FRIEDRICH EBERT STIFTUNG

STUDY

En Route to a Just Global Energy Transformation?

The Formative Power of the SDGs and the Paris Agreement

LUKAS HERMWILLE

June 2017

- The Paris Agreement for climate protection and the Agenda 2030 for Sustainable Development with the Sustainable Development Goals define an international legal frame of reference for the impending global energy transformation. This framework now makes it possible to shape the transformation leading to a sustainable global economy and society and to prevent it from being driven by the disastrous consequences of unchecked climate change.

- The two agendas can only be realized together. Without sustainable development, the climate protection goals of the Paris Agreement cannot be achieved. Conversely, without climate protection the development goals cannot be achieved either in the developing countries or in industrialized countries. Renewable energy sources are a key component of both endeavors.

- However, the expansion of renewable energy alone is not sufficient to ensure that the global energy transition will be accomplished on time. In addition, the phase-out of coal, oil, and gas must be organized. This is required to ensure that the impending structural changes are just and socially acceptable. Only in this way can a continuous transformation be guaranteed and social fractures avoided.

Wuppertal Institut

Contents

1. Introduction

Manuela Mattheß, Friedrich-Ebert-Stiftung

Climate change is without doubt among the major challenges of the twenty-first century. It poses a threat not only to the natural foundations of life worldwide, but also to economic and social development in many countries, as well as to fundamental human rights. Climate change also plays an important role in questions of justice because in essence it hits members of the poorest and most vulnerable social strata the hardest, that is, those who for the most part have contributed only slightly to its causes and are the least able to adapt to it. Therefore, climate and development policy can no longer be detached from each other.

In the context of the climate negotiations held in Paris in December 2015, climate change was once again thrust into the public spotlight for what it is – namely, a massive transformational challenge. If we are to avoid permanently exceeding the limits of the resilience of the planet, and thus destroying important natural foundations of human and animal life, the global economic and social systems will have to undergo a comprehensive transformation. Central to this endeavor is undoubtedly the transformation of the energy sector away from fossil fuels and toward sustainable and renewable energy sources. Since 2015, renewable energy sources have continued their successful course: prices are falling and investment in these technologies has increased especially in the countries of the global South. While this trend is encouraging, it is not self-perpetuating, because a global energy transformation entails huge challenges. That a global transformation is necessary if we want to end the centuries-long dependence on fossil fuels and the concomitant environmental destruction and, in addition, to make cheaper and more secure energy accessible to all human beings, is no longer open to question. Instead, the question of »how« comes to the fore.

The Paris climate agreement (Paris Agreement) and the Agenda 2030 for sustainable development with its Sustainable Development Goals (SDGs) make it abundantly clear that greenhouse gas neutrality – that is, a balance between anthropogenic greenhouse gas emissions by sources and removals by carbon sinks – must be achieved by the middle of this century if harmful global warming and the attendant catastrophic destructive processes are to be limited. Since 2015, a central international frame of reference in the guise of these two processes has been in place to shape the impending energy transformation in a just way. The Paris Agreement points the way to a greenhouse gas-neutral future. The goals of the Agenda 2030 for sustainable development apply to rich and poor countries alike and connect aspects of human development with peace, environmental transformation, and sustainable economic development. The claim to universality raised by these agreements is of central importance and must be used for their implementation.

The present study analyzes the formative power of the Paris Agreement and the Sustainable Development Goals specifically with regard to the support they provide for a just global energy transformation. Answering the question of what concrete form the implementation of the required global phase-out of fossil fuels must take also calls for an examination of the necessary exnovation strategies and instruments as to their suitability for shaping a socially just energy transformation, hence one that is in conformity with the idea of a just transition.

The following analysis demonstrates that the Paris Agreement and the Sustainable Development Goals provide an important positive framework for shaping a global energy transformation. Although they do not provide a blueprint for a transformation, they do specify the direction leading to a greenhouse gas-neutral future. They highlight the importance of prompt and effective action and above all define negotiation and planning processes. In this regard, both the Paris Agreement and the Sustainable Development Goals provide guidance for coping with the major »transformation jungle« confronting many countries. They generate momentum for the global energy transformation, because they represent an important international point of reference and a clear mandate for a global energy transformation toward a renewable energy supply for all. The present analysis also shows that in most cases the sustainability goals can be achieved only if the global energy transformation is successful. This is equally true in the opposite direction, because many of the SDGs can have real effects only in the context of sustainable energy systems. One sentence from the study is central in this regard: »It will be virtually impossible to realize the SDGs without effective climate protection. Conversely, the battle

against climate change can be won only if we manage to steer the world's states onto sustainable development paths«:

To date there has been hardly any explicit discussion of how the phase-out of unsustainable energy systems can be conducted in a socially acceptable way and proceed at the required speed. The SDGs, and in particular the 1.5 °C goal of the Paris Agreement, contain a strong mandate in this regard. The present publication offers a first discussion of possible approaches to this process.

A global energy transformation leading to low-carbon and sustainable energy systems is also extremely important against the background of the question of how sustainable development can be accomplished. The transformation must be planned and implemented in socially just ways – and, above all, as soon as possible. The present study is intended as a contribution to this discussion based on evidence and research.

Manuela Mattheß,
International Energy and Climate Policy
Friedrich-Ebert-Stiftung, January 2017

2. The Perfect Storm or the World in the Face of Economic and Ecological Crises

2.1 Welcome to the Anthropocene

At the end of August 2016, a group of experts at the annual International Geological Congress (IGC) submitted a report that turns a long-cherished paradigm upside down: Previously, the physical and geological limits of our planet were regarded as largely immutable for human life and economies. According to the report, however, it is in the meantime apparent that humanity has become the main driver of geological processes. The environment, the experts argue, is no longer merely the background for human action; rather, it has already become the product of human action, so that the earth has entered a new geological era, the »Anthropocene« (see O'Brien and Selboe 2015).

Humanity is henceforth not only the most important geological factor but it has also »succeeded« in unhinging some of the key parameters of the Earth System to such an extent that human life – or at least human life in prosperity – as we know it today is not possible in the long run. Aside from human-induced climate change, human interventions in natural ecosystems and intensive farming methods in particular have resulted in some of the so-called planetary boundaries already being exceeded (Rockström et al. 2009; see also Figure 1). The situation is especially dramatic, given the current state of our knowledge, in the case of two of a total of nine of these planetary boundaries: (1) the integrity of the biosphere as measured by the dramatic loss of biodiversity, and (2) the biogeochemical material cycles, in particular the nitrogen and phosphorus cycle, both of which are already seriously out of balance (Steffen et al. 2015).

If we look beyond the planetary boundaries, there is also little of a positive nature to report. The Global Environmental Outlook 5 presented by the United Nations Environment Programme (UNEP) in 2012 concluded that significant progress has been achieved in only four of the 90 environmental goals agreed since 1992 (UNEP 2012: xvii).

The fact that climate change, according to Earth System research, is still in a state of uncertainty with an increased risk of crossing the planetary boundaries provides no grounds for complacency; but it is a reason for hope: At any rate, the critical threshold in human-induced climate change has probably not yet been crossed. If this is true, then global warming can still be limited to significantly less than 2 °C, or even to less than 1.5 °C, so that we can avoid exceeding a series of irreversible tipping points in the climate system.[1] Climate change is nevertheless producing dramatic effects – ones which are already being felt today. 2016 marked the highest global mean surface temperature ever measured, surpassing the previous record year 2015 and, prior to that, 2014. By August 2016, there had been no less than 16 consecutive months of record warmth for the globe (NOAA 2016).

There is a wealth of scientific evidence on the current and future physical impacts of climate change (IPCC 2014b). The most important effects are profound changes in precipitation and temperature patterns, an increasing probability and intensity of extreme weather events, and rising sea levels. The probability of super disasters, such as Cyclone Nargis which killed around 140,000 people in Myanmar in 2008, or of an extreme heat wave such as in the summer of 2010 in Russia (56,000 dead), is also rising (MunichRE 2016).

These physical impacts put pressure not only on the natural environment but also on the structures that stabilize the human social fabric. This can be seen from a highly topical example. Kelley et al. (2015) explain how a massive drought in the Middle East contributed to social conflicts between 2007 and 2010 and ultimately to the outbreak of war and the rise of the terror regime of the »Islamic State«. The drought first led to the collapse of agricultural production in the northeastern part of Syria, resulting in a dramatic increase in food prices. In search of work and food, 1.5 million people left their hometowns and moved to the peripheries of the large cities inside the country. These suburbs, marked by high unemployment, poor infrastructure, and rampant crime, proved to be a fertile breeding ground for the riots that eventually plunged the country into civil war (Kelley et al. 2015). This is not to imply that climate change was the

1. Tipping points are thresholds at which a system switches from one state into a completely different state, comparable to a balloon being inflated until it bursts. A series of such points are expected in the Earth System – for example, the irretrievable melting of the ice cap in Greenland and West Antarctica, the desertification of the Amazon rain forest, or the thawing of the permafrost in the tundra. Particularly ominous here is that the above-mentioned tipping points can exacerbate climate change and thus contribute to it becoming uncontrollable.

sole cause of the Syrian crisis. But it certainly contributed to stoking the flames under the pressure cooker in which radicalism and conflict arise (see Sellers 2016).

Even an increase in the global average temperature of less than the 2 °C goal will give rise to potentially dangerous environmental changes. Schleussner et al. (2016) have examined what climatic differences will predictably result from global average warming of 1.5 °C instead of 2 °C and made a comparative juxtaposition of the outcomes. Three results of this study are worth emphasizing:

- A rise in the average global temperature of 1.5 °C will lead to a decrease in the availability of fresh water in the Mediterranean area of nine per cent, a 2 °C rise already to a 17 per cent decrease. Other subtropical regions in Central America and South Africa would be affected in a similar way.

- In the tropics, a substantial decline in crop yields can be expected for important cereals: for wheat, a decline of 9 per cent at 1.5 °C and 16 per cent at 2 °C, for maize, a decline of 3 per cent at 1.5 °C and 6 per cent at 2 °C.

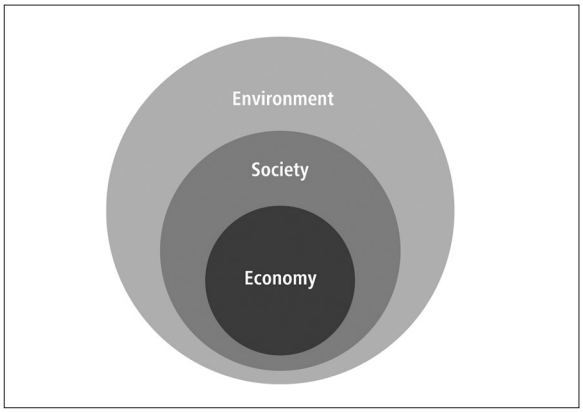
- It is assumed that, with a rise in temperature of 2 °C, almost all coral reefs – which play a key role in marine ecosystems – are exposed to an increased risk of coral bleaching. By the end of the century, this could lead to the destruction of a large portion of the coral reefs worldwide. With warming of 1.5 °C, by contrast, it is assumed that some coral reefs will be able to recover by the end of the century.

2.2 Is the global order spinning out of control?

2.2.1 The global financial and economic crisis

To date, the global economic and social systems have been anything but sustainable. By sustainability here is meant the possibility that human and other life can flourish permanently, hence that it can develop in positive ways (see Ehrenfeld 2012: 3). A positive development is ensured by three nested systems (see Figure 1): the economic system provides the material foundation for the social system, and the social system always depends in turn on the environmental system in which human society is embedded. Sustainability is achieved only when the interactions between all three levels do not impair the developmental foundations of each in the long run (Göpel 2016).

Figure 1: Sustainable development in nested systems



Quelle: Göpel 2016: 88

If a change in direction as regards sustainability is to take place, the world must transform the global economic and social systems in fundamental ways (WBGU, 2011; Hermwille 2016). However, the preconditions for such a transformation are extremely difficult. The financial crisis between 2007 and 2010 led to the deepest recession since the 1930s and affected almost all global regions. Although stimulus programs on an unprecedented scale helped to avert a second »Great Depression,« in many global regions the economy has yet to recover fully.

A further aggravating factor is that in many countries – including some countries of the global North – this fiscal response and the collapse in economic performance threw public finances out of balance. Many countries responded to the resulting budget crisis with harsh austerity policies, i. e., by making massive reductions in government spending and dismantling the welfare state. Numerous experts agree that this policy of »small government« is responsible for strengthening nationalist and populist currents in Europe and elsewhere. The logic of a strict governmental austerity policy dictates that priorities must be set on the expenditure side. This enables the increasingly strong parties on the extreme right of the political spectrum in particular to argue with the simple but successful recipe that they want to re-

serve public social benefits for the »native« population and to exclude all migrants, in particular refugees, from the welfare system. From there it is only a small step to a purely ethnonationalist political agenda (Keskinen, Norocel and Jørgensen 2016).

Such ressentiment is exacerbated by the fact that, over the past three decades, there has been a trend toward an increasingly unequal distribution of income in almost all countries in the world. In Europe, the share of gross national income accounted for by the wealthiest 10 per cent of the population has increased between 1980 and 2010 from around 30 to 35 per cent, and in the United States over the same period from approximately 37.5 per cent to 48 per cent. The picture is similar in the most important newly industrializing countries, though it is not as extreme as in the United States (Piketty 2014). The inequality is even starker if we examine financial and other material assets instead of current income. According to a study by Oxfam, in 2016 the eight wealthiest people in the world had more assets than the poorer half of the world's population taken together (Hardoon 2017).

Negative fiscal developments and rising inequality of wealth and income are not the only obstacles to the unprecedented international cooperation that would be required to combat climate change. An addition obstacle is posed by increasingly influential nationalist and protectionist tendencies, perhaps the most dramatic example being the withdrawal of the United Kingdom from the EU. Another example is the Philippine President Duterte who has repeatedly called publicly for lynchings and murders of drug dealers as part of his bloody campaign against drugs in his country. The Philippine government has categorically rejected international criticism of this policy, in particular from the United states, which rides roughshod over human rights, declaring that, if necessary, it would do without US development aid (Reuters 2016). The election of Donald Trump as President of the United States also suggests that the continuation of the trend toward globalization, and the associated focus of international diplomacy on cooperation rather than conflict, cannot be taken for granted. During the election campaign, Trump declared his intention to withdraw from the Paris climate protection agreement and to end all cooperation on international climate protection. Initial analyses suggest that the new American president could paralyze the international process through blocking tactics and thereby contributed decisively to ensuring that the 2 °C limit can never be met (Hermwille und Obergassel 2016).

Military conflicts with global geopolitical implication are also hindering the required international cooperation. The Russian annexation of Crimea, the still smoldering conflict in Eastern Ukraine, and the civil war in Syria can be cited as examples. Russia's staunch support for the Assad regime, including by placing Russian troops on the ground, is counterbalanced by American support for some rebel groups. This has long since ceased to be just a matter of combating the so-called Islamic State and has become a conflict with geopolitical repercussions. Thus, in response to the breakdown of negotiations in the Syrian conflict in October 2016, Russia unilaterally suspended the US-Russian agreement on the disposal of weapons grade plutonium. Observers judged that the relationship between Russia and the United States had reached a new low point, the most worrying since the end of the Cold War (see, e. g., Rüesch 2016). Whether the election of Donald Trump will lead to an improvement in the relationship, and what form an improved relationship might take, remains to be seen.

2.2.2 Energy markets on a rollercoaster ride

For some time, global energy markets have become volatile in ways never seen before. This development was triggered by a phase of very high oil prices on the world market, culminating shortly before the global financial crisis began in a new all-time record high of around 130 US dollars per barrel, making investments in new production facilities highly lucrative. For the first time, it also became profitable to extract oil from so-called unconventional deposits – for example, from tar sands in the Canadian province of Alberta or from deep-sea deposits off the coast of Brazil – and to extract shale oil, and in particular shale gas, in the United States. This boom even went so far that companies such as Shell made plans to explore oil fields in the Arctic Ocean, something which, ironically enough, was first made possible by the fact that the pack ice in the Arctic has melted dramatically as a result of climate change.

The large-scale extraction of oil and gas from unconventional sources has led to a significant shift in market conditions. This can be seen most clearly from the role

of the United States. Until about 2008, the United States was one of the largest importers of crude oil (around ten million barrels per day). Since then, especially as a result of the use of shale oil reserves and efficiency gains on the demand side, it has been able to reduce its imports by more than 30 per cent.

The developments in the US electricity market have been even more dramatic. The extraction of shale gas was so inexpensive and rose so sharply in just a few years that a large proportion of power generation from coal became economically unviable. In the period from 2005 to 2015, the share of coal in US power production declined from just under 50 per cent to around one third (EIA 2016; see Figure 2).

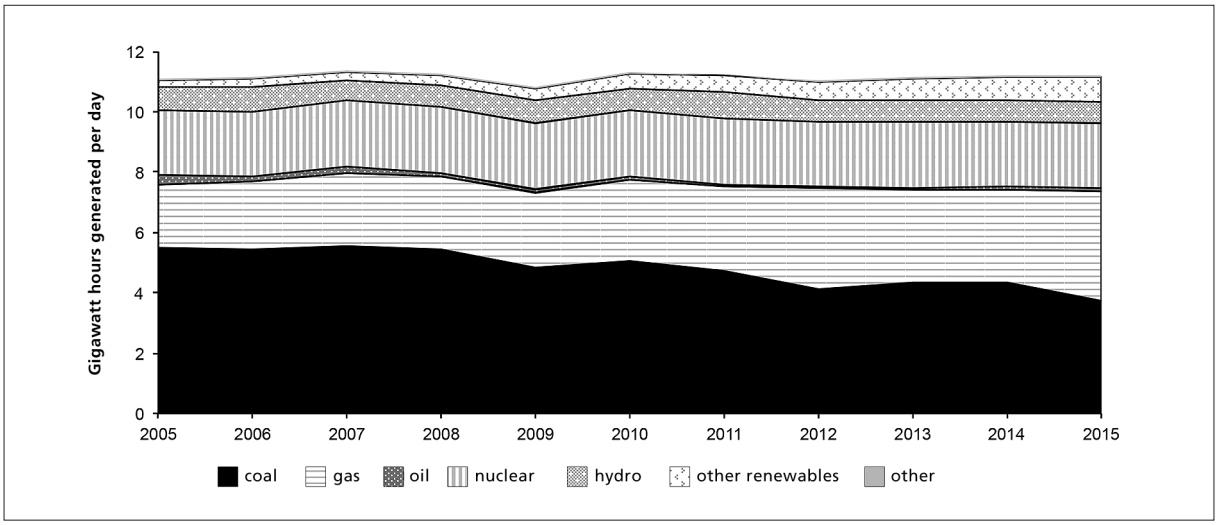
But with the collapse of the international financial markets and the ensuing global recession, commodity prices fell once again. The price of crude oil went into an unprecedented downward spiral, reaching a new all-time low in February 2016. Naturally enough, this development of prices was not without consequences. In the United States, a series of oil companies, in particular smaller ones, had to apply for bankruptcy.

