

A satellite view of Earth from space, showing the curvature of the planet and a bright, glowing horizon line. The sky is a gradient of orange and red, suggesting a sunset or sunrise. The Earth's surface is a mix of blue oceans and white clouds.

MEGATRENDS OF THE GLOBAL ENERGY TRANSITION

A Summary

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Megatrends of the Global Energy Transition

Background

In autumn of 2015 – immediately before the UN Climate Conference in Paris (COP 21) – WWF Germany and LichtBlick published the report “Megatrends in the Global Energy Transition”. Based on the German “Energiewende” (energy transition), the report took a comprehensive look at developments in the energy industry around the globe. It became clear even back then that the energy transition had long since ceased to be a European or even a German phenomenon, but had gained momentum in many regions of the world. Since then, changes in climate and energy policy have accelerated enormously at international and European level.

The most groundbreaking event was the adoption of the Paris Climate Agreement in December 2015 at the 21st Climate Change Conference, which commits the international community to limit global warming to no more than 2 °C, but preferably to 1.5 °C. The 26th Climate Change Conference in Glasgow reaffirmed this commitment. The five megatrends of the global energy transition identified in 2015 are still relevant. They have been reinforced, concretized and further developed. New processes, initiated from the center of society, drove the change. First and foremost, the global youth movement was triggered by the Swedish Greta Thunberg. These processes have been and continue to be shaped by, on the one hand, a fundamentally different view of the climate crisis in important parts of the global economy and, on the other hand, a forward-looking change in the jurisdiction and regulation of energy systems with a stronger focus on climate protection.

This report takes a fresh look at the megatrends of the global energy transition. In doing so, the headlines remain largely the same, though not always identical. We have identified two additional megatrends whose magnitude was not yet considered six years ago.

Paris and the search for a new equilibrium

The Paris Agreement is the decisive breakthrough of the global climate protection movement.

The international community made history in 2015 with the Paris climate agreement. The decision of the 21st UN World Climate Conference pursues the goal of limiting global warming to well below 2 °C compared to the pre-industrial era, but preferably to 1.5 °C. The agreement was celebrated as a groundbreaking international success, because for the first time 196 countries and the EU made a binding commitment under international law to ambitious climate protection targets.

The Glasgow Climate Pact reconfirmed compliance with the 2021 temperature threshold of the Paris Agreement and, in view of the real climate development, even moved it once again in the direction of compliance with the 1.5-degree path.¹ Now, at the 27th Climate Change Conference in Sharm el-Sheikh, the task is to finally make binding progress towards implementation in order to actually get on the 1.5-degree path. This is because humans have thrown the Earth's physical system out of balance. It is the age of humans, the Anthropocene – and almost everyday people somewhere in the world experience the fatal consequences: floods, heat records and drought are just a few examples. And we don't yet know if and when we will reach the tipping points that will make the Earth a permanently inhospitable place for Homo sapiens. It is one, perhaps the, question of humanity's survival.

The new state of equilibrium that should prevent the worst from happening is what we call “greenhouse gas neutrality” or “net zero”: humans must not release more climate-damaging gases into the atmosphere in the long term than are filtered out of it by forests, oceans and other biological sinks or technical measures over the same period. But achieving greenhouse gas neutrality is still far away.

At the heart of the Paris Agreement is the international community's promise to itself to stop anthropogenic emissions, which continue to heat up the atmosphere regardless of where they occur, before the climate crisis turns into a global and irreversible climate catastrophe.

To achieve this, energy must first be used more efficiently all over the world and a less resource-intensive way of life must emerge, especially among the global middle and upper classes. But this alone will not be enough. If more than 9.5 billion people want to live in dignity on Earth in 2050, a fundamental transformation of the energy supply within less than a generation is a necessary condition.² The burning of fossil fuels such as coal, oil and natural gas must stop now and make way for new, climate-friendly energy technologies. Wind and solar energy have established themselves – at least for today's foreseeable future and in more and more regions of the world – as the best solutions, both economically and ecologically. Digitization, the transmission of electricity via long-distance transmission lines, and various methods of electricity storage make these successful key technologies also systemically practical and ultimately superior to the traditional energy system, even beyond the climate issue. An energy system for billions of people based on wind and sun would be inconceivable without digital data processing and system control, power lines with high transmission capacity, and demand-oriented storage systems.

A look back

The first edition of the report “Megatrends of the Global Energy Transition” in 2015 was widely praised, but also criticized as “bold” because of its positively grounded propositions.³ In fact, the underlying tenor of the report was optimistic, even though the success of Paris was not yet foreseeable. One issue even then: despite discernible progress, including in the implementation of the energy transition in Germany, there was already talk of “signs of fatigue” in the pursuit of energy and climate policy goals. These have initially intensified in the years since Paris. Far too many decision-makers in politics and business had not yet understood the gravity of the situation.

The result is little more than stagnation, and not even that on a global scale. Globally, greenhouse gas emissions continued to rise even after the supposed breakthrough in Paris, reaching their highest level ever in 2019. Globally, the energy sector bears the greatest responsibility, accounting for more than one-third of total emissions. At the same time, there are no truly transformative climate change successes in any sector (Figure 1).

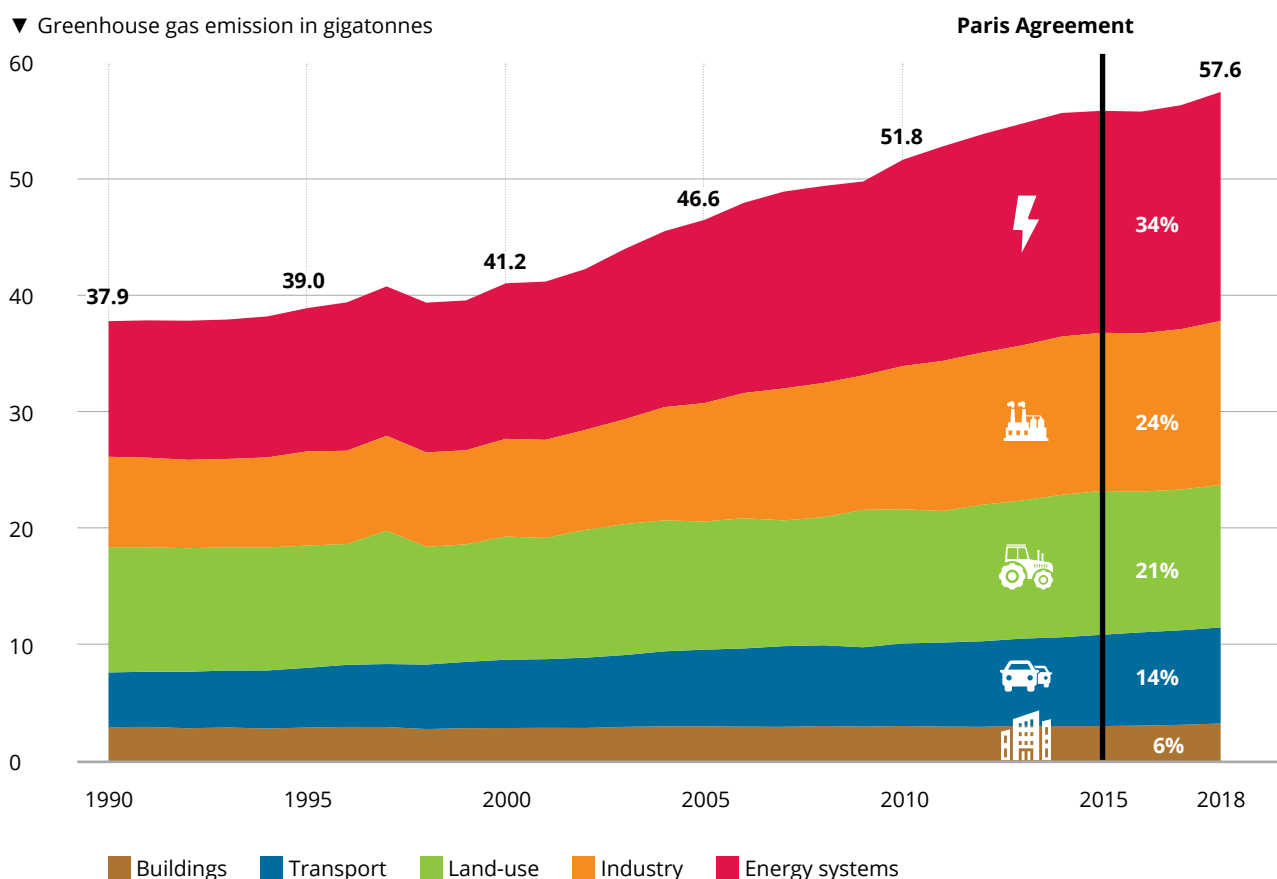


Figure 1:

Alarming assessment: The development of global greenhouse gas emissions from 1990 to 2018 by sectors; Source: Lamb et al.⁴

Although emissions in Germany and Europe fell overall, they fell short of the – in any case under-ambitious – reduction targets. Since the adoption of the United Nations Framework Convention on Climate Change in Rio de Janeiro in 1992, human-made greenhouse gas emissions have only declined in real terms in a few exceptional years: for example, after the global financial and economic crisis of 2008/2009 and in 2020, the first year of the COVID 19 pandemic.⁵ In the years since 2010, the expansion of renewable energies was just enough to slow down the increase somewhat, but not to stop or even reverse the emissions trend.

A step forward for society

On the other hand, the climate policy communication is different today than it was immediately after the adoption of the Paris climate agreement. In society as a whole, the realization is firmly anchored that the long cherished and comfortable “business as usual” is reaching its boundaries – planetary boundaries. Many countries have passed climate change legislation and net-zero targets.

The International Energy Agency (IEA) was founded in 1974 by the industrialized OECD to secure oil supplies for its members.⁶ For decades, the IEA underestimated the momentum of global renewable energy expansion in its annual World Energy Outlook (WEO) forecasts, only to be proven wrong by reality year after year (Figure 2).

