Why Affordable Clean Energy Is Not Enough. A Capability Perspective on the Sustainable Development Goals

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Abstract: This paper reflects on criticisms raised in the literature on the UN's Sustainable Development Goals (SDGs). These have been criticized as creating a dichotomy between the environment and human beings that fails to address the multiple interconnections between the two. This paper focuses on SDG7—"affordable and clean energy"—and suggests that there is in fact a tripartite distinction between the environment, human beings and technology underlying the SDGs. This distinction, we argue, does not adequately represent the multiple interconnections among the various SDGs and hampers their implementation. We contend that the formulation of SDG7 produces a circular definition of sustainability, a difficulty that is currently resolved at the level of the targets and indicators in a way that regards energy technologies primarily as artifacts. By contrast, the literature on ethical aspects of energy systems largely agrees that energy is a paradigmatic example of a sociotechnical system. We contend that, by not considering this sociotechnical nature, the SDGs run the risk of implicitly defending a certain variant of technological optimism and determinism. We argue that this is disadvantageous to the environment, human well-being and technological development. In line with recent critical evaluations of the SDGs, we argue that these (and other) shortcomings can be addressed by better connecting the SDGs to human well-being. Building on recent literature that expands the scope of the Capability Approach as an alternative measure of well-being so as to include considerations of sustainability, we articulate a framework that allows us to elucidate this connection and thus to take advantage of synergies between human well-being and the environment. On the basis of the Capability Approach, we argue that equating sustainable energy with renewable energy—as is done in the transition from SDG7's goal to its targets—is indefensible because, as part of the overarching energy systems, energy technologies cannot be classified as simply right or wrong. Rather, the indicators and targets within a framework focused on sustainability need to be (more) context sensitive, meaning that, among other things, they may vary by country and with the available technology.

Keywords: energy; justice; capabilities; capability approach; sustainability; SDG; environment; ethics of technology; sociotechnical system; engineering ethics

1. Energy and Human Life

In 2017, the report on the progress of the United Nations' Sustainable Development Goals (SDGs) once again states that SDG7, which calls for affordable and clean energy, is seriously lagging behind: "Progress in every area of sustainable energy falls short of what is needed to achieve energy access for all and to meet targets for renewable energy and energy efficiency". This not only represents a failure to achieve one specific SDG, it also hampers the realization of many other goals. The SDGs, comprised of seventeen sustainable development goals with 169 targets and 230 indicators, are to be understood as indivisible, so failure in one results in failure of others. Energy occupies a noteworthy position

here as it is intrinsically related to many important aspects of human life [1]. As the progress report on SDG7 states: "Energy is crucial for achieving almost all of the Sustainable Development Goals, from its role in the eradication of poverty through advancements in health, education, water supply and industrialization, to combating climate change". This holds for all three segments of the energy sector, namely, power, heat, and transportation. An abundant and clean energy supply could even eliminate shortages of drinking water as the abundant seawater can be transformed into drinking water by means of the energy-intensive process of desalination.

Despite progress falling short for SDG7, a transformation of parts of the energy system towards greater sustainability can already be seen today. Traditional petroleum fuels, for example, are increasingly being replaced by the use of electricity in decentralized applications like cars. Moreover, many European countries are currently witnessing a transition towards more renewable electricity sources and uses. All these transitions in the energy sector also bring enormous challenges that, at present, are often addressed primarily on the technological level. However, since the energy system is a paradigmatic example of a sociotechnical system [2,3], any transformation on the supply and distribution side is accompanied by enormous changes on the demand or use side, and it may also be possible to better address challenges in the energy sector using no-tech or low-tech solutions. Likewise, the manifold implications that these transitions have for the various aspects of human lives are not often discussed sufficiently. For example, the inclusion of more renewable energy sources may involve more (or less) decentralized energy technologies, the transfer of funds (within a society, or internationally), and other institutional and societal changes.

The formulation of the SDGs as well as the corresponding targets and indicators undoubtedly demonstrates an unprecedented achievement of the international community that, unlike the United Nations' previous Millennium Development Goals (MDGs), was greeted favorably by governments and NGOs alike (see [4] for an overview of the development that led to the SDGs). The SDGs also spurred research on and transformation towards a sustainable future. It is acknowledged that there are interconnections among the SDGs, and the goals are in fact to be seen as indivisible. Energy, for example, is not only part of SDG7, but is also explicitly mentioned on the level of targets or indicators of two other goals (For goal 12, which seeks to ensure sustainable consumption and production patterns, target 12.C addresses *inefficient fossil-fuel subsidies* that encourage wasteful consumption by removing market distortions. For goal 4, which is concerned with inclusive and equitable quality education, the proportion of schools with *access to electricity* is devised as (part of) one indicator (Indicator 4.a.1)). Nonetheless, as we will argue in the following, the current formulation of the SDGs fails to fully recognize the multiple interconnections between human well-being and the different components of the energy systems. This failure is a serious deficiency.