The collapse of the price of oil had especially dramatic consequences for countries such as Venezuela and Nigeria which derive a large share of their public revenues from the oil business. Since the collapse of the price, Russia, which had accumulated formidable foreign exchange reserves during the boom years, has also had to face a massive budget deficit and is now living off these reserves. Even countries like Saudi Arabia and the United Arab Emirates were forced to impose substantial cuts on their populations. Government energy subsidies were slashed and taxes increased to compensate for the losses in revenue from the oil business.

From oil giant to energy-multinational

The state-owned Saudi oil production company Saudi Aramco is considered to be the most valuable company in the world. Over the past decade, it has developed into an oil multinational, among other things through the acquisition of a large number of refineries throughout the world. In Spring 2016, the Saudi Government announced an even more far-reaching shift in strategy. As Saudi Deputy Crown Prince Mohammed bin Salman envisions it, the previously state-owned company will be listed for the first time on the free capital market and opened up for international investment. Furthermore, the company will diversify strongly and become a technology leader in all matters relating to

Figure 2: Electricity generation in the USA according to energy sources (2005-2015)



Source: author's account based on EIA 2016

energy. In this context, now for the first time Saudi Arabia has also set itself an aggressive target for expanding renewable energy: 9.5 gigawatts (GW) of renewable energy capacity will be installed by 2030. The goal of this »Vision 2030« is to make the Saudi state largely independent of oil production.

The global market for steam coal has also become highly volatile. The boom in shale gas in the United States has led, as already mentioned, to the almost complete decline of domestic coal-fired power generation. When they were no longer able to sell their product on the domestic market, some American coal producers rushed into the world market, so that prices began to fall there as well. As a result, a series of companies in the coal and electricity sectors had to file for bankruptcy. Among those hit was Energy Future Holdings, the largest power producer in the State of Texas with an asset value of over 36 billion US dollars. This development reached a provisional climax in April 2016 when Peabody Energy, the largest coal mining company in the world, had to file for bankruptcy protection in its home market. While President Obama had contributed to this development with his Clean Power Plan, one of Donald Trump's key campaign promises was to bring about a renaissance of coal in the United States. At present, however, it seems quite unlikely that he will be able to deliver on this promise given the changed economic conditions, especially the competition from ever cheaper sources of renewable energy (Hermwille and Obergassel 2016).

Taken together, these developments in recent years mean that energy companies have lost their traditional role as heavyweights among publicly listed companies.

Change in strategy: German utilities liberate new business models from the ballast of the fossil fuel past

In Europe as well, and especially in Germany, some major energy providers have encountered economic difficulties. With the expansion of renewable energy, the capacity utilization of fossil fuel-fired power plants decreased. Another reason for the collapse in the revenues of the providers is that at midday, when experience shows that the demand for electricity is at its highest, photovoltaic facilities deliver large amounts of power. In the past, top prices could be commanded for conventional electricity at midday on the power exchanges. But the more solar power plants that are added to the grid, the less likely it is that such top prices can be commanded for energy from fossil sources. Another reason why the big four Germany energy companies are doing so badly is that they were very slow to respond to the energy transition and were very late to enter the business in renewable energy. As a result, the two largest companies, E.ON and RWE, have decided to make a radical strategic reversal. Both corporations have split off the traditional fossil energy business (including nuclear power plants) from their more recent business models in the areas of renewable energy and energy services. The aim is to free the innovative business from ballast and thereby take better advantage of the growth potential.

2.2.3 The global energy transformation is gathering speed

While the development of prices on the coal, oil, and gas markets in recent years resembled the ups and downs of a rollercoaster ride, the price development of energy from renewable sources pointed in a single direction – sharply downwards. In recent years, wind power and especially photovoltaic power have not only become steadily cheaper, but in some locations are by now the most cost-effective way of generating electricity. In future the cheapest electricity ever produced will come from Abu Dhabi where a major solar project was the winner in an auction and will produce electricity for 2.4 cents (US dollars) per kilowatt hour (Bloomberg 2016). Wind power in Morocco is similarly cheap at around three cents (US dollars) per kilowatt hour (CleanTechnica 2016).

In Germany, the cost of producing electricity from photovoltaic facilities decreased between 2005 and 2014 from around 40 cents to nine cents per kilowatt hour. At

the better locations, the prices are already even below this level. It can be assumed that this price development will continue in the coming years. Even conservative estimates converge on rates of four to six cents per kilowatt hour in 2025 and of two to four cents per kilowatt hour in 2050 (Fraunhofer ISE 2015; see also IRENA 2016).

Against this background, a turning point seems to have been reached: In 2015 investments in renewable energy in the electricity sector (265.8 billion US dollars) were more than double the global investments in conventional coal and gas-fired plants (130 billion US dollars), and that is not even including large hydropower plants. 2015 counts as a record year for energy from renewable sources not only in this regard. If heat production is included, for example, no less than 285.9 billion US dollars were invested in this sector, hence five per cent more than in 2011, the previous record year. With 118 GW, the installed capacity also exceeded the previous record (94 GW) by a considerable margin. These records are particularly striking when viewed against the backdrop of the dramatic collapse in the price for coal, oil, and gas, because low prices for fossil fuels could have been expected to strengthen their ability to compete with energy from renewable sources (Frankfurt School-UNEP Center and BNEF 2016).

It is also striking that for the first time investments in renewable energy in developing countries exceeded those in industrial countries. China apart, India, Brazil, South Africa, and Chile are now among the top ten countries when it comes to investment in renewable energy sources (Frankfurt School-UNEP Center und BNEF 2016). An unexpected picture also emerges when expenditures on renewable energy are correlated with a country's gross domestic product (GDP). In this statistic, the following countries are at the forefront: 1. Mauritania, 2. Honduras, 3. Uruguay, 4. Morocco, 5. Jamaica (REN21 2016: 21).

This seems to indicate that the trend reversal is complete. Yet, this is insufficient to address climate change given the gigantic scale of existing non-renewal capacities. Still only around 10 per cent of global energy consumption is met by modern renewable energy sources, even if they already represent 24 per cent of the electricity sector (REN21 2016: 32). Yet coal-fired power generation has also increased steadily in recent years. In the fast-growing Asian economies, in particular, economic growth has gone hand in hand with increasing hunger for energy, which the local governments could often satisfy the fastest with coal-fired power stations (Steckel, Edenhofer, and Jakob 2015). Coal is still relatively cheap and low risk from a financial perspective, and hence easy to finance. Even if the currently existing and planned coal-fired plants were to be deployed in accordance with their technical lifespans, that alone would swallow up almost half of the carbon budget still at our disposal if global warming is to be limited to less than 2 °C with some certainty (Edenhofer, Flachsland, and Kornek 2016).

2.3 The transformation is unavoidable

When we speak of the »great transformation«, the question can no longer be: Do we want this transformation or not? Climate change will transform the world's economic and social systems whether we like it or not. All that remains is decide whether the impending transformation is the result of a moderated, cooperative, and reflexive process or of unchecked climate change accompanied by chaos and disasters. One thing is certain, however: the time for »business as usual« is past.

Although initial progress toward a sustainable system geared to renewable energy sources can be discerned – in the field of energy, at least – climate change still poses a formidable challenge for humanity. Although the technological capabilities for meeting this challenge are already available in the form of low-cost electricity from wind, hydropower, and solar power (even allowing that research is still needed on detailed questions), they have not yet been consistently implemented (Michael Liebreich, quoted in Freedman 2016). This is essentially due to path dependencies entrenched over decades – in the description of Unruh (2000; 2002), »carbon lock-in« – that are a matter not only of the technological infrastructure, but also of organizations, society, norms, and laws, as well as the mode of government regulation. This means in concrete terms that until now the expansion of energy from renewable sources has taken place largely in economically and/or politically created niches, without significantly challenging the *»Techno-Institutional Complex«* (Unruh 2000: 817) as such.

But that is now changing in some countries, among them Germany where the energy transition has entered a phase in which the expansion of renewable energy sources is »threatening« the foundations of the existing

energy system. Because the existing business models of the large energy providers are no longer working, political power struggles are taking place between representatives of the fossil energy industry and heavy industry, on the one hand, and the proponents of renewable energy, on the other. The industrial union for mining, chemicals and energy workers, IG Bergbau, Chemie, Energie (IG BCE), for example, has proposed delaying the energy transition: If Germany is to maintain its status as a location for high-performance industry, it argues, the phase-out of coal, oil and gas can begin only when the question of how electricity from renewable sources can be stored has been answered. But there is no shortage of research in the field of storage technologies. In Germany, funding for research on energy storage increased almost tenfold between 2007 and 2014, when it reached around 30 billion euro (IEA 2016). What is in fact lacking, on the contrary, is implementation. Only the use of storage technologies on a large scale will lead to a substantial drop in prices. A clear roadmap for phasing out coal could have created corresponding incentives here.

These kinds of conflicts are destined to increase dramatically in future, because far-reaching changes such as the radical transformation of our energy systems inevitably produce losers as well as winners. Consider the following example: According to studies by McGlade and Ekins (2015), the 2 °C limit can be met only if one third of the world's currently known and economically recoverable gas reserves, one half of its oil reserves, and even over 80 per cent of global coal reserves remain in the ground. This is true even assuming that technology for carbon capture and storage (CCS) becomes available within a realistic timeframe. But the economic equivalents of these reserves are already listed in the books of the companies that hold the production rights for the reserves in question. It is obvious that the question »Which country and which companies should forgo what share of the income they considered to be secure?« is bound to lead to fierce distribution battles. Even if these conflicts are successfully moderated, phasing out the extraction and use of fossil fuels remains an formidable economic, political, and social challenge for countries and regions that have large reserves of fossil raw materials and are specialized in exploiting them. The transformation will force these countries to change how they create economic values and to convert their industrial structures to other raw materials and other product paths and business models. If the global energy transformation is to succeed, therefore, it requires governance processes at all policy levels, hence political processes to control and shape transformative change. Thus far, however, a comprehensive vision of a sustainable and climate-friendly society in all of its complexity has been lacking. Although many of the individual components are known from sustainability research – including the technical components of a sustainable energy system – merging the existing puzzle pieces into a coherent and functioning whole, into a sustainable vision, and then realizing them represents a key transformational challenge. Normative concepts need to be developed, negotiated, disseminated, and legitimized which strike a balance between the environmental, economic, and social aspects of the energy transformation.

Governance processes are also needed because the transformation must be accompanied by continuous reflection. The question of whether the transformation is taking a just course and is headed in the right direction has to be continually reassessed, because social, and possibly also individual, values and schemes of evaluation will inevitably undergo repeated shifts in the course of the transformation.

Last but not least, governance processes are needed because every process of change entails adjustments. It is first and foremost a political challenge to moderate the speed of the changes in ways that, on the one hand, take climate policy imperatives into account and, on the other, make possible adjustments to break down resistance and contain reactionary movements which, if the measures taken are too abrupt, prevent a continuous and socially acceptable transformation (Polanyi 1978).

2.4 Justice dimensions of the global energy transformation

Unchecked climate change pays no heed to justice. On the contrary, it often hits those the hardest who are in any case disadvantaged – geographically or socially or in terms of their age – and who can do little or nothing to defend themselves against it.

Geographically speaking, it is the countries of the global South that are primarily affected by climate change. These are the least developed countries in the world, mainly African countries, as well as many small island states. The impacts of weather-related disasters are al-

ready being felt most strongly in these countries (see Table 1), which at the same time have contributed the least to climate change.

Within societies it is in turn the poorest and most vulnerable who suffer the most from the effects of climate change. For example, procuring drinking water is generally the task of women and children, who spend on average up to six hours per day on this alone. In places where droughts will become more frequent, longer, and more intense in future, this enormous expenditure of time will increase still further and come at the expense of educational opportunities, for example. Another example of an unfair distribution of the costs of climate change is unequal access to financial services and insurance. In many places, underprivileged sections of the population have only limited access to such services and hence are often unable to protect themselves against losses caused by extreme weather events.

Last but not least, climate change also has a strong temporal justice component. Although the effects of climate change can already be felt painfully, in future they will certainly become even greater. That would be true even if humanity immediately stopped emitting greenhouse gases, because the Earth System is very slow to respond. The volume of greenhouse gases released into the atmosphere by human beings over the past 200 years will certainly lead to long-term warming of a further 0.6 °C (in addition to the already measurable +0.9 °C since the beginning of industrialization). This value already presupposes that reforestation or technical procedures will succeed in re-absorbing greenhouse gases from the atmosphere. On the other hand, should this not occur, global warming of around 1.5 °C is pre-programmed. In this respect, unchecked climate change hits those hardest who were born recently or who have not yet been born.

Yet even if the transformation is successfully steered toward sustainability, a range of issues of justice remain to be solved. Given the limited overall ability of the atmosphere and the Earth System to absorb CO_2 and other greenhouse gases, the 2 °C target raises the question of how the remaining carbon budget should be divided up among the states (WBGU 2009). The fundamental guiding principle for this question in international climate negotiations is that of *common but differentiated responsibility*, though it remains controversial what form this differentiation would take. Some countries have suggested that the sole determining factor should be states' historical responsibility for climate change, hence the sum of all of a country's historical emissions since the beginning of industrialization. Other approaches propose that a pathway towards

Table 1: The ten countries in the world hardest hit by weather-related disasters between 1995 and 2014 (annual averages)

Rank (previous year)	Country	Climate Risk Index Score	Death toll	Death per 100 000 inhabitants	Total losses in million US-Dollar (PPP)	Losses per unit GDP in %	Number of events (total 1995-2014)
1 (1)	Honduras	11.33	302.75	4.41	570.35	2.23	73
2 (2)	Myanmar	14.17	7 137.20	14.75	1 140.29	0.74	41
3 (3)	Haiti	17.83	252.65	2.76	223.29	1.55	63
4 (5)	Philippines	19.00	927.00	1.10	2 757.30	0.68	337
4 (4)	Nicaragua	19.00	162.30	2.97	227.18	1.23	51
6 (6)	Bangladesh	22.67	725.75	0.52	2 438.33	0.86	222
7 (7)	Vietnam	27.17	361.30	0.44	2 205.98	0.70	225
8 (10)	Pakistan	31.17	487.40	0.32	3 931.40	0.70	143
9 (11)	Thailand	32.33	164.20	0.25	7 480.76	1.05	217
10 (9)	Guatemala	32.50	83.35	0.66	407.76	0.50	88

Source: Kreft et al. 2015

convergence of global per capita emissions should serve as a basis for differentiation (Höhne, den Elzen and Weiss 2006). Last but not least, there are approaches that locate responsibility, not at national level, but instead at the level of income and hence also want to make affluent sections of the population in very poor countries liable (Baer et al. 2008) and calculating national obligations as if they were the aggregated obligations of individuals, the framework treats every global citizen identically, and allocates obligations even to poor countries that are proportional to their actual middle-class and wealthy populations. When coupled to a trajectory of rapid emissions reductions (for example, 80 per cent reduction below 1990 levels by 2050.

A successful sustainability transformation will also give rise to challenges for justice within societies. Thus, the exploitation of fossil raw materials it is often concentrated in certain regions. An ambitious climate protection policy aimed at decarbonizing the global economic system that would lead to a halt in the extraction of fossil raw materials is often perceived as an existential threat by the corresponding regions. The people and companies in these regions see themselves as the losers of climate protection.

The just transition approach of the labor unions

The International Trade Union Confederation (ITUC) has set itself ambitious climate protection targets. Against the background of the 2 °C limit, and even the 1.5 °C target, the ITUC calls for global emissions to be reduced to zero as soon as possible and by 2070 at the latest (ITUC 2016). The times are past, it declares, when climate protection was decried as a job killer. Instead, the overwhelming majority of climate protection policies have a positive net effect on employment. A total of up to 60 million new jobs could even be created by these policies. Therefore, the ITUC does not see any contradiction between climate protection and good work. On the contrary: »There are no jobs on a dead planet« (ITUC 2016: 3).

At the same time, the trade union approach emphasizes that millions of workers and their families continue to earn their living in sectors that are heavily dependent on the production and consumption of coal, oil, and gas. In the past, processes of economic structural change often took chaotic forms, so that the workers and their families bore the brunt of the change. Therefore, the definition of a just transition refers to a transformation that maximizes the positive side effects of climate protection on the path leading to a climate-friendly and resilient economy while minimizing the negative impacts on workers and their families and communities (ITUC 2015).

Important strategies in this connection include:

- research on and early assessment of the impacts of climate policy on society and on employment;
- serious investments made with the involvement of all those affected, while respecting human rights and worker rights and the principles of decent work;
- initial and further (re-)training of affected workers; and
- social protection and active labor market policy, in particular plans for local economic diversification that support decent work and the stability of the community during the transformation.

A global energy transformation can also have positive effects when it comes to aspects of justice. For example, 1.2 billion people across the planet are still without access to electricity. In addition there are a further 1.5 billion people who use traditional biomass for their daily needs, for instance for cooking (IEA 2015b; IEA 2015a). If these people could be supplied with electricity from renewable sources, their quality of life would increase dramatically.

The questions of justice outlined here will feature centrally in political conflicts over what form the global energy transformation will take. The next chapter, therefore, will examine whether and how the two central agreements at the international level – the Agenda 2030 for sustainable development with the Sustainable Development Goals and the Paris Agreement under the UN Framework Convention on Climate Change – provide a framework and approaches for solving these issues.

3. The New Political Framework – The Sustainable Development Goals and the Paris Climate Agreement

2015 was a stand-out year for international cooperation. What made it so exceptional was that two international agreements were concluded that will shape environmental policy throughout the world over the coming years and decades. In September, the UN General Assembly, in the presence of over 150 heads of state and government, adopted the agenda for development and sustainability until 2030. At its center are 17 goals, the Sustainable Development Goals (SDGs), which are in turn concretized in a total of 169 targets. The SDGs apply universally for the first time and over the next 15 years will set the agenda for sustainability and development policy not only in the global South but also in the industrialized world.

The second breakthrough of multilateralism was the Paris climate protection agreement (Paris Agreement). As recently as 2009, the first attempt at the Copenhagen climate summit to reach a comprehensive climate protection agreement that finally also commits the United States and the fast-growing newly industrializing countries to climate protection was a resounding failure. Six years later, following protracted negotiations, such an agreement was successfully reached. In the Paris Agreement, in contrast to its predecessor, the Kyoto Protocol, all states, and not only the developed countries, made a commitment to formulate climate protection goals – the so-called nationally determined contributions (NDCs) – and to take measures to implement them. From 2020 onwards, the signatories will update their NDCs every five years. Therefore, the Paris Agreement lays down in advance a continuous, long-term, and binding framework for international climate policy.

In the following summary of the results of these two achievements of international diplomacy, I will analyze whether and to what extent they can contribute to the governance of an equitable global energy transformation.