▼ Expansion of renewable energies in gigawatts

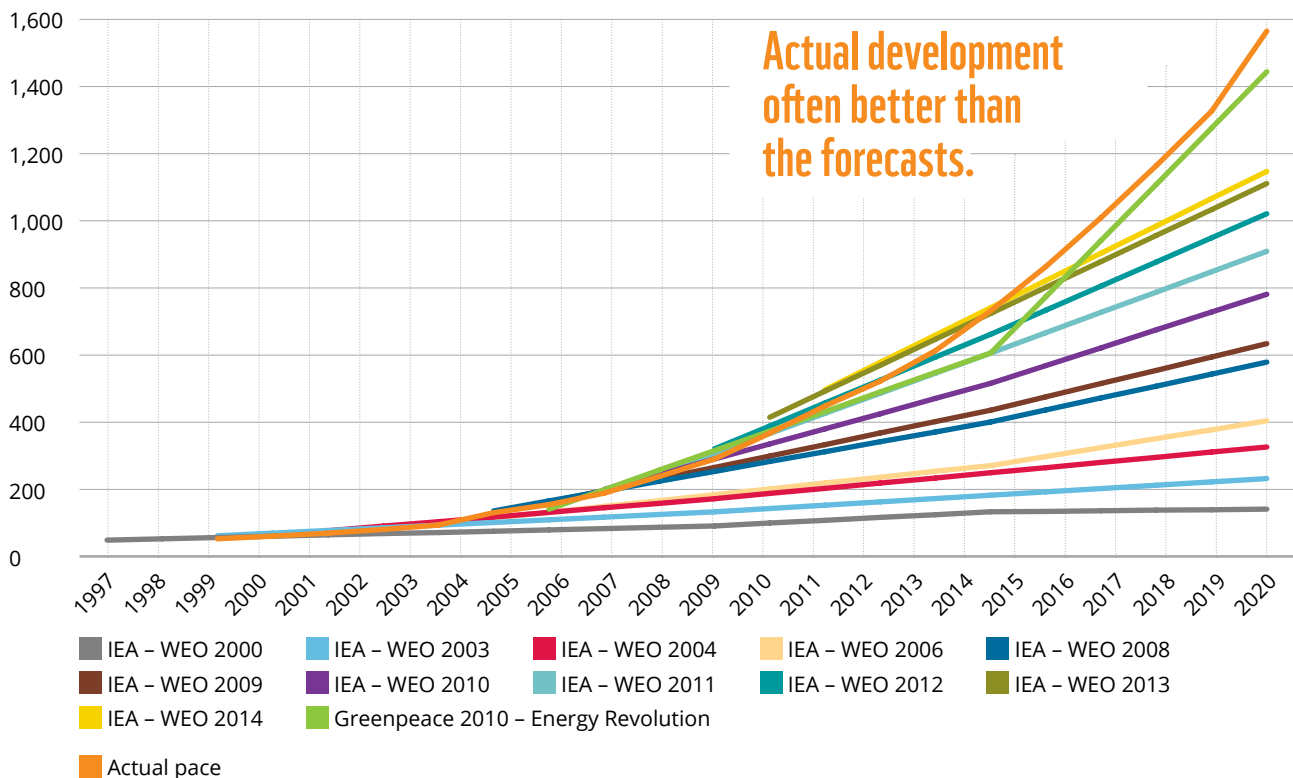


Figure 2: Forecasts of the expansion of renewable energies (excluding hydropower) worldwide and their actual development; sources, IEA, Greenpeace, IRENA⁷

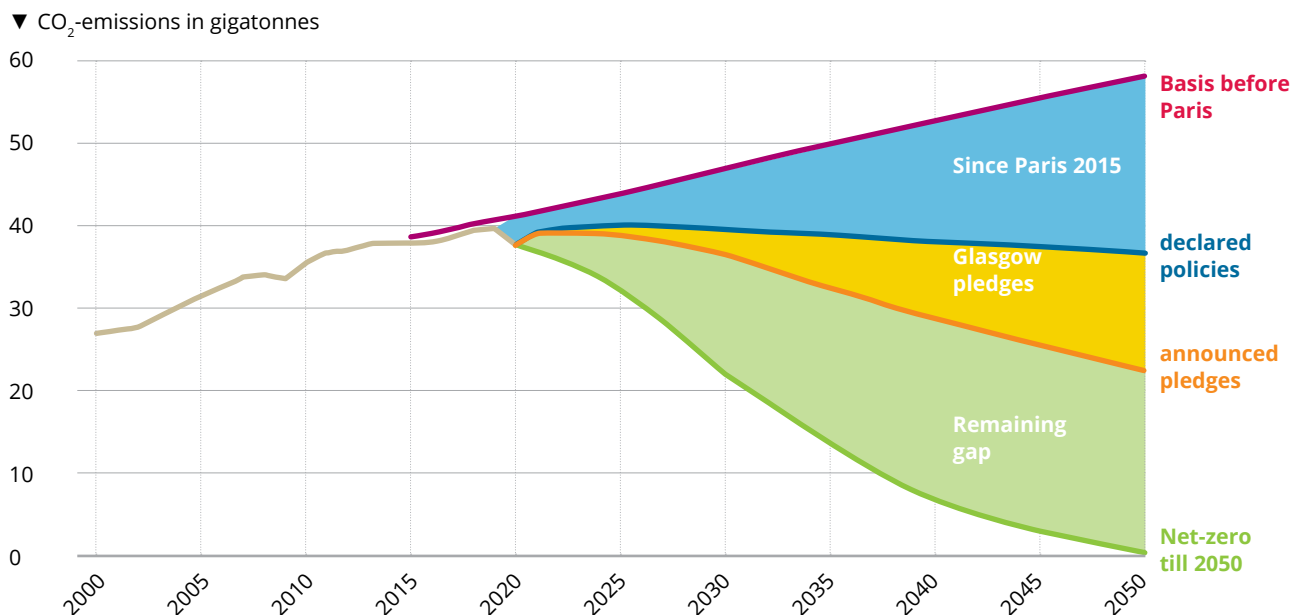


Figure 3:

The pledges made by the Parties to the Paris Climate Agreement at the World Climate Conference in Glasgow by October 2021 are nowhere near enough to achieve climate neutrality by 2050; source: IEA⁸

After the 2015 World Climate Conference when new Executive Director Fatih Birol took office, the IEA finally moved closer to reality. Finally, in May 2021, the complete turnaround occurred when Birol presented the new IEA lead scenario for the world entitled “Net Zero by 2050”.⁹ Since then, the agency has seen itself at the forefront of the movement to curb the global climate crisis. Ahead of COP 26, the IEA released its “World Energy Outlook”¹⁰, as it does every year, in which the organization urged the world’s rulers to step up efforts against the climate crisis and completely end the use of fossil fuels as soon as possible. Birol pointed out that the pledges made by the signatory countries up to this point would close less than 20 percent of the gap to the IEA’s net-zero scenario (Figure 3).

A lot has happened since Paris. In addition to environmental NGOs, other civil society actors as well as many representatives of the business community are now emerging as drivers of the transformation. There are still fossil-based companies in their usual role as preventer. But a large number of company representatives have changed sides because they have recognized that the age of fossil combustion is coming to an end and that anyone who does not adapt their business model in good time to the emerging era of climate-friendly energy systems will lose out.

For this reason, too, the time seems right to draw another interim conclusion after the megatrends of 2015, to trace what has happened on a global scale on the way from Paris to Sharm el-Sheik and what this means for global energy and climate policy. What progress has been made in global development towards climate neutrality, and what deficits must be overcome in order for the climate transition to succeed in time?

The turning point

Four developments that have changed the view of the climate crisis since Paris

Four phenomena could be identified as factors that have shaped the view of ever larger parts of society on the climate crisis since the publication of the first WWF report “Megatrends of the Global Energy Transition”.¹¹ The four drivers for the change in perception of the climate crisis after Paris are fundamentally different, but they have intensified until the general conviction finally prevailed that “business as usual” can no longer be an option.

Driver 1: The reality of the climate crisis

For far too long, climate change deniers got away with the slogan that bad weather has always existed after every flood or drought. Many climate scientists were deeply concerned by the increasingly tangible reality of the crisis – and yet mostly defensive in their public statements. They feared, not unjustifiably,¹² being attacked as alarmists who dramatize the changes. But scientists have long known the connection between the accumulation of extreme weather events and the atmosphere charged by the consequences of human activities.

The summer of 2021 exceeded the worst fears: the “heat dome” in the north-west of the USA and western Canada with temperatures never before recorded, the wiping out of the village of Lytton (British Columbia) with hundreds of premature deaths; the flood disaster in several Chinese provinces with tens of thousands of homes destroyed, almost 38 million people affected, and at least 300 victims; finally, the unprecedented rainfall in July in central-western Europe. These disasters continued noticeably into the summer of 2022, as can be seen for instance in Pakistan.

For decades, scientific institutions and initiatives have been striving for a better understanding of the processes in the changing atmosphere, also in order to be able to warn potentially affected people better and earlier. A separate branch of science, known as attribution studies, has emerged that deals solely with the question of which extreme weather events can be attributed to climate change and with what degree of probability.¹³

With every extreme weather event, knowledge about the changing conditions in the atmosphere grows. It is still true that not every violent hailstorm has its origin in global heating. But the accumulation of events around the globe and their alarmingly growing intensity make this discussion increasingly obsolete. Not only experts have realized: The dramatic weather phenomena of the present are only the beginning.

Driver 2: Greta Thunberg, a global youth movement and what it triggers

Greta Thunberg sat down with her self-painted sign *Skolstrejk för klimatet* (School strike for climate) in front of the Swedish Parliament in Stockholm on the first school day after the summer vacations on August 20th, 2018. Unexpectedly her action triggered a global youth movement, which rapidly achieved what scientists and activists had been trying to do for decades: to establish the climate crisis at the top of the agenda of many countries and world politics.

Three factors contributed to their success: Firstly, young people have the scientific facts on their side when it comes to the dramatic drawing of the crisis and its foreseeable consequences; secondly, they are not responsible for the heating up of the climate by virtue of their age; and thirdly, for the same reason, they will be the ones who will be more extensively affected by it than their parents' and grandparents' generations. The bitter truth is: children are liable for their parents.

The resulting “Fridays for Future” movement thus became a motor for a climate protection policy that might be appropriate in the future. Through the school strikes, the issue of the climate crisis thus became a point of discussion in many families and ultimately in society as a whole. In sum, this did not remain without effect on politics.

Driver 3: The fear of the future of industry in the Global North

Before Paris, decarbonization was often equated with deindustrialization or negative growth. In the meantime, it is rare for leading industrial sectors and companies to hold public events without a representative of “Fridays for Future” to contribute to the discussion. Arm in arm with environmental activists and scientists, business leaders from the automotive and steel industries, for example, are now calling for the accelerated expansion of renewable energies, because otherwise, the switch to steel made from hydrogen, electric cars or heat pumps makes no sense. However, some seem to have already given up hope on the state and are forming consortia with energy companies or wind turbine manufacturers to secure clean power in their own portfolio.

Of course, even this picture is not uniform. There are stragglers, and it is still the strategy of companies to cash in on the old climate-damaging business model for as long as possible in order to then approach the transition from a supposedly secure position. Greenwashing seems to be on the rise. But a steadily growing number of well-known companies have moved on from this phase. They got it.

