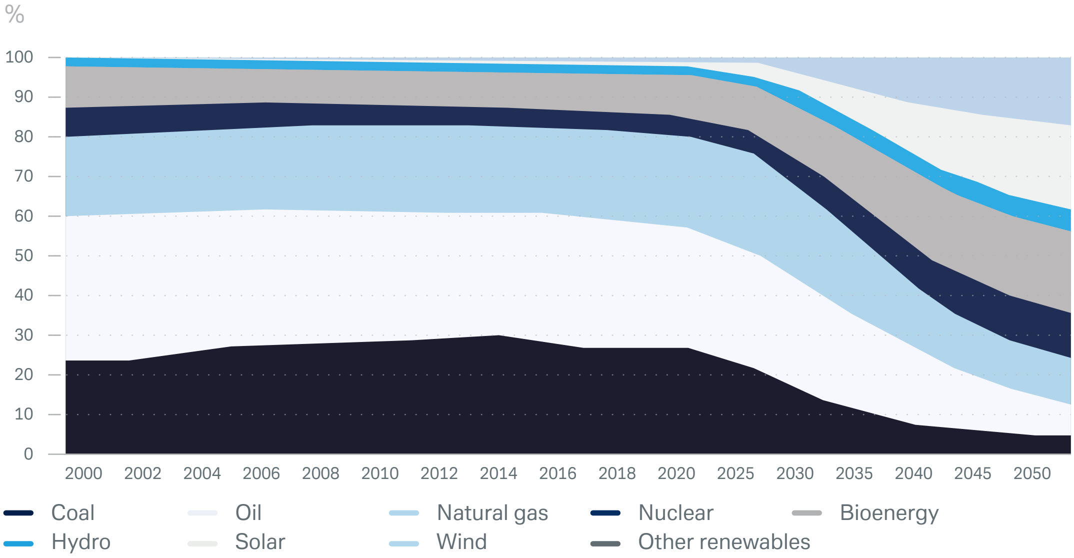
Hydropower and other renewables. Installed capacity (excluding pumped hydro) had risen to over 1,200 GW by 2021, equivalent to around 40% of total renewables capacity.[21] Installed capacity for other renewables technologies is relatively small, but has been rising fast from a small base. Bio energy power is the leader here, accounting for over 80% of installed capacity from these sources (e.g. geothermal, solar thermal and ocean-generated power) of 166 GW in 2021.[22]

Bioenergy-based electricity could prove interesting in situations where its costs are lower than other possible costs (for example, where biomass feedstock is accessible and cheap, or heat can be used in co-generation). It may also help balance electricity grids otherwise highly dependent on inherently variable wind and solar power sources. BECCS (bioenergy with carbon capture and storage) is a further development that could contribute to efforts to meet emissions targets.

Energy distribution infrastructure. Because it was very simple to transport fossil fuels using railroads and pipelines from the point of extraction to the energy plants where they would be burned to produce electricity, utilities have historically located the majority of their energy facilities close to rapidly-expanding cities. For this reason, the majority of nations rely on pipelines and railroads to transport fuels over vast distances to power plants, and then on transmission lines to provide electricity over short distances to the cities that require it. That model does not work with solar and wind, as sunlight and wind energy must be converted to electricity on the spot.

Figure 4: Global energy mix by technology

Source: IEA NZE forecasts, Deutsche Bank AG. Data as of March 2023.



Many areas where renewable sources are abundant (for example, deserts for sun power or high seas for wind) can also be far away from demand centres. Components for long-distance transmission systems will therefore be needed, including high-voltage direct current (HVDC) cables and interconnectors. One likely future development is that upgrading of transmission and distribution (T&D) networks in order to deliver reliable future higher levels of electricity supply may require a shift from current systems based on Distributed Network Operators toward an approach based on a Distributed System Operator which is responsible an active coordinating role on both demand and supply. One related issue is variable renewable energy (VRE) system development. Running such systems will require the application of new technologies and approaches to system operation, supported by appropriate energy market design. Provided those enablers are in place, it may be feasible and cost-effective to run energy systems with VRE penetration rates as high as 75% to 90%.[23]

System development will likely involve long-distance interconnection with other regions (both within and across countries) which have complementary renewable resources.

Another infrastructure issue is dispatchable (i.e. on demand) generation. This could come from various sources including hydro, nuclear and other newer combined options for emissions-free generation. One of these is to use natural gas with carbon capture and storage (CCS). Another is to produce hydrogen from electrolysis and then burn it in combined cycle gas turbines (CCGTs). Biomass (see above) is a further option, combined with CCS or on its own.

