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# Ethics of Energy Transitions

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## **Description**

Energy transitions raise significant questions of ethics and justice. This is particularly true today as the US and the world contemplate large-scale transformations of energy systems: the greening of energy production, the construction of smart grids and the rise of big data in energy services, the creation of electric and hybrid-electric vehicles, and the rise of unconventional oil and gas. These transitions have the potential to influence not only energy production and delivery but also the social, economic, and political organization of the energy sector.

## **Abstract**

## **Body**

# I. INTRODUCTION: SOCIO-ENERGY SYSTEM DESIGN

The global energy system is at the outset of a massive transformation. The significance and occurrence of this transition is not in doubt. The precise timing and ultimate outcomes of this transition, on the other hand, are deeply uncertain. Cars may electrify, go hydrogen, or remain based on carbon fuels. Unconventional fuels, biofuels, or synthetic fuels may dominate. The world may build thousands of new nuclear plants, or only a few dozen more. Renewable energy may further centralize or decentralize energy production. About the only thing we know for certain is that the energy systems of 2050 and 2100 will look little like their current contemporaries, in terms of fuels, of socio-economics, or of geographies.

This article examines the ethical quandaries that surround the future of energy system change. These quandaries stem from three key facts about energy systems that are particularly significant in the context of large-scale energy transitions. The first is that energy systems are not merely technological systems but rather systems that closely intertwine technologies with a wide range of people: investors, workers, engineers, industrialists, customers, users, citizens, etc. [1] Energy transitions, therefore, are not simply shifts in fuel or the technological basis of energy production and/or consumption. Instead, these technical changes occur in parallel, and in relation to and exchange with, changes in values, decisions, behaviors, relationships, practices, and institutions. Past transitions make clear, in fact, that often the most important aspects of major energy transitions are the accompanying social, economic, and political reorganization [2, 3].

The second key fact follows from the first. Energy transitions not only reorganize energy production and consumption, they also redistribute power, wealth, risk, vulnerability, resilience, etc. The ethics of energy transitions is thus bound up with the reallocation of important societal outcomes, on scales from the individual to the globe [4]. In imagining and fashioning energy systems for the future, therefore, it is crucial to design and plan for integrated socio-energy systems and not just for energy technologies. Unfortunately, this is far from our current practice, either in energy engineering or energy policy.

The third key fact is that energy technologies are flexible in design, especially as they are incorporated into larger social, economic, and technological systems [5]. PV panels are not all alike, but far more importantly, the organization of PV panels into a working energy delivery system can take strikingly different forms, ranging from solar calculators or lanterns to rooftop systems to utility-scale power plants. Around each of these technologies, different social and business models are possible. The net result is a wide range of opportunities for socio-energy system design, often with radically distinct ethical profiles.

## **II. ENERGY TRANSITION ETHICS**

Ethics is the practice of judging right and wrong. In modern societies, this is inevitably a complex, multi-faceted, and context dependent exercise—and energy transitions are no exception. Diverse traditions of ethical analysis approach this complexity from distinct perspectives, bringing important questions to bear on considerations of the ethics of energy transitions. One important set of questions emphasizes distribution: who benefits, who bears the burden? Another asks about voice and authority: who participated, in what ways, and to what effect? Still a third focuses on injustice, especially when injustice is systematic and seeming integrated into the design of processes or outcomes. Finally, a fourth attends to organizational values and practices, especially with regard to the rights and responsibilities of professionals, employers, employees, contractors, clients, and so forth. In all of these dimensions, ethics operates at the level of individuals (what has come to be understood as micro-ethics) as well as at the level of organizations, professions, and societies (what has come to be understood as macro-ethics) [6].

Ethical questions permeate the planning and execution of energy transitions. At the most macro-scale, temporally and spatially, humanity must address a range of questions, for example: (1) how much longer continuing to pump carbon into the atmosphere can be justified, given its projected impacts on future generations; (2) who is responsible for taking action to reduce carbon emissions; (3) who will pay for those reductions; and (4) what other sacrifices are justified or required in the face of impending climate change [7]. These questions are not the focus of this article. My concerns are focused on more meso-scale questions that directly impact energy system design and thus the work of engineers transforming the energy system. Let

me offer two illustrations, one focused on distributive justice, the second on procedural justice.

### ***A. Who benefits and who loses?***

Fred Krupp and Miriam Horn observed, in an effort to encourage entrepreneurs to find new ways to provide energy, that energy is a \$5 trillion business [8]. Go get your share! In markets, of course, winning and losing is the name of the game, and markets reward the most competitive companies. But markets are just an abstraction of more complex realities. Losing companies fire employees, shutter production facilities, and renege on debt obligations, perhaps pushing whole regions into patterns of economic decline. Choosing to build a coal-fired power plant vs. a nuclear plant may or may not mean a lot in terms of the number of electrons delivered to the grid or the price paid for them, but the two will generate very different distributions of benefits, costs, and risks among their respective fuel cycles, supply chains, and downwind neighbors.

