Climate Change and Energy Ethics

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Abstract

Climate related energy ethics is still an underdeveloped field of normative ethics. While it is urgent to achieve truly decarbonized and otherwise climate friendly global energy systems as fast as possible, contrary to what is often assumed in current climate ethics we do not yet know in sufficient detail how this can be achieved. Thus, there is a need for *Climate Ethics 2.0* which focuses more on the solution side of the required energy transition and the involved problem of the needed knowledge base. It is important and difficult to develop realistic scenarios of net-zero global energy systems and to develop expedient national climate policies and climate related energy policies. All this involves plenty of normative problems and normatively relevant tasks. We especially focus on the problem that for economic development energy and power dense energy sources are needed, so that poor countries have every incentive to overcome their poverty with the help of fossil fuels. This, combined with the recognition that immense amounts of climate friendly electricity are needed for climate neutral global energy systems, raises the question of the role of nuclear energy in climate change mitigation. To answer this question may be considered to be one of the most important tasks of current climate related energy ethics.

Keywords: mitigation, adaptation, decarbonized energy systems, need for knowledge, target and transition scenarios, energy poverty, economic development, energy density, national climate policy, nuclear energy

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1 Introduction

Energy is still a neglected topic in philosophy and ethics. Apparently, it can easily be overlooked how closely connected the moral rights of persons and the secure access to safe energy are.[3] We are used to see the rights to life and physical and psychological integrity connected with access to food (itself a source of energy), clothing and shelter, but may fail to notice that energy is needed to produce and distribute food in sufficient quantities, to preserve it at low temperatures, to cook it, or to keep our dwellings sufficiently warm or cool. Energy is necessary to secure our basic needs, to make economic development possible, and to allow for a certain standard of living which facilitates the protection of the rights of persons. The absolute poverty or the very low standard of living of still billions of human beings is closely connected to widespread energy poverty, i.e., the lack of access to sufficient amounts of secure, safe and affordable energy.[4]

It is no accident that industrialization and modern economic development, or the breathtaking recent economic development of China, were mostly driven by fossil fuels, first by coal, and then, additionally, by petroleum and natural gas.[5] For these fossil fuels, with their large energy densities and power densities, allow for the reliable conversion of relatively high amounts of energy per amount of fuel used and space needed.[6]

It is here that we are confronted with one of the most intricate problems of climate related energy ethics. On the one hand, in order to combat global warming, a *complete* and *rapid* reorganization of the current fossil fuel based global energy systems to fossil fuel free energy sources is needed. On the other hand, the required reorganization seems to conflict with the development needs of a large part of mankind and may endanger the reliable access to energy on which the well-being and the protection of the rights of the richer part of mankind is based.[7]

These tensions are often addressed as an *energy dilemma* between limiting global warming and combating global energy poverty or as an *energy trilemma* where preserving or attaining energy security is added as a further task which cannot be easily dealt with without jeopardizing the solution

[3] But see e.g. Douglas MacLean and Peter G. Brown (eds.), *Energy and the Future*, Totowa, NJ: Rowman and Littlefield, 1983; Simon Caney, "Climate change, energy rights, and equality," in: Denis G. Arnold (ed.), *The Ethics of Global Climate Change*, New York: Cambridge University Press, 2011, 77-103; Henry Shue, "Climate hope: implementing the exit strategy", *Chicago Journal of International Law* 13,2 (2013), 381-402. For a growing literature on energy ethics and energy justice initiated by social scientists see especially the extensive work by Benjamin K. Sovacool, e.g. Benjamin K. Sovacool, *Energy and Ethics: Justice and the Global Energy Challenge*, Basingstoke: Palgrave Macmillan, 2013; Benjamin K. Sovacool, Michael H. Dworkin, *Global Energy Justice: Problems, Principles, and Practices*, Cambridge: Cambridge University Press, 2014, and the contributions of Kirsten E.H. Jenkins, e.g. Kirsten E.H. Jenkins, Jenny C. Stephens, Tony G. Reames and Diana Hernández, "Toward impactful energy justice research: Transforming the power of academic engagement," *Energy Research and Social Science* 67 (2020), 101510, and the apt characterization of this literature by Aileen McHarg, "Energy Justice. Understanding the 'Ethical Turn' in Energy Law and Policy," in: Inigo del Guayo, Lee Godden, Donald N. Zillman, Milton F. Montoya and José Juan Gonzalez (eds.), *Energy Justice and Energy* Law, Oxford: Oxford University Press, 15-30.