Both generation and transmission development will raise questions about land and sea use. In theory, there are easily sufficient natural resources to support required growth in zero-carbon electricity generation. However, this will have implications for land use. One estimate is that generating 100,000 TWh of annual electricity production from solar alone would require 1-1.2% of the land area of the world to be covered by solar farms.[24] (It is also estimated that this share could fall to 0.3-0.4%, if solar panels could be based above oceans, but there are multiple uncertainties here.) Offshore wind may remain attractive in this context: the IEA estimates that it alone in theory could generate more than 420,000 TWh per year – four times the expected annual energy demand in 2050, but this again is speculative.

Mineral Resources. As the trend towards cleaner technologies advances, the metals and mining sector will need to deliver the huge quantities of raw materials required for the energy transition. As this is a long lead-time, highly capital-intensive sector, supply bottlenecks and price volatility are certain, encouraging technology shifts and materials substitution. Lithium and cobalt pricing may be especially volatile, although copper, nickel and aluminium prices may also climb dramatically.

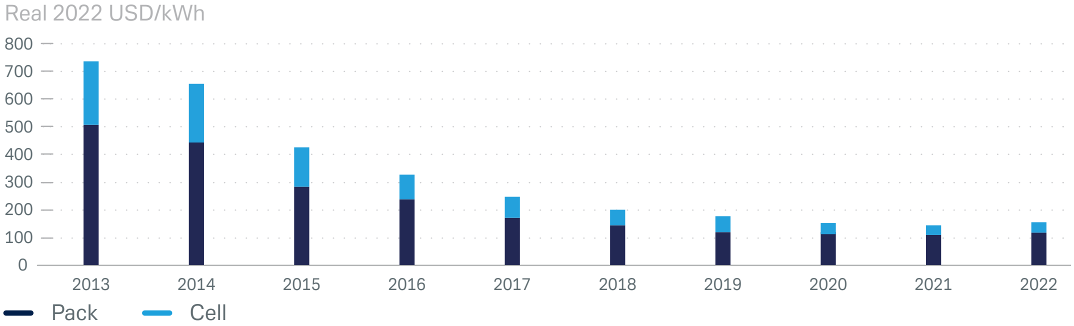
This is not simply a problem with battery storage; for instance, producing one terawatt-hour of electricity from solar or wind power could require, respectively, 300% and 200% more metals than producing the same amount from a gas-fired energy plant, on a copper equivalent basis.[25]

Electricity storage. We anticipate that the quick uptake of short-duration battery energy storage systems (SDES, which can supply power for up to ten hours) will open up investment opportunities throughout the renewable energy and battery value chains, including for producers of storage systems, miners of essential minerals, and developers of renewable energy sources. Due to declining battery prices and growing government assistance in several nations, including the U.S. and China, energy storage system technologies are advancing and becoming more cost-competitive, as illustrated in Figure 5. A variety of additional heat- or pressure-based storage technologies are being investigated, including flow batteries, an alternative to lithium-ion batteries, may enable energy storage to satisfy daily balancing needs.

Long-duration energy storage (LDES) systems, most notably in the form of pumped storage hydropower systems, have been available for decades, delivering energy output for longer than 10 hours. However, LDES systems were unable to be widely adopted due to economic, technological, and regulatory challenges. However, current technology and assistance from the government might encourage an expansion of LDES capacity. The U.S. unveiled the Long Duration Storage Shot programme in July 2021 with the goal of bringing LDES costs down to 90% by 2030.[26]

Figure 5: Lithium-ion and battery cell and pack price evolution

Source: BloombergNEF, Deutsche Bank AG. Data as of March 2023.



Hydrogen energy storage. The need for LDES systems may add to the case for hydrogen, particularly green hydrogen. Hydrogen-based energy storage has the capacity to store power for weeks to months, thus these projects might be employed to account for seasonal changes in electricity production. However, power-to-hydrogen-to-power industrial scale operations are currently in the very early phases of development.

