TOWARD AN ECOCENTRIC PHILOSOPHY OF ENERGY IN A TIME OF TRANSITION

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Ecocentrism is a philosophical position developed in the field of environmental philosophy that offers an alternative view of the complex relationships between humans and the nonhuman world. This dissertation develops an ecocentric philosophy of energy in order to account for a wider set of ethics and values dimensions involved in energy politics. It focuses especially on inter-species justice as a crucial missing element behind even those energy policies that seek to transition society from fossil fuels to renewable energy sources. The goal is to develop an ecocentric philosophy of energy that accounts for the fundamental and deep ecological interdependences of human and nonhuman animals, plants, and other living and non-living beings.

I start with an introduction and a summary of the chapters followed in chapter 2 by a clarification of the terms “paradigm” and “energy.” In chapter 3 I offer an exploration of the origins of the “energy paradigm” or the predominant understanding of energy that emerged during modernity (18th century onwards). The modern energy paradigm progressively became a “traditional” forma mentis that is nonetheless based on flawed presuppositions about the human-energy-nature relationship. I criticize the homogeneous, colonizing and hegemonic nature of this paradigm, unveil its tacit anthropocentric and instrumental assumptions, and show how it still fuels contemporary lifestyles and policy. Chapter 4 presents a literature review that traces the most significant contributions from the humanities (broadly construed to include social sciences such as anthropology and sociology) to the study of energy. In this chapter, I also focus on the scarcer yet relevant literature on energy’s metaphysical, ontological, and ethical dimensions. In chapter 5 I develop the theory of a radical, ecocentric philosophy of energy, building on the work

of other ecocentric thinkers such as Holmes Rolston III, J. Baird Callicott, and Arne Naess. Chapter 6 suggests paths towards the realization, in praxis, of this ecocentric philosophy of energy. It provides the sketch of an "ecocentric energy ethic" to enhance an ecologically sustainable and inter-species just energy transition. This normative framework is intended as a flexible and nonetheless precise "moral compass" that supports an ecocentric turn in the human-energy-nature relationship. The energy ethic outlines key principles to evaluate the "morality" of energy policies, practices, and technologies. These principles can provide ethical guidance to energy practitioners (engaged consumers, energy users, educators, designers, and public policy makers) and thus contribute to the theoretical and practical achievement of an ecologically sound and inter-species just energy transition.

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CHAPTER 1

INTRODUCTION AND OVERVIEW

"E" is an algorithm, "energy" is a loaded word. "E" is meaningful only within a formula, "energy" is charged with hidden implications: it refers to a subtle something which has the ability to make nature do work.
Ivan Illich, *The Social Construction of Energy*

Few topics are as important as energy. Indeed, energy is not so much a distinct topic as it is a thread woven throughout many of today's most pressing issues – from political economy to ecology to science and technology. As a result, there is no shortage of talk about energy. Especially since the oil crises of the early 1970s, one only needs to open a newspaper or scroll a webpage, to find a wide range of discussions that span from the energy costs of Bitcoin mining to surging wind development in West Texas, to talk of uranium in Iran or the promises of Tesla's Powerwall. Yet no matter what the topic of conversation, I contend that the discourse is grounded on a problematic understanding of "energy," a *forma mentis* that has deep roots in the modern worldview, and specifically in questionable assumptions about the human-energy-nature relationship. I call this assumed understanding "the energy paradigm," an account that has been produced within the natural sciences and has become "traditional" through the marvels of engineering. Admittedly, the traditional energy paradigm implies a great number of features typical of the modern period: a certain ideal of progress, assumptions of anthropocentrism linked to the commodification of nature, a strong reliance on technoscientific apparatus, a proactionary approach to risk assessment, free-market capitalism, individualistic and competitive values, and so on. As I will explain in the beginning of chapter 2, my use of the term "paradigm" derives from historian of the physical sciences Thomas Kuhn and philosopher of technology Albert Borgmann.

In this work, I will concentrate specifically on the anthropocentric aspect of the energy paradigm, along with its emphasis on the instrumental, mechanistic, and quantitative properties which are assumed in the study, management, and consumption of the natural world. In the discussion of such a paradigmatic worldview, my work agrees with Lynn White, Jr. that what we do depends on what and how we think: “What people do about their ecology depends on what they think about themselves in relation to things around them” (1967, p. 1205). Similarly, the conceptualization of energy has material consequences. I will unravel the sense in which what we practically do in terms of power production, consumption, distribution, and waste ultimately depends on what we think about energy.

The problem of an anthropocentric energy paradigm is not limited to fossil fuels and their socio-environmental implications. Even the current transition to renewable energy sources perpetuate the energy paradigm, that is, they falls short with regard to human justice and they largely fail to account for the nonhuman world. Energy projects and policies are focused on maintaining or expanding the current production of power, or extending its distribution, for more human consumption. Questioning the deeper assumptions of such doings, evaluating alternative directions, and addressing the related ecological consequences are only minor preoccupations.

In the meantime, there are dramatic issues of energy poverty and access worldwide and, of course, it is still essential to provide basic access to electricity to more than one billion people. It is important to clarify upfront that criticizing the anthropocentric nature of the traditional energy paradigm does not conflict with issues of human justice and equity. In fact, although the discourse of energy justice that emerged during the past decade has been tackling these issues, it has also been substantially human-centered. Thus, although there is much good in the ongoing transition to renewables and in the concerns of energy justice scholarship, they are both still problematically focused on humans and consider everything else as secondary, if at all.

My thesis is that a transition to a truly just and sustainable energy future requires a change in mindset – about the human-energy-nature relationship – and not only a change in policies or technologies. Because I maintain that the energy transition should be just also in inter-species terms and ecologically sound, my goal in this dissertation is to provide a more inclusive and non-anthropocentric account: an ecocentric philosophy of energy.

This dissertation sits at the boundaries of three fields: ecocentric environmental philosophy, energy humanities, and philosophy of technology. I conceive this latter broadly to include more traditional energy analysts such as Vaclav Smil who puts a special emphasis on the philosophical, ethical, and cultural implications of energy issues. I now sketch the contours of these three areas and further expand on them in chapter 5 as I mine more specific resources in these traditions for my argument.

1.1 Ecocentric Environmental Philosophy and Ethics

Some antecedents of the type of reasoning to be outlined here began in the mid-1970s in the field of environmental philosophy and ethics. Ecocentrism is a philosophical position that acknowledges and promotes the moral centrality and considerability of all the species and the inanimate beings that live within different ecosystems of which humans are also considered an essential part. Nonhuman beings can be understood individualistically (each singular entity) or as part of communities (plants), populations (animals), ecosystems, eco-regions, or even the entire Earth (Callicott 2013). Although it has been accused of being excessively radical and even indicted for eco-fascism, ecocentrism need not be misanthropic. Indeed, the vast majority of ecocentric positions typically argue, not against humanity, but rather against the centrality or primacy of human beings, and advocate for a reshaping of the human-nature relationship in less hierarchical ways. Generally speaking, ecocentrism derives metaphysical and moral implications from the knowledge and insights of the ecological sciences (Callicott 1986). Since its emergence in the early 1970s, ecocentrism has branched out into several versions or philosophical positions. Some of the most influential and "classic" references are North American scholars Holmes Rolston III (1988; 1991) and John Baird Callicott (1989; 1999), along with Norwegian philosopher Arne Naess (1973; 1989), father of the "Deep Ecology" movement. Since ecocentric reasoning has rarely been imported into the discussion about energy policy and justice, this dissertation seeks to fill that gap. Chapter 4 clarifies in detail the most effective and convincing arguments supporting an ecocentric philosophy of energy.

Besides these academic contributions, my research suggests that there are other sources of an ecocentric understanding. In this sense, I claim that the predominance of the traditional paradigm in the energy discourse has hindered the emergence of different cultural perspectives, preventing alternative or more holistic views regarding the human-energy-nature relationship. In both my reading of the anthropology of energy literature, and in my ethnographic study of the indigenous-led protests concerning the construction of the Trans-Pecos pipeline (TPPL) in southwestern Texas, I came across many non-Western, non-anthropocentric, and non-mechanistic views that serve as further examples of ecocentrism (Frigo 2018a). In the case of controversial energy projects such as the TPPL or the Dakota Access Pipeline (DAPL) the merging of the traditional energy paradigm with petrocultures[1] are evident and create instances

[1] I embrace a broad definition of "petrocultures" such as that suggested by Karina Baptista: "the term "petrocultures" refers to the social imaginaries constituted by the knowledge, practices, and discourses resulting from the consumption of and subsequent dependence on oil" in (Baptista 2017).

of environmental and energy injustice. Besides the struggles of humans, nature is emptied of any spirituality and sacredness. Traditional ecological knowledge is often dismissed, lost or erased. Therefore, as I explain later, I propose that the understanding of the natural sciences and engineering should be enriched and integrated also with these alternative cultural perspectives which are often thematized in the social sciences and humanities.

Throughout this work, I embrace an ecological definition of energy à la the conservationist and writer Aldo Leopold who, in "The Land Ethic" (1949) proposed the idea that the very functioning of nature depends on the circulation of a "fountain" of solar radiation flowing through the land:

> Plants absorb energy from the sun. This energy flows through a circuit called the biota, which may be represented by a pyramid consisting of layers. The bottom layer is the soil. A plant layer rests on the soil, an insect layer on the plants, a bird and rodent layer on the insects, and so on up through various animal groups to the apex layer, which consists of the larger carnivores. […] Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals. Food chains are the living channels which conduct energy upward; death and decay return it to the soil. The circuit is not closed; some energy is dissipated in decay, some is added by absorption from the air, some is stored in soils, peats, and long-lived forests; but it is a sustained circuit, like a slowly augmented revolving fund of life. (pp. 182-184)

This deliberately broad definition, for instance, integrates, rather than opposes, the mechanistic definition of physics that reduces energy to the "capacity of doing work," transforming nature into something to be used for the needs of humans. Although I provide other similar, and even more holistic definitions of energy in other sections of this dissertation, it is important to consider that thinking about energy from the perspective of environmental philosophy accomplishes two important goals. First, it enriches our understanding of energy in its conceptual and cultural dimensions. Second, and related, the proposal of an ecocentric outlook reshapes and reevaluates our relationships to the planet and its other (in)animate nonhuman beings. An ecocentric perspective can shed light on the theoretical frameworks of the energy discourse, the soundness of its reasoning, and the ecological and ethical and socio-political implications of its practical developments in energy policies and projects.

Following in the steps of Arne Naess' "The Shallow and the Deep, Long-Range Ecology Movements" (1973), I suggest a deeper reflection on the philosophy of energy. Bill Devall and George Sessions (2007) point out that, through the distinction:

> Naess was attempting to describe the deeper, more spiritual approach to Nature exemplified in the writings of Aldo Leopold and Rachel Carson. He thought that this deeper approach resulted from a more sensitive openness to ourselves and nonhuman life around us. The essence of deep ecology is to keep asking more searching questions about human life, society, and Nature as in the Western philosophical tradition of Socrates. […] Thus deep ecology goes beyond the so-called factual scientific level to the level of self and Earth wisdom. (p. 65.)

As David Rothenberg wrote in his *Introduction* to a collection of essays by Naess (1989),

> Depth only applies to the distance one looks in search of the roots of the problem, refusing to ignore troubling evidence that may reveal untold vastness of the danger. One should never limit the bounds of the problem just to make an easier solution acceptable. This will not touch the core. One should think not only of our species but of the life of the Earth itself. The planet is more than us, more fundamental and basic than our own single species in isolation. (p. 12)

To paraphrase Naess, if a "shallow" philosophical reflection would basically consist in a commentary, a philosophy *for* the existing science and technology of energy, a "deep" philosophy *of* energy begins *within* the concept of energy and its assumptions, analyzing them, exploring their historical roots, highlighting their socio-cultural and economic implications, thus directly "asking more searching questions about human life, society, and Nature."

Another useful differentiation, similar to Naess is to further understand my point would be that between "weak" and "strong" sustainability (Neumayer 2013; Pelenc and Ballet 2015). In a basic sense, the weak version postulates the full substitutability of natural capital with human capital. Based on the work of Robert Solow (1974; 1986; 1993) and John Hartwick (1977; 1978a; 1978b), weak sustainability influenced the ideas of "limits to growth" (Meadows et al.

1972) and “sustainable development”[2] (Brundtland 1987) that gained traction in the international climate summits since Rio 1992, and inspired landmark documents such as *Agenda 21* (UNCED 1992). Strong sustainability, by contrast, provides a framework that is more radical and assumes that natural and human capital are not interchangeable, but complementary. Herman Daly’s proposal is especially powerful in consideration of the fact that, for example, humans are living in a “full world” where population increases and the limiting factor is, *de facto*, natural capital (Daly (1995; 2005). As Eric Neumayer (2013) puts it,

> proponents of SS [Strong Sustainability] are not against achieving WS [Weak Sustainability]. Rather, they would regard achieving WS as an important first, but insufficient, step in the right direction. In a sense, SS encompasses WS, but adding further requirements. […] WS is better than traditional neoclassical economics, but it is still a far cry away from what is needed for SD [Sustainable Development]. (p. 25)

Holland (1997) wrote that “absurdly strong sustainability is not absurd” and I would similarly argue that a deep, strong philosophy *of* energy is possible and is more adequate for the social and environmental issues currently facing planet Earth. Besides technological innovations and scientific advancements, the discourse of energy implies questioning deep assumptions regarding the socio-cultural construction of energy (Illich 2015; Crease 2004) which should be understood in connection to the human-energy-nature relationship.

1.2 Energy Humanities

Over the past decade, a new field of intellectual engagement has developed, the energy humanities, an area of inquiry about energy that sits at the crossroad of humanities and social

[2] The famously cited definition is: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland 1987).

sciences. Two of the "founders" of this novel endeavor are Dominic Boyer and Imre Szeman[3] who affirm in "Breaking the Impasse: the Rise of Energy Humanities" (2014) that

> energy humanities […] overcomes boundaries between disciplines and between academic and applied research. Like its predecessors, energy humanities highlight the essential contribution that the insights and methods of the human sciences can make to areas of study and analysis that were once thought best left to the natural sciences. Energy is a perfect example of an issue that exceeds the traditional division of academic labour. As we've entered a new geological era, the Anthropocene, experts and publics across the world want to know how to cope with rising demand for energy when our current energy portfolio is already inducing global warming, ocean acidification and climate change. (p. 40)

Moreover, for energy humanities scholar Imre Szeman (2015),

> energy has had a key role in shaping culture and society especially since human communities began to use petrocarbons to an ever-increasing degree, first, through the addition of coal in the expansion of industrial capitalism in Northern European, and then via the global expansion of economies and populations through the extensive (if globally uneven) use of oil and gas. (p. 7)

Scholars such as Stephanie LeMenager (2014) and Szeman (Szeman and GAPSSHRC 2016; Szeman 2014) have proposed and explored the term "petrocultures" to "emphasize the ways in which post-industrial society today is an oil society through and through. It is shaped by oil in physical and material ways, from automobiles and highways we use to the plastics that permeate our food supply and built environments" (Petrocultures Research Group 2016). The collection *Cultures of Energy. Power, Practices, Technologies,* edited by Sarah Strauss et al. (2013) and the Special Issue *Exploring the Anthropology of Energy: Ethnography, Energy and Ethics* edited by Jessica Smith and Mette High (J. Smith and High 2017), gather timely anthropological and ethnographic studies on the theme of energy. These contributions are examples of the potential of anthropology of energy to offer alternative views about energy,

[3] (Szeman and Boyer 2017) Boyer direct the Center for Energy and Environmental Research in the Human Sciences (http://culturesofenergy.com/) at Rice University and work with Cymene Howe on the anthropology of energy also through media such as podcasts and a blog. Imre Szeman (University of Alberta) is another important contributor in energy humanities and one of the founders of the Petrocultures Research Group at the University of Alberta.

offering more diverse perspectives that can enrich the energy discourse and hence benefit energy policy (Jones 2016). These perspectives are emerging and are oriented toward a more comprehensive, and qualitative, understanding of energy that would enrich the quantitative one.

Anthropology of ethics challenges the disciplinary idea that ethics is most of all a theoretical study of morality, an approach strenuously defended for decades in academia (despite the flourishment of fields such as bioethics) showing that morality can be successfully studied from the bottom up (Zigon 2008). Energy research benefits from the approach of the anthropology of energy because of "agile modes of inquiry that study both the diversity and malleability of energy-society relations. Anthropology is equipped to engage with both spheres simultaneously: cultural and ideational aspects (energy imaginaries) as well as the conflicts and asymmetries that result from energy practices (contested powers)" (Partridge 2016). In particular, energy ethnographies have the power of making people's understandings and experiences of energy *visible*. For instance, they do not merely discuss what energy justice is in ethical theory. Rather, they present concrete lived energy experiences, clarifying the different meanings of energy justice in practice. Therefore, this dissertation is conceived and envisioned also as an original contribution to the emergent field of energy humanities.

1.3 Philosophy of Technology and Energy Studies

Some of the points I raise in the following pages are not very dissimilar from what has already been affirmed since the 1970s by many scholars in the area of philosophy of technology and science, technology and society (STS) studies who wrote in the context of peak oil and scarcity. I broadly understand this group of intellectuals as pivotal "thinkers of technoscience," because some of them are not recognized as professional philosophers. Yet, I suggest that their contributions amount to a type of philosophizing regarding energy. A first group of intellectuals I refer to are academic scholars such as Lewis Mumford (1934; 1951; 1966), Martin Heidegger (Heidegger 1977), Carl Mitcham (Mitcham 1994; Mitcham and Rolston Smith 2013; Cutcliffe and Mitcham 2014), Albert Borgmann (1984; 1992; 2000), and Adam Briggle (Briggle 2015), all of whom have offered a diverse but compelling array of analyses of the relationships between humans and energy technologies.

The second group of "energy thinkers" is more diverse and include, for instance, the work of heretical thinkers such Ivan Illich (1974; 2013) and Günther Anders (Anders 1980), non-traditional economists such as Nicholas Georgescu-Roegen (1971), and influential "systemic" analysts such as Vaclav Smil (2003; 2008; 2010b; 2010a; 2010c). All these are important antecedents of my proposal. To better understand the contribution of philosophy of technology, I now succinctly introduce the work of Mumford, Heidegger, and Mitcham to the study of energy and technoscience. I then refer to other authors in the coming chapters.

Lewis Mumford (1895-1990) was a prolific historian, sociologist, and philosopher of technology who wrote broadly about the influence of modern technology on the human condition. In his 1951 Lectures at Columbia University titled *Art and Technics* (1951), for example, he clarified one of the starting point of the modern worldview about technology which, significantly enough, occurred in parallel to the progressive marginalization of the humanities:

> Three and a half centuries ago Francis Bacon hailed the advancement of scientific learning and mechanical invention as the surest means of relieving man's estate: with a few expiatory gestures of piety, he turned his back upon religion and philosophy and art and pinned every hope for human improvement on the development of mechanical invention. (p. 4)

In an earlier book, *Technics and Civilization* (1934), Mumford distinguished between "polytechnics" and "monotechnics." The former are technologies that humans have developed to express rich, multivalent ways of life, while the latter those that are pursued for only one end, power, thus transforming human societies into oppressive technocratic assemblages. In the historical evolution from the "Paleotechnic" (i.e. Industrial Revolution) to the "Neotechnic" epoch (post WWII), Mumford saw an expansion of monotechnics, visible for instance in the planned spread of the automobile-based transport system in the United States. Increasingly evident in the period of Neotechnic are also "Megamachines" – machines whose components are both artifacts (such as mechanical parts) and humans – which necessarily imply meticulous accounting, standardization, and an enormous bureaucratic apparatus. I later return to the connections that Mumford highlights between energy and mechanization. For now, it suffices to say that, behind his provocative philosophy of technology, there are ecocentric inclinations. In *The Myth of the Machine, Vol II: The Power of the Pentagon*, Mumford criticizes the violent intrusion of humans into the nonhuman world, stressing that a specific modern, European attitude disrespected the land, disregarding its sacredness and the well-being of its inhabitants for the sake of conquest and exploitation:

> Unfortunately the hostility that the European displayed toward the native cultures he encountered he carried even further into his relations with the land. The immense open spaces of the American continents, with all their unexploited or thinly utilized resources, were treated as a challenge to unrelenting war, destruction, and conquest. The forests were there to be cut down, the prairie to be plowed up, the marshes to be filled, the wildlife to be killed for empty sport, even if not utilized for food or clothing.
>
> In the act of 'conquering nature' our ancestors too often treated the earth as contemptuously and as brutally as they treated its original inhabitants, wiping out great animal species like the bison and the passenger pigeon, mining the soils instead of annually replenishing them, and even, in the present day, invading the last wilderness areas, precious just because they are still wildernesses, homes for wildlife and solitary human souls. Instead we are surrendering them to six-lane highways, gas stations, amusement parks, and the lumber interests, as in the redwood groves, or Yosemite, and Lake Tahoe—though these primeval areas, once desecrated, can never be fully restored or replaced. (p. 11)

By looking at the problem and promises of technology, Mumford helps make sense of the ways technology is interwoven with human language, symbolism, city planning, as well ecosystems.

Martin Heidegger's (1889-1976) philosophy of technology played a pivotal role in shaping much of the conversation about philosophy and technology in the second half of the 20th century. Mitcham underlined the significant fact that Heidegger wrote three different works in the span of just 13 years, all of which include the term "question" in the title. This choice "suggests a need to examine the 'question concerning technology' especially in relation to the 'question of Being' and perhaps even the 'question of the thing.' It may also be that these other two questions concerning the thing and technology can help illuminate the fundamental question of Being" (Mitcham 1994, pp. 50-51).

I pointed out earlier that, because of its anthropocentric orientation, the traditional energy paradigm tends to quantify, reify, and commodify nature. Its different components and beings become "things" through the use of technology. But in a more profound sense, what does technology *really* do? For Heidegger (1977), it "reveals" something is a kind of "truth," and therefore shows some specific traits of modern humans. In Heidegger's words,

> what has the essence of technology to do with revealing? The answer: everything. For every bringing-forth is grounded in revealing. Bringing-forth, indeed, gathers within itself the four modes of occasioning-causality-and rules them throughout. Within its domain belong end and means, belongs instrumentality. Instrumentality is considered to be the fundamental characteristic of technology. If we inquire, step by step, into what technology, represented as means, actually is, then we shall arrive at revealing. The possibility of all productive manufacturing lies in revealing. Technology is therefore not mere means. Technology is a way of revealing. (p.12)

It is important, at this point, to examine the terms "Bestand" and "Ge-stell" (En-framing). Modern technology allows the conversion of the whole universe of beings into an undifferentiated "standing reserve" (Bestand). These beings become things, and ultimately energy available for any human use. If Bestand is the world as manipulable resources, Ge-stell is the ontological framing that makes Bestand possible. Later in “The Question Concerning Technology” Heidegger argues that Ge-stell is essentially what lies behind modern technology:

> Enframing means the gathering together of that setting-upon which sets upon man, i.e., challenges him forth, to reveal the real, in the mode of ordering, as standing-reserve. Enframing means that way of revealing which holds sway in the essence of modern technology and which is itself nothing technological. (1977, p. 55)

Heidegger thus rejects the common idea that technology is a means toward specific human ends and suggests that it actually represents a (powerful) mode of human existence, a way to chase and tame Bestand. As Mitcham puts it: “Heidegger argues that technology is a kind of truth or revealing, and that modern technology in particular is a revealing that sets up and challenges nature to yield a kind of energy that can be independently stored and transmitted” (1994). It is important for the following discussion about the energy paradigm to better understand the connection between the question of technology and that of the “thing.” Mitcham (1994) helps untangle the complex Heideggerian lingo:

> Heidegger argues that technological processes, unlike traditional techniques, never create things in the genuine sense. […] In place of unique things like the potter's earthenware jug, modern technology generates a world of what Heidegger calls Bestand -"resources;' "standing reserve;' "stock" objects that are available to be used and consumed. The world of modern artifacts always stands ready and available to be manipulated, consumed, or discarded. This is not just because of mass production, but because of the kinds of articles that are mass-produced. Bestand consists of objects with no inherent value apart from human use. […] Modern science is characterized by an objectification of the natural world, the re-presentation of the world in mathematical terms that necessarily leave out of account its earthiness, thus setting up the possibility for producing objects without true individuality or thinghood. (p. 52)

If modern technology is a mode of revealing that is intrinsically connected to instrumentality and objectification, we better understand how and why the nonhuman world has been tacitly conceived and treated as a reservoir of resources and materials waiting to be exploited by and for humans. Profoundly and without compromises, Heidegger describes how the Western human-energy-nature relationship is problematic and, undoubtedly, “The Question

Concerning Technology" presents a sharp critique of modern technology. Toward the end, however, after pointing out that "the destining of revealing is […] not any danger but *danger* as such," Heidegger offers an opening to a different world: "Enframing does not simply endanger man in his relationship to himself and to everything that is. As a destining, it banishes man into that kind of revealing which is an ordering" in the sense of creative power, or *poiesis*. Famously, then, Heidegger cites Hölderlin: "But where danger is, grows the saving power also" meaning that "in this destining the saving power is said to grow." In conclusion, "the closer we come to the danger, the more brightly do the ways into the saving power begin to shine and the more questioning we become. For questioning is the piety of thought" (1977). As Mitcham puts it: "it is this questioning of technology, or the attempt to enclose technological certitude within philosophical questioning, that is at the core of Heidegger's philosophy of technology" (1994).

The contribution of Mitcham's thinking is pervasive in this dissertation. In 1994, Mitcham published a book that is recognized as a classic introduction to the philosophy of technology, *Thinking through Technology: The Path between Engineering and Philosophy* (Mitcham 1994). In this seminal work, Mitcham develops a comprehensive philosophy of technology that analyzes and merges the approaches of engineering and the humanities toward a comprehensive account. For instance, Mitcham proposes an analysis of engineering design, which continues Illich's distinction between tools and machines as well as his analysis about the relationships between the power used by mechanical machines in contrast to "human energy." Moreover, Mitcham provided in other writings profound insights about the etymologies and the semantics of key terms that abound in this dissertation such as "technology," "technics," "engineering" (Mitcham 1991). Finally, Mitcham is one of the very few philosophers who engaged the topics of energy and ethics (Mitcham and Rolston Smith 2013). Together with

Jessica Smith, Mitcham proposed a “distinction between type I and type II energy ethics as a framework for advancing public debate about energy” to which I return in the last chapter. Besides these foundational works, during 2017 I have been fortunate to learn from Mitcham through some fruitful discussions in Germany and Colorado. From these experiences, I was able to better understand both his perspective on technoscience as well as that of his former friend, Illich, thus refining my own thinking about energy.

1.4 High Energy Societies and the Conundrum of Energy Transition

Starting in the Western world, modern societies have become high energy socio-political assemblages. In many parts of the globe, humans are extremely *energivorous*, addicted to a commodious lifestyle based on abundant and intense energy, the availability of which they expect and take for granted (Borgmann 1984). Contemporary lifestyles are based on sophisticated technoscientific premises and are unthinkable without recurring to ad hoc socio-political and economic apparatuses that guarantee an enormous and steady input of resources into the system.

Although *Homo sapiens* has always interacted and used the environment to survive (Price 1995), it is especially throughout the last two centuries that a growing number of humans have extracted from nature larger amounts of fuels and materials, exploiting the work of other animals and the services of ecosystems at rates that many consider unsustainable (Kowalsky and Haluza-DeLay 2013; Fay and Golomb 2012). The astonishing rate of population growth has brought humans from 1.6 billion in 1900 to more than 7.6 billion in 2018, an almost five-fold increase. In the span of just a few decades a new animal has appeared, *Homo energeticus* who, through technoscientific domination, reifies, commodifies and prices nature to serve its growing needs (Kowalsky and Haluza-DeLay 2013). This is the classic energy transition to modernity.

Another energy transition to renewables is currently happening through fits and starts worldwide. They seem to require the electrification of infrastructures and devices, and the switch of entire systems (Meadowcroft, 2009; Smil, 2010; Grubler, 2012; Araújo, 2014). Although an evolution of energy sources has happened more than once in human history (Price 1995; Fouquet and Pearson 2012), and in very different ways (O'Connor 2010), the current energy transition involves unprecedented scales and must deal with an existing dependence on petroleum. Nonetheless, transitioning away from fossil fuels is the prerequisite for a meaningful worldwide contribution to climate change mitigation (Stephenson 2017)) and depends on significant technological innovation (Stolten & Scherer, 2013).

But are technoscientific strategies enough for an energy transition that will take into account also nonhuman life? The question is not trivial because, again, it applies to the core mindset, the underlying assumptions of individual and collective lifestyles, policies, and political decisions. Following the tracks of several other contemporary thinkers in energy humanities and social sciences (Ruotsalainen et al. 2017), I hold that the energy transition is not only technical affairs. The energy transition should not be understood only as a human socio-technological and economic problem, but also (primarily, at its core) as an ecological and philosophical one. They are intertwined with other dimensions of individual, social, and ecosystemic life. Culturally and philosophically, they imply metaphysical, psychological, sociological, behavioral, gendered, legislative, and religious considerations. Ecologically, they take place within complex ecosystems in which other species require adequate space and resources to thrive. These cultural and ecological dimensions of the transition are less visible than wind farms or Tesla Model 3 but are essential to fully grasp their breadth and depth. If we ignore them by underestimating their influence or sweeping them under the rug as a humanistic nuisance or unnecessary environmental alarmism, we run the risk of understanding only part of the story. As Janet Stephenson suggests, "to work effectively across disciplines, social scientists will need to learn something of what *energy* means, and physical scientists will need to learn something of what energy *means*" (Stephenson 2017). Environmental ethics, philosophy of technology, energy humanities and social sciences can help integrate the understanding of energy produced in the natural sciences toward a more holistic account.

1.5 Summary of the Chapters

Chapters 2 and 3 constitute the *via negativa* of this dissertation. In them, I provide first a clarification about the usage of the terms "paradigm" and "energy." There follows a detailed description of the origins, homogenization, colonization, and hegemony of the "traditional energy paradigm," or the classic modern conceptualization of energy. As it has been well documented by other scholars (Smil 2006; Smil 2008; Smil 2010b; Illich 2013; Mitcham and Rolston 2013) the concept of energy has undergone a two millennia long evolution. However, what modern and contemporary energy scholars and practitioners (engaged consumers, policy makers, government officials, grassroots activists, nonprofit leaders) mean when they talk about energy mostly depends on the mechanistic and quantitative account provided by the natural sciences and especially thermodynamics over the past 250 years. In the final part of chapter 2, I propose a critique of the reductionist character of the modern energy paradigm by claiming that it relies on an understanding that is anthropocentric, instrumental, mechanistic, quantitative, and mathematized. Chapter 3 is instead more focused on the socio-cultural and political dimensions implicated in the homogenization, diffusion, and hegemonizing of this way of thinking about energy on a planetary scale.

Chapter 4 initiates the *via positiva* of the dissertation. Here I present a literature review of several alternative voices to expand, integrate, and enrich the narrative of the natural sciences and engineering. I survey some of the most significant contributions from humanities and social sciences to the study of energy. Even though many of these perspectives do not directly challenge the traditional energy paradigm I described in the previous chapter, they nonetheless provide different and insightful studies and reflections. In particular, I focus on two areas, energy and ethics and the scarcer yet relevant literature on philosophy and energy.

