sustainability

MDPI

Review

Sustainable Energy: Concept and Definition in the Context of the Energy Transition—A Critical Review

Edward Halawa

Faculty of Science and Technology, Charles Darwin University, Darwin, NT 0810, Australia; edward.halawa@cdu.edu.au or e.halawa@gmail.com

Abstract: The term sustainable energy is very familiar to all of us, yet its exact definition or meaning has so far been vague. To date, the widely adopted definition of sustainable energy has been inspired by the definition of sustainable development formulated more than 30 years ago in *Our Common Future—the UN's Report of the World Commission on Environment and Development*. The current definition conceals the true spirit of the report, and this has some ramifications. It raises the question as to whether we have put too much emphasis on attaining the future dimension of sustainability in the middle of a situation where energy survivability is in fact the real issue in many parts of the world. In this paper, the role of energy in sustaining the livelihoods of low-income communities is discussed. The existing definition of sustainable energy that the whole world seems to have embraced is looked at critically and its downsides exposed. The identified pillars of sustainable energy and the associated issues are discussed, and the need for an additional pillar, i.e., *affordability*, is discussed and called for. This paper will argue that the *global* definition of sustainable energy seems inappropriate and should be jettisoned, and a more realistic definition should be formulated, adopted, and embraced at the local (i.e., national or regional) level taking into account local attributes and factors. The current push for a transition from the reliance on conventional energy sources to "cleaner" energy sources (generally associated with renewable energy) has further exacerbated the issue of energy affordability that has made the conditions even more dire for so many groups of the world's population. In the midst of this situation, those who push for a rushed energy transition seem to be those who also produce an unsustainably high carbon footprint but who can easily offset their carbon footprint through the 'net-zero' concept.

Keywords: affordability; climate change; energy efficiency; energy justice; energy survivability; energy transition; global warming; global boiling; renewable energy; sustainable development; sustainable energy

Citation: Halawa, E. Sustainable Energy: Concept and Definition in the Context of the Energy Transition—A Critical Review. *Sustainability* **2024**, *16*, 1523. https://doi.org/10.3390/su16041523

Academic Editor: Francesco Nocera

Received: 18 December 2023
Revised: 31 January 2024
Accepted: 3 February 2024
Published: 10 February 2024

1. Introduction

In a recent article published in the Australian Financial Review, McCubbing and Fowler [1] reported on the rise of energy affordability issues among low-income Australians, while on the other hand, "*Wealthy Australians are buying solar panels and ordering electric cars*. . ." This is occurring in one of the world's developed countries, which is among the richest in terms of its natural (including energy) resources, and a member of the Organization for Economic Cooperation and Development (OECD) [2].

Energy is one of the major drivers for the sustainable livelihoods of low-income communities [3–5]. According to Vera and Langlois [3], energy "*is vital for eradicating poverty, improving human welfare and rising living standards*". The same researchers point to the following facts all of us are already aware of, that is, that "*Electricity particularly*. . . *is an important and sometimes irreplaceable input to modern productive activities, dissemination of information and other services industries*" [3] (p. 879).

Many other studies (e.g., [6–8]) have demonstrated the link between increased energy demand and rising living standards. Rising living standards, as observed in developing

countries [6], increase the need for energy-consuming appliances. These new appliances (for instance, electric or gas stoves) function among others to ease the physical efforts to perform daily activities, to move from one place to another (motor vehicle), or to attain thermal and visual comfort (air conditioners and lights), communication (cellphones), entertainment (music player/recorder, television), education, etc. The above observations are good examples of how energy plays a crucial role in helping people survive, and to some extent, start enjoying a more comfortable life and empower them to prepare for a better future.

The current push for the energy transition from "dirty" conventional energy resources to "cleaner" energy resources can potentially threaten—or in many situations has already started threatening—the little luxury these low-income communities have started to and are currently enjoying. *Sustainability* is a luxurious word for them. The energy transition push has pushed them back to the state of *survivability*.

This paper revisits the widely cited/adopted definition of sustainable energy and its pillars. It proceeds by contrasting the state of survivability with the state of sustainability of groups of people having different levels of access to resources. This is followed by a detailed discussion of how the definition was formulated and its ramifications. The important elements or messages originating from the Brundtland Report [9], which inspired the definition, have resurfaced. This paper also critically looks at *horizontal* (current) and *vertical* (future) dimensions of sustainability and contends that its current (widely adopted) definition has put too much emphasis on the vertical dimension and largely overlooks the horizontal dimension with all its implications. The two sustainability paradigms are briefly discussed to give a perspective on pathways to sustainability. The identified pillars of sustainable energy and the issues associated with them are discussed. *Affordability* has often been neglected in the discussions of sustainable energy, and it should be formally declared and adopted as a new pillar. In dealing with immediate issues of sustainable energy, the global definition seems inappropriate and should be jettisoned, and a more realistic definition should be embraced, taking into account local attributes and factors. This paper also critically looks—albeit briefly—at energy transition, its challenges, and its ramifications. Is the world ready for such a transition? Is a hasty energy transition the solution to the sustainable energy issue? Many seem to have been trapped into believing this amidst the constant and consistent narrative that the earth will soon be doomed. An unnecessary and tragic byproduct of this is a new mental health issue called eco-anxiety, defined as "*a chronic fear of environmental doom*" [10].

How urgent is the action to tackle the impacts of climate change or global warming? Annual meetings of the Conference of the Parties (COPs) organized by the United Nations Framework Convention on Climate Change (UNFCCC) can be considered as the main indication of its urgency. A recent statement by the UN Secretary-General António Guterres on the arrival of "*the era of global boiling*" [11]—implying that the worst is yet to come—can be added to that. This paper briefly discusses how that urgency is indeed not always demonstrated.

2. What Is Sustainability?—Overview of Current Definitions

At one stage, the Oxford English Dictionary [12] defined sustainability as "*the ability to be maintained at a certain rate or level*". Another definition given by the same dictionary at that particular time was "*avoidance of the depletion of natural resources in order to maintain an ecological balance*" [12]. About 6 years later, the definition changed slightly to "*The quality of being sustainable at a certain rate or level*" [13]. The word sustainable is currently defined as "*capable of being maintained or continued at a certain rate or level*" [14]. Despite minor changes in the wording of the definition, the meaning is essentially unchanged.

