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Renewable Energy

1. How shifting to renewable energies is morally mandatory

Anthropogenic greenhouse gas emissions are the major contributor to climate change, which is generating severe disruptions to human and non-human life on this planet. Risks to humans include those associated with an increasing number of extreme weather events, heat exposure, water and food security, sea level rise and subsequent disappearing islands and coastal regions, and the spread of infectious diseases; many of these climate-induced effects are already being felt and are likely to worsen over the course of this century even if warming could be kept to 1.5°C (IPCC 2018a).

The largest proportion of our greenhouse gas emissions results from the way we generate and use energy, in particular from the burning of fossil fuels (IPCC 2014). Fossil-fuel based energy generation and consumption are thus the main drivers of climatic change. In order to mitigate climate change, we must reduce our greenhouse gas emissions substantially. This reduction will only be possible if we manage to profoundly change the way we use and generate energy (IEA 2020).

There are a number of ways to reduce emissions in order to mitigate climate change. According to Mark Diesendorf (2011), greenhouse gas emissions have three drivers:

- 1) Consumption per person
- 2) Population
- 3) Technology choice

Total emissions are a product of the number of people on the planet, the energy use per person and the emissions related to each unit of energy:

C	=	P	x (E/P)	x (C/E)
CO ₂ emissions	=	number of persons	x energy use per person	x emissions per unit of energy use (technology choice)

Table 1 (*ibid.*)

Diesendorf argues that in order to reduce emissions substantially we must address each factor (2011: 562). While the first factor – population size – is politically highly problematic, many people are already addressing the second and third factors to reduce their individual carbon footprint. Individual emissions matter (Nolt 2011), and each of us can reduce their emissions by using more efficient appliances (C/E), but also by using public transport instead of driving a car, refraining from air travel, or conserving electricity domestically. But while it is necessary that individuals, especially those living in the world's ten richest countries (Oxfam 2015), consume less energy and adopt environmentally friendly behaviours, there is only so much energy each of us can save – the emissions problem cannot be resolved through individual carbon footprint reductions alone (Schwenkenbecher 2014). What is needed, ultimately, is a structural response (IRENA 2019). In order to reduce emissions on a significant scale, society as a whole must shift to lower-emission energy technologies (Diesendorf 2010, 2011; Climate Council of Australia 2018; IEA 2020).

There are a number of technology options for lowering GHG emissions while still satisfying the global demand for energy services (IPCC 2011). These include:

- Renewable energy (RE) technologies: wind, solar, biomass, tidal and wave, geothermal;
- “Clean” fossil-fuel-based energy technologies which produce few or no greenhouse gas emissions: nuclear, carbon capture and storage (CCS)

However, not all of these options are equally effective in mitigating climate change to the required extent, and some come with serious problems attached. The risks of nuclear energy are well known (e.g. Shrader-Frechette 2011), notwithstanding continued political appetite for nuclear energy solutions (Pampel 2011; Neumann et al. 2020), but what about so-called ‘clean-coal’ technologies such as CCS when juxtaposed with renewable forms of energy generation?

Renewables versus ‘clean’ fossil-fuel based technologies

Despite its potential for being a viable future technology and various CCS technologies reaching maturity (Bui et al. 2018), the roll-out of CCS globally has been hindered by slow technological change and a lack of complementary and targeted policy measures (IPCC 2018b; IEA 2020). As continuing global fossil fuel dependence seems likely over the medium term (Bui 2019), however, CCS is deemed a critical technology for most of the IPCC’s mitigation pathways, stressing the need for further development of the technology in the near term (IPCC 2018b; Budinis 2018).

Irrespective, various problems remain with CCS. Firstly, the technology harbours the risk of prolonging our reliance on fossil fuels, locking in the suite of environmental, social, and political problems resulting from the extraction of fossil fuels. In addition, there are risks associated with the required carbon dioxide (CO₂) storage and potential leakage of CO₂ (Leung et al. 2014). Large quantities escaping would severely impact on greenhouse gas concentrations in the atmosphere (diminishing the technology’s impact on mitigation), the local environment, and health of local populations. Diesendorf (2003) points to detrimental impacts on living organisms in waterways and ground water given that CO₂ can dissolve to form a weak acid in water. Similarly, soil microbes can be negatively affected by carbon dioxide release into the ground. This may have impacts on local ecosystems as a whole (2003: 10). Zoback and Gorelick (2012: 10164) have argued that “there is a high probability that earthquakes will be triggered by injection of large volumes of CO₂ into the brittle rocks commonly found in continental interiors”, concluding that large-scale CCS is too risky a strategy to be adopted in the reduction of GHG. While some experts judge the changes of leakage to be vanishingly small (e.g. Alcade et al. 2018), many admit that there is still a significant amount of uncertainty surrounding the risks associated with CCS projects (Anderson 2017; Vinca, Emmerling & Tavoni 2018; van der Zwaan & Smekens 2009).

Finally, if CCS were employed on a large scale, in contrast to renewable energies, the environmental costs of harvesting coal (including methane release, the loss of carbon sequestration capacity through vegetation removal, the emissions from extraction machinery and transport (see Keith et al. 2012: 23), would, in fact, increase. Capturing carbon dioxide is energy intensive and consumes roughly 20-25% of the energy a CCS plant produces. Therefore, CCS plants require more coal per energy unit produced than current coal-fired power plants, because some of the produced energy will be used for the capture and storage process. This means that a large-scale employment of CCS is only possible with increased coal production (ATSE 2009: 66f).

Furthermore, unlike wind and solar energy, coal as a resource is finite: “clean-coal” technologies postpone the problem of long-term energy security, instead of solving it. According to the 2011 *IPCC Special Report*, successful mitigation is more likely to be achieved

if a complete substitution of fossil fuel-based energy generation takes place: “Individual studies indicate that if RE deployment is limited, mitigation costs increase and low GHG concentration stabilizations may not be achieved.” (IPCC 2011: 24). In light of the current carbon lock-in globally “clean coal” technologies are considered vital for effective mitigation (IPCC 2018b). Nonetheless, there are good reasons to think that in order to achieve effective and timely GHG mitigation, while also securing long-term energy security, we must shift to renewable energy technologies, away from fossil fuels (for a third option – geo-engineering – see chapter on *Geoengineering*).

Wider benefits of renewable technologies

Apart from being instrumental in reducing emissions and stabilizing greenhouse gases in the atmosphere, there are other morally compelling reasons for shifting from conventional, fossil-fuel-based technologies to renewable energies (RE). The IPCC (2011: 7) asserts that RE “can provide wider benefits. RE may, if implemented properly, contribute to social and economic development, energy access, a secure energy supply, and reducing negative impacts on the environment and health.” For these reasons, RE investments are currently being promoted for the economic recovery from the Covid-19 pandemic as part of a Green New Deal in countries such as Germany and Korea (Jung 2020).