These differences are magnified when not just individual power plants but whole forms of energy organization are at stake. Solar energy systems fit poorly into the operating frameworks of US utilities. Even when constructed in the form of utility-scale power plants, the intermittency of solar energy and its unavailability at night create problems for its successful integration into electricity grids, especially in large quantities. Even more disruptive, rapid penetration of rooftop solar systems in the Southwestern US threatens to upend utility business models and grid technologies, even as these systems deliver electricity to customers at stable, long-term, relatively low prices. Widespread adoption of distributed generation, should it happen, will have consequences that extend far beyond the owners of distributed systems to include those who continue to rely on utility-delivered electricity (who may likely face higher energy prices) and those who work for and invest in utility companies (who may see their jobs disappear and their shares decline in price) [9, 10].

To be sure, all energy systems distribute benefits, costs, and risks across individuals and groups. The choice is not, therefore, between some forms of energy being ethical and others unethical—it is between different systems designs that contribute to ethical and unethical outcomes. In highlighting the variability of these distributions as a function of socioenergy system design, my goal is to encourage the explicit consideration of ethics in design choices. Design choices can be made

more ethical, sometimes by adjusting technology designs, other times by adjusting the social, economic, and political organization of these technologies.

### ***B. Who decides?***

In ethics parlance, the question of who decides is a major element in the consideration of procedural justice. An older child may accept a smaller piece of cake in deference to her younger siblings if asked, but if the unfair distribution is simply imposed by a parent, she may seethe with a sense of injustice. So it goes in the distinction between democracy and totalitarian forms of government, where the process of how decisions are arrived at may matter as much or even more than their final outcomes.

The history of energy development in much of the world over the second half of the twentieth century has seen energy decisions devolve into the hands of a narrow group of energy experts and business and political leaders. This is largely a consequence of the stability of energy systems during this period, both in the electricity and fuels sectors. At the same time, it reflects a public sensibility to neglect what happens behind the electrical outlet or the fuel pump. This should not be confused, however, with a view that energy decisions have always taken this form. Indeed, in the early twentieth century, numerous energy policy developments, including, e.g., anti-trust legislation and the creation of public utility commissions and regulated, monopolistic utilities, were subject to widespread social and political deliberation and debate. The enormous social, political, and economic consequences and conflicts surrounding late nineteenth and early twentieth century energy transitions around oil, railroads, and electricity grids demanded careful consideration of the design, operation, and ethics of socio-energy systems.

The coming energy transformation will be no different. Already, publics are demanding a stronger role in energy decision making around both renewable energy and unconventional fossil fuels [11]. Gas wells, wind turbines, solar fields, and oil pipelines have all generated significant episodes of social protest over the past few years. Indeed, the challenge is greater even than these public controversies suggest. Given the social and economic restructuring that will accompany energy systems change, a key ethical question will be what responsibility the energy sector has to engage diverse communities in deliberations about their energy futures—and, to the extent they do have such responsibilities—how to accomplish this task effectively [12]. At present, by

contrast, regulatory and permitting processes are largely designed to exclude public participation in energy planning, except in narrow, highly structured ways that limit considerably the influence of community voices. These include limited time for public input, evidentiary frameworks that limit non-technical contributions, and beliefs that non-experts do not know enough to contribute meaningfully to energy decisions.

### **III. ETHICAL PRACTICE IN SOCIO-ENERGY SYSTEM DESIGN**

The barriers to ethical analysis and reflection in energy development, planning, and policy are significant. Energy developers and the politicians they work with want the deal done, the project constructed, and the electrons or fuel—and associated revenues—flowing. Energy engineers often imagine ideal energy systems that may conflict with public sensibilities about what they want for the future of their communities. Energy publics may feel underqualified to deliberate complex technological systems. Over and above all of this, confronting ethical quandaries seriously may require forms and processes of decision making that differ significantly from business as usual in energy planning and policy. Nonetheless, if the goal is to create future energy systems that fairly and justly distribute risks and benefits, via processes that fairly incorporate a wide range of public perspectives and views, then ethics is an essential element for energy transition management. How then can energy engineers, businesses, and regulators confront the ethics of energy transitions?