The above definition implies that the ones concerned have already tasted and are enjoying the goodness and abundance of resources, which is the logical reason to sustain them. Sustainability in this context means prolonging the periods through which this state of abundance can be enjoyed. This also means that the state of abundance should be enjoyed

not only by the present generation but also by future generations. Sustainability's second definition in [12] takes into account the impact of resource extraction on the environment.

The level of energy consumption per capita in the developed world is many times that in the developing world, making it relevant or imperative to approach the situation using the term *sustainability*. This is in stark contrast with the situation in the developing world (and even within certain groups in the developed world), where people are still in the state/stage of very limited energy consumption, mainly to sustain their very basic lifestyle. For these groups of people and communities, *energy for survival*, or *energy survivability*, may be more appropriate terms to depict their energy consumption state of affairs. *Survivability* implies the existence of threats and or emergency situations. There are many examples of such threats that are part of our daily lives, or the lives of many groups of communities.

In the tropical region, many communities are used to living in and surviving persistent hot and humid air (also called thermal discomfort), and this seems to have largely been dismissed as "*normal*", "*that's how people live in the tropics. . .!*" However, these anecdotal observations seem to point to a different or interesting reality. Malls and shopping centers are filled with people from all walks of life enjoying being there as long as they possibly can. They may not buy anything, but they enjoy being there. Why? There are many reasons, but one should not overlook the fact that at malls or shopping centers, people feel thermally comfortable; the air is cooler and drier—enabling peoples' body heat to dissipate, which has been explained thermodynamically and confirmed by an earlier study of thermal comfort [15]. They enjoy the more spacious ambiance there as opposed to when they are in their houses or sheds. They also experience audio and visual comfort there from adequate lighting levels and generally lower decibel noise, plus musical entertainment.

The above anecdotal observation seems to have been confirmed by an International Energy Agency (IEA) report which observed that homeownership of air conditioning (AC) systems is directly related to people's income and economic development [16]. The same report also noted the faster increase in AC system ownership in the "*hottest and most humid countries*". The natural adjustments, such as those observed in [17], therefore can be considered as "*merely a delayed pursuance of real thermal comfort due to economic unaffordability*" [18] and cannot simply be dismissed as *normal* or *natural*. In other words, people of low-income levels are as eager as people of high-income levels when it comes to pursuing various kinds of comfort, including—in this case—thermal comfort. This explains why simplistic but seemingly *scientific* approaches to various kinds of human subjective comfort—such as adaptive thermal comfort [19,20]—should be revisited and questioned [21].

These examples of the pursuit of this little free luxury show how people endeavor to escape the survivability state of open air and in their own homes and want to enjoy a more comfortable state of life. Unfortunately, for many people, such a little luxury can only be found in commercial buildings, malls, and shopping centers. And so, when these people want to escape all these kinds of discomfort, they have to go to these crowd-attracting places.

Recurring physical and psychological inconvenience or discomfort due to hot or cold weather, heavy rain, flood, traffic jams, noise, etc., are still the daily experience of people in many parts of the world, and therefore, *survivability* is in fact their main concern and struggle. To this group of people, the new term "*climate crisis*" or "*climate emergency*", a term coined by people who may never experience this state of survivability, is, in fact, a daily reality and not necessarily due to the impact of *climate change*, *global warming, or global boiling* but simply due to their inability to afford to have their own comfortable climate chambers in the form of more energy-efficient houses, more comfortable means of transportation, etc. In these circumstances, the term sustainability is simply irrelevant and becomes a mocking word to their ears. It is the survival of these people that is at stake. In such circumstances, the vertical (future) dimension of sustainability is irrelevant; and it is the horizontal dimension (present generation) that is often ignored.

Since—as mentioned above—energy plays a crucial role in sustaining a comfortable life, the currently very low energy consumption level per capita of the majority of people living in the developing world—and in low-income communities in the developed world—must be raised to a more acceptable level and not just left at the *survivability* level.

Table 1 summarizes the issues regarding the terms *sustainability* and *survivability*. As shown, the people in the *sustainability* group (those very much concerned with sustaining their existing enjoyment of current resources and wishing to pass them to future generations) enjoy a state of abundance, and they also enjoy overconsuming resources and generating more waste. On the other extreme, the *survivability* group struggles with all kinds of scarcity (housing, food, energy, water supply, etc.). They may have untapped resources in their vicinity, but their consumption level of resources and services is often less than they deserve as human beings.

Table 1. "Sustainability" Group vs. "Survivability" Group.

"Sustainability" Group	**"Survivability" Group**
State of abundance	State of scarcity
Overconsumption	Underconsumption
Waste	Waste
Environmental degradation (mainly due to overconsumption and waste)	Environmental degradation (due to lack of technologically sound means of mining, tapping, processing, and utilizing the resources)

Both groups of course pose a degrading impact on the environment but for different reasons. The *sustainability* group's impacts on the environment are due to overconsumption and associated waste. The survivability group, on the other hand, creates environmental degradation due to the lack of technologically sound and economic means of *mining*, *tapping*, *processing*, and *utilizing* their resources.

3. A Critical Look at Existing Definitions of Sustainable Energy

In a report on *Energy Efficient Design*—quoting the Brundtland Report [9]—Ambrose et al. [22] presented the sustainable energy definition as

"*Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (Brundtland Commission, 1987).*" (The underlined words are from the author of this review paper).

A definition similar to [9,22] can be found in the document prepared by Lemaire [23], called "Glossary of Terms in Sustainable Energy Regulation", which reads, "*Sustainable Energy: Effectively, the provision of energy such that it meets the needs of the future (present) without compromising the ability of future generations to meet their own needs. (See Sustainable Development). Sustainable Energy has two key components; renewable energy and energy efficiency*". (The word "future" here was probably meant to be "present").

The definitions of sustainable energy in [22,23] are essentially an adoption of the definition of sustainable development from the Brundtland Report [9], with the word "energy" replacing the word "development". Many other scientific articles and reports online (or printed texts) adopt the same definition.

Two keywords in this definition need special attention, namely *present generation* and *compromise*. The *present generation* should mean all people living currently on this very planet, with no exception. However, as mentioned earlier, the needs of the majority of this present generation have not been met; they have not been satisfied. In other words, the needs of the majority of the present generation have already been or are currently being *compromised*. In short, to date, the horizontal dimension of sustainable energy has largely been ignored, and the focus has been on the vertical dimension. This can easily be

explained by the fact that energy policies at national and global levels have largely been influenced—if not directed or controlled—by the previously mentioned *sustainability* group.

