Energy

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Energy is central to everyday life and industrial production, and is a major concern and focus of public policy. Its production from different sources, its use, and the societal and climatic consequences of energy systems have increased the attention paid to energy in recent years. Energy anthropology provides an in-depth understanding of the social, cultural, and ecological implications of extractivism for energy consumption and of the introduction or transformation of energy systems. Energy anthropology considers resource materialities, infrastructure, institutions, ethics, political power, beliefs, habits, and truth claims involved in energy production, distribution, and consumption. Concepts such as 'energopower', energy ethics, and cultures of energy allow us to make sense of the lived realities and cultural understandings involved in energy transition efforts. They recognise that energy is simultaneously personal, collective, and political. They also emphasise that energy transitions are both a climate-political imperative and essentially socio-cultural processes.

Introduction

Energy is what enables life on earth. We all depend on the energy the sun is providing, enabling photosynthesis and therefore plant growth, which animals and human beings feed upon. The intake of energy by animals and humans, measured in joules or in calories, determines the work they can carry out, and hence influences all forms of production, from agricultural to cultural. This omnipotence and importance of energy led, in the middle of the twentieth century, to an argument for a cultural anthropological analysis of energy:

> Everything in the universe may be described in terms of energy. Galaxies, stars, molecules and atoms may be regarded as organizations of energy. Living organisms may be looked upon as engines which operate by means of energy derived directly or indirectly from the sun. The civilizations, or cultures of mankind, also, may be regarded as a form or organization of energy [...] Cultural anthropology is that branch of natural science which deals with matter-and-motion, i.e., energy, phenomena in cultural form, as biology deals with them in cellular, and physics in atomic, form. (White 1943, 335)

This thinking laid the foundation for anthropology as a discipline to engage with energy. Anthropology has been analysing energy in relation to societies and culture, norms and values, changes and transitions. Anthropologists often think of energy systems as socio-technical intertwinements of resource extractivism, electricity and fuel, infrastructure, institutions, as well as ethics, political power, and beliefs, all of which are situated in the environment and the planetary condition. In physics, energy transformed into applied force equals work; energy can neither be produced nor destroyed, only transformed from one form into another. However, in everyday life (as well as in economics and anthropology), we use the term 'energy' with regards to something that can be used and used up: empty batteries are a common phenomenon and so are power cuts, fuel price hikes, empty gas stations, heat poverty, or oil wars. Anthropologists have addressed this experienced reality of energy along all parts of its life cycle, examining, for example, fuel and electricity in regards to their production, transmission, and consumption.

Power and politics

The lived realities of energy systems show that 'energy is, at once, personal, collective and political, an experienced reality and a total social fact' (Coleman 2021, 181). Electricity and fuel have become relevant to individual well-being and progress, social arrangements, and industrial and economic development. Electricity's invisibility allows for its flow to be taken for granted, yet the establishment, maintenance, and transformation of energy systems are highly politicised issues, where the word 'power' can be deployed in two senses. One concept used to politically frame energy systems—across production, transmission, and consumption—is that of 'energopower' (Boyer 2014). This term refers to both the political and energetic dimensions of a phenomenon and implies rethinking political power through the analysis of electricity and fuel (Boyer 2014, 325; Loloum, Abram and Ortar 2021). Energopower is related to Michel Foucault's idea of 'biopower', in that it is a mode of controlling and subjugating large numbers of bodies and populations in various aspects of their lives (1981). Conversely, anthropologists have also examined how control over energy becomes an essential part of, if not a precondition for, control over people.