Driver 4: A U-turn in jurisdiction

Since Paris, the debate about climate protection has been taking an increasingly sharp turn and has now also reached some of the highest courts of states. In Germany, for example, the Federal Constitutional Court issued a historic ruling in spring 2021, demonstratively pointing a still hesitant policy in the right direction and ordering a strong acceleration of all efforts to protect the climate. The judges decided with great clarity that today's policies must not postpone effective climate protection into the future at the expense of the younger generation.¹⁴ If the government does not want to provoke further course corrections by the supreme court, it must end the systematic delay of climate protection which has been pursued for more than one and a half decades.

Thanks to a changing jurisdiction, governments are being instructed to adapt their national climate protection policies and make them effective. Companies, too, are increasingly being held accountable for their responsibility to stop exploiting the planet to an extent that endangers our future coexistence. Business models at the expense of nature and the climate will hopefully no longer be permissible in the future.

The seven mega-trends of the global energy transition – a summary

Megatrend 1: The end of the fossil fuel era is inevitable

The binding nature of the Paris climate agreement under international law has decisively increased the pressure to phase out fossil fuels. In order to limit global warming to well below 2 °C and if possible to 1.5 °C, far greater proportions of existing coal, oil and natural gas reserves will have to remain in the ground than was assumed in 2015 against the backdrop of the 2-degree limit targeted at the time.¹⁵ The exploitation of further reserves will have to be stopped in the short term – probably in the face of resistance from exporting countries.

The demand first raised by the climate protection movement to withdraw capital from large coal, gas and oil companies is now the official strategy of international energy and financial organizations and many governments on the path to climate neutrality. Yet the world transition away from the fossil fuel era that has shaped the world's energy supply since industrialization continues to lag dramatically behind climate policy resolutions.

The phase-out of coal, oil and natural gas remains inevitable for the achievement of global climate protection goals – contrary to the final declaration of the COP 26 in Glasgow, which only calls for a reduction (“phase-down”) of coal use and does not even mention oil and natural gas.¹⁶

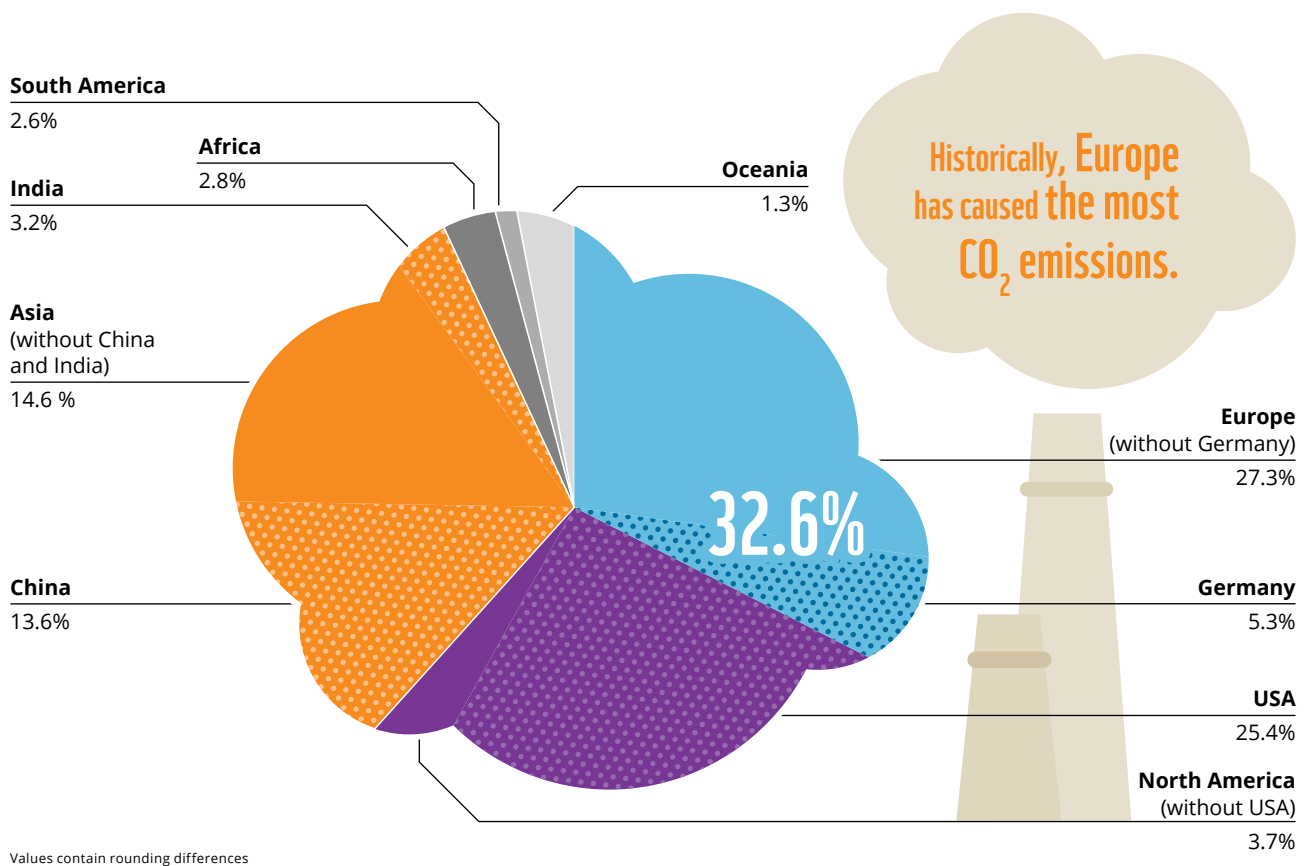


Figure 4: Historical emissions, historical responsibility: share of global CO₂ emissions from 1750 to 2019; source: Our World in Data¹⁷

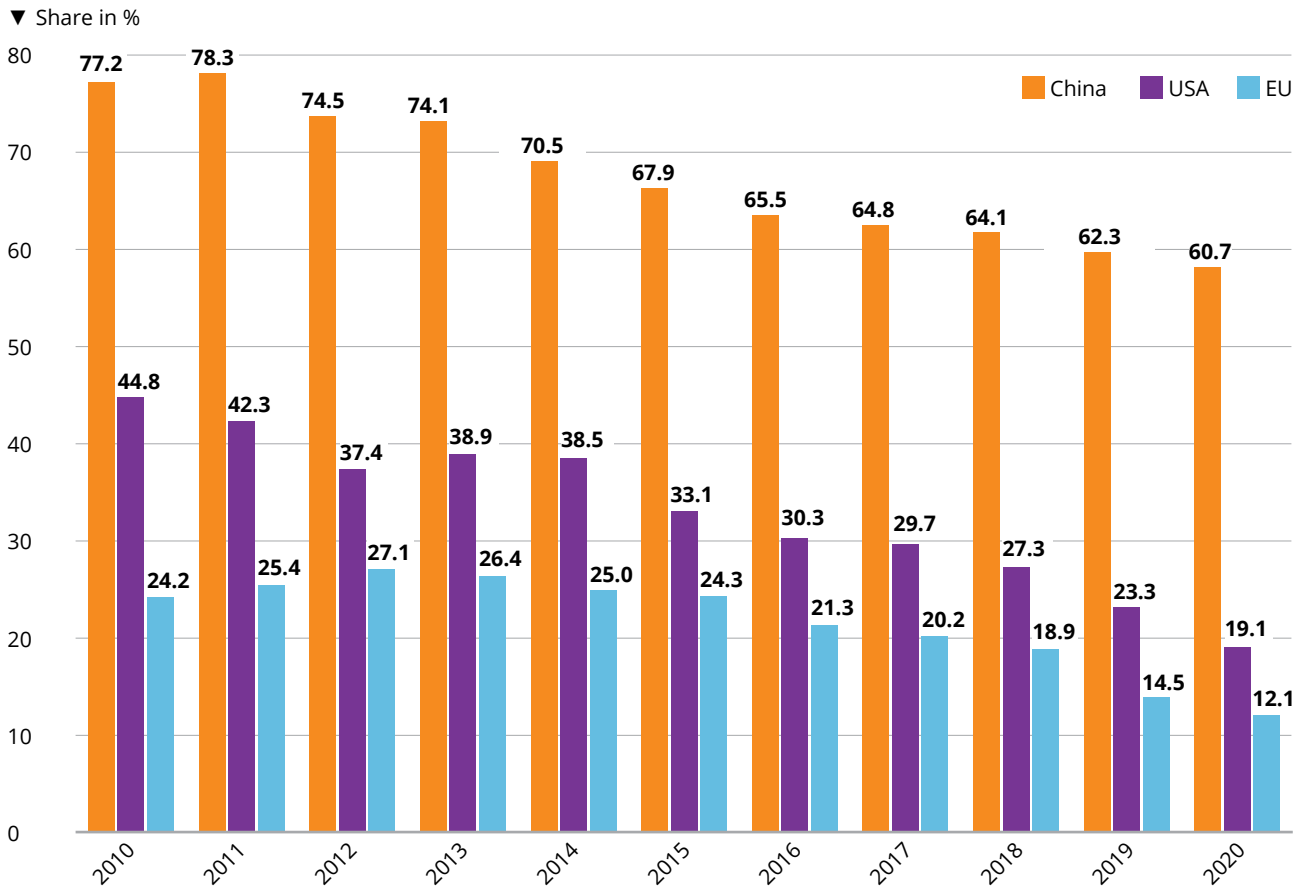


Figure 5:
Percentage share of coal-based electricity in the annual electricity mix; source: Ember¹⁸

