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Review

Organizational Energy Conservation Matters in the Anthropocene

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Abstract: Almost a century after its onset, the present era—when human endeavor significantly affects the environment and the future of the Earth's ecosystem—is now regularly being referred to as the "Anthropocene". Electric energy is recognized as one of the main forces of change that have contributed to the rise of the human reign. Moreover, its consumption, especially in organizations, is considered responsible for a large part of the greenhouse gas emissions whose curtailment is necessary for the preservation of our climate. This work focuses on turning the spotlight onto the importance of a far-from-exhausted resource in the fight for environmental protection: organizational energy conservation—as exhibited by both the organization and its members individually. Reviewing existing literature, we find that organizational energy conservation is concurrently a matter of environmental sustainability, ethics, and social justice and a matter entwined with crises. Aiming to further guide future research and practice in this field, we discriminate between and provide guidelines for conducting both "hard" (which include facility retrofitting and automation and pose the highest cost in their execution) and "soft" (which include the utilization of IS and/or behavioral interventions and pose a significantly lower cost in their execution) organizational energy-saving interventions.

Keywords: organizational; energy conservation; Anthropocene; crisis; behavior; IS; soft; hard; intervention

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1. Introduction

Human activity is increasingly leading to environmental degradation. Hence, an alarmed concern for the environment and the preservation of natural resources has sparked the conversation on how we can reverse a destructive course toward irreparable climate change and avoid rendering Earth utterly uninhabitable. Although international treaties such as the Paris Agreement were drawn to apprehend its course, we are already faced with the results of the environmental degradation we have brought forth ourselves. In this context, a new term has risen to capture the overarching human domination over the Earth's climate: the Anthropocene [1–7], "the present time interval in which many geologically significant conditions and processes are profoundly altered by human activities, and during which humans have a decisive influence on the state, dynamics and future of the Earth system" [5].

Air pollution and exposure to it have been associated with increases in mortality and hospital admissions because of respiratory and cardiovascular disease [8]. Concurrently, the importance of clean air in organizational environments has recently earned increased attention in the context of the COVID-19 health crisis [9]. The electricity sector is currently the largest source of CO_2 emissions, accounting for >40% of the 36.3 Gt (gigatons) CO_2 emitted worldwide in 2021 [10] (one gigaton equals one billion metric tons, or one trillion kilograms). To achieve net-zero emission targets by 2050, electricity generation is expected to further rise by almost 40%—to account for the increasing electrification of end uses (such as transportation) as a means of more efficient production and consumption of products and services [11]. The buildings sector in specific consumes 20% of the total delivered energy worldwide and the commercial sector features the fastest-growing energy demand—on average 1.6% per year projected until 2040 [12,13]. Moreover, buildings are responsible for 40% of the total energy consumption in the EU (European Union) and 36% of CO_2 emissions, while one-third of this demand can be attributed to nonresidential buildings [14]. Therefore, energy conservation, along with energy management [15], in public buildings and workplaces is an important measure toward addressing the worldwide recognized issue of climate change. Efficiency and conservation must furthermore not be overlooked when planning for the future of energy consumption [16].

Energy efficiency is a key element of the European Green Deal and the EU strategy to achieve a decarbonized economy by 2050 in a cost-effective way [17]. It is considered "the first fuel of a sustainable global energy system" that enables growth in clean energy sources to outpace growing demand for energy services [11]. Apart from the quickest and most affordable way to decarbonize our economy and ensure reliable and sustainable energy for everyone on the planet, energy efficiency is also considered as "the trillion-dollar opportunity" [18] because of the high value behind achieving it. According to the International Energy Agency (IEA), energy efficiency improvements can deliver a third of the energy-related emission reductions needed to reach the 2050 net-zero scenario [19]. However, energy efficiency needs to double for the IEA's net-zero emission targets to be realized by 2050 [11]. However, it is important to also bear in mind that energy (over)consumption has not been horizontal across the planet. This raises issues of energy justice and poverty that have also been proven sensitive to the onset of recent global economic and health crises (COVID-19).

Three out of the 17 Sustainable Development Goals (SDGs) on the UN's 2030 Agenda are also—either directly or indirectly—related to energy conservation, poverty, and justice: (i) Goal #7 is to "Ensure access to affordable, reliable, sustainable and modern energy for all", (ii) Goal #9 is to "Ensure sustainable consumption and production patterns", and (iii) Goal #13 is to "Take urgent action to combat climate change and its impacts" [20]. Therefore, urgent action to manage energy demand is necessary to meet the SDGs [21], as only a drastic reduction can allow for "an affordable and manageable transition to a global energy system based on renewables" [22]. Furthermore, it can help ameliorate issues of energy justice and poverty. To create successful and productive energy-saving policies it is necessary to gain a full understanding of energy-consumption drivers, motivation, and behavior [21]. Moreover, to ensure strong ownership and quick deployment of the needed energy savings actions, the stronger involvement of citizens, as well as local and regional authorities and actors, is needed [17], while energy leaders should exhibit both social awareness and technological innovation at the same time to effectively construct future energy consumption policy [16].

Bearing all the above in mind, in this paper we review existing evidence as per the importance of a far-from-exhausted resource in the fight for environmental protection: organizational energy conservation (OEC)—as exhibited both by the organization itself and by its members individually. Moreover, we also examine it in connection to recent global economic and health crises (COVID-19) and conflicts (Ukraine), as well as underlying energy justice and poverty issues. In essence, we focus on the following research question: "*How important is organizational conservation (OEC) (a), what matters does it bring forth (b), and how can it be practiced effectively (c), in the context of the Anthropocene?*" Hence, our research model can be summarized through the following three-step logic: *Contextual Matters* ➔ *Organizational Energy-Saving Interventions* ➔ *Organizational Energy Efficiency and Conservation*. Accordingly, following a narrative literature review approach [23], we present, combine, and reflect upon existing facts from the literature to aid future researchers and practitioners in this very important research area. We find that, in the context of the Anthropocene, organizational energy conservation is concurrently a matter of environmental sustainability, ethics, and social justice and a matter entwined with crises (as it both causes and is caused by them). Practical advice is presented accordingly for conducting both "hard" (which include building retrofitting and automation and pose the highest cost in their execution) and "soft" (which include the utilization of IS and/or behavioral interventions and pose a significantly lower cost in their execution) organizational energy-saving interventions. Specific suggestions for advancing theory and enabling practice are provided accordingly. We stress that in this paper we focus on energy in the form of electricity with regards to our findings and suggestions regarding energy (consumption, conservation, efficiency, etc.).

The novelty of the present work can be traced to three different points: (a) evidence from different scientific fields (from environmental and natural sciences, to information systems, engineering, social sciences, organizational behavior, business ethics, and even anthropology and philosophy) are concurrently presented, combined, and discussed in the context of organizational energy conservation and the Anthropocene, (b) four important matters that affect the impact and characteristics of organizational energy conservation are outlined and described, and (c) two important facets of organizational energy conservation are identified ("hard" and "soft" interventions) and combined advice is provided as per their practical adoption and application in the context of the Anthropocene, as well as in connection to the four forementioned matters.

2. Background and Study Context

2.1. The Rise of the "Anthropocene" and the Onset of the "Great Acceleration"

Our planet is inhabited by an impressively large number of life forms. In fact, while over 1.2 million species have been identified thus far, it is estimated that 86% of existing species on Earth and 91% of species in the ocean have not yet been properly described by man [24]. However, increasing evidence supports the notion that the human species alone (accounting for a mere 0.01% of the biomass composition on Earth), has risen to dominate this planet unrivaled, with radical ecologic effects on the biosphere that are mainly due to major innovations that led to a dramatic increase in population, thus endangering the survival of life as we have grown to know it [25]. Accordingly, Planet Earth has been described as "Spaceship Earth", a craft on which humans sail in exploring the rest of the universe [26].

Time is divided by geologists according to marked shifts in Earth's state in the geologic time scale (a calendar for events in Earth history, which subdivides all time into named units based on stratigraphy—the correlation and classification of rock strata) [6,27]. The global impact of human activities on the environment has grown to make us a significant geological and morphological force, with a decisive influence on the state, dynamics, and future of the Earth system, thus justifying assigning the term "Anthropocene" to the current geological epoch [1–7], which denotes "the present time interval in which many geologically significant conditions and processes are profoundly altered by human activities, and during which humans have a decisive influence on the state, dynamics and future of the Earth system" [5]. Although still under consideration as per its formal inclusion as a geologic era, such is the widespread acceptance of the term that the Anthropocene has already been included in encyclopedia articles regarding "geologic time scale", as well as in movie and book titles. Indicatively also, a search on Google Scholar in October 2022 with the term "Anthropocene" returned more than 343,000 results.

A proposed onset for the Anthropocene epoch coincides with the world's first nuclear bomb explosion during World War II, on 16 July 1945 at Alamogordo in New Mexico [7]. The significant increase in the "human enterprise" after World War II has, in fact, been so dramatic that the time period that began after 1945 and spans until today has been characterized as "*the Great Acceleration*". The effect of mankind on the environment has been especially disproportionately large during the "Great Acceleration" period, compared to the vastness of the geological lifetime of our planet. To illustrate further, Table 1 includes selected events in Earth's history projected on the scale of one calendar year. In this scale (where 1 s equals ~146 years) the first modern man (homo sapiens) was born 12 min ago [28], Michael Faraday invented the electric motor 1.4 s ago, and the "Great Acceleration" began just 0.4 s ago.