Only through the acknowledgment of this situation and making a concerted effort to improve it can the noble goal of sustainability be achieved. Unfortunately, the current definition does not seem to have adequately addressed this very concern; hence, it needs critical review and revision. This presentation does not attempt to present an alternative to the existing definition; however, it draws attention to a number of elements found in the Brundtland Report [9] which should be conveyed in the new (revised) definition.

4. How Was Sustainability "Defined" in the Brundtland Report?

The document from which some words were adopted to formulate the sustainable energy definition is titled "Our Common Future" [9] and is the report prepared by the World Commission on Environment and Development of the United Nations. This report is popularly known as the Brundtland Report, named after Gro Harlem Brundtland, who chaired the commission and who wrote the foreword for the report.

The report consists of an overview titled *Our Common Future—From One Earth to One World* as part of the main report, *Our Common Future*. Both the overview and the main report contain the words that appear in the sustainable energy definition being discussed.

The first heading of the overview of the report—*The Global Challenge*—contains the subheading "3 Sustainable Development", which consists of four paragraphs, i.e., paragraphs 27–30. As shown, the first sentence of paragraph 27 contains a group of words, "*meets the needs of the present without compromising the ability of future generations to meet their own needs*", which are employed to define the term *sustainable development* as we know it today. And this definition was also directly borrowed to define the term *sustainable energy* as we know it today.

Unfortunately, the current definition of sustainable energy ignores the important aspirations and messages contained in paragraphs 28–30 of the report, as shown in Table 2.

Table 2. Main Elements of Sustainable Development in the Brundtland Report [9].

No	Message
1	Sustainable development requires "*meeting the basic needs of all and extending to ALL the opportunity to fulfill their aspirations for a better life*".
2	That endemic poverty "*always be prone to ecological and other catastrophes*".
3	The report requested that the poor "*get their fair share of the resources*" to sustain economic growth.
4	Sustainable development entails political systems that secure *effective citizen participation in decision making* and greater democracy in international decision making.
5	That sustainable global development "*requires that those who are more affluent adopt lifestyles within the planet's ecological means—in their use of energy, for example*".
6	That "*painful choices have to be made*".
7	That "*sustainable development must rest on political will*".

The explicit definition of sustainable development is presented in the first sentence of the first paragraph of Chapter 2: Towards Sustainable Development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." It contains within it two key concepts:

· The concept of "needs", in particular, the essential needs of the world's poor, to which overriding priority should be given;

· The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

The main elements—the main spirits of the report regarding sustainable development—are missing from the sustainable energy definition that has been embraced today. Without further elaboration, all seven elements listed in Table 2 can hardly be seen as having been implemented in any policy at any level after the publication of this report. Perhaps one exception to this statement is in regard to element 6, that "*painful choices have to be made*". It is not an exaggeration to say that almost all "*painful choices*" being made/implemented have compromised the needs of the majority of the present generation who are in the survivability state/group: rising energy bills and deprivation from the enjoyment of little luxuries of life, such as thermal comfort, audio comfort, etc.

5. Attempted Revision of "Sustainable" Definition

There have been a number of attempts to redefine sustainable energy. One such attempt was by Tester et al. [24], who proposed the following definition: "*A dynamic harmony between the equitable availability of energy-intensive goods and services to all people and the preservation of the earth for future generations*".

This new definition, however, has not yet gained widespread attention. On the positive side, people have started to become familiar with inspiring terms such as *energy justice* [25] and *climate justice* [26].

While the current definition of sustainable energy—inspired by the Brundtland Report—talks about the needs of the current generation (horizontal dimension), as well as the needs of future generations (vertical dimension), it lacks detail or clarity as to how these needs—especially of the present generation—are or will be satisfied. This lack of detail or clarity may have been the main cause of controversies in energy policies formulated at regional, national, and global levels.

6. Pillars of Sustainable Energy

Having discussed the main drawbacks of the current definition of sustainable energy, it is worth looking at its pillars or main components. Researchers have identified energy efficiency and renewable energy as the twin pillars of sustainable energy [27]. The reasoning behind this is as follows. Assuming no economic growth, energy efficiency will slow down the growth of energy demand. However, economic growth is always needed, and therefore, energy efficiency alone will not curb the energy demand; in fact, it provides a stimulus to increase energy demand. An increased renewable energy uptake is aimed to reduce the reliance on fossil fuel, which is still the main source of energy. In existing systems, energy efficiency will make better use of renewable energy in terms of its reduced system size and cost.

In order to reach that *ideal* situation, significant investment is required to improve energy efficiency and renewable energy technologies. For the latter, there are a number of solar technologies, such as discussed in [18], which have limited technical and commercial viability due to their inherent technological drawbacks. In another instance, the energy efficiency performance of a solar energy system was ignored in its rating methodology, whose main aim is to boost renewable energy production [28–30]. In addition, not every region has good renewable energy resources. As a result, in general, prior to technology maturity, the cost of such systems is economically prohibitive. This is why, in many cases—where massive government intervention is required to significantly increase the uptake of renewable energy—subsidies are inevitable. To date, in many cases, subsidies have been enjoyed mainly by those who can afford to procure renewable systems.

A little more than 40 years ago, a *Global Power Grid* in which renewable energy would play the main role was proposed [31]. A recent review of the possibility of this idea within the Australian–Asian region [32] was to some extent inspired by this grand vision. While this intercontinental grid connection is technically viable, economic, social, political, and managerial challenges are almost insurmountable, at least for the foreseeable future [32].

The omission of "affordability" [33,34] as a pillar has had mixed results so far; on the one hand, technological advancement gives rise to technological innovations and

reduced prices of renewable energy systems. But this comes at the expense of low-income communities suffering from escalating energy prices. In the case of Australia, for instance, affordability has made solar power an option only for middle- to high-income households, with low-income ones left behind [35] with increased energy bills.

Even those who can afford and have already installed renewable energy systems, in this case, rooftop solar PV systems, their dream of much lower energy bills has already been shattered by decreasing feed-in-tariffs for the energy production they export to the grid, currently at AUD 0.05/kWh or less [36].