Compelling reasons for endorsing renewables arise from concerns about the negative environmental impacts of conventional energy generation. The environmental impact of energy technologies is usually measured by way of producing so-called ‘lifecycle assessments’ (LCAs). LCAs attempt to quantify the environmental impact of technologies over an entire lifecycle, from resource extraction, via manufacturing to operation and disposal (for a discussion of LCA, see IPCC 2011: 730). As a general tendency, RE technologies are clearly favored in LCA (IPCC 2011). Even for solar photovoltaic (PV) systems, which traditionally had poorer LCAs (Varun et al. 2008), technological changes in recent years have greatly improved the environmental performance of PV (Muteri et al. 2020).

Environmental impacts have a direct influence on human health. Conventional power plants (coal, gas and oil-fired) emit “thousands of tons of emissions of sulphur dioxide, nitrogen oxides, carbon monoxide, particulate matter, hydrocarbons, mercury, and other pollutants” (Rosenberg 2008: 523) every year, while renewable energies such as wind and solar produce no such emissions when in operation (see also Kaswan 2009: 1146). Moving away from fossil-fuel based energy technologies will reduce these so-called co-pollutant emissions, which in turn will have a positive impact on human health (WHO 2012).

Commonly, the health burdens of conventional energies are very unequally distributed. Given that pollution is always limited to certain areas, the distribution of health impacts often exacerbates existing inequalities. For decades, environmental justice advocates have been raising awareness of the problem of unequal distributions of exposure to environmental hazards within populations. According to Kaswan (2009: 1146), emissions and air pollution “are disproportionately concentrated in disadvantaged areas, since many of the most significant emission sources, like refineries, power plants, transportation corridors, and other industrial land uses, are located in poor and minority neighbourhoods”. High-income communities or neighborhoods, in contrast, are less affected by air, water, or soil pollution. Technologies that do not cause such pollution, like renewable energy technologies, are inherently fairer. In this sense, a shift from conventional energy generation to RE will be especially beneficial to those who are disproportionately affected by these adverse impacts. Kaswan argues that “[b]y reducing fossil fuel combustion, greening the grid could serve a critical environmental justice function” (ibid.; see also Rabinowitz 2012 and McCauley et al. 2019).

Apart from promoting environmental justice, reducing pollution can entail substantial economic benefits for all. According to Kaswan, “The consequences of these public health threats fall not only on those directly exposed, but on society as a whole through higher medical costs, lost school and work days, and lower productivity” (2009: 1147, see also Groosman et al. 2011: 600; ATSE 2009; Gielen et al. 2019).

RE can – subject to policy settings (Monyei et al. 2019; Samarakoon 2019) – also play a crucial role in the eradication of poverty and for reaching the United Nation’s *Sustainable Development Goals* (Swain & Karimu 2020). “Historically, economic development has been strongly correlated with increasing energy use and growth of GHG emissions, and RE can help decouple that correlation” (IPCC 2011: 18, see also Cherni & Hill 2009). The availability of affordable energy is critical to the economic development of a community. According to the IPCC, under favorable conditions, RE will in some locations be cheaper than non-RE technologies, for instance, through avoiding expensive energy imports. This often makes them the only feasible option in remote and poor rural areas (ibid.). This means that “RE can help accelerate access to energy, particularly for the 1.4 billion people without access to electricity and the additional 1.3 billion using traditional biomass” (ibid., see also Florini 2012: 297). RE is seen by many as a key factor in ensuring that economic development is sustainable and equitable (Stephens 2019). The IPCC *Special Report on Renewable Energy* mentions other aspects in which RE can aid development: “RE deployment might reduce vulnerability to supply disruption and market volatility if competition is increased and energy sources are diversified” (IPCC: 2011).

In fact, long-term energy security is not only desirable for developing economies, but for all economies. Just how much of an improvement independence from fossil fuels would be becomes clear when considering the economic and political costs of securing continuing supply, for instance through military presence and political engagement in oil-producing countries (Babson 2019). Furthermore, even large fossil-fuel deposits that will last for several centuries from now will eventually be exhausted or too expensive to extract; fossil fuel energy-return-on-investment ratios are already beginning to fall (Brockway 2019). In the meantime, those who control the resources can control those who depend on it, economically and politically (Lehmann 2019). Renewable energies, such as wind and solar, provide long-term energy security and independence. They are potentially unlimited, available at no (extraction) cost, and harvesting them does not diminish their availability to anyone else, neither present nor future people.

In sum, there are morally compelling reasons for shifting to renewable energy other than mitigation of dangerous global warming (Florini 2012, IPCC 2011, Jamieson 2011, O’Neill 1993, Shue 2005). A broad scale adoption of RE can generate considerable public health benefits and broader environmental benefits, bear the potential for sustainable and just economic development and equitable energy access and, finally, provide long-term energy security.

2. The feasibility of a zero carbon economy

Even though overwhelming moral and prudential reasons seem to speak in favor of shifting to renewable energies and away from conventional fossil-fuel based technologies, some may doubt that this shift is politically, economically, or technologically feasible. In the following, we will briefly address each aspect in turn.

Is the shift *technologically* feasible? There is an increasing number of low-emission and zero-emission technologies available for large-scale deployment, including hydro, solar PV and concentrated solar thermal, wind, biomass, and geothermal power. Expert opinions on the

viability and capacity of the currently available low-emission and zero-emission technologies differ, but these differences concern merely the timeframe within which conventional energies can be completely substituted by low-emission and zero-emission technologies, they do not usually doubt that this substitution is technologically feasible (see Diesendorf 2011, 2019; Lund 2007; Rissman et al. 2020).

RE pioneers such as Denmark, Finland, Iceland, Norway, and Sweden are already covering large portions of their energy needs with renewables and

“[e]ach has a series of longstanding policy goals; each has binding climate targets; each are attempting to become entirely or mostly “fossil fuel free” or “carbon neutral,” with Denmark, Sweden, and Norway committed to 100% renewable energy penetration, Finland 80%, and Iceland 50–75%.” (Sovacool, 2017).

But some experts, in fact, think that even for a country with the energy needs of Australia a complete shift to RE is technologically feasible within ten years to twenty years (The Australian Greens 2019; Diesendorf 2019; ZCA 2010; for an overview of Zero Carbon blueprints see Wiseman & Edwards 2012).