Table 1. Development of life on Earth and selected important events on the scale of one calendar year (1″ = ~146 years), adapted from [28].

Mn Years	Event	Relative to One Calendar Year (Date Time)
4600	*Earth formed from planetary nebula*	*1/1 00:00*
3900	Inferred origin of life (first cells)	25/2 13:02
1500	First multi-celled organisms (seaweed and algae)	3/9 23:28
505	First fish	21/11 22:18
470	First fossil evidence of land plants	24/11 16:57
375	First land animals (amphibians)	2/12 05:52
245	*End of Palaeozoic Era, 96% of all life on Earth perishes—Advent of Mesozoic, the "Age of Reptiles"*	*12/12 13:26*
228	First dinosaurs (Eoraptor and Saltoposuchus)	13/12 21:48
221	First mammals (shrew-like)	14/12 11:08
155	First bird, Archeopteryx	19/12 16:49
115	First flowering plants	22/12 11:50
65	*End of Mesozoic, probably meteor or comet impact—Advent of Cenozoic, the "Age of Mammals"*	*26/12 20:13*
64	First ancestors of dogs and cats	26/12 22:07
55	First horses (eohippus)	27/12 15:15
39	First monkeys	28/12 21:43
4	Oldest human like ancestors (hominids)	31/12 17:20
1	*First of four ice ages*	*31/12 22:05*
1	Oldest direct human-ancestor fossil, Homo habilis	31/12 23:02
0.10	First modern man, Homo sapiens	31/12 23:48
0.05	Mammoth and mastodon bones, Big Bone Lick, KY	31/12 23:54
0.0002	Michael Faraday invented the electric motor (~200 years ago)	31/12 23:59:58.6
0.00007	*WW II—Advent of the "Great Acceleration" (~70 years ago)*	*31/12 23:59:59.6*

2.2. Human Activity and Its Impact on the Environment

Although a recent census revealed that humans account for a mere 0.01% of the biomass composition on Earth and 3% of animals (see Table 2), the impact of humanity on the biosphere over the relatively short span of human history has been significant, mainly because of major innovations that led to a dramatic increase in human population and radical ecologic effects [25]. If we continue on the same track, in a few generations, mankind is estimated to deplete the fossil fuel that was generated over several hundred million years toward producing energy, while burdening the atmosphere with large amounts of emissions of air pollutants, damaging ecosystems, and harming plants, animals, and humans, and overall causing an unsustainable anthropogenic climate change [1,29,30]. At the same time, although in the past 20,000 years there have already been three periods of time when atmospheric CO_2 levels have changed rapidly, today we are experiencing the fastest-ever rise, accelerated by the burning of fossil fuels for the production of energy [31].

Reflecting on all of the above, and in this context, a phrase included in the transcripts of the UK House of Commons parliamentary record comes to mind: "*the possession of great power necessarily implies great responsibility*" [32] or, as more popularly re-phrased in the words of Peter Parker (a.k.a. "your friendly neighbor Spiderman"), "with great power comes great responsibility". Recognizing this responsibility, the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) released a report on the forthcoming impacts of climate change on 9 October 2018 [33]. The report concluded that humankind had a mere 12 years left (until 2030) to sufficiently and dramatically effect carbon-emission mitigation strategies to avoid the global average temperature from rising above the 1.5 °C limit set by the 2015 Paris Climate Change Agreement, toward significantly ameliorating some of the worst effects of climate change, such as hundreds of millions of people irreversibly imperiled by drought, flooding, extreme heat and increased poverty in the decades to come [33–35]. Therefore, with carbon emissions still rising, to avoid lacing our planet's atmosphere with carbon dioxide, overly warming the climate to which we owe our very existence and bringing forth some of the most devastating impacts of climate change, it is estimated that a 45% decrease in CO_2 emissions must be achieved by 2030, and humankind must completely decarbonize by 2050 [36,37].

Table 2. Summary of est. total biomass for abundant taxonomic groups on Earth. Adapted from [25].

Taxon	Mass (Gt C)	% of Total	Taxon	Mass (Gt C)	% of Animals	% of Total
Plants	450.0	81.82%	i. Arthropods	1.2	60.0%	0.218%
Bacteria	70.0	12.73%	ii. Chordates	0.8	40%	0.146%
Fungi	12.0	2.18%	Fish	0.7	87.5%	0.1273%
Archaea	7.0	1.27%	Livestock	0.1	5%	0.0182%
Protists	4.0	0.73%	*Humans*	*0.06*	*3%*	*0.0109%*
Animals	*2.0*	*0.36%*	Wild mammals	0.007	0.35%	0.0013%
Viruses	0.2	0.04%	Wild birds	0.002	0.10%	0.0004%
Total	*550.0*	*100%*	iii. Annelids	0.2	10%	0.036%
			iv. Molluscs	0.2	10%	0.036%
			v. Cnidarians	0.1	5%	0.018%
			vi. Nematodes	0.02	1%	0.004%
			Animals (Total)	*2.0*	*100%*	*0.36%*

Climate change now represents a "near- to mid-term existential threat" to human civilization [38]. It is in essence a public health problem, affecting the social and environmental determinants of health—clean air, safe drinking water, sufficient food, and secure shelter [39,40]. At current rates, between 2030 and 2050, it is expected to exacerbate health problems worldwide and cause approximately 250,000 deaths per year, in addition to creating estimated direct damage costs to health between 2–4 billion USD/year by 2030 [40,41]. Therefore, reducing greenhouse gas emissions through policies, individual and collective choices that include energy usage can also result in improved health for all [40].

2.3. Climate Change Vis-a-Vis Organizational Energy Conservation

As already noted, the imprint of human on the environment during "the Great Acceleration"—which rivals some of the great forces of nature and shows no signs of being slowed or arrested—has come as a result of energy-dependent processes and activities [2]. Moreover, the rapid expansion of world population, depletion of energy resources, and increase in environmental concerns have made the urgency of increasing the efficiency of energy usage worldwide more prominent than ever before [16]. Fortunately, worldwide acknowledgement of the imperative need to reverse climate change is increasing, as illustrated by the fact that Global 500 companies are now increasingly recognizing the importance of nature, with 83% having already formally acknowledged the significance of climate change and set targets toward reducing their impact on the environment [42]. As further discussed, owing to its prominent position in terms of its potential impact, energy conservation should be, and is, in the heart of such targets and efforts.

As the global environmental crisis has been identified as an "energy crisis" in its essence, our focus must be to a great extent on decreasing energy consumption worldwide. For the remainder of this paper, unless otherwise stated, when we refer to "energy", we refer to electric energy in specific. Thomas Edison achieved his vision of a full-scale central electric power station (the "Pearl street station") on September 1882 with a system of conductors that distributed electricity to end users in the high-profile business district of New York City [43]. Since then, electric energy has conquered the world and its ever-rising worldwide consumption has led to a spectacular increase in human activity, as well as impact on the environment. More specifically, total electricity production has more than doubled since 1990, and, taking into account the increase in world population, per capita energy consumption had also increased by more than 50% [44]. Moreover, according to the IEA: "Worldwide efforts to address climate change is leading to the rapid electrification of numerous end-users from transport to industry, driving a massive increase in power demand as well as the need to generate as much of it as possible from renewable sources. The result is a dramatic transformation of power systems globally" [45].

3. Organizational Energy Conservation as a Multi-Faceted Matter

Drawing from all the above, we deduce that, in the context of the Anthropocene, organizational energy conservation is an important and multi-faceted matter, with economic, social, and environmental repercussions. Moreover, delving deeper into existing evidence from the literature, we identify four main viewpoints: organizational energy conservation as a matter of (i) environmental sustainability, (ii) ethics, and (iii) social justice and (iv) as a matter entwined with crises. We discuss these four views separately in the following paragraphs.

3.1. Organizational Energy Conservation as a Matter of Environmental Sustainability

The Earth's history has been marked by cataclysmic events when life was threatened and species faced extinction on many occasions. From the formation of Earth from planetary nebula 4.6 billion years ago until today, there have been at least six cases that fall into this category: (a.) the end of the Paleozoic Era 245 million years ago was marked by the annihilation of 96% of all life on Earth, (b.) the end of the Mesozoic Era 65 million years ago was marked by a meteor or comet impact that caused the extinction of dinosaurs, and (c.) in the past million years alone there have been four ice ages that caused the extinction of many species that were dominant in their time, among which were the mammoths.

Today, it is human activity that threatens to disturb the fragile equilibrium in Earth's climate and perhaps also cause another cataclysmic event that may threaten our species' survival. Our actions, mainly powered by energy over-consumption, are increasingly leading to environmental degradation, the depletion of natural resources, and increasing disturbance of the delicate balance of gases in the atmosphere. Thus, the conversation on how we can reverse the destructive course toward a new irreparable climate change and avoid rendering Earth utterly uninhabitable has been sparked. So far, international treaties such as the Paris Agreement have been drawn to suggest ways to apprehend climate change. However, if we do not manage to adequately reduce our energy consumption, we may face not only an environmental crisis but also a humanitarian one, risking our own extinction. Nonetheless, geologic history has taught us that throughout all past environmental crises, however fierce the events, Earth always managed to heal itself throughout the vastness of its existence, even without the presence of its extinct children. Therefore, however devastating our actions' effect may become for the environment in the future, if we fail to remedy them, and even if this leads us to our own extinction, Earth itself will survive and in time find the way to heal itself so that new species will grow to rule it. It is up to us and our own choices to keep such a catastrophic scenario from becoming a reality and maintain our present "regal" status in the ecosystem.