For households that intend to or already have installed rooftop solar PV systems, Saman [36] discussed a number of practical methods to maximize their savings. These include (1) the use of efficient appliances, (2) running appliances during times of high solar radiation, and (3) choosing a retail electricity plan that best matches one's needs. While the first two approaches are implementable, they may not all be practicable due to technical and economic reasons for some of the system owners. While it is true that energy-efficient appliances will reduce energy consumption in some circumstances, they may actually boost energy consumption in other situations, especially for people with high incomes, where energy efficiency measures will enable them to explore and further enjoy various kinds of comforts. This is of course against the appeal made in the Brundtland Report [9], which urges people "*who are more affluent*" to "*adopt lifestyles within the planet's ecological means—in their use of energy*. . ." Households also do not have much choice in terms of a "retail electricity plan". Energy retailers keep adjusting their profit margins amidst the aggressive penetration of solar rooftop systems into the grid.

A relatively recent study conducted on energy consumption among low-income earners [37] indicated that, because of their already very low energy consumption level, further reduction in energy consumption could result in compromising their (thermal) comfort. This is in line with the survivability state discussed in Section 2.

This brief discussion should now help clarify why renewable energy should not always be associated with sustainability. The Brundtland Report [9] uses the term *sustainable form of renewable energy*, which implies that some renewable energy resources and systems cannot be sustainable alternatives to conventional energy sources/systems. Without a formal declaration by energy policy decision makers to add *affordability* as the third pillar of sustainable energy, the role of renewable energy in sustainable energy transition is limited. In fact, for the sustainable energy definition to properly work to avoid *compromising* the needs of low-income groups of the present generation, economic affordability must be the pillar that is highlighted at the decision-making level. This can only be addressed if sustainability is formulated at the national or regional level, *not* at the global level, where the voices of the people who fall into the survivability group are hardly heard while their needs are largely compromised. The beautiful and inspirational wording of the Brundtland Report [9], which till now is still *on paper*, is a direct testament to this observation and assertion.

7. Sustainability: (Un)Sustainable and (Un)Just Energy Transition

The energy transition concept is perhaps as old as the history of mankind. Energy is crucial to human survival; and, as human knowledge improves, the ways energy is produced from various sources and utilized constantly change, in line with human technological advancement. Hence, naturally, energy transition has been an integral part of human civilization.

In the current discussion, however, we should focus our attention on the energy transition being pushed globally by world institutions—notably institutions under the umbrella of the United Nations (UN). In this context, energy transition has been defined as "*a continuing process requiring long-term energy strategies and planning, with a country-tailored focus on applying appropriated energy technologies to reach net-zero emission*" [38]. Net-zero emission means "*achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere*" [39].

On paper, this definition is quite appropriate; it emphasizes the role of individual countries in choosing appropriate technologies to reach "net-zero emission". In reality, however, the push for the energy transition is practically associated with proposals for the total abandonment of conventional fossil fuel resources and an accelerated switch to renewable energy sources deemed to be cleaner. This happened at the recent COP28 meeting in Dubai, where some countries wanted the COP28 draft to include the words *phase out* [40]. It can also be observed that this UN-led annual forum is not a very effective forum to discuss, let alone to come up with, the solution to the impact of so-called *climate change* and *global warming*, let alone *global boiling*. This is evidenced by several declarations during the forum from various groups representing countries with common interests in this particular matter [41].

Fossil fuels have been playing a crucial role in raising community living standards in many parts of the world. In essence, these poor communities cannot go without fossil fuels, which they need to transport their products to nearby community markets, to operate their fishing boats, to go to the town a few kilometers away from their village to buy household needs, or simply to ease their physical burden by cooking using kerosene stoves, etc. An article in a UN chronicle [42] conveys some invaluable points in relation to emission reduction which are still relevant today. These include that (1) emission reduction should not mean abandonment of fossil fuels, (2) in line with the arguments laid out in Section 6, energy efficiency and renewable energy are not sufficient, (3) there are many energy systems that cannot simply be replaced by renewable energy systems, and (4) the aggressive push to phase out fossil fuels will not be considered a reasonable solution by developing countries that have untapped fossil fuel resources.

In short, in its implementation, energy transition should—or more appropriately must—always be inspired by the noble ideas breathed into the discussion and definition of *sustainability* by the Brundtland Report [9] to avoid an unsustainable and unjust transition. Given the issues discussed/raised above, the energy transition in its current state can hardly be deemed "*crucial for sustainable development, impacting inclusive prosperity and social justice*", as stated in [43].

8. A Brief Note on the Urgency to Act "Now"

From the author's anecdotal observations, there are at least three reasons why some people are skeptical about the urgent call to act "now" in relation to actions to minimize the impacts of climate change or global warming. *First*, there seem to be personal anecdotal observations or thoughts that point to the fact that the impacts of so-called global warming may not necessarily always be disastrous. For instance, rather warm temperatures may in fact benefit people in colder climatic zones—especially the low-income groups—in terms of reduced heating energy requirements. These are the present generations mentioned in the Brundtland Report [9] whose needs are being compromised by practically all policies on climate change, global warming, sustainable energy, and energy transition. This is in line with Gates' own experience and observation [44] (p. 26).

Secondly, there seems to be a *business-as-usual* attitude among people who are at the forefront of the campaign against the impacts of climate change/global warming. For instance, Gates admitted that his "*carbon footprint is absurdly high*" [44] (p. 14), although he pledged to be carbon neutral in 2021 [44] (p. 15). Another very relevant and related example is annual events discussing climate change which create a significant amount of carbon footprints (CFs) [45]. Using common sense, people can easily make a comparison between the CFs of those who travel to attend such a meeting with the CFs of those who live in the condition of survivability (see Section 2) on a daily basis, who have no fridge in their kitchen, who also do not add environmental burden to nature by opening cans of refreshing drinks, and whose children travel few kilometers daily to reach school to prepare for their future. Again, these are the groups of people classified in Brundtland's sustainability definition as the present generation whose needs are being compromised on a daily basis! On the positive side, despite their survivability struggle on a daily basis, they and their

children do not suffer the new mental health disease of the 21st century, eco-anxiety, where those who are suffering from it see no future for themselves, perhaps because they think the water level will reach their neck or that they could not cope with the unbearable heat, even though they currently enjoy a comfortable life in their air-conditioned house. These two examples fail to show how they lead to the way to avoid the so-called *climate disaster*.