Across the world, cities and municipalities have adopted ambitious emission reduction plans: The Copenhagen Climate Plan (2009) aims at carbon neutrality for the city of Copenhagen by 2025. The Australian Capital Territory, home to Australia’s capital Canberra, envisages it for 2060 (ACT Government 2012); indeed, various jurisdictions in Australia have made pledges to carbon neutrality (ClimateWorks Australia 2020).

But on a large scale, globally, is such a shift possible in a short time while maintaining current levels of energy consumption? A common argument against a radical shift is that we critically depend on GHG emissions – we cannot currently have decent lives without emitting. Importantly, transition plans to RE will usually see a major role for increasing energy efficiency. However, the German Advisory Council (WBGU) finds that “even in a world characterized by rapidly growing energy consumption, it is possible to transform global energy systems such that they become sustainable” (WBGU 2009: 129. Since WBGU operate with very high growth rates of energy use and economic development, they arrive at a more conservative model which achieves 90% coverage of energy needs by renewables by 2100). Further, as the 2011 IPCC Special Report points out: “The theoretical potential for RE greatly exceeds all the energy that is used by all economies on Earth.” (p.165).

What about the *economic* feasibility of a shift to renewables? According to the IPCC, in principle, the employment of renewable energies does not hinder economic growth or limit projected future energy demand:

“The global technical potential of RE sources will also not limit continued market growth. A wide range of estimates are provided in the literature but studies have consistently found that the total global technical potential for RE is substantially higher than both current and projected future global energy demand.” (IPCC 2011: 165).

It should be noted, though, that some scholars argue that in order to successfully mitigate climate change and create sustainable future societies, fundamental changes to our economic system are imperative (Diesendorf 2010, 2019).

Another way of thinking about economic feasibility of transitioning to RE is the comparative economic cost of ‘business as usual’. The *Stern Review on the Economics of Climate Change* focuses on the cost of climate change adaptation and mitigation on a global scale and concludes that timely mitigation is less costly than later adaptation:

“The Review estimates that if we don’t act, the overall costs and risks will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year” (Stern 2006).

These figures, as confirmed by other studies (Garnaut 2008), indicate that, from an economic perspective, substantial climate change mitigation is preferable to business-as-usual.

Finally, let us very briefly look into the question of *political* feasibility. It is obvious that for some countries the shift is (or has been) possible, with some countries, including the Nordic Five mentioned above, meeting a large proportion of the energy demands with RE. Yet it may be argued that for most countries and on a global scale, while the shift is not *impossible*, it is politically *unfeasible*. But what does that mean?

According to Holly Lawford-Smith (2012: 14), “[f]easibility is a concept that treads a fine line between possibility, on the one hand, and likelihood, on the other.” She suggests a scalar understanding of feasibility: “the probability of the outcome given the best (or best equal) action” (ibid. 13). That is, the feasibility of an outcome is the higher the more likely (or probable) that outcome is when the best available action to achieve that outcome is taken. Outcomes that are possible are made less probable and therewith less feasible through so-called soft-constraints, the most common of which are economic, institutional and cultural constraints (ibid.). However, it is possible to influence these constraints – for instance by attempting to change the culture or values of a given society: “In some instances, if we want the reforms badly enough, we will have to be prepared to really manipulate people’s incentives in order to secure success.” (ibid.).

On this analysis, the shift *is* political feasible in that it has a positive probability given the best available action. We can also see that the best available actions are not currently taken by many governments. Why this may be so will be discussed in the following. Second, it also reveals that in order to increase the feasibility of the shift (and its probability) given the best action, one must address those soft constraints: facts about the current political and economic system, facts about the current system of energy governance and ownership, but also facts about people’s values regarding the environment and climate change.

But why is so little happening? Why do politicians mostly fail to take the “best” action for steering our societies towards RE? Why do some countries embrace these new technologies more than others? The reasons for the lack of appropriate policy responses in so many countries are diverse and cannot be discussed in any detail here, but we will indicate some possible explanations. Richard Norgaard (2011) argues that part of the problem lies in the economic analysis of the problem of climate change itself and its theoretical foundations. Cost-benefit analysis – a major decision-making tool for public policy – is best used in small-scale contexts, but is not suitable as a decision-making tool when it comes to addressing global problems such as climate change where costs and benefits are dispersed over time and space (p. 191). According to Norgaard, because not all relevant outcomes can be adequately captured, decisions made on the basis of traditional cost-benefit analyses are flawed (ibid.).

Ann Florini considers defects in institutional design and the lack of power one of the greatest problems of energy governance: “almost no country has a coherent and sensible energy policy implemented by a well-designed set of institutions” and existing institutions do not have the “necessary institutional clout” (2012: 299). In addition, there exist strong vested interests in the oil and coal industries. Florini remarks that “Transparency International’s “Bribe Payer’s Index” has ranked the oil and gas sector as the fourth worst sector (out of nineteen) for bribing public officials.” (ibid., 298). On the global level, there is currently no comprehensive energy organization and no coherent global energy governance: “the current system of global energy governance is a mess, with many actors, many priorities, little coherence, and limited effectiveness” (ibid.). Furthermore, governments have been passing the buck on climate leadership for some time in order to avoid possible national disadvantages from making unilateral efforts (Schwenkenbecher 2013; Shue 2011).

Why some countries have managed to overcome these problems, cannot be discussed here, unfortunately. However, it does not seem far-fetched to assume that at least some of the political determination to execute the shift to renewables resulted from necessity. For instance, Denmark's economy suffered enormously during the 1970s oil crises as it was extremely dependent on oil imports. Together with a strong anti-nuclear movement, this led to a complete shift in domestic energy policy and cleared the way for renewables. Hence, it appears to have been partly a need for greater levels of energy security which prompted the Danes to adopt those changes (Rüdiger 2019). The political feasibility of shifting to renewables depends on countries' geographic and socioeconomic context, including the ability of political actors to intervene in the economy in a range of interdependent ways (Jewell & Cherp 2020).

Even though we have merely hinted at some of the obstacles to national and global sustainable energy regimes, it is safe to say that the transition to RE is economically, technologically, and politically feasible (at least in many of the OECD countries) at this point in time. However, in order to significantly increase the likelihood of such a transition what is needed is a political shift, or rather many political shifts on the national, regional, and local levels. We can and must work towards such a shift in our own societies and globally.

3. The ethical problems of (some) RE

Yet, even if there is agreement on the necessity and feasibility of a transition to a renewable energy regime, we will still be required to make choices between different possible pathways towards that goal. Each of these choices will involve some undesirable consequences which we will need to balance. Some of these undesirable consequences will result from technology choices and others from policy and economic measures. Some decisions will concern different ways of living: Do we have to give up our current living standard for a sustainable (energy) future? If a trade-off is needed: how does the value of high living standards compare against that of a sustainable energy regime? Fundamentally, changing the way we generate and use energy will entail tough choices, sometimes between equally desirable aims, and sometimes between options that seem impossible to compare.