#### ***A. Develop ethics criteria for transition outcomes.***

In one of the few systematic reports to address energy ethics head on, the Nuffield Council on Bioethics (one of the UK's most important bioethics bodies) highlighted the ethical dilemmas associated with large-scale development of biofuels and developed a set of substantive ethical criteria for future investments [13]. This is an important development and should be extended to all fields of energy. Most contemporary energy policy is driven by considerations of, first, the price at which energy can be delivered, second, the reliability of energy supply, and third, the resulting carbon emissions. Environmental and health risks are also important, if less so. Considerations of equity and access, of the just distribution of revenues,

benefits, costs, and risks, of the social value or social destructiveness created—these far less frequently factor into energy transition planning, except where they give rise to social and political conflict and violence. The Nuffield Council's six principles for biofuels ethics are illustrative (if entirely focused on the distributional and environmental aspects of energy ethics):

1. Biofuels development should not be at the expense of people's essential rights (including access to sufficient food and water, health rights, work rights and land entitlements)
2. Biofuels should be environmentally sustainable.
3. Biofuels should contribute to a net reduction of total greenhouse gas emissions and not exacerbate global climate change.
4. Biofuels should develop in accordance with trade principles that are fair and recognise the rights of people to just reward (including labour rights and intellectual property rights).
5. Costs and benefits of biofuels should be distributed in an equitable way.
6. If the first five principles are respected and if biofuels can play a crucial role in mitigating dangerous climate change then, depending on certain key considerations, there is a duty to develop such biofuels.

***B. Confront the socio- in socio-energy systems design early and often.***

Especially for energy engineering design, one of the major challenges posed by the ethics of energy transitions is finding strategies for incorporating ethics into the design of projects. One strategy here is to routinely, throughout the design process, ensure that the human and social dimensions of energy are taken into consideration [14]. People are involved in energy as designers, operators, engineers, managers, workers, users, consumers, purchasers, and, ultimately, inhabitants of energy systems. In short, people live and work with, in, and around energy systems, and this should influence the design process at all stages. Consultations can occur prior to beginning the design process, around preliminary designs, around final designs, and as the project design is being implemented in construction and operation. This occurs naturally in many engineering design processes, but it may occur indirectly, e.g., when Steve Jobs insisted that he could represent the user experience in Apple design processes; it may occur in a perfunctory way, where inputs are minimal and not taken overly seriously; and it may occur narrowly, with only end users (or even only some groups of end users) incorporated. Particularly in the context of energy transitions, it seems important to open the design process up to engagement that is

direct, serious, and with broad groups, so as to get as broad a picture of the social dynamics of future energy systems as possible. Other approaches might be to invite humanists and social scientists who can study the social phenomena surrounding energy projects to participate in design processes.

### ***C. Expand lifecycle assessments to include social outcomes and outcome distributions.***

Lifecycle analysis has properly become a staple of engineering sustainability analysis, extending the analysis of environmental risks and impacts beyond those created by a particular facility to its supply chains, waste streams, and end-of-life dismantlement. As an input into ethical deliberation, however, lifecycle analysis falls short in three critical ways. First, it generally looks only at issues of environmental risk and impact, neglecting considerations of socio-economic risk and impact. Social impact analyses are conducted in some contexts, such as international development projects, but here the framework is not typically carried out using lifecycle methods. The real solution is to conduct social outcomes and risk assessments as part of lifecycle analysis, thus extending our understanding of what new energy projects mean for society from cradle to grave.

The second shortcoming of traditional life cycle analysis is it generally aggregates the impacts and risks of projects to create an overall summation. This is highly useful in cost-benefit calculations but significantly less useful for ethical analyses (at least outside of narrowly utilitarian frameworks), which rely on the distribution of impacts across different communities. Distributions of outcomes may be significant geographically, demographically, or temporally, in other words, across communities separated spatially, across groups within the same community, or across time [15, 16]. For example, even if the overall sum of risks from a proposed new power plant are small, if they fall disproportionately on one group of people, it may create significant justice issues, especially if that group fails to benefit proportionately from the project. To address this, lifecycle analysis needs to understand the spatial and social geography of social and environmental risks and outcomes associated with energy developments.

Finally, lifecycle analysis falls short in addressing the outcomes of energy systems change as a whole. Lifecycle analysis typically is conducted for an individual facility or product. Yet, the coming energy transition is likely to bring systems-wide transformation that may multiply (or cancel out) the impacts of individual

technologies or projects.