As environmental problems can be reduced if we more consistently engage in pro-environmental actions [46], to avoid the dire consequences of natural resources overconsumption we must learn to consume them sensibly, adopting the centuries' old wisdom that called for adopting and keeping to measures in life, such as "everything in moderation" *«μέτρον ἄριστον» (Cleovoulos, Rhodes—Greece, 6th century B.C.)*, and "*nothing in exaggeration*" *«μηδὲν ἄγαν» (Solon, Athens—Greece, 6th century B.C.)*. Their meaning converges into the dictum that excellence is to be found in the balance and not in the quantity of things [47]. Existing evidence reveals that the Anthropocene and the Great Acceleration has emerged as a result of the unsustainably increased utilization of energy. Moreover, although the electricity sector is currently the largest source of CO_2 emissions, electricity generation has been and is expected to continue rising through the electrification of end uses (such as transportation or heating) as society continues to utilize it as a basic means to sustain its modern way of life. As a large proportion of energy is consumed in public buildings and workplaces, promoting organizational energy conservation is increasingly important toward addressing climate change and meeting three of the seventeen Sustainable Development Goals (SDGs) on the UN's 2030 Agenda.

Acknowledging the fact that the gap between energy research and modeling and the social sciences needs to close in the modern reality of the Anthropocene [48], we deduce that to ensure the availability of this important commodity for mankind while preserving the environment for future generations, both social (human energy conservation behavior) and technical (hardware-based energy conservation) means need to be leveraged.

3.2. Organizational Energy Conservation as a Matter of Ethics

The word energy stems from the Greek word '*energeia*' (*ενέργεια*) that is frequently interpreted as "being-at-work" and, together with the word '*ousia*' (*ουσία*), a.k.a. thinghood, they are the two ultimate ideas that govern Aristotle's thinking toward capturing the heart of the meaning of being [49]. Although the source and usage of energy have significantly changed over time, the fact remains that human societies have always needed to produce and consume energy. The global environmental crisis has at the same time been identified as an "energy crisis" in its essence. Therefore, the increase in environmental concerns has made the urgency of energy conservation more prominent than ever before. While climate change is widely considered a result of energy consumption, our decisions and actions—both personally and collectively—determine how much energy is consumed. In fact, we seem to thrive by personally or collectively "feeding" on energy, similar to the way other species thrive by feeding on their natural habitats. We even consume energy while asleep through our devices' standby energy consumption. Much like the way meat-consuming animals may be characterized as carnivorous, plant consumers as herbivore, and so on, we propose that modern humans should perhaps also be considered as *energovorous* (energy consumers/"eaters"), or perhaps also be denoted as "*homo energovorous*" by combining the fact that our species has indeed evolved to lead its life in a much different way compared to the pre-electricity age homo sapiens.

The dire effects of energy overconsumption and the corresponding urgency for its conservation have gradually led to the transformation of energy conservation into a matter of ethics. In this context, the notion of "hubris" comes to mind with regards to current human endeavor and the consumption of energy. Hubris, defined as "*overweening presumption that leads a person to disregard the divinely fixed limits on human action in an ordered cosmos*" [50,51] or, more simply, "overstepping the bounds of proper behaviour" [52], was a basic concept of the ancient Greeks' worldview. (According to ancient Greek thought on justice (e.g., as reflected primarily in Homeric poems, as well as by Solon and Aeschylus), the greedy saturation '*κόρος*' (koros) of one's needs (without observing limits) leads to hubris (*ύβρις*), which in turn leads to blinded negligence, '*άτην*' (atē), and the provocation of divine justice and nature's revenge, '*νέμεσιν*' (nemesis), which ultimately leads to punishment and destruction, '*τίσιν*' (tisis) {[*κόρος* ➔ *ύβριν* ➔ *άτην* ➔ *νέμεσιν* ➔ *τίσιν*], or [*koros* ➔ *hubris* ➔ *atē* ➔ *nemesis* ➔ *tisis*]} [52–59].) In our case, it seems that, based on our energy-related choices and actions as illustrated in Figure 1, the greedy saturation, *κόρος*, of our overly ambitious needs for energy has led to hubris, *ὕβριν*, as we have over-evaluated our abilities and powers, overstepped the bounds of sustainable energy consumption, and violated the unwritten laws of nature in the process. Therefore, unless we acknowledge our resulting blinded negligence, *ἄτην*, of the effect on the environment and make all possible efforts to limit the overconsumption of energy, we are bound to inevitably face nature's wrath and revenge, *νέμεσιν*, in the form of climate change and ultimately punishment in the form of extreme natural phenomena (floods, hurricanes, etc.) and perhaps even risk facing extinction, *τίσιν*.

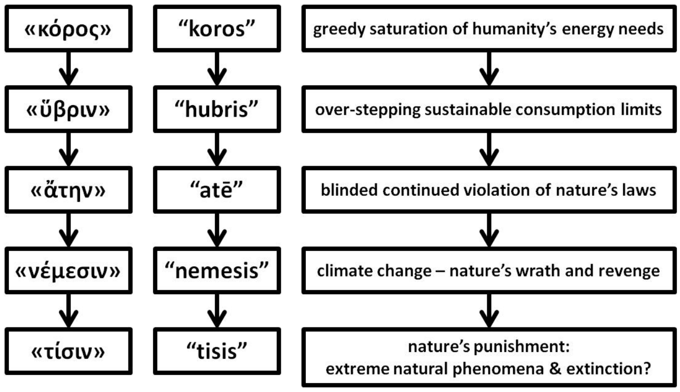

Figure 1. Climate change as a "Greek 'energy' tragedy".

3.3. Organizational Energy Conservation as a Matter of Social Justice

Although the repercussions of energy overconsumption are felt globally, energy is not uniformly consumed worldwide. This raises issues of social justice. NASA's black marble Night-Time Lights (NTL) product suite (VNP46) utilizes instrumentation on board the Suomi National Polar-orbiting Platform (SNPP) satellite to scan the Earth's surface for lights that are lit during the night (at roughly 1:30 a.m. local time) [60]. Based on this data, NASA scientists have released a global map of Earth where light intensity provides an indication of—among others—the patterns of energy-use across our planet at night, thus showing how humans have shaped the planet and lit up the darkness [61,62]. By observing this map, areas such as the USA appear very intensely lit at night, while other areas, such as Africa, are not nearly as much so. This provides an indication that the amount of electricity consumed per person seems to be significantly higher in some areas of the planet than others (see Figure 2).

Figure 2. Earth at night, as seen in 2016: night lights in the USA vs. Africa. Source: NASA black marble Night-Time Lights (NTL) product suite (VNP46) [61].

For many, the lack of energy availability in the developing world, especially compared to developed countries, is the real energy crisis that we need to deal with globally [63]. The term "*energy poverty*" is widely used to describe issues of domestic energy deprivation [64]. Moreover, it can be positioned as [65]: "*an inability to realize essential capabilities as a direct or indirect result of insufficient access to affordable, reliable and safe energy services, and taking into account available reasonable alternative means of realizing these capabilities*". It is estimated that more than 1.5 billion people live without access to electricity and another billion only have access to unreliable electricity, thus living in "energy poverty" that results in unmet basic needs and depressed economic and educational opportunities [66]. However, although the lack of "*energy justice*" is widely acknowledged [67], and our share in consuming energy may not be equal worldwide, we are all called upon to strive to conserve it in concert for the benefit of the environment and future generations.

In line with the above, to secure our energy future and achieve a just future energy system that enhances human well-being and is sustainable, we must alter infrastructure and technology, as well as support social change by integrating insights from the physical and social sciences, and widely recognize that energy production, consumption, and policy are both social and technical domains [68]. The need to close the gap between energy research and modeling and the social sciences has become pressing in the modern reality of the Anthropocene [48]. Therefore, to paraphrase the statement recorded in the literature claiming that "*environmental psychology matters*" [69], based on the above we deduce that "*energy consumption psychology matters*". To ensure the availability of this important commodity for mankind while preserving the environment for future generations, energy conservation is an important and widely recognized interdisciplinary issue, across both social (human energy-behavior change) and technical (hardware-based energy conservation) domains. Overall, as access to energy (and energy services, such as lighting, cooking, and heating) is not a given for all people, applying energy efficiency and passive energy conservation technologies can at the same time also help toward ameliorating energy justice and poverty issues [21].

Toward visualizing the issue of sustainable energy consumption in relation to social justice we turn to "doughnut economics", a recent metaphor regarding environmental sustainability and human endeavor through natural resource consumption. The "doughnut" essentially consists of three concentric layers: a social foundation of well-being that no one should fall below with regards to basic commodities in life (e.g., sufficient food, clean water, and access to energy), an ecological ceiling over which life becomes unsustainable on Earth, and a middle layer between them where a safe and just space of existence is possible [70]. Outside these three zones lie two areas of unsustainable existence. In the middle of the "doughnut" lies a zone where the lack of basic commodities in life leads to critical human deprivation, whereas outside the outer layer of the "doughnut" lies an area where the overconsumption of resources is set to lead to critical planetary degradation and endanger our own existence as a species.