In the following, we will not conduct a comprehensive analysis of all available renewable energy technologies, but rather provide a number of examples of tough ethical choices entailed by solar, wind and hydro power. We will also attempt to rebut some of the common misconceptions regarding RE technologies.

Hydropower – green electricity in exchange for environmental destruction?

Hydropower is a paradigmatic example of a controversial RE technology (Jamieson 2011; Diesendorf 2011). On the positive side, it generates energy at extremely low cost and offers “significant potential for carbon emissions reductions” (IPCC 2011: 442). If replacing conventional fossil fuel-based energy technology, hydropower helps secure environmental benefits, because it does not cause air pollution and soil contamination. Furthermore, in contrast to open pit mines, dams often provide recreational benefits for humans. On the negative side, dams severely interfere with landscapes and ecosystems, altering existing waterways and disrupting a river system's ecology with possibly devastating effects on fauna and flora (see Kahn, Freitas & Petrere 2014). Depending on local conditions, hydropower may even potentially result in higher emissions than the fossil-fuel-based power generation it seeks to replace (Giles 2006). The decision to build and use a hydropower plant necessarily entails a decision as to which of these conflicting aspects are more important: significant emission reductions at low cost or (possibly) the preservation of an existing ecosystem; further, there are

often significant impacts on local communities and their livelihoods to consider (Moran et al. 2018). Whether or not building any particular hydro power plant is overall the ethically best choice will depend on the specific circumstances. In some cases, the potential to gain access to cheap energy may override environmental concerns and the interests of the local community (where these conflict with the project). It should also be noted, that not all hydro power systems are equally problematic from an environmental point of view. For example, run-of-river hydropower systems do not alter a river's flow regime in the way systems with reservoirs do and have therefore more benign ecological impacts (IPCC 2011: 463).

Solar photovoltaic – a sham package?

Solar PV is a versatile RE technology and often used for small-scale, self-supporting electricity generation. It enables households and communities to have greater independence from the electricity grid. While governments all over the world have provided economic incentives for homeowners to install solar PV systems, these measures have been criticized for reinforcing inequality as people in low-income groups are less likely to benefit from them (see Hitzerth, Jehling & Brueckner 2017; Macintosh & Wilkinson 2011). However, while this may be true for relatively well-off urban and suburban residents, small-scale solar PV can provide enormous benefits to remote communities subject to country-context and policy setting (Baurzhan & Jenkins 2016; Okoye & Oranekwu-Okoye 2018). It can provide those who have not formerly had access to electricity with affordable energy, therewith improving their living-standard and benefitting those who are usually disadvantaged in society (IPCC 2011: 66).

One downside of solar PV is that, in contrast to wind and hydro technologies, it has been a comparatively costly way to generate electricity (IPCC 2011: 188, Figure 1.19), though this is changing rapidly. However, the relative cost would vary depending on circumstances: “In some applications, PV systems are already competitive with other local alternatives (e.g., for electricity supply in certain rural areas in developing countries).” (ibid. p. 68). In terms of the environmental record of PV, lifecycle emissions of first-generation PV systems have been considerable and were, on average, greater than those from hydro and wind (Varoun et al. 2009). Improvements in manufacturing processes and PV performance, however, have seen dramatic reductions in PV systems' environmental footprint and overall energy amortization (Muteri et al. 2020).

On a large scale, solar PV has less clear economic and ethical benefits than concentrated solar thermal (CST) and wind power. It is both more expensive and less effective in terms of climate change mitigation (Desideri & Campana 2014). Depending on the subsidy structure, it may often benefit primarily those who are already well-off. However, it can play a very important role as a small-scale technology in providing remote communities with electricity and resulting benefits, therewith in some cases benefitting those who are often comparatively worse-off.

In contrast, concentrated solar thermal (CST) has overwhelming ethical benefits and few downsides. Employed on a large scale it can contribute substantially to emission reductions and climate change mitigation (Sonawane & Bupesh Raja 2018). It is furthermore inexpensive, safe and effective. However, it is not suited for small-scale employment, but rather as a substitute for conventional power plants.

Wind power – saving the climate while destroying the landscape?

Wind energy, after hydropower, is the world's most widely used renewable energy resource (Ritchie & Roser 2020), and is a desirable way of generating electricity in many respects. Wind turbines have low life-cycle emissions (AER 2009: 52-3, ATSE 2009) and wind power “has significant potential to reduce (and is already reducing) GHG emissions” (IPCC 2011: 99).

Wind energy is currently the cheapest of the renewable energies available. Notwithstanding some noted negative economic impacts (Dorrell & Lee 2020), implementing wind energy on a large scale in many places has been shown to positively influence the job market and manufacturing sector, creating new jobs and establishing a (or expand the existing) renewable technology industry (see e.g. *Clean Energy Council* 2012: 4; IPCC 2011: 719; Ortega-Izquierdo & Río 2020, for the U.S. this is confirmed by Wei et al. 2010. See also Patterson 2012 and *Zero Carbon Australia Stationary Energy Plan* 2020). Also, wind farms can constitute a source of income for the rural population, safeguarding them from the impacts of droughts or other unforeseeable events (IPCC 2011:195, see also Rosenberg 2008: 525f). It has been suggested that the value of properties can be negatively affected by views of wind turbines (Sunak & Madlener, 2016), but also that this impact is correlated with acceptance of (or opposition to) wind power (Vyn, 2018).

While generating electricity from wind instead of from fossil fuels avoids a number of health hazards and environmental damage resulting from conventional energy generation (e.g., GHG emissions, air, water, and soil pollution and degradation), wind turbines have been suspected to sometimes have adverse health effects on the people living in the immediate vicinity of the turbines. Problems have been said to result from infrasound noise, electromagnetic interference, shadow flicker, and blade glint. Yet, according to several studies surveyed by the National Health and Medical Research Council (NHMRC 2010), there is no evidence for a positive link between wind turbines and adverse health effects: “There are no direct pathological effects from wind farms and ... any potential impact on humans can be minimised by following existing planning guidelines” (ibid.; see also Sustainable Energy Australia 2004). The German Advisory Council comes to a similar conclusion: “[p]rovided adequate distances to settlements are maintained, noise emissions from modern wind power plants are therefore no longer a problem.” (WBGU 2004: 64). This suggests that rather than being the result of the actual impact of wind turbines, health problems that people experience in the vicinity of turbines seem to be resulting from anxiety surrounding the turbines and be correlated to people’s attitudes towards them (See NHMRC 2010, CSIRO 2012). Anxiety issues and negative attitudes may successfully be addressed by involving local populations early in the decision-making process and providing them with the relevant information to prevent such problems (see Schwenkenbecher 2017).