***D. Create strategic, open-ended, participatory energy planning at local, national, and global scales.***

In the context of a global energy transition, fashioning novel energy systems is a major undertaking that will have longterm implications for the structure of social, economic, and political institutions. It is not an accident, for example, that Texas oilmen have had an outsized influence on the political dynamics of the United States. Energy transitions, therefore, are as much about the future of society as they are about the future of energy. Certainly energy planners in the Tennessee and Columbia River valleys understood that fact in the 1920s and 1930s as they envisioned the future of hydropower in their regions. Yet, today, most energy planning is quite narrow. In Arizona, for example, utilities were only very recently given responsibility for conducting regular integrated resource planning. And, even so, this planning still occurs on a utility-by-utility basis. No state-level strategic planning has sought to integrate utility and transportation planning, even as hybrids, electric cars, and natural gas vehicles increasingly bridge these two systems. Indeed, in Arizona, no statewide agency exists that has comprehensive authority for energy policy. At the national level, the US Department of Energy (DOE) is simply misnamed. The bulk of DOE authority (and budget) is focused on nuclear weapons, while DOE itself is responsible for only a fraction of the federal government's energy policy initiatives. Most of the regulation of energy resources, for example, is done by the Department of Interior, while the Department of Defense, through its procurement policies and research budgets often has greater influence than DOE on energy innovation. At the global scale, similarly, the major institutions of energy governance are focused, on the one hand, on climate change, and on the other, on nuclear safeguards. Only the International Energy Agency is squarely focused on energy, and it is largely an information provision organization—not global energy planning and coordination.

The absence of strategic energy planning makes addressing the ethical challenges of energy transitions particularly difficult, as no institution has the kind of integrated and overarching authority that would enable (a) setting ethical criteria for future energy systems; (b) ensuring comprehensive attention to the social dimensions of energy systems change; and (c) carrying out comprehensive, distributional life cycle assessments. Just as significant, from a procedural justice perspective, the

absence of comprehensive energy planning also makes difficult efforts to enable and facilitate routine, robust, diverse participation of publics in energy governance. Effective public participation in some forums will likely only lead those who wish to restrict participation to focus their efforts to design energy systems on forums with less effective participation rules, unless comprehensive energy planning processes occur that can open up all aspects of energy policy to greater public input. Given the importance of energy transitions to broader social, economic, and political transformation, however, public involvement is not only important, to ensure good energy policies, but ethically (and democratically) responsible.

## **IV. ENERGY AND HUMAN THRIVING**

No discussion of energy ethics would be complete without a commentary on the relationship between energy and human thriving. In a recent essay, Carl Mitcham and Jessica Rolston argue for a consideration of two types of ethical questions surrounding socio-energy system design [17]. The first follows largely our analysis here. The second raises the question of energy consumption as an ethical dilemma on its own terms. Beyond some level of ethical energy consumption, they wonder, following Illich, whether energy gluttony is as ethically problematic as other forms of over-consumption [18].



**Figure 1. Human development as a function of primary energy consumption. From Steinberger and Timmons Roberts.**

My response to this concern follows from the work of Steinberger and Timmons Roberts who measure the relationship between energy consumption and human wellbeing in countries over time [19]. As Figure 1 illustrates, there is a general relationship between energy and human development, in which human development rises as a function of energy consumption. This relationship is not linear, however, nor is it uniform across all countries. Indeed, two important features of Figure 1 stand out. First, countries with similar levels of energy consumption have very different levels of human development. Costa Rica has much higher levels of development than China, for example, at lower per capita energy consumption levels. Second, countries with similar levels of human development have very different levels of energy consumption. Japan and Spain achieve identical scores on the human development index to the US, at half of the per capita energy consumption.

These two observations suggest, at the macro scale, that socio-energy design matters a great deal to the relationship between human outcomes and energy consumption. Proper socio-energy system design can contribute much higher value to society than poor socio-energy system design. The same is true at the micro-scale. Solar lanterns offer some of the most expensive energy on the planet on a dollars per kilowatt basis. They are also very expensive in comparison to rural African incomes, which are among the poorest in the world. Yet solar lanterns are selling rapidly. Why? Because the light and stored energy they deliver to communities without electricity provides extraordinary social value. By focusing critical attention on socio-energy system design, engineers and social scientists working together are positioned to significantly enhance the social value that humanity is able to derive from the energy it produces.

In an era of climate change, in which humanity will need every trick in the book to find solutions that enable high levels of human development to persist in an era of radically reduced carbon emissions, proper socio-energy system design must be a critical focus. Yes, over-consumption of energy is a serious problem. But the real problem is deriving less social value from energy than possible, which contributes to excess carbon emissions and/or excess costs to produce energy, both of which make addressing carbon emissions more difficult.

## **V. CONCLUSION**

At no prior point in history has humanity systematically reflected on the ethics of large-scale energy systems change as an integral part of an energy transition process. Unfortunately, it shows. Past and current energy systems are riddled with a wide variety of injustices. The coming energy transition offers a unique opportunity to correct some of those injustices and to avoid their future analogs. To accomplish this, however, will require new approaches to energy design, planning, and operation. Perhaps most important, it will require getting beyond carbon and price in efforts to define and develop sustainable, socially responsible energy systems. Reducing carbon emissions and maintaining low and stable costs for energy are both significant goals, but they are insufficient criteria for a just, ethical energy transition. To them, it is appropriate to add criteria that assess the fair distribution of benefits, costs, and risks and the justice of decision processes.

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