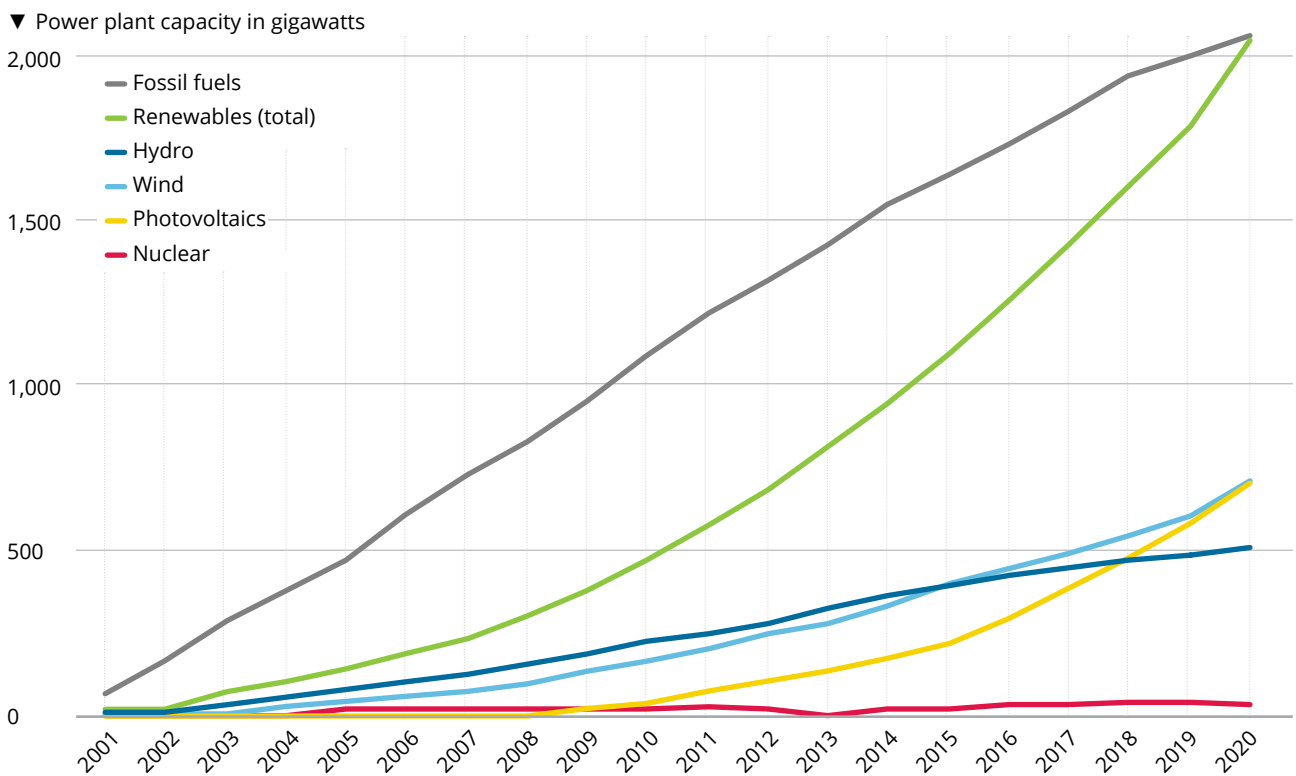


Figure 6:
Development of worldwide installed power plant capacity since 2001; source: IRENA¹⁹

Megatrend 2: The energy future is now – almost everywhere

Renewable energies based on wind and solar power are now more cost-effective and competitive in many regions of the world than traditional electricity generation from coal, natural gas or nuclear power. The cost advantage of wind and solar energy over fossil-fuel generated electricity will continue to increase as CO₂ emissions from electricity generation are priced in more and more regions of the world, albeit still at insufficient levels given their real and expected climate damage.²⁰

As a result of these developments, renewables already dominate the expansion of new power generation capacity around the globe. Between 2014 and 2020, global installed wind power capacity doubled, and photovoltaic capacity nearly quadrupled. More than four-fifths of new generation capacity installed in 2020 was renewable. In 2020, fossil and nuclear power plants still accounted for a total of 18 percent, lagging far behind. 70 percent of new investments went to renewable power generation plants, 22 percent to fossil power plants and eight percent to nuclear power plants.²¹ Wind energy and photovoltaics are the most cost-effective generation technologies of the future. They overcome the major risks of the fossil and nuclear energy systems of the 20th century.

All countries of the world are called upon to install climate-neutral energy systems based on their own specific realities.

▼ Installed solar energy capacity in gigawatts

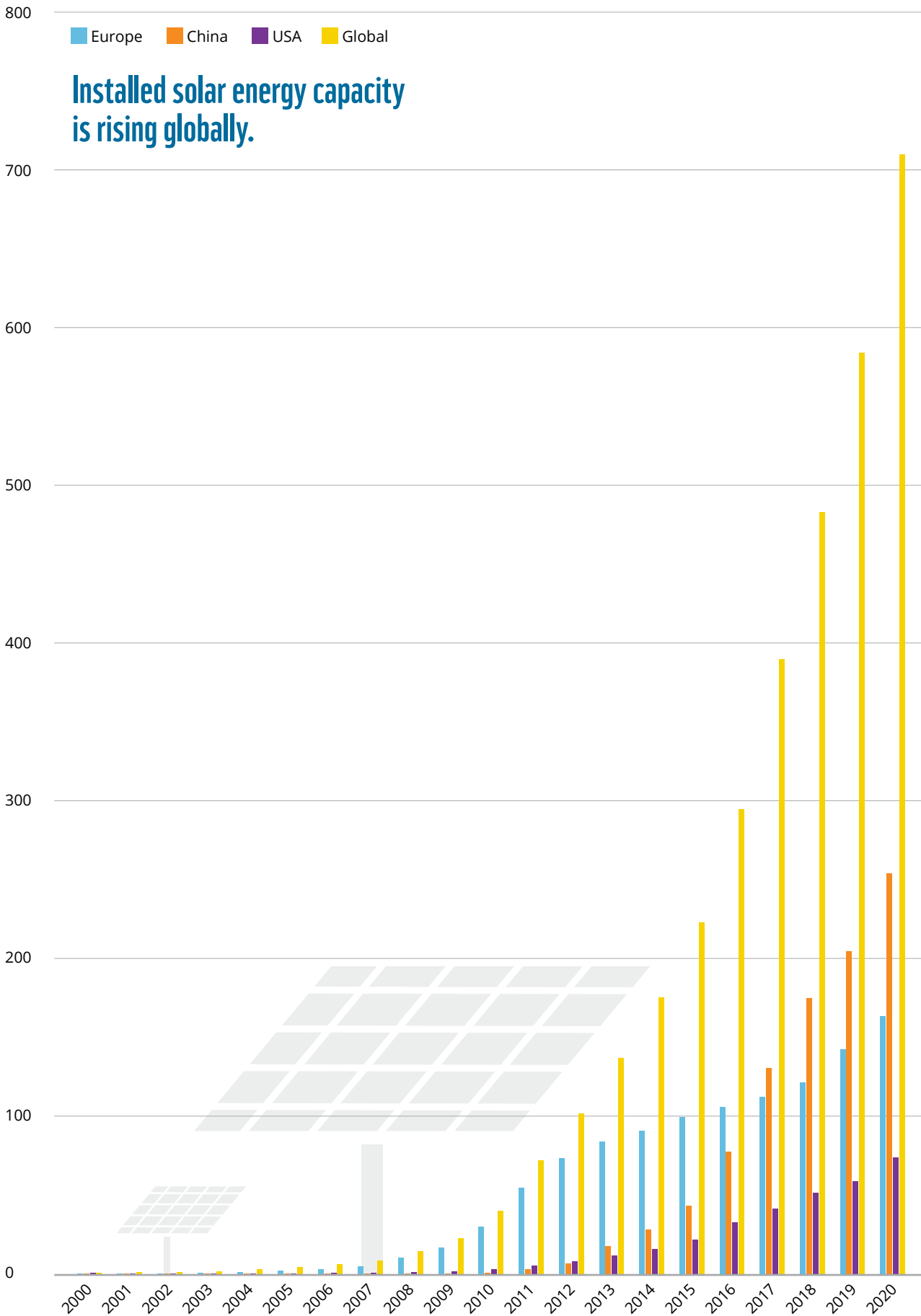


Figure 7:
Development of globally installed solar energy capacity since 2000; source: IRENA²²

▼ Installed wind energy capacity in gigawatts

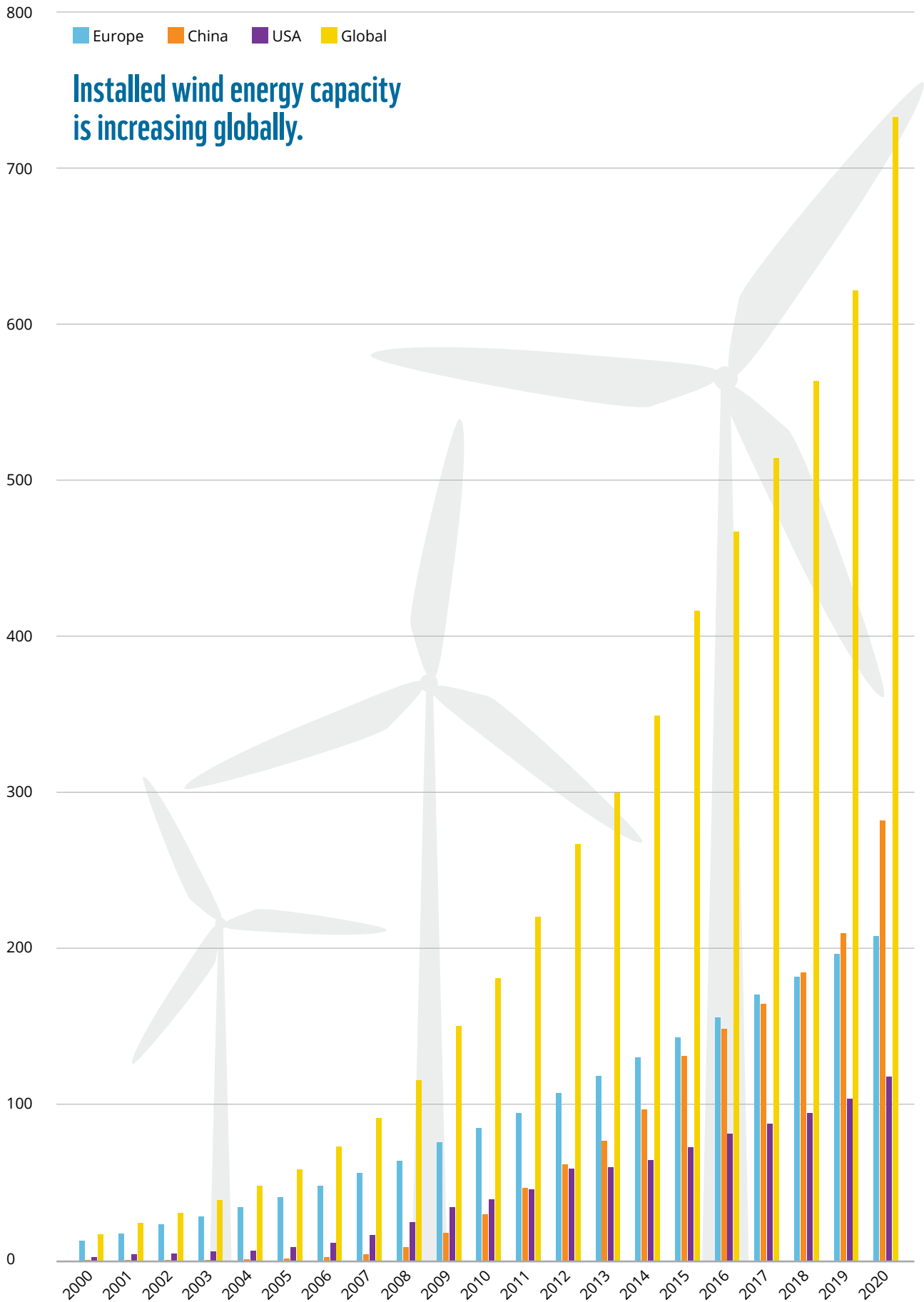


Figure 8:
Development of worldwide installed wind energy capacity since 2000; source: IRENA²³