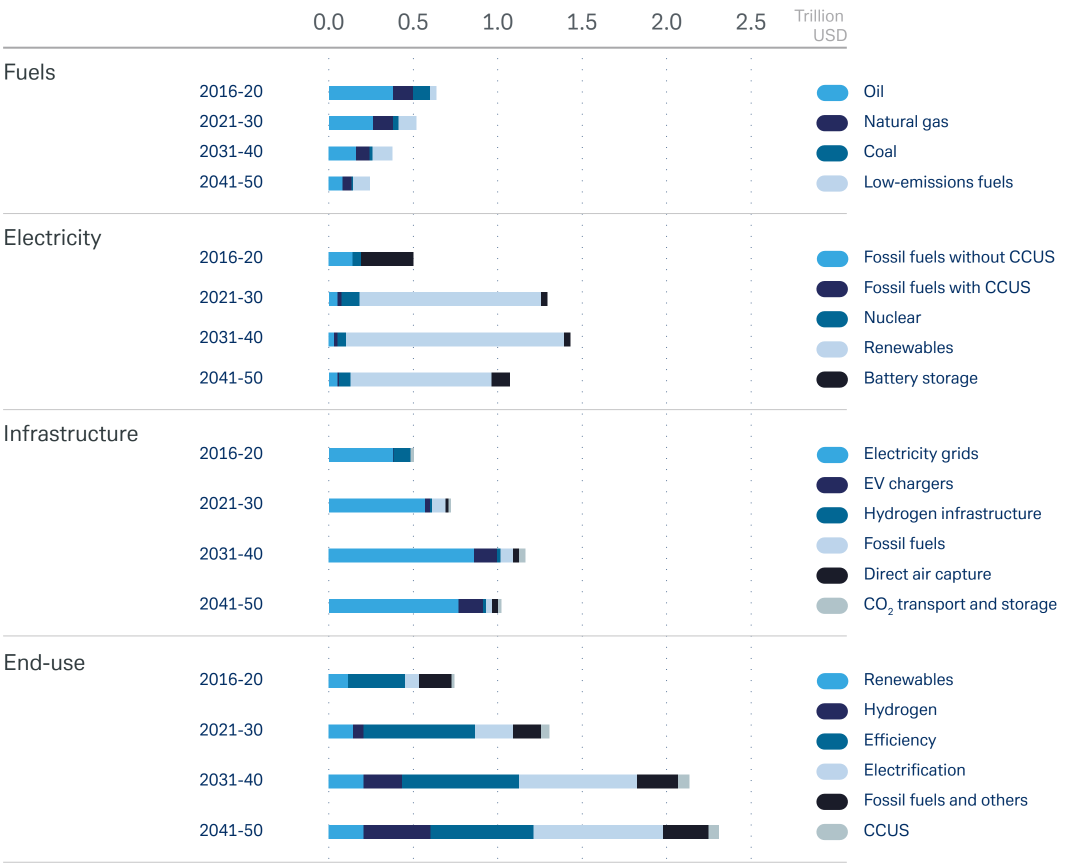
Carbon Capture and Storage. This will be necessary to hit net zero targets as, even with renewables use, some emissions will still be generated in 2050 from fossil fuel use and industrial processes still be generated targets.[27] CO_2 removal measures and technologies are based on a wide range of quite different approaches: nature-based measures such as reforestation as well as BECCS, direct carbon capture and storage (DACCS). Direct air capture (DAC) technologies can remove CO_2 directly from the atmosphere before storing but currently use large amounts of energy. Other approaches are being experimented with.

Finally, fossil fuel company transition strategies will continue to have a major impact on the overall energy market. Oil and gas companies are already undertaking a wide variety of approaches in response to energy transitions, but the deteriorating economics of fossil fuel-fired power plants do not always appear to be correctly priced by the market. This may create both increased price volatility and considerable uncertainty about the economic rationale for planned and future investments.

Figure 6 below shows the great difference in investment needs for various technologies, highlighting a constant decrease in the needs of fossil furls sources.

Figure 6: Global average annual energy investment needs by sector and technology for a net zero economy

Source: IEA, Deutsche Bank AG. Data as of March 2023.



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What does this mean for investors?

In our view, many companies in the energy, capital goods and utilities sectors will be able to play a critical role in the transition towards a lower-carbon world. As the world becomes more electrified with the deployment of new approaches such as heat pumps and electric vehicles, more electrical devices and systems will need to be installed and modernized, with implications for the capital goods sector.

Carbon-free electricity generation will remain at the core of the energy transition. Huge investments in wind, solar, energy storage and transmission lines (amongst others), as mentioned in the previous chapter, will be needed to decarbonize the energy supply. Consequently, we expect these industries to experience substantial growth over the next few years, partially at the expense of industries like oil & gas as we gradually phase out fossil fuels.