Wind farms do have some adverse environmental impacts, too (for an overview see Nazir et al. 2020). For example, there is proven interference of rotating blades with local fauna, especially birds and bats (ATSE 2009, Baisner et al. 2010, Drewitt & Langston 2008, Mindermann et al. 2012). However, studies suggest that careful planning can avoid or minimize these effects (IPCC 2011: 100, see also Australian Greenhouse Office and Australian Wind Energy Association 2004: 3). Overall, the environmental impacts appear to be negligible compared to those of conventional energies: “attempts to measure the relative impacts of various electricity supply technologies suggest that wind energy generally has a comparatively small environmental footprint” (IPCC 2011: 99).

The only impact of wind farms that cannot be mitigated is their visual impact on the landscape. Wind farms usually feature prominently in the landscape and alter the visual composition of their surroundings (and this applies to hydro power plants, and to a lesser extent to CST, too). Concerns about landscape alterations seem to be at the heart of a lot of opposition to wind farms (Wolsink 2007). Bell et al. (2005, 470) have argued that “there is no ‘technical fix’ for the problem of landscape impact. Instead, the only way of accommodating people’s landscape concerns is to site wind farms in places that people find more acceptable”. People’s concerns regarding landscape impacts of wind turbines can be addressed in a number of ways. The Australian Greenhouse Office and Australian Wind Energy Association (2004) suggest

communities should always be consulted on turbine placement and important viewpoints should be agreed upon early in the process (see also Auswind & ACNT 2007 and Gross 2007). Another possibility is to compensate communities affected by renewable energy developments, including wind farms, for loss of “environmental qualities that people might otherwise have expected to keep” (Cowell et al. 2012: 12, see also Cowell et al. 2011). Compensation should hence be combined with consultation to ensure that legitimate complaints are heard and that compromises are found if possible. It appears then that many of the seemingly negative aspects of wind power are based on attitudes and prejudices, which can be moderated or overcome if stakeholders are involved in the decision-making process (Bell and Rowe 2012, see also Toke 2002 & Zoellner et al. 2008).

Finally, another downside of renewables, in particular wind and solar power, is the intermittent energy supply and resulting issues of energy security. We cannot go into any detail, but it should be noted that the technological challenges of intermittency appear to be perfectly resolvable (Jacobson et al. 2015) and that from a socio-political perspective RE can be seen as affording greater energy security than fossil fuels (Valentine, 2011; Viviescas et al. 2019).

In sum, there are downsides and limitations to each RE technology which must not be ignored and – where possible – must be mitigated. Addressing them will ensure that the shift is as equitable, socially just, and environmentally sustainable as possible. Those orchestrating the transition must be sensitive to these goals – the process should be fair and ecologically sound so as not to replicate many of the energy justice problems of conventional modes of energy generation.

4. Concluding remarks

The moral, economic, and prudential reasons for a transition to renewable energies globally and domestically not only, but most urgently, to mitigate climate change are overwhelming. Some countries are pioneering this shift in an exemplary way. Other countries, especially large and historically large GHG emitters must follow in due course and help developing nations in their efforts to shift to renewable energy. The major obstacles to doing what needs to be done are not technological, but seem to result from lacking political will and power as well as vested economic interests in perpetuating the status quo.

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Related topics

18. Moral basis of response to climate change

28. Hydroelectricity

30. Energy poverty

31. Urban sustainability

References

- Alcalde, J., Flude, S., Wilkinson, M., Johnson, G., Edlmann, K., Bond, C.E., Scott, V., Gilfillan, S.M., Ogaya, X. & Haszeldine, R.S. (2018) "Estimating geological CO2 storage security to deliver on climate mitigation." *Nature Communications*, 9(1), 2201.
- Anderson, S. T. (2017). Risk, Liability, and Economic Issues with Long-Term CO2 Storage— A Review. *Natural Resources Research*, 26(1), 89-112.
- Australian Academy of Technological Sciences and Engineering (ATSE) (2009) *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*.
- Australian Capital Territory (ACT) Government (2012) *AP2 - A new climate change strategy and action plan for the Australian Capital Territory*.
- Australian Greenhouse Office & Australian Wind Energy Association (AGO & AusWEA) (2004) *Wind farm fact sheets*.
- Australian Wind Energy Association & Australian Council of National Trusts (AusWEA & ACNT) (2007) *Wind Farms and Landscape Values. National Assessment Framework. Foundation Report*.
- Babson, E. (2019). *US Oil Dependence. More drilling does not make the US more energy secure*. American Security Project. Retrieved from: <https://www.americansecurityproject.org/wp-content/uploads/2019/05/US-Oil-Dependence.pdf>
- Baisner, A. J., Andersen, J. L., Findsen, A., Yde Granath, S. W., Madsen, K. O., & Desholm, M. (2010) "Minimizing collision risk between migrating raptors and marine wind farms: development of a spatial planning tool." *Environmental management*, 46(5), 801-808.
- Baurzhan, S., & Jenkins, G. P. (2016). "Off-grid solar PV: Is it an affordable or appropriate solution for rural electrification in Sub-Saharan African countries?" *Renewable and Sustainable Energy Reviews*, 60, 1405-1418.
- Bell, D., Gray, T., & Haggett, C. (2005) "The 'Social Gap' in Wind Farm Siting Decisions: Explanations and Policy Responses." *Environmental Politics*, 14(4), 460-477.
- Bell, D., & Rowe, F. (2012) "Are Climate Policies Fairly Made." Joseph Rowntree Foundation.
- Bodansky, D. (1996) "May we engineer the climate?" *Climatic Change* 33(3): 309-321.
- Brockway, P. E., Owen, A., Brand-Correa, L. I., & Hardt, L. (2019). "Estimation of global final-stage energy-return-on-investment for fossil fuels with comparison to renewable energy sources." *Nature Energy*, 4(7), 612-621.
- Budinis, S., Krevor, S., Dowell, N. M., Brandon, N., & Hawkes, A. (2018). An assessment of CCS costs, barriers and potential. *Energy Strategy Reviews*, 22, 61-81.
- Bui, M., Adjiman, C. S., Bardow, A., Anthony, E. J., Boston, A., Brown, S., ... & Hallett, J. P. (2018) Carbon capture and storage (CCS): the way forward. *Energy & Environmental Science*, 11(5), 1062-1176.
- Bui, M., & Mac Dowell, N. (Eds.) (2019) Introduction. In: *Carbon Capture and Storage*. (pp. 1-7), Croydon, UK, The Royal Society of Chemistry.
- Cherni, J. A., & Hill, Y. (2009) "Energy and policy providing for sustainable rural livelihoods in remote locations: The case of Cuba." *Geoforum*, 40(4), 645-654.