Moving from the perspectives of social sciences and humanities, chapter 5 delves into the relevance of environmental philosophy and ethics to the understanding of energy. I begin by retrieving the examples of ecocentrism that better serve the purpose of the energy discourse. Then I sketch the contours and explore the theoretical foundations of an "ecocentric philosophy of energy" intended as a philosophical enrichment of the traditional energy paradigm beyond technoscience. Here, I clarify how and explain why an ecocentric philosophy of energy constitutes the appropriate basis for an ecologically sound and both intra- and inter-species just energy transition, the most promising way to reshape, or upgrade, the energy paradigm. An ecocentric philosophy of energy, however, should not remain only a theoretical construct. In fact, I propose that it constitutes the basis for a radically different way of relating to and acting about the nonhuman world generally and energy issues specifically.

Chapter 6 clarifies the connections between this ecocentric philosophy of energy and its practical ethical consequences. The core of the chapter presents an "energy ethic," a normative framework that can help identify some key principles and values for a "moral compass" to orient human thinking and decision-making (individually and socially) regarding most, if not all energy issues. I also acknowledge the fact that my proposal is idealistic, and I admit that more knowledge is probably not going to help, given that many humans do not believe in the danger even though they know about it (Dupuy 2012; 2014). So this is why we need to pause and reflect on the future trajectories of our relationship with nature-energy. Thus, the ecocentric philosophy and its practical counterpart, the ethic, are here envisioned as optimistic avenues of reflection and praxis respectively. They would require a change of mentality, and beliefs system. I believe that this is possible in the course of one or two generations and given a broader ecocultural shift that, to some extent, is already in the making.

The moral content of the energy ethic depends on scientific observations and/or factual evidence produced among natural sciences, social sciences, and humanities. In this sense, it constitutes an interdisciplinary effort to bridge different types of knowledge that is coherent with an ecocentric outlook. The energy ethic suggests a path for meaningful lifestyles, practices, and policies that are lower-energy intensive but highly remunerative and beneficial for both humans and nonhumans. This energy ethic does not correspond to a life of scarcity or frugality, nor does it negate freedom of choice. It should rather be understood as part of an educational re-orientation of the human-energy-nature relationship, a "radical pedagogy of energy."

1.6 Relevance of this Work

Energy is one of the most debated topics in contemporary public discourse and is the subject of increasing theoretical and applied research that is carried out especially by Science, Technology, Engineering, and Mathematics (STEM disciplines). Historically speaking, energy discourse has mostly relied on expertise from technoscience. Its operative arm, energy engineering, has played a predominant role in deciding how to tackle and overcome issues related to energy production, accessibility, distribution, consumption, and waste. This means that for more than two hundred years the study of energy and its countless applications (and by a large extent also the energy transition!) have been the domain of the natural sciences and engineering. This fact may appear obvious, but it depends on an underlying, invisible philosophy of energy. Its assumptions affect not only the thinking (or thoughtlessness) of people but what they do in both the private and public spheres. Humans' energy-related past and present practices, those being individual actions, social choices, or public policies fundamentally depend on the traditional energy paradigm.

At this point, an example may help clarify what I am up to. The energy discourse regularly frames the scarcity of a material within a techno-fix mentality or the belief that most if not all shortages can find solutions in new, better, or updated technologies. The reasoning is that the problem can be fixed through increased efficiencies and decoupling, or the idea that human development can happen without increasing ecological footprint (Caine et al., 2014; Asafu-Adjaye et al., 2015). For example, the depletion of conventional oil and gas deposits is seen primarily as an economic problem, not an ecological one. Unconventional shale reservoirs such as the Barnett or the Permian Basin in Texas are expected to deliver enormous quantities of oil and gas through fracking. However, some observers note that such energy abundance implies unprecedented risks which are hard to quantify. Moreover, a long-term exploitation of these sources can lead to catastrophic climate consequences (Davis and Fisk 2014). This example shows that every time there is a shortage of some natural element, the socio-economic and political systems invoke the help of the technoscientific apparatus which invents a new technology or discovers a surrogate. In this specific case, the invention of horizontal hydraulic fracturing has temporarily solved the immediate issue, allowing the exploitation of shale deposits which were economically unfeasible before. The point is that, in this typical mentality, a new part of nature is again commodified, a price tag is attached to it and this new "item" will be regulated by the market. Since these and similar cases are typically taken for granted, my goal is to unveil the worldview on which they depend.

The significance of this project can be summarized in four main directions. First, the analysis and deconstruction of the ontological and ethical dimensions of the classic conceptualization of energy improves our understanding of energy in its historical developments and suggests possible improvements. Second, the development of a radical ecocentric philosophy of energy provide the theoretical foundations for an ecologically sound and just energy transition. Third, the identification of the basic principles of an energy ethic can enhance personal choices about lifestyles, as well as educational practices, politics, and policy. Fourth, this philosophical reflection on energy is an attempt to break the disciplinary model of "purified" academic philosophy (Frodeman 2010; Frodeman and Briggle 2016a). Developing new ways of tackling real world problems demands philosophers get out of their comfortable institutions and requires them to become familiar with other branches of knowledge and disciplines while preserving their curious and inquisitive attitudes, methodologies, and epistemological autonomy. In this sense, this dissertation follows the idea of a "field philosophy" of energy, an approach that requires us to leave "the book-lined study to work with scientists, engineers and decision makers on specific social challenges. […] Rather than seeking to identify general philosophic principles, they begin with the problems of non-philosophers, drawing out specific, underappreciated, philosophic dimensions of societal problems" (Frodeman 2010).

If absorbed by culture, diffused in educational practices, and implemented in policymaking, an ecocentric philosophy of energy and its applied counterpart, energy ethic, have the potential to improve the socio-cultural debate about environmental and energy issues and, overall, the human-energy-nature relationship.

CHAPTER 2

ENERGY PARADIGMS

> *Your paradigm is so intrinsic to your mental process that you are hardly aware of its existence, until you try to communicate with someone with a different paradigm.*
>
> Donella Meadows, *The Global Citizen*

This dissertation aims to develop an ecocentric philosophy of energy. The first step is to characterize and then challenge the predominant understanding of energy produced by the natural sciences, engineering, and economics: the energy paradigm. Hence, this chapter and the next represent the *via negativa* of the dissertation. The *via positiva* begins in chapter 4. This part opens with some notes about "paradigm" and clarifies upfront my use the term. My interpretation depends on the work of Thomas Kuhn and Albert Borgmann. I then further provide a brief etymological and semantic reflection on the other key term: energy.

2.1 Paradigm: Terminological Clarification

I use the term paradigm as a "pattern" or "characteristic way" of conceptualizing energy, and indirectly of *seeing* the nonhuman world. This interpretation bridges both Kuhn's "extended" or "global" meaning of scientific paradigm and Borgmann's idea of a "pattern of technology" represented by the devices which constitute the modern way "to take up with the world."[4] In his *Introductory Essay* to the 50th anniversary edition of *The Structure of Scientific Revolutions* (Kuhn 1962), philosopher of science Ian Hacking explores the general ancient meanings of the term "*paradeigma*" and provides an interesting etymological analysis of its use

[4] Ben Mylius (2018) stresses that "any paradigm you or I (or all of us) might use will both enable and constrain our thinking, in one and the same movement. In enabling our thinking, our paradigm will also, by that action, *necessarily* constrain it." Mylus provides also an interesting point about how a paradigm can be descriptively anthropocentric, passively normatively anthropocentric, or actively normatively anthropocentric.

in Aristotle's *Rhetoric*. The gist of Hackings' reasoning is that "Aristotle meant something more like *exemplar*, a very best and most instructive example." For Aristotle, "in general: something is in dispute. One states a compelling example about which almost everyone in the audience will [eventually] agree – a paradigm. The implication is that what is in dispute is 'just like that'." Of course, issues of power and authority stem from these considerations, but here I would like to recall the Aristotelian idea that "something is disputed."

I would like to insist on the fact that although humans conceptualize energy in diverse ways, mainstream energy studies, education, and policy have absorbed a distinctive energy paradigm found in the natural sciences, relying almost exclusively on it. This account is unnecessarily reductive, especially when considering the complexity that energy phenomena display and the cultural, socio-economic, and religious nuances that different understandings have produced.

Examples of alternative accounts can be found as much in the Western tradition as in others. For instance, before it was dismissed by other scientists, in 1686 Leibniz posited the idea of *vis viva* in his *Brief Demonstration of a Notable Error of Descartes's and Others Concerning a Natural Law* (Leibniz 1989). Leibniz's proposal gave rise to a famous debate between his views on motion and those of Descartes, and later to a broader philosophical and scientific discussion known as the "*vis viva* controversy" (Hankins 1965; Iltis 1971; Smith 2006). In the East there is the Vedic concept of *agni* and the Chinese *qi* (Mitcham and Rolston Smith 2013). In South America, there is a particular concept of "vital energy" related to the economies of indigenous peoples of Panama and Colombia (Gudeman 2012). Similarly, the conceptions of sacredness of land and its resources recently re-affirmed by Native American groups and environmental activists in the place currently known as the United States is a further example that there are alternative meanings of energy, nature, and resources that can challenge the traditional energy paradigm. In particular, in the context of the 2016 pipeline protests in North Dakota (DAPL), or the Trans-Pecos pipeline (TPPL) in South-West Texas, there are theoretical alternatives and conceptual nuances regarding the understanding of energy and nature which deserve the attention of energy scholars, politicians, and policy makers.[5]

My current research is also focused on Native American voices (Frigo 2018a) and other non-Western perspectives, such as animistic conceptions of energy. Due to the vast amount of materials, and because surveying even a bit of them would require and deserve several pages, here I only highlight the fact that counter-narratives to the traditional energy paradigm can be found by looking especially at traditional ecological knowledge (TEK) and anthropology of energy. The interested reader can turn to section 4.1 where I mention several works specifically devoted to this.

So far, however, the potential richness of the diverse accounts offered by indigenous contributions and by the anthropology of energy, energy ethnography and environmental ethics have played a minor role in energy discussion and decision-making, or have been sometimes purposefully silenced. More dramatically, the major institutions which deal with energy and resources management (in the US, the Environmental Protection Agency and Department of Energy) have not yet considered such non-standard contributions in their policymaking. This demonstrates once again that many scholars and energy practitioners have assumed that what energy is and how it functions corresponds substantially to what the natural sciences claimed. The problem is that the reduction of energy to what is physically and mathematically measurable

[5] I am currently working on the article derived from my anthropological study of the indigenous-led protests against the construction of the Trans-Pecos pipeline (TPPL) in South-West Texas.

hinders more nuanced understandings of what energy might be, preventing the consideration of different worldviews and more diverse sets of values. Therefore, I suggest that a rather specific account of energy has been, firstly, achieved through an organized effort by the scientific community in a disciplinary setting and then shared, exported and popularized as a predominant mode of human-nature-energy relation when it comes to energy issues. This does not mean that there was an organized conspiracy, or a conscious manipulative attitude, Rather, it is an interpretative description of a cultural evolution of a way of understanding the human-nature-energy relationship. There is more to observe after considering in more detail the two independent terms "paradigm" and "energy."

2.1.1 Kuhn's Paradigms

According to Ian Hacking (2012), Kuhn realized a few years after the publication of *Structure* that the meaning he intended for the term "paradigm" was being misunderstood and often misused. In the postscript to *Structure*, Kuhn already suggested that a synonym for "paradigm" could be "exemplar" (interestingly, the more popular English translation of Aristotle's *paradeigma*), but it seems that the former prevailed and became his legacy, especially through the notion of "paradigm shift." Even though he later abandoned the term "paradigm" altogether – because he perceived that he had "lost control of the word" (Kuhn 1970) – Kuhn tried again to clarify his intentions by providing a distinction between a "local" paradigm and a "global" in "Second Thoughts on Paradigms" (Kuhn 1977). There, Kuhn proposes a local or more specific version of the paradigm as the "disciplinary matrix" shared by a scientific community. The matrix is made of symbolic generalizations, models, and exemplars – a definition that, he clarifies, would be also more "philologically" accurate. Kuhn affirms that instead of a paradigm we may talk about a disciplinary matrix:

> 'disciplinary' because it is the common possession of the practitioners of a professional discipline and 'matrix' because it is composed of ordered elements of various sorts, each requiring further specification. Constituents of the disciplinary matrix include most or all of the objects of group commitment described in the book as paradigms, parts of paradigms, or paradigmatic. […] Let me refer to them as symbolic generalizations, models, and exemplars. (p. 297)

Firstly, the disciplinary matrix needs "a shared commitment to a set of symbolic generalizations, [as basic requirements for] logic and mathematics be applied in the community's work." Secondly, it requires models, which are "what provide the group with preferred analogies or, when deeply held, with an ontology." Thirdly, a disciplinary matrix demands exemplars, or "concrete problem solutions, accepted by the group as, in a quite usual sense, paradigmatic," they are "a community's standard examples." Kuhn ends his essay by saying that "shared examples of successful practice are the paradigms of a scientific community, and as such they are essential to continued research" (Kuhn 1977). Even though the scientific study of energy involves all three of these requirements – symbolic generalizations, models, and exemplars – I think that this specific sense, although pertinent, is not the most *philosophically* relevant for my critique of the energy paradigm.

A second version of the idea of paradigm would be a global or extended one. Kuhn asserts that, assuming we recognize the existence of a scientific community of practitioners of a specialty, "a paradigm is what the members of a scientific community, and they alone, share. Conversely, it is their possession of a common paradigm that constitutes a scientific community of a group of otherwise disparate men" (Kuhn 1974, p. 2), a definition that is also found in *Structure*. It is in this sense that I propose to understand the energy paradigm, as a progressively shared notion that is debated and agreed upon among the members of a recognizable scientific community which then, I add, becomes a cultural notion embraced outside the scientific community. But to further understand the essential connection between the emergence of the energy paradigm as a modern, technoscientific, and quantitative exemplar, we may turn to a less popular article by Kuhn, "The Function of Measurement in Modern Physical Science" (1961), published the year before *Structure*. There, Kuhn provides a thorough study of the process of quantification and mathematization that occurred in what he calls the "Baconian sciences." He starts by dividing the fields of physical sciences of the 17th century into two groups. Then, he specifies the process of quantification of the sciences related to what will later become "energy"

> the first, to be labeled the traditional sciences, consists of astronomy, optics, and mechanics, all of them fields that had received considerable qualitative and quantitative development in antiquity and during the Middle Ages. These fields are to be contrasted with what I shall call the Baconian sciences, a new cluster of research areas that owed their status as sciences to the seventeenth century's characteristic insistence upon experimentation and upon the compilation of natural histories, including histories of the crafts. To this second group belong particularly the study of heat, of electricity, of magnetism, and of chemistry. […] Magnetism, heat, and electricity emerged still more slowly as independent subjects for learned study. Even more clearly than chemistry, they are novel by-products of the Baconian elements in the "new philosophy'," (p. 186)

> That realization-exemplified in the work of Fourier, Clausius, Kelvin, and Maxwell – is one facet of a second scientific revolution no less consequential than the seventeenth-century revolution. Only in the nineteenth century did the Baconian physical sciences undergo the transformation which the group of traditional sciences had experienced two or more centuries before. (p. 188)

In his introduction to *Structure*, Hacking helps us understand the connection between the emergence of the "Baconian" sciences and, indirectly, the energy paradigm:

> heat, light, electricity, and magnetism acquired paradigms, and suddenly a whole mass of unsorted phenomena began to make sense. This coincided with – went hand-in-hand with – what we call the industrial revolution. It was arguably the beginning of the modern technoscientific world in which we live. (p. 9)

Thomas Kuhn's notion of paradigm has been very influential in both its local and global meanings. Following Kuhn and the insightful analysis of Hacking, I propose that the modern and scientific understanding of energy became "paradigmatic" because the technoscientific community progressively agreed on a "homogenized" exemplar which was then diffused through technoscientific rhetoric, institutional authority, and practical work and artifacts (technology and engineering) its anthropocentric, instrumental, mechanistic, quantitative, and mathematical understanding of energy. This has become, progressively, the paradigmatic account of energy.

2.1.2 Borgmann's Device Paradigm

The second relevant antecedent for my use of paradigm is Albert Borgmann, a contemporary philosopher of technology who uses the term "paradigm" to mean a "pattern of technology" that has shaped the world "over the last three or so centuries" (Borgmann 1984, p. 35). At its core, Borgmann's inquiry is a response to, or a dialog with Martin Heidegger's "The Question Concerning Technology" (1977) and indeed Borgmann's concept of the device paradigm is loosely based on Heidegger's Bestand I described in the previous chapter. In his seminal book entitled *Technology and the Character of Contemporary Life* (1984), Borgmann writes that the

> promise of technology was first formulated at the very beginning of the Enlightenment. […and…] both Bacon and Descartes saw themselves as initiators of a new era in which human reason was to attain self-determination. Reason would exercise its power in part by wrestling from nature its secrets through scientific investigation. The resulting knowledge would in turn increase the power of reason and allow it to be asserted in the material realm. (pp. 35-36)

However, at least initially, the goal of domination was not only an issue of power or human imperialism over nature. In fact, technoscience "is from the start connected with the aim of liberating humanity from disease, hunger, and toil, and of enriching life with learning, art, and athletics" (p. 36). But for Borgmann this project of modernity fell short of its ambitious goals in many ways. A characteristic trait of modern technology is, for instance, the industrial production of consumer commodities whose availability and readiness are expected, often at the expense of other important aspects of a meaningful and richer life experience:

> Implied in the technological mode of taking up with the world there is a promise that this approach to reality will, by way of the domination of nature, yield liberation and enrichment. […but…] the notion of liberation and enrichment are joined in that of availability. Goods that are available to us enrich our lives and, if they are technologically available, they do so without imposing burdens on us. Something is available in this sense if it has been rendered instantaneous, ubiquitous, safe, and easy. (p. 41)

The very presence and power of a sheer amount of these technological artifacts leads Borgmann to conclude that a "device paradigm" characterizes modern technological life. To explain it, Borgmann presents the distinction between "things" and "devices." A thing "is inseparable from its context, namely, its world, and from our commerce with the thing and its world, namely, engagement. The experience of a thing is always and also a bodily and social engagement with the thing's world" (p. 41). Conversely, a device is typically a piece of machinery that "makes no demand on our skill, strength, or attention, and it is less demanding the less it makes its presence felt. In the progress of technology, the machinery of a device has therefore the tendency to become concealed or to shrink" (p. 42). This is problematic because the instrumentalism of modern technological devices hinders the pursuit and appreciation of focal practices, that is skillful and fulfilling engagements with life.

Borgmann provides several concrete examples, many of which are directly tied to energy. For instance, he highlights the differences between a central heating plant, a machinery that exemplifies the device paradigm, and a wooden stove, a thing requiring an engaged focal practice. My use of paradigm connects to the notion of the device paradigm as it applies to energy-related technologies, either visible in what Borgmann calls the "foreground" (e.g. transport, light, food), or concealed in the "background" (e.g. electric systems and grids, pipelines, engines). Indeed, the energy paradigm allowed for a certain way of being modern to arise, *Homo energeticus*. This recently evolved (or de-evolved) species has some quite specific traits: it typically inhabits crammed and polluted cities, lives a commodious lifestyle surrounded by technological artifacts, demands increasing resources, and seems too busy to think about, or is simply unaware of the links between its survival and that of the nonhuman world.

2.2 Energy: Etymological and Semantic Considerations

Paradigms help to articulate the way conceptions of reality depend on the geographical, historical, and cultural contexts in which they arise. As such any conception is a specific cultural creation that assumes and implies certain ideas and values. Recalling Lynn White Jr's insight that what we think about something often translates in our actions and choices (1967), and aware of the risks of etymological fallacy, I now briefly summarize the terminological history of the other key term of this chapter, energy. A brief genealogy unveils profound meanings, nuances, historical adoptions as well as the evolution of some semantic issues. Philosopher and historian of science Robert P. Crease wrote that

> The history of energy is an intriguing episode in the history of science that sheds some light on this issue. It does so because the phenomenon of energy nicely illustrates the presence of factors such as the technological transformation of the world, and even the role of more metaphysical considerations such as the changing patterns of thought that sometimes have to occur for a concept to be taken as applying to nature. (2004, p. 418)

According to the *Comprehensive Etymological Dictionary*, energy derives "from Greek *energeia* (ενὲργεια) 'activity, action, operation,' from *energos* (ἐργος) 'active, working,' from *en* 'at' + *ergon* 'work, that which is wrought [caused]; business; action'".[6]

[6] Derivatives are, for instance, the adjectives *energic*, and *energetic*; the verb *energize*; and the noun *energizer*. Interestingly, the term *energy crisis* was firstly attested in 1970. See, Ernest Klein, *A Comprehensive Etymological Dictionary of the English Language*, vol. I (Amsterdam - London - New York: Elsevier, 1966), p. 521.

The first use of the term energy in modern languages dates back to "1590s, [as] 'force of expression,' from Middle French *énergie* (16c.), from Late Latin *energia*." (Klein 1966). The *Oxford English Dictionary* reports that energy has been used "in the sense of 'force or vigour of expression' (since 1599), 'exercise of power' (1626), 'ability to produce an effect' (1677)."[7]

In the context of Western civilization, the term energy was probably first introduced by Aristotle, and it is a key term for his study of change in nature, or physics. For Aristotle, understanding change was inseparable from understanding motion. In this sense, his concepts of potentiality (*dynamis*) and actuality (*energeia/entelechia*) are interwoven, as well as those of *form* and *matter* (the notion of hylomorphism). Conceptually, Aristotle describes *energeia* (ενέργεια) as "being-at-work-ness" in the sense of an entity that reaches its actuality, and so it is sometimes used as a synonym of entelechia (ἐντελέχεια), complete or perfect actuality, end-in-itself. Joe Sachs (2018) clarifies this idea of energy as "being-at-work," adding some surprising insights regarding the nonhuman world:

> The root of *energeia* is *ergonó* deed, work, or *actó* from which comes the adjective *energon* used in ordinary speech to mean active, busy, or at work. […] By the actuality of a thing, we mean not its being-in-action but its being what it is. For example, there is a fish with an effective means of camouflage: it looks like a rock but it is *actually* a fish. When an actuality is attributed to that fish, completely at rest at the bottom of the ocean, we don't seem to be talking about any activity. But according to Aristotle, to be something always means to be at work in a certain way. In the case of the fish at rest, its actuality is the activity of metabolism, the work by which it is constantly transforming material from its environment into parts of itself and losing material from itself into its environment, the activity by which the fish maintains itself as a fish and as just the fish it is, and which ceases only when the fish ceases to be. Any static state which has any determinate character can only exist as the outcome of a continuous expenditure of effort, maintaining the state as it is. Thus even the rock, at rest next to the fish, is in activity: to be a rock is to strain to be at the center of the universe, and thus to be in motion unless constrained otherwise, as the rock in our example is constrained by the large quantity of earth already gathered around the center of the universe. A rock at rest at the center is at work maintaining its place, against the counter-tendency of all the earth to displace it. The center of the universe is determined only by the common innate

[7] https://en.oxforddictionaries.com/definition/energy

> activity of rocks and other kinds of earth. Nothing is which is not somehow in action, maintaining itself either as the whole it is, or as a part of some whole. […] The material and organization of a thing determine a specific capacity or potentiality for activity with respect to which the corresponding activity has the character of an end (*telos*). Aristotle says "the act is an end and the being-at-work is the act and since *energeia* is named from the *ergon* it also extends to the being-at-an-end (*entelecheia*). (*Metaphysics* 1050a 21-23)

Thanks to Sachs, we are able to appreciate that the original Aristotelian meaning of energy not only applies to other entities beyond humans and their ends but is actually intrinsic to the functioning of all nature.

However, thousands of years separate the original concept of energy in Aristotle and the scientific study of phenomena related to energy in the 18th century. For an informative history of ancient and medieval energy-related research, and especially regarding the development of proto-notions of "work," "force," and energy, see the section of (Lindsay 1971) entitled "Roots of the Concept of Energy in Antiquity. The Philosophers" where he writes, for instance:

> One plausible source of the idea [of energy] is connected with the invention of machines, an important technological development in the life of early man. People early learned the social significance of the fact that human life is impossible without somebody's labor, but rather naturally sought to reduce the terrific burden of this labor. Eventually, some clever and imaginative folk discovered the possibility of taking the sting out of human labor by the use of such devices as the lever, the inclined plane, and various forms of pulley systems. These gadgets, which we now call simple machines, must have seemed to the ancients to be endowed with almost magical powers, they made it so much easier to raise heavy weights, for example, or to give an arrow greater speed, as by the use of the bow. The discoverers and users of such machines must have observed very early, however, that the mechanical advantage provided by them is always accompanied by a compensating disadvantage: nature is not inclined to give something for nothing. It was found, for example, that to raise a given weight by applying to a pulley system a force much less than the weight, the speed with which the pulley rope is pulled must be much greater than the speed with which the weight is raised. Alternatively, if one wishes to pull with low speed, the time needed for raising the weight is correspondingly increased. With the gain in ease of exertion in the performance of a given bit of labor provided by the machine there goes an inevitable loss of something represented in general by an increase in the time required to do the job. This fact was recognized explicitly in the writings on mechanics of Hero of Alexandria, who flourished around 60 A.D. This peculiar principle of compensation, in which a certain gain in a vital effect is always balanced by a corresponding loss in an associated phenomenon, contained within itself the root of the concept of energy. (p. 385)

Although during the Middle Ages there were of course advancements in the practical construction and efficiency of many machines, it seems that there were not many corresponding theoretical developments. It is perhaps for this reason that energy scholar Vaclav Smil could affirm that "no noteworthy intellectual breakthroughs refined these definitions for nearly two subsequent millennia, as even many founders of modern science had very faulty concepts of energy" (2006). The truth probably sits in the middle, since most of medieval, and early-modern conceptions and uses of energy are indirect and apply rather to the notion of work and the functioning of machines. For these reasons, and because I am interested in the scientific conceptualization of energy achieved later, I simply reference the history of Hellenistic, medieval, and pre-modern conceptions of energy in R. B. Lindsay (1971), the collection of treatises ascribed to Euclid of Alexandria (300 B.C.E.), Archimedes (3th century-212 B.C.E.), Thabit ibn Qurra (836-901 C.E.), Jordanus de Nemore (13th century C.E.), and Blasius of Parma (1335-1416) edited by Moody and Clagett (1952), the book by Clagett *The Science of Mechanics in the Middle Ages* (1959) and Erwin N. Hiebert's *Historical Roots of the Principle of Conservation of Energy* (1962).

For what follows, it suffices to repeat that the concept of energy used by Aristotle is much different from the one emerging during modernity and still used in contemporary energy discourse, education, and policy. But what is remarkable is the fact that the modern study of energy began as the study of machine's efficiencies – of external combustion engines (e.g. steam engines, steam turbines) and later internal combustion engines (e.g. gas and diesel vehicle engines) – with the general aim of producing more with less. On this regard, Kuhn (1969) notices that

> The concept work is the most decisive contribution to energy conservation made by the nineteenth-century concern with engines. That is why I have devoted so much space to it.

But the concern with engines contributed to the emergence of energy conservation in a number of other ways besides, and we must consider at least a few of them. For example, long before the discovery of electro-chemical conversion processes, men interested in steam and water engines had occasionally seen them as devices for transforming the force latent in fuel or falling water to the mechanical force that raises weight. “I am persuaded,” said Daniel Bernoulli in 1738, “that if all the *vis viva* hidden in a cubic foot of coal were called forth and usefully applied to the motion of a machine, more could be achieved than by the daily labor of eight or ten men. (p. 334)

The Western conceptualization of energy has depended on the scientific endeavour of controlling the forces of nature through mathematics, quantification, and the application of the scientific method, all of which should be understood as the fundamental theoretical assumptions of the Industrial Revolution (Wrigley 2010). This process was instrumental in clarifying the laws of thermodynamics, which are the foundations of the modern energy paradigm.

Of course, before the study of energy actually began, the idea of a mechanical universe, quantifiable and measurable, was already provided by intellectuals such as Francis Bacon (1561-1626), Galileo Galilei (1564-1642), and René Descartes (1596-1650). However, energy was approached philosophically and scientifically by European intellectuals only later, starting in the 18th century, and reached conceptual maturity only in the 19th century, when we witness the practical attempt of “controlling the universe” for the sake of (some) humans.

As noted by both Smil (2006) and Mitcham & Smith (2013), David Hume devoted conspicuous attention to the concept of energy, underlying both its ambiguity and importance. Aware that notions such as force and energy were widely discussed in the intellectual circles of his time, Hume advocates in his *An Enquiry Concerning Human Understanding* (1748) for a deep philosophical engagement: “there are no ideas, which occur in metaphysics, more obscure and uncertain, than those of *power*, *force*, *energy* or *necessary connexion*, of which it is every moment necessary for us to treat in all our disquisitions” (Hume 2007, p. 45). As an example of his concern with the “problem of induction,” in the VII section of *Enquiry*, entitled “Of the Idea of Necessary Connection," Hume writes about determining the type and reliability of knowledge regarding energy that is achievable through experience and observation. Hume affirms that

> the motion of our body follows upon the command of our will. Of this we are every moment conscious. But the means, by which this is effected; the energy, by which the will performs so extraordinary an operation; of this we are so far from being immediately conscious, that it must forever escape our most diligent enquiry. [11] For first; is there any principle in all nature more mysterious than the union of soul with body; by which a supposed spiritual substance acquires such an influence over a material one […] by which the one is able to operate, in so many instances, upon the other. [14] Secondly, We are not able to move all the organs of the body with a like authority; though we cannot assign any reason besides experience, for so remarkable a difference between one and the other. […] And experience only teaches us, how one event constantly follows another; without instructing us in the secret connexion, which binds them together, and renders them inseparable. [14] Thirdly, We learn from anatomy, that the immediate object of power in voluntary motion, is not the member itself which is moved, but certain muscles, and nerves, and animal spirits, and, perhaps, something still more minute and more unknown, through which the motion is successively propagated (pp. 47-48)
>
> But philosophers, who carry their scrutiny a little farther, immediately perceive, that, even in the most familiar events, the energy of the cause is as unintelligible as in the most unusual, and that we only learn by experience the frequent Conjunction of objects, without being ever able to comprehend anything like Connexion between them. (p. 51)

Hume's epistemological inquiry shows that energy was not only very much debated as a concept at the time of its development, but its ambiguous nature also suggests fundamental issues regarding the type of knowledge we can gain through inductive reasoning. But, as Hume warned, and Smil suggest, energy was and is hard to grasp conceptually: "energy is not a single, easily definable entity, but rather an abstract collective concept, adopted by nineteenth-century physicists to cover a variety of natural and anthropogenic […] phenomena" (2006, pp. 9-10).

Scientists and energy studies scholars have pointed out further difficulties in the definition, understanding, and teaching of the energy concept. American Physicist Richard Feynman famously stated in his *Lectures on Physics* (1963) that

> in physics today we have no knowledge of what energy *is*. We do not have a picture that energy comes in little blobs of a definite amount. It is not that way. However, there are formulas for calculating some numerical quantity, and when we add it all together it gives

"28"—always the same number. It is an abstract thing in that it does not tell us the mechanism or the *reasons* for the various formulas. (pp. 4-3)

When addressing the law of energy conservation Feynman added that it is

> a most abstract idea, because it is a mathematical principle… [it] says that there is a numerical quantity which does not change when something happens. It is not a description of a mechanism, or anything concrete; it is just a strange fact that we can calculate some number and when we finish watching nature go through her tricks and calculate the number again, it is the same. (p. 4-1)

Feynman's observations are important because they inform us that experts in the scientific study of energy raised concerns about the difficulty to treat, conceive, and define the multiform phenomena brought under the conceptual umbrella of energy.