▼ Capacity growth in gigawatts

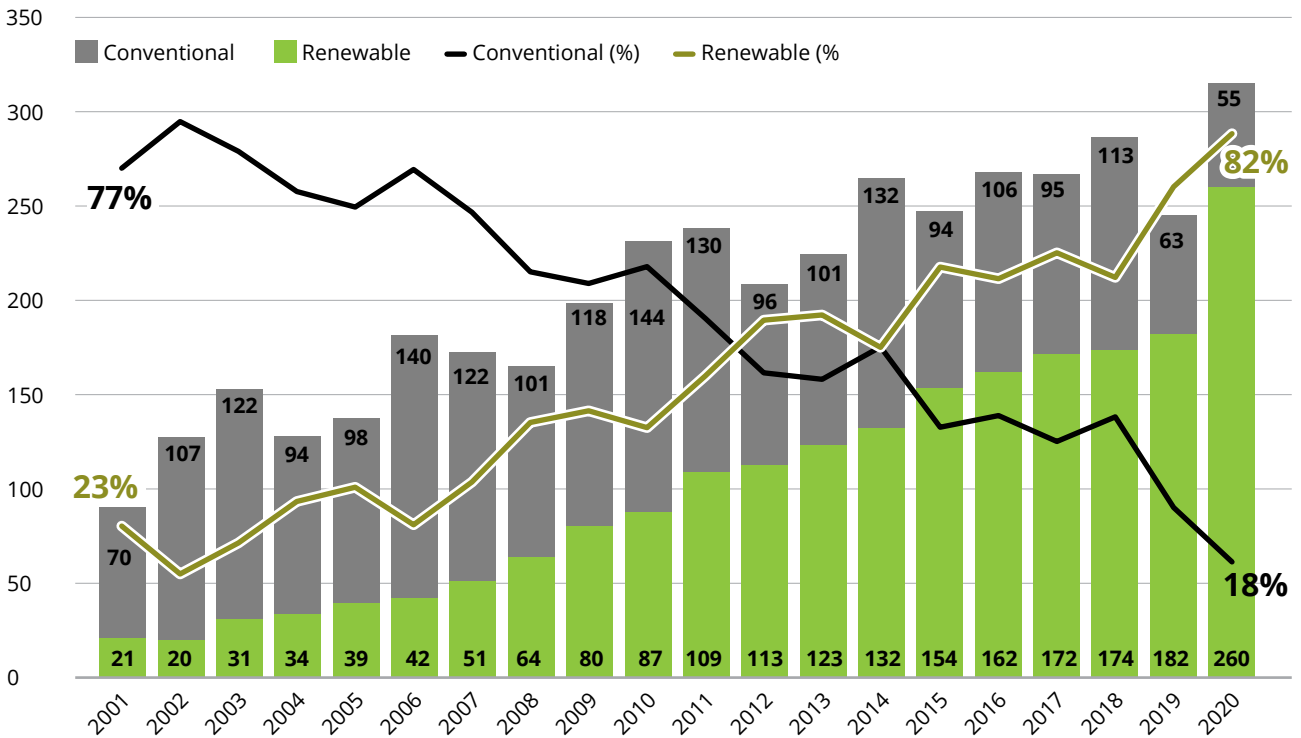


Figure 9:

Annual worldwide installed power plant capacity; source: IRENA²⁴

▼ Capacity in gigawatts

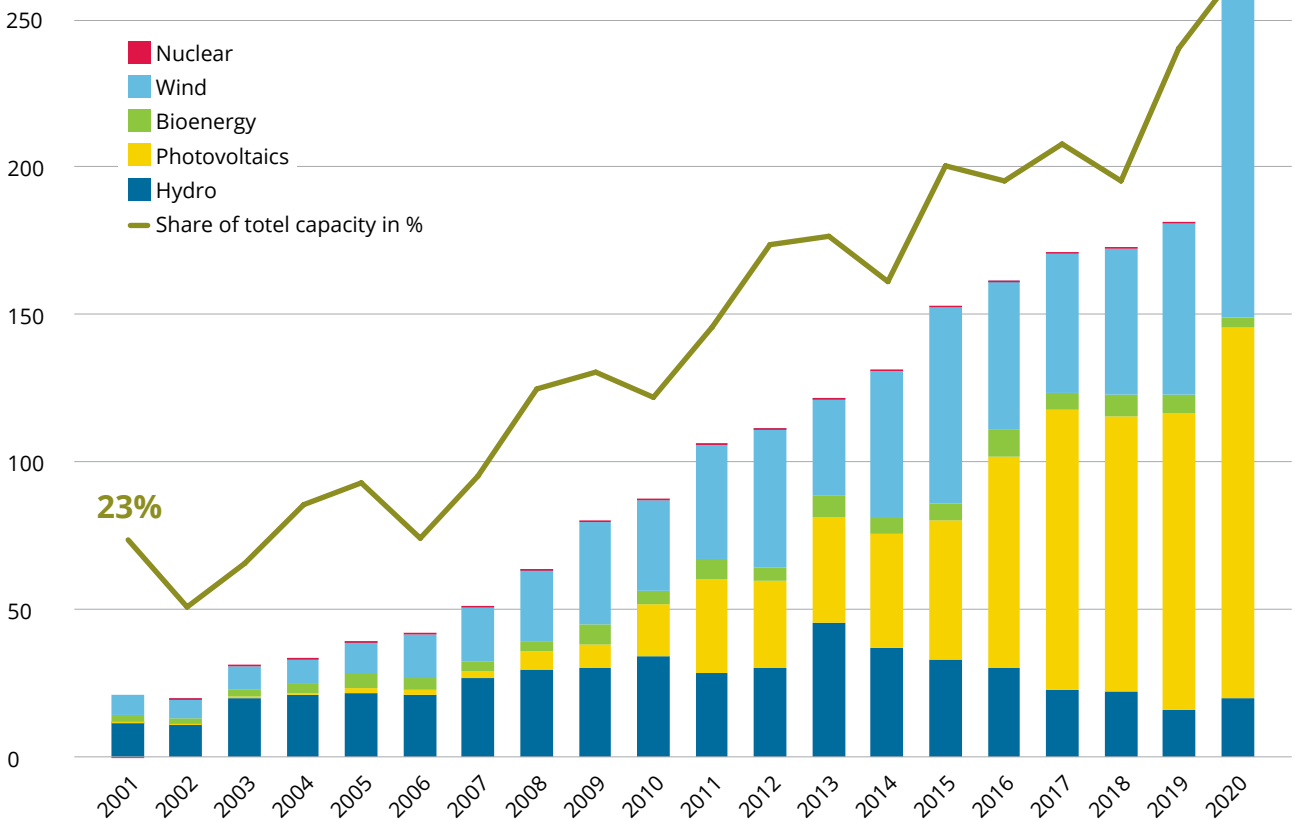


Figure 10:

Annual installed power plant capacity with renewables and nuclear power; share of renewables of total newly installed capacity; source: IRENA²⁵

Megatrend 3: The energy future is renewable – and irreversible

Driven by further declining costs, renewable energies based on wind and solar power have become key global technologies for the 21st century. Because at the same time electricity from the combustion of fossil fuels is systematically becoming more expensive, a reversal of the trend is no longer imaginable. In the future, nuclear energy will play no role in Germany and a secondary role, if any, in Europe and the world. It is too expensive, its risks cannot be controlled, and its long-term consequences are incalculable.

A renaissance of nuclear power based on new, smaller reactors would come too late as a contribution to solving the climate crisis, even if the financial and safety problems were all to disappear into thin air.²⁶ The energy future will be driven by renewables – the trend has been irreversible since the Paris Agreement came into force and was reconfirmed in Glasgow.

The expansion of renewable energies, especially wind energy and photovoltaics, must continue at an accelerated pace around the globe until climate neutrality is achieved worldwide. Wind and solar have long been the cheapest energy suppliers, and costs are expected to fall even further in the future.