Thirdly, the mainstream narrative has been on *mitigation*, while the other option—*adaptation*—has been largely overlooked. It is interesting, or rather surprising, that Gates [44], who advocated mainly for the mitigation option, failed to refer to a book that advocates for adaptation [46] that was published earlier. Since energy transition will impact all humanity, it is common sense to expect that all the stakeholders—including the experts with opposing opinions—should consider as many options as possible before adopting the most viable option(s) technologically, economically, socially, and environmentally.

The skepticism discussed above should not be construed as an attitude of *burying one's head in the sand*; rather, it should be considered as a positive contribution toward identifying/establishing more sustainable pathways that avoid compromising the needs of the current generation—especially those who are in the *survivability* state. This kind of skepticism, the author believes, is much more valuable and constructive than the alarmist attitude that has caused some people to suffer eco-anxiety. This new mental health issue would have not come into being had the so-called *climate experts* and public figures come up with more careful statements which cannot be easily misunderstood or misinterpreted by the public. Phrases describing climate change such as "*the biggest threat to humanity*" [47] or "*the era of global boiling has arrived*" [11], while they might convey some truth, will not solve the issue at hand. They just create unnecessary panic, and they can potentially be distracting and take necessary attention from the issues and threats being experienced daily by the people from the survivability group (see again Table 1). Credit should be directed to Gates [44] who admitted that climate science, our knowledge about how the climate "is changing", is far from being settled [44] (p. 24). Unfortunately, such honest statements or acknowledgments will never be as *viral* as the alarmist news that the public watches on television or social media platforms on a daily basis.

9. A Brief Note on the Complexity of Climate Modeling/Forecasting

The main reason for our limited understanding of the climate, according to Gates, is that it is "*mind-blowingly complex*". Our tools to study such complexity are computer models, which are "*far from perfect*" [44] (p. 24). And, in order to gain a little grasp of what is going on in such a complex scientific object, experts make many simplifying assumptions. Assumptions made by researchers or experts should also make them humble, and every time they go public with their scientific findings, they should not forget to remind the public about the limitations of their findings. On the other hand, the public should always be warned about the limitations of science; in fact, they should always start with a skeptical attitude [48]. This is not to dismiss science as *lacking value* or *lacking credibility*; rather—on the contrary—it makes science stronger, as it is built on a more solid foundation. Those interested in climate models should refer to [49], and a recent Intergovernmental Panel on Climate Change (IPCC) Report on climate change discusses in detail its impact, human adaptation, and vulnerability [50].

10. Who Should Define Sustainable Energy?

It is clear that the "global" definition of sustainability (including, in this case, sustainable energy) is practically irrelevant, prone to misuse and abuse, and in fact, can prolong the "survivability" period for some groups of people. A more realistic approach is to define the term with local attributes and factors taken into account. After all, it is the local prevailing conditions that dictate the options and viable paths to sustainability. It is due to this very reason that the current paper avoids proposing a new or revised definition of sustainability. Instead, this paper offers some thoughts for the relevant authorities on what they should consider when defining the sustainability that is suitable to their specific

region. Rather than entirely focusing on the "future", there should be a concurrent effort to look for solutions to the following challenges or issues.

Firstly, there is the empowerment of *survivability* groups to obtain better access to more "reasonable" levels of the enjoyment of resources. One recent example of the potential success of this approach comes from fishery. According to the research in [51], securing fishing rights and rebuilding traditional small-scale community fisheries around the world could recover the global fish populations to a healthy level. Such an approach could be adopted in the energy sector. After all, the uncertainty of having a secure supply of energy for the majority of people who are at the stage of survivability often leads to the *self-initiative* of exploiting whatever resources are available at hand at the expense of the environment. In this case, it is not only members of the future generation of that community who are at risk but also the current members. Therefore, the key solution to this problem is to provide them with at least the basic goods and services that enable them to improve their own quality of life. This of course rests on the political will of those in decision-making positions.

Secondly, efforts must be made to look for more rational pathways of exploitation and sharing of resources for the benefit of present and future generations. Sustainability is viewed from two opposing paradigms, namely the "weak sustainability" paradigm and the "strong sustainability" paradigm [52,53]. The tenet of the "weak sustainability" paradigm can be summarized as follows: future technology will take care of the needs of future generations. In this paradigm, the issue of scarcity is "*resolved through substitutability between natural capital and human-made capital*". On the other hand, "strong sustainability" asserts that not all natural capital is substitutable—some parts need to be preserved [53]. On paper, weak sustainability looks like focusing on the needs of the present generation and "forgetting" about the needs of the future generations and entrusting these needs to the hands of "backstop technology" ([54] as cited in [55]). However, given the issues currently being faced by the developing world in its effort to provide adequate levels of energy to its people and to maintain or boost the momentum of its development, its emphasis on caring for the present generation is logically and reasonably understandable.

This paper does not attempt to delve further into these two competing sustainability paradigms. However, it is worth noting the interesting discussions on this topic that have come about through the emergence of the *entropy* (and the *Second Law of Thermodynamics*) concept entering the thinking of sustainability theorists, such as those in [53,56].

Who then should define (energy) sustainability? This shall be the scope for political decisions at the national and regional levels. Inputs from academia are central to the proper formulation of the term at the decision-making level. Unfortunately, it seems many decision makers often simply choose experts, i.e., those who provide them expert advice to enable them to formulate policies—in this case, on energy transition and sustainable energy—*at random*. An article written by Sutherland and Burgman [57] discusses how these advisers "*make judgments and predictions*". According to this article, due to various "*cognitive frailties*", such as "*experts' values, mood, whether they stand to gain or lose from a decision, and by the context in which their opinions are sought*", their expert advice may not always be accurate or reliable. Policy makers should be aware of all the above frailties when choosing the most reliable expert advice and avoid being "*starstruck*" by expert seniority, publication records (with its own very real issue of flawed processes [58]), memberships to various scientific or professional bodies, etc. [57].