The coal miners' strikes that occurred in Europe and North America at the end of the nineteenth and the beginning of the twentieth centuries are an historic example. Mining companies, with the help of state police, tried to subdue coal miners' fights for better working conditions, but the miners continued the strike and challenged the state's authoritarian control over energy supply. In effect, the strikes became an essential contributing factor for the formation of worker's unions in Europe and Northern America and for democratic participation in state formations (Mitchell 2011). This energy workforce co-determined labour conditions, ideas of the welfare state, notions of private and public ownership, economic systems, and political formations, among other things. Oil drilling, as a contrasting example, did not have the same political effects. Its decentralised infrastructure and a minimised workforce with little ability to organise, along with the fluidity and flexibility involved in bypassing and detouring oil tankers, proved less suitable in helping to form democracies. We can hence talk of 'carbon democracies' as ones that are influenced or even formed by the way carbon, in its physical structure and materiality, has been drilled, mined, transported, sold, or used. Thus, the concept of energopower allows us to see the various energy-related materialities, transformation processes, discourses, and truth claims as socio-political phenomena, where

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the power to influence or control events or people serves as a critical factor for the formation of both energy and political systems.

A second, closely related concept to make sense of the political nature of energy is 'energopolitics', denoting the various ways in which this power is applied and operates. Thinking of energy systems as energopolitics allows us to re-politicise energy systems, rather than taking for granted their historically evolved material infrastructure and physico-chemical aspects. Turning attention to energopolitics sheds light not only on critical issues of energy systems, but also on its rough edges and sometimes highly violent forms: energy systems can lead to the murder of activists and system opponents or to the creation of 'sacrifice zones' that make life unbearable or impossible (Kaur 2021). Politicisation in the form of increased attention and control over energy has occurred whenever energy provision or energy prices were in turmoil. The global oil price crises in the 1970s have led to an increased investigation into energy systems, with a strong stance in anthropology for the voices of Indigenous and other communities affected by energy production to be included (see Rogers 2015, 366). The nuclear armament and reactor dismantling of the 1980s and 1990s, the US war for oil in Iraq, and more recent climate change discourse have contributed to a re-politicisation of energy systems, as did the Russian war on Ukraine and the subsequent rise in European energy prices in 2022.

These energy price crises demonstrate distinctly that there is a nexus between state, energy, and economics. Oil is a prime example: The capital accumulation based on extraction, distribution, and consumption of petroleum, called 'petrocapitalism', has been shaping economies as well as political institutions. In the US, for example, big oil companies like John D. Rockefeller's Standard Oil Company used money made from oil to monopolise industrial organisation. Here, petrocapitalism comprises corporate economic power, intertwined with political power, as well as their impact on the patterns of ordinary life: gasoline and plastic are common products for mobility, consumption, and comfort, and their ubiquity shape understandings of freedom, security, and national pride (Huber 2013). Like petroleum, other forms of fossil fuels also co-shape capitalist logics. Extractive capitalism, which accumulates fossil capital and uses it for political ends (Malm 2016), relies on 'nature's free gifts', which are commoditised and used as cheap energy. Extractive capitalism focuses on creating surplus value based on exploiting natural resources and human labour. In the process, it pays less attention to (often externalised) costs such as deforestation, greenhouse gas emissions, workforce exploitation, or environmental degradation (Moore 2015; Degani et al. 2020). The accumulated fossil capital is one basis for today's financial markets that have an extraordinary power of their own. The oil market, for example, is increasingly detached from the actual circulation of oil. Rather, it has turned into a financial instrument for investments and profits (Labban 2010), with its own financial narratives to determine future extraction of fossil fuel deposits (Field 2022). Renewable energy has become enveloped into this market. Examples are fossil capital, or 'petrodollars', used for building complete 'green' cities like Masdar in the desert of Abu Dhabi (Günel 2019;

Koch 2022), green bonds (Bracking et al. 2023), or fossil fuel divestment (Langley et al. 2021).