In this paper, we contend that, due to a failure to recognize the sociotechnical nature of the energy system, the SDGs insufficiently address the interconnections among the various goals and targets and the manifold ways in which energy in all its forms can impact human lives. Scholars have argued that an analytic distinction between the environment and human beings underlies the SDGs and thus valuable synergies between the environment and human well-being are not recognized. We extend this argument and propose that there is in fact a tripartite differentiation between environment, human well-being, and technology underlying the SDGs, and this gives rise to a mild technological determinism that fails to embrace valuable synergies among the three. We see this as but one reason why the transition towards a more sustainable energy system is not achieving its goals. Moreover, we will argue that the oversimplified view of the energy system that falls short of acknowledging its sociotechnical nature ultimately fails to specify the fundamental nature of sustainable energy.

The paper is organized as follows. With a focus on SDG7, we argue in Section 2 that the SDGs are built on a circular definition of sustainable energy, and that the identification of targets thus remains somewhat arbitrary. As we will contend in Section 3, the failure to recognize the sociotechnical nature of the energy system leads to a mild technological determinism that fails to fully embrace synergies between

human and environmental health and technological developments. If the sociotechnical nature of energy is to be taken seriously, a normative guideline is needed that spells out precisely what sustainable energy systems entail. Section 4 thus suggests that the Capability Approach may provide such a normative framework that is able to link individual well-being to sustainable behavior. By using the Capability Approach as normative framework for the SDGs, we can also address other criticisms that have been raised repeatedly in the literature, namely, that an overarching and systematic framework that links the SDGs is needed [5]. In Section 5, we discuss applications of this framework to the energy system and spell out how sustainable energy goals derived within the framework of the Capability Approach differ from those of the UN's SDGs. The paper concludes with Section 6, highlighting some of the pros and cons of the suggested approach.

2. Energy in the SDGs

2.1. Sustainability as a Thick Term

Given the enormous impact that energy supply and distribution as well as energy use has on the environment and on human beings, the importance of affordable and clean energy as a central part of the SDGs is undisputed. However, unlike for clean water, it is far from obvious how to specify what "clean" actually refers to when applied to energy, since all means of energy conversion come with downsides. When we look at the formulation of SDG7, however, the lack of clarity is not resolved: "Ensure access to affordable, reliable, sustainable and modern energy for all". Instead of specifying what sustainable energy is, we find here an obviously circular specification. While this may seem innocent at first reading, we argue that this circle is vicious as it blurs some serious challenges for a transformation towards more sustainable energy systems, namely, how to balance the pros and cons of different means of energy conversion, use, and infrastructures. It seems that these challenges can only be resolved by an overarching systematic framework that is currently lacking for the SDGs [6].

Let us begin, however, with a charitable reading of SDG7 and try to make sense of the formulation of this goal. What can it mean when a Sustainable Development Goal is specified using the term "sustainable"? One possibility is that the conflict is resolved on the level of targets and indictors. This solution will be discussed below in Section 2.2. Another way of understanding SDG7 is to take the term 'sustainable' in "Sustainable Development Goals" as having a normative meaning, while it is used as a descriptive term in the formulation of SDG7, assuming that the meaning of 'sustainable energy' in a descriptive sense is clear. This is indeed a common equivocation, and thus, so the argument, the specification only appears to be circular due to an innocent equivocation of the term 'sustainable,' first as normative concept and then in SDG7 as a descriptive one. This charitable reading that addresses the charge of circularity, however, fails to do justice to the nature of the term 'sustainability.' As has been argued elsewhere [7], sustainability is an ethically thick term.

Although sustainability may seem to be a descriptive concept at first glance, it is often used to make normative claims. Sustainability is what has come to be known as a thick concept, i.e., one that contains evaluative as well as descriptive elements [8,9]. Though the difference between thin and thick normative concepts may not be a sharp distinction, it may nonetheless be useful for discussions [10]. When referring to a technology as sustainable the speaker not only expresses her evaluation, i.e., that she thinks that in certain respects this is a 'good' technology, but also makes a descriptive claim, for example, that this energy conversion technology is CO_2-neutral. The descriptive claim may be appropriate or not. This is very different from thin ethical concepts like 'good', which only express the evaluation of the person who uses this term, as well as from merely descriptive terms like yellow, hard or soft.

It should be noted that in addition to 'sustainability' many other terms we use to "describe" technologies are in fact thick terms in which descriptive and normative statements are inseparably intertwined. This holds for terms such as 'risky' or 'safe' [11], as well as for the other terms used in formulating SDG7, such as 'reliable' or 'modern.' The way these terms are used here clearly indicates

that, for example, reliability is something good (in a moral sense) and worth striving for, but at the same time it is also a description of a certain type of energy system.