On a similar note, the Argentinian-Canadian philosopher of science and technology Mario Bunge provocatively claimed that the principle of conservation of energy "is so extremely general that it belongs in philosophy rather than in physics" (Bunge 2000, p. 460). More recently, Portuguese historian and philosopher of science Ricardo Lopes Coelho extensively examined the emergence and diffusion of the conceptualization of energy (2009a; 2009b; 2014; see also Cardwell 1967; Kuhn 1969; Lindsay 1971; Harman 1982; Crease 2004; Coppersmith 2015). Coelho reminds us that indeed many scholars have pointed out the hardship of defining energy by underlining how "since the concept of energy was worked out in a mechanical context, the criticism that the definition of energy as capacity of doing work is too restricted, is understandable" (Coelho 2009b, p. 980).

Even though these debates have occurred mostly among scholars who have been studying the science of energy, they also show how individuals as diverse as Smil, Feynman, Bunge, and Coelho have been keenly aware of the difficulty of articulating and defending a singular and consistent definition for energy as well as of the epistemological limits of the scientific understanding of energy. As a result, Coelho warns against the potential misconceptions that can occur when students are introduced to concepts such as force, power and energy (Coelho 2009a; see also, Sexl 1981).

However, the precautionary advice of these scholars has not had much influence, and in both education and policy the modern energy paradigm has been continuously propagated. The most remarkable consequence for the present study is that its metaphysical and cultural assumptions have been taught worldwide for decades. For instance, students still learn that energy is primarily what science says it is. Textbooks usually define energy as "the capacity to do work: that is, to move an object against a resisting force" (Everett et al. 2012). Then they provide the distinction between *potential* and *kinetic* energies, and offer examples of its different kinds: electricity, biomass energy, geothermal, fossil fuel, hydro power and ocean energy, nuclear energy, solar energy, wind energy, transportation energy, and so forth. By contrast, it is essential to point out that the scientific understanding of energy is a cultural construct produced in a very specific context: the Western, modern, and scientific world. Energy has been defined primarily by the natural sciences as a property of objects, that is the capacity of matter to do work. But this and other similar definitions stress only certain measurable, quantifiable, and mechanistic properties of reality leaving outside everything else. The fact that the modern energy paradigm is anthropocentric, mechanistic, quantitative, mathematized, and has instrumental attitudes toward the nonhuman world makes it not only obviously reductionist but ecologically and philosophically problematic. By providing a detailed story of the emergence of the modern energy paradigm, my primary interest is to highlight its fundamental anthropocentric and instrumental attitudes toward nature. Of course, affirming that the paradigm is anthropocentric means that human thinking about energy has been primarily species-centered, that is mostly if not exclusively focused on the benefits reaped for humans.

2.3 Characteristics of the Modern Energy Paradigm

Now consider the emergence and progressive homogenization of this way of thinking about energy. The modern energy paradigm has its roots in the scientific attempt, starting in the 18th century, to “make sense” and name various phenomena related to, for example, heat exchanges, magnetism, light, electricity, and especially improving the efficiency of different engines (e.g. steam, internal combustion), and hence the productivity of machines. The modern energy paradigm has been emphasizing anthropocentric ideas and instrumental values within the human-energy-nature relationship. Its norms, values, and principles derive from a scientific, mechanistic, quantitative, mathematized, and even patriarchal approach that accounts only partially for the complexity of energy as a multi-faceted phenomenon.[8] As anticipated, the study of energy bears the weight of its initial aim, which was improving the efficiency of machines. As Vaclav Smil (2006) has put it,

> Theoretical energy studies reached a satisfactory (though not a perfect) coherence and clarity before the end of the nineteenth century when, after generations of hesitant progress, the great outburst of Western intellectual and inventive activity laid down the firm foundations of modern science and soon afterwards developed many of its more sophisticated concepts. The ground work for these advances began in the seventeenth century, and advanced considerably during the course of the eighteenth, when it was aided by the adoption both of Isaac Newton’s (1642–1727) comprehensive view of physics and by engineering experiments, particularly those associated with James Watt’s (1736–1819) improvements of steam engines. (p. 2)

The Western conceptualization of energy has depended on the scientific control of the forces of nature through mathematical language and the application of the scientific method: a rather homogeneous conception of energy emerged, which has become predominant and has been reigning substantially unchallenged in educational settings and policymaking. The blooming of

[8] For the sake of focus, this dissertation does not delve into the last of these characteristics. I mention some relevant works by ecofeminsit scholar in section 4.6. One of the most thorough account of the relationships between patriarchy, control of nature, and the scientific revolution is (Merchant 1980; see also Merchant 2006)

the Industrial Revolution, a tremendous population expansion, the diffusion of ideas of progress and human exceptionalism have increased human hubris, individualism, and greed, with the support of ad hoc socio-economic and ethical theories (Moncrief 1970). These views are so deeply ingrained that they have become normalized and consequently invisible.

2.3.1 Anthropocentrism and Instrumental Value

Although in the Western worldview anthropocentric and instrumental views of nature precede the modern period and have been identified with the Judeo-Christian tradition (White 1967), it is probably correct to affirm that they were mostly supporting ideas of stewardship or guardianship. Famous biblical references such as *Genesis* 1:26:28[9] represent, in practice and for the majority of Western history, forms of weak anthropocentrism that did not stress ecosystems beyond resilience. Etymologically, the meaning of anthropocentrism appears simple: human-centered.[10] However, over the past forty years there have been dozens of books and articles on this and related topics. Despite the "convergence hypothesis" of philosopher Bryan G. Norton (1991, pp. 237-243) – "the view that if we have a suitably sophisticated anthropocentrism, then in practice, anthropocentrism and nonanthropocentrism will converge" (McShane 2007) – when

[9] The complete passage from Genesis 1:26-28 is: "[26] Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals,[a] and over all the creatures that move along the ground." [27] So God created mankind in his own image, in the image of God he created them; male and female he created them. [28] God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish in the sea and the birds in the sky and over every living creature that moves on the ground."

[10] https://www.etymonline.com/word/anthropocentrism. It is perhaps significant that, in English, the adjective appeared for the first time in 1855 and the noun in 1897, at a moment of growing awareness of the powers of humankind.

it comes to policymaking, the policy interests of anthropocentrists and nonanthropocentrists do not ultimately nor obviously converge.[11]

To elaborate on the characterization of the energy paradigm as anthropocentric, consider two recent cases, J. Baird Callicott's differentiation among *metaphysical*, *moral,* and *tautological* anthropocentrism (J. Barid Callicott 2013), and Ben Mylius' distinction among *perceptual*, *descriptive*, and *normative* types of anthropocentrisms (Mylius 2018).

In the introduction of *Thinking Like a Planet* (2013), Callicott references Aristotle's idea of "first philosophy" as the investigation to "the very architecture of philosophical thought. The study of such foundational concepts is called metaphysics. Accordingly, we might denominate as *metaphysical anthropocentrism* the doctrine that human beings occupy a privileged place in the order of being" (p. 9). If, alternatively, we limit "the membership to all and only human beings in what Richard Routley calls the 'base class' of an ethic – the set of entities to which ethical regard is appropriately directed – may be called *moral anthropocentrism*" (p. 9). Finally, anthropocentrism could be the obvious realization that "All human experience, including all the ways that human beings experience value, is human experience and therefore tautologically anthropocentric" (p. 10). Even if humans value something intrinsically it would still be a human act of valuing: since "all human valuing is human valuing" it is thus "tautologically anthropocentric" (2013, pp. 9-10).[12] From Callicott's perspective, the energy paradigm would be anthropocentric both metaphysically and morally. Finally, it is important to remember that "moral anthropocentrism is conventionally justified by appeal to metaphysical

[11] Despite the limitations of the overall debate about "Centrism-Terminology" (as criticized by Lars Samuelsson, 2013), these distinctions are not trivial when it comes to energy practices and policies.

[12] Callicott adds that "tautological non-anthropocentrism is indeed incoherent and self-contradictory, but moral non-anthropocentrism is entirely coherent and self-consistent. The claim that all human beings are tautologically anthropocentric is trivially true or analytically true and is, therefore, a hollow claim not worth making—except for purposes of sophistical argumentation.

anthropocentrism" (p. 36) and it is in this sense that I propose that most moral practices related to energy depend on the specific metaphysics of energy provided by the modern paradigm.

In "Three Types of Anthropocentrism" (2018), Ben Mylius begins by noticing that "a quick glance at some of the founding texts of environmental ethics reveals that many either do not define the term or hardly use it at all. Where definitions are provided, they are often negative, characterizing anthropocentrism as the inverse of things like 'holism,' 'ecocentrism,' or 'deep ecology'." His survey of ten notable examples indeed creates "the impression that anthropocentrism is exclusively, and inevitably, a matter of normative claims about human superiority." Mylus' thesis is that

> Claims about human superiority are by no means the only form of anthropocentrism; questions of anthropocentrism are not only questions about ethics; and, in my view, the concept properly understood should be front and center in any philosophical inquiry that takes seriously its connection to contemporary life and contemporary questions (like the question of the Anthropocene). There are therefore some significant misunderstandings that deserve to be rectified. (p. 3)

To re-situate the concept "at the center of contemporary philosophical inquiry" the author purports to create a distinction between "three types of anthropocentrism – perceptual, descriptive, and normative (with the latter being further divisible into actively and passively normative variants)" that are useful to characterize a "paradigm."[13] Perceptual anthropocentrism occurs when a paradigm is directly or indirectly informed by data received or gathered by the senses of the human body" and in this sense is an inevitable fact that we can also call anthropogenic. Second, "a paradigm is also *descriptively* anthropocentric if it in some way

[13] Interestingly, Mylus also uses the term paradigm and essentially assumes the "extended" or "global" sense clarified by Kuhn (see above). Mylus states that "In a very real sense, a paradigm precedes individual agency, because *some* paradigm is a condition of possibility for thinking about anything (including paradigms themselves). This is why a paradigm change, or paradigm shift, is such a revolutionary event. At the same time, there must be *some* individual agency in questioning paradigms, for it is precisely this process that allows scientists and other thinkers working collectively to begin the processes that lead to paradigm shift." The upcoming discussion of the origin of the modern energy paradigm will intentionally point out some of these individual agents.

begins from, revolves around, focusses on, takes as its reference point, is centered around, or is ordered according to the species *Homo sapiens* or the category of 'the human' […] it is 'centered upon' the human in its descriptions. Other objects of contemplation are defined within the paradigm by reference to, by comparison with, or in terms of their relation to the Anthropos that is at the center of the paradigm."[14] Third, *normative anthropocentrism* which can have, for Mylius, two variants:

> *passively normative* anthropocentrism manifests in paradigms that constrain inquiry in a way that somehow privileges *Homo sapiens* or the category of 'the human' (generally because the paradigm at issue is descriptively anthropocentric). [Moreover] *actively normative* anthropocentrism manifests in paradigms that either [a.] contain assertions or assumptions about the superiority of *Homo sapiens*, its capacities, the primacy of its values, its position in the universe, etc.; and/or [b.] attempt to make ethical or legal prescriptions (shoulds/oughts) based on these assertions or assumptions. (p. 25)

Given the different versions elaborated by Callicott, my view is that the modern energy paradigm is anthropocentric in both metaphysically and morally. I disagree with Mylius' claim that "any paradigm that is descriptively anthropocentric is necessarily also passively normatively anthropocentric" because the energy paradigm has not always been descriptively anthropocentric. In fact, it is plausible that the energy paradigm "begins, from, revolves around, focusses on, takes as its reference point, is centered around, or is ordered according to the species *Homo sapiens*" it is not true that it is also "centered-upon humans in its descriptions." Therefore, my conclusion is that the anthropocentrism of the energy paradigm is primarily normative but in both a passive and active way.

After this clarification, it is key to remember that the technoscientific anthropocentrism that characterizes the energy paradigm was shaped during modernity, when a particular view of

[14] To clarify, Mylus provides the example of "descriptive heliocentrism" in the sense that "A heliocentric paradigm is one that is 'centered upon the sun,' in the sense that the sun is posited as the physical center of the solar system, and/or that it is the object with reference to which distances and positions are calculated, the object around which the planets orbit, etc."

nature that was influenced by proto-scientists and both rationalist and empiricist epistemological traditions. Rationalists such as Thomas Hobbes (1588-1679) and René Descartes (1596-1650) as well as empiricists such as Francis Bacon (1561-1626), laid the foundations for the modern technoscientific enterprise. They developed a worldview according to which nature is something inanimate and separated from humanity. The effects on the nonhuman world have started to be considered only later, and perhaps significantly in Western countries only since the 1970s with the realization of several incumbent crises, such as widespread pollution, alarms of oil peak, or the ozone hole. Therefore, although the energy paradigm is irreducibly anthropogenic, it need not be anthropocentric (neither metaphysically or morally, nor normatively).

Besides anthropocentrism, another key character of the modern energy paradigm lays in the constant use of *instrumental value* toward the nonhuman world. Here it suffices to say that criticizing the instrumental attitude of the energy paradigm does not mean that humans should not use nature. As I mentioned in chapter 1, *Homo sapiens* like all other animals must interact and use the nonhuman world to survive. However, I propose that the energy paradigm can and should imply both instrumental and intrinsic values, a point to elaborate in chapter 5.

2.3.2 Mechanization, Machines, and Magic

Some ancient philosophies such as atomism and stoic physics (Sambursky 1959) already considered the universe reducible to completely mechanical principles. Explaining change in general, and the motion and collision of matter in particular, was one of the fundamental concerns of materialist thinkers such as Democritus (c. 460 – c. 370 BCE), or Cleanthes of Assos

(c. 330 – c. 230 BCE).[15] But the modern energy paradigm is mechanistic in a different sense. It holds that nature is essentially a “big machine” whose legitimate masters and skillful operators are human beings. The scientific journey is, in this sense, the attempt to understand the functioning of nature in order to exploit it. Typically, the idea that the world is a complex machine, or a mechanic clockwork universe (Dolnick 2011) implies, or goes hand-in-hand with two other assumptions, *materialism* and *determinism*. Philosophical materialism, or the idea that matter is the fundamental substance in nature, assumes that not only all things, but also all beings and phenomena are reducible to the results of material interactions. Determinism means that scientific models are, by necessity, based on the physical outcomes of causality, or cause-effect relations and, accordingly, all phenomena can be explained through the motion of matter through the laws of classical physics.

A classic example of this anthropocentric and mechanistic view can be found in Hobbes’ *Leviathan* (1660), where the English philosopher suggests that, overall, “solutions to the problem of knowledge are solutions to the problem of social order” (Shapin and Schaffer 1985, p. 332). In the introduction, Hobbes states that

> NATURE (the art whereby God hath made and governs the world) is by the art of man, as in many other things, so in this also imitated, that it can make an artificial animal. For seeing life is but a motion of limbs, the beginning whereof is in some principal part within, why may we not say that all automata (engines that move themselves by springs and wheels as doth a watch) have an artificial life? For what is the heart, but a spring; and the nerves, but so many strings; and the joints, but so many wheels, giving motion to the whole body, such as was intended by the Artificer? Art goes yet further, imitating that rational and most excellent work of Nature, man. (Hobbes 1996, p. 7)

On a similar note, historian J. P. Sommerville underlined that 17th century “mechanical philosophers modeled their view of the world on machines (not organisms, as Aristotelians had

[15] Another example is the beautiful didactic Latin poem *De Rerum Natura* by Lucretius (ca. 99 – ca. 55 B.C.E.) which reflects the mechanistic philosophy of Democritus and Epicurus (Lucretius 2013).

done). They wished to produce general theories that accounted in quantifiable terms for many different types of interaction" (Sommerville 2011). Famously, Descartes supposes in the very first page of his *Treatise* "the body to be nothing but a statue or machine made of earth" (1985, p. 99). He later affirms: "I should like you to consider that these functions (including passion, memory, and imagination) follow from the mere arrangement of the machine's organs every bit as naturally as the movements of a clock or other automaton follow from the arrangement of its counter-weights and wheels" (1985, p.108). This and similar formulations introduced the materialistic idea that, potentially, science can study animals' and humans' bodies as completely mechanistic automata. Moreover, in Part V of the *Discourse on Method* (1985), Descartes explores the differences between an artificial human body and that of a "real" person, praising the godly perfection of the latter:

> This will not seem at all strange to those who know how many kinds of automatons, or moving machines, the skill of man can construct with the use of very few parts, in comparison with the great multitude of bones, muscles, nerves, arteries, veins and all the other parts that are in the body of any animal. For they will regard this body as a machine which, having been made by the hands of God, is incomparably better ordered than any machine that can be devised by man, and contains in itself movements more wonderful than those in any such machine. I made special efforts to show that if any such machines had the organs and outward shape of a monkey or of some other animal that lacks reason, we should have no means of knowing that they did not possess entirely the same nature as these animals; whereas if any such machines bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain means of recognizing that they were not real men. (pp. 139-140)

At this point, it is important to avoid the risk of demonizing these modern authors. The case of Bacon is particularly pertinent, since it illustrates a scholarly tendency to qualify mechanist philosophers as the scapegoats for many subsequent effects. Indeed, many authors have interpreted the work of Bacon in this way, claiming that his identification of science with progress and technology is the *direct* cause of later problems (Bacon 1999; Merchant 2007). An example of this approach can be found in a book by historian of science Eduard J. Dijksterhuis (1964) who presents the idea that

> That the adoption of the mechanistic view has had profound and far reaching consequences for the whole of society is an historical fact which gives rise to the most divergent opinions. Some commend it as a symptom of the gradual clarification of human thought, of the growing application of the only method that is capable of producing reliable results in every sphere of knowledge…Others, though recognizing the outstanding importance it has had for the progress of our theoretical understanding and our practical control of nature, regard it as nothing short of disastrous in its general influence on philosophical and scientific thought as well as on society. (pp. 3-4)

This view seems too extreme and biased. As Nieves Mathews (1996) sharply wrote,

> All the ills of industrialization, from soil erosion and the fumes of car exhaustion to the loss of human values in an alienated consumer society, have been laid at Bacon's door, and he was denounced by Heidegger and Marcuse as the evil animus of science, a very symbol of its "nefarious identification" with technology. At the time when people had begun to feel the damaging effects of industrial development, who better fitted than the author of the *New Atlantis* for the role of scapegoat so often awarded him? The deposed father of experimental science became its wicked stepfather. (pp. 409-410)

So, why is shaming or accusing the fathers of modern science would be misleading? The story is more complex because, although it is incontrovertible that many of these intellectuals were optimistically announcing a worldview of progress and technoscientific success, they cannot be considered personally responsible, for instance, for the ecological consequences of modern capitalistic society. The fact is that the scientific study of energy began about a century after Descartes, Bacon, and Hobbes proposed their mechanistic views, and the visible effects of a capitalist view on nature appear only two centuries later. Therefore, modern epistemologists should not be condemned for the "nefarious" effects of technoscience. We only need to recognize that, because of their influence, energy-nature has been mostly studied through a mechanist, determinist, and materialist approach that has become habitual, conventional, very much like the practices of driving a car for locomotion or fueling it with oil. Other actors promoted the actual conquest of nature and, as we see later, they have been operating under the influence of the mechanistic philosophers as well as of capitalism and neoliberalism.

A more nuanced understanding of the profound implications of the reduction of nature to a giant mechanism can be appreciated through the etymological comparison of the nouns "machine" and "magic."[16] *Etymoline* and *The Oxford English Dictionary* both explain that, on the one hand, the term "machine" firstly appeared in the "1540s, as 'structure of any kind,' from Middle French *machine* 'device, contrivance, from Latin *machina* 'machine, engine, military machine; device, trick; instrument,' from Greek *makhana*, Doric variant of Attic *mekhane* 'device'."[17] *The Oxford English Dictionary* provides also a link to Jürgen Schäfer's *Early Modern English Lexicography. Vol. 2*, where he reports that in 1545 the term machine is used to mean already the functioning of the planet: "Machine, hath many significacions, but here it is taken for the worke of the hole worlde." Then followed the main "modern sense of 'device made of moving parts for applying mechanical power' appeared in the 1670s and 'probably grew out of mid-17c. senses of 'apparatus, appliance' and 'military siege-tower'."[18] The notion of machine is therefore at the basis of the adjective "mechanistic" that is "connected to theories which explain phenomena in purely physical or deterministic terms."[19]

"Magic," on the other hand, first occurred in the "late 14c., [as the] 'art of influencing events and producing marvels using hidden natural forces,' from Old French *magique* 'magic, magical,' from Late Latin *magice* 'sorcery, magic,' from Greek *magike* (presumably with *tekhne*

[16] I owe this insightful comparison to my friend, mentor, and companion of mind-walks Keith "Maggie" Wayne Brown.

[17] https://www.etymonline.com/word/machine

[18] Ib.

[19] The Oxford English Dictionary

"art"), fem. of *magikos* "magical," from *magos* "one of the members of the learned and priestly class," from Old Persian *magush*.

The interesting fact is that both nouns share the same root of the reconstructed Proto-Indo-European language (PIE): machine as **magh-ana* and magic as the activity of the *magush* come from a common root **magh-* "to be able, have power."[20] *The Oxford English Dictionary* notes that "subsequently, with the spread of rationalistic and scientific explanations of the natural world in the West, the status of magic has declined." It is true that many of the energy-related phenomena that were considered forms of sorcery in the pre-modern period are explained scientifically. The epistemological debates of the period led to the separation of magic from science, astrology from astronomy, obscure speculation from clear reasoning and demonstrations. However, I suggest that the fascination for something marvelous and beyond human capabilities did not cease overnight. The idea of outwardly wonders became a human affair rather than a matter of superstition: witchcraft became engineering. The mechanistic approach to nature allowed humans to experiment the power of conceptualizing the natural world as an inanimate reservoir of resources. The ability to transform these resources into useful materials and fuels moved at unprecedented pace. The invention of "magical machines" liberated humanity from misery and was the premise for taming nature.

2.3.3 Quantification and Mathematization

The last two key characteristics to cover are the quantitative and mathematized traits of the modern energy paradigm. The scientific study of energy has occurred, from the very beginning, in the language of mathematics, with the aim of quantifying amounts of different

[20] https://www.etymonline.com/word/magic

properties such as heat, electricity, friction, drag, and so forth. Quantifying nature according to mathematical language and the application of the scientific method has had the objective of systematically studying nature, controlling its forces, and precisely comparing results, all for the benefit of humanity. Modern science has been grounded on this reductionist and abstract approach to a world that is seen quantifiable and hence measurable. This fact is best summarized by Galilei's famous metaphor in *The Assayer* that nature is a book whose language are numbers:

> Philosophy [Nature] is written in this grand book - I mean the universe - which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering around in a dark labyrinth. (Galilei 1623)

Similarly, modern scientists maintain that mathematics makes reality intelligible to humans, and it is its privileged form of translation. Certainly, as mentioned above, the idea of a mechanical universe, quantifiable and measurable, was also provided by other modern intellectuals such as Francis Bacon and René Descartes. Among others, they had a pivotal influence on modern science, and especially on the creation of a socio-scientific worldview that foresees human and cultural flourishing through the marvelous powers of technoscience.

Descartes proposed the idea that all nature can be seen as a mechanism, a giant machine that can be studied through mathematics and improved through science. Bacon, on the other hand, imagined a utopian reality of a techno-advanced future in his *New Atlantis*: there, machines and automata work for humans, while freedom and technoscience co-inhabit and serve human betterment and flourishment (Bacon 1999). Collectively, the contributions of thinkers such as Bacon, Galilei, and Descartes laid the metaphysical and cultural basis for the technoscientific dominion of humans on the planet and its resources. As Lynn White Jr. put it,

> Western Europe and North America arranged a marriage between science and technology, a union of the theoretical and the empirical approaches to our natural environment. The emergence in the widespread practice of the Baconian creed that scientific knowledge means technological power over nature can scarcely be dated before about 1850, save in the chemical industries, where it is anticipated in the 18th century. Its acceptance as a normal pattern of action may mark the greatest event in human history since the invention of agriculture, and perhaps in nonhuman terrestrial history as well. (1967, p. 1203)

These contributions have been pivotal in that they made possible the mathematization of the Baconian sciences (Kuhn 1961) and, with it, the *quantification of the world* and its analysis through instrumental rationality. In his attempt to popularize scientific research on energy, Italian physicist Alessandro Pascolini has pointed out that

> the general concept of energy became meaningful only through the establishment of the principle of conservation of energy in all its generality. Thus the story of the emergence of the energy concept and the story of the establishment of the conservation law cannot be disentangled. [He proceeds by explaining that] the conservation laws weren't derived by symmetry principles, but laboriously worked out on ontological basis, with (often heated) discussions in the process of fixing the concepts and finding a comprehension of the basic phenomena […] the result was the establishment of a fully mechanistic concept of Nature."[21]

Pascolini underlines that scientists had to carefully proceed in this clarification of what energy is, as related to the ideas of conservation, by following some precise threads: the clarification of the philosophical belief in general conservation principles in Nature; the clarification of the force of a body in motion: the mathematical formulation of mechanics; fixing the concept of work; connect the mathematical treatment of the power of machines; gather a comprehension of the basis of chemistry related to energy; consider the evolution of the thermology and the theories of heat; acquiring the laws of electricity and magnetism; reduce concepts such as animal heat or vital forces, namely physiology to the laws of inanimate nature mathematically defined. It goes without saying that the energy paradigm was not formed

[21] Alessandro Pascolini, presentation at the conference 'Energietag 2014' in Pöllau, Austria.

overnight. But anthropocentrism, instrumentality, mechanization, quantification, and mathematization should be seen as the fundamental assumptions of the modern energy paradigm. Slowly, but consistently, these characteristics were tacitly assumed or absorbed by the intellectuals who studied the phenomena that are eventually scientifically understood as energy.

CHAPTER 3

EMERGENCE AND DIFFUSION OF THE ENERGY PARADIGM

> *Paradoxically, the term energy, used for the preceding 300 years to designate the forcefulness of a face or the liveliness of a statement was first used to designate the "force of nature" precisely at the time when – in all the natural sciences – nature's vitality, its "Lebenskraft", was being systematically denied.*
>
> Ivan Illich, *The Social Construction of Energy*

In this chapter, I characterize and then challenge the predominant understanding of energy produced by the natural sciences and applied through engineering. I offer a genealogy of the Western, modern energy paradigm by investigating the historical and cultural process that led to the emergence of the scientific study of energy, and later to its conceptual homogenization. I clarify the key characteristics of the modern energy paradigm as anthropocentric, instrumental, mechanistic, quantitative, and mathematized. I argue that the way "energy" has been conceptualized by the natural sciences amounts to a "paradigmatic" way of thinking, talking, and ultimately acting toward nature. I show that the conceptual evolution of energy and its socio-cultural assumptions have had fundamental implications for the human and the nonhuman world. Overall, I argue that the modern energy paradigm mirrors the dichotomous view of human-nature developed in Western modernity and, for this reason, perpetuates similar ecologically problematic assumptions.[22] In the final part, I discuss how the modern energy paradigm has become "traditional." Once the scientific community reached an agreement about definitions, equations, and the *modus operandi* of the energy laws for the control of nature, the ontological dimension of energy became less debated and has been eventually assumed by default. Despite

[22] For a study non-Western, or "alternative modernities" see (Gaonkar 2001).

the temporal and geographical richness of alternatives – the existence of countless different cultural understandings of "energy" – the modern, Western, and scientific paradigm prevailed.

Physicists and engineers may affirm that this fact is obvious because the scientific way of inquiry is more correct, or the true one. Here, I am not interested in debating the epistemological merit of technoscience, whose innumerable achievements I indeed understand, admire, and benefit from. Instead, I want to focus on the concrete socio-political and ecological consequences of this specific mode of thinking. First, on the human-energy-nature relationship. Second, and more practically, through the visible impacts of energy projects and policies. I argue that the modern energy paradigm, once understood as traditional, has been "inadvertently" propagated across the world through socio-political and economic hegemony. That is, the different actors behind (neo)colonialism, such as international organizations, educational and policy institutions spread the traditional energy paradigm worldwide along with capitalistic socio-economic theories and later neoliberal political agendas.

The global influence of technoscience in education and policy have eventually rendered the energy paradigm not only homogeneous and traditional, but also hegemonic through globalized free-market capitalism and neoliberal policies. This fact has produced great consequences, both positive and negative, which go far beyond the work (and the intentions) of the scientific community that studies energy. In China as much as in Brazil, Kenya, or the Silicon Valley, what most people learn in school and experience as the consequence of policymaking is the traditional energy paradigm, the powerful but ecologically short-sighted story narrated by the natural scientist, realized by engineers, and overall fulfilling the socio-economic and political aims of free-market capitalism and neoliberalism.

3.1 Origin and Homogenization of the Modern Energy Paradigm

Since the second half of the 18th century, the Western scientific tradition has studied energy especially through specific branches of physics, chemistry, and engineering. As anticipated above, the most substantial journey to understand what energy began in Europe with the attempt to improve the efficiency of machines, to reduce the input-output ratio of the first experimental engines, and ultimately increase the production of goods. Yet, we must wait until the 19th century to witness the practical realizations of these projects. Thus, it is important to underline that the energy paradigm is a theoretical construct elaborated and refined in the Western, modern, and technoscientific world.

The adjective homogeneous firstly appeared in "1640s, from Medieval Latin *homogeneus*, from Greek *homogenes* 'of the same kind,' from *homos* 'same' + *genos* 'kind, gender, race, stock' (from PIE root **gene*- 'give birth, beget')"[23] The etymology of the term already provides a hint of the specific sense in which I propose that the scientific community "gave birth" to a notion of energy that became paradigmatic.

There is a quite abundant scholarship that investigates the origin and the evolution of the energy concept in physics. Here, I refer to few solid works appeared between 1969 and 1971 to illustrate the key passages that led to an homogenized version of the paradigm.

Thomas Kuhn's chapter "Energy Conservation as an Example of Simultaneous Discovery" sheds light on the antecedents to the homogenization of the modern energy paradigm by offering a recapitulation of a "striking instance of the phenomenon known as simultaneous discovery" (Kuhn 1969). He starts out by noticing that "in the two decades before 1850 the

[23] https://www.etymonline.com/search?q=homogeneous

climate of European scientific thought included elements able to guide receptive scientists to a significant new view of nature" (p. 321).[24] On the same page Kuhn states

> Between 1842 and 1847, the hypothesis of energy Conservation was publicly announced by four widely scattered European scientists – Mayer, /Joule, Colding, and Helmholtz—all but the last working in complete ignorance of the others. [But even earlier] "Between 1837 and 1844, C. F. Mohr, William Grove, Faraday, and Liebig, all described the world of phenomena as manifesting but a single 'force,' one which could appear in electrical thermal, dynamical, and many other forms, but which could never, in all its trans-formations, be created or destroyed.

Kuhn then clarifies his aims:

> Even to the historian acquainted with the concepts of energy conservation, the pioneers do not all communicate the same thing. To each other, at the time, they often communicated nothing at all. What we see in their works is not really the simultaneous discovery of energy conservation. Rather it is the rapid and often disorderly emergence of the experimental and conceptual elements from which that theory was shortly to be compounded. It is these elements that concern us. We know why they were there: energy is conserved; nature behaves that way. But we do not know why these elements suddenly became accessible and recognizable. That is the fundamental problem of this paper. Why, in the years 1830 to 1850, did so many of the experiments and concepts required for a full statement of energy conservation lie so close to the surface of scientific consciousness? (p. 323)

Kuhn notices that the five pioneers "who produced a quantitative version of energy conservation" did so by merging the previous, but quite obscure, notion of *vis viva* with the tradition "of water, wind, and steam engineering." But their approaches varied greatly, from theoretical work (metaphysical) and ideas of conservation to laboratory experiments on conversions: "the very homomorphism between the theory, energy conservation, and the earlier network of laboratory conversion processes indicates that one did not have to start by grasping the network whole" (p. 325). In any case, the layman popularization of the conservation law

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[24] On the same page Kuhn states "Between 1842 and 1847, the hypothesis of energy Conservation was publicly announced by four widely scattered European scientists—Mayer, /Joule, Colding, and Helmholtz—all but the last working in complete ignorance of the others. [But even earlier] "Between 1837 and 1844, C. F. Mohr, William Grove, Faraday, and Liebig, all described the world of phenomena as manifesting but a single "force," one which could appear in electrical thermal, dynamical, and many other forms, but which could never, in all its trans-formations, be created or destroyed" (Ib.).