Energy transitions and conflict

Paying attention to the financial aspects of renewable energy production is not least a consequence of climatisation, i.e. the spillover process of climate issues and concerns into international negotiations as well as into wider society (Aykut et al. 2019; Müller et al. 2024). Protecting the climate and trying to keep global warming well below 2°C[1] requires transitioning from fossil fuels to renewable energy. These new energy frontiers necessitate new fields of investment, but they also bring energy conflicts. Energy transitions from fossil fuels to renewable resources are but the latest example of how societies scrutinise the socio-technical, cultural, and politico-economical aspects of energy systems. The consequences and impacts of energy transitions have been subject to debate and contestation: What social and cultural impact does an innovation in or exit from an energy industry have? What will be the results of energy transitions for individuals, communities, and societies at large, including their political systems and financial dependencies? Are new energy frontiers and energy transitions predestined for energy conflicts between their beneficiaries and negatively affected parties (see Abram et al. 2023)? Energy conflicts may be driven by fundamental questions over the use or rejection of particular sources of energy. Yet, they can also comprise distributional conflicts, such as the question of who benefits from the financial rewards of energy projects. They may raise procedural questions, involving planning and decision-making processes, access to information, and opportunities for participation and transparency. Or they may raise locational and territorial issues around the use of land for energy projects, as well as questions of identity and belonging (Becker and Naumann 2018).

One widely used typology for the assessment of energy projects is the distinction between different principles of energy justice, which are often lacking in one or multiple forms (see e.g. Abram et al. 2023; Bickerstaff, Walker and Bulkeley 2013; Degani 2022). These principles include: energy availability, or having sufficient energy resources when needed; affordability, encompassing stable and equitable prices for energy use; due process, including stakeholder participation in energy policymaking and fair and informed consent; good governance, including transparency and accountability. Energy justice also comprises the principles of ecological sustainability; inter- and intra-generational equity in accessing energy; and the responsibility of nations towards societies and the natural environment, to minimise their energy systems' negative impacts (Sovacool and Dworkin 2015). Normative assumptions and European canons of value—Western philosophical ideas of virtue, reason, or equality—form the basis of this justice concept (Sovacool and Dworkin 2015).

Anthropologists have formulated energy ethics as an alternative conceptual framework to assess how just and equitable energy systems, and parts thereof, are (Smith and High 2017). Combining moral questions

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regarding justice and fairness with an anthropological tradition of taking emic perspectives seriously, energy ethics take into account the heterogeneity of energy as different people experience and conceptualise it. Energy ethics stress the way people judge energy's place in their lives, working with a bottom-up approach rather than a predefined moral canon. Energy ethics then aim to identify how people themselves evaluate the role energy plays for what they understand as the good life. This can comprise notions of justice, fairness, and equity but it can also go beyond them (Smith and High 2017). Renewable energy technology, for example, can involve different concepts of 'nature' that is to be protected, and a highly specific understanding of natural elements such as wind. Take the isthmus of Mexico as an example, where large-scale wind parks are being installed, transforming landscapes and income structures, providing benefits for landowners and often non-local wind park operators. Wind became a valuable energy resource in this stretch of land. The introduction of wind energy to the isthmus is consequently welcomed and highly regarded by some who see wind as an exchange of air due to heat differentials, and wind as a salvational object or a promissory force (Howe 2019, 25ff.). Yet, for others in the isthmus, wind is part of the local Zapotec cosmology and of the Indigenous traditions of communal land use. They see contemporary wind parks as problematic energy projects. Renewable energies have the potential to provide what is frequently ethically required and demanded in a climate-affected life: distributed models of social control of renewables as a public good (Goodman et al. forthcoming). But the practice of energy transitions also can spur displacement, disenfranchisement, and disenchantment, which lead people to contest renewables, thereby delaying energy transitions and further locking in fossil fuels (Goodman et al. forthcoming). Studying people's energy ethics, therefore, considers energy with the diverging values, paradigms, and expectations that people have in mind, as well as of the consequences of these systems (see e.g. Franquesa 2018; Boyer and Howe 2019).