2.2. Sustainable Energy as Renewable Energy

Let us turn to the second strategy for dealing with the circularity. On the level of the targets, the circularity can be resolved by equating sustainable energy with renewable energy. Indeed, this also occurs in other areas of the discourse, particularly in the public debate. If we take intergenerational justice to be at the core of sustainability [12] then, so the argument, it seems all too clear what needs to be done, namely, avoid methods of energy conversion that come with long-lived waste or other long-lasting side effects. This quickly leads to the conclusion that nuclear power (at least without the possibility of nuclear reprocessing or transmutation) is out of the question due to its radioactive waste, as are fossil fuels since they contribute to climate change and its arguably unprecedented negative impact on future generations.

However, it is overly hasty to simply equate sustainable energy with renewable energy. The use of renewables has negative side effects, too. Due to the comparatively low energy density, renewables demand a lot of space that could otherwise be used for farming, for example. Efficiency as introduced on the level of targets (7.3. and 7.A) and indicators seems to be exclusively concerned with the efficiency of energy appliances, while the efficiency of means of energy conversion does not seem to play a role. Moreover, the use of renewable energy may conflict with other aspects of protecting environmental health. Such conflicts have recently come to be known as green–green conflicts. For example, a total of over 250,000 bats is estimated to die per year in Germany alone due to the use of onshore wind power. Renewables also pose other, direct risks to human well-being. Over the last few decades hydroelectric facilities have been responsible on average for 1.4 fatalities globally per terawatt hour per year (TWh/yr) due to accidents (including the major accident in Banqiao, China, in 1975). For comparison, nuclear energy (including the accidents in Fukushima and Chernobyl) is associated with 0.04 deaths per TWh/yr. Moreover renewables, reshape and destroy nature in a largely irreversible way. Moreover, hydroelectric facilities may conflict with other water use. During the construction phase of the so-called Grand Ethiopian Renaissance Dam, a gravity dam on the Blue Nile River in Ethiopia that was claimed to be about 60% finished by 2017, there had been armed conflicts between Ethiopia and Sudan and Egypt, which lie farther downstream and fear a reduced access to water due to the dam. Such conflicts highlight how the intergenerational perspective, which may favor the use of renewables, can conflict with issues of intra-generational justice, a conflict that has been recognized to be at the core of any sustainability analysis since the Brundtland report [12]. By not specifying what sustainable energy actually is on the level of the goal, the SDGs fail to address this central problem of sustainability analysis in the context of energy systems.

Even from the perspective of future generations it may not be clear that transitioning to 100% renewable energy is an attractive goal. The multiple links between energy and human well-being seem to suggest that in some perspectives "the more, the better" is a good option when it comes to energy. An abundant energy supply could solve many problems including water scarcity or food shortage. Several recent studies suggest that the world's energy will be able to be generated (almost) entirely from renewables by the middle of this century or even earlier. Greenpeace [13], for example, predicts that 97% of the energy in the EU27 can come from renewable sources by 2050, Ram et al. [14] or WWF [15] even consider a 100% renewable energy supply for the whole world to be possible within the same time frame. Jacobson and Delucchi [16] present a scenario in which the latter is already achieved by 2030. However, all of these (almost-)all-renewable scenarios assume very low final energy consumption, such as electricity consumption that is sometimes as low as half of that found in the International Energy Agency's (IEA) Blue map scenario, which already assumes 13% lower electricity use than in the Baseline scenario [17]. It is beyond the scope of this article to discuss whether this significantly reduced energy consumption can be achieved with changes in behavior that are positive overall, or whether it would require genuine sacrifices. Here we only want to stress that even transitioning to fully renewable energy sources in a short time scale may have ethically

disadvantageous effects on present or future generations, which the literature has thus far insufficiently taken into account. For comparison, the German energy transition, which is sometimes heralded as being very ambitious compared with other countries, only aims to achieve 80% of electricity and 60% of overall energy from renewable resources by 2050. On a different time scale, the EU is calling for 20% energy from renewable resources by 2020 (one of the EU's 20-20-20 targets).

As an important side note it should be stressed that, when it comes to renewables in the SDGs, the use of modern renewable energy sources must be clearly distinguished from the use of coal or wood for cooking. Though the report on the progress of SDG7 acknowledges this difference, it is not mentioned on the level of targets or indicators.

2.3. Energy in All Its Form and Usages

Energy is used in different forms, which creates its own complexities. Within the SDGs, energy seems to be concerned mostly with electricity (and partially also heat). Transport, however, is not represented by an independent SDG. It is mainstreamed across several SDGs and targets, especially those related to food security, health, energy, infrastructure, and cities and human settlements. However, as the three segments of the energy sector—power, heat, and transport—are expected to be even more closely connected due to an anticipated increased digitalization of the energy system, the underrepresentation of one sector does not do justice to the complexity of the energy system as a whole.