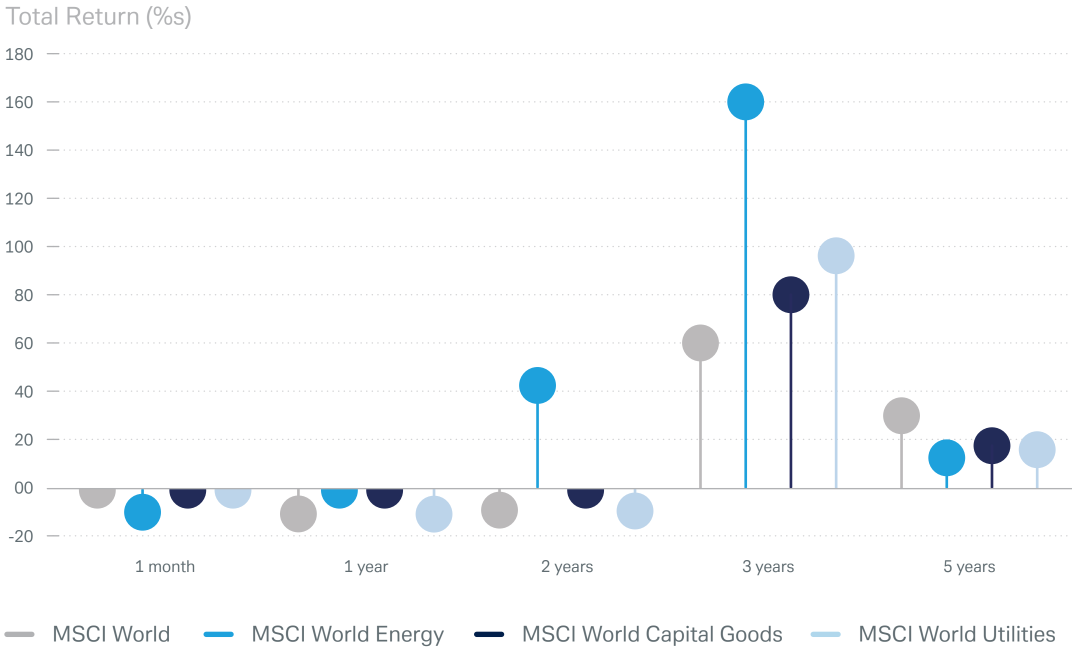
However, it is important to be careful in drawing investment conclusions. Investors in general appear concerned about the competitive threats to the traditional energy sector, but it may be difficult to judge the impact of such concerns on the sector's financial performance over the past few years.

As shown in Figure 7, the Energy sector has lagged both the broad market (MSCI World Index) and the Utilities and Capital Goods sectors over the last 5 years. Energy overperformance over 2- and 3-year time horizons overperformance can be easily explained by recovery from the initial huge downturn of the energy sector during the pandemic and the consequent conflict in Ukraine, which instead provided a strong upwind for the sector.

Not withstanding such short-term developments, we believe the energy sector and certain utilities (like those based on gas) will undergo several challenges in the future as burning fossil fuels for electricity accounts for most of the world's carbon dioxide gas emissions and will have to be reduced. We expect many energy firms' financial performance to be affected in consequence over the long term, with substantial downside risks resulting also from current asset bases of undesirable coal or gas plants.

Figure 7: Performance of energy transition sectors over different time periods

Source: Bloomberg Finance L.P., Deutsche Bank AG. Data as of 24th March 2023.



In the context of encouraging energy transition, for example, there are many opportunities to reduce the emissions intensity of delivered oil and gas by reducing associated gas flaring and CO_2 venting, addressing methane emissions, and incorporating renewables and low-carbon electricity into new upstream and liquefied natural gas (LNG) developments. Oil and gas extraction and delivery to customers currently accounts for 15% of all global energy-related GHG emissions.[28] As a result, for example, it seems reasonable to expect increased pressures on those companies not taking action to stop methane leaks into the atmosphere.