In a nutshell, the decision makers should be aware that the advice they receive from the experts they choose may not necessarily be the best advice from the field due to several factors mentioned above. In addition, in any scientific field, scientific opinions can vary within a broad spectrum, especially when dealing with complex systems such as grid-scale electricity systems. For instance, until recently, the levelized cost of electricity (LCOE)—the most popular economic measure employed to compare the cost of different energy sources—is still controversial among researchers [59–65]. The limitations of the LCOE are succinctly explained in [65], while the basics of renewable energy economics can be found in [66]. In such a controversial scenario, it is unwise for any decision maker to

simply take a side *at random*. A wiser approach would be to invite experts with opposing scientific views to present their respective opinions. This may not result in a consensus, but at least it will help decision makers to make decisions more wisely, convincingly, and responsibly.

11. Conclusions and Recommendations

1 Energy is one of the major drivers for the sustainable livelihoods of low-income communities. Lacking or limited access to energy makes this group vulnerable and stuck in a state of survivability. Their seemingly very natural adaptation to harsh environments, such as hot or cold weather, should not be considered "normal", as if they do not deserve more comfortable conditions like others with easy access to abundant resources, including energy.

2 The current definition of sustainability, including energy sustainability, has practically betrayed the spirit of the Brundtland Report from which the definition originated. Many of the elements, aspirations, and noble messages of the report have essentially been overlooked, resulting in the needs of the majority of the present generation being compromised. This can be explained by the fact, among others, that almost every energy policy at the local, national, and global level hardly mentions energy affordability as the third pillar of energy sustainability.

3 Energy policies at every level so far have benefitted the people in the sustainability group who have already tasted the goodness and abundance of resources, which seems to be the reason why this group is at the forefront in demanding concrete actions on sustainability. The benefits include subsidies for various energy systems which are still a luxury for the survivability group.

4 Contrary to common perception or belief, renewable energy is not always identical to a pathway to sustainability. Intermittency, reliability, geographical conditions, and associated costs are among the drawbacks of adopting these types of energy sources.

5 As the energy affairs of nations and regions are greatly diverse and complex, the global definition of (energy) sustainability is totally unjustifiable. A definition that takes into account the local context is more realistic and desirable, and it brings more fairness to the present generation whose needs are being compromised on a daily basis and who are in the constant predicament of survivability.

6 The is no energy policy decision without social and economic consequences; yet, in the majority of cases, it is the poor who suffer a lot, at least in the initial stage of the technological advancement. The question to be answered and reflected on is then whether we should continue to follow this classic path in our common goal of attaining sustainability.

7 Our knowledge as to why and how the climate changes is far from settled. It is a very highly complex scientific object. To study such a complex phenomenon, scientists rely heavily on computer models, which are far from perfect. Scientists who work on these highly complex scientific objects have to make many simplifying assumptions whose ramifications on the modeling outcomes cannot be easily quantified. As such, the political decisions based on this are very vulnerable to unpredictable errors with unpredictable impacts. Therefore, it is crucial that any advice coming from the so-called experts in this field is further scrutinized. Such a scrutiny mechanism needs to be established and should consist of experts from multidisciplinary scientific backgrounds, including those opposing the mainstream scientific narratives.

8 Experts should be humble and admit the limitations inherent in any scientific endeavor they carry out for the good of humanity and avoid being trapped into becoming a mere soulless tool in that endeavor.

9 In line with points 7 and 8, experts and public figures should endeavor to avoid sweeping scientific statements which can easily be misunderstood or misinterpreted by the public.

10 Energy transition has been an integral part of human civilization, and as such, it is inevitable. However, a hasty transition without properly considering all factors can potentially lead to more serious disaster(s) than the disasters that are supposed to be avoided.

Funding: This research received no external funding.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The author declares no conflicts of interest.

References and Notes

1. McCubbing, G.; Fowler, E. Energy Affordability Exposes Brutal Divide between Rich and Poor—An Article in Financial Review Published on 2 February 2023. Available online: https://www.afr.com/companies/energy/energy-affordability-exposes-brutal-divide-between-rich-and-poor-20230202-p5chex (accessed on 6 December 2023).
2. Australia and Oceania. Available online: https://education.nationalgeographic.org/resource/oceania-resources/ (accessed on 30 November 2023).
3. Vera, I.L. Langlois. Energy indicators for sustainable development. *Energy* **2007**, *32*, 875–882. [CrossRef]
4. Fan, J.; Liang, Y.; Tao, A.; Sheng, K.; Ma, H.-L.; Xu, Y.; Wang, C.-S.; Sun, W. Energy policies for sustainable livelihoods and sustainable development of poor areas in China. *Energy Policy* **2011**, *39*, 1200–1212. [CrossRef]
5. Wolde, Z.; Wu, W.; Ketema, H.; Karikari, B.; Liu, X. Quantifying Sustainable Land-Water-Energy-Food Nexus: The Case of Sustainable Livelihoods in an East African Rift Valley. *Atmosphere* **2022**, *13*, 638. [CrossRef]
6. Wolfram, C.; Shelef, O.; Gertler, P. How Will Energy Demand Develop in the Developing World? *J. Econ. Perspect.* **2012**, *2691*, 119–138. [CrossRef]
7. Paczynski, W.; Dabrowski, M.; Dewulf, L. The Relationship between Energy and Economic and Social Development in the Southern Mediterranean (7, February 2013). MEDPRO Technical Papers 2013. Available online: https://ssrn.com/abstract=2213797 (accessed on 12 December 2023).
8. Lambert, J.G.; Hall, C.A.S.; Balogh, S.; Gupta, A.; Arnold, M. Energy, EROI and quality of life. *Energy Policy* **2014**, *64*, 153–167. [CrossRef]
9. Brundtland Report. *The World Commission on Environment and Development—Our Common Future*; Oxford University Press: Oxford, UK, 1987.
10. Dodds, J. The psychology of climate anxiety. *BJ Psych. Bull.* **2021**, *45*, 256. [CrossRef] [PubMed]
11. Secretary-General's Press Conference on Climate. Available online: https://www.un.org/sg/en/content/sg/press-encounter/2023-07-27/secretary-generals-press-conference-climate?_gl=1*1fvejr*_ga*MTQxMjEwMjk4NC4xNzA1NDg3OTM1*_ga_TK9BQL5X7Z*MTcwNTQ4OTg0Ni4yLjEuMTcwNTQ5MDIyNC4wLjAuMA..*_ga_S5EKZKSB78*MTcwNTQ4OTgwMS4yLjEuMTcwNTQ5MDIyNS41OS4wLjA (accessed on 17 January 2024).
12. Oxford English Dictionary. Available online: https://en.oxforddictionaries.com/definition/sustainability (accessed on 30 August 2017).
13. Oxford English Dictionary. Available online: https://www.oed.com/search/dictionary/?scope=Entries&q=sustainability (accessed on 30 November 2023).
14. Oxford English Dictionary. Available online: https://www.oed.com/search/dictionary/?scope=Entries&q=sustainable (accessed on 30 November 2023).
15. Fanger, P.O. *Thermal Comfort: Analysis and Applications in Environmental Engineering*; McGraw Hill Book Company: New York, NY, USA, 1970.
16. Dean, B.; Dulac, J.; Morgan, T.; Remme, U.; Motherway, B. *The Future of Cooling: Opportunities for Energy-Efficient Air Conditioning*; International Energy Agency: Paris, France, 2018; Available online: https://www.iea.org/futureofcooling/ (accessed on 20 December 2021).
17. Feriadi, H.; Wong, N.H. Thermal comfort for naturally ventilated houses in Indonesia. *Energy Build.* **2004**, *36*, 614–626. [CrossRef]
18. Halawa, E.; Bruno, F. Energy Performance and Thermal Comfort Delivery Capabilities of Solid-Desiccant Rotor-Based Air-Conditioning for Warm to Hot and Humid Climates—A Critical Review. *Energies* **2023**, *16*, 6032. [CrossRef]
19. de Dear, R.J.; Brager, G.S. Towards an adaptive model of thermal comfort and preference. *ASHRAE Trans.* **1998**, *104*, 145–167.
20. Nicol, J.F.; Humphreys, M.A. Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy Build.* **2002**, *34*, 563–572. [CrossRef]
21. Halawa, E.; van Hoof, J. The adaptive approach to thermal comfort: A critical overview. *Energy Build.* **2012**, *51*, 101–110. [CrossRef]
22. Ambrose, M.; Delsante, A.; Miller, A.; Tucker, S.; Bell, J.; Demirbilek, N.; Mead, N.; Wales, N. *Sustainable Subdivisions—Energy Efficient Design*; Research Project No: 2002-063-B-02 Final Report; Cooperative Research Centre for Construction Innovation: Brisbane, Australia, 2004.