“was achieved only after the work of Joule, Mayer, Helmholtz, and their successors had provided a full quantitative substructure for the conception of force correlation” (p. 330).[25] Again, even though there were multiple paths that led to the theoretical agreement among scientists, the fundamental assumptions were mechanistic, quantitative, and mathematized.

In his “Some Factors in the Early Development of the Concepts of Power, Work and Energy” Cardwell (1967) challenges the common account that work and energy were described in the classical framework of Newtonian mechanics. Cardwell notices that “energy” was not “the end product of the celebrated *vis-viva* dispute in the eighteenth century.” Instead he warns of the fact that there is “a gap of a full century between the dying of the *vis-viva* debate and the achievement of the idea of an underlying “force” which appears in various forms, as the source of work.” Similarly to Kuhn, Cardwell affirms that, in the meantime, “the science of power engineering came to maturity, based on water fully as much as on steam; and the impact of voltaic electricity” should be considered as key factors. More specifically, Cardwell claims that the conceptualization of energy necessarily depended on that of mechanical work, both of which were made possible through the contribution of British and French scientists in the eighteenth century. Cardwell then explores the origin of the study of work, accrediting it to Galileo:

> Galileo showed very clearly, the machines of the time—pulley, wedge, screw, inclined plane, capstan – could be reduced to the lever principle, it followed that the weight or force applied to the machine multiplied by its speed must equal the load multiplied by its speed. In this work of Galileo's then, we have the beginnings of a rational science of machines and the origin of the concept of work […] Since the essential conditions had been established by Galileo, we should expect to find that other followers of his had taken them up and developed them, without, of course, relating them to the Third Law. And this, in fact, was the case. Thus, in 1704, Antoine Parent published his important paper on the maximum of useful power to be obtained from a particular machine, a water-wheel driven by the impact of water on flat blades. (p. 354)

[25] In this chapter, Kuhn writes about twelve pioneers and specifies “Though Germany in the 1840’s had not yet achieved the scientific eminence of either Britain or France, five of our twelve pioneers were Germans, a sixth, Colding, was a Danish […], and a seventh, Hirn, was a self-educated Alsatian […]” (p 339).

After mentioning the importance of power engineering, or of work for the conceptualization of energy, Cardwell clarifies the significant steps that, mostly in France, led to the establishment of the energy concept through a series of works that "reveal a steady clarification in ideas and language:" In conclusion, Cardwell contribution shows that "science is derived from human experience" and thus "it would be unreasonable to suppose that the problems of the transformation of power: water power into mechanical power, heat into mechanical power, were not formative influences in the development of scientific thought; especially when dramatic changes in everyday life were associated with these things."[26]

R. B. Lindsey provides a genealogy of the energy concept "from the standpoint of its early historical origin and the philosophical implications thereof" in his "The Concept of Energy and Its Early Historical Developments" (1971). Lindsey begins by noticing that energy,

> Not only has it played a major role in the logical development of physics itself, but by common consent it is the physical construct which has proved to contain the greatest meaning for all aspects of human life. Under the misnomer "power," it is the stock in trade of the engineer and that which makes the wheels of the world go round. More and more, it is recognized by economists as the real wealth of nations. (p. 383)

Then follows the discussion of the philosophical significance of energy. Lindsay emphasizes that

> [The study of energy took place] in the light of certain assumptions which are of essentially philosophical nature, namely, that the basis of the concept of energy as we use it today is the idea of invariance, which here means constancy in the midst of change. We think in this connection of what we now call the mechanical energy of a system of mass particles subject only to their mutual interactions: this quantity is a function of the velocities and positions of the particles (in some inertial reference frame) that stays *constant in time*, no matter what the motions of the particles may be. (p. 384)

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[26] Cardwell conclusion is also remarkably useful: "The establishment, then, of the concept of work led inevitably to that correlative idea which Rankine called "actual" and Kelvin "kinetic" energy: ½ MV^2. Thus the *vis-viva* doctrine was replaced by the work doctrine. And, in the course of the nineteenth century the concepts of work and energy reached their full usefulness in the development of thermodynamics and field theory. To quote Bridgman again: we are entitled to the generalized energy concept ". . . only after the establishment of the First Law" (of thermodynamics). For this purpose they proved ideal tools" (p. 223).

For Lindsay, the concept of energy has great past and future impacts that are both *ideological* and *technological*:

> The ideological influence consists largely in the fact that the concept serves as a unifying element in all scientific descriptions of experience, enabling all scientists to think more effectively about their various problems and thus promoting the fundamental unity of science. As knowledge of nature becomes more specialized, this role of energy becomes of increasing significance. The technological aspect of the impact of the concept of energy on society scarcely needs emphasis. It is necessary only to remind ourselves of the stupendous increase in the average number of energy "slaves" per head of population on the earth in the last quarter century. This has correspondingly increased the well-being and comfort of many millions. At the same time, progress along this line has not been devoid of serious sociological problems. The energy supply available for transformation has not been well distributed, and many segments of the earth's population are going without their fair share. (p. 384)

Based on the worldview of thinkers such as Galilei, Bacon, and Descartes, intellectuals such as Newton and Leibniz introduced the foundational contribution of calculus, or the mathematical study of continuous change, thus preparing the basis for a more precise understanding of the nature of motion, space, and time. Meanwhile, it is not by chance that an emphasis on the quantification of power, and therefore on mechanics, took place in France and England especially, due to the importance of mining therein (Cardwell 1967). Crosbie Smith notices that energy is "a construct rooted in industrial culture, but now transcending that relatively local culture to form the core of a science claiming to have universal character and universal marketability" (C. Smith 2002, p. 310). Mechanization and quantification became the prerequisites for a successful understanding of nature. Experimentations and empirical measurements increased greatly in the 19th century. Accordingly, Ivan Illich highlights that

> During the first half of the nineteenth century, physics construed something akin to the division of labour: value equivalents between heat, electricity and mechanical movements were measured. One Englishman boiled water by drilling a canon and related the amount of steam pressure produced in the effort made by the horse turning the drill. Another one got heat by rubbing two blocks of ice against each other, and reported the amount of water obtained in the effort expended. The search for something like a gold standard in nature thus led to a new kind of experimental metaphysics: to laboratory proofs of entities

> that cannot be observed. The objective existence of something which just changes its form in ever more precisely observed and measured appearances became itself the new scientific mythology. Though no one, of course, observed it – and for a decade there was no agreement on the term which should name it – Julius Robert von Mayer (1842), Hermann von Helmholtz (1847), William Thomson (Lord Kelvin) and several others, working independently from each other, defined this something as nature's ability to perform work. "Work" in these five years from 1842 to 1847 became a physical magnitude, and energy its sources. Work was defined as the production of a physical change, and energy was assumed as its metaphysical cause. (p. 64)

By looking at the historical roots of the conceptualization, Lindsay lingers on the French and German contributions to energy conservation ideas as promoted by Descartes, Leibniz, D'Alembert, and Lagrange's *Mecanique Analytique* (1788) which is "One of the greatest landmarks in the history of physics, this constituted a systematic presentation of the science of mechanics from a mathematical point of view" (p. 392). Lindsay's article concerns the early developments in the study of vis-viva, heat, and later energy. He concludes by saying that "from this point [essentially the work of Lagrange], the story of the evolution of the energy concept moves in the direction of other physical phenomena, notably heat" (p. 393).

After the work of physicists such as Leonhard Euler, Jean-Baptiste le Rond d'Alembert, and Joseph-Louis Lagrange, several other scholars such as Sadi Carnot, James Prescott Joule, Rudolf Clausius, James Watt, James Clerk Maxwell (1831-1879), Ludwig Boltzmann (1844-1906), and Josiah Willard Gibbs (1839-1903) clarified the concept of work with the aim of understanding and perfecting the functioning of machines, leading to the definitive formulation of the laws of thermodynamics. These were formulated for the first time in a systematic manner by William Thomson (Lord Kelvin): "Between 1851 and 1853, attributing the first law to his collaborator, Joule (although Helmholtz had stated it earlier), and the second law to Carnot and Clausius" (Ayers 2016, p. 22; see also Coelho 2009b). At this point, and because it represents the moment of definitive ontological clarification of the emergence of the energy paradigm, it is worth recapitulate the story through this lengthy but detailed account by Smith (2002) to get a clearer sense of time and characters:

> When Thomson acquired […] a copy of the very rare Carnot treatise, he presented an "Account of Carnot's Theory," written in the light of the issues raised by Joule, to the Royal Society of Edinburgh, for publication in its *Proceedings and Transactions*. In particular, Thomson read Carnot as claiming that any work obtained from a cyclical process can only derive from transfer of heat from high to low temperature. From this claim, grounded on a denial of perpetual motion, Thomson inferred that no engine could be more efficient than a perfectly reversible engine ("Carnot's criterion" for a perfect engine). It further followed that the maximum efficiency obtainable from any engine operating between heat reservoirs at different temperatures would be a function of those temperatures (Carnot's function).
>
> Acquainted with the issues through a reading of Thomson's "Account," the German theoretical physicist Rudolf Clausius (1822–1888) produced in 1850 the first reconciliation of Joule and Carnot. Accepting a general mechanical theory of heat (that heat was vis viva) and, hence, Joule's claim for the mutual convertibility of heat and work, Clausius retained the part of Carnot's theory that required a transfer of heat from high to low temperature for the production of work. Under the new theory, then, a portion of the initial heat was converted into work according to the mechanical equivalent of heat, and the remainder descended to the lower temperature. In order to demonstrate that no engine could be more efficient than a perfectly reversible one, Clausius reasoned that if such an engine did exist, "it would be possible, without any expenditure of force or any other change, to transfer as much heat as we please from a cold to a hot body, and this is not in accord with the other relations of heat, since it always shows a tendency to equalise temperature differences and therefore to pass from hotter to colder bodies."
>
> At the same time, a young Scottish engineer, Macquorn Rankine (1820–1872), had been turning his attention to the question of the motive power of heat […] Thomson and Rankine began evaluating in 1850 the claims of Clausius for a reconciliation of Joule and Carnot, and especially the new foundation that Clausius appeared to have offered for the theory of the motive power of heat. Prompted by these discussions, Thomson finally laid down two propositions early in 1851, the first a statement of Joule's mutual equivalence of work and heat, and the second a statement of Carnot's criterion (as modified by Clausius) for a perfect engine. His long-delayed acceptance of Joule's proposition rested on a resolution of the problem of the irrecoverability of mechanical effect lost as heat. He now privately believed that work "is lost to man irrecoverably though not lost in the material world." Thus, although "no destruction of energy can take place in the material world without an act of power possessed only by the supreme ruler, yet transformations take place which remove irrecoverably from the control of man sources of power which ... might have been rendered available." In other words, God alone could create or destroy energy (i.e., energy was conserved in total quantity), but human beings could make use of transformations of energy, for example, in waterwheels or heat engines. (pp. 297-299)

Several other formulations and adjustments followed. In 1853 William Rankine claimed that "the term 'energy' comprehends every state of a substance which constitute a capacity of performing work. Quantities of energy are measured by the quantities of work which they constitute the means of performing" (Rankine 1881).[27] In Part II of his *Miscellaneous Scientific Papers*, Rankine affirms that "Energy, or the capacity to effect changes, is the common characteristic of the various states of matter to which the several branches of physics relate; if, then, there be general laws respecting energy, such laws must be applicable mutatis mutandis to every branch of physics, and must express a body of principles to physical phenomena in general" (Ib.). Smith notices that "the new science of thermodynamics was embodied in successive textbooks by Rankine (1859), Tait (1868), and Maxwell (1871)." Smith concludes by arguing (against Kuhn) that the concept of energy was "not the inevitable consequence of the "discovery" of a principle of energy conservation in midcentury, but the product of a North British group concerned with the reform of physical science and with the rapid enhancement of its own scientific credibility" (p. 310). About half a century later, in 1905 Albert Einstein proposed in one of his *Annus Mirabilis Papers* the theory of mass-energy equivalence, developing one of the most influential equations in physics: $E = mc^2$.

These are some examples of the way energy became a shared paradigm, a construct that depends on a materialistic and mechanistic "quantification" of reality. This is the context in which the conceptualization of energy took place: a world in which technoscience is perceived as a powerful force that is strongly dependent on the human will (or human hubris) to control the natural environment and its "resources" for the sole sake of mankind. The energy paradigm emerged in relation to the socio-political events that were taking place in the context of the

[27] Ayers correctly notes that Rankine's definition of energy is closer to the contemporary definition of exergy.

Industrial Revolution. Energy has been defined as a property of matter, that is, as the capacity of nature-matter to be converted in heat, work, and/or radiation (e.g. causing motion, or the interaction of molecules). Undoubtedly, there are many other definitions of energy, depending on the context and on the "form" that it takes: potential, kinetic, thermal radiant, electromagnetic, and so forth. But what is distinctive in all of them is that these frameworks are strongly influenced by the natural sciences, and as such they stress certain measurable, quantifiable, and mechanistic properties of reality. Their goal is to provide overall scientific explanations, universal and comprehensive laws of nature, abstracting from anything that is not measurable, quantifiable, or possibly mechanized. As philosopher Harold Chapman Brown underlines, "the scientists' world is the real world, but with a qualification. It is a selected real world according to those aspects which are significant for a certain purpose. Unlike the artist, whose aim is expression, the scientist cannot introduce what is not there into a certain context, but he can preserve in that context only what is fruitful for a certain purpose" (Chapman Brown 1917).

In summary, what energy is commonly assumed to be, how it is studied in educational settings, and understood in policy making all depend on the broader scenario in which modern science and a planned control over nature arose. The modern energy paradigm underwent a slow process of *homogenization* that displaced other ways of conceptualizing energy and therefore nature. Culturally, it proposed an anthropocentric, instrumental, and mechanistic view of the natural world that has been an obstacle for alternative, less anthropocentric and less instrumental, conceptualizations of energy. More specifically, the conceptualization of energy has slowly become homogenous. Technically, scholars had to find conceptual agreements on complex terms and heterogenous phenomena such as "energy," "power," "force," or "work." Although, as presented above, some scholars admitted difficulties in defining what energy is, the overall outcome has been the energy paradigm. Accordingly, I posit that, within Western culture, energy has usually been understood as a rather straightforward process: the use of some kind of fuel (from Adenosine Triphosphate aka ATP, to carbon and hydrogen, from uranium to wind), to power different media (people, animals, machines, power plants) in order to produce a process that is generally defined as "work." Precisely because of its narrow scope, and due to its abstract mathematical language, the energy paradigm has not recognized that energy is part of nature in ways and with meanings that may transcend the understanding of the natural sciences.

3.2 Colonization and Hegemony of the Traditional Energy Paradigm

Now that I have briefly outlined the history of how the modern energy paradigm became homogenized, we can proceed to examine in greater detail how – through *(neo)colonization* and *hegemony* – this reigning paradigm spread beyond the natural sciences. It indeed became very influential not only for thinking about nature, but also for the design of technologies, far-reaching energy systems and policies.

I underscore that making a critique of the dominance of the energy paradigm does not imply that we should rid ourselves of it. Western science has been spread and cultivated by people around the globe, and this way of understanding and manipulating our physical environment has produced fundamental benefits and conveniences, such as advancements in electrification and transportation. Precisely because modern technoscience has produced countless powerful discoveries and inventions which have changed the lifestyles of an increasing amount of people worldwide, scientific accounts are often perceived to be the "best" narrative, or at least the most "precise" or "useful." While dogmatic thinkers presume that science provides absolute "truths," a cultural relativist approach acknowledges that science is only one of the possible stories humans are able to tell. Here I take the stance that science represents a powerful tool, but we must recognize it as just one of the possible narratives developed by humans to understand the world. Otherwise we narrow the scope of the ethical questions we pose and take for granted the assumptions and values embedded in a Western scientific worldview. What I suggest instead is an enhanced conceptualization of energy that integrates the understanding of natural sciences and those of other more qualitative disciplines.

The homogenized conceptualization of energy did not remain within physicists' laboratories. It was implicitly propagated across the globe through cultural, economic, and technoscientific colonization carried out by different actors, including multinational companies, international organizations, and educational institutions while being also religious worldviews such as Lutheranism and Calvinism.[28] For decades, this understanding of energy has informed the mainstream textbooks on physics, chemistry and biology. Meantime energy practitioners such as engineers have transformed natural environments based on this conception worldwide. These assumptions have been influencing the design of energy systems, technologies, and policies in decisive ways.

On social and political levels, the traditional energy paradigm translated into geo-political dynamics which are symptoms of global disparities. Elsewhere, I have criticized the "paradoxical character of capitalistic utilitarianism" and the "flaws in the traditional proactionary approach to technology" which often characterize fossil-based energy systems (Frigo 2016). Here, I underline that, moreover, many individuals ignore that they are living within a neoliberal

[28] The possible connection between these religious confessions and the development of capitalism have been explored by sociologist Max Weber in his *The Protestant Ethic and the Spirit of Capitalism* (1905).

ideology which is often acritically taken for granted (Monbiot 2016). Geographer David Harvey (2005) has described neoliberalism as,

> a theory of political economic practices that proposes that human well-being can best be advanced by liberating individual entrepreneurial freedoms and skills within an institutional framework characterized by strong private property rights, free markets, and free trade. The role of the state is to create and preserve an institutional framework appropriate to such practices. […] State interventions in markets (once created) must be kept to a bare minimum […]. (p.2)

It is well-known that neoliberalism has developed an "alliance" with free-market capitalistic economic theory. It is hard to deny that both theories and practices have been diffused and embraced by the political elites of many nation-states throughout the world. The tacit alliance between neoliberalism, capitalism, the technoscientific apparatus and specific religious worldviews appears to many as a natural occurrence, that is, it has been *normalized*.

In other words, many people are unaware that they are thinking, talking and acting about "energy" within a framework that assumes the traditional energy paradigm created by the natural sciences. Some examples of the practical consequences created by this framework include the pervasive diffusion of the mantra of efficiency, the division of labour brought to the extreme of an 'assembly-line mentality' and the tacit agreement on utilitarian principles as the ultimate ethical theory for the common good. With specific regard to energy, the alliance of neoliberal theories, free-market capitalism,[29] technoscience and religious accounts has produced broader socio-political consequences, defining energy accessibility and democratic control over energy devices and energy systems. In his provocative article, environmental writer George Monbiot (2016) points out that the *anonymity* of neoliberalism is

> both a symptom and cause of its power. […] So pervasive has neoliberalism become that we seldom even recognise it as an ideology. We appear to accept the proposition that this

[29] This specific alliance has been the prevalent one. However, it must be recognized that communist and socialist political systems that have assumed the traditional energy paradigm have caused similar, if not worse, consequences.

> utopian, millenarian faith describes a neutral force; a kind of biological law, like Darwin's theory of evolution. But the philosophy arose as a conscious attempt to reshape human life and shift the locus of power. Neoliberalism sees competition as the defining characteristic of human relations. It redefines citizens as consumers, whose democratic choices are best exercised by buying and selling, a process that rewards merit and punishes inefficiency. […] Inequality is recast as virtuous: a reward for utility and a generator of wealth, which trickles down to enrich everyone. Efforts to create a more equal society are both counterproductive and morally corrosive.

The pervasiveness of this approach applies to the energy sector as much as to other dimensions of our life. It affects our conceptualization of energy as well as people's energy practices. Philosopher of technology Albert Borgmann highlights that Westerners especially got accustomed to a commodious way of life. Over the past few decades humans started to live surrounded by devices - many of them related to energy, fossil-fuels or electricity - which they do not really understand, but are nonetheless transforming their daily experience of the world and with it their existences (Borgmann 1984). Similarly, Monbiot underlines the oppression of neoliberal ethics on cultural and political grounds: "Neoliberal policies were imposed - often without democratic consent - on much of the world. The 'market' sounds like a natural system that might bear upon us equally, like gravity or atmospheric pressure. But it is fraught with power relations." As regard energy and ethics, Monbiot affirms that the most concerning point is that neoliberalism has not much "to say about our gravest predicament: the environmental crisis. Keynesianism works by stimulating consumer demand to promote economic growth. Consumer demand and economic growth are the motors of environmental destruction" (Borgmann 1984).

To explore more analytically the theme of energy hegemony, it is useful to refer, first to its etymology, and secondly to both the fields of cultural studies and energy humanities. *Etymonline.com* informs that the term comes from Greek "*hegemon* 'leader, an authority, commander, sovereign,' from *hegeisthai* 'to lead,' perhaps originally "to track down," from PIE *sag-eyo-, from root *sag- "to seek out, track down, trace."[30] Thus, hegemony means that something is "ready to lead, capable of command" and I propose that what took command in the cultural conversation about energy was precisely the modern, scientific paradigm.

Cultural studies scholars, among them mostly historians and political theorists, have been devoting conspicuous attention to the theme of hegemony (Lears 1985; Lash 2007), especially in the context of international relations, and Marxist historicism. Here, I only briefly refer to a couple of studies that attempted to update Antonio Gramsci's (1891-1937) notion of hegemony to determine if and how it relates to the diffusion of the energy paradigm.

In their *Preface* to *Selections from the Prison Notebooks* (Gramsci 1971), Hoare and Smith notice that, in Gramsci's thinking, there is

> a crucial conceptual distinction, between power based on "domination" and the exercise of "direction" or "hegemony". In this context it is also worth noting that the term "hegemony" in Gramsci itself has two faces. On the one hand it is contrasted with "domination" (and as such bound up with the opposition State/Civil Society) and on the other hand "hegemonic" is sometimes used as an opposite of "corporate" or "economic-corporate" to designate an historical phase in which a given group moves beyond a position of corporate existence and defence of its economic position and aspires to a position of leadership in the political and social arena. (p. XIV)

In the paper "Why Gramsci's Time Has Come (Again)" (2018) anthropologist Ronald Niezen asserts that Gramsci succeeded

> in redefining the concept of hegemony (*egemonia*) by taking it beyond the realm of politico-military domination of one state over another and extending its meaning to include the ideological predominance of a ruling class that manipulates the value system and world view of the ruled as a way to legitimate existing forms of power. At the same time, his concept of hegemony leaves room for agency and resistance (or what some refer to as counter-hegemony) among those subjected to illegitimate domination. (p. 2)

For Niezen, the premise of Gramsci's thought is that the "monopolization of ideas does not occur without struggle and limitation." Gramsci's "concept of hegemony is imbued with

[30] https://www.etymonline.com/word/hegemony

agency and the possibility of strategic dissent." Niezen states that "Conceptions of power as reaching deeply and unconsciously into subjectivity," and indeed this is the sense in which I claimed that the energy paradigm has become "traditional." Moreover, Niezen clarifies that, for Gramsci, "hegemony is a political tool, used by the ruling classes to transmit and popularize their ideas and values to the point that they become generally accepted by the whole of society. The goal of the exercise of hegemony is to attach power to commonly shared sensibilities, including among the subaltern classes" (p. 12). In my view, and specifically regarding the energy paradigm, I envision the "agency of resistance" as philosophy (the political concept of "subaltern") in its attempt to show that energy's ideas and values depend on a specific dominant power, that is the alliance among the scientific energy paradigm, capitalism, and neoliberalism (the dominant powers).

According to sociologist Scott Lash, Gramscian thinking belongs to a specific epoch so that we should now talk about post-hegemony (Lash 2007). Since "Hegemony is often understood to work through 'the symbolic order' or the symbolic […] We think that both domination and resistance in the post-hegemonic order takes place through the real" (p. 56). In this sense, the energy paradigm should perhaps be understood as a case of post-hegemony, a domination from both *within* the Western civilization and *over* other human groups through (neo)colonization rather than an issue of monodirectional oppression. Finally, Lash suggests that while "Cultural studies, in its hegemonic paradigm, understood power largely as operating *semiotically*, through discourse […] Post-hegemonic power and cultural studies is less a question of cognitive judgements and more a question of being" (p.58). It is in this resemblance of Heideggerian thinking that the question of being intersects that of materiality. Energy is hegemonic in the sense that its actualization or manifestation tends to occur in homogenous ways dictated by dominant powers, which decide how to design, structure, and create the reality of built environments based on the traditional energy paradigm.

With regard to energy humanities, Dominic Boyer's concept of *energopower*, "a genealogy of modern power that rethinks political power through the twin analytics of electricity and fuel" (Boyer 2014, p. 325). This concept is not just an import from physical to social sciences. Instead by defining energopower as "a concept designed to bridge discourse, materiality, and history - we feel that the concept, and the multiattentional method that informs the concept, will help undermine impasses among the analytics of modernity and power that come to us through the Marxian and Foucauldian traditions and through more recent iterations of the anti-anthropocentric turn" (p. 326). Boyer's stress on the biopolitical connotation of energy resonates well with the criticism of energy hegemony delineated here and raises fundamental questions regarding the material realization of energopowers. Energy hegemony has shaped the design of energy artifacts, devices, and machines according to specific values which are often unspoken. The oil and gas industry, for instance, has created oligarchical power structures which can influence and at the same time limit a real democratic control over energy production and distribution. In other terms, lifestyles in 'developed' economies typically follow a Western, high-energy, high-consumption model. This way of life requires the use of huge amounts of fossil fuels, which have brought several scholars to describe these types of civilizations as petrocultures (LeMenager 2014; Petrocultures Research Group 2016; Baptista 2017). What the concept of "energopower" allows us to see is that this state of affairs requires special institutional powers to be created and maintained, namely economic leadership which entails dependency, and military power that protects the harvesting of fossil fuels for the benefit of those same petrocultures.

The diffusion of the traditional energy paradigm, therefore, has occurred in parallel to the discovery and exploitation of fossil fuels and is deeply connected to the ‘polyamorous marriage’ among neoliberalism, free-market capitalism, technoscientific apparatus, and specific religious worldviews. The social actors behind these different cultural forces, mainly governments, international organizations, and multinational companies, have consolidated the energy paradigm as a cultural construct. This is problematic because it has produced a homogenized understanding that silently exclude alternatives, limiting the kinds of ethical questions that are posed about our relationship with energy and the values considered in answering them. The predominance of this paradigm has caused – indeed is still causing - conflicts and injustices.

CHAPTER 4

HUMANITIES AND SOCIAL SCIENCES ON ENERGY: A REVIEW

But the humanistic project of reframing energy as a social or human question has not advanced very far. Currently, new energy inputs such as wind power, solar power, biofuels, and so on are posited as the end game of the transition, but fundamental commitment to values, to satisfying social relations, and to our collective imaginaries are, at best, left to the margins of the discussion, if not erased from the conversation.

Petrocultures Research Group, *After Oil*

The previous chapter showed that the modern energy paradigm constitutes a way of thinking about the human-energy-nature relationship that became traditional for most energy practitioners, educators, and learners. The energy paradigm has several key characteristics (anthropocentric, instrumental, mechanistic, quantitative, and mathematized)that are problematic in representing a form of reductionism that has led to an overarching hegemonic mentality. Practically, it has promoted an approach to nature that lacks an ecological outlook and is therefore detrimental not only for the part of humanity that does not benefit from such exploitation, but especially for the nonhuman world that is constantly reified, priced-out, and sold.

Shifting toward the *via positiva*, this chapter presents examples of energy scholarship from five main areas: social sciences such as anthropology and ethnography of energy, the emergent field of energy humanities, Christian religious studies, and ethics and philosophy of energy. It also mentions some conferences and interdisciplinary projects. The most important aspect to remember to fully appreciate the novelty and provocative character of many of these works is considering the fact that for more than two hundred years the study of energy has been the domain of the natural sciences and engineering. However, over the past three decades scholars, writers, and poets have gradually but persistently developed alternative narratives to explore the nuances of energy. Books and journals, policy work, international conferences, and interdisciplinary research projects have also expanded the scope and enlarged the audience that can benefit from these alternative accounts. Although I am not aware of previous attempts to explicitly develop an ecocentric philosophy of energy, its achievement depends on, and is indebted to many of these alternative accounts of energy. The overall goal of this chapter is to bridge the scientific modern energy paradigm (criticized before) to the perspectives of social sciences and humanities. This integration attains a more holistic understanding of energy with the potential to influence practical ethics and even produce a normative framework for action (in chapter 6).

The engagement of humanities scholars and social scientists with energy issues has been primarily required by two facts. First, a growing awareness that concrete energy issues do not happen only theoretically, in the scientists' labs, or in the void but are entangled with ethical and socio-political dimensions. What has slowly grown over the past decade or so is the recognition that energy plays a great role and impacts human life in so many ways many of which remain unsurprisingly outside of the approach of the physical sciences. For quite some time psychological, behavioral, ethical, and socio-political aspects of energy have been, for instance, ignored, dismissed, or not seriously taken into account. Of course, here I am particularly interested in philosophical and ethical dimensions, such as the values surrounding personal and social issues. Second, and related, scholars in the social sciences and humanities have been challenging the monopoly of natural sciences in studying energy. The key idea is to propose studies that are based on the methods and analyses of different scholarly traditions as well as non-academic studies and practices, thus emphasizing alternative paths of inquiry through different media and outlets.

Yet, what is remarkable is that most if not all the intellectuals I mention here have also assumed the modern and traditional energy paradigm. Given that I just mentioned that these other disciplines have challenged the monopoly of natural sciences and engineering, this affirmation may sound confusing. But the fact is that even the sect of "heretical" intellectuals who challenged high-energy societies, the entanglement of technoscience and modern society, or the illusion of perpetual growth (Latouche 2009) have, overall, assumed the ontology or paradigmatic outlook provided by technoscience. To put it differently, the difference in their thinking lays in the *normative* side. These authors have indeed proposed alternative ways of envisioning the *moral* and *political* dimensions of the human-energy-nature relationship by suggesting, for instance, ideas of degrowth or frugality. But the point is that most social scientists, artists, and philosophers have implicitly adopted (knowingly or not) the *descriptive* account that I called the traditional energy paradigm. To my knowledge, the exceptions are, on the one hand and generally speaking, cultural anthropology for its stress on cultural relativism and on the other hand, a few intellectuals with a keen philosophical attitude.

A formidable example of the latter group is Ivan Illich who was aware that, also ontologically, the pre-modern meaning of energy differed from the scientific one. For example, he writes:

> To get at the matter I must review briefly the core meanings of "energy", how it was transmogrified from human vigor to nature's capital. In Greek, the word "energy" is both frequent and strong. It might best be rendered in English as "being on the make", with all the shades this expression carries. In its Latin version, in actu, the term is of central importance in medieval philosophy, meaning form, perfection, act, in contrast to mere possibility. In ordinary English, the word first appears in the sixteenth century. For Elizabethans, energy means the vigor of an utterance, the force of an expression, always the quality of a personal presence. A hundred years later the word can qualify an impersonal impact: the power of an argument or the ability of church music to generate an effect in the soul. The term is still used exclusively for psychic effects, although only for those engendered by either a person or a thing. During the seventeenth century, the attempt got underway to quantify nature's forces. (2013, p. 108)

Despite this and a few other exceptions that I reference later, there has not been a systematic attempt to challenge the metaphysical and ontological assumptions of the traditional energy paradigm. Therefore, I suggest that there is a need to conceptualize energy in more interdisciplinary and transdisciplinary ways.