3.1 The Paris Agreement as a pacemaker of climate policy

In Paris, following 25 years of climate diplomacy within the UN framework, an internationally binding treaty that obligates all countries in the world to take measures to protect the climate was concluded for the first time. After the failure of the climate negotiations in Copenhagen in 2009, some observers had feared that this would mean the end of serious multilateral efforts to mitigate climate change. The success of the Paris negotiations now demonstrates the contrary: The countries of the world are still capable of engaging in international cooperation despite all adverse circumstances.

Whether the Paris Agreement can also be judged a success as regards its content depends heavily on one's perspective. If climate change is understood narrowly as a purely environmental problem, then the Paris Agreement clearly falls short. Those who understand climate change first and foremost as a development problem, as a struggle for »atmospheric space for economic development,« also cannot fail to be disappointed by Paris. The agreement avoids any form of central allocation of emission rights or assignment of reduction obligations, leaving this instead up to the contracting states. A balancing or even transfer between developed and developing countries in accordance with a jointly agreed »justice formula,« as was repeatedly demanded by many observers and even by some developing countries, is not foreseen (Hermwille 2016; Obergassel et al. 2015; Obergassel et al. 2016b).

But would such consequences have even been realistic? In evaluating the results achieved in Paris we should keep in mind that international negotiations and international diplomacy do not take place in a vacuum and that the positions of the negotiation partners are essentially shaped by the political reality in their respective countries. On the international stage, therefore, it is virtually impossible to make decisions that go far beyond what has already been resolved in the capital cities of the world, or at least what is within the realm of political feasibility (Hermwille et al. 2015; Sterk and Hermwille 2013). In spite of this, international climate policy is not superfluous, because the international negotiations are a key driver of political processes at the national level. In other words, without progress at the national level, there will not be any progress on the international stage; but without the international process and the public attention it generates, there would probably be substantially less progress at the national level.

So what contribution can the new climate agreement actually make to shaping the great transformation within the global community more actively and to pre-

venting it from becoming a process driven by disasters? Six elements of the Paris Agreement can contribute to this:

- The Paris Agreement ensures that the multilateral negotiation process remains an arena in which those involved can collaborate in mutual trust and in a spirit of cooperation.

- With its 1.5 °C/2 °C long-term goal, it formulates a shared vision, if not as a clear target, then at least as a rough direction in which to move.

- It defines a political process with a shared agenda and a concrete timetable.

- It mobilized (with certain qualifications) means to implement adopted measures.

- It creates transparency to make necessary information available, establish trust, and enable reflexivity.

- And it creates a way of dealing with the undesirable effects of the other transformation, the one driven by environmental disasters, and hence with the unavoidable losses and damages caused by anthropogenic climate change.

In the following sections, these six elements will be discussed in greater detail.

3.1.1 The comeback of multilateralism in the battle against climate change

The disastrous failure of the Copenhagen climate negotiations in 2009 enduringly shook confidence in international negotiation processes. The French foreign minister at the time and subsequent president of the Paris Climate Change Conference, Laurent Fabius, captured this mood concisely in 2015: »[I]f, today, we were so misfortunate as to fail, how could we rebuild hope? Confidence in the very ability of the concert of nations to make progress on climate issues would be forever shaken.« (Fabius 2015)

That it proved possible to avert a complete loss of confidence in the negotiating process and to restore lost confidence at least in part, was due to three aspects: (1) The French presidency of the negotiations, together with the UN Climate Change Secretariat, did a great job in preparing the conference and guided the negotiations in an outstanding manner (Dimitrov 2016). (2) The »High Ambition Coalition« – a new coalition under the chairmanship of the Marshall Islands (advanced decisively by its Foreign Minister, Tony de Brum) comprising the small island states particularly affected by climate change and the group of the least developed countries,[2] as well as the EU, Japan, the United states, Brazil, Canada, and Switzerland – made decisive efforts to ensure that in Paris the states would not be content with the usual lowest common denominator. (3) The contracting states managed to adopt an agreement that for the first time calls on all nations to engage in climate protection – taking into account their respective preconditions for development. In this way, the deep gulf separating developed and developing countries, which in the past hindered climate negotiations, could be bridged.

3.1.2 The normative vision: the long-term goal of climate policy

The Paris Agreement formulated the goal of limiting the increase in average global temperatures to substantially less than 2 °C, and if possible even to 1.5 °C, above the pre-industrial level, because this significantly reduces the risks and impacts of climate change (UNFCCC 2015, Paris Agreement, Art. 2). This goal of limiting global warming to 1.5 °C, instead of just to 2 °C, as previously, in addition to representing a quantitative intensification of the previous target, also expresses a new qualitative interpretation of the ultimate objective of the Framework Convention on Climate Change. The stated aim of the Framework Convention is to avoid dangerous anthropogenic climate change. The new formulation in the Paris Agreement admits of only one interpretation: there is no »comfort zone« – any global warming is dangerous.

2. Within the UN framework there is an official list of the least developed countries (LDCs). The criteria for inclusion in this list are low per capita income, low values for indicators on nutrition, health, education and literacy, and national economic vulnerability. In 2016, the LDCs comprised: Afghanistan, Angola, Equatorial Guinea, Ethiopia, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Democratic Republic of Congo, Djibouti, Eritrea, Gambia, Guinea, Guinea-Bissau, Yemen, Cambodia, Kiribati, Comoros, Laos, Lesotho, Liberia, Madagascar, Malawi, Mauritania, Mozambique, Myanmar, Nepal, Niger, East Timor, Rwanda, Solomon Islands, Zambia, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, Sudan, South Sudan, Tanzania, Togo, Chad, Tuvalu, Uganda, Vanuatu, and Central African Republic.

Furthermore, the signatories have made a pledge to achieve a »balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century« (UNFCCC 2015, Paris Agreement, Art. 4). Other formulations could probably have provided even stronger normative practical orientation for states, as well as for private companies. For example, achieving complete decarbonization by a particular date had been mooted at times during the negotiations. However, it would not have been possible to achieve a political consensus on such a formulation. Although a concrete date for decarbonization would probably have been more effective as a norm in virtue of its clarity, the formulation chosen goes even further from a scientific point of view, because it covers not only CO_2 emissions, but also other greenhouse gases and, in particular, the absorption of greenhouse gases by natural sinks or the loss of this absorption capacity as a result of unsustainable land use. Therefore, Paris sends a clear message: the era of coal, oil, and gas is over!

3.1.3 A pacemaker for climate policy

The Paris Agreement obligates the states to define and communicate national climate protection goals, the so-called nationally determined contributions (NDCs). However, it does not formally obligate the states to meet these targets. This lack of binding force is intended to be offset through a cleverly drafted transparency mechanism, which is supposed to ensure in other ways that the climate protection goals will also be implemented. Mandatory transparency and review procedures give rise to a significant reputational risk for states that fail to translate their promises into actions. A first global stocktake will be conducted already in 2018. Thereafter the agreement stipulates that this will be repeated every five years, thereby ensuring that political perception will be focused at repeated intervals. In addition, the states have pledged that every future NDC must go beyond the goals achieved up to that point (UNFCCC 2015, Paris Agreement, Art. 4.3). With this, the Paris Agreement includes a mechanism that functions like a ratchet: it goes forward, but not backward, making it impossible to fall back behind climate protection pledges once they have been made.

Another advantage of the Paris Agreement is that it is not time-limited. With this long-term perspective, it will hopefully ensure that national policies and investment decisions are brought into harmony with the long-term goals of the agreement. The states are called upon to draw up long-term plans to achieve climate-friendly development or to develop climate-friendly economic systems. These long-term plans could help to ensure that climate protection plays a role in all other government decisions as well.

3.1.4 Financing climate protection

The statements on financial questions are one of the weaknesses of the Paris Agreement. The agreement itself does not include any formal obligations to increase the scale of climate financing. The accompanying decisions of the Conference of the Parties (COP) to the Framework Convention on Climate Change merely state that the funding target from Copenhagen – 100 billion US dollars annually from developed and developing countries from 2020 onwards – is still valid. A new collective funding target is then supposed to be established by 2025. The only success from the perspective of developing countries is that the 100 billion US dollars, which was previously understood as a maximum upper limit, is now deemed to be the lower limit.

3.1.5 Transparency

The Paris Agreement created a universally applicable transparency system for the first time in the history of the Framework Convention on Climate Change. Previously, developed and developing countries were subject to different reporting and verification systems. The innovation now requires the developing countries to provide much more detailed information than previously about their climate protection efforts. The industrialized countries are called upon in turn to document in far greater detail how and on what scale they provide (financial) support to developing countries. A further innovation is that now for the first time *adaptation* to climate change, in addition to climate change *mitigation,* is also subject to the transparency mechanism. The results will be collated every five years in so-called global stocktakes (i. e., international performance reports), thereby establishing whether the contracting states are individually and collectively on track to achieving the long-term goals.

When it comes to reporting, the devil is in the details. And the details will be negotiated only in the coming years as part of the small print to the Paris Agreement. Initial discussions on contents were conducted at the climate conference in Marrakesh in November 2016. However, the main decisions taken there were procedural ones: the entire set of rules is supposed to be negotiated by the time the next climate conference is held in 2018 and to be adopted there as a package (Obergassel et al. 2016a).

3.1.6 How to deal with the other transformation?

If the world does not manage to shape the transformation in sustainable ways, it can expect a transformation driven by environmental disasters. Yet, even in the most favorable case, such disasters cannot be avoided entirely. Therefore, ways must be found to cope with the effects of this »other« transformation.

Many developing countries agreed to the Paris Agreement because it finally took into account two of the demands that they have been pressing for years. Firstly, the status of the theme of adaptation to climate change was enhanced significantly. Synchronically with the five-year climate protection cycles in the area of reduction, adaptation measures will now be reviewed and, if necessary, strengthened. Secondly, the Paris Agreement acknowledges that it will not be possible to avert or to adapt to all effects of climate change. Climate-related losses and damage are unavoidable in spite of all transformation efforts. This topic was one of the sticking points in the negotiations. The developing countries wanted to establish the concept of loss and damage as a stand-alone article in the agreement. However, the industrialized countries feared that liability and compensation claims could be derived from this. Ultimately, both positions were taken into account: Loss and damage is a separate part of the Paris Agreement, but the accompanying decisions explicitly exclude any resulting liability and compensation claims.

In Marrakech, the topic of loss and damage was once again on the agenda and it will remain relevant beyond the international climate negotiations. In Germany, for example, a first public trial began in November 2016 in which an activist from Peru is suing the German energy group RWE on the grounds that his home town of Huaraz is being threatened by a flood disaster resulting from a lagoon filled with melt water (Germanwatch 2016). His demand is that RWE should participate in the adaptation costs incurred by his local community in proportion to its approximately 0.5 per cent share in causing cumulative global greenhouse gases. In all probability, such legal actions will become more frequent occurrences in future.

3.1.7 Dawn of a new climate policy paradigm?

The climate protection objectives announced thus far by the states are not sufficient to set the world on a path of development compatible with limiting global warming to substantially less than 2 °C, let alone to 1.5 °C. Even if the existing non-binding pledges were to be fulfilled completely, the result would probably still be warming of between 2.7 and 3.5 °C by the end of the century (Fawcett et al. 2015; UNFCCC 2016). Critical voices among researchers have pointed with concern to the growing disjunction between the collective goal and the individual national targets (Geden 2016). But it is striking that this inconsistency has also been explicitly underscored by the contracting states themselves in the accompanying COP decisions (UNFCCC 2015, para. 17).

The question is whether the Paris Agreement provides a solid basis for the international governance process required to accomplish the great transformation. Does it ensure a sufficiently high level of inclusiveness to avoid the hitherto prevailing collision course and to facilitate genuine cooperation on the climate? Will it lead to the long-term realization that the great transformation calls for political coordination by the global community? And will it ultimately provide the political decision-makers at all levels with the necessary support to make the right decisions to realize a truly sustainable global community? The principles stated in the preamble of the Paris Agreement at any rate represent a promising starting point. There references are made to fundamental human rights: the right to healthcare, the rights of indigenous peoples, local communities, migrants, children, people with disabilities, and especially vulnerable people, the right to development, and the right to gender equality. In addition, the just transition approach has found its way into the preamble (see box, p. 13.) and as a result is elevated to a conceptual guiding principle at the international level as well.

At the present point in time, therefore – which, admittedly, is far too early for a final assessment – it seems as though the Paris Agreement does indeed create quite a good basis for genuine cooperation on climate change. Moreover, Paris is not the end of the road, but only the starting point on a long journey. The first steps taken after Paris are also promising: contrary to all prognoses, the Paris Agreement was able to come into force already less than a year after its adoption. In the case of the Kyoto Protocol, by comparison, the required national ratification by at least 55 states with joint responsibility for at least 55 per cent of global emissions took almost eight years. Evidently, the states continue to stand behind the Paris Agreement. But only after 2020, when the contributions to climate mitigation take effect, will it become apparent whether they will also devote themselves with the same élan to implementation and are willing to intensify their efforts step by step to close the gap between what is physically required and what is politically possible.

It is also striking that the Paris Agreement has proved to be quite resilient against the default of the United States as a progressive partner in international climate policy made probable by the victory of Donald Trump in the US presidential election. Donald Trump's election initially left the delegates at the Marrakesh climate conference in a state of shock. However, this shock gave way relatively quickly to a defiant response – in the sense that the contracting states reaffirmed their commitment to the Paris Agreement and their intent to implement the agreement »now more than ever.« Whether they will also manage to do this in the face of an active blocking tactic on the part of the US Government remains to be seen (Hermwille and Obergassel 2016).

Summing up, it can be stated that the Paris Agreement creates room for policy initiatives. It reformulates the guidelines and objectives of international climate policy and in this respect it provides a frame of reference, also in particular for civil society organizations, to which they can refer in their targeted political work.

3.2 The Agenda 2030 and the Sustainable Development Goals

3.2.1 The negotiation process

The Agenda 2030 for Sustainable Development and the Sustainable Development Goals (SDGs) it contains are the product of what were originally two parallel strands of international negotiations. On the one hand, they can be understood as a continuation and further development of the Millennium Development Goals (MDGs), which, with their 2015 time horizon, were at the center of the international development agenda. On the other hand, they resume discussions and processes begun in the context of the UN Conference on Sustainable Development (Rio+20) in 2012. While the MDGs placed human beings at the center of the political agenda, the Rio+20 conference had a much more inclusive focus on the planet as a whole. The Agenda 2030 for sustainable development and the SDGs make the claim to integrate these two perspectives and thereby to establish a universally valid concept of sustainable development (see Gore 2015).

The mandate for developing the Sustainable Development Goals was one of the key results of the Rio+20 summit. The final document, »The Future We Want,« calls for the creation of an inclusive and transparent intergovernmental process to develop goals for sustainable development that is open to all stakeholders (Chasek et al. 2016). Unlike the MDGs, which were worked out largely behind closed doors by a committee of experts under the supervision of the UN Secretary-General and were in effect presented to the world after the fact as a *fait accompli,* the SDGs were intended to be developed through a joint process. Because the attempt to develop the goals with all 193 states around a single table would probably have been doomed to failure, it was decided to work out the SDGs in an Open Working Group on Sustainable Development Goals (OWG) with a novel composition in 13 meetings held between March 2013 and July 2014.

The mandate for this OWG provided for seats for a total of just 30 states. But because 70 countries wanted to participate in the process, it was agreed that some countries would have to share a seat. With a few exceptions, in each case three countries were merged into a so-called troika. The exceptional thing about this was

that in the process traditional boundaries between negotiating groups from the developed and from the developing countries were also bridged. Thus, for example, Iran, Japan, and Nepal shared a seat. This structure led to a much more dynamic style of negotiation than is usual in other contexts. In the first eight meetings of the OWG, submissions from over 80 experts were heard and inputs from civil society were compiled, among other things by means of a large-scale Internet survey. In the remaining meetings, a draft of 17 SDGs with a total 169 targets was worked out. Although a large number of the objectives also met with criticism, the negotiating process was nevertheless a great success, not least because the innovative negotiation format meant that a joint and universal sense of ownership could be achieved (Chasek et al. 2016).

3.2.2 17 goals for people, planet, prosperity, peace, and partnership

During the negotiations, the greatest difficulties arose when it came to developing a narrative capable of classifying the 17 goals to be agreed upon in the context of both the previous development goals and the impending transformational challenges. This is already reflected in the title of the Agenda: »Transforming Our World: The 2030 Agenda for Sustainable Development.« The preamble to the Agenda 2030 sheds light on additional central points of reference. The SDGs are marked by the five Ps: people, planet, prosperity, peace, and partnership, and have to take these five dimensions into account. With this, the contents of the 17 SDGs staked out a much more extensive terrain than the eight MDGs did previously, since the latter focused exclusively on human development and were aimed first and foremost at the developing countries. The SDGs pick up where the MDGs left off, in particular the points that had not been implemented by 2015, and supplement them with a series of further goals. Worth highlighting here are, for example, SDG 7, which focuses on the role of energy as an essential precondition of sustainable human development, and SDG 10, which for the first time accords priority at the highest political level to distribution issues at the national and international levels.

Whereas the MDGs grouped all environmental aspects in a single goal (MDG 7), the SDGs make much finer differentiations. Thus one SDG is devoted to water use (SDG 6), one to the condition of the atmosphere and the struggle against climate change (SDG 13), one to oceans and marine ecosystems (SDG 14), and one to terrestrial ecosystems (SDG 15).

Aside from their thematic diversification, a specific difference between the SDGs and their predecessors, the MDGs, is their claim to universality. The MDGs were still based on a transfer of resources from industrial to developing countries motivated by charity, humanitarian cosmopolitanism, and recognition of historical responsibility (see Langford 2016: 172). Among the SDGs there are also goals that follow the classical reciprocal approach of the MDGs according to which developing countries make pledges to reduce or increase specific development indicators by a certain percentage, and the developed countries in return provide development aid, forgive debts, bring about trade reforms, and/or agree to technology transfers. But even in the case of these reciprocal SDGs and the associated targets, there are aspects which call for efforts from the developed countries that go beyond providing support services. For example, SDG 2 not only includes targets that are supposed to put an end to world hunger and to ensure that all human beings have sufficient access to nutritious and safe food at all times (SDG 2.1) throughout the world by 2030, but it also calls for the development of sustainable agricultural systems and sustainable food production (SDGs 2.3 and 2.4).

As a result, the distinction between developing and industrial countries is to a large extent annulled, because the SDGs recognize that the world as a whole is confronted with a development task. Even though the starting situations of the states are different, they nevertheless have to travel the long journey leading to the goal of a truly sustainable economy and society together. The developing countries face the challenge of developing in sustainable ways; the industrialized countries have to develop sustainability within their existing structures. In this sense, the Agenda 2030 and the SDGs represent a paradigm shift, because these goals cannot be reached by continuing the previous strategies – namely, expansion of markets, globalization, and liberalization (see Gore 2015; Langford 2016).