Energy's meanings and materialities

Just as anthropology highlights the multiple meanings and evaluations of energy systems through an energy ethics framework, by focusing on cultures of energy, anthropology similarly looks into how energy is variously imagined, understood, used, and contested as a cultural entity (Strauss, Rupp and Love 2013). Acknowledging cultures of energy necessitates being open to different notions of what energy can actually mean, allowing an understanding of energy as a cultural artefact rather than a given universal truth. Energy and its various forms can be framed mythically and cosmologically, and they can be imagined as something political, magical, spiritual, social, or technical (Rupp 2013; Chapman 2013). People use energy in many ways, from animistic worship of sun, wind, and other energy sources, to fetishising commodities or machines (Strauss, Rupp and Love 2013, 12). Nuclear energy and its use as weapons, for example, are seen by peace-groups as anti-humanistic and mad, while engineers with a more technocratic view experience nuclear testing as professional rites of passage (Gusterson 1996). In hydropower and electric infrastructure, by contrast, we find heroism and sacrifice as cultural conceptions. Jahawarlal Nehru, the first Prime Minister of India, considered hydropower dams to be akin to the temples of modern India and inaugurated a vast canal irrigation system in 1954.[2] They can also be seen as a necessity, and the subsequent relocation they may demand as a sacrifice—as for people in Portugal, who understood large-scale dam projects in the second half of the twentieth century by drawing on Catholic norms of sacrifice (Küpers and Batel 2023). Another example of culturally-specific understandings of energy is embodied by the smokestack of an electric power plant in Vinh City, Vietnam, which turned into a mythical, heroic symbol for perseverance against US aggression (Schwenkel 2018, 103). After 1954, the reconstruction and development of Vietnam's electrical energy generation had turned into a post-colonial project. It signified emancipation from both colonial enslavement and assumed lack of enlightened thinking among the local population by colonisers. Unlike under colonial rule, electricity was to now be produced and provided for everyone, not only for colonial rulers—aligning with socialist ideas of social justice and freedom. The electric power plant with its smokestack in Vinh City came to symbolise both these ideas and a sense of technological advancement. Consequently, when the US war on Vietnam between 1964 and 1973 targeted the power plant and other critical infrastructure, workers repeatedly defended and repaired it.

> The postcolonial power plant that had signalled the nation's advance toward global socialism, now under the threat of imperialism, came to stand as a symbol of the resilience of the Vietnamese nation. (Schwenkel 2018)

Being but one example of what energy and its materialised infrastructure entails, there is, in consequence, no universal or stable concept for its meanings. Energy's meaning is, rather, subject to individual and collective understandings, framed by society, politics, and history.

Understanding energy as a more open concept, a vessel to be filled with meaning—see this entry's opening statement, that everything may be described in terms of energy—also allows for analyses that shift focus onto the concept of 'resource materialities' (Richardson and Weszkalnys 2014). The resource materialities approach stresses that resources come into being through human thought as well as human action involved in production, drilling, mining, and technical invention. Resource materialities are also held to be of a distributed and relational nature, co-constituted by people's ontologies and their knowledge about them, as well as by their infrastructure, and the ways people experience them (Richardson and Weszkalnys 2014). For example, uranium is 'provided' by nature and geology, but its chemical and physical structure alone do not make it an energy resource. It needs to be identified as a resource to become part of a technical process for energy production. It needs to be named, mined, scientifically analysed, and desired for exchange and use. Given that electricity and fuel are produced from energy sources, resource materialities as an approach amplifies energy's various forms and material transformations. It conceives of energy as an assemblage of resources, infrastructure, electrons, petrochemical compounds, human and non-human agency, concepts, and ideas. It thereby shows that human thought and action in interrelation with the

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physicality of resources co-determine the form that energy takes across space and time.