Furthermore, SDG7 is focused primarily on supply and demand (of primary energy), but the energy system also comprises other infrastructures, such as for transportation. These can have an impact on human beings as well, and because changes in energy conversion, such as an increased share of renewables, also impact the transmission infrastructure, this cannot be completely separated. The recent local opposition to the planned expansion of the grid in Germany necessitated by a higher share of renewables elucidates this issue. Surplus on the demand side seems to be addressed in the SDGs mainly via technological changes and changes in regulation for industrial uses (e.g., target 12.C). This is discussed in more detail in the following section.

At this point it may seem that the criticism we raise expects too much of the SDGs. After all, the SDGs target sustainable development more broadly, not energy alone, and therefore cannot do justice to all the specific details of the energy system. The following section, however, aims to make clear why leaving out these essential characteristics of the energy system lead to a curtailed view on sustainability that is unable to take full advantage of the synergies among different goals. Recent empirical studies mention that challenges to achieving the Sustainable Development Goals include poor collaboration across the food, water and energy sectors, which is attributed to poor sectorial coordination and institutional fragmentation [17].

3. Energy as a Sociotechnical System

The lack of progress for SDG7 cannot, of course, be attributed solely to the formulation of the goal, its targets, or its indicators. While normative reasoning provides some motivation to act in the (normative) correct way, particularly in cases like energy consumption, conversion and transmission that arguably require substantial changes in behavioral patterns on individual and societal level the often cannot overcome all motivational hurdles. However, as [18] argue, there are certain omissions in the current formulation of the Sustainable Development Goals that promote inaction. As was the case with the earlier Millennium Development Goals, the SDGs "[...] fail to specify any division of labor to ensure success" [19]. Therefore it is difficult to allocate responsibilities and determine who needs to take action [20]. In addition to the failure to allocate responsibilities, we contend that, at least for the domain of energy, another cause for inaction inherent in the formulation of SDG7, its goals, and its indicators is the SGDs' focus on the systemic level, while the individual (whether she is living now or in the future) is addressed only indirectly.

The largest emitter of greenhouse gasses in the Western world is currently the private sector. However, the meager progress that has been made in implementing SDG7 thus far is found in

the industrial sector. As the 2017 report on progress of the SDGs emphasizes: "Meaningful improvements will require higher levels of financing and bolder policy commitments, together with the willingness of countries to embrace new technologies on a much wider scale". This focus on new technologies together with overlooking the negative impacts of renewable technologies (see Section 2) is an expression of technological optimism. 'Technological optimism' refers to a conviction that technical solutions are the only way to solve a certain problem [21,22] in this case the problem of achieving a sustainable energy supply. The assumption underlying this optimism is that future renewable energy technologies will provide clean energy in the sense that they have no significant long- or short-term negative impact on humans or the environment. Given the current state of research, this is not realistic (cf. 2.1). Technologies can certainly help to overcome many problems and are, in our opinion, one part of the transition towards a more sustainable energy future. However, the formulation of the SDGs and its underlying optimism when it comes to future energy technologies starts down a slippery slope that ends in technological determinism. We contend that this is because the reciprocal relationship between technological artifacts and human beings is not sufficiently considered in SDG7.

Literature on the topic has argued that, despite a more inclusive process as compared with previous efforts, the SDGs fail to "embrace potential synergies between the environment and human well-being" [6]. A special issue has been dedicated to this from the perspective of land use. The various contributions share the common theme that an analytic distinction between environment (in this case agriculture) and human beings underlies the SDGs; they are presented as diametrically opposed, and thus potential synergies between environmental and human health are overlooked. According to [6], the SDGs neglect recent research on land use showing that an agricultural landscape can also serve important functions within an ecosystem, for example by using thoughtful design and management in order to enhance biodiversity and contribute to conservation more broadly. Similarly, we hold that the SDGs could profit from a more thoughtful consideration of recent research in philosophy and social studies of technology that stresses the sociotechnical nature of technological systems, particularly for the energy system [2,3]. The analytic distinction underlying the SDGs is thus not just a dichotomy between the environment and human beings, but is rather a tripartite distinction among the environment, human beings and technology. Because of this, valuable synergies among the three that could be utilized in realizing a sustainable future are not sufficiently taken into account.

The energy system is depicted in the SDGs primarily as a technological system instead of a complex sociotechnical one. For the latter, however, changes in user behavior or other systemic responses tend to offset (some of) the beneficial effects of new technology. This has come to be known as the "rebound effect". Moreover, sociotechnical systems also offer low- and no-tech solutions to problems where the technocratic ideal sees only the technological solution. In any case, the "willingness of countries to embrace new technologies on a much wider scale" and the policy commitments (SDG12, targets) demanded by the SDGs must be supplemented by the willingness of a country's people to adjust their behavior if a sustainable energy future is to be realized in practice. It is the individual who creates and shapes the energy system in multiple ways. She can be a supporter or, even more prominently, an opponent of energy infrastructure or certain energy technologies [23]. Individuals further directly shape the energy system as consumers, either directly by consuming electricity or heat, or indirectly by consuming goods that require more or less energy for their production or delivery. With the increasing digitization of the electricity and mobility sector and the increasing number of its decentralized applications, the end user as a so-called "prosumer" can also function as supplier.