The 17 Sustainable Development Goals

1 End poverty in all its forms everywhere.

2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

3 Ensure healthy lives and promote well-being for all at all ages.

4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

5 Achieve gender equality and empower all women and girls.

6 Ensure availability and sustainable management of water and sanitation for all.

7 Ensure access to affordable, reliable, sustainable and modern energy for all.

8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

10 Reduce inequality within and among countries.

11 Make cities and human settlements inclusive, safe, resilient and sustainable.

12 Ensure sustainable consumption and production patterns.

13 Take urgent action to combat climate change and its impacts (acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change).

14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

The downside of the inclusive drafting process of the SDGs tailored to achieving a high level of identification with the goals (ownership) by the states is their complexity. The 17 goals and behind them the 169 targets are anything but »concise and easy to communicate,« to quote the aspiration expressed by the states in the declaration of the Rio+20 Summit (United Nations 2012, para. 247). In fact, one weakness of the SDGs is their almost all-encompassing claim. A shorter list of goals would have made it necessary to set priorities and to focus on certain particularly neglected topics (Langford 2016). Such prioritization is virtually absent from the SDGs; instead, it is left up to the states to formulate their own objectives in the domain of implementation or to set priorities according to their respective national circumstances.

The SDGs have also been criticized on the grounds that only very few goals are actually defined precisely or that specific information about endpoints, timeframes, or benchmarks for their implementation is largely lacking (Stokstad 2015). In target 10.1 for reducing inequality, for example, a concrete timeframe is specified within which the contracting states must achieve an improvement in income distribution; however, the benchmarks for reviewing the process (rate of improvement) and also a concrete goal (what distribution of income should be aimed at?) are missing. Another example is goal 12.2: »By 2030, achieve the sustainable management and

efficient use of natural resources.« This target is also formulated so openly that a clear evaluation and quantification of progress is all but excluded. This criticism bears not only on the formulation of the goals, but also on the statistical indicators selected in the wake of the adoption of SDGs that are supposed to be consulted to verify the goals (Hák, Janoušková and Moldan 2016) a preliminary set of 330 indicators was introduced in March 2015. Some SDGs build on preceding Millennium Development Goals while others incorporate new ideas. A critical review has revealed that indicators of varied quality (in terms of the fulfilment certain criteria).

Measuring progress:
Statistical indicators of the SDGs

In order to be able to check whether the contracting states are actually on their way to achieving the agreed goals at the national and global levels, progress toward achieving the SDGs has to be made measurable. This is not so simple, of course, if the goals themselves do not contain any clear limit or target values. In order not to overtax the political negotiations of the SDGs, the choice of statistical indicators was separated from the political process. Instead, an expert commission composed of representatives from different national and international statistics offices was tasked with working out a set of indicators. This commission identified a total of 241 indicators for the 17 goals and 169 targets. However, nine of these indicators are used for more than one target, so that a total of 229 different indicators were identified. The indicators can be subdivided roughly into five categories (AtKisson Group 2016):

- People: 90 indicators measure the number or proportions of people.
- Finances: 60 indicators measure transfers and payments for various purposes.
- Governance: 38 indicators assess the introduction and/or implementation of laws, plans, and policies.
- Production and consumption: 20 indicators measure energy and material flows of the global economy.
- Environment: 18 indicators measure directly natural or physical factors.

The proposal of the expert commission was adopted by the Economic and Social Council of the United Nations (ECOSOC), so that the indicators are stipulated for the international level. However, the choice of the indicators is not binding for the nation-states, which can set their own priorities and, where appropriate, take additional indicators into account.

3.2.3 Governance and implementation of the SDGs

How will the SDGs be implemented and how will it be ensured that the world is collectively on track for the purposes of the Agenda 2030? When it comes to implementing the SDGs the nation-states play a central role, even though they are not bound by any hard, legally binding obligations. Paragraph 63 of the Declaration to the Agenda 2030 states that: »Cohesive nationally owned sustainable development strategies, supported by integrated national financing frameworks, will be at the heart of our efforts. We reiterate that each country has primary responsibility for its own economic and social development …« (United Nations 2015b, para. 63). In addition, there are no concrete guidelines for implementing the SDGs.

Somewhat more specific, by contrast, are the regulations governing the so-called follow-up and review of the Agenda. Here, too, the procedures for reporting are at the initiative of the countries and are voluntary. The countries are called upon to report regularly and in transparent ways with the involvement of all relevant stakeholders. These reports will then be collated by the so-called high-level political forum on sustainable development, a ministerial council anchored in the Economic and Social Council of the United Nations. Furthermore, there will be annual progress reports by the UN Secretary-General that will build essentially on global indicators

and data from the national statistics offices. Every four years, the high-level political forum is supposed to report to the UN General Assembly and to submit recommendations and guidelines for the further implementation of agenda.

While the reporting processes are relatively clearly formalized, there are no concrete requirements for what the countries should report. In the first place, it remains open whether the states adhere strictly to the international SDGs, their targets, and the associated indicators or whether they define (additional) goals and priorities of their own that would then, where appropriate, be more strongly internalized and integrated with national policies. The strong mandate that the Agenda 2030 grants the nation-states as the central implementers would indeed allow such adjustments and prioritizations (Persson, Weitz and Nilsson 2016).

Another aspect that remains open is whether the states, in their reporting, take their orientation from results (outcome-based reporting), hence emphasize measurable indicators and thus provide essentially statistical reports. An alternative would be to report on the policies and measures implemented (behavior-based reporting). The high level of complexity of the transformational challenge posed by the SDGs makes it all but impossible to reduce progress to individually measurable factors. It seems reasonable, therefore, to combine both approaches, outcome-based and behavior-based reporting (Persson, Weitz and Nilsson 2016).

Like the Paris Agreement, the SDGs are in this respect primarily relevant as an international frame of reference to which national governments, but also civil society actors, can refer when it comes to implementing the transformation. This is underscored by their universal character and the way in which the SDGs were developed and negotiated. However, ensuring that the framework laid down is also respected at all levels is not within the power of an international agreement such as the Agenda 2030. This calls for concerted action at all political levels.

4. The Global Energy Transformation within the New International Framework

4.1 Energy in the SDGs

Access to electricity is an essential factor for almost any form of (sustainable) development. For example, electricity first makes it possible to take advantage of the evening hours for economic activities. Electrical power profoundly changes people's living conditions: health care is improved because treatment conditions are more favorable and medicines can be reliably cooled, and the level of education rises because the evening hours can also be used for learning (IPCC 2012: 721ff.).

In this respect, energy is necessarily central to any development agenda. This is also evident in the SDGs. In the following, I will outline and discuss the connections and interrelationships between the SDGs and a global energy transformation.

4.1.1 SDG 7: Access to affordable, reliable, sustainable, and modern energy

In contrast to the MDGs, the SDGs acknowledge the central role of energy by devoting a separate goal to the topic. A total of five targets are associated with SDG 7, three of which clarify and differentiate the SDG, while the two remaining deal with implementation and the necessary means for implementation. Overall progress will be measured using six indicators (see Table 2, below).

The aim is that, by 2030, all human beings should have access to affordable, reliable, and modern energy services (SDG 7.1). In 2013, approximately 1.2 billion people throughout the world still had no access to electricity. While the electrification rate in urban areas is now 95 per cent, things look very different in rural areas. Only around 70 per cent of the world's population has access to electricity. The situation is especially dramatic in rural sub-Saharan Africa – there not even one in five has access to electricity. But also in rural India a quarter of the population is it still without access to modern energy (IEA 2015b).

In these rural areas, in particular, decentralized sources of renewable energy represent an opportunity to provide people with electricity even in the most remote corner of a country within a short time and without a costly expansion of power grids. Even before the adoption of the SDGs, the United Nations was working to remedy this deficiency with its campaign Sustainable Energy for All (SE4All).

The synergies between climate mitigation and sustainable development are particularly strong at this point, something which is also made evident by the Africa Renewable Energy Initiative launched at the margin of the climate negotiations, whose goal is to more than double the continent's total power generation capacity by 2030 with the help of renewable energy. The plan is to install a total of 300 GW of renewable energy capacity. Canada, France, Germany, Italy, Japan, the United States, the United Kingdom, the EU, and Sweden have already pledged to mobilize jointly at least 10 billion US dollars to support this initiative.

Table 2 : Statistical indicators for reviewing progress made in the SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

7.1.1	Proportion of population with access to electricity
7.1.2	Proportion of population with primary reliance on clean fuels and technology
7.2.1	Renewable energy share in the total final energy consumption
7.3.1	Energy intensity measured in terms of primary energy and GDP
7.a.1	Mobilized amount of US dollars per year starting in 2020 accountable towards the $100 billion commitment
7.b.1	Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to

Source: author's account based on United Nations 2016

While this first target (ensure universal access) is very clearly defined, the second target – to »substantially increase« the share of renewable energy sources in the global energy mix by 2030 – remains noticeably vaguer. In view of the dynamic development both in the costs of and investments in renewable energy, this target at first sight seems to be something that can be taken for granted, especially since the number of percentage points that the increase must exhibit in order to count as »substantial« is not spelled out in concrete terms. In fact, however, the share of global final energy consumption accounted for by renewable energy has risen only slightly in recent times, namely, from 17.4 per cent in 2000 to 18.1 per cent in 2012 (UN Data 2016). Although there has been a substantial increase in the production of energy from renewable sources, its share of global final energy consumption has remained largely unchanged because over the same period generation from conventional power plants, in particular coal-fired plants, has also increased to the same extent.

Although recently the increase in the share of renewables in the global energy mix has accelerated slightly – data from the REN21 network show a share of 19.2 per cent in 2015 – there can still be no question of »substantial« progress. If such progress is to occur, not only must renewable energy sources be promoted, but limits must also be placed on the growth of fossil fuels and, in some global regions, measures must even be taken to actively phase down the use of oil, gas, and above all coal.

SDG 7.3 calls for a doubling in the rate of increase of energy efficiency by 2030. This can be achieved only if the demand side is transformed as well. The point is that in the energy services demanded in modern societies could be made available with a great deal less energy by exploiting the potentials for the efficient use of energy to the full. This is why energy efficiency is also referred to as »hidden fuel« (IEA 2014a). In almost all sectors there are still enormous untapped savings potentials. Through improved technology and optimal management, 30 per cent of the energy consumed in the industrial sector could be saved, and that more or less for free because many of the measures pay for themselves through the savings in energy costs. In the building sector and in the areas of domestic appliances and lighting, savings of even up to 80 per cent could be achieved (GEA and IIASA 2012).

The specific challenge is that energy efficiency, as hidden fuel, is indeed invisible – saved energy is difficult to record. Efficiency potentials are often embedded in complex technological systems and in many cases steep initial investments are required to realize them. However, the success of the global energy transformation toward a sustainable energy system depends essentially on tapping into these potentials in spite of all the difficulties.

In addition to these substantive targets, SDG 7 also specifies implementation-oriented targets. By 2030, for example, international cooperation should be strengthened to improve access to research and technology in the field of clean energy, in particular renewable energy and energy efficiency, and to promote investment in sustainable energy infrastructure and clean energy technology (SDG 7.a). It is striking that the corresponding indicator is used for both the energy target and the climate target. What will be measured are the flows of money mobilized (US dollars) from 2020 onward. These can be charged against the 100-billion-dollar target for international climate financing. Therefore, there is also a direct statistical link between climate protection and the global energy transformation.

In addition, modern and sustainable energy services are supposed to be made universally available in developing countries by 2030 – in particular, in the least developed countries, in small island states, and in developing countries without access to the sea – through the expansion of modern infrastructure (SDG 7.b).

4.1.2 Further targets with direct or indirect relevance for the global energy transition

Apart from the dedicated energy goal that has direct repercussions for the global energy transformation, there are a series of sustainability goals that are interconnected with the global energy transformation and individual SDGs or targets. On the one hand, a successful energy transformation would have impacts on the attainment of these goals; on the other hand, achieving some of these goals would also affect the way in which a global energy transformation can occur. The following analysis suggests that most of the sustainability goals can be achieved only if the global energy transformation is suc-

cessful, and that, conversely, a successful energy transformation is conceivable only if the sustainability goals are also implemented.

Many of the goals described below could also be implemented with energy from conventional fossil fuels in particular cases and considered only for the respective subsystem. But, given the impacts that this would have on climate change, it is clear that this strategy is a non-starter for the purposes of a sustainable solution for the overall system. When speaking of access to electricity in the following, therefore, this always refers to access to electricity from renewable energy sources.

SDG 1: End poverty

The interconnections between modern energy and human development were already described above (section 4.1). Without access to modern energy it is virtually impossible to escape extreme poverty. Electric lighting first enables many people, for example, to take advantage of the evening hours to achieve an income above the subsistence level by generating extra income through craft activities and the sale of the goods they produce, such as textiles, basketry, toys, and the like. Target 1.4 demands in particular that all people be ensured »access to basic services [and] appropriate new technology« by 2030 (United Nations 2015b: 15). Target 1.5 focuses on the resilience of especially vulnerable populations to climate-related extreme events as well as to other disasters and shocks. Access of to modern energy, and hence also to other modern infrastructure, is central to improving resilience. Examples of increasing resilience through infrastructure are, for example, early warning systems and reliable weather forecasts, which make it easier to plan agricultural activities and help to counteract crop failures with adaptation measures.

SDG 2: End hunger

The connection between SDG 2 and the global energy transformation is similar to the interconnections described in the last paragraph. Considerable increases in agricultural productivity can be accomplished through modern energy and electricity (SDG 2.3). In addition, enormous resources are freed up when women and children no longer need to use their time and labor to collect traditional fuel, but households can use modern energy for cooking. Target 2.a calls, among other things, for investment in rural infrastructure to implement SDG 2. In places that have lacked access to electricity until now and are far removed from central electricity grids, decentralized generating plants based on renewable energy can make a significant contribution to realizing this goal (see section 4.1).

SDG 3: Good health care

Target 3.8 calls for access to quality essential health-care services and medicines. Here, too, the interconnections are obvious: without electricity it is almost impossible to ensure the availability of modern health-care services or to store drugs, and hence to achieve this goal. Conversely, this electricity must be generated from sustainable energy sources to avoid jeopardizing the other development and climate protection goals.

SDG 4: Quality education

For many children and young people, access to education becomes possible only when the availability of modern energy frees up capacities – that is, only when electric lighting makes learning in the evenings possible or modern stoves are present, making it unnecessary to spend hours searching for firewood or other fuel. Conversely, quality education and well-trained skilled workers are a necessary precondition for the success of the energy transformation (Hirsch 2015).

SDG 5: Gender equality

Women can benefit in special ways from access to modern energy, because it makes performing certain tasks traditionally within their area of responsibility much easier and faster. In addition, implementation target 5.b calls specifically for improvements in the use of information and communications technologies to promote the empowerment of women. This goal cannot be achieved universally without a reliable and affordable electricity supply.

SDG 6: Clean water and sanitary facilities

The infrastructure systems water/waste water and energy are closely interrelated. Large amounts of energy are required for wastewater and drinking water treatment (target 6.3). The same holds when it comes to supplying freshwater, especially where, for want of alternatives, this first has to be produced elaborately in seawater desalination plants (target 6.4). Conversely, energy production is in turn highly dependent on the availability of clean water. The connection is evident in the case of hydropower; but all thermal power plants – coal, oil, gas, even nuclear power – also need large amounts of water to generate steam and for cooling. The use of wind power and photovoltaic systems, by contrast, requires no water or negligible amounts of water (e.g., for cleaning the solar panels). In areas where water is extremely scarce, therefore, the use of sun and wind power is particularly attractive.

SDG 8: Good jobs and economic growth

A global energy transformation presents opportunities not only for human development but also for the economy. Already today, more than eight million people are employed in the renewable energy sector. Employment in the renewable sector involves not only high-tech jobs, but also jobs in the construction industry and in the installation or maintenance of plants for which relatively low skills are sufficient, so that they are open to large sectors of the population (REN21 2016).

Here two aspects of SDG 8 merit special emphasis: target 8.4 calls for an improvement in resource efficiency and for decoupling economic growth from environmental degradation. Some industrialized countries have already managed to decouple economic growth from the use of raw materials and energy. In part, however, the production of energy- and resource-intensive goods was merely outsourced to other countries. The fundamental transformational challenge, therefore, is to implement this decoupling on a global scale. Here the electricity sector assumes a pioneering role, because electricity can be imported, and its production outsourced, only to a very limited extent. Thus, the objectives of the SDG 8 cannot be achieved without a global energy transformation.

A particular challenge for the global energy transformation will be how to deal with labor rights (SDG 8.8). Historically, trade unions are particularly strong in the mining and heavy industry sectors. This means, on the one hand, that in some places trade unions oppose ambitious climate change and the energy transformation because they fear that workers' interests will be infringed. On the other hand, workers in the renewable energy sector are generally less well organized, also because the industry is still relatively young. A socially acceptable global energy transformation will be possible only if trade union structures that help to ensure good working conditions also develop in the emerging industries (on this, see also the box on p. 13 above). Even if the net effect of the energy transformation on employment turns out to be balanced or even positive, this must not lead to good jobs in the fossil part of the energy system being replaced by precarious working conditions in the climate-friendly part of the energy industry. Green jobs must also provide good working conditions. These aspects will pose a key challenge for the success of a global energy transformation, especially in the industrialized nations.

SDG 9: Innovation and infrastructure

SDG 9 calls for the development of resilient and climate-friendly infrastructure (SDG 9.1). Needless to say, this includes the energy sector. Beyond that, SDG 9.4 is aimed at upgrading industrial infrastructure in sustainable ways. The extensive decarbonization of emissions-intensive industrial processes can be achieved only by electrifying these processes. This means that procedures based on fossil energy sources have to be progressively replaced by electrochemical or electromechanical procedures – for example, the use of electrolytic processes in iron and steel production or in the chemical industry (Lechtenböhmer et al. 2016).

SDG 9.5 calls for the enhancement of technological capacities and of training and research especially in the poorest developing countries. In many countries, the transformation of the energy sector is not proceeding at full speed also because there is a lack of technical know-how. This is true of basic and applied research, on the one hand, and of the training of craftsmen to install and maintain renewable energy plants, on the other (Hirsch 2015). Here, a global energy transforma-

tion presents an opportunity to increase investment in education and training for fields of work relevant for renewable energy.

SDG 11: Sustainable cities and communities

The proportion of the world's population living in cities will have doubled by 2050. If housing is to remain affordable and the supply of basic services to be ensured (target 11.1), then the urban infrastructure must also increase twofold over the same period. Should the world fail to provide the necessary housing in much more energy-efficient ways than in the past, then the prospects of observing the 2 °C limit, let alone meeting the 1.5 °C target, are extremely poor (WBGU 2016). In future, urban transport systems (target 11.2) will also be increasingly powered by electricity and are therefore an integral part of a global energy transformation.

One of the most daunting problems in the urban setting in many emerging and developing countries is local air pollution (target 11.6). Thus, China's large cities suffer almost continually from extremely high and hazardous exposure to air pollutants, a problem which also has a massively adverse effect on the country's economic development. The direct environmental damage from air pollution for 2011 is estimated to have been five to six per cent of GDP (Watts 2012). The smog was so bad in some places that public life was completely paralyzed for days. The primary cause of this problem is the combustion of coal in old and inefficient power plants and for heating and it is exacerbated by pollutants from the combustion of diesel and gasoline in vehicles. Renewable energy sources can help to remedy this problem, which is one of the main reasons why the Chinese government is promoting their expansion (see Kofler et al. 2014).