Attempting to capture the issue of energy conservation in the "doughnut", we propose that an *"energy consumption doughnut"* would include three viable layers: on the inner ring lies an area of minimal energy use necessary to preserve a healthy lifestyle, on the outside ring lies an energy consumption ceiling over which environmental impact becomes unsustainable, and in the middle layer lies a zone where safe and just energy consumption allows for human endeavor to continue while preserving the environment for future generations. Moving outside these limits of energy consumption toward the center of the doughnut leads to either energy poverty (which is due to a lack of necessary energy resources to sustain a reasonable standard of living), or unsustainable energy consumption that would in turn lead to pollution and climate change, and finally to critical planetary degradation that would endanger our existence on Earth. The envisioned "energy consumption doughnut" outlined above is depicted in Figure 3.

The recent crises (due to COVID-19 and the ongoing conflict in Ukraine)—apart from their economic and health impact—have also exerted issues of energy justice. First, they led to an escalation for a part of society in the difficulty of covering the cost of energy provision. Additionally, due to the energy supply uncertainty and lack of energy they have caused, access to basic health services has been compromised for many, while in some areas the need to revert to the production of energy from fossil fuel has led to increased pollution. As a result, the need for energy efficiency is also important to increase the resilience of societies to energy crises. Recognizing that energy production, consumption, and policy are both social and technical domains, to achieve a just future energy system that enhances human well-being and is sustainable, we must alter infrastructure and technology, as well as support social change [68].

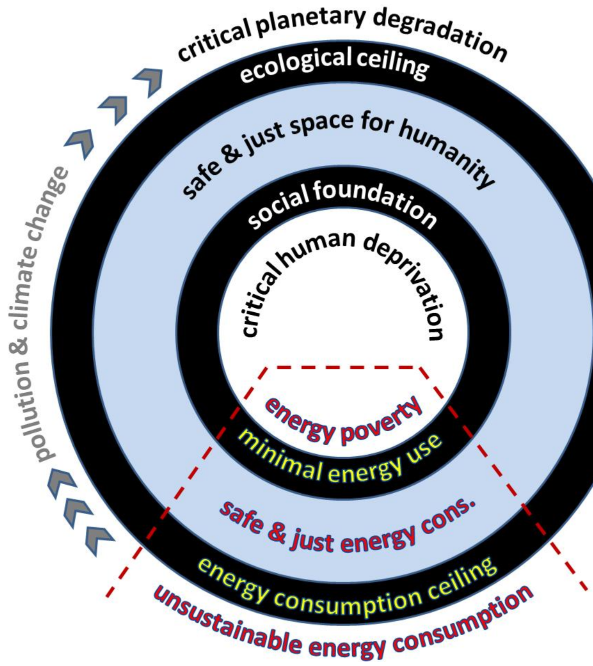

Figure 3. The "energy consumption doughnut", adapted from "The doughnut of social and planetary boundaries" (K. Raworth & C. Guthier. CC-BY-SA 4.0) [70].

3.4. Organizational Energy Conservation as a Matter Intertwined with Crises

Energy crises are not a rarity in modern history. In fact, several such events have occurred over the past five decades. From the energy crises of the 1970s and on, it has been clear that energy conservation is both capable of and effective in producing significant savings, and human behavior along with engineering technology can greatly affect energy consumption and conservation alike [71]. To illustrate, as is visible in Figure 4, although total electricity production has more than doubled since 1990, growing from 11,960.33 to 28,466.29 TWh in 2021 [44,72], this steady increase has been halted during the two recent global crises (the economic crisis of 2010, and the COVID-19 health crisis). However, it seems that any fall in energy consumption (or its rate of increase) observed during crises is usually not permanent, nor does it reprehend the general tendency for increased consumption. In fact, in the aftermath of crises, energy consumption tends to rebound. Global electricity demand in 2018 in specific increased by 4%, the fastest increase since 2010 (when the global economy recovered from the financial crisis), thus also leading to a 2.5% increase in CO_2 emissions from power plants worldwide [73]. Electricity output in 2019 was 174.6% of 2000, and accordingly, despite the efforts to reduce the resulting harm to the environment, CO_2 emissions from electricity generation were 154.3% of 2000 [74]. This course of increased consumption was once more arrested, only temporarily, by the unprecedented effect of the COVID-19 quarantine periods that followed.

The severe negative impact of the COVID-19 crisis on energy consumption has been outlined both by the International Energy Agency (IEA) and by a number of researchers who reported that "the lockdowns caused by the COVID-19 pandemic have drastically changed energy consumption patterns and reduced CO_2 emissions throughout the world" [75], while "residential customers have increased their consumption around 15% during full lockdown and 7.5% during the reopening period but, in contrast, globally, non-residential customers have decreased their consumption by 38% during full lockdown and 14.5% during the reopening period" [76], and overall, "on a global scale, the shutdown of a large number of social activities not only caused economic decline, but also resulted in a sharp reduction in energy consumption" [77].

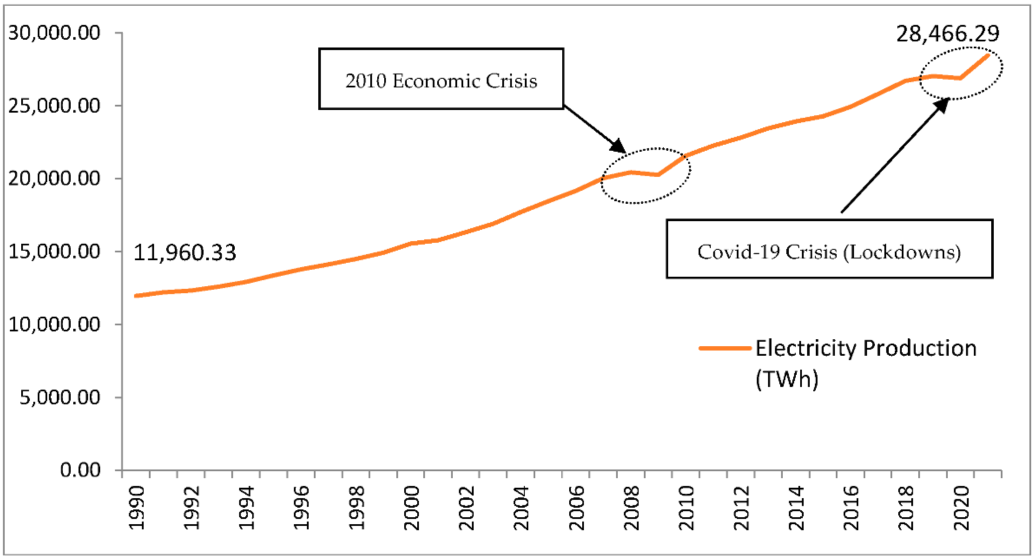

Figure 4. Total electricity production worldwide 1990–2021 (TWh)—data source: BP statistical review of world energy [72].

Apart from a health crisis and an economic crisis, the global COVID-19 pandemic is also an energy justice crisis that brings to light multiple ongoing, underlying social crises of energy sovereignty, as exhibited by the following facts [78]:

- Access to basic health services is compromised for many because of the lack of energy services necessary to provide them;
- Some are more vulnerable to COVID-19 because of their exposure to environmental pollution associated with energy production;
- The loss of stable income because of the COVID-19 crisis may lead to the loss of reliable access to essential energy services;
- The COVID-19 crisis has in some cases created a window of opportunity for the aggressive pursuit of energy agendas that perpetuate carbon-intensive and corporate-controlled energy systems by energy-producing companies.

In line with the above, some call for energy sovereignty in the design of a post-COVID-19 energy system, defined as "the right for communities, rather than corporate interests, to control access to and decision making regarding the sources, scales, and forms of ownership characterizing access to energy services", to increase resilience to future shocks without exacerbating social injustices [78]. In essence, we are currently once more within an ongoing global energy crisis that was sparked as a side-effect of the COVID-19 global health crisis and has grown even stronger because of the ongoing 2022 conflict in the Ukraine. The effects of this more recent energy crisis have been global, as well as horizontal, leading to economic, social, and food provision issues, as well as to unprecedented turbulence in the energy production scene, with some of the EU countries seeking to transform their energy production. The recent onset of the crisis that is due to the conflict in the Ukraine has made it clear that—apart from the benefits for the environment—energy efficiency is also imperative for increasing the resilience of societies to energy crises, as it can reduce fuel import dependence, and lessen exposure to energy price volatility [79].

The energy crisis of the 1970s had played a key role to an economic downturn that is similar to what we are now experiencing: although businesses and consumers were asked to help by conserving energy, and entrepreneurs worked on energy-saving solutions, the economic crisis worsened and, as prices and unemployment rose, inflation and economic stagnation produced "stagflation" [80]. Energy efficiency and savings are, hence, now more highly valued than ever, as supply uncertainty, high prices, and urgent climate targets have led to a worldwide focus on the reduction in energy demand [81]. Accordingly, there is also a recognized need to address the issue of energy generation and consumption mismatch. More specifically, as energy consumption is not evenly distributed within a day, additional (CO_2-intensive) generators are often utilized by energy producers to satisfy the increased energy demand during peak hours [82]. Photovoltaic (PV) systems are often used in installations to address this issue. However, these systems require the utilization of—often expensive—energy storage systems, such as batteries [83]. Thermal as well as hybrid storage systems (which may, e.g., employ batteries along with storage heaters or water cylinders) can also be utilized to incorporate renewable energy in an installation to ameliorate this phenomenon that leads to increased CO_2 emissions while, at the same time, significantly reduce their lifecycle costs (by as much as more than 40%) [82,83]. Moreover, apart from the positive impact on the environment, leveraging such energy storage systems equipped with PV, heat pumps (HP), and thermal and electrical energy storage systems can also simultaneously help organizations in reducing the cost of energy consumption (by as much as 80% or even more) [83].