In any case, the beginning of concerted public moral concern for the broader implications of energy, and implicitly for the environment, followed events such as the Manhattan Project and the following discharge of the atomic bombs during WWII (Briggle and Mitcham 2012), the growing consciousness of aggravating environmental problems such as the detrimental effects of DDT (Carson 1962), and the multiple energy crises of the 1970s (Runyon 1973; Garrison 1987).

There are many textbooks that describe the evolution of energy use by humans, present analyses, and future prospects (Fay and Golomb 2012; McElroy 2010). There have also been attempts to write an entire cultural history of humankind based on the relationship of humans to energy. A little known example of the latter is, for example, the book *Man and Energy* by chemical engineer Alfred R. Ubbelohde, who proposed a history of energy sources linked to the study of thermodynamics, suggesting a political arrangement à la Bacon (*New Atlantis*) in which most of the work is done by inanimate energy slaves (Ubbelohde 1955). In the initial chapter, emphatically entitled "Dominion over Matter through Energy" Ubbelohde describes the intricate and fascinating human dependency on energy throughout history, underlining also the fact that thermodynamic laws constitute physical limits, and may represent also ethical boundaries for humans. This and similar publications by scholars such as Vaclav Smil (1994; 1999; 2010c; 2004; 2014) explore the cultural history of humankind in connection to energy, resources, and civilization. This kind of work is surely interesting for this research because it advances the notion that human evolution is intrinsically linked to the use of different resources over time

(Price 1995). However, in this chapter I focus primarily on energy scholarship that has dealt with the theme of energy not only historically, but also somewhat *philosophically*. The following review shows that the present discussion about the philosophy of energy is not taking place in the void but comes after more than five decades of work, a legacy on which also my efforts are built.

4.1 Social Sciences I: Anthropology and Ethnography of Energy

In the English-speaking world, an explicit engagement of social sciences[31] with energy studies started in the 1940s, with the publication of Leslie A. White's *Energy and the Evolution of Culture* (1943). Although his cultural evolutionist position was later criticized, his famous article is one of the corner stones of anthropology of energy. According to White, "we see, on all levels of reality, that phenomena lend themselves to description and interpretation in terms of energy […] the whole cultural structure depends upon the material, mechanical means with which man articulates himself with the earth." From this assumption, White derives what he calls "*the* law of cultural evolution: *culture develops when the amount of energy harnessed by man per capita per year is increased; or as the efficiency of the technological means of putting this energy to work is increased; or, as both factors are simultaneously increased*" (p. 338, italics in the original). White, however, does not derive any explicit moral consequence from his study of cultural evolution. Even though he mentions different stages of development, and social structural organization dependent on amounts of energies and type of technological advancement, his interest remains mostly on the descriptive and analytical sides.

Over the past decades, anthropologists and ethnographers of energy have been stressing a bottom-up approach aimed at making the different understandings of energy, sustainability, and

[31] Here, by social sciences I mean essentially anthropology, ethnography, and sociology.

nature produced in different cultural contexts visible. Other aspects that have been studied, that are important but are not extensively considered here concern psychological, behavioral (Allcott and Mullainathan 2010), sociological (Mazur 2017), gendered (Gaard 2001; Winner 2003), economic (Georgescu-Roegen 1971; Georgescu-Roegen 1976) and political (Burke and Stephens 2017; Do et al. 2018; Vanderheiden 2013; Shaffer 2009; P.-P. Verbeek 2011; Leggett 1991; Leggett 2014; Hughes and Lipscy 1979) dimensions of energy issues.

To understand the reasons why the perspectives of social sciences can benefit energy studies we can refer to a guest editorial of *Anthropology Today*. In his "Why Energy Needs Anthropology" (2005) anthropologist Harold Wilhite asks why there is not such a thing as energy anthropology and makes the case for its implementation. He writes

> There is hardly a place anywhere where consumption of energy is not straining the economic or environmental limitations of energy resources, as well as the economic and technical capacity to convert resources into usable energy. Given the cen- trality of energy in daily life everywhere around the world, and its significance in some of the more contested political debates of our times, one would expect it to be an important emerging subject for anthropology. […] Energy exists in many physical forms, and the ways of converting it into something useful have rightly been seen as the domain of engineering, physics and the other natural sciences. However, energy is of little use in and of itself. It must pass through a socio-technological system in order to reach the site of its intended us. (p. 1)

Since energy "begins its social life as a limited resource requiring management," and given that over the 1990s and 2000s there was "a massive worldwide shift toward the market, through the privatization or deregulation" there is a need for a reflection about the "biography of energy" that goes beyond social sciences based on economics. Aware that climate change has been the springboard of much energy debate: "new ways of thinking are called for, drawing on the bread and butter of anthropology, for example in understanding the ways in which family relations (kinship), gender, relations of production, meaning and morals are all mutually implicated in the uses of energy. This could also provide new thinking in energy policy" (p. 2).

After several calls to action such as this, from around 2010 there has been a boom of social sciences scholarship concerning energy. Some of the most important venues have been both specific journals such as *Energy Research & Social Science* (established in 2014) as well as multiple edited volumes. Many of the contributions in the anthropology of energy have focused specifically on "oil" (Hitchcock 2010; Reyna and Behrends 2008; Buell 2012; Love 2008; Rogers 2015) and aspire to study energy systems as energy cultures (Pfister et al. 2017). . Several scholars have also explored other important aspects of the human-energy-nature relationship, thus providing an interesting bridge to both energy justice and energy humanities discussed below. Consider some examples and four main collections of studies.

Cesare Marchetti (2003), for example, offers a historical perspective of human evolution through the lens of energy systems and according to the corresponding type of resource extracted from nature. Moving from the concern of energy crisis, Lynton K. Caldwell (1976) presents the links between energy and the structure of modern social institutions that promoted a characteristic type of economic growth:

> The institutions of modern industrial society have been better adapted to promote this growth than to control or direct it. Even in societies where mechanisms of state planning should, in theory, enable government to deal rationally with the growth problem, ideological commitments to general growth have, in effect, prevented the problem from being addressed. (p. 31)

Another interdisciplinary collaboration is that of sociologist Santander Cabrera and biologist Vicente Fuster who, in their "Energy and Sociality in Human Populations" (2002) attempt to characterize and define human populations from a thermodynamic point of view. These and other studies, such as the collection edited by Mogens Rüdiger (2008) show the potential of social sciences to offer alternative, non-dominant views about energy.

Anthropology and ethnography of energy are certainly in tune with the methods of other social sciences. However, they are typically characterized by a qualitative approach to research, rather than quantitative. In practice, this means that they favor data collection based on smaller groups samples and through techniques such as interviews and participative observation, utilizing "a long-time perspective in which context is crucial" (Nader et al. 2010). Laura Nader was one of the first intellectuals to stimulate the discussion about energy and anthropology. For instance, she proposed novel ideas regarding the interwoven realities of power and democracy presenting "four views of the future involving widely varying levels of energy consumption and life-styles" (Nader 1980). More recently, she edited with Leticia Cesarino and Chris Hebdon the rich collection *The Energy Reader* (2010) which collects examples of anthropology of energy written by "physicists, philosophers, economists, engineers, businesspeople, historians, and more." In the introduction, the editors write

> While Lawrence Summers once said that the third world is ''under-polluted,'' a more ecological perspective would stress the planet as interlinked; we're all in this together. Furthermore, as the United States transitions from present sources of energy to future possibilities, paradigm shifts will occur. (p. 1)

Interestingly, here the authors use the term paradigm too, indirectly endorsing the idea I indicated above, that an ecological understanding of energy would constitute a sort of paradigm shift. The greatest merit of this collection is probably its interdisciplinarity, because it gathers

> paradigmatic points of view more colloquially called 'mind-sets,' found everywhere, whether in business, science, economics, technologies, or anthropology. When people refer to thinking in or out of a box they are referring to mind-sets or paradigms. Quite commonly, people discover their mind-sets when they come into contact with others at interdisciplinary meetings, leading to either frustration or expressions of 'Ah-ha'. (p. 2)

For the sake of this review, the most provocative chapters are those found in *Part II: Mind-Sets – a Critical Perspective*. In chapter 12, which is derived from another paper (Nader 1981) also entitled "Barriers to Thinking New About Energy" Laura Nader recalls her experience at an interdisciplinary NASA conference in Monterey, California, where she was invited as “the anthropologist.” The idea behind the gathering was to “think freely” about different future energy scenario, but Nader noticed that

> it became quite clear that there were already boundaries around those scenarios. You were to think freely–within those boundaries. When you went beyond them, someone would tell you, ‘You’re off the track.’ Finally, I told one fellow that we didn’t know where the track was; that was why we were there. (p. 9)

Nader recalls that all the interactions she had during this and other events were mostly with white males, either scientists and engineers. She also highlights a number of “taboos” that were not discussed (e.g. public safety always assumed within the design and never really debated) as well as other “basic” but essential assumptions that were worth discussing such as that “breeder reactors is the only way to go.” A striking point for Nader occurred when she was asked to work in the Synthesis Panel to describe what life would be like in 2010:

> I was intrigued by how people were working on the project. In the first place, I’d never done any work with the future. As I’ve said, anthropologists study the past and the present; we don’t study societies that don’t exist, nor do we invent them. I soon learned that our humility was probably misplaced in this project, because economists don’t mind inventing all kind of societies/ When what they invent often happens, invention becomes self-fulfilling prophecy […]. (p. 10)

Nader then challenged her team to think about a scenario that did not involve an increase in energy demand but would maintain the same level of amenities still, a hypothesis that sounded impossible to several members. But the point of the conversation is that the incredulous fellows concluded that it was impossible because they were assuming growth models only, thus begging the question: “what do people think is possible?” Nader concludes by suggesting that, indeed, the 70-to-70 quads energy scenario she and few others suggested “is fairly easy to carry out, with little disruption in people’s lives. Essentially what we focused on was technical efficiency. Cars get more miles to the gallon, refrigerators give the same service but use less electricity […] a lot of little things that added to a fair amount of saving with very little change."

Similarly, in chapter 14, ''Energy as it Relates to the Quality and Style of Life,'' Nader and Stephen Beckerman challenge the idea (also introduced by Illich and Smil) that increased energy consumption equals increased quality of life, concluding that one does not necessarily follow from the other. In the end, the interdisciplinary experience of this anthropologist shows that a philosophy of energy depends on the cultural assumptions and disciplinarian attitudes underlying the conversation. It is in this sense that anthropology of energy is mostly concerned with what different actors think and experience regarding energy in different geographical, socio-economic and cultural contexts, also in relation to the benefits and burdens of energy projects. By doing this, it also relates to the theme of energy justice/injustice. However, the perspectives brought in by anthropologists are rarely normative, although they can provide a descriptive basis for it. Rather, the attempt is to look underneath the surface of contemporary energy debates, to gain a complex, hard look at the ideas and values which are fueling different peoples' understanding of energy and the environment. An important assumption is that how humans think about energy has an impact on the built environment and on their countless relationships with nature. Nevertheless, anthropologist do talk about ethics, just not as philosophers do. Anthropology of ethics challenges the disciplinary idea that ethics is most of all a theoretical study of morality, an approach strenuously defended for decades in academia. Scholars such as Jarrett Zigon and Michael Lambek have shown that morality can be successfully studied from the bottom up, as ordinary ethics (Zigon 2008; Lambek 2010). Energy ethnographies present concrete lived energy experiences, clarifying the meaning of energy justice and sustainable energy in practice. The inclusion of more diverse understandings of energy is an important step to improve our thinking about what energy is for different groups of people and in the ecosphere.

In their introduction to a recent special issue entitled *Exploring the Anthropology of Energy: Ethnography, Energy and Ethics* Jessica Smith and Mette High write that

> Given this conceptual orientation of anthropology, our calling for attention to energy ethics does not involve the scholar making a priori assumptions about what constitutes a good life, a good community, a moral person and the like. This is not an exercise in which scholars impose their own moral views on to those we study. Rather, it is a call for us to be cognizant of the moral aspects of social life as it pertains to matters of energy. (2017, p. 4)

In the same collection feature several articles on the anthropology of energy, addressing topics as diverse as decolonization (Lennon 2017), aesthetics of electric transmission (Wuebben 2017), bacteria and bioenergy (McLeod et al. 2017; Chatti et al. 2017), blackouts (Kesselring 2017), off-grid living (Forde 2017), radioactive waste (Richter 2017), in contexts as different as United States, Zambia, India, or Wales.

Sara Strauss et al. edited another seminal collection of anthropological studies entitled *Cultures of Energy. Power, Practices, Technologies* (2013). The editors clearly summarize why anthropology can provide a fruitful outlook for a more inclusive study of energy:

> Energy is an area ripe for anthropological investigation in at least three ways: how people experience and utilize energies of various qualities (types), how we rely on its quantity (continued flow), and how we harness both qualities and quantities of energy to construct socially meaningful worlds. First, people tend to interact with energy in a variety of forms, not as a monolith. Each form has its own specific qualities such as frequencies, strengths, sources, and potential uses—chemical, mechanical, kinetic, electrical—and availability that ranges from intermittent to constant, institutionally provided or individually generated. […] An anthropology of energy must shuttle back and forth among laws of physics, opportunities and constraints of ecological systems, and processes of culture; furthermore, these layers of reality are necessarily intertwined materially, rhetorically, and metaphorically. Second, we build our social relationships and cultural understandings to coalesce around the continued flow of energy of familiar qualities in expected quantities. Ensuring access to continued supplies of energy and other resources is one of the central functions of centralized political systems. Shortages of energy—blackouts and queues for gasoline—quickly become political problems and

> often have political antecedents. […] Because of the necessity of institutions to manage energy flows, and because of the necessity of energy flows to individual agency, an anthropology of energy is necessarily political. (pp. 11-12)

But it is the third reason stressed by the editors that really links to the philosophy of energy:

> although people realize at some level that "energy" drives our worlds, humans typically think about and experience energy according to what it does and how it enables our goals. As contributors to this volume demonstrate, energy never just "is," existing as some unmediated potentiality; it flows through socionatural systems via the nodes and switches in the social circuitry of power and meaning-making. People make sense of energy in a plethora of ways, from animistic veneration of the sun, wind, or other natural forces to commodity or machine fetishism. An anthropology of energy must therefore also analyze multiple, contested meanings. (p. 12)

This anthology presents a series of case studies and conceptual essays that explore "cultural conceptions of energy as it is imagined, developed, utilized, and contested in everyday contexts around the globe" (p. 10). Moving from the work of Appadurai (1990), the volume "offers analyses of 'energyscapes' at local, national, and transnational levels." The conceptual threads of many of the contributions emphasize the ideas of "currents" and "flows" that are expressed, for instance, in the metaphor of the "powerlines." The other two key themes are "transformations" and the "blurry cultural boundary between technology and magic, highlighting the multiple and simultaneous interpretations of energy and energy technologies that people in diverse societies hold" (p. 11).[32] The two most interesting chapter for this review are Stephanie Rupp's "Considering Energy: $E = mc^2 = (\text{magic} \cdot \text{culture})^2$," and "Multinatural Resources: Ontologies of Energy and the Politics of Inevitability in Alaska" by Chelsea Chapman.

Rupp moves from the hypothesis that New Yorkers rarely stop to think about energy and yet they "experience energy as a force that is ubiquitous yet invisible, uncontrollable yet indispensable" thus bearing assumptions and expectations about energy. Rupp argues that "that

[32] The reader may recall my discussion of "machine" and "magic" in chapter 2, section 2.3.2.

lacking accessible technical knowledge for thinking about energy and its uses, New Yorkers turn to multiple and hybrid images—magical, spiritual, corporeal, social, political, as well as technical—to explain the forces that enable their everyday lives" (p. 79). For Rupp, New Yorkers' discussions of energy reveal that

> city residents perceive energy through both formalist and substantivist models. Formalist models refer to quantifiable energy systems that provide the technical infrastructure on which high-energy, high-technology, information-saturated city residents depend. Substantivist models of energy are reflections on energy as a qualitative force that is socially embedded and mediated by people's relationships with each other and with the conditions of their daily lives. […] applying these theoretical frameworks to contemporary understandings of energy in New York City reveal a multiplicity of concurrent models that together shape how urban residents perceive and manage energy, the forces necessary to get things done. These models of energy—quantitative, rational, formalist on the one hand; qualitative, relational, substantivist on the other—are distinct but are complementary rather than contradictory. (pp. 80-81)

In chapter 14, Chapman uses the term ontology "to signal the presence of alternative and indigenous epistemic spaces in such conflicts as it indicates ways of knowing and acting toward energy sources that, like water, land, and wildlife, are all too often considered neutral and static commodities" (p. 96). She proposes a dual framework to understand energy perceptions. On the one hand, "natural resources" have been mostly conceptualized in multinational ways "extracted and circulated among countries, metrics, economies, and other sorts of petro-capital alliance." On the other hand, indigenous Alaskans seem to understand them as "multinatural" phenomena:

> they are also multinatural in the ways that they exist in many natures, diverse cosmologies of resources, society, and environment. In Alaska, such curious hybrids—especially oil and gas—have a long and storied presence as a recurring gold rush, as sources of phenomenal wealth and indigenous empowerment and/or dispossession, and as harbingers of ecological collapse. These mythic narratives are underpinned by historical conceptions of what energy is and fields of knowledge of how it works that hover uneasily around the interactions of corporations, state and federal regulatory groups, tribal governments, scientists […]. (p. 96)

Therefore, these examples of anthropology of energy take the cosmologies elaborated in contexts as different as New York City and Alaska seriously into account as possible path of inquiry to better understand how people make sense of energy in their situated experience. Besides anthropology tout court, the most recent and promising avenues of research in the social sciences are probably energy justice (Jenkins 2018; Jenkins, McCauley, and Forman 2017; Heffron and McCauley 2017; Sovacool et al. 2017; Hall 2013), energy transitions (Shaffer 2009), and energy democracy (Menser 2018; Menser and Hayduk 2014; Meadows 1991; Morris and Jungjohann 2017; Morris and Jungjohann 2016; Fairchild and Weinrub 2017).

4.2 Social Sciences II: Energy Justice

Leaving aside for reasons of space energy transition and energy democracy literature, I examine here only the conceptual matrix of energy justice and then explain how the concept differs, according to its founders, from both climate and environmental justice. In general, the relevance of this notion is demonstrated by the recent publication of two distinct journal special issues, *Energy Research & Social Science* Vol. 18, 2016 and *Energy Policy* Vol. 105, 2017.

The scholarship on energy justice seems to have flourished especially in the United Kingdom where several scholars have been actively working to establish the notion, clarify the orientation, and spread its adoption. A strong advocate for energy justice is energy scholar Benjamin Sovacool whose numerous publications offer an overall idea of the intersectional trajectories of philosophically relevant social science research. In his *Energy & Ethics: Justice and the Global Energy Challenge* (2013) Sovacool stresses the relationships between access to energy and resources, technologies, policies and the moral issue of justice. *Energy & Ethics* appears in dialog with another, more recent publication of Sovacool and Dworkin (2015) devoted to a comprehensive and comparative account of energy justice studies specifically. Both publications attempt to engage social sciences with ethics on the pivotal issues of poverty and unbalanced access to energy and resources. They introduce the idea that energy justice issues are so relevant and widespread that energy justice can become, by itself, an actual area of inquiry.

Two other recent articles compared in *Energy Research & Social Science* (Jenkins et al. 2016; Jenkins 2018) further expand on the theoretical foundations as well as the "specialty" of energy justice. By expanding on the work of McCauley et al. (2013), Jenkins et al. open their "Energy Justice: a Conceptual Review" with a definition of energy justice:

> [it] evaluates (a) where injustices emerge, (b) which affected sections of society are ignored, (c) which processes exist for their remediation in order to (i) reveal, and (ii) reduce such injustices. (p. 175)

Then, they present the three types of justice that constitute the so-called triumvirate of tenets: distributional, procedural, and recognition-based justices. *Distributional* justice investigates the cases in which energy production and consumption raise justice concerns. *Recognition-based* justice "moves researchers to consider which sections of society are ignored or misrepresented" and highlights cases of non-recognition and disrespect concerning, for instance, indigenous (de Onís 2018; Whyte 2017), aging, or disabled people. Finally, *procedural* justice "inspires researchers to explore the ways in which decision-makers have sought to engage with communities" and suggests, for example, mechanisms for the inclusion of communities and individuals affected by energy projects. Finally, Jenkins (2018) clarifies what differentiates energy justice from both climate and environmental ones. She outlines "three points of departure, which [she] argues increase the opportunity of success for the energy justice concept: (1) "bounding out" [of environmental and climate justice] (2) non-anti-establishment [non-activist] pasts and (3) methodological strength" (p. 118). Summarizing, Jenkins concludes that

> Energy justice is (1) more targeted in its topic of concern and systems focus, and therefore has increased potential for policy uptake, (2) unlike environmental and climate justice, is not the outcome of anti-establishment social movements, and (3) is backed by a strong methodological tradition which shows a range of both academic and policy-

relevant applications. Each of these factors increases its potential for widespread applications. By implication, there should be a continued and fervent increase in energy justice scholarship and application. (p. 120)

Although it is debatable whether energy justice really constitutes a separated area of inquiry, it is worth recognizing that, at least there is a growing awareness of the fact that philosophy and ethics can be relevant in the discussion about energy.

4.3 Energy Studies

Besides anthropology/ethnography and energy justice, the other key area of scholarship that contributed significantly to a more profound discussion about energy's socio-political implications is what can be called "energy studies." Broadly construed, this field includes several scholars who are typically trained in the natural sciences, economics, environmental studies, geography, and energy policy. Among them, I highlight here the contribution of Vaclav Smil, whose prolific and pioneering work deserves a special recognition. Smil has devoted numerous articles and books to the theme of energy, contributing to the popularization of the topic (Smil 2006; Smil 2008b), and linking it in innovative ways to issues of sustainability and energy transition (Smil 2010b), resources availability and ecological footprint (Smil 2002; Smil 2012), and even meat production (Smil 2013b). However, the two most interesting elements of Smil's scholarship may reside, first, in his attempt to deconstruct some "energy myths" and "soft energy illusions" (Smil 2010a), or what he otherwise calls "the infatuation of global energy" (Smil 2011) and, second, in his study of energy consumption thresholds related to quality of life. In *Energy at the Crossroads* (2003), for instance, he identifies specific amounts of annual per capita energy use in relation to key parameters that are significant to express minimal levels of human well-being. Applying his research to the 57 most populous countries, Smil begins by recognizing that

> All energy conversions undertaken by humans share the same raison d'être: they are just means toward a multitude of ends. All of the commonly used measures of energy use—be it conversion efficiencies, energy costs, per capita utilization levels, growth rates, consumption elasticities, or output ratios—are just helpful indicators of the performance and the dynamics of processes whose aim should not be merely to secure basic existential needs or to satisfy assorted consumerist urges but also to enrich intellectual lives and to make us more successful as a social and caring species. (p. 97)

Smil is aware that the "assessment of average national quality of human life cannot rely on a single surrogate" and since "quality of life" is obviously a multidimensional concept, it

> embraces attributes of narrow physical well-being (these, in turn, reflect wider environmental and social settings) as well as the entire spectrum of human mental development and aspirations. Foremost in the first category is the access to adequate nutrition and to health care, as well as the capacity to address effectively a large array of natural and man-made risks (ranging from air pollution to violent crime): only a successful record in these matters can assure a full span of active life. The second key component of human well-being starts with the universal delivery of good-quality basic education and should obviously include the exercise of personal freedoms. (p. 97)

Among several indicators, he suggests that "infant mortality and life expectancy are perhaps the two best indicators of the physical quality of life." Smil discusses several other indicators (civil rights or access to education, etc.) but overall concludes that

> annual per capita energy consumption of between 50–70 GJ thus appears to be the minimum for any society where a general satisfaction of essential physical needs is combined with fairly widespread opportunities for intellectual advancement and with the respect for basic individual rights. […and so concludes that…] The quest for ever-higher energy use thus has no justification either in objective evaluations reviewed in this section, or in subjective self-assessments. (p. 105)

The important fact to consider here, is that countries such as the United States or Canada consume almost three times the required minimal amount, with 285 GJ (6800 koe) and 318 GJ (7600 koe) annual per capita energy use respectively. Although debatable because of the risk of imposing imperialistic and/or Western standards of well-being, Smil's key point is that acceptable infant mortalities (below 30/1,000 live births) corresponded to annual per capita energy use of at least 30–40 GJ. But fairly low infant mortalities (less than 20/1,000 live births) prevailed only in countries consuming at least 60 GJ a year per capita, and the lowest rates (below 10) were not found in any country using less than about 110 GJ (fig. 2.10) [see, fig. 4.1]. However, increased energy use beyond this point is not associated with any further declines of infant mortality, and the correlation for the entire data set of 57 countries. (p. 98)

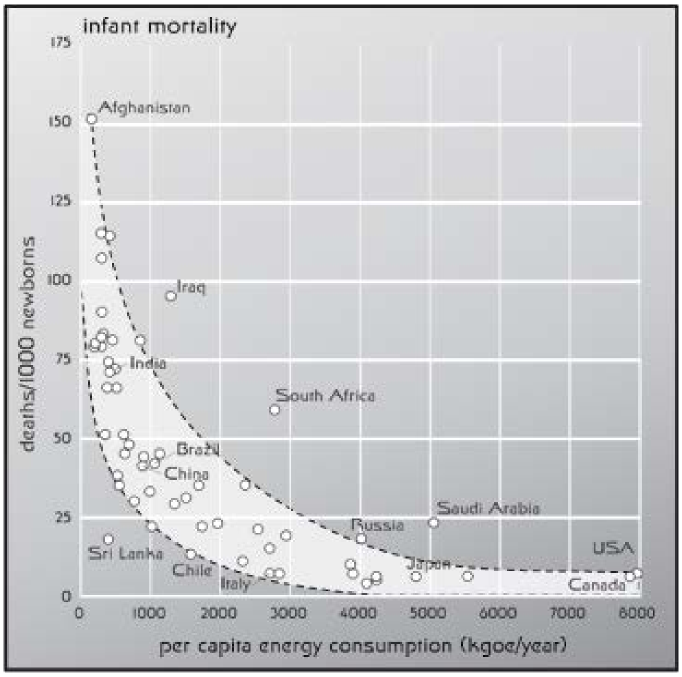

Figure 4.1: Comparison of infant mortality with average annual per capita use of commercial energy. Plotted from data in UNDP (2001). Source: (Smil 2003)

Following Smil's reasoning, I deliberately play the devil's advocate claiming that both the parameters he indicated (life expectancy and mortality at birth), but perhaps even more significantly the overall quality of life is definitely not increased by energy consumption above 110 GJ/c/y. My home country of Italy, for instance, remains at about 104 GJ (2,400 koe) while maintaining an average life expectancy of 83.5 (US: 78.3) and infant mortality rate of 2.67 deaths per thousand live births (US: 5.58). Of course, this does not represent a competition between nations' well-being, but just a comparison between energy consumptions rates and the open-ended debate about quality of life as it relates to standards of living and other factors.

In conclusion, Smil's observations have inspired others to take a hard look at the relationships between amounts of energy fluctuating in ecological and social systems (production, consumption, distribution, and waste) in relation to individual and social wellbeing. The contribution of energy studies can definitely enrich the philosophy of energy by complexifying the debate and adding nuances to how energy is actually part of human and ecosystemic life.

In the end, how do the contributions of social sciences and energy studies cohere, contrast, or depart from the modern energy paradigm? In general, although part of the contributions of social sciences largely perpetuate the traditional energy paradigm and use quantitative analyses and methods they integrate the account of natural sciences and engineering in the energy debate. As we have seen, anthropology and ethnography of energy tend to contrast also the ontological dimensions of energy, thus representing an "ally" of the philosophy of energy explored in this dissertation. The following three sections: energy humanities, ethics and philosophy of energy, and interdisciplinary conferences and projects, further explore paths of inquiry similar to the anthropology of energy.

4.4 Energy Humanities

Writers, artists, and poets have been cultivating the innovative field of energy humanities especially over the past decade. Among other things, scholars in energy humanities (similar to those of environmental humanities) analyze energy through poetry, novels, and essays, but also explore how the theme can fruitfully be investigated by other media such as photography and film. Since I already discussed the key features of energy humanities in chapter 1 (in that case together with anthropology, p. 8), here I rather linger on the creative dimension of this approach.

Because they are both concerned with delving into the muddy waters of "energy cultures," there are many connections between anthropology/ethnography of energy and energy humanities. Even though there is no need to neatly distinguish them, energy humanities can be characterized as those contributions that do not employ specific scientific methods of inquiry. Rather they utilize the tools of investigative journalism, the literary acumen of novelists, or the mesmerizing charm of poetry. At times, they change the game altogether by refusing the written format and embark on innovative adventures through audio-visual and performative arts. The novelty of energy humanities resides, perhaps, in these uncommon attempts to talk about energy.

One of the richest collections of energy humanities is Paula Farca's *Energy in Literature* (2015), the first anthology in energy humanities. This recent volume collects 20th and 21st century poems, critical essays, and photos which show the connections between energy, society, and environment from the unusual but rich perspective of the humanities. Various contributions deal with different sources of energy, while others concentrate on issues of pollution, waste, or extractions. The most relevant essays tackle timely topics related to the interwoven dimensions of gender and ethnicity, or the ever-lasting (and debatable) tension between nature and culture.

As mentioned earlier, foundational work for the academic establishment of this field was done by, among others, Dominic Boyer and Imre Szeman (Szeman and Boyer 2017). Boyer directs the *Center for Energy and Environmental Research in the Human Sciences*[33] at Rice University and organizes with Cymene Howe and the scholars of the Center an annual workshop called *Energy Cultures* (at its 7th edition in 2018). Boyer and Howe also produce a blog and a weekly podcast that features energy scholars and artists. The other "founder father," Szeman, is based at the University of Alberta and is one of the leaders of the Petrocultures Research

[33] http://culturesofenergy.com/

Group.[34] Together, they edited the second anthology in the field (Szeman and Boyer 2017). The volume collects almost fifty pieces ranging from classics of literature to contemporary stories. Some contributions stand out in the third part, "Energy in Philosophy: Ethics, Politics, and Being" for they connect to the development of a philosophy of energy.

To get a further glimpse of energy humanities it can be useful to turn to the article "The Charge Against Electricity" by Mark Anusas and Tim Ingold. In it, the authors report a legal case in which electricity is charged with gross deception. This is the beginning:

> Electricity has become such a ubiquitous feature of modern life that most of us would have no idea how to manage without it. Interruptions in supply are experienced as unsustainable moments of crisis. The possibility that the supply of electricity might eventually run dry is every government's worst nightmare and underpins the global politics of energy. Do we blame electricity for having brought us to this state of dependency? Can we hold it responsible for the disempowerment of citizens, for the entrapment of their lives within a state-sponsored grid maintained by corporations? Or does it, on the contrary, hold the potential for emancipation? Is electricity guilty or not guilty? In what follows, we begin with the case for the prosecution. Then we present the case for the defense. You, our readers, are the jury, and we leave the verdict for you to decide. (p. 540)

In this case, the authors wanted to create a fictional story that, nonetheless, implies some profound reflections on energy, from the commodious lifestyle afforded by an electrified built environment, to issues of public (de)empowerment over energy production and distribution.