The consequences of energy's materialities can be severe, affecting human beings, flora, fauna, and geology. Objectifying and exploiting ecological, geological, and sociocultural worlds often go hand in hand (Bollig and Krause 2023), and environmental approaches to energy speak to the impact that resource extraction and further energy infrastructures have on their immediate surroundings. Industrial extraction projects can cause pollution and environmental degradation, and affect landscapes (Powell 2018). Coal mining causes pulmonary diseases and acidic rain; nuclear power production bears the risk of nuclear accidents and radiation contamination (Parkhill 2010; Powell 2018; Fortun and Morgan 2016). Upstream and downstream aspects of energy production heavily impact the environment too, albeit often in other regions and hence other immediate surroundings. For example, before generating wind energy, the copper, nickel, and rare earth metals mined for wind turbines are often tied in with the long history of vices and violence in mining (Jacka 2018). On the other end, the debris from dismantled power plants and infrastructure can remain on site or very close to it, as when radioactive waste is kept in former nuclear power plants and hence in the vicinity of former workers (Liubimau 2019) and thus continues to impact humans and non-humans alike.

In addition to energy-related accidents, devastation of regions, and pollution of air and rivers, energy's environmental impact is now also geo-environmental, threatening all species including the future of humanity (Howe 2019). We have come to call the planetary consequences of energy systems and human consumption in the current age 'the Anthropocene', or, when referring to the atmospheric impacts, 'climate change' or 'global warming'.

Forms and materialisations

The concepts and analytical lenses presented so far have evolved from detailed anthropological research on energy production, transmission, and consumption and on the ruptures and contestations that electricity and fuel have brought about. The sources of electricity and fuel have guided energy research for several decades. One example is oil, because 'for the better part of a century, petroleum has been the energy source of industrial capitalism' (Appel, Mason and Watts 2015, 9). Oil is tightly linked to global finance, but oil drilling is also a very localised, concentrated, and highly profitable form of extractivism. It raises hopes for prosperity and a better future (Weszkalnys 2016), but when it is drilled for, it often comes with conflicts over oil rents, i.e. culturally and politically determined struggles over profits and benefits (Reyna and Behrends 2008). Oil is a prime example of the 'resource curse', holding that countries rich in resources show less economic growth, get exploited, and tend to suffer from more corruption and political instability than those countries with few resources. Unpacking the resource curse in the context of oil, anthropologists have pointed out that prevailing modes of domination within a nation-state play a determining role in whether oil is experienced as a boon or a bane in countries such as Venezuela, Chad,

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Sudan, Norway, or the US (Behrends, Reyna and Schlee 2011). These comparisons of different countries and their use of violent and non-violent forms of allocating profit from oil show that there is no 'resource curse' or 'oil curse' per se.

Anthropology has also attended to the contestations around energy sources. In the 1940s and 1970s, these were predominantly economically and energy-security induced concerns. Contemporary arguments around oil and other fossil fuels have been emanating particularly with increased awareness about their impact on the climate. The potential end of oil drilling and the combustion of petroleum might be publicly demanded or contested, but is hard to execute. Norway, for example, could take a lead in a responsible exit from oil, but it produces arguably the 'cleanest oil', i.e. with less environmental impact, which remains a blessing to the state rather than a curse (Lautrup 2022). Oil drilling is the basis of the Norwegian welfare state. Hence, climate activists in Norway, who demand an exit from oil, contest local jobs and living standards as well as national values of prosperity and oil-as-welfare. Goodness for the nation might no longer be enough, given the global effects of burning fossil fuels (Lautrup 2022; see also Schöneich 2022). Historic trajectories continue to impact localised social structures as well as modes of trade and global economies, while at the same time new frontiers, such as fracking, are crossed (Rogers 2014).