[4] Antoine Halff, Benjamin K. Sovacool, Jon Rozhon (eds.), *Energy Poverty. Global Challenges and Local Solutions*, Oxford: Oxford University Press, 2014.

[5] See Vaclav Smil, *Energy and Civilization: A History*, Cambridge, Mass.: MIT Press 2017; Vaclav Smil, *Energy Transitions. Global and National Perspectives.* 2nd edition, Santa Barbara: Praeger 2017, Michael Shellenberger, *Apocalypse Never: Why Environmental Alarmism Hurts Us All*. New York: Harper, 2020), 175-199.

[6] Smil, *Energy and Civilization* (fn. 5), 9 and 10 defines *energy density* as "the amount of energy per unit mass of a resource", i.e. J/kg or J/m^3, and *power density* as "the rate at which energies are produced or consumed per unit of area", i.e. W/m^2. On the importance of power density, see Vaclav Smil, *Power Density: A Key to Understanding Energy Sources and Uses*, Cambridge, Mass.: MIT Press 2015.

[7] On energy security see Marilyn Brown and Benjamin K. Sovacool, *Climate Change and Global Energy Security*: *Technology and Policy Options*, Cambridge, Mass.: MIT Press 2011.

of at least one of the two other tasks.[8] The conflicts in the dilemma or trilemma pose serious normative problems, but each of the conflicting tasks is also quite challenging in itself. This article will especially focus on the problem(s) of the decarbonization of the global energy systems.

There is a tendency in current climate ethics to hold that we already possess the knowledge and the means to fulfill this latter task. Consequently, there is a growing moral indignation that the knowledge is not used, and the means are not employed by the governments or inhabitants of the rich countries. For instance, Henry Shue writes 'While our feckless leaders reason in circles, the problem itself deepens relentlessly, (…)',[9] or 'The desultory, almost leisurely approach of the world's national states to climate change reflects no detectable sense of urgency. (…) with this persistent lack of urgency (…) everything is wrong (…).'[10] Stephen M. Gardiner holds that 'we may end up being remembered not just as a profligate generation, but as "the scum of the earth," the generation that stood by as the world burned.'[11] However, the required decarbonization poses more difficult questions and normative problems and conflicts, and climate related energy ethics is, therefore, a more challenging task than is often thought.

2 The Urgency of Decarbonizing the Global Energy System

We will presuppose that in view of the rights of the affected people 'mitigation' of anthropogenic climate change and therefore limiting global warming is a morally urgent task.[12] This requires the reduction or elimination of the global emissions of greenhouse gases and net-zero emissions of carbon dioxide. In particular, there are three reasons why net-zero emissions of carbon dioxide must be achieved as soon as possible.[13]

First, carbon dioxide accumulates in the atmosphere, and the degree of global warming is to a large extent dependent on the amount of carbon dioxide accumulated in the atmosphere.[14] This is