My reading of the energy humanities literature suggests that a theme that has gained traction is that of oil cultures or "the socio-cultural complexities and contradictions of petrocultures" (Petrocultures Research Group 2016). Moving from the work of LeMenager, Farca, Boyer, and Szeman, several other authors have written about this, conjugating ethnographic experiences, travels, and sometimes philosophical reflections. The only problem

[34] http://petrocultures.com/

with this trend, highlights Christopher Jones (2016), is that oil is “currently over-represented in the energy humanities, a state of affairs [Jones] describes as petromyopia.”

For example, the online issue of August 2017 of *Technology’s Stories* – the online platform of the Society for the History of Technology – gathers several of these interesting narratives. For example, Abby Spinak oil encounters in West Texas (Spinak 2017) and Sarah Stanford-McIntyre’s Latourian reflection “When Oil Was Modern” (Stanford-McIntyre 2017).

4.5 Religious Studies

The expression “energy ethics” was coined by Dieter T. Hessel as the title of his book *Energy Ethics: A Christian Response* (Hessel 1979). This publication is an example of the contribution of religious thinking to the theme of energy ethics, a trend that has re-emerged more recently in the work of contemporary scholars. Hessel’s book was the result of the work of a committee appointed in 1974 by the National Council of Churches of Christ (NCCC) “to study the moral and religious issues in the use of plutonium as a commercial nuclear fuel.” Even though it was intended as a “sourcebook for discussion in Christian churches” it represents an early example of the interests for energy issues that emerged during the 1970s in the wake of the energy crisis. In this edited volume, Hessel’s contribution is an “analysis of the justice of energy politics from a biblical perspective.”

More recently, Erin Lothes Biviano et al. (2016) focus on energy ethics from a religious standpoint, in the wake of Hessel’s work. Their *Catholic Moral Traditions and Energy Ethics for the Twenty-First Century* aims at founding a Catholic energy ethics that pays “attention to current energy realities with scientific and technological precision, and can offer unique clarity about the specifically moral character of the problem” (Biviano et al. 2016, pp. 1-2; see also

Biviano 2018). “Clarity” for Biviano depends on the special alliance that Christian believers maintain they have with a god who gifted them the world as creation. From an environmental philosophy standpoint, this Christian approach to energy ethics is interesting in that it provides a counterargument to the ‘accusatory’ stance of scholars such as Lynn White Jr. who saw in the Judeo-Christian teleology and metaphysics the primary causes of the ecological crisis because, “especially in its Western form, Christianity is the most anthropocentric religion the world has seen.” White claimed that since both science and technology are blessed words in our contemporary vocabulary, we need to remember that both notions are culturally interlinked with religion and may perpetuate some of its teleological aims. First, historically, modern science is an extrapolation of natural theology and, second, modern technology is at least partly to be explained as an Occidental, voluntarist realization of the Christian dogma of man's transcendence of, and rightful mastery over, nature.[35] But, as we now recognize, somewhat over a century ago science and technology-hitherto quite separate activities-joined to give mankind powers which, to judge by many of the ecologic effects, are out of control. If so, Christianity bears a huge burden of guilt.

A final example of Catholic engagement with environmental and energy issues came in 2014 with the publication of Pope Francis’ encyclical *Laudato Si’* (2015), which constitutes both a call for action and a theological and ecological vision.[36] But the strong positioning of the pontifex maximus was indeed anticipated and followed by several other activities and events organized by the Vatican. The antecedents go back as far as the week of study retreat held in

[35] For a similar exploration of the teleological nature of supposedly post-Christian ideologies, see the seminal work of philosopher of history Karl Löwith, *Meaning in History* (Lowith 1949).

[36] Franciscan perspectives on the human-nature relationship are also very relevant. See, for instance, (Mizzoni 2008).

Vatican City on November 10-15th, 1980, titled "Mankind and Energy: Needs, Resources, Hopes" (Pontifical Academy of Sciences 1982). A more recent example is the joint workshop organized on May 6th, 2014, by the Pontifical Academies of Sciences and Social Sciences. This event produced a trilingual report on *Sustainable Humanity Sustainable Nature Our Responsibility* (2014) in which several intellectuals presented their research and agreed on a final joint Statement entitled "Stabilizing the Climate and Giving Energy Access to All with an Inclusive Economy." In it, for instance, the participants state that

> Perhaps the greatest challenge lies in the sphere of human values. […] We need, above all, to change our convictions and attitudes, and combat the globalization of indifference with its culture of waste and idolatry of money. We should insist upon the preferential option for the poor; strengthen the family and community; and honor and protect Creation as humanity's imperative responsibility to future generations. We have the innovative and technological capability to be good stewards of Creation. Humanity needs urgently to redirect our relationship with nature by adopting the Sustainable Development Goals so as to promote a sustainable pattern of economic development and social inclusion. A human ecology that is healthy in terms of ethical virtues contributes to the achievement of sustainable nature and a balanced environment. Today we need a relationship of mutual benefit: true values should permeate the economy and respect for Creation should promote human dignity and wellbeing. (p. 23)

But the encyclical also explicitly and repeatedly mentions "energy" in connections to its efficiency, conservation equal distribution and access, and toward non-polluting forms. For example, in paragraph 26 Francis (2015) links climate change and energy issues by writing:

> There is an urgent need to develop policies so that, in the next few years, the emission of carbon dioxide and other highly polluting gases can be drastically reduced, for example, substituting for fossil fuels and developing sources of renewable energy. Worldwide there is minimal access to clean and renewable energy. There is still a need to develop adequate storage technologies. Some countries have made considerable progress, although it is far from constituting a significant proportion. Investments have also been made in means of production and transportation which consume less energy and require fewer raw materials, as well as in methods of construction and renovating buildings which improve their energy efficiency. But these good practices are still far from widespread. (p. 24)

Finally, in the year following *Laudato Si'*, the Pontifical Council for Justice and Peace published the book *Energy, Justice, and Peace: A Reflection on Energy in the Current Context of Development and Environmental Protection* (2016) which add an ulterior clarification of the links between the topic of energy and those of justice and peace.

Unfortunately, I have not found literature from other religious traditions such as Islam or Hinduism engaged with the concept of energy. But again, this might be a further confirmation that energy itself is a rather contextualized concept. In any case, the Christian tradition has, on the one hand, assumed the traditional energy paradigm but, on the other, it has thought about the ethical implications of energy. Christian intellectuals have prioritized, understandably, the discussion of a more just redistribution of God-given resources rather than embarking on the development of an ecocentric outlook.

4.6 Philosophy and Ethics

If we turn specifically to possible antecedents of a philosophy of energy, or more specifically to an ethics of energy, the examples become rarer and sometimes they are "under cover." By this, I mean that sometimes the work that has the more philosophical significance is not called directly "philosophy" and is therefore hidden under other labels.

But what is especially surprising is that there are very few metaphysical and ontological reflections explicitly devoted to energy, and even fewer that address the philosophy behind its conceptualization. The interest for this intersection appeared during the period of "energetics" studies at the turn of the 20th century. Non-deterministic, non-mechanistic perspectives flourished during this period too. We can look at the history of math, geometry, statistics, and physics but also at the work of philosophers, psychologists, and psychiatrists. Examples do not abound but can be found, for instance, in John G. Hibben's "The Theory of Energetics and Its Philosophical Bearings" (1903), Harold Chapman's "Matter and Energy" (1917), or Henri Bergson's *Mind-Energy* (1920). Another example is William James who, in his *The Energies of Men* (1907) grapples with the surprising resourcefulness of humans, not only in physical terms, but as "inner work" that allows men to move from higher to lower states and vice versa:

> Writing is higher than walking, thinking is higher than writing, deciding higher than thinking, deciding "no" higher than deciding "yes" –at least the man who passes from one of these activities to another will usually say that each later one involves a greater element of inner work: than the earlier ones, even though the total heat given out or the footpounds expended by the organism, may be less. Just how to conceive this inner work physiologically is as yet impossible, but psychologically we all know what the word means. We need a particular spur or effort to start us upon inner work; it tires us to sustain it; and when long sustained, we know how easily we lapse. When I speak of "energizing," and its rates and levels and sources, I mean therefore our inner as well as our outer work. […] The first point to agree upon […] is that as a rule men habitually use only a small part of the powers which they actually possess and which they might use under appropriate conditions. […] Either some unusual stimulus fills them with emotional excitement, or some unusual idea of necessity induces them to make an extra effort of will. Excitements, ideas, and efforts, in a word, are what carry us over the dam. (pp. 11-16)

Another very influential philosophical perspective that has tackled energy issues especially in relation to the logic of domination (already explored in chapter 2) is that of ecofeminism. Scholars such as Vandana Shiva and Maria Mies (Mies and Shiva 2014), Karen Warren (Warren 1990; 1997), Val Plumwood (Plumwood 1993; 2002), Carolyn Merchant (Merchant 1980; 2005), or Trish Glazebrook (Glazebrook 2004; 2005; Glazebrook and Kola-Olusanya 2011) wrote extensively about how a patriarchal mode of understanding nature has shaped the way (some) humans relate to the natural world. Moreover, ecofeminist scholars have extensively explored the interconnection between nature and motherhood (Roach 1996; 2003), ethics, energy, and climate change (Glazebrook 2011; Gaard 2015), and the specific situation of women dealing with energy and water issues (Gaard 2001). Finally, a recurrent theme in ecofeminist scholarship that is worth mentioning here, although it is not separated from those above, is that of (in)justice and inequalities which are often framed in terms of planetary North-South imbalances (Gaard and Gruen 2003; Seppälä 2016; Shiva 1988; 2003).

If we turn to ethics of energy, or energy ethics, the intellectual landscape becomes more nuanced. In this section, I mention some of the most relevant philosophical works and then offer some examples of a moral engagement with energy issues.[37] On the more theoretical side, an example is psychiatrist Stanley Jacobs who, aware of the risk of raising some controversial points about linking ancient Indian philosophy to the scientific study of energy, promotes in his "A Philosophy of Energy" (1989) a broadening of the definition of energy as

> that from which the whole manifest universe arises, causal, subtle and physical. It can be experienced through its manifestations. It can be measured precisely in the physical world by scientific instruments, and measured precisely in the worlds beyond the physical by a direct knowledge of measure itself. (p. 96)

Jacobs agrees that "there is potential energy, by virtue of position, kinetic energy by virtue of movement, and inertial energy by virtue of mass." But he argues that energy of inertia "that energy associated with the inertia of a body, by virtue of its mass, whether in a vacuum or resting on a surface – can also be thought of as the resistance of an object to movement, or to doing work." Since we know from experience that a "person who is self-motivated and 'raring to go' implies also that "after intellectual work we have moved ideas around and in emotional work we have shifted certain feelings and attitudes around." Jacobs suggests a broader definition of energy that "includes both the capacity to do work, and the capacity to resist doing work," thus proposing that "the physical phenomena of energy are, perhaps, reflections of the more subtle,

[37] I owe to Professor Carl Mitcham credit regarding the antecedents of an "energy ethics," through his LAIS Research Award Lecture titled, "From the Ethics of Energy to the Energy of Ethics" presented on Nov 28th, 2012. The works I refer to are those published and available in English.

psychological ones." In this way, Jacobs does not really challenge the energy paradigm, but expands it to include human emotional life.

A second example of philosophy of energy is the provocative article of another psychiatrist, Stanley W. Jackson. In his "Subjective Experiences and the Concept of Energy" (1967), he aims at integrating the scientific conceptualization of energy, Jackson proposes that yet another factor, man's subjective experience of effort, energy, or vigor, has *also* played a critical role in the origins and development of the concept of energy" (p. 602, Italics in the or.).

More recently, praiseworthy attempts have been recently made to delineate a philosophy of energy (Geerts et al. 2016; Geerts 2017b; 2018).[38] In "Towards a Philosophy of Energy" Geerts et al. (2016) attempt to establish the field of philosophy of energy by locating it amongst

> its theoretical neighbors and identifying its roots and ancestors. We compare and contrast the philosophy of energy to these fields, and defend the position that this indeed entails a distinct niche that comes with its own specific perspective that is not, and cannot be, adequately addressed by any other field. (p. 107)

The authors suggest that there are at least three philosophies of energy which, altogether, contribute to a "fully-fledge philosophy of energy."

First, the inquiry into the natural phenomenon of energy. Second, a critique of the functioning of energy in society, and third, the philosophy of technology in its "empirical turn." The first of these ways of philosophizing about energy repeats, to a certain extent, some of the points I raised in chapter 3 about the emergence of the scientific conceptualization of energy:

> There is a specific understanding of energy underpinning all these developments [of the energy paradigm]: a quantitative, abstract concept of "the ability to do work" that mutually interconnects a broad range of physical phenomena. This is the first philosophy of energy that we encounter, and most present-day natural scientists subscribe to some similar form of understanding energy. Although the unification of physical phenomena via the concept of energy has been exceptionally successful, conflicting conceptions of

[38] I was happy to realize that the work of Robert-Jan Geerts, including his dissertation entitled *Philosophical Explorations on Energy Transition* (Geerts 2017a) most closely resembles the type of research I am pursuing here.

> energy do exist. These conceptions are also the result of inquiry into the natural phenomenon of energy, but, rather than relating to the scientific, quantitative paradigm, they appeal to qualitative approaches. (p. 109)

Referring to qualitative energy paradigms is key here because the authors affirm that it would be very relevant to determine whether an overarching philosophy of energy could reconnect "two apparently disjointed conceptions of energy," that is the traditional energy paradigm and the "non-exact phenomenon of 'life energy'." In fact,

> the scientific understanding of energy has enabled society to plug into ever increasing amounts of energy in various forms, but it fails to say much about the *effects* of these developments on society. […] Something similar holds for inquiries into life energy: they are silent on energy external to the body. However, while this is not problematic in itself, should we seek to gauge what is changing in energy transition, a static understanding of energy falls short of the mark. (p. 110)

After a dense discussion of the contributions of Mumford, Bataille, and Heidegger, Geerts et al. clarify the empirical turn that took place in philosophy of technology toward the end of the first decade of the 21st century (P.-P. Verbeek 2011; Brey 2010):

> From grand critiques on technology in general, attention has shifted towards the ways in which particular technologies – say, pre-natal ultrasound or Skype – lead to new moral problems, or new conceptions of proximity. This focus on artifacts has proved very useful in providing clarification and guidance in an increasingly complicated technological lifeworld. (pp. 118-119)

Furthermore, the researches of Science, Technology and Society (STS) studies point out that science is not a value-free endeavor (Douglas 2009) and that devices and systems (e.g. pipelines, dams, transmission lines, power plants) do not happen in the void but incorporate cultural and societal preferences and values, a 'morality' of their own (Winner 2003; Verbeek 2011; 2013). Nevertheless, the authors disagree with the use of such approach in relation to energy technologies because of "the way the energy aspects of our daily practices tend to get hidden from sight by the artifacts we adopt and use." Instead they propose a systemic view "because only at the systemic level can we fruitfully distinguish between different energy practices." Moving from this systemic perspective, they make a distinction between an understanding of energy as potentiality, which is static, and one as flux, characterized by its dynamicity, highlighting that the difference is crucial because it "revolves around whether or not humanity *controls* it." Finally, applying the twin concept of flux/dynamic and potential/static to the electric grid, Geerts et al. point out that the electricity is typically conceptualized as potentiality/static, where it is actually in flux:

> this misconception might be fine as long as its ultimate source is an easily controlled form of potentiality: measuring electricity as just a proxy for the amount of fossil fuels being burnt to make it. However, when fluctuating sources become significant, this becomes problematic. Presently, German renewable electricity is already dumped on neighboring markets on sunny, windy days, because there is no place for it in the national network. As we do not control the availability of solar and wind power, there are periods of surplus as well as periods of shortage. Approaching electricity solely as potentiality becomes untenable. (p. 122)

The conclusion, then, is that "the formerly unproblematic misconception of electricity as potentiality becomes an issue when intermittent renewable sources become more significant in the energy mix." In times of energy transition from fossil fuels (potential) to renewable sources (flux) "technological solutions can go a long way, but still need some help from consumers." Therefore, consumer awareness of the fluctuating nature of renewable energy becomes the key premise for their active participation and cooperation, thus showing "how a brief philosophical exploration of a rather specific issue to energy transition quickly leads onto fundamental questions regarding the functioning of energy in society."

Moreover, as I anticipated in chapter 1, philosopher Mario Bunge writes about the metaphysical dimensions of energy in his "Energy: Between Physics and Metaphysics" (2000). At the crossroads of ethnography and philosophy of energy lies the article "Vital Energy" by Stephen Gudeman (2012) offers a reflection on the concept of "vital energy" as a current of "strength" or "force." This idea is central to the economies of Panama and Colombia and "connects all activities in the local economies and establishes relationships, from kin to strangers" (p. 57).

On a very different note, Finnish philosophers Tere Vadén and Antti Salminen (2007) identify the connections between the nature of modernity, the addiction to fossil fuels, and the socio-political structure in which most humans are embedded:

> The fact that fossil energy is in a blind spot of social thought is in itself remarkable, as many of the experiential characteristics of modernity are directly connected to fossil fuels. The experience of speed and acceleration, celebrated by futurists and modernisers, fascists and communists alike, is derivative of the use of fossil fuels. Many commentators have lauded an independence from or even a victory over nature. Ironically, the impression of independence is made possible by a unique natural endowment, namely, amassed high quality hydrocarbons. This ironical twist gives modernity its characteristic epistemologically delusional nature. (p. 51)

In subsequent work, they have analyzed what human existence means in the neoliberal, capitalistic age of fossil fuels by offering an 'experiential, phenomenological, and therefore politico-economical view on oil', a 'nafthology' capable of investigating both its material and theoretical dimensions (2015; see also Vadén and Salminen 2018).

Luckily, reflections that grapple explicitly with energy issues from a moral perspective are not as rare as those on the metaphysical and ontological aspects (Mitcham & Rolston, 2013; Heckel, 2015; Sovacool, 2013; Briggle, 2015). Most of the work has been devoted to energy in connection to the concept of equity (Illich 1974), responsibility (Shirani et al. 2013; Dernbach and Brown 2009), or the fundamental problem of obligations toward future generations (Wenz, 1983; Parfit, 2010; Jamieson, 2014).

All-around theorist Ivan Illich wrote about "energy and equity" stressing that a precise moral concern for higher energy consumption on a planet with limited resources arises in relation to incomparable privileges in the access of resources (Illich 1974; Illich 2013). Probably also as a consequence of his religious background, Illich was concerned with the actual practice of morally virtuous energy choices. In this sense, he was one of the first intellectuals to show that choices that are made in how we organize spaces and infrastructures, that is ultimately utilizing energy, depend on specific socio-historical and geographic assumptions, and may have moral relevant consequences. His famous discussion of "how energy is used to move people" proposes the comparison between bicycles and cars, and it represents an exemplary, provocative attempt to apply moral philosophy to energy issues. For instance, regarding traffic issues Illich affirms that

> There are two roads from where we are to technological maturity: one is the road of liberation from affluence; the other is the road of liberation from dependence. Both roads have the same destination: the social restructuring of space that offers to each person the constantly renewed experience that the centre of the world is where he stands, walks and lives. […] A concrete analysis of traffic betrays the truth underlying the energy crisis: the impact of industrially packaged quanta of energy on the social environment tends to be degrading, exhausting and enslaving, and these effects come into play even before those which threaten the pollution of the physical environment and the extinction of the race. The crucial point at which these effects can be reversed is not, however, a matter of deduction, but of decision. (pp. 75-76)

If we turn to academic philosophy, we discover that professional ethicists have devoted very little space to the themes of energy and ethics, where most of the contributions come from the field of environmental ethics. Rather than looking at energy in a technical sense or attempting to understand how nature ends up in built environments, traditional environmental philosophy and ethics have focused more on ideas and practices related to nature, environment, and resources. Two interesting examples of this kind of approach are Peter S. Wenz's paper "Ethics, Energy, Policy, and Future Generations" (1983), which explores the intertemporal dimension of an ethical approach to energy policy and Dale Jamieson chapter "Energy, Ethics, and the Transformation of Nature" (2014).

Finally, a recent interdisciplinary example that summarizes the approaches of both anthropology and philosophy of technology to the theme of energy ethics can be found in the work of Carl Mitcham and Jessica Smith in their "Energy Constraints" (Mitcham and Rolston Smith 2013). Their article offers an overview of the area of energy ethics according to the perspectives of both anthropology of energy and philosophy of energy. In line with what I argued above, they also suggest that

> the historico-philosophical analysis of the concept of energy in the West from Aristotle to Einstein further suggests the need for much more careful analysis than is usually found in talk about energy policy and politics. Aristotle's energia or active reality is only remotely related to the energy of early modern natural philosophy and mechanics. (p. 316)

In the core of the article, Mitcham and Smith turn to ethics proposing "type I and type II energy ethics as a framework for advancing public debate about energy" which, they claim, "can easily modify common productive, economic, environmental, and political attitudes toward energy." Type I energy ethics is based on the belief that there is a linear relation between energy and culture and "it necessarily assumes that energy production and use is a fundamental good." Further developing the reasoning of Illich in his *Energy and Equity* (1974), the authors propose that "skepticism with regard to such a linear relationship is the foundation of a type II framework." The type II energy ethics resembles both Illich's and Smil's approaches, in that it assumes that "beyond a threshold abstractly defined as that between enough and too much, energy production and consumption begins to undermine the abilities of people to lead their own lives" (p. 317). Interestingly, type II energy ethics can adapt to different ethical theories:

> Energy is argued to be at most a qualified rather than an unqualified good; as perhaps necessary, but only up to a point, beyond which it can in multiple ways become counterproductive. In the form of a consequentialist or utilitarian argument, after crossing a certain threshold, increasing energy production and use reduces the quality of life. In teleological terms, stabilized or balanced energy use by humans is more natural than unrestricted increases. From a deontological perspective, humans are rationally obligated to limit not only their utilizations of energy but its production as well. Historically there are clearly questions to be raised about whether the grand narrative of human change can be characterized as simply one of progressive energy development. And surely there are instances in which energy is ugly—ugly even in its sublimity. (p. 318)

This seminal for the recent study of energy and ethics ends with three provocative questions which are also a call for ulterior engagements of both anthropology and philosophy:

> Could it not be that energy production and use, when examined from the limited perspectives of economics and politics, is itself a constraint on leading the good life? Do not both anthropology and philosophy suggest that life is more than energy production and use? Are there not other perspectives from history to art, poetry, psychology, and religion that could further de-constrain and enrich the way people think about energy? (p. 318)

These are just some examples of the initial engagement of philosophy and ethics with the topic of energy. It can surely be affirmed that the work and insights of these intellectuals, among others, represent the basis for contemporary debates. What clearly emerges from these early works is the realization of the moral consequences of the finitude of resources, as well as a conceptual challenge to think energy in relation to justice, equality, equity, and responsibility, for both present and future generations.

4.7 Conferences and Interdisciplinary Projects

In this last section, I mention six important public occasions in which the conversation about energy departed from a disciplinarian setting and opened up to favor a broader discussion. These are examples of interdisciplinary work that began the dialog that the dissertation aims to continue. Philosophy of Technology and Science, Technology and Society (STS) studies have been discussing the theme of energy broadly, focusing mainly on engineering's demand for ethics in its educational curricula.

First, from a more pedagogical standpoint, philosopher Douglas MacLean created in 1982 a "model course" entitled "Ethics and Energy" at the Center for Philosophy and Public Policy at the University of Maryland which was the first university class aimed at merging ethics and energy issues (MacLean 1982). More recently, two MIT scholars, Nathan Lee and Lucas Stanczyk, promoted a course entitled "The Ethics of Energy Policy," started in fall 2015.[39]

The second contribution stems directly from an institution and might anticipate NAE's project was UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST). James Peter Kimmins edited in 2001 a study entitled *The Ethics of Energy: A Framework For Action* which was the result of the work of the COMEST sub-commission on the Ethics of Energy that gathered in Paris in November 2000 (Kimmins 2001). COMEST's contribution to energy ethics can be found in the central, formidable section entitled *The Ethical Challenge of Energy*:

> Linking ethics inextricably to energy requires this type of universal vision, one that seeks to arrive at practical action that is responsive, flexible and participatory. The complexity of energy issues […] shows that all potential solutions to individual energy questions involve a social cost, an ethical dilemma and an impact on the way other problems are resolved. Thus, they can only be looked at within a broader consideration of the functioning of the world system of which energy is but one intimately woven component. […] Ethics play an important role in issues of development for the future by clarifying values at stake in policy decisions and giving moral reasons for alternative courses of action. Environmental and development questions are loaded with moral implications that need to be understood and carefully weighed before intelligent choices are made. This should help resolve value conflicts that thwart ecological conservation and development projects. (pp. 33-35)

Kimmins also writes that "with the help of ethics, a new social paradigm should evolve that would promote sustainable development with the maintenance of cultural diversity, social justice and equity" thus also highlighting the fact that a change of mentality is overdue.

Third, the Conference *Ethics, Energy and the Future: Technology for a Sustainable Society* organized in June 2010 by S. Matthew Liao at Delft University of Technology in the Netherlands was probably the first institutionally organized event that explored the links between

[39] http://energy.mit.edu/news/morals-matter-new-class-explores-energy-and-ethics/

ethics and energy in the field of STS. The goal of this gathering was to develop guidelines for a "sustainable ethics for future energy systems." This conference was part of an overall project pursued at the 3TU.Centre for Sustainable Energy Technologies (nowadays 4.TU.) aimed at "(i) the analysis of the notion of sustainability in the context of the discussion of future energy systems, (ii) the development of a normative framework (a sustainable ethics) for the moral evaluation of sustainable energy systems, and (iii) recommendations for the use of such an assessment framework in R&D processes."[40]

A fourth example is *Energy Ethics in Science and Engineering Education*, a cutting-edge project that the National Academy of Engineering and Arizona State University developed between 2011 and 2014. According to NAE's *Outcomes Report*, the project's findings

> indicate that choices to develop or reorient energy technologies entail ethical and societal commitments that go beyond those that can be captured in cost-benefit analyses. They involve issues of justice as well as community life, so the choices should attend to questions of public participation and engagement, particularly how to include those persons and groups who are less influential. Design decisions that scientists and engineers make, and alternative energy pathways that can be selected, will influence the answers to these social and ethical questions so they need to be accounted for in these decisions. These findings influenced the educational framework and materials developed in the project. The project introduces energy systems as complex socio-technological systems and introduces ethical approaches to the analysis of these systems and system transitions.[41]

The first conference on the theme of "Energy Ethics" – particularly from an anthropological perspective – was organized on March 17th-18th 2016, by Mette High and Jessica Smith at the University of St. Andrews, Scotland.[42] During April 2nd-5th, 2017, publishing

[40] http://ethicsandtechnology.eu/research-projects/a_sustainable_ethics_for_future_energy_systems/

[41] https://www.nae.edu/EnergyEthics.aspx

[42] http://energyethics.wp.st-andrews.ac.uk/

company Elsevier organized the First International Conference on Energy Research and Social Science "Energy for Society" in Melia Sitges, Spain.[43]

At the Public Philosophy Network (PPN) Conference held in Boulder, CO in February 2018 I myself organized a workshop on the "Philosophical and Ethical Contributions to the Sustainable Energy Discourse" (Frigo 2018c). In conclusion, these and other courses, conferences, workshops, and projects aim at expanding the interdisciplinarity of the energy discourse and have been instrumental in both enlarging the audience of such issues and stimulating my passion for these topics.

[43] https://www.elsevier.com/events/conferences/international-conference-on-energy-research-and-social-science

CHAPTER 5

THEORY OF AN ECOCENTRIC PHILOSOPHY OF ENERGY

I agree with the nature of the world. Not to deviate from nature, but to be formed according to its law and example—that is wisdom.
Seneca, *On the Happy Life*

The commonly accepted basis of our economy is the supposed possibility of limitless growth, limitless wants, limitless wealth, limitless natural resources, limitless energy, and limitless debt.
Wendell Barry, *Faustian Economics*

This chapter sketches the contours of an ecocentric philosophy of energy that extends beyond anthropocentrism to include the nonhuman world. Moving from the critique of the traditional energy paradigm, I argue that ecocentrism provides a more appropriate theoretical foundation for understanding energy, accounting for both humans' and nonhumans' interests and wellbeing. We have seen in chapter 3 that the energy paradigm originated in the natural sciences and applied through engineering is based on an understanding of nature that is anthropocentric, instrumental, mechanistic, quantitative, and mathematized. Accordingly, it stresses certain measurable and quantifiable properties of reality, leaving outside of its boundaries all phenomena or characteristics that are epistemologically unfit. I also described both the emergence and the diffusion of this modern, scientific way of thinking about energy and how it became, eventually, hegemonic.

It is important to remark that my position is not in contrast to that of physicists or engineers, but rather integrative. Undoubtedly, hard sciences and engineering have granted modern humans conveniences and commodities, countless inventions, achieving groundbreaking improvements in transportation, electrification, intellectual and fine arts, material conditions, and health. However, although their work has improved human life greatly, I argued that the traditional energy paradigm constitutes a form of reductionism that does not appropriately take into account the interests and the wellbeing of the nonhuman world.

In chapter 4, I offered a literature review that, far from being exhaustive, indicates that social sciences and humanities have recently been devoting more attention to energy research. But despite these promising developments and few notable exceptions (Chapman Brown 1917; Bunge 2000; Mitcham and Rolston Smith 2013; Jamieson 2014; Briggle 2015; Geerts et al. 2016), professional philosophers have not yet tackled the topic of energy in any comprehensive way. For instance, in a broad review of several social sciences journals published over 15 years focused on energy scholarship, Sovacool et al. showed that "one author within the entire sample of thousands reported training or institutional affiliation with philosophy or a philosophy department, yet questions about equity, futurity, and distribution are predominately about ethics, ontology, and epistemology" (Sovacool 2014, p. 15).

I discussed in previous chapters and elsewhere (Frigo 2017; Frigo 2018b; Frigo 2018c) that, historically, conventional or "disciplinary" philosophy has not paid much attention to the conceptualization of energy, nor to the major links existing between energy and ecological issues as they influence public life, politics, and policy. This fact is especially surprising if we consider that non-mainstream areas of philosophical inquiry such as environmental ethics or philosophy of technology are very often tied to questions around energy, either directly or indirectly. As noted in chapter 4, this is in contrast to other fields, like anthropology and ethnography of energy. The disregard of professional philosophers for this topic probably resides in the fact that, when it comes to energy, academic philosophy has played the role of *ancilla scientiae*, mostly delegating its inquiry to the expertise of technoscience, engineering and economics.

But, as I repeated several times, systemic and infrastructural energy challenges are complex and require also innovative reflections on the ontological, moral, religious, gendered, socio-economic, and political dimensions of energy. For example, the location, size, and functioning of a coal mine in China (Andrews-Speed and Ma 2008; Smil 2004a), a wind farm in the Netherlands (Rasch and Köhne 2017) or Texas (Swofford and Slattery 2010), or a biofuel industry in Brazil (Wilkinson and Herrera 2010; La Rovere et al. 2011) may impact the lives of both people and nonhuman beings very differently. Moreover, even in the apparently non problematic case of renewable energy projects such as wind or solar farms, issues concerning their social acceptance (Wüstenhagen et al. 2007), economic feasibility, and rapidity of implementation may be a constraining factor in achieving a successful energy transition and the opportunity of providing a reliable system 100% based on renewable sources (Jacobson and Delucchi 2011; Delucchi and Jacobson 2011; Jacobson et al. 2015) has raised scientific controversies and achievability doubts (Clack et al. 2017).