The currently high energy prices and the conflict in Ukraine have given renewed impetus to the need to save energy to ensure the EU becomes independent from Russian fossil fuel imports as soon as possible [17]. This has also had significant consequences on the EU's energy and climate policies. Notably, the EU recently increased its energy savings goal to 13% from 9.5%, while EU Parliament groups recently united behind the adoption of a 14.5% goal for 2030 as a means to help ease energy prices for consumers and eliminate imports of Russian fossil fuels [84–86]. Recently, the EU Commission also published an 'EU Save Energy Communication' detailing short-term behavioral changes that could cut gas and oil demand by 5% in view of the Ukraine crisis [86].

According to ancient Greek stoic philosophers, there is always a positive side to negative things, or "*Οὐδὲ γὰρ ἐνταῦθα τὸ κακὸν ἀμιγὲς καὶ τοῦ ἀγαθοῦ*" (Proklos, 5th century B.C.). Hence, however negative crises may generally be, it seems that they help in conveying the message of the urgency in conserving energy. Unfortunately, news coverage about promoting energy conservation is limited under normal conditions, and significant events such as crises are strong drivers for agents to more effectively convey their messages and influence the public toward conserving energy [87]. At the same time, the increased need for energy conservation has also, in turn, led to an increase in entrepreneurial activity on energy conservation, as is evident, for example, through the increase in startups within this field that have recently flourished by designing or enabling relative solutions employing various innovative techniques and technologies (spanning from IoT to AI) [88–90].

4. Organizational Energy Conservation in Practice

A relatively limited number of studies exist in the literature regarding energy conservation in a work environment compared to household contexts [91,92]. In organizational environments, three overlapping energy rationales guide its consumption: *energy as a cost* (primarily financial, but also social or environmental), *energy as an implicit right* (required to meet occupants' expectations of comfort), and *energy as a utility* (to be always available for meeting the goals of the organization and ensuring continuity of service) [93]. Hence, apart from the energy savings it can produce, organizational energy efficiency is additionally important as it can lead to improvements in worker comfort, product quality, overall flexibility, and productivity, as well as reductions in maintenance cost, risk, production time, and waste [94].

According to the existing literature, organizational energy conservation is a complex matter that usually calls for the organization to consider combining different practices. Moreover, the involvement of its members and stakeholders is necessary to ensure their quick deployment, adoption, and strong ownership [17]. At the same time, to create effective energy-saving policies, organizations need to gain a full understanding of the drivers of energy-consumption at their premises, as well as the level and intricate characteristics of the occupants' energy-saving motivation and behavior [21]. Hence, leveraging both social awareness and technological innovation is required [16]. Organizations should therefore concurrently consider [68]: (a) altering their infrastructure and adopting passive energy conservation technologies, and (b) setting, supporting, and monitoring energy efficiency policies and social change (enhancing employees' energy consumption habits and behavior). Inspired by facilities management (FM) literature, we refer to the first as "*hard*" and the latter as "*soft*" approaches to achieving organizational energy conservation.

Facilities management (FM) is defined as "the practise of coordinating the physical workplace with the people and work of the organisation", and "the integration and alignment of the non-core services, including those relating to premises, required to operate and maintain a business to fully support the core objectives of the organisation", while its implementation involves the synergistic blend of both "hard" and "soft" issues [95]. Their difference can be easily explained by adopting the metaphor of a computer system that consists of its hardware (its physical components that are somewhat difficult to change) and software (nonphysical components that are comparatively easy to change). Accordingly, hard FM essentially deals with the physical properties and assets in buildings (building shell, heating, cooling, ventilation, electric devices, etc.), and soft FM oversees the activity within buildings (including the actions of their occupants).

Based on the above, we denote that organizational interventions for energy conservation can also belong to two main categories: *"hard" interventions* that include building retrofitting and automation and pose the highest cost in their execution and *"soft" interventions* that include the utilization of information systems (IS) and/or behavioral interventions that pose a significantly lower cost in their execution. The combination of both these types of interventions can in turn lead to the optimal achievement of organizational energy efficiency and conservation.

Combining all the above with the multiple facets of organizational energy conservation we focus on in this paper, it becomes clear that the four dominant matters in the context of the Anthropocene (environmental sustainability, corporate ethics and sustainability, social justice, and crisis management) drive the need for both "soft" and "hard" organizational energy-saving interventions, toward achieving organizational energy efficiency and conservation. Further insight as per the characteristics of both "hard" and "soft" energy-saving interventions, as well as practical advice toward their introduction in organizations, is provided in the following corresponding sub-sections.

4.1. "Hard" Energy-Saving Interventions

Although "hard" interventions, such as sustainable building renovation and retrofitting, are considered important worldwide toward increasing energy conservation, putting them into practice is very challenging because of the wide variation in the characteristics of each project, and applying one-size-fits-all solutions is nearly impossible [16,79]. However, international [21,79], national [96–98], and commercial [99] organizations have proposed a range of commonly accepted strategies and practical suggestions for energy conservation in business environments through building retrofitting and automation. They can be reviewed in Table 3.

Existing research on energy conservation through building retrofitting, automations, rules, and policies has also led to the accumulation of specific insight for managing such interventions. A collection of such notes and advice from the existing literature for designing "hard" interventions and combining related strategies in organizations can be reviewed in Table 4.

Table 3. "Hard" interventions—effective strategies for organizational energy efficiency and conservation through building retrofitting, automation, rules, and policies.

Effective Strategies for Organizational Energy Efficiency and Conservation in "Hard" Interventions (Compiled and Adapted Insight from [12,16,21,79,96–109])
a. Building energy-efficiency retrofits (incl. industrial efficiency and net-zero energy buildings strategies)
(1.) Upgrade insulation. (2.) Install heat pumps and low-energy cooling devices. (3.) Conduct an energy audit to ascertain how the organization is using energy and identify areas of waste. (4.) Consider installing blinds or reflective window film to minimize cooling needs. (5.) Become a prosumer by installing energy-generating equipment on your premises (e.g., employ solar panels or wind turbines—geographic diversity increases the value of wind, while low-cost bulk power storage leads the value of solar panels [15]). (6.) Utilize thermal and/or hybrid energy storage systems when incorporating renewable energy in an installation to reduce PV and heat pump systems' lifecycle costs [82,83]. (7.) Improve or upgrade the insulation, especially in areas such as cavity walls or lofts. (8.) Replace windows or install double glazing where needed. (9.) If you use compressed air, consider reducing pressure by 10% to achieve 5% savings in energy and regularly check for leaks. (10.) Keep cold room (e.g., walk-in freezers or coolers) doors shut, or install automatic door closers or low-cost PVC curtains in the openings to reduce the energy leakage. (11.) Optimize energy intensity (manufacturing energy intensity could improve by 44% between now and 2040, with 70% of the energy savings potential in less energy-intensive manufacturing sectors). (12.) Avoid attempting to apply "one-size-fits-all" solutions (it is nearly impossible because of the wide variation in the characteristics of each project).
b. Smart buildings (sensors, automated controls, and other smart solutions)
(1.) Install automatic lighting controls, presence, motion detectors, and daylight sensors to turn off lights automatically in vacant areas, especially frequently unoccupied areas such as restrooms and copy rooms. (2.) Install automated timers and thermostats to maximize heating/cooling efficiency. (3.) Utilize energy management system (EMS) technology to control devices automatically. (4.) Use a smart meter to record when and where energy is mostly consumed and regularly measure the savings you achieve against your set targets.
c. Appliance and equipment efficiency (optimal use and maintenance)
(1.) Regularly service, maintain, and upgrade business equipment as needed. (2.) Replace old heating, ventilation, or air conditioning systems with new, energy-efficient systems. (3.) Install locking covers on thermostats to prevent people from tampering with the temperature settings. (4.) Try increasing the set temperatures in the winter or decreasing them in summer by 1 degree. (5.) Keep the windows clean to optimally leverage natural light and minimize the need for artificial lighting. (6.) Upgrade lighting fixtures to LED technology. (7.) Clean dusty diffusers and lamps every 6–12 months. (8.) Use laptops instead of desktops. (9.) Adjust (minimize) automatic doors' closing delay.
d. Energy conservation rules and policies (for optimal building and equipment use)
(1.) Shut off unused areas. (2.) Switch off equipment when not in use—e.g., turn lights, computers, and other equipment off when unneeded (e.g., at night) and reduce standby power consumption. (3.) Adopt a print less policy, or even paperless, if possible, to minimize printer usage. (4.) Use email instead of sending memos and faxing documents. (5.) Use only the lights in areas used. (6.) Try to ensure that energy is not wasted on heating or lighting in empty areas or during afterhours and, when possible, turn the air conditioning off for the last hour of each workday. (7.) Communicate the company's energy-saving measures to engage all its members. (8.) Involve and train employees in energy conservation practices. (9.) Utilize reminders such as posters or stickers, reminding employees of the way in which they should operate equipment to conserve energy at work. (10.) Advise employees to avoid wasting heat and make sure that heating or cooling is not escaping through openings (doors, windows, and gaps), especially when heating or cooling is on. (11.) Employ a facilities manager (FM) to supervise and shape the supply and consumption of energy within buildings, and interface between senior management, the organization's energy strategy, employees, and the building's equipment and infrastructure.