Coal mining and combustion have been central to the Industrial Revolution and for regionalised mining communities for over more than one and a half centuries in several countries, laying the foundation for fossil capital (Malm 2016; Mitchell 2011). As part of a coal-development nexus, governments have wanted the resource extracted and combusted to 'develop' nations and their industries (Goodman et al. 2020). Coal mining induces incisions into the earth's surface as well as into social systems: it spurs the devastation of villages, the creation of new mining towns, dust, and the material pollution of the surroundings, and emits greenhouse gases as the single-largest source (Lewin 2017; Lahiri-Dutt 2014; Goodman et al. 2020). Yet, coal mining has also provided for a strong sense of community and coalition among workers, especially when done underground. With the comparatively large, but little-supervised, workforce required to mine it, and a place-based, easy-to-sabotage infrastructure, coal mining has historically contributed to union building and democratisation (Mitchell 2011). At the same time, the economisation of this resource extraction, i.e. the exploitation of nature and workforce at the lowest economic costs, has led to threats or actual abandonment of former mining communities and towns, while coal miners as a workforce continue to be exploited, often with little concern for their dignity, health, and life (Smith 2019; Lewin 2017; Ringel 2018). Coal and coal mines have turned out to variously be colonial death pits, creators of working classes, and symbols of nationalism, fostering militarisation, love for landscape, or a sense of belonging (e.g. Lahiri-Dutt 2014; Kikon 2019; Powell 2018; Morton and Müller 2016).

The lived realities of coal mining resemble those of mining minerals or stones, in that they are simultaneously highly exploitative and life-threatening, and engender conceptualisations of community and identity. As several countries are planning for and executing coal-mining phase outs, especially in Europe

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and Southeast Asia, they foster demands for just transitions as a form of energy justice. Coal exits provoke identity politics because coal has been providing employment and economic potential as well as shaping people's lives and cultural understandings. In the former German Democratic Republic, for example, brown coal was the prime energy source and in the 1980s the country was the world's leading brown coal producer. Mining engineers and mineworkers received the highest recognition; their work was essential for the country's economy. The state's establishment of a 'Day of the Miner and Energy' is but one expression of this appreciation (Müller 2017). However, the mineworkers' massive layoffs in the 1990s and the more contemporary coal exit invalidates this. These transitions consequently require individual and regional ethical, economic, and political realignments.

Mining minerals such as rare earths, iron, or copper is an important part of the construction of wind turbines and solar panels. Due to the location of mineral deposits and due to cost efficiency considerations (with companies aiming for low wages and low environmental standards), materials used in constructing wind turbines and solar panels are often mined in countries of the Global South. For example, Brazil is a major exporter for iron ore, as is China for rare earths, while Peru, Chile, and Brazil lead copper exports. Central contributions to energy anthropology, however, investigate predominantly the sites of installing and operating wind turbines and solar farms. Wind turbines in general have the advantage of co-existing with human activity. With rotor blades turning several metres above the ground, people can make use of fields, forests, or meadows underneath (Müller and Morton 2021). There are, however, two major sources of conflict over wind energy: concentration of capital and conflicts over land. The former connects renewable energy production to an extractivist capitalism from fossil fuels. The installation and operation of wind parks marks the area as wasteland, which becomes productive of value in an economic logic. Wind parks in Spain's Southern Catalonia, for example, are being installed as large investments of centralised, international Spanish corporations. The produced electricity is transported to and used elsewhere in Spain and abroad (Franquesa 2018). Such extractivism can become a site for contestation. The local population supported the first wind parks, but the corporations' attitudes and their questioning of local understandings of a dignified, self-determined way of living in this rural region led to disputes (Franquesa 2018). Anthropologists have noted similar developments in Mexico, Greece, and elsewhere, where investors see wind energy as export opportunities and wind parks as safe returns on their investments. Meanwhile, local populations often underscore the costs of wind energy production, which is borne by local communities and fauna, in the form of noise, exclusion from surrounding lands, and disturbing gregarious animals and avifauna (Boyer and Howe 2019; Siamanta 2019). The concentration of wind parks in particular areas or regions is a result of trying to govern wind energy production: to prevent rank growth, to regulate investments, to foster technical development, or to optimise infrastructure use. But the concentrating of wind turbines significantly contributes to locals' feelings of being surrounded, impaired, and used: concentrated capital and wind turbines reinforce centralised patterns of exploitation with both the electricity and the profits consumed elsewhere.