As part of the implementation of SDG 11, target 11.b calls for a substantial increase by 2020 in towns and cities that adopt and implement integrated policies and plans »towards inclusion, resource efficiency, mitigation and adaptation to climate change, [and] resilience to disasters« (United Nations 2015b: 22). The sustainable construction and reconstruction of energy infrastructure must be an integral part of these plans and policies.

SDG 12: Responsible consumption and production

In addition to making energy available, the global energy transformation must also aim at its efficient and frugal use both in the production of goods and by consumers. SDG 12 focuses on precisely this aspect. Target 12.6, for example, calls for incentives for companies to introduce sustainable production processes including the sustainable use of energy.

Of outstanding relevance for the global energy transformation is, in addition, implementation target 12.c, which calls for the abolition of inefficient subsidies for fossil fuels. Incredible sums still flow for this purpose worldwide. The International Energy Agency (IEA) estimates that each year around 550 billion US dollars are spend on subsidies for fossil fuels (IEA 2014b). This money distorts prices and provides incentives for wasteful consumption. As long ago as 2009, the G20 countries agreed to abolish such inefficient subsidies. But little has happened to date. On the contrary, vast sums of money continue to be spent through direct payments or tax breaks for the exploration and development of additional fossil reserves. According to a report issued by the organization Oil Change International, 78 billion US dollars are spent on this every year (Bast et al. 2015), in spite of the fact that the available reserves are already sufficient to exceed the 2 °C limit (see chapter 4.2.2). This practice illustrates how inconsistent the actions of many states continue to be and how they frustrate the achievement of their own political goals.

SDG 15: Terrestrial life

There are also direct interconnections between the global energy transformation and SDG 15, especially when one considers the role of biomass and agrofuels. At present, 8.9 per cent of global energy needs are met by the use of traditional biomass, which becomes a problem when the biomass in question is not produced in sustainable ways.

The demand for biomass can be expected to increase still further, because in future fuels produced from vegetable raw materials will become increasingly important. This applies to the aviation industry, for example, where until now technical alternatives to the combustion of liquid fuels have been almost completely lacking. But also

in the power sector, systems based on biogas and biomass are already an important component. A further factor is that a variety of model simulations foresee the use of negative emissions for compliance with the 2 °C limit if there is even a slight delay in pursuing ambitious climate protection (IPCC 2014a). This simply means than that previously emitted CO_2 will be removed from the atmosphere later, something which can be accomplished, for example, through the combustion of sustainably produced biomass in combination with systems for the capture and storage of CO_2 (bio-energy with carbon capture and storage, BECCS).

Each of these technologies, taken in isolation, is highly controversial, the large-scale use of bio-energy first and foremost because it is in competition with the use of the same land for food production. This can lead to conflicts when the demand for biomass for energy production also drives up prices for (basic) foodstuffs. This is a risk factor for achieving SDG 2. A further point of criticism is the use of intensive monocultures for energy crops, which is undesirable for reasons of biodiversity. Objections against carbon capture and storage focus mainly on the question of whether greenhouse gas emissions can actually be stored permanently or whether a considerable portion of the CO_2 stored will not escape again due to leakage. A further consideration is that infrastructure would have to be built on a large scale for transport and storage, with all of the difficulties that such projects entail (Pietzner 2015). It is more than doubtful, therefore, whether combining these two technologies can make a substantial contribution to climate mitigation. If the global energy transformation does not take place quickly enough, however, there could be no alternative to using them if catastrophic climate change is to be avoided. In this respect, the energy transformation can also be interpreted as insurance against future dependence on such controversial technologies.

Target 15.2 specifies that the global deforestation must be brought to a halt already by 2020 and that sustainable forest management must be promoted. This represents a key challenge for the global energy transition, because the use of biomass for energy must be prevented from increasing the pressure for deforestation and from counteracting the goal of sustainability.

SDG 17: Global partnership

The global energy transformation will succeed only if the use of sustainable and climate-friendly technologies spreads far more quickly than at present and if technology is also transferred across borders. Target 17.7 takes up this point and calls for the transfer of environmentally compatible technologies, among them also renewable energy technologies, from industrial to developing countries, and specifically that this should take place on favorable terms that are agreed in advance.

4.2 Energy in international climate protection

4.2.1 The long-term reduction target of the Paris Agreement

The energy sector is essential for climate protection. CO_2 emissions from the use of fossil fuels for energy production and industrial processes account for around two-thirds of global greenhouse gas emissions. The electricity sector already plays a central role, and in future its importance is likely to increase still further because it is foreseeable that a far-reaching energy transformation will be achieved only by extensive electrification of further sectors. This applies, for example, to the transport sector, but also to industry and in some cases to residential heating, and ultimately wherever biomass or biogas cannot be used.

When there is talk of a »decarbonization of global economic systems,« this means first and foremost a decarbonization of the world's power supply. Somewhat surprisingly, the heads of state and government were able to reach an agreement on this formulation at the G7 summit meeting in Elmau in the summer of 2015. This formulation was also wrestled with in Paris, though in vain, for political reasons. A long-term, concrete reduction target proved to be one of the substantive »sticking points« in the negotiations. In the end, an agreement could be reached in a roundabout way on the principle of greenhouse gas neutrality: the aim is »to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century« (UNFCCC 2015, Paris Agreement, Art. 4.1). In substance, however, the different variants of the long-term reduction target are essentially equivalent: The phase-out of coal, oil and gas must begin immediately.

The inclusion of the 1.5 °C target in the Paris Agreement was at least as big a surprise as the mention of decarbonization in the declaration of the G7 states. Although the least developed countries in the world and the small island states had repeatedly insisted on introducing this target in previous negotiations, it had never previously been considered seriously by the most powerful negotiators. The latter had argued that the goal could be achieved, if at all, only by extensive recourse to the ecologically and socially questionable methods of so-called geoengineering, i. e., the large-scale manipulation of the earth's geophysical system. The inclusion of the 1.5 °C target in the Paris Agreement should therefore be understood primarily as an expression of solidarity and as an acknowledgment of the fact that global warming of 2 °C already poses a threat to the very existence of certain countries, including many small island states.

If this expression of solidarity is taken seriously, the pace of the energy transformation must be stepped up even more then would be necessary to observe the 2 °C limit. According to an initial study, for Germany this would mean phasing out lignite and hard coal by 2025 and oil and gas by 2030 (Höhne et al. 2016).

4.2.2 The financial sector, climate protection, and investment in energy infrastructure

Yet another aspect seems to be important for the global energy transformation, albeit less directly so than the long-term reduction target. In Article 2.1c of the Paris Agreement, states have pledged to bring global financial flows into harmony with climate-friendly development that is resilient against climatic changes. This goal is not restricted to financial flows within the framework of international climate finance, but extends to the global financial system as a whole. The financial sector plays an important role in the global transformation, because the need for investment in the coming years will be enormous. Investments totaling around 89 trillion US dollars will be needed in the global infrastructure systems in the areas of urban systems, land use, and energy between 2015 and 2030. Only four trillion US dollars, or less than five per cent of the total sum, would have to be made available to ensure that the investments in infrastructure assume a climate-friendly form (Hansen et al. 2016; New Climate Economy 2014).

These huge investments represent, on the one hand, a tremendous opportunity to set the course for sustainable infrastructure systems in the coming years. On the other hand, investment in infrastructure, because of its long-term nature, also entails the danger of – quite literally – cementing an unsustainable development path, if the rules and incentives for the global financial system are not aligned accordingly.

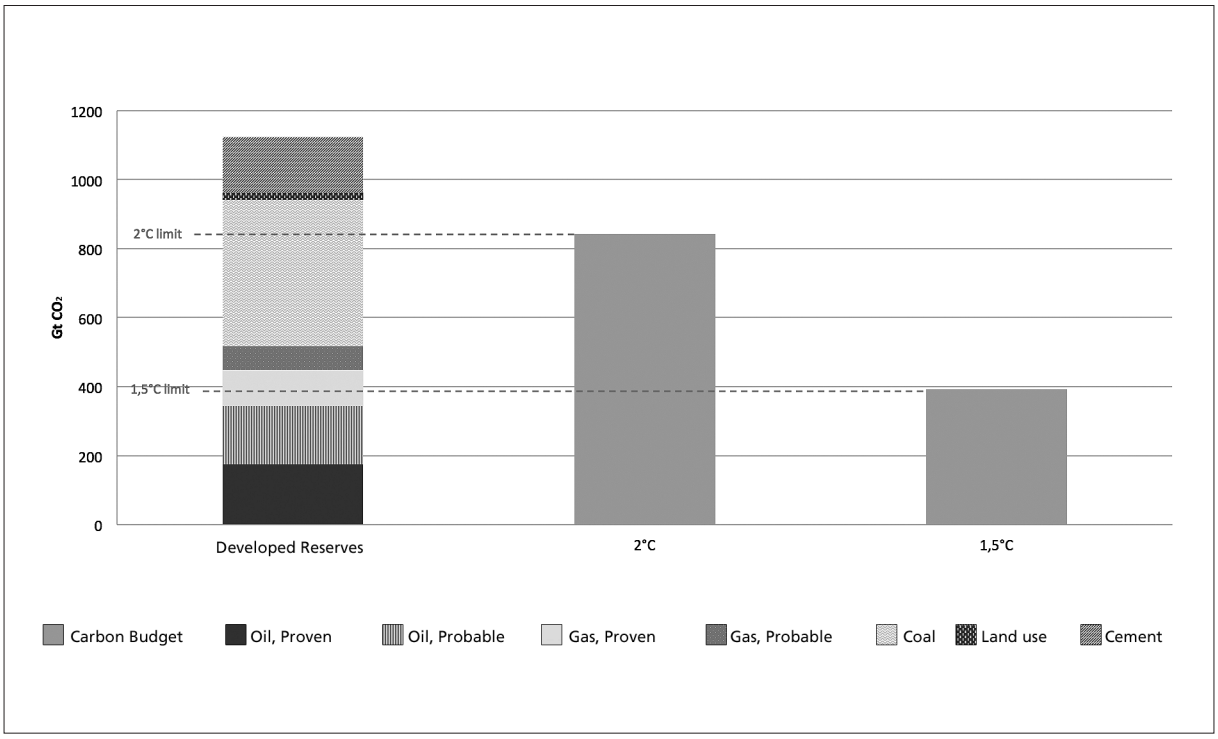
For the energy sector, this means that banks, especially the international development banks, must stop financing infrastructure for fossil fuels as soon as possible. If only the fossil reserves that have already been developed – i. e., all oil and gas fields as well as all coal mines already in production – are fully exploited, the 2 °C limit will be exceeded with a certain degree of probability (Oil Change International 2016, see Figure 3). Any further investment in new mines, pipelines, or other infrastructure is thus incompatible with the goals of the Paris Agreement. The authors of the study cited above put the point trenchantly: »If you're in a hole, stop digging!«

4.2.3 Renewable energy as an object of national climate protection goals

CO_2 is and remains the currency of international climate policy. Energy policy objectives as well as targets for the development of renewable energy sources are therefore almost invariably formulated only as secondary goals or as a means for achieving the greenhouse gas targets. Nevertheless, renewable energy sources feature prominently in almost all national climate protection goals (i. e., the nationally determined contributions, NDCs).[3] In the meantime, 162 NDCs have been submitted to the UNFCCC Secretariat, including the communal NDC of the 28 EU countries. Just 15 of these 162 NDCs fail to mention renewable energy (UNEP DTU 2016). However, among the fifteen countries in whose NDCs renewable energy does not feature at all are the EU, Mexico, and the United States, which have already formulated binding targets for expanding renewable energy in their respective national legal systems. In the case of the EU,

3. In the run-up to the climate conference in Paris, the states were called upon to present their climate protection objectives in the form of so-called intended nationally determined contributions (INDCs). Following Paris, the first countries confirmed these intentions, so that the INDCs became NDCs. The subsequent analysis will ignore this difference for the most part.

Figure 3: Emissions from already developed fossil fuel reserves, together with expected emissions from land use and cement production, in comparison with the remaining carbon budgets for compliance with the 2°C and 1.5°C limits



Source: Oil Change International 2016: 6

this is even explicitly part of an integrated energy and climate package. In addition, countries such as Albania can be found here that are already utilizing renewable energy sources almost exclusively, at least in the electricity sector.

Of the remaining 147 countries, 108 countries declare their intention to expand renewable energy further as part of their reduction strategy, and 75 of them have also quantified this. Eight countries – the Cape Verde Islands, Cook Island, Costa Rica, Fiji, Papua New Guinea, Samoa, Tuvalu, and Vanuatu – even intend to decarbonize their power systems completely already by 2030, and in some cases significantly earlier (see Stephan, Schurig, and Leidreiter 2016).

In any case, the climate protection objectives of China, India and Brazil are of global importance. China intends to increase the share of renewables in its energy mix from 11.2 per cent (2014 level) to at least 20 per cent in 2030. For this purpose alone, China plans to double its wind power capacities to 200 GW and to increase solar energy even 2.5 times to 100 GW (see Stephan, Schurig, and Leidreiter 2016).

Brazil already has a share of about 40 per cent of energy from renewable sources in its total energy consumption (75 per cent in the electricity sector) due in particular to the use of large hydropower plants. It is planned to increase this share further by 2030 by raising the proportion of renewables (excluding hydropower) in the electricity mix to 23 per cent. Together with the existing hydropower capacities, an almost complete decarbonization of the power supply would be achieved as a result (see Stephan, Schurig, and Leidreiter 2016).

India's INDC stands out in the fact that India is one of the few countries that have not only made a binding commitment to a greenhouse gas target in the context of their climate protection goals, but also to an expansion target for renewable energy. The details of India's INDCs are summarized in the box on page 31.

Renewable energy at the center of the climate protection strategy – India's climate protection goal

India is one of the few countries which, in the context of its national climate protection target (INDC) formulated in the run-up to the climate conference in Paris, did not confine itself to specifying a target based on greenhouse gas emissions. India has not only pledged to reduce the greenhouse gas intensity of its economic output (measured in tonnes of CO_2e per GDP unit) by 33 to 35 per cent by 2030 compared to 2005 levels. Complementary to that, India intends to increase the share of power plant capacities based on non-fossil fuels to at least 40 per cent of total generation capacity over the same period. Although it remains open what role renewable energy will play in this plan and what role nuclear power will have, the renewable energy target is already set: By 2022, at least 175 GW of renewable energy capacities are to be installed (100 GW of which will be accounted for by solar energy).

It is noteworthy that the two targets are not coherent. In fact, the energy target is far more aggressive than the intensity target. If the target of 40 per cent non-fossil capacities is actually achieved, it should be possible to reduce the greenhouse gas intensity of the Indian economy not only by 33 to 35 per cent but by 41 to 42 per cent (Climate Action Tracker 2015). The lower target might have something to do with the fact that states often find it easier to formulate positive development objectives than to impose (development) limits on themselves (Sterk and Hermwille 2013).

At any rate, the Indian INDC is not ambitious enough to keep pace with the rapid rise in the demand for energy. The policies and measures already introduced should be largely sufficient to reach both targets. In fact, Indian Prime Minister Modi also indicated in an interview in October 2016 that, with corresponding international support, India could refrain from building additional coal-fired power plants in future altogether (First Post 2016).

4.3 Paris Agreement and SDGs as a normative reference point for (energy) policy

The Paris Agreement and the SDGs initiate paradigm shifts in their respective fields and are complementary: The SDGs set extremely ambitious targets, but they lack binding provisions when it comes to reporting and the possibility of public monitoring of progress. The relevant procedures are scarcely formalized. Although the Paris Agreement also lacks binding national climate protection goals, it contains provisions that the states must at least provide binding reports on how and with what measures they implement climate protection targets. A further feature is that these reports will be subject to an international review. In addition, the five-year cycle of review and the updating or reformulation of the national climate protection goals (NDCs) will lead to repeated moments of concentrated public attention and thus exert pressure on government leaders to make good on their promises to protect the climate.

If both agendas and the corresponding processes can be brought into even greater harmony with each other, considerable synergies could arise. As long as climate protection measures are perceived as an expensive additional cost, no corresponding dynamic can develop. It is therefore important to use the scarce funds of international climate financing to test climate-friendly technologies and practices and to demonstrate that they are attractive in their own right. The best way to achieve this is by prioritizing projects and measures that benefit the climate while also promoting the development goals. Particularly suitable in this regard are rural electrification projects based on decentralized renewable energy sources. One thing is certain, at any rate: It will be virtually impossible to realize the SDGs without effective climate protection. Conversely, the battle against climate change can be won only if we manage to steer the world's states onto sustainable development paths.

A common feature of both agendas is that they establish a new normative consensus that not only justifies a strong mandate for action at the national level, but also legitimizes the activities of non-governmental and subnational actors whose importance is acknowledged in both agendas.

A glance at the details shows how relevant the two agreements are for energy policy. Around two-thirds of

global greenhouse gas emissions are attributable to CO_2 emissions from the use of fossil fuels to produce energy and from industrial processes. The electricity sector is therefore of central importance for climate protection, because there – in contrast to many other areas, such as traffic, agriculture, and many industrial processes – technical solutions for climate friendly alternatives with renewable energy are already available today. Moreover, foreseeable technical solutions in these still immature areas are often based on the electrification of the processes in question, for example, electric vehicles in the transport sector. Thus targets for renewable energy play a central role in the national climate protection goals of the countries. Analysis of the SDGs and of the detailed targets also reveals the central role of sustainable energy. Not only does SDG 7 explicitly formulate the goal of promoting sustainable energy; almost all of the other SDGs have direct or indirect implications for energy policy.

While both agendas refer to the development of sustainable energy infrastructure through the use of renewable energy and to the increase in energy efficiency, therefore, the flip side of the coin remains largely ignored: There is hardly any discussion of how unsustainable energy systems can be phased out in socially acceptable ways and at the required speed. The SDGs and, in particular, the 1.5 °C target of the Paris Agreement include a strong mandate for this withdrawal. The following chapter provides a first discussion of possible approaches to politically shaping this phase-out.

5. Out of the Niche and into the Mainstream – How Can the Step into the Next Phase of the Global Energy Transformation Be Taken?

5.1 A look at the theory: What does a successful transformation require?

Socio-technical transformations can be successful if two things come together: niches for protected development of sustainable alternatives and external pressure on the core of the unsustainable socio-technical regime. The niches are necessary so that innovative technologies and practices can be tested and reach maturity. Such niches can be artificially created, an example being the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) which includes an agreement on a fixed tariff guaranteed for 20 years for electricity from renewable energy sources fed into the national grid. The EEG created a market for wind and solar power in Germany that was large enough to generate important learning effects and to dramatically reduce the costs of the two technologies, in particular of photovoltaic systems. It was only as a result of this policy that the technologies also became interesting for other markets outside of the niche created by the EEG and were finally able to achieve a worldwide breakthrough.