Various strands of literature on the SDGs or on sustainable energy seek to connect sustainability considerations with concepts of well-being that go beyond traditional economic measures such as the GDP [24–26]. Lu et al. [5] argue that, in measuring advances in sustainable energy, "parameters other than just economic growth must be included, such as income inequality, [. . .] population and lifespans". We add that taking the sociotechnical nature of the energy system seriously requires addressing the individual such that the individual benefits of sustainable behavior become transparent.

The systemic level of sustainability considerations needs to be linked to an individualistic concept of well-being [27].

4. Capabilities and Sustainability

In the following, building on [27], we propose the Capability Approach as a useful conceptual framework for elucidating the multiple implications that energy systems may have at the individual level. As we will show, the Capability Approach provides a conception of well-being that can provide the SDGs with a metric for intra- and intergenerational considerations of justice and thus for specifying sustainable energy.

It is a dominant assumption in contemporary Western societies that well-being can only be defined by the individual herself. This view is commonly used in economic cost-benefit analysis and often provides the basis for sustainability considerations. Various different approaches are used here for which preference-based utilitarianism provides the theoretical underpinning. For our considerations on sustainability, it is sufficient to note that these approaches in principle do not provide any way to acquire information about individual well-being other than to ask the person herself. Consequently, the possibilities of measurement and inter-individual comparison are severely impeded, to say nothing of inquiring about the satisfaction of future generations. From a purely methodological point of view, this approach does not help us in dealing with future generations as their preferences remain hidden from us. However, considerations of future generations and intergenerational justice are at the core of sustainability analysis. This can be addressed by the Capability Approach, as it provides a multidimensional concept of well-being that is at its core objective, i.e., applicable to everyone. This is not to suggest that there are no challenges in using the Capability Approach as a basis for sustainability analysis. The operationalization of the capabilities is sensitive to context, and so differences in time and space do matter, which is at least partially relevant for sustainability analysis. Before we consider some of these challenges in Section 6, let us first briefly outline what is valuable according to the Capability Approach.

The Capability Approach, proposed by A. Sen and M. Nussbaum, has over the last few decades become the leading alternative to standard economic reasoning on well-being (e.g., [28–31]). Measures of human well-being that are, if somewhat loosely, connected to the Capability Approach such as the Human Development Index (HDI), the Human Poverty Index (HPI), or the Multidimensional Poverty Index (MPI), have established themselves as alternatives or additions to economic measures such as the GNI or GDP [30,32]. While there are differences among the many capability theorists, they all accept the core idea that what is valuable in a human life is the freedom to choose and to actively realize the things one has reason to value, and this freedom is constitutive for a good human life. A capability is defined as the set of alternative combinations of 'functionings' that can feasibly be achieved by a person. These functionings are facts about what the person is and what the person is able to do. Human well-being thus depends on what she does or who she is (functionings) and on what she is able to do or who she is able to be (capabilities). By assessing quality of life in terms of freedom and action, the capability theorist can account for the fact that human beings differ in their capacity to make use of goods and resources. By focusing on what people are actually able to do and to be, the capability theorist can thus evaluate the various elements of what is considered to be morally valuable.

The value of making comparisons across alternative energy scenarios is hence the ability to promote people's freedom to choose and actively realize the things they have reason to value. Here the focus is not just on the impact that an energy scenario has on human well-being per se (functioning), but rather on the freedom or actions it enables that constitute, among other things, the prerequisites for well-being (capabilities). The Capability Approach thus provides an interpersonal basis for comparison of well-being and in so doing provides a metric for considerations of justice. It therefore provides the theoretical framework that we and others have criticized as lacking in the SDGs and sustainability analysis more generally (e.g., Rauschmayer, Omann, and Frühmann 2012).

Though the literature on empirical studies that use capability reasoning to assess sustainability is fairly ample (see, for example, [33,34] and Tiwari 2014 and references therein), the Capability Approach has also occasionally been applied on a more conceptual level to considerations of sustainability [26,35–38]; [39] and ethics of technology understood more broadly . For example discussions on 'greening' the HDI (e.g., [40] tried to gauge the extent to which the HDI would be able to integrate ecological aspects. Generally, it has been stressed that the focus on freedoms allows us to move beyond the satisfaction of needs and wants, and thus provides a better and more comprehensive account of human well-being than, for example, utilitarian accounts (e.g., Baumgärtner and Quaas 2010; Ballet et al. 2011). Moreover, scholars have stressed that the Capability Approach enables a more complete consideration of individual rationales, and it explicitly allows for other-regarding goals, which are seen as the primary motivation of sustainable development [41]. Sen here explicitly recognizes agency freedoms as distinct from wellbeing freedom; these can also include agent's actual objectives on her regards for others [28].