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[8] See e.g. Michael Bradshaw, *Global Energy Dilemmas: Energy Security, Globalization, and Climate Change*, Cambridge: Polity Press 2014; Caroline Kuzemko, Michael F. Keating, Andreas Goldthau. *The Global Energy Challenge: Environment, Development, Security*, London: Palgrave, 2016.
[9] Henry Shue, "Face Reality? After You! – A Call for Leadership on Climate Change," *Ethics and International Affairs* 25, 1 (2011), 17-26, 18.
[10] Henry Shue, "Human rights, climate change, and the trillionth ton," in: Denis G. Arnold (ed.), *The Ethics of Global Climate Change*, New York: Cambridge University Press, 2011), 292-314.
[11] Stephen M. Gardiner, "In Defense of Climate Ethics", in: Stephen M. Gardiner, David A. Weisbach, *Debating Climate Ethics,* New York: Oxford University Press, 2016, 3-133, 4.
[12] See, e.g., Simon Caney, "Climate change, energy rights, and equality" (fn. 3); Simon Caney, "Two Kinds of Climate Justice: Avoiding Harm and Sharing Burdens," *Journal of Political Philosophy* 22,2 (2014), 125-149; Simon Caney, "Climate Change and Non-Ideal Theory: Six Ways of Responding to Non-Compliance," in: Clare Heyward, Dominik Roser (eds.), *Climate Justice in a Non-Ideal World*, Oxford: Oxford University Press 2016, 21-42; Simon Caney, "Climate Justice," in: *Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta (Winter 2021); Stephen M. Gardiner, "In Defense of Climate Ethics" (fn. 11); Henry Shue, "Deadly Delays, Saving Opportunities: Creating a More Dangerous World?" in: Stephen M. Gardiner, Simon Caney, Dale Jamieson, and Henry Shue (eds.), *Climate Ethics: Essential Readings*, Oxford: Oxford University Press, 2010, 146-162; Henry Shue, *Basic Rights: Subsistence, Affluence, and U.S. Foreign Policy.* 40th Anniversary Edition, Princeton: Princeton University Press, 2020, ch. 8; Henry Shue, *The Pivotal Generation: Why We Have a Moral Responsibility to Slow Climate Change Right Now*, Princeton: Princeton University Press, 2021.
[13] See, e.g., Klaus Steigleder, "Climate Risks, Climate Economics, and the Foundations of Rights-based Risk Ethics," *Journal of Human Rights* 15,2 (2016), 251-271; Klaus Steigleder, "The Tasks of Climate Related Energy Ethics: The Example of Carbon Capture and Storage," Jahrbuch für Wissenschaft und Ethik 21 (2016), 121-145.
[14] Myles R. Allen, David J. Frame, Chris Huntingford, Chris D. Jones, Jason A. Lowe, Malte Meinshausen, and Nicolai Meinshausen, "Warming caused by cumulative emissions towards the trillionth tonne," *Nature* 458 (2009), 1163-1166; Malte Meinshausen, Nicolai Meinshausen, William Hare, Sarah C.B. Raper, Katja Frieler, Reto Kutti, David J. Frame, and Myles R. Allen, "Greenhouse-gas emission targets for limiting global warming to 2°C," *Nature* 458 (2009), 1158-1162; Raymond T. Pierrehumbert, "Cumulative carbon and just allocation of the global carbon commons," *Chicago Journal of International Law* 13,2 (2013), 527-548.

a relatively new insight, which has a huge impact on climate ethics and climate policy.[15] A considerable part of the carbon dioxide emitted into the atmosphere will stay there for hundreds or thousands of years.

Originally, man-made global warming was considered to be significantly caused by the increases in the regular *flow* of emissions of carbon dioxide. A certain degree of, say, annual emissions was considered to be connected with a certain degree of global warming. Consequently, to simplify a bit, it was hold that a restriction of global warming can be achieved by a curbing of the annual global emissions of greenhouse gases, especially of carbon dioxide.[16] Against this backdrop, climate ethics was mainly concerned with the question of who is allowed to emit what amount of climate gases. Climate ethics was mainly concerned with arguing that the rich countries have an obligation to significantly reduce their emissions in order to allow for the increase in the emissions necessary for the economic development of the poor countries while keeping the increase of global mean temperature at an acceptable level.[17]

However, if carbon dioxide accumulates in the atmosphere and global warming is to a large part a function of the *stock* of accumulated carbon dioxide, then even a restricted or reduced quantity of regular emissions will lead to a perhaps decelerated but steady increase of global warming. This increase can therefore not be stopped without net-zero emissions of carbon dioxide.

