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Discussion Paper for the
INTERCONNECTIONS Conference
Bonn, 12-13 May 2017

SDGs and Paris Agreement: Terms of Reference for the Global Energy Transformation?

Global environmental change in the anthropocene implies a fundamental transformation of global economies and societies. The adoption of the SDGs and the Paris Agreement in 2015 marks a paradigm shift: the two agendas recognize this transformational challenge and provide a international framework to govern this transformation away from catastrophic unabated climate change towards a transformation to sustainability.

The discussion paper analyses to what extent the two agendas provide terms of reference for the governance of a global energy transformation. It summarizes the provisions made that are particularly relevant for the energy sector and discusses their complementarities with a particular view on how the two agendas can serve as reference points for managing the sunset of fossil fuels and associated industries in compliance with the guiding principle of the SDGs: leaving no one behind.

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Hermwille, L. (2017). *Auf dem Weg zu einer gerechten globalen Energietransformation? – Die Gestaltungsmacht der SDGs und des Paris Agreement*. Berlin: Friedrich-Ebert-Stiftung. http://library.fes.de/pdf-files/iez/13272.pdf

an English version of this report will be available as of June 2017

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1 Introduction: 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). 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). The same researchers accord that with respect to climate change the Earth System, is still in a state of uncertainty with an increased risk of crossing the planetary boundary. This, however, 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.

Climate change is nevertheless producing dramatic effects – ones which are already being felt today. There is a wealth of scientific evidence on the current and future physical impacts of climate change (IPCC, 2014). 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 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 sole cause of the Syrian crisis. But it certainly contributed to stoking the flames under the pressure cooker in which radicalism and conflict arise (vgl. Sellers, 2016).

It is now almost a commonplace that avoiding dangerous climate change requires a fundamental transformation of global economic and societal systems (WBGU, 2011). But, in fact, the notion of the anthropocene makes it clear that such a transformation is already underway and it is so on the grandest imaginable, the geological scale. Therefore, 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.

If, in this vain, the global energy transformation is to succeed, governance processes are required at all policy levels, political processes to control and shape transformative change. Governance processes are required to shape a collective vision of a sustainable and climate-friendly society in all of its complexity. 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 (vgl. Polanyi, 1978).

This discussion paper discusses to what extent the two milestones of international governance, the Paris Agreement and the SDGs, can serve as terms of reference for the governance of a transformation of global energy systems towards sustainable energy systems based on renewable energy.

2 The Paris Agreement as a Pacemaker for Climate Protection

2.1 General remarks

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

1 | **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.** The French foreign minister at the time and 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 na-

tions to make progress on climate issues would be forever shaken." (Fabius, 2015). The adoption of the Paris Agreement is testament for viability of environmental multilateralism and hence restored some of the confidence that was lost after the disastrous failure of Copenhagen in 2009.

2 | **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.** In addition to representing a quantitative intensification of the previous target, it 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. With respect to the global energy sector the message is clear: the era of coal, oil, and gas is over!

3 | **It defines a political process with a shared agenda and a concrete timetable.** 5-yearly cycles of national climate protection plans (the so-called nationally determined contributions – NDCs) and periodic global stocktakes of the collective and individual efforts create a pace maker in that it stimulates and synchronizes climate policy cycles at national and international levels.

4 | **It creates transparency to make necessary information available, establish trust, and enable reflexivity.** A universally applicable transparency framework is key for holding countries accountable with respect to implementing their contributions.

2.2 Specific Implications for the Global Energy Transformation

2.2.1 The long-term reduction target of the Paris Agreement

The energy sector is essential for climate protection. CO2 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).

2.2.2 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 totalling 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). 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!"

2.2.3 Renewable energy as an object of national climate protection goals

CO2 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).[1] 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, 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 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 (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. India has pledged to reduce the greenhouse gas intensity of its economic output (measured in tonnes of CO2e per GDP unit) by 33 to 35 per cent by 2030 compared to 2005 levels. Over the same period, 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. Strikingly, the two targets are not coherent. In fact, the energy target is far

[1] 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.

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 may reflect the fact that states often find it easier to formulate positive development objectives than to impose (development) limits on themselves (Sterk and Hermwille 2013).

3 The Sustainable Development Goals and the Global Energy Transformation

3.1 General Remarks

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 centre 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 centre 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 (vgl. Gore, 2015).

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 with a novel negotiation format, the Open Working Group on Sustainable Development Goals (OWG). 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. This approach helped to bridge traditional boundaries between negotiating groups from the developed and from the developing countries. 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 (Chasek et al. 2016).

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.” Moreover, the SDGs are marked by the five Ps: people, planet, prosperity, peace, and partnership, and have to take these five dimensions into account. 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 (Langford, 2016, p. 172). Among the SDGs there are also goals that follow the classical reciprocal approach of the MDGs, but even in these within 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 (vgl. Gore, 2015; Langford, 2016).