- City of Copenhagen (2009) *Copenhagen Climate Plan*.
- Clean Energy Council (2012) *Wind Farm Investment, Employment and Carbon Abatement in Australia*.
- Climate Council of Australia (2018) Clean & reliable power: roadmap to a renewable future. Retrieved from: <https://www.climatecouncil.org.au/wp-content/uploads/2018/03/Clean-and-Reliable.pdf>
- ClimateWorks Australia (2020). Net Zero Momentum Tracker. Local Government Sector. Retrieved from: https://www.climateworksaustralia.org/wp-content/uploads/2020/01/ClimateWorks_NZMT_Local-Government-Report_Jan20.pdf
- Cowell, R., Bristow, G., & Munday, M. (2011) "Acceptance, acceptability and environmental justice: the role of community benefits in wind energy development." *Journal of Environmental Planning & Management*, 54(4), 539-557.
- Cowell, R., Bristow, G., & Munday, M. (2012) *Wind energy and justice for disadvantaged communities*: Joseph Rowntree Foundation.
- CSIRO (Commonwealth Scientific and Industrial Research Organisation) (2012) *Exploring community acceptance of rural wind farms in Australia: a snapshot*.
- Dennekamp, M. and M. Carey (2010) "Air quality and chronic disease: why action on climate change is also good for health." *New South Wales Public Health Bulletin* 21(6): 115-121.
- Desideri, U., & Campana, P. E. (2014). "Analysis and comparison between a concentrating solar and a photovoltaic power plant." *Applied Energy*, 113, 422-433.
- Diesendorf, M. (2003) *Australia's Polluting Power: Coal-fired electricity and its impacts on global warming*. World Wildlife Fund Australia.
- (2010) "Strategies for radical climate mitigation." *Journal of Australian Political Economy* (66), 98-117.
- (2011) "Redesigning Energy Systems." In D. Schlosberg, R. B. Norgaard & J. S. Dryzek (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 561-580). Oxford, England: Oxford University Press.
- (2019). Energy futures for Australia. In *Decarbonising the Built Environment* (pp. 35-51). Palgrave Macmillan, Singapore.
- Dorrell, J., & Lee, K. (2020). "The Cost of Wind: Negative Economic Effects of Global Wind Energy Development." *Energies* 2020, 13, 3667.
- Drewitt, A. L., & Langston, R. H. W. (2008) "Collision effects of wind-power generators and other obstacles on birds." *Annals of the New York Academy of Sciences*, 1134, 233-266.
- Figuroa, R. M. (2011) "Indigenous Peoples and Cultural Losses." In D. Schlosberg, R. B. Norgaard & J. S. Dryzek (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 232-247). Oxford, England: Oxford University Press.
- Florini, A. (2012) "The Peculiar Politics of Energy." *Ethics & International Affairs*.
- Gardiner, S. M. (2011) "Cost-Benefit Paralysis." In *A perfect moral storm: the ethical tragedy of climate change* (pp. 247-298): New York ; Oxford : Oxford University Press, c2011.
- Garnaut, R. (2008). *Garnaut climate change review*. Final report. Canberra.
- German Advisory Council on Global Change (WBGU) (2004). *World in Transition: Towards Sustainable Energy Systems*.
- Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). "The role of renewable energy in the global energy transformation." *Energy Strategy Reviews*, 24, 38-50.
- Giles, J. (2006). "Methane quashes green credentials of hydropower." *Nature* 444, 524.

- Gross, C. (2007) "Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance." *Energy Policy*, 35(5), 2727-2736.
- Groosmann, B., Muller, N.Z. & O'Neill-Toy, E. (2011) "The Ancillary Benefits from Climate Policy in the United States." *Environmental and Resource Economics*, 50(4): 585-603.
- Hanna, E. G. (2011) "Health Hazards." In D. Schlosberg, R. B. Norgaard & J. S. Dryzek (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 217-231). Oxford, England: Oxford University Press.
- Hitzeroth, M., Jehling, M., & Brueckner, M. (2017). "Apples and oranges? A multi-level approach explaining social acceptance of renewable energy in Germany and Australia." *International Journal of Global Energy Issues*, 40(3-4), 141-165.
- Holland, B. (2008) "Justice and the Environment in Nussbaum's "Capabilities Approach": Why Sustainable Ecological Capacity Is a Meta-Capability." *Political Research Quarterly*, 61(2), 319-332.
- IEA. (2009). *Technology Roadmap: Carbon capture and storage*. Retrieved from: <https://www.iea.org/reports/technology-roadmap-carbon-capture-and-storage-2009>
- (2020) *Clean Energy Innovation*. Retrieved from: <https://www.iea.org/reports/clean-energy-innovation>.
- (2020) *CCUS in Power*. Retrieved from: <https://www.iea.org/reports/ccus-in-power>.
- Intergovernmental Panel on Climate Change (IPCC) (2011) *Special Report on Renewable Energy Sources and Climate Change Mitigation - SRREN*.
- (2013) Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- (2014) Energy Systems. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- (2018a). Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, Switzerland: IPCC.
- (2018b). Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Geneva, Switzerland: IPCC.
- IRENA (2019) *Global energy transformation: A roadmap to 2050*. International Renewable Energy Agency, Abu Dhabi.
- Jacobson, M.Z., Delucchi, M.A., Cameron, & Frew, B.A. (2015). *Stabilizing grid with 100% renewables 2050*. Proceedings of the National Academy of Sciences Dec 2015, 112 (49) 15060-15065.
- Jamieson, D. (1996) "Ethics and intentional climate change." *Climatic Change* 33(3): 323-336.