Second, we do not know precisely what amount of accumulated carbon dioxide in the atmosphere will lead to what increase of the global mean temperature. The standard answer is that 1 Tt (one teraton, i.e., one trillion metric tons) of carbon, i.e. 3.67 Tt of carbon dioxide, is likely to correspond to an increase of 2°C of global mean temperature. Others hold that a much lesser amount of carbon or carbon dioxide in the atmosphere will already lead to such an increase.

Third, we do not know what the exact consequences of which increase in global mean temperature will be. The aim to limit the increase of the global mean temperature to below 2°C was justified by the assumption that this will preserve a sufficiently high chance that catastrophic events can be avoided. We know that the temperature driven linear rates of change will give way to exponential developments, but we do not know where and at what temperatures. There will be self-reinforcing effects which may accelerate certain developments and lead to certain points of no return, e.g., to a sudden increase in temperature and an accelerated increase in the rise of sea levels because ice shields are not only irreversibly lost, but also start to melt much faster than expected.

From the standpoint of risk ethics,[18] this justifies the requirement not to risk certain catastrophic events and, therefore, to limit the increase of global temperature *as far as possible*. Consequently, the

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[15] This is stressed with admirable and gloomy clarity by Henry Shue, "Climate hope: implementing the exit strategy" (fn. 3); see also Henry Shue, "Human rights, climate change, and the trillionth ton" (fn. 11).

[16] This is the reasoning behind the original "wedges approach" by Stephen W. Pacala and Robert H. Socolow and still behind the "alternative wedges approach" by Philip Cafaro, see Stephen W. Pacala, Robert H. Socolow, "Stabilization Wedges: Solving the Climate Problem with Current Technologies," *Science* 305 (2004), 968-972; Robert H. Socolow, Stephen W. Pacala, "A Plan to Keep Carbon in Check," *Scientific American* (September 2006), 50-57; Philip Cafaro, "Beyond business as usual: alternative wedges to avoid catastrophic climate change and create sustainable societies," in: Denis G. Arnold (ed.), *The Ethics of Global Climate Change*, New York: Cambridge University Press, 192-215. For a revised approach see Stephen J. Davis, Long Cao, Ken Caldeira, Martin I. Hoffert, "Rethinking Wedges," *Environmental Research Letters* 8, 1 (2013).

[17] See, e.g., the early articles of Henry Shue collected in Henry Shue, *Climate Justice: Vulnerability and Protection*, Oxford: Oxford University Press, 2014; Simon Caney, "Cosmopolitan Justice, Responsibility, and Global Climate Change," *Leiden Journal of International Justice* 18 (2005), 747-775.

[18] See Steigleder, "Climate Risks" (fn. 13), see also Shue, "Deadly Delays" (fn. 12); Lauren Hartzell-Nichols, *A Climate of Risk: Precautionary Principles, Catastrophes, and Climate Change*, London: Routledge, 2017.

global emissions of carbon dioxide must be curbed to net-zero *as fast as possible*. Thus, the fossil fuel-based global energy systems must be decarbonized *as fast and as extensively as possible*. A considerable part of the problems and tasks of climate ethics and climate related energy ethics are contained in this 'as possible'. For 'as possible' does not only relate to what is feasible or practicable but does also involve profound normative questions.[19] 'As possible' does also mean 'as far as it is compatible with the moral rights of all affected persons'. Thus, we must decarbonize the energy system as fast and as far as it is compatible with combating poverty and overcoming global energy poverty. We must decarbonize without bringing down the viability of the economy and without endangering energy security, but fast enough to avert the dangers of climate change.