Table 4. Notes and advice for organizational energy efficiency through "hard" interventions (building retrofitting, automation, rules, and policies).

Notes and Advice for Designing "Hard" Interventions and Combining Related Strategies in Organizations
(1.) Applying energy efficiency and passive energy conservation technologies can at the same time also help toward ameliorating energy justice and poverty issues [21].
(2.) An alarming performance gap (reaching up to 300%) between the predicted and actual energy consumption of buildings has been widely acknowledged in the literature [110].
(3.) The key identified drivers toward energy conservation at the workplace include the structural context, building design, and technology [107].
(4.) Sensors, automated controls, and other smart solutions can optimize energy use and reduce it by 15% or more if applied correctly [21].
(5.) The largest potential savings in commercial and public buildings is usually in heating, cooling, and lighting, which together represented more than 60% of the energy consumed in buildings [12,105,106].
(6.) Three broad groups of barriers exist toward the success of energy-efficient technologies (EETs), such as automated lights and programmable thermostats: knowledge of their existence, access to them, and willingness to use them [100].
(7.) After applying energy-conservation technologies and smart-building automations, employees tend to learn and adapt, experiment, and improvise to resolve practical problems they may face at work as part of their daily routine (e.g., they may resolve to place post-it notes on light sensors to disable them) [109].
(8.) Consumers (employees and/or their organizations) often do not act rationally when making the decision to adopt energy conserving strategies, mainly because of a number of non-technical issues surrounding the impact to the building owners, occupants, and stakeholders, as well as their goals and expectations [16].
(9.) Any efforts to reduce energy consumption through technological improvements should be considered alongside energy conservation through behavioral change [103].
(10.) As structure-focused and employee-focused approaches are not by definition distinct strategies toward decreasing energy use, but complementary, changing employees' energy-use behavior is also considered necessary to support structural or operational changes toward energy conservation [104].
(11.) The human factor also significantly affects the successfulness of technology-based efficiency improvements [108].
(12.) Buildings' occupants constantly interact with their surroundings in order to optimize their ambient environment (e.g., opening windows to improve air quality, or turning on lights to increase illumination), thus also influencing energy consumption [102].
(13.) Understanding the daily routine of employees at their workplace to identify problematic issues, as well as opportunities for energy conservation, should precede the development of practical interventions [108].
(14.) Establishing a cohesive organizational culture through integrated efforts across organizational levels that combine structural changes with employees' behavioral change is suggested for energy conservation at work [109].
(15.) Although a facilities manager (FM) is a key actor with considerable potential impact in organizational energy conservation through socio-technical change, their ability to limit energy consumption is constrained by three factors that constrain their agency and capacity to act: demands to meet workforce expectations of comfort, a lack of support from senior management, and a shortage of resources [93].

4.2. "Soft" Energy-Saving Interventions

The main means for accomplishing energy conservation in organizational environments through "soft" interventions include the utilization of information systems (IS), and/or designing and executing behavioral interventions that aim to improve occupants' energy-saving habits. However, although IS can play a significant role in reducing energy consumption, they have inadequately been researched in connection to organizational energy saving [111]. "Energy informatics" focuses on how IS can be used to monitor and reduce energy consumption and offer practical solutions to advance environmental sustainability, as well as motivate actual energy-saving actions [112]. The main types of IS that can be utilized for organizational energy conservation include green IS, energy management systems (EMS), and energy management information systems (EMIS). Their description and usage in this context are outlined in Table 5. We note that despite their proliferation in industry they seem to have received limited attention within the IS community [113] and, therefore, there is a need for further research on their actual design and impact on the organization [114,115].

Table 5. Types of IS for organizational energy conservation—description and usage.

Type	Description and Usage
Green IS	*Description:* Green IS support initiatives/programs directly or indirectly addressing environmental sustainability in organizations [116]. *Usage:* - To simplify and automate environmental management tasks by facilitating and including environmental cost assessment, lifecycle assessment, compliance management, modeling, environmental cost assessment, environmental management system and knowledge management support, and health and safety management functionality [117,118]. - To support EMS to improve the flow and management of information with the aim of greening supply chains, operations, strategy, human resources, marketing, and technology within an organization [119]. - Only long-term green IS adoption has been positively related to organizational pro-environmental performance [120].
EMS	*Description:* Environmental management systems (EMS) are IS comprised of environmental management processes and metrics [113]. *Usage:* For improving the environmental performance of an organization [113].
EMIS	*Description:* Energy management information systems (EMIS) comprise of IS tools and services designed to manage commercial building energy use [121] and ensure environmental sustainability and energy efficiency [122], which can provide a common platform to analyze, transmit, and ultimately display energy consumption data [123] and include performance monitoring software, data acquisition hardware, and communication systems to store, analyze, and display building energy information [124]. *Usage:* - To automate the collection, storage, analysis, transmission, and display of energy consumption data in organizations [122,123]. - To allow the calculation of effective targets for energy use and comparative energy consumption by facilitating metering, data collection, data analysis, reporting and cost benefit analyses, early detection of poor performance, support for decision making, and effective energy reporting, thus enabling businesses to improve energy performance [125]. - To calculate an energy-use baseline and identify potential energy-efficiency measures and energy-saving actions that can be targeted (before an intervention), and to compare post-implementation usage with a previous baseline under similar operating conditions and then determine associated energy savings (after an intervention) [123]. - They can take the forms of IS for external reporting, early warning systems for the identification of environmental risks, eco-controlling for internal operations research, life-cycle assessment, key performance indicator based, environmental accounting, sustainability reporting, input-oriented, output-oriented, process-oriented, and production-related EMIS [122].

The inclusive (onion-like) relationship between the different forms of IS mentioned above can be seen in Figure 5.

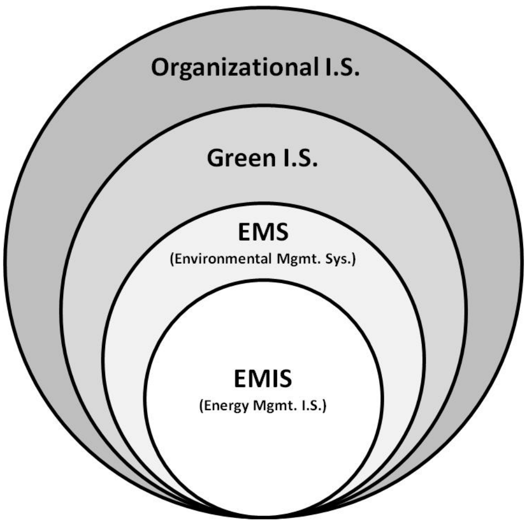

Figure 5. Energy management IS in relation to other IS systems.

To improve employees' energy consumption patterns at work, organizations need to organize and execute specifically designed behavioral interventions that usually employ feedback and specially designed IS, which may also feature motivational means such as gamification that is defined as "the use of game design elements in non-game contexts" [126], to increase employees' motivation for energy conservation through various actions (for examples, see [127–133]). Organizations are not simply rational, homogeneous entities, but rather complex networks of technologies and humans, the latter comprising a diverse set of roles, each with particular orientations toward energy and with particular agency and capacity to act [93]. Hence, apart from the effect on a building's structure and operation, applying energy-conservation technologies in a building also affects its occupants' daily routines [16], while the knowledge of and access to energy-efficient technologies, but a lack of intent or willingness to use them, often results in them being disrupted, or going unused [100,102]. At the same time, although the centralization of energy control within modern offices gives the facility manager (FM) almost complete control over many aspects (temperature, humidity, airflow, and light levels), in a traditional office space with decentralized controls, comfort settings are decided by informal negotiation, with the individual sitting closest to a window latch or thermostat control liable to adopt the role of gatekeeper [93]. Therefore, to achieve energy conservation, organizations should strive to establish a cohesive organizational energy-saving culture that combines structural changes and technological improvements with employees' behavioral change [103,109].

Research on employees' energy conservation behavior, as well as the socio-psychological influences of organizational contexts on individual energy decisions, is limited, constraining appropriate and effective policy and planning [104,134]. Hence, a recorded need for further research on the relationships between individual behavioral, social factors and energy use at the workplace exists [135]. However, energy-saving behavior is an expression of a wider category of behaviors that further expands in the context of organizational environments in specific. Therefore, insight from behavioral interventions aimed toward affecting this family of behaviors may be utilized when designing organizational energy-saving interventions. Definitions and a comparison of the terms used in research on organizational energy-saving behavior can be found in Table 6.

Reviewing the effectiveness of existing evidence on organizational energy-saving behavioral interventions, we find that, overall, it has varied widely, ranging from negative (increased energy consumption), to none (same energy consumption), or positive (actual energy savings achieved). Moreover, their design is complex and context-specific since, for example, it has been noted that the kinds of messages and campaigns that might be most effective in crisis situations differ to normal situations [81]. Behavioral interventions can also utilize the means from both hardware interventions (e.g., IoT devices, or energy-saving hardware) and software interventions (e.g., a behavioral intervention can be executed by employing a specially designed IS), or even accompany them in parallel to optimize the effectiveness of an organization's energy conservation policy. Specific insight and strategies toward designing and applying "soft" interventions (with minimal or no changes on the physical characteristics of the building) for organizational energy conservation (including IS and behavioral interventions) are presented in Table 7.