- (2011) "Energy, Ethics, and the transformation of nature." In D. G. Arnold (Ed.), *The ethics of global climate change / edited by Denis G. Arnold* (pp. 16-37). Cambridge, UK; New York: Cambridge University Press.
- Jewell, J. & Cherp, A. (2020). "On the political feasibility of climate change mitigation pathways: Is it too late to keep warming below 1.5°C?" *WIREs Climate Change*, 11: e621.
- Jung, Ys (2020). Renewable Energy: EU Green Deal and Korea Green New Deal. BusinessKorea. (25 June). Retrieved from: <http://www.businesskorea.co.kr/news/articleView.html?idxno=48066>
- Kahn, J.R., Freitas, C.E. & Petreere, M. (2014). "False Shades of Green: The Case of Brazilian Amazonian Hydropower." *Energies*, 7: 6063-6082.
- Kaswan, A. (2009) "Greening The Grid And Climate Justice." *Environmental Law*, 39(4).
- Keith, G. et al (2012) *The Hidden Costs of Electricity: Comparing the Hidden Costs of Power Generation Fuels*. Prepared for the Civil Society Institute.
- Lawford-Smith, H. (2012). Understanding Political Feasibility. *Journal of Political Philosophy*, 21 (3):243-259.
- Lehmann, T.C. (2019). "Honourable spoils? The Iraq War and the American hegemonic system's eternal and perpetual interest in oil." *The Extractive Industries and Society*, 6(2), 428-442.
- Leung, D. Y. C., Caramanna, G., & Maroto-Valer, M. M. (2014). An overview of current status of carbon dioxide capture and storage technologies. *Renewable and Sustainable Energy Reviews*, 39, 426-443.
- Lund, H. (2007) "Renewable energy strategies for sustainable development." *Energy*, 32(6), 912-919.
- McCauley, D., Ramasar, V., Heffron, R. J., Sovacool, B. K., Mebratu, D., & Mundaca, L. (2019). "Energy justice in the transition to low carbon energy systems: Exploring key themes in interdisciplinary research." *Applied Energy*, 233-234, 916-921.
- Melbourne Sustainable Society Institute. (2012). *2020 Vision for a Sustainable Society*: The Melbourne Sustainable Society Institute.
- Minderman, J., Pendlebury, C. J., Pearce-Higgins, J. W., & Park, K. J. (2012) "Experimental evidence for the effect of small wind turbine proximity and operation on bird and bat activity." *PloS one*, 7(7).
- Monyei, C. G., Sovacool, B. K., Brown, M. A., Jenkins, K. E., Viriri, S., & Li, Y. (2019). "Justice, poverty, and electricity decarbonization." *The Electricity Journal*, 32(1), 47-51.
- Moran, E.F., Lopez, M.C. Moore, N. Müller, N. & Hyndman, D.W. (2018). *Sustainable hydropower in the 21st century*. Proceedings of the National Academy of Sciences, 115 (47), 11891-11898.
- Muteri, V., Cellura, M., Curto, D., Franzitta, V., Longo, S., Mistretta, M., & Parisi, M.L. (2020). "Review on Life Cycle Assessment of Solar Photovoltaic Panels." *Energies*, 13, 252-.
- National Health and Medical Research Council (NHMRC) (2010) *Wind turbines and health: A rapid review of the evidence*. Available at http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf. Accessed 3 February 2014.
- Nazir, M. S., Ali, N., Bilal, M., & Iqbal, H. M. N. (2020). "Potential environmental impacts of wind energy development: A global perspective." *Current Opinion in Environmental Science & Health*, 13, 85-90.

- Neumann, A., Sorge, L., von Hirschhausen, C., & Wealer, B. (2020). Democratic quality and nuclear power: Reviewing the global determinants for the introduction of nuclear energy in 166 countries. *Energy Research & Social Science*, 63, 101389
- Nolt, J. (2011). "How Harmful Are the Average American's Greenhouse Gas Emissions?" *Ethics, Policy & Environment*, 14(1), 3-10. doi:10.1080/21550085.2011.561584
- Norgaard, R. B. (2011) "Weighing Climate Futures: A Critical Review of the Application of Economic Valuation." In D. Schlosberg, R. B. Norgaard & J. S. Dryzek (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 190-204). Oxford, England: Oxford University Press.
- Nugent, Daniel, and Benjamin K. Sovacool. "Assessing the Lifecycle Greenhouse Gas Emissions from Solar Pv and Wind Energy: A Critical Meta-Survey." *Energy Policy* 65, no. 0 (2// 2014): 229-44.
- Okoye, C. O., & Oranekwu-Okoye, B. C. (2018). "Economic feasibility of solar PV system for rural electrification in Sub-Sahara Africa." *Renewable and Sustainable Energy Reviews*, 82, 2537-2547.
- O'Neill, J. (1993) *Ecology, Policy, and Politics: Human Well-Being and the Natural World*: Psychology Press.
- Ortega-Izquierdo, M., & Río, P. d. (2020). "An analysis of the socioeconomic and environmental benefits of wind energy deployment in Europe." *Renewable Energy*.
- Oxfam (2015) *Extreme carbon inequality. Why the Paris climate deal must put the poorest, lowest emitting and most vulnerable people first*. Retrieved from: https://oi-files-d8-prod.s3.eu-west-2.amazonaws.com/s3fs-public/file_attachments/mb-extreme-carbon-inequality-021215-en.pdf
- Pampel, F. C. (2011). "Support for Nuclear Energy in the Context of Climate Change: Evidence From the European Union." *Organization & Environment*, 24(3), 249–268.
- Patterson, J. (2012) "Jobs vs. Public Health Is A False Dilemma." *Environmental Forum*, 29(2).
- Rabinowitz, D. (2012) "Climate Injustice: CO2 from Domestic Electricity Consumption and Private Car Use by Income Decile." *Environmental Justice (19394071)*, 5(1), 38-46.
- Rissman, J., Bataille, C., Masanet, E., Aden, N., Morrow, W. R., Zhou, N., . . . Helseth, J. (2020). "Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070." *Applied Energy*, 266, 114848
- Ritchie, H. & Roser, M. (2020). *Renewable Energy*. Retrieved from: <https://ourworldindata.org/renewable-energy>
- Rosenberg, R. H. (2008) "Diversifying America's Energy Future: The Future of Renewable Wind Power." *Virginia Environmental Law Journal*, 26, 505-544.
- Rüdiger, M. (2019). "From Coal to Wind". *Scandinavian Journal of History*, 44(4), 510-530.
- Samarakoon, S. (2019). "A justice and wellbeing centered framework for analysing energy poverty in the Global South." *Ecological Economics*, 165, 106385.
- Schwenkenbecher, A. (2013) "Bridging the Emissions Gap: A Plea for Taking up the Slack." *Philosophy and Public Issues* 3(1): 273-301.
- (2014) "Is there an obligation to reduce one's individual carbon footprint?" *Critical Review of International Social and Political Philosophy* 17(2): 168-188.
- (2017). "What is Wrong with Nimbys? Renewable Energy, Landscape Impacts and Incommensurable Values". *ENVIRONMENTAL VALUES*, 26(6), 711-731.
- Seligman, P. (2012) "Energy." In *2020 Vision for a Sustainable Society* (pp. 37-46): The Melbourne Sustainable Society Institute.
- Shrader-Frechette, K. (2011) *What Will Work: Fighting Climate Change with Renewable Energy, Not Nuclear Power*. Oxford University Press.