3 The Underrated Challenge of Decarbonizing the Global Energy System

3.1 The Need for Climate Ethics 2.0

Climate ethics and climate related energy ethics are impeded by an often overlooked principal problem, namely of how specific climate ethics and energy ethics can and must be. Climate Ethics so far, or what one may call *Climate Ethics 1.0*, has mainly focused on clarifying fundamental normative issues (and has made important contributions here), e.g., the determination of the duties the people living today have 'to' or 'in relation to' the people living in the future[20] or the development of basal criteria for the just distribution of the burdens of fighting climate change.[21]

Climate ethics builds on the current state of research on anthropogenic climate change as, e.g., outlined in the reports of the Intergovernmental Panel on Climate Change, IPCC.[22] It especially focuses on the threats connected with climate change and points out that, in view of these threats, climate change constitutes an urgent morally relevant problem. It is imperative to limit global warming as much as possible.[23] Thus, it is an essential task of climate ethics to set an appropriate target for the maximum increase in average global mean temperature that is morally acceptable.[24] The target is normally set between 1.5° and 2°C, but, as Caney points out, a much higher target has often been advocated on the part of climate economics.[25]

From the respective target the remaining global budget of the emissions of carbon dioxide and other greenhouse gases can be calculated. This involves uncertainties and the corresponding normative questions of how to adequately deal with them. As even limited global warming will have

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[19] See also Stephen M. Gardiner, "In Defense of Climate Ethics" (fn. 11).

[20] See, e.g. Edward A. Page, *Climate Change, Justice and Future Generations*, Cheltenham: Edward Elgar, 2006; Steve Vanderheiden, *Atmospheric Justice: A Political Theory of Climate Change*, New York: Oxford University Press, 2008, ch.4; Stephen M. Gardiner, *A Perfect Moral Storm: The Ethical Theory of Climate Change*, New York: Oxford University Press, 2011, esp. ch. 5 and 6; Darrel Moellendorf, *The Moral Challenge of Dangerous Climate Change: Values, Poverty, and Policy*, New York: Cambridge University Press, 2014, esp. 220-235.

[21] See, e.g., the important recent overview article on "Climate Justice" by Simon Caney (fn. 12).

[22] But see the further research literature used, e.g., in Shue, *Climate Justice* (fn.17) or Shue, *Basic Rights*, ch. 8. (fn.12).

[23] See, e.g., Shue, "Deadly Delay" (fn.12); Caney, "Climate change, energy ethics, and equality" (fn.3), Steigleder, "Climate risks" (fn.13).

[24] See Caney, "Climate Change and Non-Ideal Theory" (fn.12); Caney, "Climate Justice" (fn.12).

[25] Caney, "Climate Justice" (fn.12). For an explanation and critique see, e.g., Nicholas Stern, *The Economics of Climate Change: The Stern Review*, Cambridge: Cambridge University Press, 2007; Dale Jamieson, *Reason in a Dark Time: Why the Struggle Against Climate Change Failed – and What It Means for Our Future*, New York: Oxford University Press, 2014, ch. 4; Gernot Wagner and Martin L. Weitzman, *Climate Shock: The Economic Consequences of a Hotter Planet*, Princeton: Princeton University Press, 2015; Hartzell-Nichols, *A Climate of Risk* (fn. 18); Klaus Steigleder, "Climate Economics and Future Generations," in: Marcus Düwell, Gerhard Bos, Naomi van Steenbergen (eds.). *Towards the Ethics of a Green Future: The Theory and Practice of Human Rights for Future People*, London: Routledge, 2018), pp. 131-153; Michael Roos, Franziska Hoffart, *Climate Economics: A Call for More Pluralism and Responsibility*, Cham: Palgrave Macmillan, 2021.

severe negative consequences (e.g., increased storms, droughts, sea level rise), the 'mitigation' of climate change must be complemented by adaptive measures which offer protection against the consequences of the tolerated global warming. Finally, unprevented harms must be compensated.[26]

Climate ethics is mainly concerned with justifying the fundamental criteria of a just distribution of the responsibilities and burdens connected particularly with the tasks of mitigation and adaptation, but also with compensation. However, the level of discussion and argument has mostly been quite abstract. Thus, it has been discussed whether the former polluters, the beneficiaries of earlier greenhouse gas emissions or those who are especially able and competent to assume the burdens and tasks should 'pay'.[27] The respective tasks are treated only in a general way. They comprise the avoidance of emissions through the decarbonization of the energy systems by use of renewable energies, power grids of the future, increases in energy efficiency, technology transfers into poor countries and raising the prices of fossil fuels due to carbon taxes or cap and trade.