But the creation of socio-technical niches alone is not sufficient to transform the energy system completely. The so-called socio-technical regime must simultaneously be exposed to external pressure. The »socio-technical regime« is the term used in transition research to refer to a complex system involving technical practices, production processes, product features, technical skills, ways of dealing with technology and people, the way in which problems are defined, infrastructures, and the formal and informal rules in which these are embedded (see Rip and Kemp 1998, 338). In short, the socio-technical regime designates what can be described in colloquial terms as the economic and social »mainstream« with its infrastructures, actors, networks, and institutions.

Quite clearly, today one cannot deny the existence of powerful »external influences« (see also section 2.1 above). The consequences of anthropogenic climate change and other environmental changes are already so palpable that they are placing the energy regimes worldwide under enormous pressure to adopt. The Paris Agreement and the SDGs help to translate these external influences into a political language in order to magnify them further in the socio-technical systems of the energy industry.

To this extent, two basic preconditions for the transformation – the dynamic development of alternatives in socio-technical niches and massive external pressure – are fulfilled and the energy transformation seems to be underway. The question is whether these two preconditions are sufficient to achieve the goal of transformation at the required speed and not just at some time in the future.

Transformations in a capitalist economic system are always processes of »creative destruction« (Schumpeter 2003). This means that every innovation, every new product, every new technology, and every new practice will render other products, technologies, and practices obsolete – the old will be replaced by the new. Needless to say, this correlation also holds for a global energy transformation. The stronger the pressure of innovation, the stronger is the resistance that can be expected from established players in the fossil energy industry (Geels 2014; Turnheim and Geels 2012; Turnheim and Geels 2013).

In the past, the political efforts were mainly focused on the creative side of the process. Innovative technologies were promoted and developed to market readiness by creating niches. By contrast, emissions reductions aimed almost exclusively at the demand side. To date there have been hardly any approaches in climate policy that place restrictions on the promotion of fossil energy sources (Lazarus, Erickson, and Tempest 2015).

This must change as a matter of urgency if the global energy transformation is to acquire further momentum. The adoption of the Paris Agreement and SDGs has removed any remaining political doubt that there is no future for the use of fossil fuels. The necessary demise of these industries cannot occur overnight, of course, for that would be a transformational disaster. No less than the creative side, the destructive component of the process of creative destruction has to be politically monitored and controlled so that societal adaptation processes can be shaped in socially just ways for all. Moderating the speed of change processes in ways that, on the one hand, take the imperatives of climate policy into account and, on the other, reduce resistance to changes that

otherwise prevents continuous and socially acceptable transformation is first and foremost a political challenge (Polanyi 1978).

Therefore, achieving a sustainable energy transformation calls for a targeted combination of policies – namely, policies that create socio-technical niches and establish effective systems of innovation. A certain amount has been achieved in this respect over the past decade, though this is far from being the case in all areas and all countries. But policies designed to destabilize the unsustainable practices of the socio-technical regime also need to be developed (see Kivimaa and Kern 2016). As a last step, finally, we need policies that organize the dismantling of the unsustainable system so that it does not collapse and lead to an economic and social disaster.

5.2 Exnovation or how unsustainable technologies and practices can be phased out

What is exnovation? Kimberly (1981) describes exnovation as the last step of an innovation cycle consisting of (1) invention, (2) adoption, (3) use, and (4) exnovation. According to Kimberly, the concept of exnovation goes beyond the mere non-use of a (former) innovation. On the contrary, exnovation involves a conscious decision to phase out a technology or practice, to decommission it, and to withdraw the corresponding resources and use them for other purposes (see Kimberly 1981: 91f.). Thus far, political efforts have focused for the most part on *innovation* as a creative element of the energy transformation understood as a process of creative destruction. The concept of exnovation is now intended to focus attention on the flip side of the coin, the destructive component: »How can we rid the world of what is unsustainable, be it technologies, individual products, practices or institutions?« (Antes, Eisenack, and Fichter 2012: 37; see also Heyen, 2016)

For the global energy transformation, we must ask how exnovation from unsustainable practices such as the use of fossil fuels can be accomplished in socially acceptable ways. What form can the phase-out of coal, oil and gas assume? A series of implicit and explicit exnovation strategies that are available for this purpose will be briefly presented and discussed in what follows.

5.2.1 Wait for technology to become obsolete

No explicit strategy is also a strategy: the focus on innovation and the spread of climate-friendly alternatives, in particular renewable energy sources, implicitly follows the logic that these will eventually render fossil fuels obsolete once prices have fallen far enough. This idea is informed by a superficially plausible economic theory, though one that often proves to be incorrect in practice. In fact, renewable energy sources are already the most cost-effective alternative in many countries and regions, taking into account the total cost over the lifetime of the power plants. This is true at any rate of newly-built plants.[4] But even where renewable energy sources enjoy a price advantage, investments continue to be made in unsustainable technologies.

Perhaps the most glaring example of the fact that one should not rely exclusively on the economic forces of the market when it comes to phasing out complex infrastructure systems that are deeply interwoven into socio-technical systems is the newly planned Hinkley Point C nuclear power station in the United Kingdom. The construction costs for new nuclear reactors are everywhere rising to dizzying heights. In the case of the Finnish reactor Olkiluoto 3, the initial estimated costs when construction began in 2005 were around three billion euros, but in the meantime they have risen to 8.5 billion euros. The costs of the French reactor Flamanville 3 were estimated at 3.3 billion euros at the start of construction in 2007 and by now are also at 8.5 billion euros. As a result, at first no investor could be found to construct the British nuclear reactor. It was only when the British government ensured the future operator a guaranteed feed-in tariff that the French nuclear group EDF was prepared to implement the project. The feed-in tariff roughly follows the familiar financing model for energy from renewable sources. However, the guaranteed price is already more than twice as high as the price paid for wind power. And – in contrast to what is typically agreed in the case of energy from renewable sources – it will not sink over time but, on the contrary, will rise with inflation. It is difficult to comprehend why the British government not only agreed to such a deal, but also even promoted it. One possible answer is that military interests may have played an important role. In their

4. Existing plants generally have an advantage over climate-friendly alternatives because the investment costs have already been incurred and do not have to be taken into account in short-term production decisions.

analysis, Johnstone and Stirling (2015) conclude that the concern of the British government could be to maintain infrastructure and capacities to support the British nuclear submarine fleet.

5.2.2 Carbon price as an accelerator of exnovation

A price for greenhouse gas emissions (i. e., carbon pricing) can be created, for example, through an emissions trading system or via a greenhouse gas tax. An emissions trading system operates in such a way that an upper limit, a so-called cap, is set for greenhouse gas emissions in the economic sectors to be regulated. Within the regulated area, only a limited quantity of emissions rights (or allowances) is issued – namely, just enough to ensure that the stated reduction target is reached. Every company that falls under the emissions trading system has to have an emission permit, i. e., an allowance, for every tonne of CO_2e emitted. Either a portion of the required allowances is allocated to each company free of charge or the companies can acquire the rights from the state at an auction. In addition, the emissions rights can be freely traded, which allows the regulated companies either to purchase additional emissions rights or to sell surplus allowances once the climate protection measures have been successfully implemented. This process leads to a uniform CO_2 price that performs an important signal function. Regulated companies can take the CO_2 price into consideration both when taking short-term management decisions and when making long-term investments. How high the price is depends essentially on how ambitiously the cap for the emissions trading system is fixed and how expensive the implementation of climate protection measures is for the companies.

A greenhouse gas tax imposes a fixed levy on each tonne of CO_2e emitted. Such a tax also sets a price for emissions and thereby sends a signal to the regulated companies to reduce their emissions in the short term and to structure their long-term investments in a climate-friendly way. In contrast to the emissions trading system, however, there is no trade and thus the companies have hardly any flexibility. While an emissions trading system stipulates the absolute amount of emissions, a greenhouse gas tax defines the price of the emissions. Although a tax system ensures a stable CO_2 price, it cannot guarantee that the reduction target set in the regulated sectors will actually be met. The incentive effect depends largely on the tax rate. If this is high, the incentive to avoid greenhouse gas emissions is high as well.

Implementing both approaches in an ambitious way proves to be an extremely difficult political task. Both high taxes and hard emission reduction obligations are opposed by extensive and concerted political lobbying. Within the framework of the EU Emissions Trading System (EU ETS) the support of industry was »bought in« by allocating high shares of certificates free of charge. However, these free allocations distort the incentive structure and at worst can even make polluting technologies particularly lucrative (Neuhoff, Martinez, and Sato 2006; Hermwille, Obergassel, and Arens 2016). Furthermore, a corresponding incentive for exnovation is also so difficult to implement in an emissions trading system because the price cannot be calculated in advance, so that there is a danger that an economically feasible limit will be fixed instead of an ecologically required limit. This can also be seen in the EU ETS. The cap on emissions for the third trading period was set before the full impact of the European financial and economic crisis had been felt. The declared positive forecasts for economic growth in the EU on which the calculation was based duly proved to be wrong; in fact much less was produced, and therefore also less emitted, than expected. The result was a large surplus of certificates in the carbon market, which led in turn to a collapse in the carbon price. This has now remained at such a low level for years that an effective incentive effect can no longer be assumed. The solution to this problem would have been to increase the European emissions reduction goal to be achieved by 2020 and thereby remove some of the surplus certificates from the market. However, this was not politically possible. Evidently, once emissions caps have been decided, they are carved in stone (Sterk and Hermwille 2013).

As an exnovation strategy, carbon pricing is basically similar to the strategy of waiting described above, only that it imposes additional costs on unsustainable technologies. In this way, the moment at which renewable energy sources become financially competitive occurs earlier.

In addition, a greenhouse gas price functions as a signal and can have a psychological effect, because it renders the harmfulness of fossil fuels for the climate visible in a direct way. Therefore, placing a price on greenhouse gas emissions can stigmatize »polluters« and thus accelerate the search for alternatives.

5.2.3 Signal effect of clear time horizons

Both strategies – promoting innovation and waiting, on the one hand, and carbon pricing, on the other – have the disadvantage that they do not formulate a clear time horizon for the phase-out.[5] On the one hand, this creates space for political power struggles and, on the other, provides the companies involved with only an inadequate signal to reorient their innovative power or to look for new business models. Every phase-out of a technology or practice frees up resources that could then be used for climate-friendly alternatives. This can be illustrated by a thought experiment: If the German government were to make a credible decision, for example, to prohibit the sale of automobiles with combustion engines from a certain cut-off date, the automakers would be immediately forced to reorient their research and development departments. Engine development would be shut down or severely decimated during the transitional period and research would suddenly work flat out on alternative powertrains.

In the case of the German automotive industry what is at stake is the industry's core from which it derives its identity, but which cannot have any future when faced with advancing climate change and the consistent implementation of internationally agreed targets. The companies affected face the question of whether they are using their resources to combat the demise of an unsustainable business model or whether they are looking for alternatives and are developing them with full force. An exnovation strategy with a clear time horizon can help to force companies to be forward-looking.

Of course, it is politically difficult to adopt such clear timelines, especially against the opposition of powerful vested interests that naturally want to recoup the maximum revenues from their business models. The simplest approach would be to begin by formulating a time horizon as a guiding principle, for instance in a white paper or as part of a climate protection strategy. Further support could be generated, for example, through regulatory instruments (see below), though this could also provoke stronger political resistance from the affected interest groups. Nevertheless, just formulating a political goal can give rise to a strong signal effect. This can be illustrated by an example from the field of (electric) mobility: From the established goal that the transport sector must be largely greenhouse gas neutral by 2050, one could deduce the goal that from 2030 onwards only cars with electric motors may be sold.[6] This statement is much more concrete than a general reduction target and is therefore likely to generate a stronger signal effect in the automotive sector.

5.2.4 Negotiated consensus on a phase-out

A variant of a phase-out with a clear time horizon and a solid foundation is a negotiated consensus between business and government. An example is the »atomic consensus« that the German federal government concluded in 2000 with the major energy supply companies. Both sides had agreed to allow the use of existing nuclear power plants to run its course and not to build any new reactors. The nuclear phase-out was organized by establishing a residual quantity of electricity corresponding to an average life span of all nuclear reactors of 32 years. It was left up to the operators of the nuclear power plants how to divide up the remaining electricity (around 2.6 million GW hours at the time of the agreement) among the power stations. As a result, there was no fixed overall date by which nuclear power had to be completely phased out, but nevertheless a sufficiently clear agreement.

After the atomic consensus had been agreed between the German Federal Government and the power companies it was also legally enshrined in the form of an amendment to the Atomic Energy Act. That the companies involved made hardly any investments in renewable energy in spite of this consensus was probably because they were secretly hoping, or even assumed, that a subsequent government would revise the consensus and abandon the nuclear phase-out (Heyen 2011). And, in fact, this is exactly what happened in 2010. It was only after the Fukushima nuclear disaster in March 2011 that a society-wide consensus – and not just one between

5. An escalating greenhouse gas tax is conceivable in principle – that is, a fixed predetermined price path could be set directly with the introduction of the taxes that de facto creates a clear time horizon. Issuing an emissions budget just a single time is also conceivable in the case of emissions trading systems. This would also define a clear time horizon. So far, however, these two variants have hardly been implemented.

6. Of course, this deduction is based many assumptions – for example, concerning the contribution of biofuels and synthetic fuels and that these would be used, for instance, to reduce emissions in air and heavy-load vehicle traffic. Whether these assumptions are justified cannot be discussed here. Thus, the stated goal of »no new passenger cars with an internal combustion engine from 2030 onwards« merely serves as an illustration of a possible political goal.

the nuclear industry and the federal government at the time – developed on the phase-out of nuclear power (Hermwille 2015).

An advantage of a consensual model is that a clear time horizon is agreed upon. A disadvantage is that the target sets a difficult political process in motion. The long-established, unsustainable actors often enjoy disproportionate political influence. There is therefore a risk that an agreement will prove to be extremely expensive and thereby give the impression that the unsustainable industries have been »bought out« of the system and thus have even been rewarded for their environmentally destructive or climate-damaging behavior. In fact, there is probably no alternative to agreements involving compensation payments. However, it is important in this context that the funds are expressly used in accordance with a preventive structural policy (see below) to build sustainable structures and are not distributed using the watering can method or as a »pay-off« to those who caused the climate problem.

5.2.5 Exnovation through regulatory measures

Another variant of the exnovation strategies is to increase technical standards by steps, thereby regulating unsustainable technologies »out of existence,« as it were. An example of this approach is the step-by-step withdrawal of inefficient light bulbs from the market in the EU. Research had been conducted for decades on the development of efficient lighting fixtures (initially energy-saving light bulbs, then LEDs), but their adoption for indoor lighting has progressed only very slowly. A variety of entry barriers were too steep, such as the significantly higher investment costs (albeit with lower lifecycle costs compared to ordinary filament lamps). Therefore, the European Commission adopted the approach of defining efficiency classes in its Ecodesign Directive for lighting and setting a timetable within which lamps with low efficiency classes could no longer be produced or imported. The efficiency requirements in the first round were already so demanding that it was not technically possible to fulfill them with high-performance classical filament lamps. The efficiency threshold was raised in steps to such a level that, except for special applications, classical light bulbs have disappeared from the market entirely. Since the beginning of September 2016, the efficiency regulations for lamps are so exacting that even a wide range of different types of halogen lamps may no longer be produced or imported. The Ecodesign Directive does not rely on specific prohibitions, therefore, but nevertheless leads with certainty to the exnovation of inefficient lamps within a clear temporal horizon.[7]

The US Environmental Protection Agency (EPA) is pursuing a similar approach as part of the Clean Air Act, with whose help the United States wants to reach its climate protection goals. The EPA has set limits for emissions of toxic air pollutants (sulfur oxide, nitrogen oxide, and mercury). The standards are so demanding that they can be met by coal-fired power plants only if the industry invests heavily in additional installations to filter and capture these pollutants. In many systems, these retrofits prove to be impossible, either because space is simply lacking or because the economic costs of retrofitting are out of proportion to the revenue from the sale of electricity. Together with the shale gas boom (see section 2.2 above), these standards have led to a sharp decline in coal-fired power generation.

Such regulatory measures can be effective as an exnovation strategy and are particularly attractive when the measures in question are legitimized by existing laws, as in the case of the EPA in the United States. The Clean Air Act was originally adopted in 1963 and extensively amended most recently in 1990. One drawback of such approaches, however, is that they leave the companies little scope to search for efficient ways to implement the corresponding directives.

5.2.6 Divestment

A growing worldwide divestment campaign has been waged for around the past five years. Its objective is to convince as many investors as possible, and in particular institutional investors such as pension funds and university endowment funds, to remove shares in companies that generate a large part of their revenue in the fossil energy industry from their investment portfolios. The intention is to make it more difficult for these companies to raise capital for their unsustainable activities.

7. Amazingly enough, this directive did not meet with large-scale protests, which may also be because the large manufacturers of lighting fixtures had positioned themselves comparatively early with products of their own. The losers of the transformation process were thus simultaneously the winners.

The campaign is based on a very simple argument: If we want to avoid catastrophic climate change, then the capacity of the earth's atmosphere to absorb CO_2 and other greenhouse gases is limited. The remaining carbon budget is much smaller than the known and economically recoverable fossil reserves. If we assume that at some point climate protection is taken seriously, then some companies will not be able to realize the revenues from the extraction of fossil fuels that they have already factored into their revenue calculations, so that they are exposed to a considerable financial risk. The campaign argues that there is a speculative bubble, a so-called carbon bubble, which must eventually burst. That is why it is not only morally, but also financially imperative to exit from investments in fossil fuels.

The divestment campaign has been very successful. By October 2016, 612 institutions had joined the campaign and declared their intention to withdraw from fossil fuels entirely or at least from some of them (especially coal). Perhaps the most prominent examples are:

- the Norwegian sovereign wealth fund, the largest fund of its kind with a volume of almost one trillion US dollars;

- the Rockefeller Foundation, whose assets (similar to that of the Norwegian sovereign wealth fund) were created with oil and gas exploration and production, in spite of which the oil magnate's heirs have decided to restructure their foundation assets;

- the insurance groups AXA and Allianz, which as a first step will sell their stakes in companies in the coal industry (totaling around 500 million US dollars the case of the AXA Group);

- many religious communities and groups have also declared their intention to divest, for example, the Church of England.

Taken together, the 612 institutions and companies manage assets totaling 3.4 trillion US dollars (gofossilfree.org 2016).

The divestment campaign contrasts sharply with the above-described exnovation strategies in that it does not necessarily require a political decision-making process. Nevertheless, there are quite a number of public investors or funds under public control that have also decided to divest from fossil companies. Divestment is not one of the exnovation strategies that actually ensures the success of decarbonization and the phase-out of coal, oil, and gas. But the instrument represents an effective way of initiating the process of exnovation, of increasing the pressure on the socio-technical regime, and if necessary of preparing the ground for more far-reaching decisions.