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Photovoltaics tend to entail similar conflicts, especially when concentrated, i.e. installed as green-field solar parks rather than rooftop solar arrays, and when seen as investments for internationally operating investors. The Pavagada Solar park in India is but one example, where an allegedly arid area has been turned into a mega-project for energy production. As the world's largest solar park at the time of its construction in 2019, the Pavagada solar park covers 53 km^2 with an installed capacity of 2000 MW_p. While the government brokered the solar park, drawing on the trust of local landowners in state government officials rather than private companies, resulting changes to the local social system were massive (Ghosh, Bryant and Pillai 2022). With a prevailing system of landowners and dependent landless labourers tilling the land, rents produced through energy production went solely to landowners, while the landless labourers were completely deprived of their means of existence. Adding to the unbearable situation for some was the absence of promised 'development', as jobs in the solar (as well as wind) energy production sector are very limited aside from installation (Ghosh, Bryant and Pillai 2022). The mutually exclusive use of land for solar parks, often underscored with fences around the parks, can take neo-colonial form, and renew or reinforce existing domains of governance. They often become 'green grabs', i.e. a form of land grabbing that comes with an ecological or climatic benefit and associated moral heft (Stock 2023; Cantoni and Rignall 2019).

Each of the fuels, used resources, and the produced electricity require an infrastructure, which again has the potential for becoming a contested site. Energy infrastructure can be invisible, apparent only at times of dysfunctionality: we may take for granted that electricity comes from the plug socket, that we can turn the heat or the air conditioning on, and that switches will work (Star 1999; Müller 2021). Yet, the set-up of energy transport systems—think of coal on rails and ships, oil and gas in tanks, steam and hot water for heat or hydrogen in pipelines—has seen its own glitches and histories. The same goes for the secondary infrastructure needed for energy systems, such as coal mining towns, supply systems for workers, financial portfolios and investments, policies, rules, and regulations. Electrical grids and fuel transport infrastructure with their technical setups facilitate an inclusion of parts of society and co-constitute people's feeling as part of it: flying trained coal miners in and out of mining towns in central Australia (Askland and Bunn 2018) will not contribute to democratisation in the same way as did, historically, coal miners' joint work underground in Europe (Mitchell 2011). The informal sector of collecting coal that falls off lorries, prevailing in India's coal mining areas, again creates different communities of energy workers (Lahiri-Dutt 2014). The electric grid, as another example, epitomises energy's potential for social inclusion and social construction once again: living off the grid can be a deliberate choice for some, but much more frequently, people perceive brown-outs or black-outs as a form of mismanagement and failure of maintaining the grid (Bakke 2016). Furthermore, when energy infrastructure is entangled with citizenship claims, people often prefer the electrification of remote rural areas through the grid rather than through solar lamps. In these instances the grid can be seen as citizenship materialising in wires (Cross 2019).

Electrifying villages or areas that have not yet been connected to the grid, and the resulting energy consumption, have the potential to change individual lives and interpersonal relationships. People understand electricity as a marker of modernity, signifying citizenship, and rearranging social status. Electrifying a village in Zanzibar in 1990, for example, meant that people got access to mass media and communication, reclaimed outdoor spaces at night, or could meet for watching television in the evenings (Winther 2008; Winther and Wilhite 2015). The fact that electrification can speed up the pace of life, with new cultural practices and a dissolving limitation of activities due to sunlight, makes it a biopolitical project that potentially brings liberation as well as surveillance and control (Gupta 2015). The effects of energy consumption also show in transitions from one energy source to another, i.e. when wood is substituted for low pressure gas cylinders, when solar cookers are introduced, or when biogas plants replace heating systems based on fossil fuels. Such transitions can bring individual advantages when shifting from consuming one fuel to another, such as less smoke pollution and fewer health hazards when used in cooking. They may also serve the interests of constituent energy communities requiring improvements in energy access (Campbell, Cloke and Brown 2016).