The abstraction becomes apparent in connection with Caney's treatment of the problem that the existing duties, tasks and responsibilities are not sufficiently discharged.[28] Caney sets out to characterize all possible ways of reacting to such 'non-compliance'. Besides the redistribution of responsibilities and burdens, a less ambitious target could be set, violations of moral ideals, like the preservation of beautiful landscapes, could be tolerated. The perhaps most important response is to try to improve compliance. As Caney emphasizes, the possible responses to non-compliance can be combined, they will differ for different duty-bearers and are difficult to evaluate normatively. The abstraction of the possible responses is rooted in the abstraction regarding the initial determination of the basic tasks and the just distribution of responsibilities and burdens. Here, a shared background knowledge is presupposed, namely that we know what the required compliance would consist in in the first place and what the duties justified by climate ethics are.

There seems to be a widespread belief among climate ethicists that we already know 'what will work'.[29] Thus, inaction and non-fulfillment of what ought to be done are considered to constitute the real problem. It is no accident that Caney in his 40 pages overview article[30] devotes little more than half a page to 'Mitigation and Alternative Energy Sources', where he shortly mentions the possible negative effects of hydroelectric power generation, first generation biofuels and nuclear energy. The 'theoretical problems' outlined by Gardiner[31] pertain almost exclusively to normative problems of, say, exercising one's responsibilities in relation to future generations or the missing representation of future generations in current processes of decision making.

However, it is implausible to assume that we are able to set a target and to determine the necessary responsibilities and burdens without knowing in considerable detail how the target can be achieved in the first place. Caney considers as a possible response to *non-compliance* attempts to

[26] Caney, "Climate Change and Non-Ideal Theory" (fn.12).
[27] See, e.g., Caney, "Cosmopolitan Justice" (fn. 17); Simon Caney, "Climate Change, human rights and moral thresholds," in: Stephen Humphreys (ed.), *Human Rights and Climate Change*, New York: Cambridge University Press, 2010, 69-90; Caney, "Climate Justice" (fn.12); Shue, *Climate Justice* (fn. 17); Henry Shue, "Historical Responsibility, Harm Prohibition, and Preservation Requirement: Core Practical Convergence on Climate Change," *Moral Philosophy and Politics* 2,1 (2015), 7-31.
[28] Caney, "Climate Change and Non-Ideal Theory" (fn.12).
[29] Kirstin Shrader-Frechette, *What Will Work: Fighting Climate Change with Renewable Energy, Not Nuclear Power*, New York: Oxford University Press, 2011.
[30] Caney, 'Climate Justice' (fn.10).
[31] Gardiner, "In Defense of Climate Ethics" (fn.11), see also Gardiner, *A Perfect Moral Storm* (fn.20), ch. 7 and 8.

decarbonize by imposing burdens on others, e.g., by using biofuels or nuclear energy.[32] However, could there be a burden-free way to decarbonize in the first place? How does Caney know that the required decarbonization of the global energy systems could be achieved without nuclear energy? Besides, there are many indications that, at least currently, it would be awfully difficult, if not impossible, for a poor country to develop and to overcome energy poverty with solar (photovoltaic) and wind energy.[33] The reason for this is the low energy density and power density of these renewables. The need for required materials and *space* would be enormous. Vaclav Smil calculates that trying to cover a quarter of the global demand of electricity by 2030 with the help of wind turbines 'would require roughly 450 million tons of steel' for highly efficient turbines alone. 'To make the steel required for wind turbines that might operate by 2030, you'd need fossil fuels equivalent to more than 600 million tons of coal.' To this the materials and energy for producing the airfoils (each 60 meters long and weighing 15 tons) of the wind-turbines would have to be added.[34]

If it is 'difficult' to develop with decarbonized energy systems, then setting the target turns out to be much more difficult than usually assumed. For there are possible conflicts between overcoming poverty and avoiding a certain level of global warming. From the standpoint of an individual country, it may be both rational and morally justified to prioritize one's adaptation capacity over mitigation. This is not the global alternative between economic growth or adaptation on the one hand and mitigation or limiting global warming on the other hand, which Caney has convincingly criticized.[35] It is the country-specific alternative a poor country may be confronted with between a rapid economic development with the help of energy dense fossil fuels, possibly domestic coal, and an unprecedented and uncertain carbon-free economic development.