- Shue, H. (1995) "Avoidable Necessity: Global Warming, International Fairness, and Alternative Energy." *Theory and Practice, NOMOS XXXVII*, edited by Ian Shapiro and Judith Wagner DeCew (New York: NYU Press), pp. 239-64.
- (2005). "Responsibility to future generations and the technological transition." In Sinnott-Armstrong, W. and Howarth, Richard B. (eds) *Perspectives on climate change, vol. 5*. Oxford: Elsevier, pp. 265-283.
- (2011) "Face Reality? After You!—a Call for Leadership on Climate Change." *Ethics and International Affairs* 25(1): 17-26.
- Sonawane, P. D., & Bupesh Raja, V. K. (2018). "An overview of concentrated solar energy and its applications." *International Journal of Ambient Energy*, 39(8), 898-903.
- Sovacool, B. K. (2017). "Contestation, contingency, and justice in the Nordic low-carbon energy transition." *Energy Policy*, 102, 569-582
- Stern, N. (2006) *Stern Review on the economics of climate change*.
- Stephens, J. C. (2019). "Energy democracy: Redistributing power to the people through renewable transformation." *Environment: Science and Policy for Sustainable Development*, 61(2), 4-13.
- Sunak, Y., & Madlener, R. (2016). The impact of wind farm visibility on property values: A spatial difference-in-differences analysis. *Energy Economics*, 55, 79-91.
- Swain, R. B., & Karimu, A. (2020). "Renewable electricity and sustainable development goals in the EU." *World Development*, 125, 104693
- Sustainable Energy Australia (2004) *The Noise Emissions Associated With Wind Farming In Australia*: Australian Government, Australian Wind Energy Association.
- The Australian Greens (2019) *Renew Australia 2030 Powering Past Coal to a Clean Future for all of us*. Retrieved from: <https://greens.org.au/sites/default/files/2019-03/Greens%202019%20Policy%20Platform%20-%20Renew%20Australia.pdf>.
- The Royal Society (2009) *Geoengineering the climate: science, governance and uncertainty*.
- Toke, D. (2002) "Wind Power in UK and Denmark: Can Rational Choice Help Explain Different Outcomes?" *Environmental Politics*, 11(4), 83-100.
- United Nations Environment Programme (UNEP) (2007) *Convention on Biological Diversity. Report on Indigenous and Local Communities Highly Vulnerable to Climate Change Inter Alia of the Arctic, Small Island States and High Altitudes, With a Focus on Causes and Solutions*.
- van der Zwaan, B., and Smekens, K. (2009). "CO₂ capture and storage with leakage in an energy-climate model". *Environmental Modelling & Assessment*, 14, 135–148.
- Voigt, T., et al. (1998) "Air pollution in the Latrobe Valley and its impact upon respiratory morbidity." *Australian and New Zealand Journal of Public Health* 22(5), 556-561.
- Vinca, A., Emmerling, J., & Tavoni, M. (2018). "Bearing the Cost of Stored Carbon Leakage." *Frontiers in Energy Research*, 6(40) doi:10.3389/fenrg.2018.00040
- Viviescas, C., Lima, L., Diuana, F. A., Vasquez, E., Ludovique, C., Silva, G. N., . . . Paredes, J. R. (2019). "Contribution of Variable Renewable Energy to increase energy security in Latin America: Complementarity and climate change impacts on wind and solar resources." *Renewable and Sustainable Energy Reviews*, 113, 109232.
- Vyn, R. J. (2018). Property Value Impacts of Wind Turbines and the Influence of Attitudes toward Wind Energy. *Land Economics*, 94(4), 496-516.
- Wei, M. (2010) "Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?" *Energy Policy*, 38(2), 919-931.
- Wiseman, J., & Edwards, T. (2012) *Post Carbon Pathways. Reviewing Post Carbon Economy Transition Strategies*: Melbourne Sustainable Society Institute & Centre for Policy Development.

- Wolsink, M. (2007) "Planning of renewables schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation." *Energy Policy*, 35(5), 2692-2704.
- World Health Organization (WHO) (2005) *Ecosystems and human well-being*. Health synthesis.
- WHO (World Health Organization) (2011) *Health co-benefits of climate change mitigation – Transport*. Executive Summary. Available at http://www.who.int/hia/examples/trspt_comms/hge_transport_factsheet_low-resdurban_30_11_2011.pdf?ua=1. Accessed 4 Feb 2013.
- (2012) *Health indicators of sustainable energy*. Available at http://www.who.int/hia/green_economy/indicators_energy2.pdf, Accessed 4 Feb 2014.
- Zero Carbon Australia (ZCA) (2010) *Zero Carbon Australia Stationary Energy Plan: The University of Melbourne Research Institute & Beyond Zero Emissions*.
- Zoback, Mark D., and Steven M. Gorelick (2012) "Earthquake Triggering and Large-Scale Geologic Storage of Carbon Dioxide." *Proceedings of the National Academy of Sciences* 109(26): 10164-68.
- Zoellner, J., Schweizer-Ries, P., & Wemheuer, C. (2008) "Public acceptance of renewable energies: Results from case studies in Germany." *Energy Policy*, 36(11), 4136-4141.

Further reading on the transition to renewable energy

- Centre for Alternative Technology (2019) *Zero Carbon Britain: Rising to the Climate Emergency*. Available at <https://www.cat.org.uk/download/35541/> (accessed 3 August 2020).
- Committee on America's Energy, F., National Academy of, S., National Academy of, E., & National Research, C. (2009) *America's Energy Future: Technology and Transformation*. Washington, D.C.: The National Academies Press. Available at: https://www.nap.edu/login.php?record_id=12091&page=https%3A%2F%2Fwww.nap.edu%2Fdownload%2F12091 (accessed 3 August 2020).
- United Nations Development Programme (UNDP) (2012) *Transforming On-Grid Renewable Energy Markets*. Available at: [https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/UNDP_FIT_Port_TransformingREMarkets_15Nov2012%20\(B\).PDF](https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/UNDP_FIT_Port_TransformingREMarkets_15Nov2012%20(B).PDF) (accessed 3 August 2020).
- World Wildlife Fund (WWF) Report (2017) *PLANNING TO SUCCEED. How to build strong 2050 climate and energy development strategies*. Available at: http://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_maximiser_planning_to_succeed_guidance_report_1.pdf (accessed 3 August 2020). See Annex 1 for more literature.

Notes on Contributors

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