▼ Costs in USD cents₂₀₂₀ per kilowatt hour

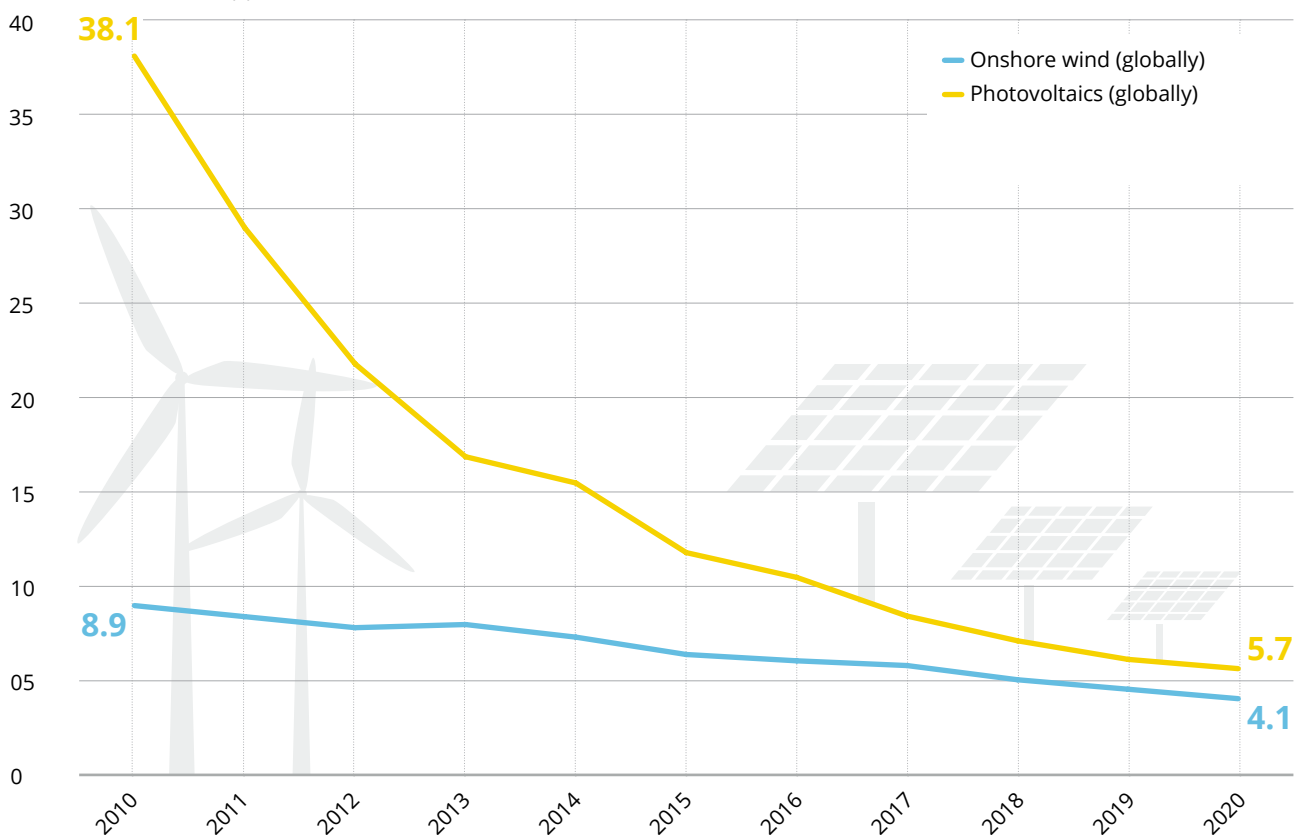
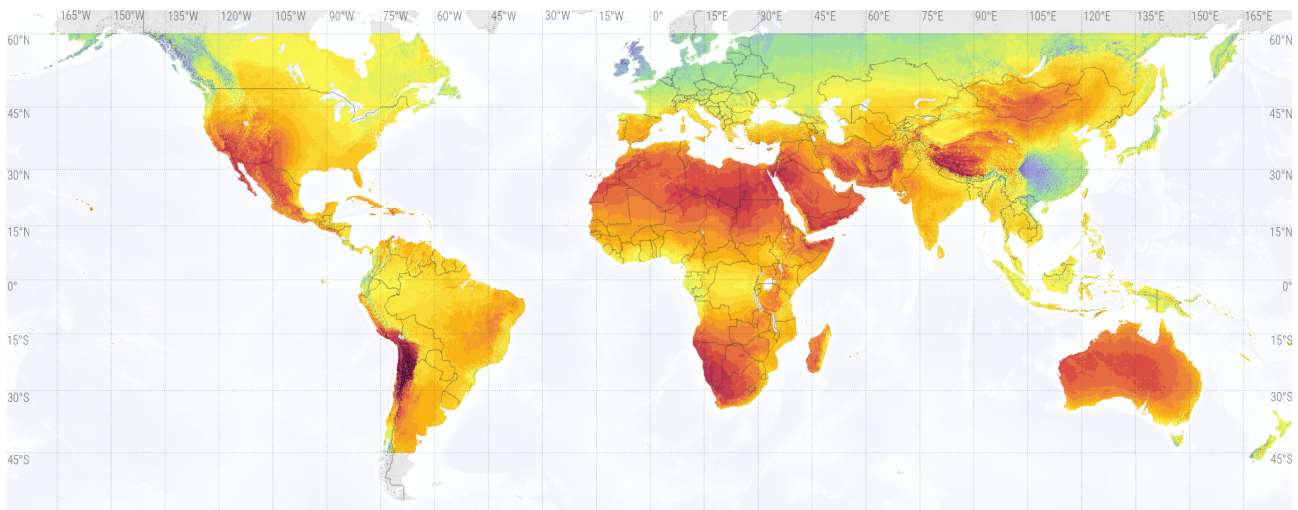


Figure 11:

Electricity generation costs of new wind energy and solar plants; source: IRENA²⁷

Megatrend 4: The energy future is decentralized and opens up opportunities for a fairer world

After more than a hundred years, the power supply from large-scale fossil and nuclear power plants is coming to an end, making way for a decentralized energy system based on renewable energies. The physics of renewable energy power sources results in a mixed system of decentralized power generation in millions of small plants. But there will also be a significant number of large generation plants and centrally coordinated, at least partially automated, system control. As with electricity generation from renewable energy sources, new electricity applications, such as in the transportation and building sectors, are leading to more decentralized structures and an overall more evenly distributed electricity consumption over the territory.²⁸



Long-term average electricity generation potential for photovoltaics

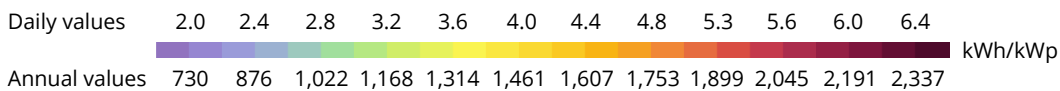


Figure 12:

Global photovoltaic power generation potential: opportunity to redistribute global wealth?;
source: World Bank Group²⁹

On a global scale, the renewable energy system tends to lead to more distributive justice, because regions of the world that were previously disadvantaged in the fossil-nuclear energy system have large renewable generation potentials. The energy and climate transition can thus open up opportunities for a fairer world overall.

The Global North is called upon, especially in view of its historical responsibility for the climate crisis, to drive and finance this system and technology transfer as well as the development of the energy systems of the future in the Global South.³⁰

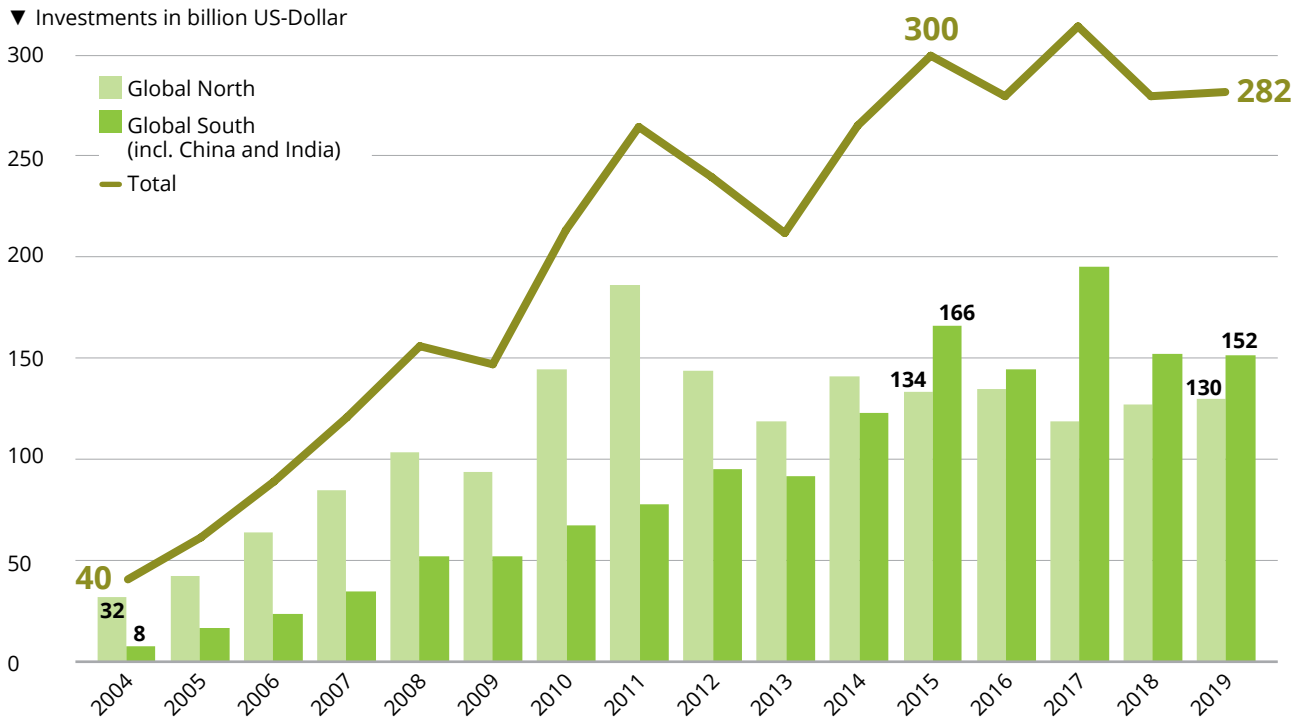


Figure 13: Investments in renewable energies by region; sources: UNEP, Frankfurt School-UNEP Centre, BloombergNE³¹

▼ Investment share in %

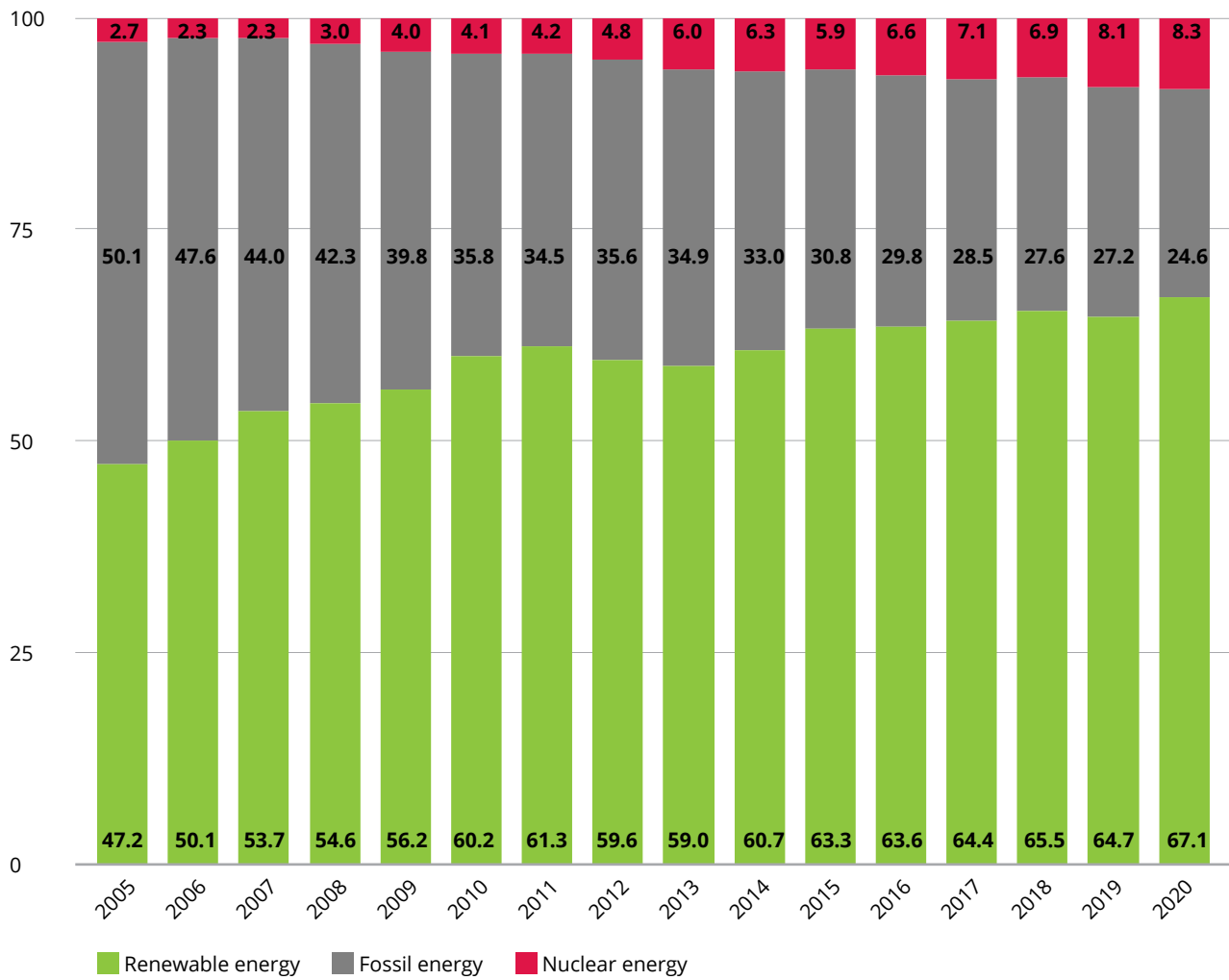


Figure 14:

New investments in renewable power generation are increasing worldwide; source: IEA³²

Megatrend 5: The energy transition is electric

With the energy transition, electricity from renewable sources is becoming a universally usable energy carrier, even beyond its traditional applications. The decarbonization of the transport sector, the heating sector, and industry is largely achieved through the direct or indirect use of renewably generated electricity. The conversion of the energy base from fossil and nuclear fuels and fissile materials to renewables and green electricity will also result in a profound technological change for the affected industries on the user side.