5.2.7 Preventive structural policy

Phasing out unsustainable practices often has very uneven regional impacts. Even if the energy transition can achieve a positive overall economic balance as a whole (for example, by creating jobs in the fields of renewable energy and energy efficiency, and the like), phasing out coal would have very negative impacts on the affected mining regions and districts where coal-fired power plants, opencast mining operations, and underground mines are located today. The same holds for coal, oil, and gas globally: The extraction areas and the dependent value chains are often restricted to certain regions. Decarbonization and the phase-out of these technologies will lead to especially pronounced economic and social change in these regions. Correspondingly, more far-reaching exnovation strategies can expect to meet with political and social resistance.

Against this background, structural policy measures could help to accompany and support exnovation strategies. The dismantling of emissions-intensive economic practices and branches of industry can be organized in socially acceptable ways especially in regional contexts. For example, compensation can be provided for short-term and medium-term social and economic hardships, while at the same time promoting the development of new economic perspectives.

Thus far, structural policy measures have mainly been remedial in nature and have been organized in the mode of crisis when regional transformation processes were already far advanced. As part of a comprehensive exnovation strategy, however, the phase-out of coal, oil, and gas would have to be planned and executed in a proactive, long-term way and systematic new economic perspectives would have to be developed for the affected regions. This is also the starting point of the just transition approach of the International Trade Union Confederation (see box on p. 13).

6. Conclusions and Recommendations for Political Action

The Paris Agreement and the SDGs provide tailwind, but not blueprints, for the energy transformation. A blueprint could not be reasonably expected, however, and was never on the agenda because there is no simple »solution« for climate protection or for sustainable development. On the contrary, the global community is facing a formidable transformational challenge affecting the foundations of human civilization. That the global energy transformation is a central part of this challenge has finally been acknowledged by the two major international agreements concluded in 2015.

6.1 Three contributions to addressing the global transformational challenge

What can the SDGs and the Paris Agreement contribute to a just and socially acceptable approach to meeting this transformational challenge? The analysis of the two agendas has shown that they make three important contributions to shaping the global energy transformation: They provide certainty concerning the direction of change, they define negotiation and planning processes, and they create room for reflexivity to repeatedly re-examine and re-evaluate the progress of the transformation.

The Paris Agreement and the SDGs each sketch visions of the future that can serve as a reference and a guide for the transformation. The Paris Agreement defines a new long-term goal for climate policy. Global warming of 2 °C above the pre-industrial level is declared to be an absolute upper limit, but the intention is to tailor the ambition of climate protection efforts to the goal of limiting climate change to 1.5 °C. The Paris Agreement also defines how this goal is to be achieved: In the second half of the century, greenhouse gas neutrality – that is, a balance between anthropogenic greenhouse gas emissions and absorption by carbon sinks – must be implemented worldwide. In accordance with the principle of common but differentiated responsibility for climate protection, this means that the industrialized countries must have achieved the decarbonization of their economic and social systems already by the middle of the century. Therefore, the Paris Agreement stipulates in no uncertain terms that the use of climate-damaging fossil energy sources must be abandoned.

The Agenda 2030 with the SDGs formulates a complementary positive vision, as can be seen, among other things, from the claim that no one should be left behind in the development process (United Nations 2015b: 2). The SDGs raise a claim to universal validity and, in 17 targets and 169 targets, define in a highly differentiated, if not always very precise way what has to be accomplished. Our analysis in Chapter 4 above demonstrated that the global energy transformation makes an essential contribution to achieving these goals. This follows explicitly form the energy target (SDG 7) devoted to the transformation, on the other hand, and from the fact that it is implicitly contained as an auxiliary condition in almost all of the other targets, on the other.

The processes foreseen by both agendas also complement each other. Both allow a lot of room for considering national priorities and thus promote national ownership of the climate protection and development plans. Although the procedural guidelines of the Paris Agreement are much clearer in this respect than those of the Agenda 2030, here, too, a large number of details are left open for further negotiations. The Paris Agreement functions like a pacemaker for national and international climate policy. Every five years, the contracting states have to make an inventory and update their climate targets. Hence, public attention will be focused at regular intervals, something which should discipline the contracting states to implement their climate protection plans, while motivating them to gradually increase their climate protection ambitions.

Furthermore, both international treaties offer room for reflexivity, which is welcome insofar as the transformation is not only a matter of converting technological infrastructure but also necessarily of changes in consumption, production patterns, and values. For this reason, the progress of the transformation has to be repeatedly reassessed in the energy sector as well as in all other areas and, if necessary, adapted to changed values. Room for reflexivity is created in the Paris Agreement by the structure of the five-year climate protection cycles, by the review and assessment of the national climate protection efforts by international experts, and by the regular global stocktakes in which the overall progress of the global community will be subjected to close examination. The SDGs also envisage a review process every four years within the framework of the UN General Assembly. Moreover, in contrast to the Paris Agreement,

the development agenda is subject to a time limit. The 2030 time horizon leaves room for adaptation and reorientation for possible subsequent development goals.

It remains to be seen whether the formative power of the two agendas will play out in practice as sketched out in this study at the theoretical level. However, the way in which the two agreements were concluded provides grounds for optimism in this regard. In contrast to the Millennium Development Goals, the SDGs were negotiated in an innovative and highly inclusive process and were adopted correspondingly quickly by the General Assembly. The Paris Agreement was the result of years of negotiations. At the concluding conference in Paris, the diplomatic skill demonstrated by the French handling of the negotiations was such that it managed to annul the putative natural laws of international diplomacy – namely, that negotiations always end in a mediocre compromise on the lowest common denominator. Indeed, in Paris, more was extracted from a mediocre basis for negotiation than even optimistic observers could have hoped for (Obergassel et al., 2015; Obergassel et al., 2016b). This success continued when the Paris Agreement entered into force less than a year later having been ratified by a sufficient number of countries. No one could have predicted this development in Paris either; after all, it had taken the Kyoto Protocol eight years to come into force. The signals from the Marrakesh climate summit are also positive. The contracting states took unambiguous positions and made it clear that even the forty-fifth President of the United States of America will not be able to unravel the consensus recognizing climate change as a transformational challenge. Should the United States turn its back on the transformation, it will primarily harm itself.

Nevertheless, it is clear that the actual transformation still lies before us. The conversion of our infrastructures, business models, and lifestyles has not yet taken place. In this sense, the Paris Agreement and the SDGs are important milestones, but only mark the beginning of the transformation. The internationally agreed goals still have to be implemented at the national level. And, in the case of the Paris Agreement, the national contributions submitted to date are not sufficient to achieve the climate goal as a whole. Figuratively speaking, now is not the time to sit back, but instead to roll up our sleeves.

6.2 The significance of the two agendas for the global energy transformation

How do the Paris Agreement and the SDGs change the framework conditions for the global energy transformation? The Paris Agreement, and the 1.5 °C goal in particular, make completely new demands on the speed of the transformation. If we want to avoid the 1.5 °C goal being reached only through the large-scale use of geoengineering, then the decarbonization of the energy supply system must begin immediately. The SDGs identify the framework conditions for this: We do not need just any restructuring of the energy systems, but one that also helps to achieve the development goals – and that is possible only with energy from renewable sources. The Paris Agreement thus generates a clear mandate for a just global energy transformation toward renewable energy sources; in addition, it represents a reference point to which actors at all political levels can relate and against which the nation-states in particular will have to expect to be measured.

The mandate for renewable energy can already be read off clearly from the national climate protection plans (i. e., the NDCs). Those states that do not explicitly include renewable energy in their plans are in a minority and have often integrated other explicit plans for expanding energy from renewable sources into their national climate policies. This applies, for example, to the EU, the United States, and Mexico.

Buoyed by this tailwind, the global energy transformation is entering a new phase. Transformation processes typically unfold in different phases:

1 During the incubation phase, it becomes apparent that the status quo is untenable in the long run. The unsustainable design of the energy system exhibits initial symptoms.

2 During the initial phase of implementation, new ideas and concepts are perceived and discussed in the system for the first time, but a consensus on the best options has not yet developed. Experimentation continues.

3 During the acceleration phase, technologies reach maturity that hitherto were successful only in market niches and they develop into genuine alternatives to the previously dominant technologies. The speed at which the system changes increases.

4 If the transformation is successful, a new dominant system develops during the stabilization phase. The energy transition is complete.

These phases fit well with a famous quotation from Mahatma Gandhi: »First they ignore you [1], then they laugh at you [2], then they fight you [3], then you win [4]« (Mersmann and Wehnert 2014: 34). The phase of ignoring came to an end at the latest with the Kyoto Protocol. According to this model the world currently finds itself in transition from the second to the third phase: Renewable energy sources have long since shrugged off the status of »new options« and are already established in many places. The phase of ridicule and denial – both that there is a climate problem and that alternatives are available – also seems to be coming to an end. With the Paris Agreement and the SDGs, the challenges of climate change have gained international recognition and solutions are at least being sketched out. In some countries the energy transformation is even a stage further on and is entering the phase in which technical, social, and economic conflicts with the existing system and distribution battles are beginning. If these conflicts are to be conducted in just ways, not only are innovation and the development and expansion of alternatives necessary, but now even more so also the planning and execution of the phase-out of unsustainable technologies and practices: Proactive exnovation policy is required.

6.3 Principles of a proactive exnovation policy

There is no doubt that the global energy transformation toward renewable energy and energy efficiency is indispensable and will certainly have a positive economic overall effect by comparison with the catastrophic consequences of unchecked climate change. But it is equally certain that it will not only produce winners. There will also be losers, especially where the fossil energy economy makes a major contribution to regional value creation. Active exnovation policy means that these losers must not be abandoned to the forces of the market – for two reasons: Firstly, the global energy transformation can be successful and sustainable in all dimensions in the long run only if it does not lead to social turmoil. The maxim of the Agenda 2030 – »No one may be left behind« – applies here as well. Secondly, a proactive approach to exnovation can help to moderate the speed of the transformation of society as a whole, to reduce resistance, and hence to ensure the continuity of the energy transformation. What speed is appropriate is a profoundly political question (see Polanyi 1978).

In Chapter 5, I identified initial exnovation strategies. The key insight is that no strategy is also a strategy, but probably the worst of all. If the phase-out of unsustainable technologies and practices is simply left up to market forces, this process will in all likelihood not be fast enough to keep pace with the imperatives of climate policy. Moreover, the danger of economic and social hardship is increasing.

In our view, the focus on carbon prices is not a sufficient strategy either (Gawel, Strunz, and Lehmann 2014; Hermwille, Obergassel, and Arens 2016). Although, economically speaking, a global carbon price is an elegant solution that could certainly accelerate the phase-out of coal, oil, and gas, in practice this idea has proved to be vulnerable to political pressure. The European Emission Trading Scheme (EU ETS) is the best example of this. Because the financial and economic crisis could not be foreseen when the caps on emissions were fixed, the EU ETS created a glut of surplus emissions rights. As a result, the carbon price decreased dramatically and has now been so low for years that there no longer seems to be a serious incentive effect (Morris 2013). Nevertheless, it was not possible to raise the emission reductions target to effectively remove the surplus of certificates from the market and restore an effective carbon price.

In our view, the optimal exnovation strategy would fix a clear end date for the use of unsustainable technologies. The first German atomic consensus negotiated in 2000 provides a precedent for this which could also be applied to other cases. Such an instrument should always be accompanied by preventive structural policy measures, such as are also envisaged by the just transition approach of the International Trade Union Confederation. Where negative effects of the transformation are concentrated, investments must be made at an early stage in the initial and further training of the affected workers and in diversifying the regional economic systems.

As long as such a combined exnovation strategy is not yet politically feasible, divestment campaigns can also be an effective means of accelerating the energy transformation. Such campaigns do not depend on political decisions at the highest level, and can also be organized decentrally by civil society actors.

6.4 Next steps

The transformation of the energy systems has been gaining momentum around the world in recent years. The Paris Agreement and the Agenda 2030 coincide with the beginning of a new phase in the global energy transformation. However, the progress of the transformation is not self-perpetuating. If the next phases of the energy transformation are to be shaped by politics and not merely the result of largely uncontrolled economic processes, the first step must be to focus also on the less pleasant side of the process of creative destruction. Exnovation of unsustainable technologies and practices must be placed on the national and international political agenda. In the context of the global energy transformation, the phase-out of coal-fired energy generation is the first item on the agenda, because coal is the fossil fuel that causes the greatest damage to the climate. The proportion of economically recoverable coal reserves that must remain beneath the ground in order to limit global warming to significantly less than 2 °C is still much greater than in the case of oil and gas (McGlade and Ekins 2015).

But exnovation strategies still require a lot of research. Numerous questions need to be answered: What dynamics shape exnovation processes? Who exactly are the losers? What political and sociocultural barriers exist? What concrete forms do exnovation strategies take? And what possibilities exist for international cooperation? What kinds of support could be offered to developing countries if they actually agreed to phase out coal?

The global energy transformation has been set in motion. However, it remains a major challenge. It can even be assumed that this challenge will become greater if political conflicts also increasingly take center stage. It is already becoming clearer that the transformation will not only have winners, but also losers. Only if we manage to dismantle unsustainable structures in an orderly way will it be possible to distribute the negative impacts fairly. Creating socially acceptable transitions will be central to this process, because only then can the global energy transformation assume an equitable form. The world is at the very beginning of this task. The Paris Agreement and the SDGs send a clear start signal and provide orientation and certainty concerning the direction of change for this side of the transformation as well.

References

Antes, Ralf, Klaus Eisenack and Klaus Fichter (2012): »Wirtschaftswissenschaftliche Ansätze zur Gestaltung von Wandlungsprozessen«. *Ökologisches Wirtschaften* 27 (3): 35.

AtKisson Group (2016): »The SDG Indicators: What are we Measuring?« http://atkisson.com/analysis-of-the-sdg-indicators/.

Baer, Paul, Glenn Fieldman, Tom Athanasiou and Sivan Kartha (2008): »Greenhouse Development Rights: towards an equitable framework for global climate policy«. *Cambridge Review of International Affairs* 21 (4): 649–69. doi:10.1080/09557570802453050.

Bast, Elizabeth, Alex Doukas, Sam Pickard, Laurie van der Burg and Shelagh Whitley (2015): *Empty Promises – G20 Subsidies to Oil Gas and Coal Production.* London and Washington, DC: Overseas Development Institute / Oil Change International.

Bloomberg (2016): »Cheapest Solar on Record Offered as Abu Dhabi Expands Renewables«. *Bloomberg.com,* https://www.bloomberg.com/news/articles/2016-09-19/cheapest-solar-on-record-said-to-be-offered-for-abu-dhabi.

Chasek, Pamela S., Lynn M. Wagner, Faye Leone, Ana-Maria Lebada and Nathalie Risse (2016): »Getting to 2030: Negotiating the Post-2015 Sustainable Development Agenda«. *Review of European, Comparative & International Environmental Law* 25 (1): 5–14. doi:10.1111/reel.12149.

CleanTechnica (2016): »New Low For Wind Energy Costs: Morocco Tender Averages $US30/MWh«. *CleanTechnica.com.* Januar 18. https://cleantechnica.com/2016/01/18/new-low-for-wind-energy-costs-morocco-tender-averages-us30mwh/.

Climate Action Tracker (2015): »Tracking INDCs«. http://climateactiontracker.org/indcs.html.

Dimitrov, Radoslav S. (2016): 'The Paris Agreement on Climate Change: Behind Closed Doors'. *Global Environmental Politics* 16 (3): 1–11. doi:10.1162/GLEP_a_00361.

Edenhofer, Ottmar, Christian Flachsland and Ulrike Kornek (2016): »Koordinierte CO_2-Preise: zur Weiterentwicklung des Pariser Abkommens«. In *Unter 2 Grad? – Was der Weltklimavertrag wirklich bringt*, edited by Jörg Sommer and Michael Müller, 69–78. Stuttgart: Hirzel Verlag.

Ehrenfeld, John R. (2012): 'Sustainability: An Emergent Property of the Web of Life'. Florence: Global Systems Dynamics & Policy. http://www.gsdp.eu/uploads/tx_conturttnews/Ehrenfeld_-_Sustainability_-_An_emergent_property_of_the_web_of_life.pdf.

EIA (2016): »Short-Term Energy Outlook«. U.S. Energy Information Administration (EIA). https://www.eia.gov/forecasts/steo/query/index.cfm?periodType=MONTHLY&startYear=2005&endYear=2017&formulas=x112x3x7x4x25x8.

Fabius, Laurent (2015): »COP21 – Plenary session for the submission of the final draft text«, gehalten auf der UNFCCC – COP21, Paris, December 12. http://www.diplomatie.gouv.fr/en/french-foreign-policy/climate/events/article/cop21-plenary-session-for-the-submission-of-the-final-draft-text-speech-by.

Fawcett, Allen A., Gokul C. Iyer, Leon E. Clarke, James A. Edmonds, Nathan E. Hultman, Haewon C. McJeon, Joeri Rogelj et al. (2015): »Can Paris pledges avert severe climate change?« *Science* 350 (6265): 1168–1169.

First Post (2016): »Watch: PM Modi talks to David Letterman about climate change and clean energy«. http://www.firstpost.com/bollywood/watch-pm-modi-talks-to-david-letterman-about-climate-change-and-clean-energy-3040804.html.

Frankfurt School – UNEP Centre and BNEF (2016): »Global Trends in Renewable Energy Investment 2016«. Frankfurt am Main: FS-UNEP Collaborating Centre for Climate & Sustainable Energy Finance / Bloomberg New Energy Finance (BNEF). http://fs-unep-centre.org/publications/global-trends-renewable-energy-investment-2016.

Fraunhofer ISE (2015): »Current and Future Cost of Photovoltaics. Long-term Scenarios for Market Development, System Prices and LCOE of Utility-Scale PV Systems.« Freiburg: Fraunhofer ISE. http://www.agora-energiewende.de/fileadmin/downloads/publikationen/Studien/PV_Cost_2050/AgoraEnergiewende_Current_and_Future_Cost_of_PV_Feb2015_web.pdf.

Freedman, Andrew (2016): »Hey, Bill Gates, our ‚energy miracles' are already here«. *Mashable.* April 5. http://mashable.com/2016/04/05/gates-renewable-energy-miracle/.

Gawel, Erik, Sebastian Strunz and Paul Lehmann (2014): »A public choice view on the climate and energy policy mix in the EU – How do the emissions trading scheme and support for renewable energies interact?« *Energy Policy* 64 (Januar): 175–182. doi:10.1016/j.enpol.2013.09.008.

GEA and IIASA (2012): *Global Energy Assessment – Toward a Sustainable Future.* Cambridge, United Kingdom; Luxemburg, Austria: Cambridge University Press; International Institute for Applied Systems Analysis. http://www.globalenergyassessment.org/.

Geden, Oliver (2016): »The Paris Agreement and the Inherent Inconsistency of Climate Policymaking: The Paris Agreement and the Inherent Inconsistency of Climate Policymaking«. *Wiley Interdisciplinary Reviews: Climate Change* 7 (6): 790–97. doi:10.1002/wcc.427.