23. Lemaire, X. *Glossary of Terms in Sustainable Energy Regulation. REEEP/Sustainable Energy Regulation Network*; Renewable Energy & Efficiency Partnership: Vienna, Austria, 2004; Revised September 2010; p. 10. Available online: http://www.reeep.org/sites/default/files/Glossary%20of%20Terms%20in%20Sustainable%20Energy%20Regulation.pdf (accessed on 12 February 2017). no longer available at the time of finalization of this manuscript, but was accessed around 2017.
24. Tester, J.W.; Drake, E.M.; Driscoll, M.J.; Golay, M.W.; Peters, W.A. Sustainable Energy. In *Choosing Among Options*, 2nd ed.; The MIT Press: Cambridge, MA, USA, 2012; p. 10.
25. Jenkins, K.; McCauley, D.; Heffron, R.; Stephan, H.; Rehner, R. Energy justice: A conceptual review. *Energy Res. Soc. Sci.* **2016**, *11*, 174–182. [CrossRef]
26. Robert, J.T.; Parks, B.C. Ecologically Unequal Exchange, Ecological Debt, and Climate Justice—The History and Implications of Three Related Ideas for a New Social Movement. *Int. J. Comp. Sociol.* **2010**, *50*, 385–409. [CrossRef]
27. Prindle, B.; Eldridge, M.; Eckhardt, M.; Frederick, A. *The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy*; ACEEE Report Number E074; American Council for an Energy-Efficient Economy: Washington, DC, USA, 2007.
28. Commonwealth of Australia (Department of Industry). *Product Profile: Solar Hot Water Heaters*; Commonwealth of Australia (Department of Industry) eEquipment Energy Efficiency (E3) Committee: Canberra, ACT, Australia, 2014. Available online: http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Product_Profiles/Water_Heating/Solar_Hot_Water/Product-Profile_Solar-Water-Heaters_August-2014.pdf (accessed on 7 November 2014). This document was accessed on 7 November 2014 for the preparation of paper in Ref [30]. It is no longer available.
29. Australian Government. *Solar Water Heaters e MEPS and Labelling Requirements*; Energy Rating Website: Canberra, ACT, Australia, 2014. Available online: http://www.energyrating.gov.au/products-themes/water-heating/solar-water-heaters/meps-and-labelling/ (accessed on 7 November 2014). This document was accessed on 14 November 2014 for the preparation of paper in Ref [30]. It is no longer available.
30. Halawa, E.; Chang, K.C.; Yoshinaga, M. Thermal performance evaluation of solar water heating systems in Australia, Taiwan and Japan—A comparative review. *Renew. Energy* **2015**, *83*, 1279–1286. [CrossRef]
31. Fuller, R.B. *Critical Path*; St. Martins Press: New York, NY, USA, 1981.
32. Halawa, E.; Shi, X.; Nepal, R.; Sari, N.H.; James, G. The Prospect for an Australian–Asian Power Grid: A Critical Appraisal. *Energies* **2018**, *11*, 200. [CrossRef]
33. Halawa, E. Penalty-reward-pinch (PRP) design for improving sustainability of existing commercial buildings—Chapter 3.1. In *Sustainable Retrofitting of Commercial Buildings–Warm Climates*; Hyde, R., Groenhout, N., Barram, F., Yeang, K., Eds.; Earthscan: London, UK; Routledge: London, UK; Taylor and Francis Group: Abingdon, UK, 2013.
34. Lee, M.; Park, D.; Saunders, H. *Asia's Energy Adequacy, Environmental Sustainability, and Affordability: An Overview*; ADB Economics Working Paper Series no 398; Asian Development Bank: Mandaluyong, Philippines, 2014.
35. Linnenluecke, M.; Marrone, M.; Best, R. Solar Power can Cut Living Costs, but It's not an Option for Many People—They Need Better Support. The Conversation 2023. Available online: https://theconversation.com/solar-power-can-cut-living-costs-but-its-not-an-option-for-many-people-they-need-better-support-201090 (accessed on 30 November 2023).
36. Saman, W. How to Maximise Savings from Your Home Solar System and Slash Your Power Bills. The Conversation 2023. Available online: https://theconversation.com/how-to-maximise-savings-from-your-home-solar-system-and-slash-your-power-bills-197415 (accessed on 21 November 2023).
37. Trombley, J.; Halawa, E. Can further energy reductions be achieved through behaviour changes in low income households? *Energy Procedia* **2017**, *121*, 230–237. [CrossRef]
38. United Nations Development (UNDP). Energy Transition. Available online: https://www.undp.org/energy/our-work-areas/energy-transition (accessed on 7 December 2023).
39. Climate Council. What Does Net Zero Emissions Mean? Available online: https://www.climatecouncil.org.au/resources/what-does-net-zero-emissions-mean/ (accessed on 13 December 2023).
40. COP28 Climate Talks Go into Overtime Amid Standoff over Fossil Fuels. Available online: https://www.aljazeera.com/news/2023/12/12/cop28-climate-talks-go-into-overtime-amid-standoff-over-fossil-fuels (accessed on 13 December 2023).
41. Summary of Global Climate Action at COP 28. Available online: https://unfccc.int/documents/636485 (accessed on 13 December 2023).
42. Foster, S.; Elzinga, D. The Role of Fossil Fuels in a Sustainable Energy System. *UN Chron.* **2015**, *52*, 17–19. Available online: https://www.un.org/en/chronicle/article/role-fossil-fuels-sustainable-energy-system (accessed on 13 December 2023). [CrossRef]
43. Pillan, M.; Costa, F.; Caiola, V. How Could People and Communities Contribute to the Energy Transition? Conceptual Maps to Inform, Orient, and Inspire Design Actions and Education. *Sustainability* **2023**, *15*, 14600. [CrossRef]
44. Gates, B. *How to Avoid a Climate Disaster*; Allen Lane: Bristol, UK, 2021.
45. Greenpeace International Website. Davos Revealed, as Global Leaders Head into World Economic Forum. Available online: https://www.greenpeace.org/international/press-release/57867/hundreds-of-ultra-short-private-jet-flights-to-davos-world-economic-forum/ (accessed on 7 December 2023).
46. Lomborg, B. *False Alarm: How Climate Change Panic Costs Us Trillions, Hurts the Poor, and Fails to Fix the Planet*; Hachette: Paris, France, 2020.