Therefore, since energy projects imply many ethical and socio-political implications, there is a need for a type of philosophizing about the underlying contextual ideas and values. More specifically, what has not been investigated yet, at least to my knowledge, is the opportunity to think about energy ecocentrically. Here, I argue that energy should be understood according to a broader and holistic theory that combines aspects of the traditional energy paradigm with an ecocentric worldview.

5.1 The Challenge of Ecomodernism

It is not difficult to see that, again, the disciplines that influenced the traditional energy paradigm, or the general approach of policymaking and engineering, have so far assumed a rather narrow techno-fix mentality, and recently embraced the mantra of ecomodernism. This argues that humans can protect nature by using technology to "decouple" anthropogenic impacts from nature, thus reducing ecological impact while growing economically and demographically. Ecomodernists claim that this would be a "good, or even a great Anthropocene". In any case, ecomodernism is one of the most successful of these perspectives and it has been influencing policy makers and designers especially since the 1970s. Regarding energy, ecomodernism purports the idea that the Earth is necessarily going to become "our high-energy planet" (Caine et al. 2014). The *Ecomodernist Manifesto* (Asafu-Adjaye et al. 2015) published by the Oakland based *Breakthrough Institute* is a good example of such orientation. The group of notable scholars who co-wrote the pamphlet clearly manifest their optimistic reliance on technoscience and their sceptic attitude toward the catastrophism of "extreme" environmentalists in the very first page:

> To say that the Earth is a human planet becomes truer every day. Humans are made from the Earth, and the Earth is remade by human hands. Many earth scientists express this by stating that the Earth has entered a new geological epoch: the Anthropocene, the Age of Humans. As scholars, scientists, campaigners, and citizens, we write with the conviction that knowledge and technology, applied with wisdom, might allow for a good, or even great, Anthropocene. A good Anthropocene demands that humans use their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world. In this, we affirm one long-standing environmental ideal, that humanity must shrink its impacts on the environment to make more room for nature, while we reject another, that human societies must harmonize with nature to avoid economic and ecological collapse. (p. 6)

The ecomodernist perspective is the most challenging for the development of an ecocentric philosophy of energy because, on the one hand, it acknowledges that humans are the main cause of the countless environmental issues facing planet Earth but, on the other hand, it strongly relies on the problematic assumption that humans will use "their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world." In other words, ecomodernists do not agree that we need to change our mindset, but rather become better techno-fixers, greener architects, and smart climate stabilizers. My ecocentric counterargument, however, maintains that the Earth is not yet a human planet because assuming that would already embrace anthropocentrism, which is one of the main mistakes brought about within the traditional energy paradigm. Instead, I argue that a change of mentality is not only needed, but actually possible through a widespread ecocentric education and a renovated attention to the voices that have been unheard in the energy debate. These are the alternative narratives of the peoples who have been living in a more sustainable and/or less destructive way, caring differently and thinking about the human-energy-nature relationship ecocentrically. A cultural shift can occur, and humans could liberate themselves from the hubris of controlling nature and, instead, use the powers of technoscience to figure out the best ways to become the ecological companions of other beings, or perhaps the stewards of the planet (Chapin et al. 2011; Rozzi et al. 2012; Welchman 2012) rather than the guardians, controllers, or dominators (Bourdeau 2004). To further emphasize my disagreement with the ecomodernist perspective, I use an example that contrast one of the core theses of ecomodernism, the possibility to always decoupling human development from ecological impact/footprint. For instance, Asafu-Adjaye et al. (2015) write:

> Intensifying many human activities – particularly farming, energy extraction, forestry, and settlement – so that they use less land and interfere less with the natural world is the key to decoupling human development from environmental impacts. These socioeconomic and technological processes are central to economic modernization and environmental protection. Together they allow people to mitigate climate change, to spare nature, and to alleviate global poverty. (p. 7)

The energy discourse of ecomodernism and similar proposals is framed according to the techno-fix belief that the solution to the shortage of something can be found in new, better or updated technologies. Ecomodernists envision only a temporary scarcity, never an absolute one. However, I would challenge this idea by pointing out that there may be different types of scarcity, some of which are not matter of economics or technoscientific invention. Instead, they are primarily ecological, and their solution demands a change of mentality.

If it is true that, for example, the scarcity of a metal may be overcome through innovation, recycling or by using a surrogate or an alloy, other kinds of resources such as land/area are *de facto* limited. Space, ecologically understood, is a good example of an objectively scarce factor that is nonetheless essential for the continuation and flourishment of both humans and nonhuman beings. Even if we grant, with the ecomodernists, that humans are capable of intensifying their activities and to maximize all kinds of efficiency, it remains true that a growing human population will occupy more land and consume more resources at the expenses of other species, thus obviously producing inter-species inequality. Or, to put it differently, unless we postulate that all newborns will mandatorily reside in cities, and we assume that the forecasted population increase will not demand more resources – again, the take of ecomodernists – a growing human population on a limited planet is necessarily going to occupy more space and probably consume more resources. To claim the contrary, one must be either blind to the ecological linkages between humans and ecosystems or ignorant of the basic requirements of ecosystem functioning.

This example may suffice, for now, to support the thesis that an ecocentric perspective would radically change the predominant approach to scarcity and therefore to energy policy. An ecocentric philosophy of energy would follow the maxim that "ecology precedes economics": the study of our home-planet – eco-logy (*oiko-logia*) – should come first and inform the management of it – eco-nomy (*oiko-nomia*). Of course, this proposal may sound like a radical step, but I believe that we need to go at the roots of the human-energy-nature relationship in order to move toward an ecologically sound and just energy transition.

In conclusion, both the public discourse and the work of energy practitioners have been monopolized by the language of engineers and economists. But taking ecocentrism seriously into account means that energy practitioners need to constructively criticize the modern Western worldview and agree to a paradigm shift. Embracing an ecocentric perspective that recognizes and respect the fact that other species possess intrinsic worth, interests of their own and thus require space and resources too. Besides anthropocentrism and instrumentality, natural scientists have also understood energy (and nature) in a mechanistic, quantitative, and mathematized ways.

In chapter 1 (section 1.1), I already described the basics of ecocentrism and, in chapter 4, I mentioned the few authors who wrote about alternative understandings of energy, mostly in qualitative, relational, or spiritual terms. Here, I concentrate on the main features of an ecocentric understanding of energy and its influence for a reshaping of the human-energy-nature relationship. The novelty of my approach consists in the proposal that energy can be thought ecocentrically. Then, in chapter 6, I move from "theory to praxis" by discussing some consequences of the ecocentric philosophy of energy for ethics and policy.

5.2 The Theoretical Foundations of an Ecocentric Philosophy of Energy

On the one hand, we have seen that the predominant understanding of energy depends on broader economic, socio-cultural, and philosophical assumptions which are often overlooked by energy and policy practitioners. I concluded that the modern conceptualization of energy is a Western cultural construct that emerged in the period of the Industrial Revolution. It is grounded on the scientific and mechanistic approach of the natural sciences which have partially operated in the service of the socio-cultural values and aims emerging in that period. For instance, the development of thermodynamics has been influenced by the goals of increasing economic productivity, improving the efficiency of engines and machines, and implicitly extending human power over the natural world. However, this modern conceptualization of energy is intimately linked to the progressive devaluation of the nonhuman world, or nature. On the other hand, an ecocentric philosophy of energy is based on specific, although different, theoretical foundations. These can either be alternative to the traditional energy paradigm or, at times, can integrate it.

Before I discuss these specific traits, I clarify some of the premises of my analysis. First, I consider that the present human relationship to energy is, ultimately, an unbalanced trade-off between one dominating species, *Homo sapiens*, and a finite planet with already endangered ecosystems. To put it differently, the various materials that humans conceptualize as economic resources – extracted from nature and transformed into artifacts, fuels and food – can be understood as forms of energy. It is an observable fact that the limitless consumption of nature made possible the different types of civilizations that cover the planet as well as undisputable achievements. The ability to transform matter and nutrients at increased and/or optimal efficiency is also at the basis of both evolution and the unprecedented human population growth that counts nowadays almost 7.7 billion people (Price 1995).

Second, in the pursuit of modern dreams of progress and emancipation, many humans worldwide have progressively become detached from nature and in fact the majority of mankind resides nowadays in cities. Humans learnt how to neatly separate what is wild, untamed, and uncertain from what is proper, civil, and readily available. They have extended their sovereignty over the entire planet, swiftly conceptualizing many natural entities and beings as resources intended predominantly for human benefit. The estrangement of humans from the environment has occurred in parallel to the expansion of human dominion over nature.

Third, what appears as a rather paradoxical fact is that, meantime, this energivorous way of living has rendered the connection between natural and built environments, and between ecosystems and humans invisible, yet fundamental because all energies are ultimately coming from the nonhuman world. Indeed, it remains true that the commodious character of contemporary lifestyle (Borgmann 1984) requires huge amounts of resources to be perpetuated. Since many key resources are scarce and will likely become scarcer, there exist increasingly bigger inequalities both ecologically and among humans both internationally and within countries between different social groups.

Fourth, ideas of human autonomy and independence from nature are common and thought as a positive achievement along with values of individualism and competitiveness. Meantime, the invention of capitalist and neoliberal ideologies and policies have commodified the nonhuman world through the monetarization of natural goods and services. These ideological frameworks are at the basis of global commercial and then financial capitalisms which operate in many nations and have been diffused worldwide through socio-economic and geo-political phenomena such as (neo)colonization and globalization. Consequently, nature becomes a reservoir of inanimate means for human ends. For instance, contemporary conservation affirm that ecosystems have necessary Biological and Ecological Functions (BEF), but their worth is really measured as (and if) they provide Biological and Ecological Services (BES) for humans.

In this chapter, I discuss four key traits of an ecocentric energy concept which mirror the analysis of the traditional energy paradigm presented in the second part of chapter 2: (a) ecocentrism as opposed to anthropocentrism, (b) a balanced compromise between instrumental and intrinsic values, (c) a holistic, ecological view in contrast to a mechanistic one, and (d) finally, the contribution of a qualitative kind of knowledge that has the potential to enrich the quantitative approach of the natural sciences and engineering.

5.3 Anthropocentrism, Ecology, and Ecocentrism

We have seen that one of the fundamental consequences following from the character of the traditional energy paradigm is that the nonhuman world is typically deprived of agency or moral considerability. Essentially, all nonhuman entities are conceived as *things* existing primarily for human use. Nature is constantly reified, instrumentalized, and priced. This goes hand in hand with the notion that some substances are natural "resources," and fossil fuels *in primis* are "types of energy," reinforcing the ontological equivalence between matters useful to produce power and energy itself. The relationships between humans and nature have become increasingly schizophrenic, dualistic, implicitly promoting anthropocentric views, and eliciting strongly instrumental attitudes toward ecosystems. This approach has produced many practical consequences in engineering, land management, and conservation. The science of ecology is something very different from ecocentrism, and an ecocentric philosophy of energy depends on the former only indirectly. In the study of energy, in fact, ecology has been "imitating" the other natural sciences by adapting their theories and methods to the study of ecosystems functioning.

In their collection of studies, Donato Bergandi et al. have showed that there are structural links between ecology, evolution, and ethics (Bergandi et al. 2013). Similarly, I argue that there are fundamental links between humans, energy, and nature, or what I called earlier the human-energy-nature relationship. Surely, all living and non-living beings share the energy flowing as nutrients throughout the ecosystems which they inhabit. This energy can be understood in a materialistic way, and ecological sciences already accounts for it. But ecology and ecocentrism are two different, yet related developments. A brief clarification of how ecology has been studying energy may be helpful to then fully grasp the importance of an ecocentric outlook.

5.3.1 When Ecology Studies Energy Like Physics

The approach of ecological sciences has drawn largely from physics in terms of conceptualization of energy (Chapman et al. 2015). Ecology shows that all the different beings and species are part of a "pyramid of life" (or alternatively, of a "food web") that is structured according to different levels of biological organization: simpler elements (subatomic particles, atoms, molecules, organelles) provide the basis for life (cells, tissues, organs, organ systems). Then, at the individual level there are all the different organisms that biology classifies according to different species in its taxonomy. Assemblages of different species constitute populations, communities, and hence biomes (a large naturally occurring community of flora and fauna). Finally, biomes and the so-called inanimate components of the ecosystem (waters, minerals, soils, airs) are part of the broadest system that can be conceived on a planetary basis, that is the biosphere, or ecosphere (Mader 2010).

An example of an early stage of moral thinking connected to energy and resources can be found in the work of Aldo Leopold, whose writing on energy is particularly enlightening. Even though he is rightly recognized as one of greatest Western pioneers of a non-anthropocentric environmental philosophy, his training at Yale Forestry school somehow implied the teaching of energy according to the traditional energy paradigm. This becomes clearer when we read his statements on energy, such as in his famous essay *The Land Ethic*, where he beautifully wrote (as partially mentioned earlier), "Land, then, is not merely soil; it is a fountain of energy flowing through circuit of soils, plants, and animals. Food chains are the living channels which conduct energy upward; death and decay return it to the soil. […] It is a sustained circuit, like a slowly augmented revolving fund of life" (pp. 182-183). From the recognition of the structural complexity of the land, he then derived a moral principle which he stated as follows: "A thing is right if it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong if it tends otherwise" (Leopold 1949, p. 189).

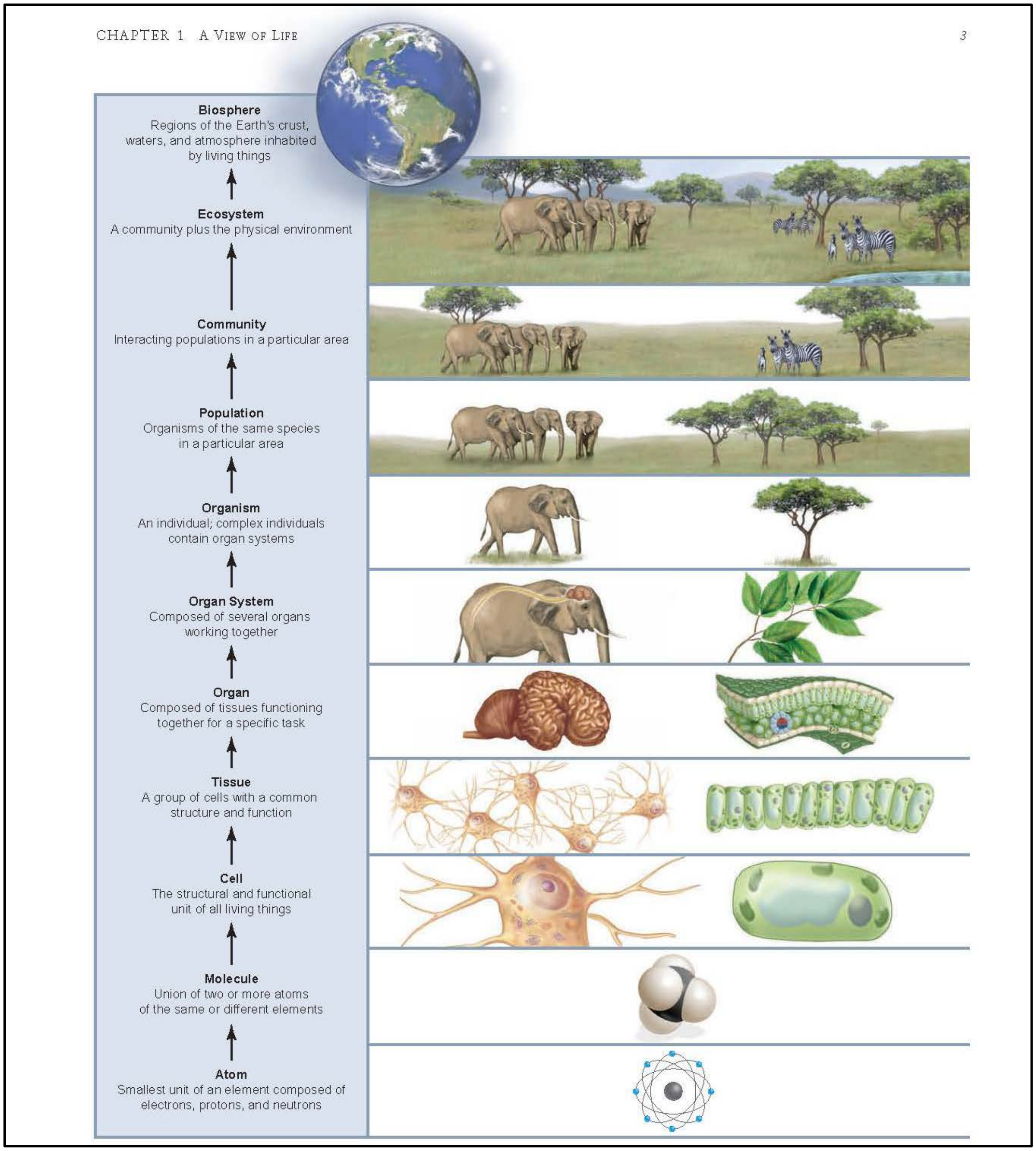

Figure 5.1: Levels of biological organization. Source: S. S. Mader. 2010. Biology. McGraw-Hill, p. 3.

Leopold's work highlights that the ecological understanding of energy can inform ethics, leading to practical moral consequences for moral agents. For Leopold, we humans as species need to remove ourselves from the top of the chain of being to embrace our role as part of the biotic community. The case of Aldo Leopold illustrates that even the proponent of the land ethic – one of the best known ecocentric environmental philosophies – talked about energy as flows of nutrients through a system, echoing the account provided by the natural sciences.[44]

Ecology has been influenced also by the broad field of "energetics" emerged between the 19th and the 20th century. A representative work of that period is, for instance, Alfred J. Lotka's "Contribution to the Energetics of Evolution" published in 1922. From the 1950s, the application of the concepts and analytical tools of physics to biological systems gained traction. According to Begon et al. (2006), one of the earliest attempt to understand energy ecologically is

> a classic paper by Lindeman (1942) [that] laid the foundations of a science of ecological energetics. He attempted to quantify the concept of food chains and food webs by considering the efficiency of transfer between trophic levels – from incident radiation received by a community through its capture by green plants in photosynthesis to its subsequent use by herbivores, carnivores and decomposers. […] More recently, a further pressing issue has again galvanized the community of ecologists into action. Deforestation, the burning of fossil fuels and other pervasive human influences are causing dramatic changes to global climate and atmospheric composition, and can be expected in turn to influence patterns of productivity on a global scale. Much of the current work on productivity has a prime objective of providing the basis for predicting the effects of changes in climate, atmospheric composition and land use on terrestrial and aquatic ecosystems. (p. 499)

Another influential historian of ecology, Robert P. McIntosh writes that "Lindeman expressed (1) the concept of efficiency of production of a single level of a food chain by relating its respiration to growth and (2) the productivity of one level of a food chain relative to (as a ratio of) the productivity of a previous level, particularly the immediate preceding level" (McIntosh 1985, p. 197). Lindeman was the first to posit the idea that the energy that flows through an ecosystem is represented mainly by food and matter that flows between the different levels of the food chain or trophic pyramid, and it is in this specific sense that energy becomes

[44] Therefore, it should not sound paradoxical that while I maintain a type of ecocentrism in line with Leopold's, I also criticize his scientific understanding of energy as another example of (milder) traditional energy paradigm.

part of the early study of ecology. Eugene P. Odum enhances this perspective with the elaboration of what he calls "bioenergetics" of ecosystem development moving forward the idea that ecology can be an integrative discipline (Eugene P. Odum 1969). The concepts of productivity, diversity and stability, food chain and food web; and homeostasis are brought together in Odum's perspective with the aim of understanding "ecological succession [and provide] a basis for resolving man's conflict with nature" (Odum 1969, p. 262). Thus, starting in the 1940s with Lindeman, continuing in the late '40s with naturalist and philosopher Aldo Leopold and then in the '60s with the development of "ecological energetics" by professional ecologists such as Odum Brothers (H. T. Odum and Odum 2000; E. P. Odum and Smalley 1959), or Hans Ziegler (1963) the spread of analytical tools to assess energy flows in ecosystems started within the field of ecology influencing also conservation biology. The traditional energy paradigm has been taken for granted also in ecology: energy is quantified in the environment by applying thermodynamics frameworks to ecosystems, mainly through calculations of the amount of biomass created by primary producers, or the quantitative exchanges of nutrients within food webs. Today, many ecologists still understand and study energy in ecosystems mainly as a "flux of matter" between different trophic levels, as the relationship between energy flux and nutrient cycling. Ecologists measure energy in ecosystems essentially through the calculation of the primary (gross and net) productivity of biomass, largely ignoring the deep philosophical implications of ecocentric thinking. But the main limitation of the physical understanding when it is applied to ecological systems is not even philosophical but primarily epistemological. Thermodynamics was elaborated in relation to the so called Complex Physical Systems (CPS) whereas ecosystems are Complex Adaptive Systems (CAS).[45] This means that the intrinsic

[45] While in CPS the elements are 'fixed' and so the systems can be studied through the well-developed tools of mathematics (i.e. differential equations), in CAS "the elements are adaptive agents, so the elements themselves

dynamicity of energy in ecosystems makes it incompatible with theories and tools developed by physics.

In conclusion, it is true that, besides physics, chemistry, and engineering, the other great effort to understand energy scientifically has been developed by ecology. Indeed, the history of ecology shows that, for quite a long time, it has been "imitating physics" and, therefore, it can be said that ecology as a science has also been influenced by the traditional energy paradigm. But ecocentrism as a philosophical position represents an alternative to it. It should now be clear that my thesis does not shift directly from physics to ecology. It rather highlights and depends on specific ecocentric consequences of the study of ecology.

5.3.2 Anthropocentrism vs Ecocentrism

An ecocentric philosophy of energy directly challenges the anthropocentric nature of the modern energy paradigm. As anticipated in chapter 1, ecocentric positions have been developed by several scholars in the field of environmental philosophy, such as Aldo Leopold, Arne Naess, Holmes Rolston III, or J. Baird Callicott. Ecocentrism should be understood as among the most radical philosophical positions that emerged during the environmental movement that started in Western countries in the 1960s. In a sort of parallel with the so-called second wave of feminism and the civil rights movement, environmental activism and scholarship were initially aimed at changing and move beyond cultural narratives which have been supporting oppression – of women, of minorities, and of nature. Environmental philosophy typically recognizes several possible ethical positions: strong anthropocentrism, weak anthropocentrism, sensiocentrism,

change as the agent adapt. The analysis of such systems becomes much more difficult" (J. H. Holland 2014, p. 11). For a more detailed distinction between CPS and CAS see Johnson 2007; J. H. Holland 2014.

biocentrism, and ecocentrism (Pojman and Pojman 2012).

In particular, ecocentric thinkers have derived the most radical philosophical implications from the findings of the ecological sciences and environmental studies (Eckersley 1992). Accordingly, ecocentrists typically start by posing a great ontological and metaphysical challenge: re-defining and re-positioning human beings and their role within ecosystemic functioning rather than considering mankind at the top of the ecological hierarchy. It goes without saying that, if taken seriously, the consequences of this change of perspective would be groundbreaking for both human and nonhuman beings. It has been argued that humans, thanks to their ability to work in groups, organize, cooperate, and eventually develop technoscience have progressively occupied the top ranks of the food chain. But, ecologically speaking, humans are not "top predators" and "dominators" but rather omnivorous animal somewhere in the middle of the food/energy pyramid. An ecocentric perspective challenges the idea that the Earth is necessarily destined to become a "human planet" as the Ecomodernists envision. By limiting human hubris, ecocentrism decenters humans and thus provide a paradigm shift similar to that occurred in 16th century astronomy from geocentrism to heliocentrism.

Ecocentrists maintain that modern humans, despite their technoscientific powers, are still dependent on the ecosystems of which they are part and, paradoxically, still know so little about. Ecocentrism borrows from ecology the notion that, in each ecosystem, there is a myriad of different beings who are constantly born or formed, live, die, decay and are cyclically transformed in nutrients by decomposers as part of the biosphere functioning. Simply put, these are animals (top predators, carnivores, omnivores, herbivores), primary producers (plants), decomposers (fungi) or detritivores (earthworms, woodlice, and sea cucumbers), minerals, soils, waters, airs.[46] In this worldview, humans do not occupy a special place, yet they are considered "special animals" in the sense that their power to dramatically change nature is recognized. In other terms, humans have been able to develop countless effective extrasomatic adaptations.

In both anthropocentric and ecocentric perspectives exergy is limited. But for the former, useful energy is primarily destined to benefit humans, while the latter posits that the nonhuman world deserves also the amounts needed for its flourishing. Moreover, an ecocentric view suggests that there may exist immaterial, spiritual, or relational forms of energy that fall through the cracks of the old paradigm because they are not epistemologically relevant or objectively measurable (they are non-quantitative and therefore non-mathematizable). However, as seen in chapter 4, these other more qualitative "dimensions" are relevant and should become part of the current energy debate.

Since humans have the possibility to become keenly aware of their power, they can also decide to follow the ecocentric philosophy of energy and live in ways that are compatible not only with their own survival and growth, but also with the preservation, flourishment, and wellbeing of other nonhuman beings. If we understand the fluxes of energy throughout the ecosphere in this inter-dependent and relational way, we begin to better understand the alternative outlook provided by ecocentrism.

The type of ecocentrism that I embrace here does not equalize humans with any other beings, but attempts at understanding also the wellbeing of the nonhuman world helped, in this, by the study of ecology. It considers humans "special animals" who possess a tendency to become an invasive species. As a disclaimer for possible accusations of eco-fascism, I

[46] I intentionally borrow from Leopold the use of plurals for all these different beings. See his essay "The Land Ethic" in Aldo Leopold. 1949. *A Sand County Almanac. And Sketches Here and There*. Oxford - New York: Oxford University Press.

immediately clarify that humans, in this perspective, are still relevant yet not central. They are not put on a pedestal or glorified as the conquerors of nature. Instead their power is acknowledged upfront and, because of it, they are recognized in the role of ecological companions, or co-inhabitants rather than managerial stewards/guardians or mere exploiters (de Groot et al. 2011). But this re-positioning of humans in the ecosphere goes hand in hand with the recognition of the limitedness of key environmental/energy factors, such as space and exergy (or useful energy). In a world currently hosting more than 7.6 billion people and counting, in the future there will inevitably be less available resources and space not only for humans, but for all other beings who are present in a specific ecosystem.

5.4 The Necessary Balance between Instrumental and Intrinsic Values

We have seen that the old energy paradigm taught humans to dominate nature and extract from it anything that may benefit them. But I also clarified that humans need to use some parts of nature to survive, likewise other biotic organisms. So, the second characteristic of an ecocentric philosophy of energy follows the realization that there are ecological and thermodynamic (broadly understood) thresholds. The key point is that they make it physically impossible to instrumentalize all nature for the benefit of some humans and the detriment of everything else. These are limitations inherent to the functioning of the ecosphere as well as the technosphere (all machines have efficiency limits), affecting both humans and other beings for they all share, eventually, ecosystemic energy. This is either coming into the system as solar radiation or is already present on the planet in the form of converted solar radiation (e.g. fossil fuels).

To better understand the instrumentality of the energy paradigm let's turn to Kant's second formulation of the Categorical Imperative, known as the "Formula of Humanity."[47] In his *Groundwork of the Metaphysis of Morals* (1785), Kant wrote: "The practical imperative will thus be the following: So act that you use humanity, in your own person as well as in the person of any other, always at the same time as an end, never merely as a means" (Kant 2011, p. 87). Since I propose that the energy paradigm should combine instrumental and intrinsic value (rather than focusing only on the former), the Kantian deontological principle can be expanded to include not only animals but all nonhuman beings. The re-formulation would be: "So act that you use nature, in your own person as well as in the person of any other (in)animate being (living and non-living), never as an end, and as little as possible as a means." This extended definition takes into account the nonhuman world *also* in an intrinsic way. It recognizes that some reasonable use of nature for human ends is inevitable, but it points to the precautionary principle of non-action whenever the consequences are unclear or possibly dangerous (Kriebel et al. 2001; DeFur and Kaszuba 2002; Sandin 2004; Cooney 2004; COMEST 2005). Moreover, this formulation would be in tune with traditional conservation (Pinchot 1910; Callicott et al. 1999), radical conservation (Adams 2006) as well as preservation (Muir 1911; Howard et al. 1991). It would imply, and thus prescribes, that when basic human needs have been met (for instance, according to the amounts described in 4.3., pp. 87-88) there is no need for any ulterior instrumentalization of the nonhuman world. Energy-nature should not merely or solely be conceptualized as a means and accordingly the recognition of intrinsic value should become a priority, leading to actions aimed at preservation and ultimately protection (Norton 1986; Meyer 1997).

[47] It should be clarified that my "extension" of Kant's deontological principle is appropriate only if, accordingly, the notion of agency is expanded beyond humans.

Energetically speaking, the worldview of modernity pictures scarcity as a temporary inability to obtain more, and it sees limits as chains that constrain an absolute freedom of which modern humans are somehow entitled. The ab-solutus character of the human-nature relationship is key in understanding the modern energivorous lifestyle. As it appears more clearly, researching the ontological and axiological dimensions of energy is the first step toward a philosophy of energy that can help improving praxis, that is our practical relationship to energy as it is linked to energy policies, personal choices and political decisions making.

5.5 A Holistic and More Qualitative View of Energy

Contrary to the mechanistic view of energy promoted by the traditional energy paradigm, an ecocentric philosophy of energy offers a holistic account. To understand what a holistic view of energy looks like, let me refer at length to a passage by Leopold (partially already mentioned in chapter 1) in which he synthesizes how energy flows through the land:

> Plants absorb energy from the sun. This energy flows through a circuit called the biota, which may be represented by a pyramid consisting of layers. The bottom layer is the soil. A plant layer rests on the soil, an insect layer on the plants, a bird and rodent layer on the insects, and so on up through various animal groups to the apex layer, which consists of the larger carnivores. […] Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals. Food chains are the living channels which conduct energy upward; death and decay return it to the soil. The circuit is not closed; some energy is dissipated in decay, some is added by absorption from the air, some is stored in soils, peats, and long-lived forests; but it is a sustained circuit, like a slowly augmented revolving fund of life. […] There is always a net loss by downhill wash, but this is normally small and offset by the decay of rocks. It is deposited in the ocean and, in the course of geological time, raised to form new lands and new pyramids. […] When a change occurs in one part of the circuit, many other parts must adjust themselves to it. […] Man's invention of tools has enabled him to make changes of unprecedented violence, rapidity, and scope. […] Waters, like soil, are part of the energy circuit. Industry, by polluting waters or obstructing them with dams, may exclude the plants and animals necessary to keep energy in circulation. Transportation taps the energy stored in rocks, and in the air, and uses it elsewhere; thus we fertilize the garden with nitrogen gleaned by the guano birds from the fishes of seas on the other side of the Equator. Thus the formerly localized and self-contained circuits are pooled on a world-

> wide scale. The process of altering the pyramid for human occupation releases stored energy, and this often gives rise, during the pioneering period, to a deceptive exuberance of plant and animal life, both wild and tame. These releases of biotic capital tend to becloud or postpone the penalties of violence (pp. 182-184).

Energy has been understood in multifaceted ways, and in its most material form as fuels and geo-chemical compounds, bio-chemically as the flux of nutrients within organic and inorganic life, metabolically as the transformation of food into movement and heat. However, there are other types of non-quantitative energies that people (and perhaps also other beings) can experience. Since these phenomena are not reducible to a quantitative and therefore measurable form, the traditional energy paradigm has disregarded or tacitly ignored them.