On the other hand, it seems that financial markets may be overlooking the potential of these companies to earn competitive returns on their decarbonisation investments, perhaps providing opportunities for valuation-focused investors with multi-year investment time horizons. The global energy transition may therefore benefit some companies that financial markets are currently neglecting, based on possibly excessive discounting of specific sectors, perhaps including energy and gas utilities. Some major oil and gas companies are preparing to change their business models to become "energy" companies that provide customers a range of fuels, electricity, and other energy services. This requires them entering sectors, most notably electricity, where there are already a variety of actors with specialized knowledge and where the majority of low-carbon investment opportunities (with the possible exception of offshore wind) differ significantly from conventional oil and petrol projects in terms of scale and financial characteristics. While spending by oil and gas companies outside “traditional” areas of supply has reached 5% of total spending in 2022,[29] we see this number increasing further over the upcoming years.

On the other hand, existing utilities generally have multi-decade development track records and established pipelines for future projects. Many utilities are skilled managers of large and complex energy projects, and their expertise should benefit them as the energy transition progresses, for example, with offshore wind projects.

Indeed, the implementation of transformational investments must originate from acknowledging that our society mostly depends on the “old economy” for its basic necessities and the required stock of physical capital. This implies that some of these disruptive investments are “transitional” by definition. In other words, investment is needed to change the capital stock and ensure that it is fit for the future world. While “old economy” companies are under increased scrutiny from an environmental perspective, many utilities companies are leading the construction of clean power infrastructure and many oil and gas companies are endeavoring to diversify their energy portfolios. Even though pure-play (i.e. exclusively focused) renewables companies will probably occupy the energy transition limelight, we should be aware of the potential for "old economy" companies to re-rate upward as they increase their renewable energy investments and gradually transition towards sustainable activities.

It is also worth highlighting the role of current regulatory regimes in this context. The implementation of ESG standards may be tilting financial investment away from equity and debt investment invested into lawfully-conducted but carbon intensive economic operations that need to reform. This trend favours divestment over investing in transition so that, in Europe, a large part of Article 8 and 9 funds are significantly underweight some of the fundamental economic activities of our existing economy.[30]

Figure 8: Valuations for different energy transition subindustries

Source: Bloomberg Finance L.P., Deutsche Bank AG. Data as of March 2023.

	NTM P/E	10y Median	vs. Median	P/B	10y Median	vs. Median
MSCI World index	16.3	16.9	-3.9%	2.8	2.3	20.3%
MSCI World Energy Index	8.3	16.0	-48.0%	1.8	1.5	16.0%
MSCI Oil, Gas & Consumable Fuels Index	8.1	15.6	-48.1%	1.7	1.5	16.2%
MSCI World Capital Goods Index	17.1	17.1	-0.4%	3.0	2.7	8.8%
MSCI Electrical Equipment Index	22.6	18.5	22.4%	3.4	2.6	28.4%
MSCI World Utilities Index	15.7	16.6	-5.4%	1.8	1.7	6.8%
MSCI Electric Utilities Index	15.5	16.2	-4.0%	1.9	1.6	16.6%
MSCI Gas Utilities Index	14.3	17.7	-19.4%	1.4	1.8	-19.4%
MSCI Multi-Utilities Index	15.1	17.0	-11.1%	1.7	1.8	-5.5%
MSCI Renewable Electricity Index	12.8	13.1	-2.3%	1.7	1.4	14.7%

This results in a market distortion and consequent capital misallocation. As demonstrated by the P/E (ratio of a company's share price to its earnings) and P/BV (ratio of a company share price to its accounting "book" value) ratios of different subsectors shown in Figure 8 above, markets are currently discounting a much rosier future for renewables and electric utilities than for multi-utilities (oil and gas) and gas utilities. While the MSCI Oil, Gas & Consumable Index Fuels is currently trading at 8.1 NTM P/E (the ratio of a company's share price to its expected earnings in the next twelve months), almost half of its 10 year median value, renewables trade at 12.8, only slightly below their 10 year median. There are clearly many good reasons for this wide discount based on macro developments and potential risks on the horizon. At the same time, however, we believe there is room for over-performance in some companies engaged with the energy transition process within these penalized sectors.

This is reflected by the fact that the market does not appear to be particularly concerned about the sustainability performance of these companies, thus valuing differently their sustainable activities in case of a mixed energy generation mix (part renewables and part fossil fuels) or diversified utilities vis-a-vis "pure" players (i.e. those focused only on sustainable activities). If, for example, you look at the 3-year return of companies within the MSCI Oil, Gas & Consumable Fuels Index plotted against the 3-year compound annual growth rate (CAGR) of average carbon emissions intensity, there appears to be no correlation at all between achieved reductions in carbon intensity and financial performance.