Table 6. Glossary of terms in the context of organizational energy-saving behavior.

Term	Definition(s)
	In all Contexts
PEB	*Pro-Environmental Behavior* (e.g., in [136–147]): i. "Behavior that harms the environment as little as possible, or even benefits the environment" [138]. ii. "Behaviour that consciously seeks to minimize the negative impact of one's actions on the natural and built world (e.g., minimize resource and energy consumption, use of non-toxic substances, reduce waste production)" [139].

Table 6. *Cont.*

Term	Definition(s)
In all Contexts	
ECB	*Environmentally Conscious Behavior* (e.g., in [148–152]): "Specific psychological factors related to individuals' propensity to engage in pro-environmental behaviours" [149]—includes the conservation of energy and materials, ecologically conscious decision-making, and more active or passive roles in environmental activism [150,151].
ESB	*Environmentally Significant Behavior* (e.g., in [153–158]): Can be defined according to both its impact—i.e., behavior that "changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself"—as well as the actors' intent—i.e., "behavior that is undertaken with the intention to change (normally, to benefit) the environment" [154].
ERB	*Environmentally Responsible Behavior* (e.g., in [159–165]): Knowledge of environmental issues and action strategies, locus of control, attitudes, verbal commitment, and an individual's sense of responsibility [165].
EFB	*Environmentally Friendly Behavior* (e.g., in [166–170]): "Behaviour with positive environmental consequences (recycling, water conservation, and so on)" [168].
Specifically in Organizational Environments	
ExRB	*Extra-Role Behavior* (e.g., in [171–180]): "Performance-related behaviours that go beyond the assigned tasks and responsibilities for which employees are typically held accountable" [175].
OCB	*Organizational Citizenship Behavior* (e.g., in [176,181–198]): i. "Voluntarily helping or assisting others in the workplace, promoting the excellence of their employer without either an explicit or implicit promise of reward for the behaviour" [183]. ii. "Extra-role behaviour that is discretionary and not explicitly related to the formal reward system of an organization but is conductive to its effective functioning" [183,194], which "supports the social and psychological environment in which task performance takes place" [189].
OCBE	*Organizational Citizenship Behavior for the Environment* (e.g., in [199–202]): A more focused form of OCB that is specifically directed toward protecting the environment [199–202].

Table 7. "Soft" interventions—effective strategies for organizational energy efficiency and conservation with minimal or no changes on the physical characteristics of the building.

Effective Strategies for Organizational Energy Efficiency and Conservation in "Soft" Interventions
a. Software interventions (utilizing information systems IS and ICT to help organizations conserve energy)
(1.) Help employees to understand the changes that the organization brings forth to achieve its sustainability goals [119]. (2.) Help apply and establish work practices and processes that are in line with sustainability goals [111,119]. (3.) Utilize one or more of the main types of organizational IS for environmental sustainability: environmental management systems (EMS), "green IS", energy management and information systems (EMIS): • Each category can help the organization in a different way; • Researchers and practitioners can utilize insight from existing research on such systems in the literature, to help them implement and design their own IS for organizational energy conservation. (4.) Utilize ICT (and IoT technologies) in energy systems to reduce energy use in buildings [105]. (5.) Enable the execution of energy-saving behavioral interventions and the assessment of their outcomes [111]. (6.) Enable and improve the way energy evaluation, measurement, and verification (EM&V) activities are conducted, and/or monitor energy consumption and/or savings in real time [123]. (7.) Improve the operational efficiency and lower total energy consumption in buildings by using real-time data [105]. (8.) Execute interventions that incentivize energy savings (total volume, or per-device/person) [123]. (9.) Provide personalized energy training and design personalized behavioral interventions [123]. (10.) Introduce intelligent energy-saving systems to the organization (with increasing awareness about the energy crisis they have become a new trend for organizations to follow) [203]. (11.) Employ human-centered design methods when designing IS systems for organizational energy-saving [204]. (12.) Combine IS with communication and persuasion methodologies to effect behavioral change [204]. (13.) Promote efficiency and digitalization in the energy sector through technological innovation [94].

Table 7. *Cont.*

Effective Strategies for Organizational Energy Efficiency and Conservation in "Soft" Interventions
a. Software interventions (utilizing information systems IS and ICT to help organizations conserve energy)
(14.) Utilize ICT, IoT, and real-time data [105] to realize intelligent IS with embedded user awareness (personal context and behavior patterns), ambient awareness (variables of the workplace context), and social awareness (patterns of social interaction) [205,206]. (15.) Integrate appliance and activity recognition mechanisms into energy management systems [206]. (16.) Utilize IoT-enabled reminder systems to improve employees' appliance usage patterns [203]. (17.) Increase employees' sense of personal responsibility at work, and ensure that ISs do not simply substitute their energy-saving actions [207]. (18.) Utilize gamification in IS aimed toward organizational energy-saving toward increasing occupants' motivation for energy conservation through various actions [127–133,208–213]—a comprehensive list of specific guidelines for the design and implementation of gamified IS toward increasing employees' motivation to conserve energy at work can be found in [214]. (19.) Utilize digital tools with nudges, goals, and incentives to continue stimulating energy-saving behavior and achieve sustained change [81,215].
b. Behavioral interventions (interventions aimed at altering employees' behavior)
(1.) Utilize behavioral interventions at work to save energy both quickly and effectively: • Changing employees' energy use behavior can lead to significant savings [216]; • Behavioral interventions can help organizations save energy quickly [79]; • Well-designed behavioral campaigns can motivate people to reduce their energy consumption by up to 20% [81]. (2.) Focus on the energy wasted through employees' behavior and suggest curtailment actions: • They generally use much more energy than they need at work [69,217]; • Their behavior significant impacts buildings' energy performance, even during closed times (e.g., devices left on) [218,219]. (3.) Design interventions to include personalized feedback: • Provide feedback (preferably direct and real-time) to each employee on their own energy-consumption (and conservation) actions [91,220–223], through ISs that utilize IoT and sensors [215,221,224] • Design information-based interventions to include nonmonetary awards [103] • Savings from feedback interventions have led to up to 15% savings [221] (4.) Incorporate insight from the existing literature on interventions in similar categories of behavior (see Table 6 for glossary of terms). (5.) Investigate the reasons behind employees' hesitancy to adopt energy-saving actions at work, and organize informational campaigns to alter their perceptions accordingly [217]. (6.) Provide training on the existing opportunities for energy-saving at work, and suggest simple (easy to explain and execute) energy-saving actions that should be followed and when they should be enacted at work [79,91,225,226]. (7.) Record employees' primary goals and the demands of their work, and make sure that you set energy-saving goals that are not in conflict with them nor harm employee productivity [69,107,135,222,227]. (8.) Survey the organization to ascertain how much energy is necessary for employees to perform their duties, and only suggest the actions that realistically can be performed by them to conserve energy [217]. (9.) Suggest energy-saving actions that are simple, easy, and affordable, to preserve employees' energy-saving attitude [101]. (10.) Focus on explaining and stressing the importance of energy saving at work, leveraging motivations beyond energy reduction itself, such as the preservation of the environment and the benefits to society or the organization [135,217,228,229]. (11.) Suggest energy-saving actions while considering the effect they will have on employees' personal comfort [135]. (12.) Assess employees' motivation to conserve energy at work before an intervention, and utilize the highly motivated ones as "ambassadors" to promote the intervention to their colleagues [227,230]. (13.) Provide ample control over their own actions, and boost feelings of personal responsibility for energy-saving at work [226]. (14.) Include social opportunities, shared goals, and promote collective targets in energy savings among the employees, especially with regard to shared devices [216,226,229]. (15.) Involve the organization's leader(s) to engage and empower employees toward energy conservation [93]. (16.) Establish a cohesive energy-saving organizational culture, clearly communicate the energy-saving targets and expectations of the organization to employees [220,226], and include employees in the (co-)design of energy-saving interventions [227]. (17.) Tailor and personalize interventions according to employees' characteristics and motivations [107,220,231,232]. (18.) Focus on the positive feelings that may come as a result of "doing the right thing" for the environment [228]. (19.) Design energy-saving interventions to include a variety of different pro-environmental behaviors [232]. (20.) Employ behavioral scientists and specialists to help design and deliver well-structured and well-communicated energy-saving messages optimally to increase and sustain the impact of your interventions [79,81]. (21.) Utilize gamification (to improve energy-saving knowledge, attitude, motivation, and behavior) [127,208–213], designing the intervention to fit its target users' individual characteristics and preferences [233,234]. (22.) During energy crises, focus energy-saving campaigns more intensely on collective action, as well as replicate news and pleas from the media regarding energy conservation [81], and take advantage of the increased news coverage on energy-saving to organize interventions and influence the participants toward conserving energy more effectively [87].

5. Discussion

Human activity and its impact on the environment have led to widespread reference to the present era as "Anthropocene". As the rise of our undisputed reign on Earth has come as a result of the consumption of energy, electricity in specific is recognized as one of the main contributing forces. At the same time, energy consumption, especially in organizations, is considered responsible for a large part of the greenhouse gas emissions, whose curtailment is necessary for the preservation of our climate. However, even though total energy consumption keeps rising worldwide, access to energy (and energy services, such as lighting, cooking, and heating) is not a given for all. A third of the population worldwide seems to be living with either no access to electricity at all, or access to unreliable electricity. Moreover, the consumption of energy is not evenly performed across all areas of the planet, with poor areas consuming less, and having reduced access to, electricity. This leads to significant issues of energy poverty and justice, and in turn to social, economic, educational, and health issues. For many, this is the essence of the energy crisis that we are called upon to deal with. Therefore, energy conservation, apart from its expected benefits for the environment and future generations, can also aid in dealing with issues of justice and sovereignty in the present.