Individual choices in energy consumption also figure in the mobility sector, but they are framed by infrastructure. The choice of transport—a car or shared car, electric or diesel train, tram or bus, cycles, scooters, etc—is shaped by people's socioeconomic conditions and aspirations, by available infrastructure as well as considerations of energy consumption. Each individual decision becomes part of the energy system and hence contributes to an ambivalent relationship between prevailing energy systems' will to persist and the transformative capacity of (un)conscious changes in energy consumption. Ambivalence also marks many of the conscious and unconscious changes in energy consumption that accompany digitised energy consumption, via smart metre rollouts, for example. Digitisation potentially allows for reduced and optimised energy consumption, e.g. when people have digital metres that monitor and reduce their in-house heating. This works well in idealised industry scenarios, but these ideals do not necessarily prove to be true in reality: prople could use energy and digital appliances in ways rational or economical but, in fact, lifestyles and household preferences tend to be more dominant than energy tariff awareness and response (Kaviani et al. 2023; Strengers et al. 2021). Habits and conventions, daily behaviour, and social practices bear multiple possibilities of rebound effects, leading energy consumption to remain constant or even increase in times of digital energy control (e.g. Morley, Widdicks and Hazas 2018; Røpke 2012). Digitisation and low-carbon energy transitions make for a complicated twin transition (Sareen and Müller 2023).

Conclusion

This entry has only mentioned a handful of sources and material forms that energy can take. Much more can be said about heat pipelines, nuclear fission, batteries, petroleum gas, oil shale, peat, or hydrogen, for

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example. They feed on similar promises of energy availability and security, of being beneficial for the state, its citizens, the economy, and development. As anthropologists studying energy have pointed out, it is not only systemic availability, political regulations, and price that determine energy use, but also our social and cultural understandings. Furthermore, energy forms and sources often require someone to make a sacrifice, devastating villages, infringing on people's rights, and violating cultural understandings. People find themselves forced to accept radiation or environmental degradation, living with the risk of accidents and calamity, rearranging social structures, or facing death when fighting against it (see e.g. Perrin 2005; Kelly 2019; Fortun and Morgan 2016; Ortiz 2024).

In the Anthropocene, we tend to group energy sources according to their CO_2 emissions, leading us to distinguish between renewable and non-renewable energy sources, or fossil and non-fossil fuels. This logic, however, has not been the same across space and time (Malm 2016, 38ff.). Energy sources comprise more than chemical and geo-environmental aspects. They can be evaluated according to their ethical, financial, political, environmental, social, and cultural aspects. Transitions from one energy source to another may seem economically and ecologically reasonable as well as technically feasible. We might overcome lock-in effects, be able to balance stranded assets, or convince ourselves of the planetary necessity of energy transitions. Yet, energy also remains subject to individual and communal understandings, experiences, and conceptions.

How we take the human and more-than-human stakeholders and their comprehension of energy into account will determine the future of energy systems. There is a threatening energy future scenario, where growing energy demand is not decoupled from greenhouse gas emissions and global warming. Weakening climate change mitigation efforts and shifting from mitigation to adaptation seems to be in line with forecasts of continuously increasing energy demand and a tardy decarbonisation. More optimistic energy futures expect technology-led transitions, where digitisation and new technology, ideally combined with changing consumer behaviour and social consent, have positive outcomes. They might lead to 'exnovation', i.e. terminating the use of an energy source in a just form. Or they may bring about creative destruction, simply making some of our current energy uses obsolete. Optimists thus hold on to the idea that energy systems can bring about greater prosperity and social benefits (see e.g. World Economic Forum 2023). Anthropological studies dampen some of these hopes, as they foreground the neo-colonial tendencies and problematic rebound effects of digitised energy consumption (Sareen and Müller 2023). They also show the great risk of failure of any energy transition that ignores how people handle energy and technology (Pink et al. 2023, 4). Being able to imagine various different energy futures (Watts 2024, 2019) will require collaboration and mutual human recognition. It will also require radically new forms of work. Transitioning from one energy system to another will likely be marked by ruptures, new infrastructural politics, and new extractivist frontiers.

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