There are several advantages of using the Capability Approach as a conceptual framework for sustainability analysis. Firstly, it provides a middle ground between objective accounts of well-being and the relativistic approaches of preference-based utilitarianisms, and thus provides a suitable value base for considering sustainability that is compatible with value-pluralistic and liberal traditions [7]. As Rauschmayer and Leßmann [42] put it: "The CA's [Capability Approach's, author's note] core value is freedom which reminds us to restrain [sic!] from a paternalistic attitude to human behavior. Human beings are seen as agents not as patients and policies should be designed accordingly".

The second advantage is that freedom is always seen in an integrated way, rather than being reduced to economic or technological freedom. The economic freedom that smart grids provide, for example, that the private user can become a decentralized provider of electricity, is not simply viewed as positive; in addition, the CA stresses that this freedom hinges on other freedoms, thus emphasizing the social integration of technological, economic, or other political freedoms. Although everyone may be able to participate in the digitalization of the energy system in principle, it may be that only the wealthy and the technologically literate are in fact able to profit from it. Consider as another example the proportion of schools with *access to electricity*, which is devised as an indicator for quality education. Here the Capability Approach stresses that access to electricity is not enough to ensure quality education because it needs to be embedded in an environment that also provides other freedoms, such as the political freedom for all children to go to school and not be excluded based on ethnicity or gender, and the economic freedom that allows children and possibly adults to attend school instead of working. This brief example also highlights how the Capability Approach integrates different Sustainable Development Goals.

The Capability Approach as depicted here provides a metric of what is valuable in a human life, which helps to navigate the complex space of a sociotechnical system. When applied to technological interventions, the capability-theoretical approach places a special emphasis on the (approximate) reversibility of such interventions, an aspect that is largely overlooked in most current sustainability assessments. This can be illustrated with an example from [43]. The capability approach clearly allows us to compare various options for renewable energy with respect to their reversibility. If future generations were to discover at some point that wind energy brings unacceptable risks, it would be relatively straightforward to dismantle all wind turbines. The same does not hold true, for example, for hydroelectric power. Large hydroelectric facilities cannot be easily dismantled, nor can the landscape simply be restored should future generations discover that such a hydroelectric facility imposes unacceptable risks. The irreversible effects that come with some technologies reduce the capabilities (freedoms) of future generations and must be taken into consideration from a capability perspective. Note that this does not yet imply anything about the overall evaluation of energy systems in which the different technologies may be embedded. The Capability Approach places an emphasis on the embedding of the technologies, including the social and institutional arrangement as well as corresponding infrastructure technologies. Furthermore, nothing has yet been said about how the different capabilities are weighed.

5. Energy Capabilities

The Capability Approach provides a metric of what is valuable in a human life, taking freedom as a normative goal, a value in itself. Justice now enters into the approach by deliberately weighing the various freedoms, of how to balance energy as a means to other freedoms and energy choices themselves as capabilities. Generally speaking, two variants of Capability Theory can be distinguished. One variant follows Sen and leaves this balancing and further specification of these freedoms to democratic discourse; another version follows Nussbaum's formulation of core capabilities. These provide a set of the most important capabilities that cannot be negotiated or traded off against each other because they form the basis of a well-lived human life [44]. The formulation of ten core capabilities is inspired not only by capability-theoretical considerations of basic freedoms, but also by an Aristotelian conception of a well-lived life.

The Capability Approach as depicted thus far is too broad to serve as a guide in realizing a sustainable energy future. Just as Nussbaum [44] herself notes in the context of gender equality: "Some freedoms limit others; some freedoms are important, some trivial, some good, and some positively bad." As has been argued elsewhere [27], Nussbaum's version of the Capability Approach can be useful for further specifying the concept of sustainable energy. Nussbaum's core human capabilities are *life, bodily health and bodily integrity, sense, imagination and thought, emotions, practical reason, other species, play, and control over one's environment*. These have been applied to energy systems and resulted in a multitude of 'energy capabilities' [27]. In the following we will outline some of these energy capabilities in order, firstly, to show how energy systems impact core capabilities, and, secondly, to highlight how the Capability Approach is able to address the criticisms that have been raised against the SGDs. In particular, the selected examples show how individual well-being (as conceptualized in Nussbaum's version of the Capability Approach) is connected to features of the energy system, and they point to possible synergies between the technological, social, and environmental realms. There are some obvious synergies between SDG7 and SDG13, which calls for climate change action, as well as with the goals concerned with environmental health (SDGs 14 and 15). However, these are not our primary interest here. Rather, in the following we focus on synergies that both the public discourse and the SDGs fail to address, or address in an incomplete way.