06

Conclusion

As shown above in Figure 6, annual global investments in low carbon power and sustainable transition technologies are expected to see an exponential rise over the next decade, shifting capital flows away from carbon-intensive activities like coal supply and other fossil fuel generation. The majority of the world's carbon dioxide emissions are caused by burning fossil fuels for electricity which is why the power sector remains the focus of efforts to decarbonize the global economy. Several utilities firms are spearheading the development of a renewable energy infrastructure, while numerous oil and gas firms are working to diversify their sources of energy.

We expect public and commercial sector priorities to increasingly converge in coming years, spurred not just by scientists' calls for action but also by technological advances that make it possible for investments in renewable energy to make an increasing contribution to economic growth. The whole energy value chain, from solar panels to distribution networks and energy storage companies, will gain from this global energy shift. But there will be transition risks in this process: established energy companies will have to work hard to adapt to the changing business environment, if they want to avoid becoming stranded assets. Within “transition” industries such as oil and gas, those companies which are better at managing the transition (e.g. via achieving lower carbon intensity, better control of methane leakages, higher renewable power generation etc.) may deliver better financial performance than their industry peers over the medium term as well as making a long-term contribution to our future wellbeing.

Ultimately, however, energy transition investment will need to be seen within a bigger picture. As we noted at the start of this report, the issue is not just how we produce energy in a different way, but also how we distribute, store and consume it. Energy transition will be challenging and policy will need to be multi-faceted to reflect this, always considering the likely impact on the natural world. It will require some compromises but will also offer many global benefits, for example through decentralisation and potentially giving a greater role to the Global South. Energy transition will be central to our existence for many years to come.

Bibliography

1. IEA, International Energy Association.
2. Climate Watch, the World Resources Institute (2020).
3. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
4. Energy Transition Commission (2021) Making Clean Electrification Possible.
5. U.S. Energy Information Administration. Retrieved from: https://www.eia.gov/tools/faqs/faq.php?id=97&t=3
6. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
7. IEA (2022), Coal-Fired Electricity, IEA, Paris
8. IEA, World Energy outlook (2022)
9. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
10. IEA, World Energy outlook (2022)
11. Energy Transition Commission (2021) Making Clean Electrification Possible.
12. Energy Transition Commission (2021) Making Clean Electrification Possible.
13. Fraunhofer Institute for Solar energy Sustems ISE, Jan 2019. Net Public Electricity Generation in Germany in 2018", Prof. Dr. Bruno Burger. Retrieved from https://www.ise.fraunhofer.de/content/dam/ise/en/documents/News/Stromerzeugung_2018_2_en.pdf
14. IEA (2019). “Nuclear Power in a Clean Energy System”
15. The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050. United States Department of State and the United States Executive Office of the President, Washington DC. November 2021.
16. BloombergNEF, “Corporate Clean Energy Buying Tops 30GW Mark in Record Year!”.
17. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
18. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
19. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
20. IEA, World Energy outlook (2022)
21. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
22. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency
23. Energy Transition Commission (2021) Making Clean Electrification Possible.
24. Energy Transition Commission (2021) Making Clean Electrification Possible.
25. “Solving the net-zero equation: Nine requirements for a more orderly transition,”

McKinsey,2021

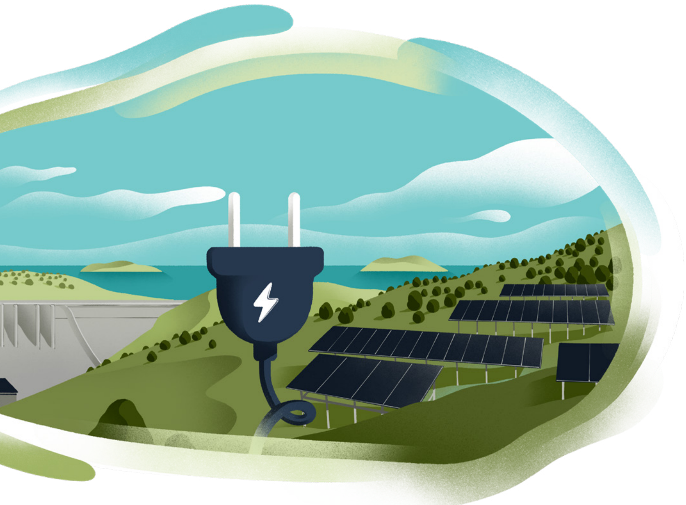
26. US Department of Energy, May 2022. https://www.energy.gov/articles/biden-administration-launches-bipartisan-infrastructure-laws-505-million-initiative-boost

27. IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency

28. IEA, "The Oil and Gas Industry in Energy Transitions" (2020)

29. IEA, World Energy outlook (2022)

30. DWS, "A framework for European Transformation", December 2022.



Glossary

BECCS (bioenergy with carbon capture and storage) is An approach that combines carbon capture and storage with bioenergy to create energy while removing carbon dioxide from the environment, or producing net negative greenhouse gas emissions.