Caney criticizes such a strategy as being counterproductive because the country will also suffer itself the consequences of dangerous climate change. Besides he stresses the increased deaths as a consequence of accepting a higher target of global warming.[36] This is not convincing, for at least three reasons. First, the chances of the combined global actions necessary for meeting a more ambitious target may be much more uncertain than the chances of one's own fossil fuel driven economic development. Second, the lives saved and improved by this path may outnumber and be more certain than the lives endangered by the increase in global warming. Third, the then (much) more wealthy country may be much better able to adapt to the consequences of increased global warming. Consider the example of China. Would we climate ethicists have been justified to advise it at the end of the 1970s against its development path?[37]

Thus, contrary to the widely held belief in climate ethics that we already know how to decarbonize the global energy systems, how to effectively mitigate and how to strike the right balance between mitigation and adaptation, the very opposite seems to be the case. Without denying the consequences of the active resistance against effective climate policies,[38] we argue that this lack of

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32 Caney, "Climate Ethics and Non-Ideal Theory" (fn.12).
33 See Arthur A. Van Benthem, "Energy Leapfrogging," *Journal of the Association of Environmental and Resource Economists* 2,1 (2015), 93-132.
34 Vaclav Smil, *Numbers Don't Lie: 71 Things You Need to Know About the World*, New York: Viking, 2020, 147, 148f.
35 Caney, "Climate change, energy rights, and equality" (fn.3).
36 Caney, "Climate Change and Non-Ideal Theory" (fn.12).
37 "The fruits of growth: Extreme poverty is history in China, officials say," *The Economist*. (2021, January 2nd – 8th), 41f.
38 See Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*, New York: Bloomsbury, 2010; Matto Mildenberger, *Carbon Captured: How Business and*

knowledge may be one of the main impediments to effectively combating global climate change. Elizabeth Cripps has convincingly argued that individuals have mainly 'promotional duties'.[39] They should try to push for the required political actions or measures.[40] But what exactly would they push for?[41]

Arguably, Climate Ethics 1.0 represents one of the most important developments in applied and political ethics. It has undertaken pivotal normative investigations and developed lasting normative distinctions and arguments. However, there is an urgent need to expand it to Climate Ethics 2.0, which is prepared to the difficult undertaking of becoming more fact-oriented, less abstract and more specific. Only with this expansion will climate ethics be able to contribute to the thorny task of finding ways to decarbonize the global energy systems which are both effective and morally defensible.

Specific normative judgments are always mixed judgments, i.e., their normative or evaluative part is always related to certain factual assumptions. To give a simple example: The prohibition to throw without any precaution a heavy object out of a window combines assumptions that someone could be hit and harmed by the object with certain normative evaluations of harming an innocent person. The problem is that combating climate change and decarbonizing the global energy systems involve so many different and complex 'factual' problems that no one does or can possess the needed knowledge. One may call this *the problem of the needed knowledge base*. Scientific research is predominantly characterized by (increasing) specialization. However, here we are confronted with the task of bringing together different knowledge bases both within and between the disciplines. But this 'interdisciplinarity' would require a sort of hyper-knowledge which is principally impossible. One can only try to approach it in second-best, third-best etc. solutions. The use of all kinds of computer-based modelling is an attempt of overcoming some of the problems (which, fortunately, interests the philosopher of science).[42] It is important, we would say indispensable, that climate ethics confronts the problem of the needed knowledge base. For, first, the normative perspective offers *considerations of relevance* which can help to see what kind of knowledge is needed. Second, it has or should have something to say on the normative questions involved by inevitable uncertainty. Third, the many specific options involve difficult normative questions which require in-depth investigations. Thus, besides assisting the required 'interdisciplinarity' the climate ethicists must be prepared to specialize. All this involves many methodological problems. Climate Ethics 2.0 is not a finished discipline but an urgent task.