In terms of the energy sector, the core capability *life* is associated with major life-threatening accidents such as those that occur during raw material extraction, while *bodily integrity* encompasses all other effects of energy systems on human health, such as those produced by particle emissions from diesel engines and mercury emissions from coal power plants. These capabilities thus loosely involve SDG3, but also extend beyond the scope of this goal.

It is particularly relevant that the Capability Approach also acknowledges the positive impact of technologies on human lives. In the context of *life* and *bodily health*, shelter or protection from adverse or severe weather are essential, and energy technologies can be very useful in addressing these issues. The same is true of clean water, which is called for in SDG6. This positive view of technology is particularly useful for sustainability analysis as it provides the opportunity to devise and design new (energy) technologies and to plan a sustainable energy future in a constructive way. While traditional ethics of technology is often charged with only placing blame on technological development without contributing any constructive criticism, this charge is thus not applicable to capability theories. Moreover, since capability theorists point out the social embeddedness of technologies, this allows for fruitful synergies between human well-being, technologies, and the social and the natural environment.

The energy system also impacts the central human capabilities that Nussbaum groups together under the term *emotions*. For example, accidents in power plants or extreme weather events due to climate change cause grief due to the loss of friends and family or due to loss of habitat. Climate refugees in Africa flee from water scarcity; some residents of Germany are resettled as a consequence of lignite production. There are also certain fears that overstate the actual risks, such as the fear of radiation emitted from a nuclear power plant or the fear of electro-smog from high-voltage power lines; these risks are

not real, but this fear may nevertheless affect people's capabilities. A capability perspective on energy is thus sensitive to the perceived risk. This is less to the fact that it is often perceived risks that shape people's behavior [45,46], but due to accepting peoples emotional responses. Although the formulation of the SGDs is of course motivated by human suffering, or rather the goal of reducing it, these emotional aspects addressed within a capability framework are hardly present in the SDGs.

The core capabilities that Nussbaum subsumes under *cognitive abilities* are relevant for the energy system in cases where certain aspects of the latter are taboo. In some countries research into climate engineering or nuclear fission is difficult to fund. This may act as an implicit taboo against further investigation and thus may prevent education or research on these topics. It should be noted that the argument here is not for (or against) geoengineering; rather, it is to stress that this aspect of the public discourse on energy is relevant to human well-being as understood along the lines of Nussbaum's Aristotelian-inspired version of the Capability Approach. Financing for research (or the lack thereof) is yet another aspect that the SDGs are largely silent about, although it connects to institutional considerations that are part of SGD 16.

There may be positive impacts from energy systems on what Nussbaum subsumes under *sense, imagination, and thought*. Energy systems make human life easier and thus allow more time for people to make use of their cognitive abilities. The decision to use a particular energy technology can also increase intellectual potential as it promotes research and development in that field. The promotion of renewable energy technology in Germany through the Renewable Energy Sources Act for example, has led to improvements in renewable energy technology. In its original form, the *Erneuerbare-Energien-Gesetz* (EEG) ensures that electricity from renewable resources can always be fed into the grid and is guaranteed a fixed price, called the "feed-in-tariff".

The core capability of *practical reason* refers to the capability to develop a conception of 'the good' and of 'the good life'. It also entails the capability to plan and critically reflect on one's own life. The central capability of practical reason relates to energy in the critical reflection on personal energy use and the preferred energy system. Such critical reflection is essential because the energy system has an enormous impact on human beings and their environment, but this reflection is only possible if decisions in the energy sector are sufficiently transparent and citizens are sufficiently knowledgeable about the field. This capability thus relates to SDG16, which is concerned with institutions, as well as SDG4, which addresses quality education.

Affiliation refers to the capabilities of social interaction and identifying with others, and is thus central to what [42] hold to be an important motivation for sustainable behavior. In connection with affiliation, *distributive justice* is of central importance to the energy system, as it concerns questions regarding the effects of energy policy regulations on the distribution of the positive and negative impact on different parts of society. Moreover, affiliation is also related to *restorative justice*. If the negative impact and benefit of the energy system affect different people in different ways, one may have to consider, for example, compensation for those living in close proximity to a power plant. Questions of *trade or exchange justice* also have to be taken into account. For example, the contract between generations can be understood as an exchange in which we leave an intact environment and raw material reserves or equivalent energy sources for future generations, and we can expect the following generations to care for us when we get older [47]. Note that this three-fold classification of justice is in a sense perpendicular to the tri-partition within the emerging field of energy justice. In the latter, distributive justice is distinguished from procedural and recognition justice [48–50].