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.

Since there are neither formal reporting requirements for countries nor clear guidance whether countries should base their reporting on outcomes or report on the policies and measures (i.e. behaviour-based reporting) (Persson, Weitz and Nilsson 2016), much like the Paris Agreement, the SDGs are 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.

3.2 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 favourable and medicines can be reliably cooled, and the level of education rises because the evening hours can also be used for learning (IPCC, 2012, p. 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.

3.2.1 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.

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, 2015).

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.

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 re-

cent 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, 2014). 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.

Moreover, 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).

3.2.2 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. Table 1 synthesises the interdependencies between various SDGs and the global energy transformation. The analysis suggests that most of the sustainability goals can be achieved only if the global energy transformation is successful, 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 nonstarter 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.

Tab. 1 Synthesis of interdependencies between Sustainable Development Goals and a global energy transformation beyond SDG7.

Goal	Interdependencies with Global Energy Transformation
SDG1: **End Poverty**	▪ Without access to modern energy it is virtually impossible to escape extreme poverty ▪ Target 1.4 demands in particular that all people be ensured "access to basic services [and] appropriate new technology" by 2030 ▪ 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.
SDG2: **End Hunger**	▪ Considerable increases in agricultural productivity can be accomplished through modern energy and electricity ▪ Target 2.a calls, among other things, for investment in rural infrastructure to implement SDG 2. Especially in remote areas, decentralized RE capacity can help to leap forward towards this goal.
SDG3: **Good Health Care**	▪ Target 3.8 calls for access to quality essential health-care services and medicines. Electricity access is essential for modern health-care services and/or to store drugs. ▪ Unsustainable forms of energy often pose a threat to public health, e.g. indoor pollution through inefficient cook stoves.
SDG4: **Quality Education**	▪ For many children and young people, access to education becomes possible only when the availability of modern energy frees up capacities. ▪ Quality education and well-trained skilled workers are a necessary precondition for the success of the energy transformation (Hirsch, 2015).
SDG5: **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. ▪ 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
SDG6: **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). ▪ Supplying freshwater can be very energy intensive, especially where this has to be produced in seawater desalination plants (target 6.4). ▪ Energy production is in turn highly dependent on the availability of clean water. Not only for hydropower, but all thermal power plants consume large amounts of water to generate steam and for cooling.
SDG8: **Good Jobs and Economic Growth**	▪ Already today, more than eight million people are employed in the renewable energy sector including many relatively low skill jobs in construction and maintenance. ▪ Renewable energy play a key role in decoupling economic growth from resource consumption and environmental degradation (target 8.4) ▪ Historically, trade unions are particularly strong in the mining and heavy industry sectors. A global energy transformation must ensure that labour rights are respected as well in emerging industries such as the renewable energy industry. ▪ Distributive implications of the energy transformation with respect to labour need to be addressed.

SDG9: **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. ▪ SDG 9.4 is aimed at upgrading industrial infrastructure in sustainable ways. Electrification of industrial processes will be a key strategy e.g. in the energy intensive basic materials industry (Lechtenböhmer, Nilsson, Åhman, & Schneider, 2016). ▪ SDG 9.5 calls for the enhancement of technological capacities and of training and research especially in the poorest developing countries. A global energy transformation presents an opportunity to increase investment in education and training for fields of work relevant for renewable energy.
SDG11: **Sustainable Cities and Communities**	▪ In line with global urban population, urban infrastructure will have doubled in 2050. Should the world fail to provide the affordable housing (target 11.1) 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). ▪ 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). By substituting coal-fueld electricity and heating as well as combustion engines and Renewable energy sources can help to remedy this problem. ▪ SDG 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”. The sustainable construction and reconstruction of energy infrastructure must be an integral part of these plans and policies.
SDG12: **Responsible Consumption and Production**	▪ 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.
SDG15: **Terrestrial Life**	▪ Direct interconnections between the global energy transformation and SDG 15 exist, especially when one considers the role of biomass and agrofuels. ▪ (Liquid) fuels produced from vegetable raw materials will become increasingly important inter alia for aviation. ▪ In the power sector, systems based on biogas and biomass are already an important component ▪ 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. The use of biomass for energy must be prevented from increasing the pressure for deforestation and from counteracting the goal of sustainability.
SDG17: **Global Partnership**	▪ Target 17.7 calls for the transfer of environmentally compatible technologies, among them also renewable energy technologies

4 Discussion and Conclusions

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.

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. The analysis 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 pro-

tection 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 discussion paper. 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 the sleeves.

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 (Rotmans, Kemp, & van Asselt, 2001):

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 bon mot 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.

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 (cf. Polanyi, 1978).

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).

The global energy transformation has been set in motion but its continuation requires continued efforts, it remains a major challenge. It can even be assumed that this challenge will become greater if and when political conflicts increasingly take centre 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.

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