Biodiversity means variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

Bioenergy is the renewable energy produced from biological sources, whether it takes the form of biofuels, biogas, or solid biomass.

Biomass or bio-feedstock is the renewable organic matter, often known as biological material includes animal or plant-based feedstocks like wood and agricultural crops, as well as organic waste from municipal and industrial sources and algae.

Carbon offsets refer to the reductions in greenhouse gas or carbon dioxide (CO_2) emissions generated by a business, industry, or economy to make up for emissions produced elsewhere in the economy.

Combined cycle gas turbine (CCGT) refers to an arrangement of heat engines that cooperate to transform heat energy into mechanical energy for powering electric generators.

Direct air capture (DAC) refers to the extraction of carbon dioxide from atmospheric air.

Distribution System Operator (DSO) refers to a local distribution network's permanent infrastructure that can now be managed and optimised by system operators. This entails working with the Transmission System Operator (TSO) to coordinate the procurement of flexibility services from network users, management of local generation and network congestion, and management of energy flows from and to the larger power grid.

Ecosystems are created by the interaction of plants, animals, weather and landscape.

Energy productivity is the energy use per unit of GDP.

ESG stands for Environment, Social, Governance, and is the acronym most commonly used for sustainable investments. They measure the sustainability and societal impact of an investment in a company or business.

Exchange-traded funds (ETFs) are a type of investment fund and exchange-traded product, i.e. they are traded on stock exchanges.

Governance (corporate governance) involves the processes of governing – whether undertaken by the government, firm, market, network – over a social system and whether through the laws, norms, power or language of an organized society.

Greenhouse gases (GHG) are gases that trap heat in the atmosphere; carbon dioxide is the primary contributor to GHG emissions.

Gross domestic product (GDP) is the monetary value of all the finished goods and services produced within a country's borders in a specific time period.

High Voltage Direct Current (HVDC) transmission refers to a power transmission method that primarily transmits electrical power using direct current. Due to lower energy transmission losses than traditional AC technology, it is particularly helpful for greater capacity and longer distances.

Impact investing refers to investments made into companies, organizations and funds with the intention to generate a measurable, beneficial social or environmental impact alongside a financial return.

Glossary

Liquified Natural Gas (LNG) refers to natural gas in its transparent, non-toxic liquid state at temperatures below -162ºC is referred to as LNG. It allows for the pressurised transport and storage of natural gas, notably over extended distances via ships.

Natural capital refers to the elements of the natural environment including assets like forests, water, fish stocks, minerals, biodiversity and land.

Nature-based solutions are actions to protect, sustainably manage and restore natural or modified ecosystems which constitute natural carbon sinks, while simultaneously providing human, societal and biodiversity benefits.

The term "Net-zero-carbon-emissions" or "Net-zero" refers to a situation in which the economy, society, or a particular economic sector emits no carbon dioxide (CO2), either because it does not produce any or because it collects the CO2 it does produce for use or storage.

Non-governmental organisations (NGOs) are independent of government involvement and can be seen as a subgroup of founded organisations by citizens.

Stranded assets are those assets experiencing redundancy or loss of value due to environmental challenges, changing resource landscapes, new government regulations and evolving social norms.

The Global Commission on Adaptation was launched in 2018 to accelerate climate change adaptation; its mandate came to an end in 2020.

The OECD (Organisation for Economic Co-operation and Development) is an intergovernmental economic organisation with 37 member countries, founded in 1961 to stimulate economic progress and world trade.

Transmission System Operator (TSO) refers to current system operators in charge of controlling the flow of electricity via the electrical transmission system, guaranteeing its dependable and secure functioning, and balancing supply and demand in both place and time.

UN Sustainable Development Goals (SDGs) were set in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030, it is a collection of 17 interlinked global goals designed to be a blueprint to achieve a better and more sustainable future for all.

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