Nussbaum lists *trust* and *connectivity* as two core human capabilities. While trust refers to the ability to bond with people, animals or things, expressed, amongst other things, in feelings of love, mourning, or longing, ecological connectivity subsumes the ability to sympathize with animals, plant, or nature more generally and develop a relation to the non-human environment. In [27] we re-interpreted these core capabilities for these energy system in the following way as both core capabilities in Nussbaum's Aristotelian denomination seem to be not suited to directly address energy-related issues. As some kind of continuity and stables in one's environment seem prerequisite

for trust, we suggest to see large-scale ecological changes as one aspect of trust, while the smaller, direct environmental impact of the energy system falls under ecological connectivity.

Control over one's environment in the sense of autonomy (Nussbaum uses the term 'separateness') is the central capability of living one's own life and not someone else's. In the form of electricity, energy can promote an autonomous life in various ways. However, it should be noted that energy can also detract from autonomy, since the more a person depends on the availability of energy in order to secure her independence, the more she depends on a complex network that involves the mining of raw materials and the generation of electricity and heat, and thus the less autonomous she is. Nussbaum labels a second aspect of the control over one's environment *strong separateness*. This means that human beings need to be able to influence their social context, such as through political participation. In this regard the degree of participation that is possible in various elements of energy systems is important. For example, in Germany *Bürgerenergie* (civilian energy) currently enables local people, particularly in rural areas, to participate directly in the energy supply system [51]. These aspects are echoed to some extent in SDG16, which also focuses on political institutions, but the capability perspective is much broader.

6. SDGs versus Capabilities for a Sustainable Future

The introduction to the 2030 Agenda for Sustainable Development states in paragraph five that the SDGs are "universal goals and targets which involve the entire world, developed and developing countries alike. They are integrated and indivisible and balance the three dimensions of sustainable development". The analysis in this paper has shown that while the first goal of universal targets that hold for different areas of the world is both untenable and counterproductive to realizing a sustainable future, the second goal of integrated and indivisible goals is not in fact realized in the SDGs.

Let us begin with the latter. We have argued that recent research in ethics and social studies of technology, which contends that energy and other technologies can only be considered as a sociotechnical system rather than in isolation, is not taken into account in the formulation of the SDGs. Their underlying analytic distinction between human well-being, the natural environment, and technology hinders the perception of synergies among the three. We contend that the Capability Approach as devised in the preceding discussion is able to provide an overarching framework for sustainability analysis that is genuinely able to illuminate these interconnections. The following example can elucidate this. From a capability perspective, while the reduction of freedom of future generations due to nuclear waste has a negative impact, it may well be that the disadvantages of other energy conversion technologies outweigh the drawbacks of a nuclear repository. But what about the dangers of nuclear proliferation? Here it is of utmost importance that the technology not be considered in isolation; rather, we must take into account the political institutions that may control transport and ownership of fissile material. In working constitutional states this risk may be very different from the risk in dysfunctional political and constitutional order as for the former institutions may coordinate surveillance of fissile material. The capability approach easily allows us to integrate institutional design as a possible solution to technological problems, which are all too often addressed solely via technological design. In general, it can be said that energy technologies are too complex to allow for a simple black and white classification as good or bad [43]. Instead, seemingly (non)-sustainable conversion technologies such as those that use nuclear or renewable resources must be evaluated as part of the larger sociotechnical system. The simple equation of sustainable technologies with renewable energy in the SDG targets is too hasty.

This points to another feature of the Capability Approach, namely that a capability-theoretical evaluation is highly sensitive to context. This context may be spatial (i.e., in which country is the technology implemented? what institutions are in place there?) or temporal (are we talking about changes in the near or the long-term future?). As in other sustainability concepts [52], this context sensitivity is shown in the operationalization of the capabilities. However, for the Capability Approach this context sensitivity goes beyond the indicators and also emerges on the level of targets. This has been

referred to as underdetermination of the Capability Approach and renders it very well suited to address ethical issues in modern technologies [7].

This underdetermination, presented as an advantage here, also presents serious challenges for a capability-theoretical approach to sustainability as it aggravates the difficulties of putting the approach into practice. Any operationalization of the Capability Approach is already hampered by the fact that capabilities are difficult to measure, and functionings are in practice often used as proxies (such as in the HDI or other indicators that build on the Capability Approach). These questions, however, cannot be addressed from a merely conceptual perspective, but require a multi- and trans-disciplinary approach that is highly sensitive to the respective context. The openness of the Capability Approach to these considerations is often stressed as one of its advantages. Though normative and positive dimensions are an integral part of all versions of the Capability Approach [30], this paper focused on the former as it aimed at a conceptual analysis of SDG7 and energy capabilities.

Another concern that has been raised in the literature is how to connect the individualistic basis of the Capability Approach with the systemic level of sustainability considerations. We want to stress that the individualistic focus of the Capability Approach, among others things, allows us to address motivational issues and to explicate the impact of a sustainable development on the individual. We thus hold that this open question is not a disadvantage particular to the Capability Approach; rather, though it is not trivial, this is a question of aggregation that is faced by any theory of well-being.

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