The future electricity-based energy system will operate much more efficiently than the old one, because the switch to electricity will minimize thermal conversion losses in power plants and many application technologies will also use the energy input more effectively.³³ The electrification of our economy and society is in progress. Electricity is the decisive final energy source of the future.

The system conversion from fossil and nuclear power generation to renewable energies and efficiency must always consciously consider and implement direct and indirect electrification in the form of coupling the sectors throughout the entire transformation process.

▼ Electricity volumes in terawatt hours

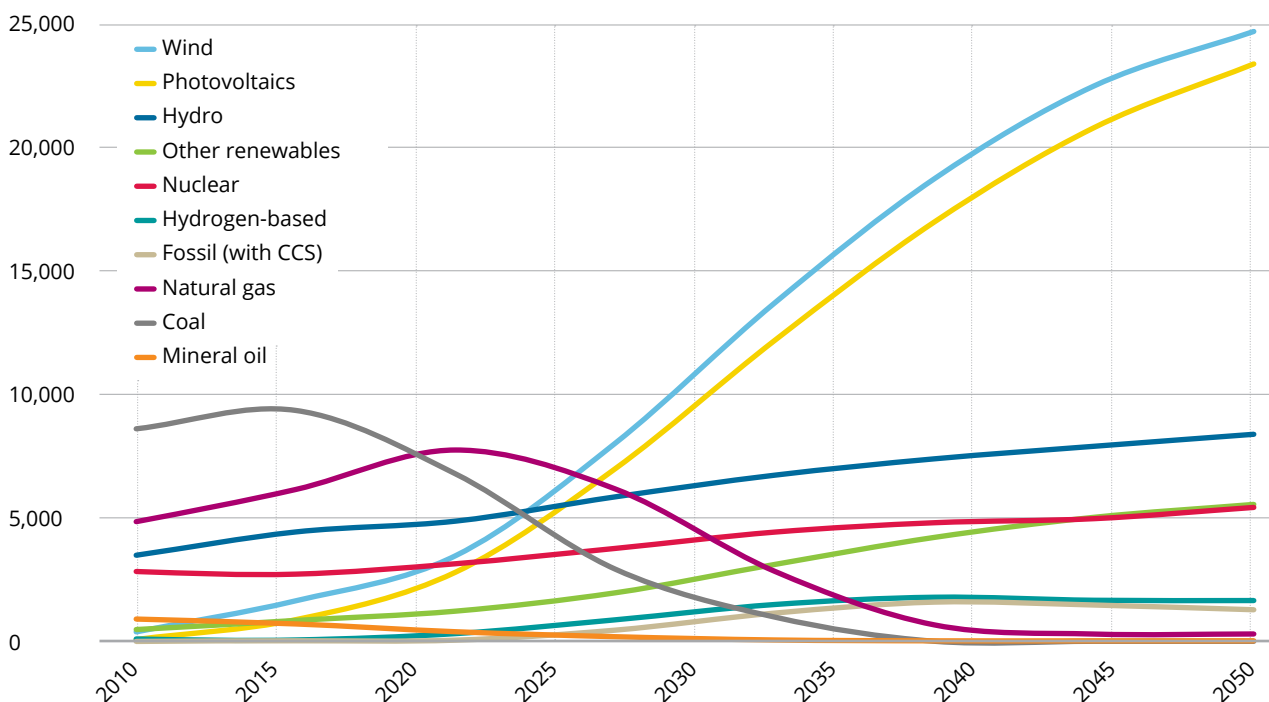


Figure 15:

Global electricity generation with individual energy sources in the “Net Zero by 2050” scenario; source: IEA³⁴

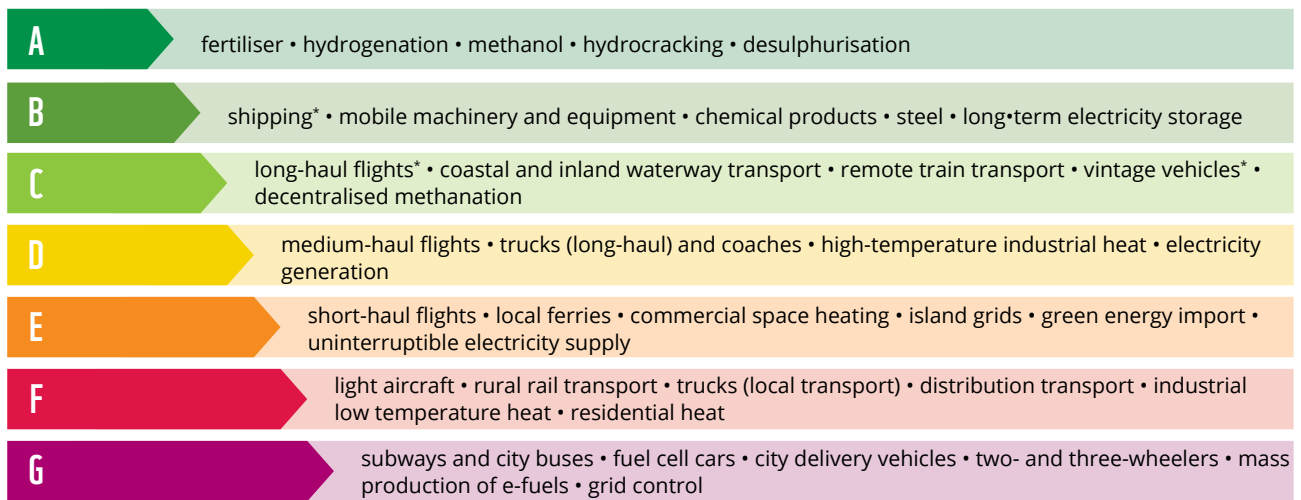
Megatrend 6: Energy transition needs hydrogen – for “special tasks”

Hydrogen is not the energy carrier to continue the fossil age by other means. Because hydrogen requires the use of green electricity for its production, hydrogen remains a rare and expensive commodity and should be used specifically where more energy-efficient electrical solutions or other alternatives are not available in the long term. On the other hand, only green hydrogen, the production of which releases virtually no greenhouse gases into the atmosphere, guarantees complete climate neutrality in the long term.

The use of hydrogen is indispensable in the decarbonization of important industrial sectors, in segments of mobility that cannot be electrified, and as a back-up (e.g., as storage and in gas-fired power plants based on H₂) for future energy systems that are dependent on volatile energy sources. Because of the uneven availability of new lead energies from wind and solar across the world, Germany will remain dependent on energy imports – then in the form of hydrogen – even after the energy transition, but to a lesser extent.

Like with the expansion of renewable energies, speed is the decisive criterion when it comes to creating the infrastructures for a sufficient supply of green hydrogen. Smart government support, management, and prioritization of the process are key requirements for success.

without alternatives



uneconomical

* Very likely e-fuels or ammonia produced via hydrogen

Figure 16:

Areas of application for clean hydrogen and its economic viability; source: Gregor Hagedorn, Wolf-Peter Schill, Martin Kittel³⁵

Megatrend 7: No energy transition and no decarbonization without digitization

Digitization of the energy sector is both, a precondition and the key to a reliable and sustainable energy system. In implementing the energy transition, the IT and energy sectors are growing together with the primary goal of ensuring that energy supply and demand are matched at all times in the future. Artificial intelligence will help make the new smart energy system more efficient, cost-effective and secure in just a few years.

Digital transformation and decarbonization are fueling each other and transforming all core industries – everywhere in the world.

The short-term challenge is to systemically link the still largely separate spheres of digital transformation and decarbonization in all sectors.

▼ Average power supply interruption in minutes/year

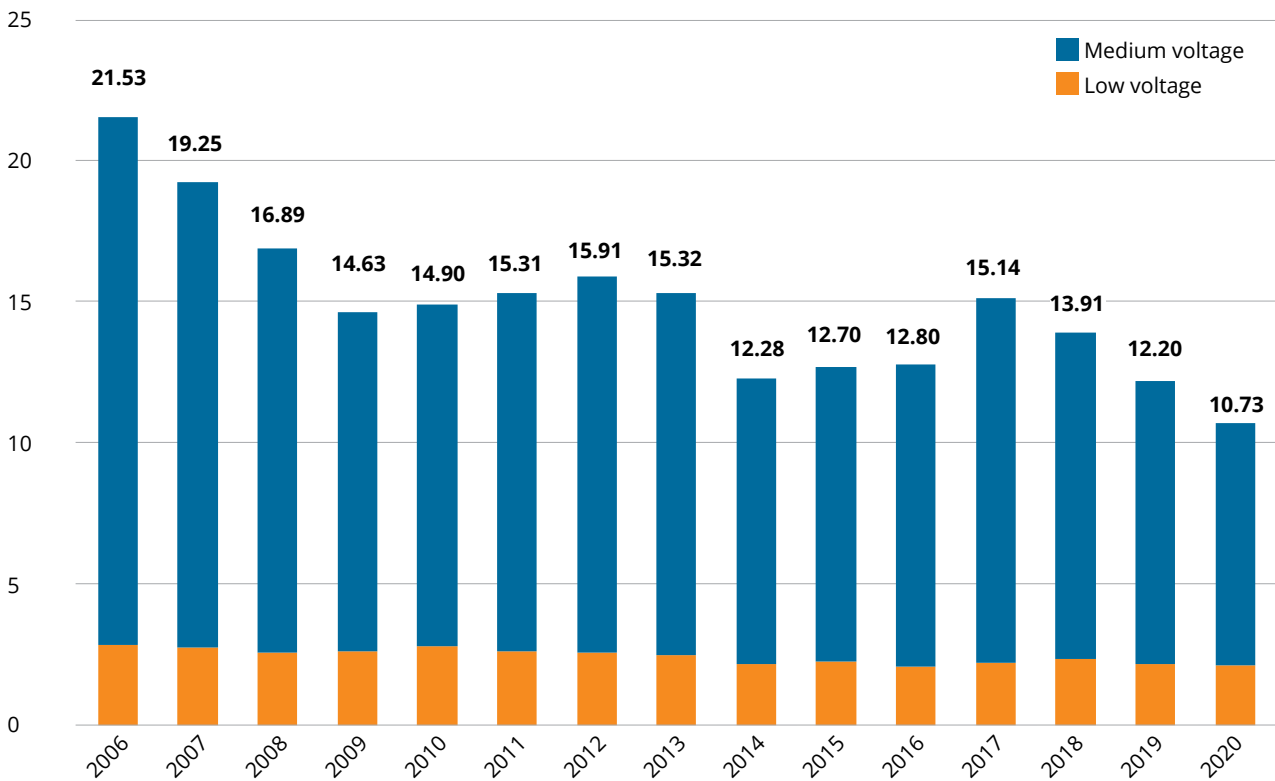


Figure 17:

Annual unplanned power supply interruptions in Germany; source: BNetzA³⁶

Conclusions

The energy transition is irreversible, but its success yet not foreseeable

The fundamental transformation of our society is not a foregone conclusion – the opposite is the case. The trigger for the megatrends is an overall objective defined by the international community. It is about protecting the world as far as possible from the consequences of global heating and about restoring a natural balance that humankind has disturbed on a global scale for the first time in the past hundred years – at first unknowingly, then despite manifold signs and countless admonitions, especially from the environmental movement and science.

Sub targets play a role in this transformation that can be decisive for the feasibility of the overall objective: For people do not just want to survive somehow, but to live in dignity, in peace, in good health and in reasonable prosperity. People also want to preserve the natural foundations of their lives because they recognize their intrinsic value, but above all because it is ultimately these foundations that make the good life possible.

From Paris to Sharm El-Sheikh: The energy transition on the path to irreversibility

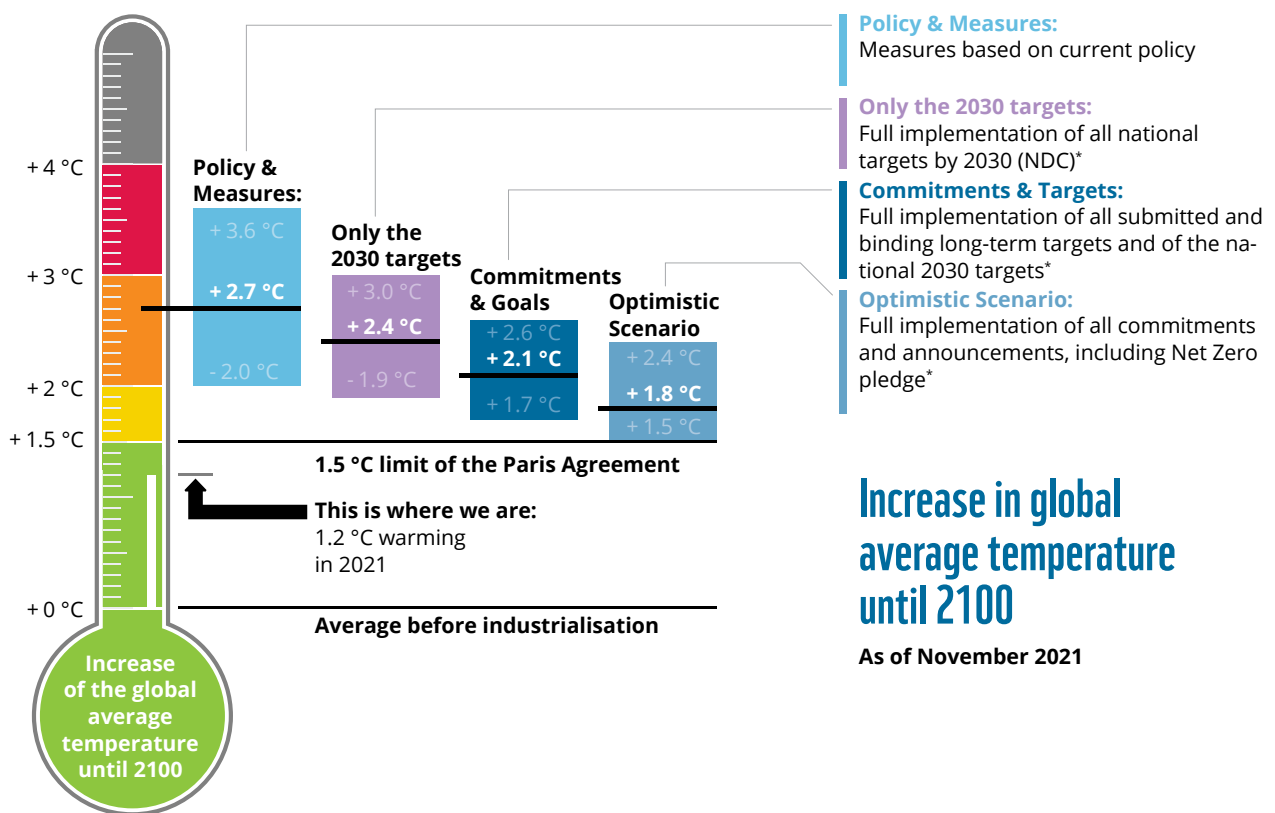
The most important result of the above-mentioned seven Megatrends proves their effectiveness and impact: they have made the energy transition irreversible on a global scale. The climate target, which was tightened in Paris compared to previous decisions in the context of the UN climate negotiations, played a significant, perhaps decisive role in this.³⁷ Isolated attempts that in 2021 still aim to question irreversibility have something anachronistic about them. They are overtaken by the reality of the energy transition.

Despite all the blockades that have characterized and continue to characterize global efforts to contain the climate crisis since Paris and, most recently, again since Glasgow: The fundamental difference to the situation in 2015 is the globally accepted irreversibility of the energy transition. At that time, the view was widespread in parts of politics and business, and not only among outsiders, that the climate crisis would not be too severe. Many still nurtured the hope that the focus of public attention would sooner or later turn to other issues. That is unthinkable today. Things have turned out differently because the real climate crisis has prevented people from turning away from the issue and will continue to do so in the future.

In fact, the global energy transition is developing against the geopolitical trend of everyone looking out for themselves. The most recent examples: In Glasgow, China and the USA – by far the two largest greenhouse gas emitters – surprisingly agreed on joint action in all areas of climate protection and the energy

transition. In the joint declaration, the U.S. and China promise to cooperate bilaterally and with third parties in all important fields of climate policy and to accelerate the process of decarbonization and electrification on the basis of the Paris Agreement.³⁸ In the German-led G7 presidency, too, the top priority was climate protection (at least on paper).

The likelihood that the national climate protection contributions submitted by the signatory states at the end of COP 26 in Glasgow would be sufficient to return the Earth's greenhouse to the 1.5-degree path was low from the outset.³⁹ The skepticism of many observers in the run-up to the world conference has been confirmed in this respect. Even if the long-term and net-zero targets announced by various countries before the Glasgow conference were all implemented in full. In this case, however, the 1.5-degree threshold of the Paris Agreement with an expected global heating of 1.8 °C would still be within sight.



* If the NDC targets for 2030 are weaker than the projected emission levels under Policy & Measures, the values from Policy & Measures are used.

Figure 18: Estimation of the expected global warming by 2100 with different intensities of climate protection efforts by the signatory states to the Paris Agreement; source: Climate Action Tracker⁴⁰

Nevertheless, the 26th World Climate Conference cannot necessarily be assessed as a failure. For example, the “rule book” of the Paris Agreement was finalized, which will increase the binding nature and transparency of the climate balances submitted by the signatory states in the future and at least curb the feared double counting in the trading of emission reduction certificates. Beyond the official agreements, this Conference of the Parties witnessed an unprecedented number of voluntary agreements between governmental, public and private actors. The vast majority of those responsible recognizably accept that the time of declarations is now ending and that the phase of decisive action and a new seriousness must finally begin.

There are exponential growth curves in climate-friendly technologies – key technologies that are now competitive almost everywhere in the world. Last but not least, there are countless small, many medium-sized and even already very large companies that are committed to climate protection and have one thing in common: They are expanding. Around the globe, new industries have emerged that could collectively be called the “decarbonization economy”. However, this cannot and must not be all.

The open question: Climate crisis or catastrophe?

After all this, there can no longer be any doubt about the fundamental direction of development. The Megatrends of the Global Energy Transition are continuing, and the energy transition is not going to stop, even if some governments here and there demonstratively turn their backs on it. Climate-compatible energy sources will replace the age of fossil fuels, the decarbonization of the economy and society has begun on a broad front, and the megatrends of electrification, digitalization and decentralization of the energy industry, as well as the targeted use of climate-neutral hydrogen, are driving development forward.

But one question remains, which even after the climate summit in Glasgow appears to be completely open and will ultimately determine the success or failure of the global energy transition. It is the question of the dynamics of the transformation. Are the megatrends worldwide pronounced and dynamic enough to keep the consequences of global heating within tolerable limits? Or must these consequences first become unbearable for large parts of humanity before real breakthroughs can be made? In other words, does the climate crisis have to become a climate catastrophe before there is sufficient focus on this global challenge?

The situation is anything but hopeless, as a dynamization of the megatrends is clearly emerging:

- » More and more people demand a boost in the energy transition.
- » The design of the Paris Agreement requires that the ambition level of the climate targets of each signatory state systematically increases over time until climate neutrality is achieved.
- » Because the Paris Agreement makes the decarbonization path binding under international law, it creates credibility for the process – and, as a result, planning certainty.
- » The mechanics of the climate agreement have decisively solidified a fundamental realignment of the innovation imagination of the techno-scientific world.
- » Finally, and perhaps in the end, this is the all-important advance: the realignment of the global innovation imagination naturally also encompasses the populous nations of the Global South.
- » The megatrend of electrification of mobility and the heating sector acts as an additional innovation driver and like a propellant to accelerate the transformation.

At least as important for the global success of the energy transition is where public and even more so private funds are deployed. Directing financial flows to the Global South is critical to medium- and long-term success. The allocation of investment funds to build clean energy systems will determine whether these countries follow the fossil path of the industrialized countries in their further development, as has essentially been the case to date, or whether they make it climate-neutral in the future.

This summary of the report “Megatrends of the Global Energy Transition” should end with this final message:

The obligation of all climate policy today is: Do it. Accelerate the megatrends of the energy transition. And in the race against time, do everything possible to contain the climate crisis and its impacts.

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