But isn't it true that we often speak about a particularly energetic atmosphere in a room, of a special energy in a relationship, or the energy that one can perceive while meditating alone in the middle of a forest? The neuroscientist may attempt to reduce also these phenomena to "states of the mind" related to specific chemicals and electric impulses in the brain, but that explanation would be, again, a form of reductionism dependent on a mechanistic and quantitative view. However, other areas of human knowledge are sometimes capable of intercepting these phenomena. We have seen in chapter 4 that anthropology and ethnography of energy are powerful tools in this sense. Another big part of human creativity that has been pushed out of the energy discourse are the humanities such as literature and poetry. For this reason, I argue that an ecocentric philosophy of energy would consider forms of expression such as poetry as qualitative sources of an understanding of energy, as much the laws of thermodynamics are used to explain energy quantitatively. For example, we can find examples of this kind of work in the emerging field of energy humanities, but also in the work of naturalistic poets such as Ralph Waldo Emerson and Henry David Thoreau who have been identified with a similar tradition. Instead of further discussing the merits of energy humanities, I choose to conclude this chapter with one of

Thoreau's poems, entitled *Nature* since it merges the theme of intimate connection with the environment with a call for human humility:

O Nature! I do not aspire
To be the highest in thy choir, -
To be a meteor in thy sky,
Or comet that may range on high;
Only a zephyr that may blow
Among the reeds by the river low;
Give me thy most privy place
Where to run my airy race.

In some withdrawn, unpublic mead
Let me sigh upon a reed,
Or in the woods, with leafy din,
Whisper the still evening in:
Some still work give me to do, -
Only - be it near to you!

For I'd rather be thy child
And pupil, in the forest wild,
Than be the king of men elsewhere,
And most sovereign slave of care;
To have one moment of thy dawn,
Than share the city's year forlorn.

Finally, borrowing Leopold's ecocentric perspective, it can be said that an ecocentric philosophy of energy "enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (1949, p. 173) but, in the meantime, decenters human beings and "charge" them with the role of being the responsible co-inhabitants, companions, and tutors of the nonhuman world (Frigo 2016).

By talking about responsibility, I am now moving from the description of the main traits of an ecocentric philosophy of energy to the moral consequences that can be derived from it. And that is the content of the next and final chapter, which presents what I call an "ecocentric energy ethic," an ethical framework to help humans decide and act ecocentrically regarding energy issues.

CHAPTER 6

FROM THEORY TO PRAXIS: DEVELOPING THE ENERGY ETHIC [48]

> *Even if nonpolluting power were feasible and abundant, the use of energy on a massive scale acts on society like a drug that is physically harmless but psychically enslaving.*
>
> Ivan Illich, *Energy and Equity*

The first three chapters constituted the *via negativa*. They introduced the topic, clarified key terminology (paradigm, energy, ecocentrism), and described the emergence and diffusion of the modern, scientific energy paradigm that was developed during the 18^{th} and 19^{th} centuries. Chapter 4 began the *via positiva*. It discussed some of the most relevant contributions, in English, to the study of energy in the perspectives of social sciences and humanities. The previous chapter sketched the contours of an ecocentric philosophy of energy. That serves, in this final chapter, as the basis for developing some practical consequences of an ecocentric understanding of energy.

Overall, we can now appreciate how environmental philosophy, energy humanities, and especially an ecocentric philosophy of energy can provide foundations for the development of energy ethics. To contribute in this direction, I outline a normative ethical framework – an *eco-centric energy ethic* – that represents the applied level of the ecocentric philosophy of energy. My proposal is that such an ethic can enhance strong sustainability, here conceived as the programmatic idea of socio-political assemblages whose policies emphasize the ecological dimension over the economic one. This energy ethic is based on a sort of "art of balancing" between normativity, physics and energy engineering, ecological knowledge, and policy making.

[48] A substantive part of this chapter is also published as: Giovanni Frigo, 2018b. "The Energy Ethics and Strong Sustainability: Outlining Key Principles for A Moral Compass." In *Strongly Sustainable Societies: Organizing Human Activities on a Hot and Full Earth*, edited by Karl J. Bonnedahl and Heikkurinen Pasi. London - New York: Routledge. Copyright retained by the author.

It is based on interdisciplinary evidence and can provide moral guidance to energy practitioners (energy users, educators, policy makers, politicians) through essential principles to inform subjective deliberations (private choices) as much as public education and policy. The framework promotes a value-laden series of principles, that is a flexible yet precise “moral compass” to evaluate the morality of energy choices, practices, policies, infrastructures, and technologies. These can be analyzed through the conceptual “sifter” of an energy ethic, showing which of them comply and are coherent with the principles of the normative framework.

I am aware of the risks of what I am proposing. More knowledge is not going to help changing the problematic trajectory on which we are marching as humanity. However, what I advocate in this project is not an increment of knowledge, but rather a change of perspective that can stimulate more people to adopt an ecocentric mentality, or at least an not-only-anthropocentric one. In his “Enlightened Doomsaying and the Concern for the Future” (2014), Jean-Pierre Dupuy aptly provides the kind of approach I would like to suggest here:

> Our responsibility is all the more enormous as we are the sole cause of what will happen to us. And yet there is a danger that our sense of our own responsibility will increase, rather than diminish, the very arrogance that gave rise to it. Once we have persuaded ourselves that the salvation of the world is in our hands, there is a risk we will throw ourselves with renewed energy into a headlong rush toward the abyss – that fatal impulse compounded of pride and panic, which with every passing day comes nearer to being the outstanding emblems of our age. (p. 7)

The following reflections are primarily directed to energy researchers, practitioners and policy makers who are operating within the energy paradigm and are willing to envision an ecologically sustainable and just energy transition.

6.1 The Foundations of the Energy Ethic

I have already mentioned that an ecologically meaningful and socially just energy transition depends on humans' ability to move toward sustainable energy production, distribution, and consumption. This is why systemic and infrastructural challenges concerning energy require innovative reflections also on the ontological, moral, religious, gendered, socio-economic, political, linguistic, and cultural dimensions of energy (Szeman 2016). They require humans to (re)think, (re)define, and (re)negotiate the meanings and nuances of pivotal concepts that have ethical and philosophical components (Smil 2010b; Stolten & Scherer 2013; O'Connor & Cleveland 2014).

The energy ethic proposed here is *normative* in that it suggests guidelines for moral conduct of how individuals, groups, and organizations think and act assuming the goal of strong sustainability. It is *non-systematic* – it does not constitute a system of ethics in the traditional sense of the term (e.g. Hegelian or Kantian ethics) – and remains open to change. The energy ethic is *dynamic,* and adaptability is one of its key features. The energy ethic is *radical* in calling on humans to act in accordance with the moral compass, changing their actions when they conflict with its principles. Because it suggests an ecocentric approach toward nonhuman beings and a special concern for future generations of all beings, it requires a drastic re-orientation of some of the most basic metaphysical assumptions at the core of Western modern culture. Finally, the energy ethic can be *pluralist* in the sense that different cultures and human groups could, in principle, reach similar practical consequences – aligning with the principle of its moral compass – but grounding them on different metaphysical and cultural premises (unless a specific system of beliefs conflicts).

For the sake of conciseness, I now analyze a few key aspects within five areas of human knowledge that are especially useful to inform the normative content of an energy ethic, as outlined in table 6.1: (1) thermodynamics and energy engineering; (2) ecological sciences; (3)

climate change science; (4) energy justice; and (5) environmental philosophy and ethics.

Area of Human Knowledge	Insight(s)	Principle(s)	Example(s)
Physics (Thermodynamics) & Engineering	Natural intrinsic limitations which are human independent. Energy machines and artefacts have efficiency limits	*Acceptance of Limitations and Thresholds within Eco-Physical Systems*	1) Laws of Thermodynamics 2) 59.3% Betz Law of wind turbines 3) Average efficiency of internal combustion engine is around 20%
Ecological Sciences	Some organisms do not only compete but show cooperative dynamics Symbiosis and co-evolution	*Cooperation*	1) Co-operation and Co-evolution: groups of organisms 'work' together for common or mutual benefits such as commensalism 2) Inter-plant cooperation through mycorrhizal networks 3) Inter-specific cooperation between individuals
Climate Change Science	Climate change is a global, trans-boundary problem which requires local action	*Collective Glocal Concern*	1) Transboundary forms of pollution (air and water) 2) Global warming and rising sea levels
Energy Justice Studies	Some individuals/human groups bear the burdens of energy projects disproportionately	*Transparency and Informed Participation*	1) Energy extraction, infrastructures and systems impact some humans unjustly 2) Energy access, energy poverty
Environmental Philosophy and Ethics	Non-anthropocentric views of nature Inter-temporal and spatial responsibility	*Eco-centrism and Intrinsic/Inherent Value* *Responsibility towards future generations of beings*	1) Bio-centric and eco-centric formulations 2) Recognition of intrinsic/inherent values in non-human biotic and abiotic beings

Table 6.1: Five areas of knowledge which inform the fundamental principles of the energy ethic. Source: Frigo 2018b..

Deriving ethical consequences from different areas of knowledge may be seen like a deterministic leap and incur in what has been described as the is/ought dichotomy. My counterargument, however, is that it is urgent and important to recognize and bring to the fore of the ethical and policy discussions the insights which appear sometimes taken for granted within a specific discipline, or whose moral consequences have not been completely and explicitly derived. The choice of presenting contributions from both natural sciences and social sciences as well as humanities aims at challenging rigid disciplinary boundaries, without compromising epistemological autonomy.

6.2 Thermodynamics and Energy Engineering

The natural sciences explain that there are planetary eco-physical limits which cannot, at least currently, be overcome. On a more practical level, engineering tells us that, for example, the ideal efficiency of a wind turbine cannot transform more than 16/27 (59.3%) of the kinetic energy of the wind, a limit that is known as the Betz Law. A common gasoline combustion engine averages around 20% in terms of thermal efficiency and plants' photosynthetic efficiency is typically between 3% to 6% of total solar radiation (Crawley 2013). Thermodynamics studies the relationships between heat and different types of energy (electrical, mechanical, chemical and so forth). It starts from several key concepts: a defined system (either isolated, closed or open) with identifiable boundaries, properties of the system (intensive/extensive, independent/interdependent), and state of a system (the characterization of a system at an instant in time). Leaving aside the ideal case of isolated systems, thermodynamics explains that closed systems such as planet Earth exchange only energy but not (significant) amounts of matter with their surroundings. An open system, such as the human body, can exchange both matter and energy with its surroundings. The key fact is that the overall quantity of exergy (i.e. energy available to be used) is always decreasing in both systems. Conversely the entropy of both systems necessarily tends to augment spontaneously, that is to say the processes are irreversible unless more energy is put into the system (Bejan 2006; Bakshi et al. 2011).

Two major attempts to apply the laws of thermodynamics to sustainability-related fields - biological systems and economics respectively - have been carried out by scholars such as Sven E. Jørgensen and Nicholas Georgescu-Roegen. Moving from the assumption that thermodynamics is a holistic science, also well suited to describe complex systems such as ecosystems, Jørgensen has developed a series of studies aimed at modelling ecological functioning according to the laws of thermodynamics. An important starting point in his chapter *A Tentative Fourth Law of Thermodynamics* is that since 'ecosystems are operating far from thermodynamic equilibrium the Second Law of Thermodynamics is not violated, because the amount of exergy received from the solar radiation is less than or equal to the amount of exergy dissipated to the environment as heat, which corresponds to the exergy utilized for maintenance of the ecosystem' (Jørgensen 2001). In a more recent paper, entitled *Ecosystem Services, Sustainability and Thermodynamic Indicators* (2010), Jørgensen states that it is possible to 'calculate the ecosystem services by use of eco-exergy or the work capacity of the ecosystems' (p. 313). Themodynamics applied to ecological systems seems to suggest that there are eco-physical limitations and thresholds which consititue intrinsic natural limitations.

One of the first scholars to point out that the laws of thermodynamics have direct economic implication (as well as moral ones, I may add) was Romanian economist and statistician Nicholas Georgescu-Roegen, whose work has been foundational for the development of bioeconomics. In books such as *The Entropy Law and the Economic Process,* Georgescu-Roegen (1971) proposed that economics must take into account the Second Law - the progressive decrease in the capacity of matter to produce work - and overall the recognition that over time low-entropy matter ceases to exist in the form that is useful for human purposes.

Interestingly, the most insightful attempts to further explore this topic have been economists interested in providing a comprehensive account of the relationships between ecology, economics and thermodynamics. Robert U. Ayres, for instance, affirms in his *Eco-thermodynamics: Economics and the Second Law* (1998) that the significance of the Second Law is that since exergy inputs are always bigger than outputs, it should be accounted for in the economic process as much as other factors of production such as labour or capital. Since "all mass extracted from the earth's crust must either be added to anthropogenic stocks (e.g. durable goods and structures) or eventually discarded as wastes […] the goal of 'zero emissions' that is often proposed by environmentalists is physically impossible" (p. 194). Ayers then states that the only feasible attempt is that of reducing the overall consumption of materials (mass) and that of recycling as much as possible: "the importance of the second law of thermodynamics for engineering economics is that it specifies precise conditions that must be satisfied by all physical processes. […] Hence economic models […] should explicitly reflect these constraints" (p. 200).

But what does all this mean for the energy ethic and for strong sustainability in general? I propose here that natural sciences, mechanical and energy engineering, and their related applications to economics theories, can inform energy ethic by suggesting the existence of eco-physical limits and efficiency thresholds, thus providing the *principles of acceptance of limitations and thresholds within eco-physical systems.* I suggest that humans should learn to see limits in a positive light, and not as a privation of liberties. In terms of policy and design, this means that policy-makers and engineers of artifacts and infrastructures should take more radically into account these limitations avoiding, for instance, not only the unnecessary waste of materials but also the production of artifacts that, for instance, favour programmed obsolescence or do not meet the highest possible efficiency. These insights bear also an existential lesson on the possible moral benefit of a more frugal lifestyle, in which materialism *per se* does not constitute the ultimate goal of human life.

In conclusion, even though thermodynamics strictly remains within the boundaries of the traditional energy paradigm, it can "teach" energy ethic that the amount of matter able to perform work is limited on planet Earth, and that the entropy of a close system such as our planet is continuously increasing. The moral implications appear obvious: humans need to comply with these limitations and work toward higher energy efficiency as well as decreases in consumption or even degrowth. An interesting counterargument may come from theorists of economic de-coupling who, generally, affirm that it is possible to sustain GDP growth without having a negative impact on the environment (Caine et al. 2014; Asafu-Adjaye et al. 2015). Even though this and similar arguments, such as the famous environmental version of the Kuznets curve, constitute serious objections to my claim, they still fail to consider, and hence to overcome the intrinsic physical limitations of ecosystems on a finite Earth such as the scarcity of land.

6.3 Ecological Sciences

Ecologically, it is easy to recognize that all sources of either fuels or materials which have allowed human civilizations to flourish and expand come from a planet that is limited. It is also evident that a multitude of beings (plants and animals) and geochemical compounds are part of complex ecosystems which possess limitations, and which functions depend on thresholds. Of course, different ecosystems have various degrees of resistance and resilience, but once specific threshold have been surpassed, the likelihood that the system will recover becomes unlikely.

Indeed, as Bergandi et al. (2013) have convincingly demonstrated, there are fundamental links between ecology, evolution and ethics. Despite the giant challenge of measuring energy fluxes in nature, the contemporary mainstream scientific approach of ecological sciences has been largely influenced by both thermodynamics and complex systems theory (Jørgensen et al. 2005; Jørgensen and Fath 2004; Jørgensen 2001; 2010). The study of energy in biological and ecological sciences is, at its core, an application of physics and chemistry analyses to modelling. In ecology, energy has been mainly understood as the solar-dependent fluxes of matter that circulate in ecosystems. For example, the former study of energy cycles or pyramids, and the more recent research on food webs attempt to quantify the amount of nutrients fluctuating across ecosystems, and cascading among the different trophic levels (plants, animals, fungi). Here I want to stress that ecology informs energy ethic in two main directions.

First, ecology teaches humans that they are inter-connected with the ecosystems that they inhabit. Barry Commoner's first law of ecology - everything is connected to everything else - and the first law of thermodynamics – the total inflow of energy into a system must equal the total outflow of energy from the system, plus the change in the energy contained within the system – provide physical limitations that should be taken seriously into account in any debate about sustainability. After all, and similarly to most animals, humans host a huge quantity of bacteria in their guts and on their skin. The very existence of these essential organisms challenges the old ontological assumption of a human-animal or human-nature dichotomy (J Baird Callicott 2013). Another example of a closer connection between ecological research and moral thinking can be found in the work of Aldo Leopold. In his famous essay *The Land Ethic*, Leopold beautifully wrote, "land, then, is not merely soil; it is a fountain of energy flowing through circuit of soils, plants, and animals. Food chains are the living channels which conduct energy upward; death and decay return it to the soil. […] It is a sustained circuit, like a slowly augmented revolving fund of life" (p. 187). Leopold's work highlights that the understanding of ecology can inform that of ethics, and that humans as a species need to reconsider their position in nature, embracing their role as a part of the biotic community. Ecology stresses that energy fluxes within ecosystems ultimately depend on the life of primary producers which, through photosynthesis, create the initial steps of the food chain. In this sense, it also teaches the values of limits, thresholds, and therefore possible moral boundaries comparable to those suggested by thermodynamics in the previous section.

Second, ecological sciences are improving the understanding of mutualistic relationships such as symbiosis. Important findings, especially with regards to plants communities, fungi and bacteria, suggest that there are cases in which inter- and intra-species cooperation and co-evolution functions as major driver in ecosystem dynamics. If we consider plants, for instance, relevant studies are provided by complex adaptive systems ecology. Gorzelak et al. (2015), for instance, suggest that some plants display adaptive behaviours consisting in rapid physiological changes, gene regulations and defence responses which "can be altered when linked to neighbouring plants by a mycorrhizal network (MN)." These mechanism "include mycorrhizal fungal colonization by the MN or interplant communication via transfer of nutrients, defence signals or allelochemicals [chemicals produced by living organisms that negatively affect other species]." Hence, Gorzelak et al. suggest the hypothesis that 'underground "tree talk" as "a foundational process in the complex adaptive nature of forest ecosystems." By studying the interactions between tall trees, Klein et al. (2016) have shown that often it is not competition for resources that drives "tree-to-tree interaction in forests: [because] trees may interact in more complex ways, including substantial carbon exchange." Besides plant communities, many animal populations (especially social mammals) seem to also display cooperative behaviours in their struggle for survivorship, evident in communal hunting tactics or parenting. These findings suggest that there are cooperative ways in which some species exchange chemicals, which may imply co-evolution and interspecific cooperation as opposed to competition-based processes.

In conclusion, ecological sciences suggest that many species tend to cooperate instead of constantly competing. Both J.B. Callicott and B. M. H. Larson have pointed out that ecology has had so far a decided emphasis on studies of competition as opposed to cooperation, thus showing both the influence of economic theories on the discipline (Rozzi et al. 2013) and the preference for studying vertebrates (a human bias) over more dissimilar species such as mushrooms and bacteria. This is not to say that competition is not a major driver of ecological functioning, but that there may be a lesson to learn from other living beings. These insights can inform the energy ethic through the *principle of cooperation*.

6.4 Climate Change Science

Since humans are both the main cause and one of the victims of global climate change, climate science advises on the *principle of collective glocal concern*, that is a preoccupation for global problems from a local perspective. As Gardiner & Hartzell-Nichols (2012) have underlined, climate change is a challenge that can inform ethical action. Despite some degree of public debate on whether climate change is happening or not, the vast majority of climate and environmental scientists and engineers agree on the fact that due to the massive production and release in the atmosphere of greenhouse gases (GHG), humans have been altering fragile planetary equilibria which influence climate, weather, temperatures, air and oceanic cycles at a planetary level. From the perspectives of moral philosophy this gigantic challenge presents also some uplifting teachings. For instance, J. Baird Callicott (2011) has questioned the effectiveness of individualistic action in the context of climate change movement. He suggested that socio-political and economic transformations should be a collective effort that starts from educational settings and inform economic and socio-political spheres of interest. Moreover, since the scale of climate change is planetary and transboundary – as air and water pollution do not respect countries' borders - climate change science recommends that climate actions be glocal. This means that global problems necessarily need to be addressed through local, situated moral practices and especially take place within educational institutions worldwide. The energy ethic should take this into account by aligning itself with the *principle of collective glocal concern* for energy issues as they obviously strongly relate to climatic change.

6.5 Energy Justice Studies

The distribution of resources, populations and climatic conditions varies drastically throughout the world. This situation has produced energy injustices on local and global scales often affecting the poorest and most vulnerable nation (Sovacool & Drupady 2012; Healy & Barry 2017). Increasing tensions among different actors have been leading to conflicts and even wars for the appropriation of energy and natural resources, from fossil fuels to water. These are some of the most important reasons why there is room and demand for an ethical engagement with the theme of energy justice (Sovacool 2013). While many investments and efforts are being spent on technologies and infrastructures, less attention has been given to the inequalities among humans and what can be called the injustices between humans and other sentient beings.

Energy justice is an area of enquiry emerged recently at the crossroads of environmental and energy humanities and social sciences. In a way, energy justice is similar to environmental justice, but it concentrates more specifically on controversial energy projects and overall access and distribution of energy sources. As Kristen Jenkins et al. (2016) have clarified “energy justice is a new crosscutting social science research agenda which seeks to apply justice principles to energy policy, energy production and systems, energy consumption, energy activism, energy security and climate change.” Bickerstaff at al. (2013) underline that the current key concerns within energy justice emerge in the context of energy transition. Issues such as fuel poverty or energy under-consumption, energy vulnerability and the politics of consumption are interrelated factors which are at the core of the notion of energy justice. By looking at energy transition in the US Finley-Brook & Holloman (2016) argue that a just energy transition does not only depend on adequate policies to mitigate injustices, but also concrete implementation: “energy justice requires not only ending disproportionate harm, it also entails involvement in the design of solutions and fair distribution of benefits, such as green jobs and clean air.” This means that energy justice should be also seen as the pro-active realization of the transition. A comprehensive treatment of ethics and energy is that of Sovacool and Dworkin (2015) who suggest a pluralist framework made of Kantianism, utilitarianism, welfare, capabilities theory and libertarian elements of freedom and choice. Noting the failures of procedural justice, they propose that we should preventively concentrate on a fourth type of justice, recognition, that they envision as a remedy to both discrimination and marginalization. Finally, Jenkins et al. (2016) provide a timely conceptual review of the most relevant literature on energy justice and describe distributional, recognition and procedural as the key categories in the current debate.

Several energy projects have indeed raised issues of justice, most of which depended on the lack of recognition, communication, and participation of all stakeholders in the policy-process and in the design of infrastructures and devices. Meantime, energy justice research suggests a pragmatic approach with a focus on specific moral agents: the different stakeholders in any energy project and/or policy, that is anyone who is affected. Since many stakeholders are not yet consistently and rightfully taking part in the policymaking processes, the principles to be derived are those of *transparency* and *informed participation* which would require all informed stakeholders in an energy project to be heard, and their opinion to be taken seriously into account. A step further would consist in their concrete representation in institutional settings as the key prerequisite for a radical redistribution of power and authority.

6.6 Environmental Philosophy and Ethics

Embracing an ecocentric ethic we can say with Aldo Leopold (1949) that humans, nonhuman animals and countless other biotic and abiotic beings co-inhabit shared environments, all transforming matter and materials which are ultimately limited and can be found heterogeneously across the Earth, with the exception of solar radiation. In this sense, the following pages expand on the realization that achieving an ecologically sound and inter-temporal just energy transition is necessarily dependent on a holistic and ecocentric approach.

Environmental philosophy and ethics can contribute to the energy ethic with two main principles. The first one is the possibility of thinking about energy and the environment from a non-anthropocentric perspective. Even though it is epistemologically impossible to step outside of our humanity - all human activities are necessarily anthropogenic - some types of environmental philosophy (i.e. animal ethics, biocentrism, ecocentrism, deep ecology) have put forward ground-breaking options for thinking about the human-nature relationships in alternative ways. Thus, ecocentric ethics can contribute with the *principles of non-anthropocentric attitudes toward nature and the recognition of intrinsic/inherent value.* Energy ethic must move from the acknowledgement that anthropocentric perspectives which have dominated over centuries especially in Western civilizations are at their roots problematic. By positioning themselves on the top of the chain of being, as the dominators, guardians, or perfectors of nature, the approach of some human beings toward the rest of nature has been, ecologically speaking, short-sighted if not even suicidal. If ecology invites energy ethic to embrace a more foresighted and less arrogant attitude, ecocentric environmental ethics (Rolston 2013; J. Barid Callicott 2013) challenges humans to do a metaphysical leap and a conceptual re-orientation of the anthropocentric hubris that has ruled the discussion about energy and nature so far.

The second element that environmental philosophy can contribute to the energy ethic concerns the theme of obligations toward future beings (temporal) as well as toward present but distant ones (geographical). The latter has to do with the spatiality of human responsibility and as such it has essentially been covered in the section about energy justice. An interesting example of the former approach is Peter S. Wenz's paper *Ethics, Energy, Policy, and Future Generations*, which explores the intertemporal dimension of an ethical approach to energy policy. Wenz moves from the fact that 'conflicts can arise between energy policies pursued to enhance or maintain the life style of present people and the needs of future people for environmental and social conditions conducive to human well-being' (Wenz 1983). The foresightedness dimension of sustainability - temporal inter-generational concern for future beings - may be paired with the recognition that historical disparities of power have led to unfair access and distribution of sources of energy. The energy ethic, in other terms, needs to find a practical balance between temporal and geographical scales by looking responsibly at both present and future times, and at local and distant beings situated in diverse places exactly because energy and matter exist also for other beings whose lives are all interconnected. Environmental philosophy contributes to the characterization of the energy ethic in another essential way by providing (and expanding in an ecocentric way) the *principle of responsibility toward future generations of all beings*. Ecocentric perspectives can expand the predominant conceptualisation of energy to include metaphysical ecocentric accounts such as pantheism or vitalism to enlarge the boundaries of the traditional energy paradigm criticized earlier.

6.7 Conclusion: Some Policy Implications of the Energy Ethic

Against the background of an energy ethic, it is useful to highlight some possible implications for a hotter and fuller planet. Going back to the interconnected theme of energy transition, the main task of the energy ethic is to reflect on the normative moral priorities of an informed group of stakeholders and then individuate common goals, which are coherent and reasonable with conditions of inter-human, inter-species, and ecosystemic justice and well-being, as well as thermodynamic limits and ecological thresholds. Practically, the energy ethic can be seen as a "sifter" (or a mesh strainer) capable of evaluating the moral worth of the different components of an energy system (infrastructures, technologies, policies, actions). If a policy maker is to analyse a policy, or an engineer is developing an energy technology, they could, in principle, be able to evaluate whether they are compatible and coherent with the principles of the energy ethic by passing their public policies or artifacts through the 'net' of the energy ethic.

Among several possible implications of the energy ethic, here I concentrate on the possible meaning, effects, and impact that the adoption of an energy ethic would realistically have for education and policy. Other implications that I do not discuss are population policy and thresholds in energy consumption, both of which should be voluntary and based on adequate education rather than coercion.

On the one hand, all energy practitioners, but especially energy engineers, companies'

CEOs, energy workers, and policy makers should be more educated about the morality of artifacts as part of their curricular training. These professionals will need to eventually recognize that the design of devices and systems implies and encapsulates ideas and values. The claim can even be bolder and purport to achieve a more radical institutional change: the school systems at all levels might set up educational programs focused on energy education, so that younger generation would become familiar, knowledgeable and sensitive to the origin of the energies and materials that are flowing so quickly through their lives. If, for example the principles of energy ethic were to be taught in schools as part of basic environmental education, they would eventually become a cultural norm, as much as consumption became one through other means and pathways.

On the other hand, policymaking that coheres with the energy ethic would have similar ground-breaking practical consequences. If a proposed energy project, for instance an oil pipeline, contrasts with one or more of the principles of the energy ethic, then the construction should not proceed until the conditions which satisfy those requirements are reached. The case of an oil pipeline is of course emblematic because given the current technologies and practices, it would not pass the 'moral test' of the energy ethic. This means that what should be evaluated, apart from mere technical features such as being functioning, convenient, feasible, efficient and so forth are the moral requirements of, for instance, justice, transparency, informed participation, and concern for future generations of all beings. In all those cases where the different perspectives of the stakeholders contradict each other, and no agreement is possible, or where the choice, project or technology violate one or more principles, the precautionary principle (UNCED 1992; Dupuy 2012; Sandin 2004; Kriebel et al. 2001; Cooney 2004; COMEST 2005; DeFur and Kaszuba 2002) should be used, and the project stopped. Continuing energy education and developing energy policies compatible with the principles of the energy ethic imply that those institutions and social actors that are willing to promote energy transition in accordance with the energy ethic should be subsidized more. At the same time the institutions and projects which do not meet these requirements should not be supported any longer, discouraged with fees and taxes, and be progressively shut down. As it should be now clear, following the energy ethic implies some radical reorientations of long-standing cultural and theoretical assumptions as well as many features of the built environment, but remains a feasible task for the near future.

In terms of practical consequences, the energy ethic has the potential to help humans determine the energy consumption limits or the better allocation of resources that are compatible with both ecological limitations and subjective and social flourishment. This would be a practical way to resolve what Wendell Barry has called "the fantasy of limitlessness" (Szeman and GAPSSHRC 2016). Following the seminal work of Ivan Illich and Vaclav Smil, there exist identifiable thresholds after which further increase of energy consumption happen at the expenses of other socially important values such as equity and justice. Self-determined but reasonable boundaries in energy consumption may promote, rather than limit, individuals' and family's blooming in terms of well-being and existential fulfillment.

The most challenging of all socio-political and policy-related consequences of the energy ethic has probably to do with human population growth. If both the ecocentric philosophy of energy and the moral framework of energy ethic are to be taken seriously, humans must envision ways to stabilize, and eventually decrease their numbers. The most surprising thing is that this topic is almost taboo in current energy debates and is delegated to either utopian (ecomodernist) or dystopian (catastrophist) narratives. Limiting human reproduction is of course a very delicate theme that can derail in outrageous ways. Nevertheless, I think that it is time for invasive humans to reflect on the trajectory of human population growth in relation to energy, environmental degradation, and interspecies justice. A possible remedy, or a way to think about such hostile topic in ways similar to other environmental issues, is that of incentives and penalties. In many countries, governments still promote larger families with subsidies or tax-breaks but do not benefit couples that decide to limit their offspring to two or less. If the contrary would be implemented, along with better education and sexual awareness, global human population growth would slow and perhaps decrease. Of course, there are obvious risks of elitism and financial differences connected to this proposal, but the theme of human population reduction is a practical conundrum worth investigating more fully.

In conclusion, we need to pause and reflect on the moral meaning of strongly sustainable societies on a hot and full Earth by questioning the concrete reality of current energy transition and the problematic character of contemporary energivorous lifestyles. I challenged the monopoly of the natural sciences and engineering in talking about energy and provided alternative accounts emerging in the social sciences, humanities, and environmental philosophy. This essay sketched the contours of the energy ethic. Normatively, the energy ethic strongly depends on the findings and insights of other disciplines to derive the possible moral consequences of efficiencies' thresholds, resources scarcity, and similar theoretical and practical insights provided by the very structure and functioning of nature, or by what is socially and politically acceptable. The main goal of an ecocentric energy ethic is to expand our theoretical reflection and our moral concern beyond anthropocentrism, recognizing that the ever-lasting questions about the good life are as much entangled with an ecologically sound energy transition as they are dependent on the health of other species and ecosystems.

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