Geels, Frank W (2014): »Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective«. *Theory, Culture & Society* 31 (5): 21–40. doi:10.1177/0263276414531627.

Germanwatch (2016): »Der Fall Huaraz«. https://germanwatch.org/de/der-fall-huaraz?page=1.

gofossilfree.org (2016): »Divestment Commitments«. *Fossil Free.* http://gofossilfree.org/commitments/.

Göpel, Maja (2016): *The Great Mindshift.* Cham: Springer International Publishing. http://link.springer.com/10.1007/978-3-319-43766-8.

Gore, Charles (2015): »The Post-2015 Moment: Towards Sustainable Development Goals and a New Global Development Paradigm«. *Journal of International Development* 27 (6): 717–32. doi:10.1002/jid.3109.

Hák, Tomáš, Svatava Janoušková and Bedřich Moldan (2016): »Sustainable Development Goals: A need for relevant indicators«. *Ecological Indicators* 60 (January): 565–73. doi:10.1016/j.ecolind.2015.08.003.

Hansen, Gerrit, David Eckstein, Lutz Weischer and Christoph Bals (2016): »Shifting the Trillions«. Bonn/Berlin: Germanwatch. http://germanwatch.org/de/download/15891.pdf.

Hardoon, Deborah (2017): An Economy for the 99% – It's time to build a human economy that benefits everyone, not just the privileged few (Oxfam Briefing Paper). Oxford: Oxfam International. Retrieved from https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/bp-economy-for-99-percent-160117-en.pdf.

Hermwille, Lukas (2015): »The Role of Narratives in Socio-Technical transitions – Fukushima and the Energy Regimes of Japan, Germany, and the United Kingdom«. *Energy Research & Social Science 11* (January): 237–46. doi:10.1016/j.erss.2015.11.001.

– (2016): »Climate Change as a Transformation Challenge – A New Climate Policy Paradigm?« *GAIA – Ecological Perspectives for Science and Society* 25 (1): 19–22. doi:10.14512/gaia.25.1.6.

Hermwille, Lukas and Wolfgang Obergassel (2016): »Was bedeutet die Wahl von Donald Trump für die internationale Klimapolitik?« Inbrief 2/2016. Wuppertal: Wuppertal Institut für Klima, Umwelt, Energie. http://wupperinst.org/fa/redaktion/downloads/publications/In_Brief_2016-2.pdf.

Hermwille, Lukas, Wolfgang Obergassel and Christof Arens (2016): »The Transformative Potential of Emissions Trading«. *Carbon Management* 6 (5–6): 261–72. doi:10.1080/17583004.2016.1151552.

Hermwille, Lukas, Wolfgang Obergassel, Hermann E. Ott and Christiane Beuermann (2015): »UNFCCC before and after Paris – What's Necessary for an Effective Climate Regime?« *Climate Policy*, November: 1–21. doi:10.1080/14693062.2015.1115231.

Heyen, Dirk Arne (2011): »Policy Termination durch Aushandlung. Eine Analyse der Ausstiegsregelungen zu Kernenergie und Kohlesubventionen«. *der moderne staat – Zeitschrift für Public Policy, Recht und Management* 4 (1): 149-166. doi:10.3224/dms.v4i1.5146.

– (2016): »Exnovation: Herausforderungen und politische Gestaltungsansätze für den Ausstieg aus nicht-nachhaltigen Strukturen«. Öko-Institut Working Paper 3/2016. Berlin: Öko-Institut. https://www.oeko.de/publikationen/p-details/exnovation-herausforderungen-und-politische-gestaltungsansaetze-fuer-den-ausstieg-aus-nicht-nachhalt/.

Hirsch, Thomas (2015): »Learning from the ‚Energiewende' – What Developing Countries Expect from Germany«. Berlin: Friedrich-Ebert-Stiftung. http://library.fes.de/pdf-files/iez/11304.pdf.

Höhne, Niklas, Michel den Elzen and M Weiss (2006): »Common but differentiated convergence (CDC): a new conceptual approach to long-term climate policy«. *Climate Policy* 6 (2): 181–199.

IEA (2014a): »Energy Efficiency Market Report 2014«. Paris: International Energy Agency. http://www.iea.org/publications/freepublications/publication/EEMR2014.pdf.

– (2014b): »World Energy Outlook – Energy Subsidies«. http://www.worldenergyoutlook.org/resources/energysubsidies/.

– (2015a): »WEO 2015 Biomass Database«. http://www.worldenergyoutlook.org/media/weowebsite/WEO2015Biomassdatabase.xlsx.

– (2015b): »WEO 2015 Energy Access Database«. http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/.

– (2016): »Energy Technolgy RD&D Statistics«. http://stats.oecd.org/BrandedView.aspx?oecd_bv_id=enetech-data-en&doi=data-00488-en.

IPCC (2012): *Special Report: Renewable Energy Sources and Climate Change Mitigation.* Bd. 49. 11. Cambridge. http://www.ipcc.ch/report/srren/.

– (2014a): »Chapter 6 – Assessing Transformation Pathways«. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* 413–510. Cambridge: Cambridge University Press.

– (2014b): *Climate change 2014: Impacts, Adaptation, and Vulnerability.* Intergovernmental Panel on Climate Change.

IRENA (2016): »The Power to Change: Solar and Wind Cost Reduction Potential to 2025«. Bonn: International Renewable Energy Agency. http://www.irena.org/DocumentDownloads/Publications/IRENA_Power_to_Change_2016.pdf.

ITUC (2015): »Climate Justice: There Are No Jobs on a Dead Planet«. Brussels: International Trade Union Confederation. https://www.ituc-csi.org/IMG/pdf/ituc_frontlines_climate_change_report_en.pdf.

– (2016): »Trade Unions' Topline Demands fro COP22«. Brussels: International Trade Union Confederation.

Johnstone, Phil and Andy C Stirling (2015): »Comparing Nuclear Power Trajectories in Germany And the UK: From 'Regimes' to 'Democracies' in Sociotechnical Transitions and Discontinuities«. SPRU Working Paper 2015–18. Brighton: SPRU-Science and Technology Policy Research, University of Sussex. http://www.sussex.ac.uk/spru/documents/2015-18-swps-johnston-stirling.pdf.

Kelley, Colin P., Shahrzad Mohtadi, Mark A. Cane, Richard Seager and Yochanan Kushnir (2015): »Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought«. *Proceedings of the National Academy of Sciences* 112 (11): 3241–46. doi:10.1073/pnas.1421533112.

Keskinen, Suvi, Ov Cristian Norocel and Martin Bak Jørgensen (2016): »The Politics and Policies of Welfare Chauvinism under the Economic Crisis«. *Critical Social Policy,* February, 0261018315624168. doi:10.1177/0261018315624168.

Kimberly, John R. (1981): »Managerial Innovation«. In *Handbook of Organizational Design*, edited by Paul C Nystrom und William H Starbuck, 1, 84–104. Oxford: Oxford University Press.

Kivimaa, Paula und Florian Kern (2016): »Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions«. *Research Policy* 45 (1): 205–17. doi:10.1016/j.respol.2015.09.008.

Kofler, Bärbel, Nina Netzer, Christiane Beuermann, Lukas Hermwille, Jan Burck, Boris Schinke and Franziska Marten (2014): »Voraussetzungen einer globalen Energietransformation«. Berlin: Friedrich Ebert Stiftung.

Kreft, Sönke, David Eckstein, Lukas Dorsch, and Livia Fischer (2015): »Global Climate Risk Index 2016 – Who Suffers Most From Extreme Weather Events?« Bonn: Germanwatch. https://germanwatch.org/de/download/13503.pdf.

Langford, Malcolm (2016): »Lost in Transformation? The Politics of the Sustainable Development Goals«. *Ethics & International Affairs* 30 (02): 167–76. doi:10.1017/S0892679416000058.

Lazarus, Michael, Peter Erickson and Kevin Tempest (2015): »Supply-side climate policy: the road less taken«. SEI Working Paper 2015–13. Seatle: Stockholm Environment Institute. https://www.sei-international.org/publications?pid=2835.

Lechtenböhmer, Stefan, Lars J. Nilsson, Max Åhman and Clemens Schneider (2016): »Decarbonising the Energy Intensive Basic Materials Industry through Electrification – Implications for Future EU Electricity Demand«. *Energy*, August. doi:10.1016/j.energy.2016.07.110.

McGlade, Christophe and Paul Ekins (2015): »The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 °C«. *Nature* 517 (7533): 187–90. doi:10.1038/nature14016.

Mersmann, Florian and Timon Wehnert (2014): »Shifting paradigms: Unpacking transformation for climate action«. Berlin: Wuppertal Institute. https://epub.wupperinst.org/files/5518/5518_Shifting_Paradigms.pdf.

Morris, Damien (2013): »Drifting toward disaster? The ETS adrift in Europe's climate efforts«. London: Sandbag. https://sandbag.org.uk/project/drifting-toward-disaster-the-eu-ets-adrift-in-europes-climate-efforts/.

MunichRE (2016): »NatCatSERVICE«. https://www.munichre.com/en/reinsurance/business/non-life/natcatservice.

Neuhoff, Karsten, Kim Keats Martinez and Misato Sato (2006): »Allocation, incentives and distortions: the impact of EU ETS emissions allowance allocations to the electricity sector«. *Climate Policy* 6 (1): 73–91. doi:10.1080/14693062.2006.9685589.

New Climate Economy (2014): »Better Growth, Better Climate: Synthesis Report«. Washington D.C.: The Global Commission on the Economy and Climate. http://static.newclimateeconomy.report/wp-content/uploads/2014/08/NCE_SynthesisReport.pdf.

NOAA (2016): »Global Analysis – August 2016 | State of the Climate | National Centers for Environmental Information (NCEI)«. https://www.ncdc.noaa.gov/sotc/global/201608#temp.

Obergassel, Wolfgang, Christof Arens, Lukas Hermwille, Nicolas Kreibich, Florian Mersmann, Hermann E. Ott and Hanna Wang-Helmreich (2015): »Phoenix from the ashes: an analysis of the Paris Agreement to the United Nations Framework Convention on Climate Change – Part I«. *Environmental Law and Management* 27: 243–62.

– (2016a): »Good Signs, Bad Signs. An Initial Assessment of the Marrakech Climate Conference«. Wuppertal: Wuppertal Institute for Climate, Environment and Energy. http://wupperinst.org/fa/redaktion/downloads/publications/COP22_First_Assessment_en.pdf.

– (2016b): »Phoenix from the ashes: an analysis of the Paris Agreement to the United Nations Framework Convention on Climate Change – Part II«. *Environmental Law and Management* 28: 3–12.

O'Brien, Karen and Elin Selboe (2015): »Climate Change as an Adaptive Challenge«. In *The Adaptive Challenge of Climate Change*, edited by Karen O'Brien and Elin Selboe, 1. Auflage, 1–23. New York: Cambridge University Press.

Oil Change International (2016): »The Sky's the Limit – Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production«. Washington, DC: Oil Change International. http://priceofoil.org/content/uploads/2016/09/OCI_the_skys_limit_2016_FINAL_2.pdf.

Persson, Åsa, Nina Weitz and Måns Nilsson (2016): »Follow-up and Review of the Sustainable Development Goals: Alignment vs. Internalization«. *Review of European, Comparative & International Environmental Law* 25 (1): 59–68. doi:10.1111/reel.12150.

Pietzner, Katja (2015): »Gesellschaftliche Akzeptanz«. In *CO_2: Abtrennung, Speicherung, Nutzung: Ganzheitliche Bewertung im Bereich von Energiewirtschaft und Industrie,* edited by Manfred Fischedick, Klaus Görner and Margit Thomeczek: 671–700. Berlin, Heidelberg: Springer.

Piketty, Thomas (2014): *Capital in the Twenty-First Century.* Cambridge Massachusetts: Harvard University Press.

Polanyi, Karl (1978): *The Great Transformation – Politische und ökonomische Ursprünge von Gesellschaften und Wirtschaftssystemen.* 10. Auflage 2013. Berlin: Suhrkamp Taschenbuch Verlag.

REN21 (2016): »Renewables 2016 – Global Status Report«. Paris: REN21 – Renewable Energy Policy Network for the 21st Century. http://www.ren21.net/status-of-renewables/global-status-report/.

Reuters (2016): »Duterte wants to liberate Philippines from U.S. shackles: foreign minister«. Oktober 6. http://www.reuters.com/article/us-philippines-duterte-idUSKCN1260X5.

Rip, Arie und René Kemp (1998): »Technological Change«. In *Human choice and climate change: an international assessment*, edited by Steve Rayner and Elizabeth L Malone, 327–399. Columbus, OH: Batelle Press.

Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, Stuart Chappin III, Eric Lambin, Timothy M Lenton et al. (2009): »A safe operating space for humanity«. *Nature* 461 (September): 472–475. doi:10.1038/461472a.

Rüesch, Andreas (2016): »Abbruch der Syrien-Gespräche: Neue Eiszeit zwischen Russland und den USA«. *Neue Zürcher Zeitung*, October 4, Abschn. Europa. http://www.nzz.ch/international/europa/abbruch-der-syrien-gespraeche-neue-eiszeit-zwischen-russland-und-den-usa-ld.120168.

Schleussner, Carl-Friedrich, Tabea K. Lissner, Erich M. Fischer, Jan Wohland, Mahé Perrette, Antonius Golly, Joeri Rogelj, et al. (2016): 'Differential Climate Impacts for Policy-Relevant Limits to Global Warming: The Case of 1.5 °C and 2 °C'. *Earth System Dynamics* 7 (2): 327–51. doi:10.5194/esd-7-327-2016.

Schumpeter, Joseph A. (2003): *Capitalism, Socialism and Democracy*. fifth revised edition. London, New York: Routledge.

Sellers, Piers J. (2016): »Cancer and Climate Change«. *The New York Times*, Januar 16. http://www.nytimes.com/2016/01/17/opinion/sunday/cancer-and-climate-change.html.

Steckel, Jan Christoph, Ottmar Edenhofer and Michael Jakob (2015): »Drivers for the Renaissance of Coal«. *Proceedings of the National Academy of Sciences* 112 (29): E3775–81. doi:10.1073/pnas.1422722112.

Steffen, Will, Katherine Richardson, Johan Rockstrom, Sarah E. Cornell, Ingo Fetzer, Elena M. Bennett, Reinette Biggs, et al. (2015): 'Planetary Boundaries: Guiding Human Development on a Changing Planet'. *Science* 347 (6223): 736–48. doi:10.1126/science.1259855.

Stephan, Benjamin, Stefan Schurig and Anna Leidreiter (2016): »What Place for Renewables in the INDCs?« Hamburg: World Future Council. http://www.worldfuturecouncil.org/inc/uploads/2016/03/WFC_2016_What_Place_for_Renewables_in_the_INDCs.pdf.

Sterk, Wolfgang and Lukas Hermwille (2013): »Does the Climate Regime Need New Types of Mitigation Commitments?« *Carbon and Climate Law Review* 7 (4): 270–282.

Stokstad, Erik (2015): »Sustainable Goals from U.N. under Fire«. *Science* 347 (6223): 702–3. doi:10.1126/science.347.6223.702.

Turnheim, Bruno and Frank W. Geels (2012): »Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913–1997)«. *Energy Policy* 50 (November): 35–49. doi:10.1016/j.enpol.2012.04.060.

– (2013): »The destabilisation of existing regimes: Confronting a multi-dimensional framework with a case study of the British coal industry (1913–1967)«. *Research Policy* 42 (10): 1749–1767. doi:10.1016/j.respol.2013.04.009.

UN Data (2016): »Sustainable Development Goals Indicators«. http://data.un.org/Explorer.aspx?d=EDATA.

UNEP (2012): *Global Environment Outlook 5 – Environment for the Future We Want.* Valletta, Malta: United Nations Environment Programme.

UNEP DTU (2016): »INDC/NDC Pledges Pipeline«. http://www.unep.org/climatechange/pledgepipeline/Portals/50136/PledgesPipelineToWeb.xlsx.

UNFCCC (2015): »Decision 1/CP.21, Adoption of the Paris Agreement, Advance unedited version«. FCCC/CP/2015/L.9/Rev.1. Paris: United Nations Convention on Climate Change (UNFCCC). http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf.

– (2016): »Aggregate effect of the intended nationally determined contributions: an update«. Document FCCC/CP/2016/2. Bonn: United Nations Framework Convention on Climate Change. http://unfccc.int/focus/indc_portal/items/9240.php.

United Nations (2012): »Report of the United Nations Conference on Sustainable Development«. Rio de Janeiro/New York: United Nations. http://www.un.org/ga/search/view_doc.asp?symbol=A/CONF.216/16&Lang=E.

– (2015a): »Transformation unserer Welt: die Agenda 2030 für nachhaltige Entwicklung«. New York: United Nations. http://www.un.org/depts/german/gv-70/a70-l1.pdf.

– (2015b): »Transforming our world: the 2030 Agenda for Sustainable Development«. New York: United Nations. http://undocs.org/A/69/L.85.

– (2016): 'Official List of SDG Indicators'. United Nations' Economic and Social Committee. http://unstats.un.org/sdgs/indicators/indicators-list/.

Unruh, Gregory C. (2000): »Understanding carbon lock-in«. *Energy Policy* 28 (12): 817–830.

– (2002): »Escaping carbon lock-in«. *Energy Policy* 30 (4): 317–325.

Watts, Jonathan (2012): »Winds of change blow through China as spending on renewable energy soars«. http://www.theguardian.com/world/2012/mar/19/china-windfarms-renewable-energy.

WBGU (2009): *Solving the Climate Dilemma: The Budget Approach.* Berlin: Wissenschaftlicher Beirat Globale Umweltveränderungen.

– (2011): *Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation.* Berlin: Wissenschaftlicher Beirat Globale Umweltveränderungen.

– (2016): *Der Umzug der Menschheit: die transformative Kraft der Städte.* Berlin: Wissenschaftlicher Beirat Globale Umweltveränderungen.

About the authors

Lukas Hermwille is a research fellow at the Wuppertal Institute for Climate, Environment and Energy where he conducts research on issues of international energy and climate policy. He is pursuing a doctorate at the Free University of Amsterdam on the question of how international climate policy can contribute to the transformation of global energy systems.

Imprint

Friedrich-Ebert-Stiftung | Global Policy and Development
Hiroshimastrasse 28 | 10785 Berlin | Germany

Responsible:
Manuela Mattheß | International Climate and Energy Policy

Tel.: +49-30-269-35-7408 | Fax: +49-30-269-35-9246
http://www.fes.de/GPol

To order publications:
Christiane.Heun@fes.de

Global Policy and Development

The Global Policy and Development department of the Friedrich-Ebert-Stiftung promotes dialogue between North and South and brings debates on international issues before the public and the political sphere in Germany and Europe. It offers a platform for discussion and consultation with the aim of raising awareness of global interrelations, developing scenarios and formulating policy recommendations. This publication appears within the framework of the working line »International Climate and Energy Policy«, responsible: Manuela Matthess@fes.de.

ISBN
978-3-95861-812-1