47. Holechek, J.L.; Geli, H.M.E.; Sawalhah, M.N.; Valdez, R. A Global Assessment: Can Renewable Energy Replace Fossil Fuels by 2050? *Sustainability* **2022**, *14*, 4792. [CrossRef]
48. Dove, S. Assumptions of Science: 5 Reasons You Should Be Skeptical. Available online: https://www.shawndove.com/assumptions-of-science/ (accessed on 7 December 2023).
49. Flato, G.; Marotzke, J.; Abiodun, B.; Braconnot, P.; Chou, S.C.; Collins, W.; Cox, P.; Driouech, F.; Emori, S.; Eyring, V.; et al. Evaluation of Climate Models. In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2013.
50. IPCC. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2022; 3056p. [CrossRef]
51. Costello, C.; Ovando, D.; Clavelle, T. Global fishery prospects under contrasting management regimes. *Proc. Natl. Am. Sci. USA* **2016**, *113*, 5125–5129. [CrossRef]
52. Kuhlman, T.; Farrington, J. What is Sustainability? *Sustainability* **2010**, *2*, 3436–3448. [CrossRef]
53. Săveanu, M. Energy and the economics of sustainability. The entropy Paradox. *Manag. Sustain. Dev.* **2014**, *6*, 1–5. [CrossRef]
54. Dasgupta, P.S.; Heal, G.M. *Economic Theory and Exhaustible Resources*; Cambridge University Press: Cambridge, UK, 1979; as cited in [55].
55. Levy, A. *From Hotelling to Backstop Technology*; Department of Economics, University of Wollongong: Wollongong, Australia, 2000; Available online: https://ro.uow.edu.au/commwkpapers/25/ (accessed on 13 December 2023).
56. Fleissner, P.; Hofkirchner, W. Entropy and Its Implications for Sustainability. In Proceedings of the Implications and Applications of Bioeconomics, Proceedings of the Second International Conference of the E.A.B.S., Palma de Mallorca, Spain, 11–13 March 1994; Edizioni Nagard, Milano. Dragan, J.C., Demetrescu, M.C., Seifert, E.K., Eds.; 1997; pp. 147–155.
57. Sutherland, W.J.; Burgman, M. Use experts wisely. *Nature* **2015**, *526*, 317–318. [CrossRef]
58. Smith, R. Peer review: A flawed process at the heart of science and journals. *J. R. Soc. Med.* **2006**, *99*, 178–182. [CrossRef]
59. Younis, A.; Benders, R.; Ramírez, J.; de Wolf, M.; Faaij, A. Scrutinizing the Intermittency of Renewable Energy in a Long-Term Planning Model via Combining Direct Integration and Soft-Linking Methods for Colombia's Power System. *Energies* **2022**, *15*, 7604. [CrossRef]
60. Antonini, J. Nuclear Wasted: Why the Cost of Nuclear Energy is Misunderstood. The Mackinac Center Website. Available online: https://www.mackinac.org/blog/2022/nuclear-wasted-why-the-cost-of-nuclear-energy-is-misunderstood (accessed on 18 December 2023).
61. Loewen, J. LCOE is an undiscounted metric that distorts comparative analyses of energy costs. *Electr. J.* **2019**, *32*, 40–42. [CrossRef]
62. Szymański, A. Levelized cost of energy definition—An economic paradox. *Electr. J.* **2020**, *33*, 106816. [CrossRef]
63. Kuckshinrichs, W. LCOE: A Useful and Valid Indicator—Replica to James Loewen and Adam Szymanski. *Energies* **2021**, *14*, 406. [CrossRef]
64. Szymański, A. LCOE: An Useless Indicator–Replica to Wilhelm Kuckshinrichs. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4033669 (accessed on 18 December 2023).
65. LCOE and Its Limitations. Energy for Grow Hub. Available online: https://energyforgrowth.org/article/lcoe-and-its-limitations/ (accessed on 18 January 2024).
66. Timmons, D.; Harris, J.M.; Roach, B. *The Economics of Renewable Energy*; Global Development and Environment Institute, Tufts University: Medford, MA, USA, 2014; p. 52.