Energy conservation has recently gained increased attention and impetus, owing to two consecutive crises—the COVID-19 health crisis and the conflict in the Ukraine. Due to the strong dependance of the modern way of life on energy consumption, energy crises are a repeatedly occurring phenomenon since the 1970s. They also tend to either precede or come in the aftermath of other types of crises (economic, health, etc.). Apart from their strong negative effects and ripples to society, they also dynamically bring forth the need for energy conservation. In the context of such crises, it has been made clear that energy conservation is both possible and effective in producing significant savings. This has been exhibited by the drop in energy consumption worldwide in the context of the recent COVID-19 health crisis and the 2010 economic crisis, which was significant and can be attributed mainly to the change they brought in nonresidential uses. However, the fact that it was also only temporary illustrates that it was mostly out of necessity and not by choice that energy conservation was adopted in these cases. Nonetheless, the drop in energy consumption observed was to the benefit of the environment, as it did indeed effectively lead to the reduction in CO_2 emissions worldwide.

Overall, the events of the past decades have brought to light the fact that energy crises are quite tightly interrelated with other types of major crises (be it health, economic, or natural phenomena that trigger them). In some cases, an energy crisis has triggered other types of crises (e.g., the economic crisis that came as a result of the 1970s' energy crisis). In other cases, other types of crises have brought forth an energy crisis in their aftermath (e.g., the COVID-19 health crisis and the conflict in the Ukraine were both followed by an energy crisis). That comes as a reflection of the highly perplexed relationship of energy consumption with the modern way of life humanity has adopted, where energy is essential for our welfare and a necessity to sustain our standard of living. Therefore, since organizational energy conservation can potentially lead to significant energy savings, it is even more important to practice it toward reducing worldwide energy consumption in times of crisis.

Acknowledging the corresponding need to amplify organizational energy conservation, in this work we provide evidence to support the notion that *in the context of the Anthropocene, organizational energy conservation is concurrently a matter of environmental sustainability, ethics, and social justice and, at the same time, a matter entwined with crises as it both causes and is caused by them*. Moreover, we discriminate between "*hard*" (which include building retrofitting and automation and pose the highest cost in their execution) and "*soft*" (which include the utilization of IS and/or behavioral interventions and pose a significantly lower cost in their execution) *organizational energy-saving interventions*. Additionally, we provide guidance for future research and practice in organizational energy conservation in the form of a detailed account of effective strategies for organizational energy efficiency and conservation through both "hard" and "soft" interventions.

Combining our findings it becomes clear that the four dominant matters in the context of the Anthropocene (environmental sustainability, corporate ethics and sustainability, social justice, and crisis management) drive the need for both "soft" and "hard" organizational energy-saving interventions, toward achieving organizational energy efficiency and conservation. This proposed relationship is graphically depicted in Figure 6 and can constitute a guide for future research and practice in organizational energy efficiency and conservation.

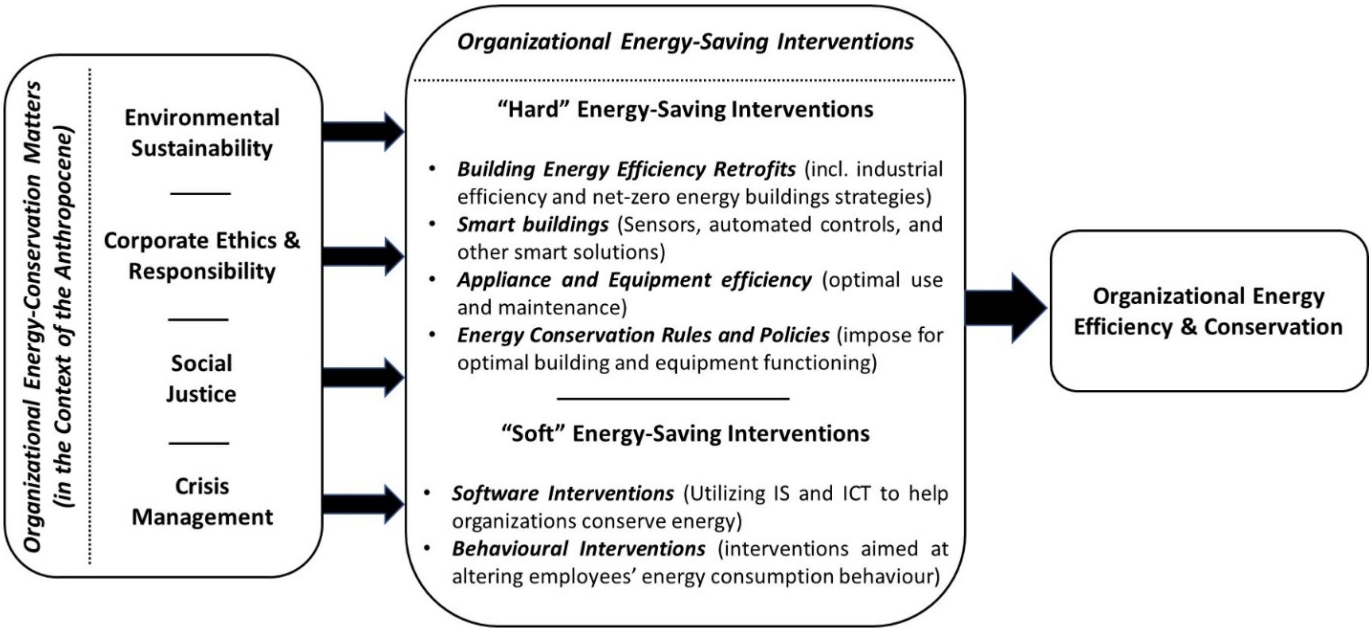

Figure 6. A guide for research and practice in organizational energy efficiency and conservation.

The present work essentially provides a novel and combined view on organizational energy conservation and its importance. First, it examines and places it in the context of the Anthropocene, considering its intricate characteristics. In addition, it provides a guide for energy-saving interventions that considers the main drivers behind it. We also shed light onto the different types of IS that can be utilized for organizational energy conservation, and the inclusive (onion-like) relationship between them, as well as provide a glossary of terms in the context of organizational energy-saving behavior. While the existing literature tends to focus and present insight on the different types of—and means for—energy-saving interventions separately, the present research combines them so that practitioners may utilize the accumulated knowledge to design more inclusive and potentially also more effective energy-saving interventions. Furthermore, the combined insight can guide future research in organizational energy saving. Researchers may accordingly benefit by examining the inherent relationships presented and designing their studies to explore them in more detail.

6. Conclusions

Acknowledging the need to amplify organizational energy conservation (OEC), this work focuses on exposing the multiple facets that it presents itself in. We contribute to existing theory by providing evidence to support the notion that *in the context of the Anthropocene, organizational energy conservation is concurrently a matter of environmental sustainability, ethics, and social justice and, at the same time, a matter entwined with crises as it both causes and is caused by them*. Moreover, aiming to further guide future research and practice in this field, we provide guidelines for conducting both "*hard*" (which include building retrofitting and automation and pose the highest cost in their execution) and "*soft*" (which include the utilization of IS and/or behavioral interventions and pose a significantly lower cost in their execution) *organizational energy-saving interventions*. A detailed account of insight from the existing literature is accordingly combined and presented. To further aid researchers and practitioners alike, we also shed light onto the different types of IS that can be utilized for organizational energy conservation, and the inclusive (onion-like) relationship between them, as well as provide a glossary of terms in the context of organizational energy-saving behavior. The present work, hence, essentially provides a novel and combined view on organizational energy conservation and its importance. Additionally, it also provides a guide for future theoretical and practical work involving both "soft" and "hard" interventions. In practice, our findings may also be utilized by facility managers to design and maintain their building efficiency plans. Moreover, they can also aid policy makers in the field of energy conservation.

Notably, our findings, apart from their benefits, also bear their limitations. First, the evidence we present was collected by following a narrative literature review approach. Future researchers may therefore corroborate and expand on our findings by following a systematic approach and attempt to filter existing scholarly work more widely and inclusively. Second, we collected static evidence with regard to the effect of contemporary crises on energy consumption and conservation. We also acknowledge the fact that there is a recorded need to investigate how technology, behavior, and policy will evolve over time, as well as how they will impact energy systems in the future [105], as well as a need for further research on the design and actual impact of IS and ICT on organizational energy conservation [114,115]. Therefore, future research may alleviate this limitation by adopting an intertemporal observation approach within which the interrelatedness between crises and energy conservation can be mapped in more detail and with greater accuracy. We also note that our findings constitute insight that has been drawn by reflecting on existing research. Therefore, to confirm their theoretical soundness and practical utility, future researchers and practitioners may focus on conducting observations and experiments in real-world scenarios. Finally, considering our collected insight, future researchers may specifically focus in more depth on uncovering the effect of the different types of "soft" and "hard" interventions we have presented on organizational energy efficiency and conservation, as well as on the impact of the four identified contextual drivers (environmental sustainability, corporate ethics and responsibility, social justice, and crisis management) on both their design and effectiveness. To fully examine these matters, intertemporal, as well as interorganizational experimentation, in international settings is suggested.

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