Labor Control Climate Politics, Cambridge, Mass.: MIT Press, 2020; Leah Cardamore Stokes, *Short Circuiting Policy: Interest Groups and the Battle Over Clean Energy and Climate Policy in the American States*, New York: Oxford University Press, 2020.

39 Elizabeth Cripps, *Climate Change and the Moral Agent: Individual Duties in an Interdependent World,* Oxford: Oxford University Press, 2013.

40 Cf. also Caney's treatment of 'second order responsibilities' in Simon Caney, "Two Kinds of Climate Justice: Avoiding Harm and Sharing Burdens" (fn.12).

41 This problem is raised and discussed in-depth in connection with touristic flights by Anna Luisa Lippold, *Climate Change and Individual Moral Duties: A Plea for the Promotion of the Collective Solution*, Münster: Mentis, 2020. Lippold builds on and tries to improve Cripp's approach.

42 See, e.g., Wendy Parker, "Computer Simulation, Measurement, and Data Assimilation," *The British Journal for the Philosophy of Science* 68 (2017), 273-304; Eric Winsberg, *Science in the Age of Computer Simulation*, Chicago: University of Chicago Press, 2010; Eric Winsberg, *Philosophy and Climate Science*, Cambridge: Cambridge University Press, 2018.

3.2 The Need for Developing Realistic Scenarios of Net-Zero Global Energy Systems

If the claim is correct that, contrary to the wide-spread beliefs held by climate ethicists and climate activists, we do not know how to decarbonize the global energy systems to net-zero,[43] it will be a central task to develop scenarios of how a viable and sufficiently decarbonized global energy system can look like.

Here, an essential question will be whether the scenario is *exhaustive*.[44] It must really comprise *all* areas of energy use, thus not only electricity generation, but also the uses of energy in industry, agriculture, buildings and in all kinds of transportation, including heavy haulage, shipping and aviation. An especially thorny task will be the decarbonization of the production of materials like ammonia, plastics, steel and cement, which, as Vaclav Smil points out, constitute the 'pillars of modern civilization'.[45] They currently contribute to 31% of the annual greenhouse gas emissions.[46]

In addition, it must be sorted out whether the energy systems of the scenario are *truly decarbonized*, i.e., whether they are suitable for achieving net-zero emissions. This will require relevant life cycle analyses of the pertinent technologies and processes. We want to cite only three examples here. We already mentioned the low energy density of wind turbines and photovoltaic installations and the resultant material requirements of these renewable energy systems. How climate neutral can the needed materials be mined and processed, and the required installations be produced and disposed of? The production and disposal of battery-driven electric cars currently involves huge climate gas emissions. So, can this technology and strategy be a viable part of a scenario of a decarbonized energy system? Similar problems are connected with the production of first- and second-generation biofuels, and it would be enormously challenging to make sure that the production of third-generation biofuels, e.g., out of the lipids of marine microalgae, will be truly climate-neutral.

A third question to be answered is of whether a scenario is sufficiently *widescale*. Will it be able to adequately cope with the current and future energy needs? Will energy provided in an amount sufficient to overcome the energy poverty of billions of people who have no (reliable) access to electricity? – The expectable energy demand constitutes a variable which is difficult to determine. Take as an example the fuel requirements of future air travel. To determine them, one could orient oneself by the global growth rates of air travel as they existed before the corona crisis set in. Or one could assume that people ought to fly less[47] and that such a norm and corresponding regulations will be widely acknowledged. Depending on the guiding assumptions, the respective scenario will, say, allow either for aviation fuel out of marine microalgae[48] or hydrogen-driven

[43] If one doubts this, one should ask oneself whether the existing scenarios really outline a functioning decarbonized global energy system. Often the scenarios are neither global nor decarbonized, nor do they offer any prospect that they could function.

[44] See also Bill Gates, *How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need*, London: Allen Lane 2021.

[45] Vaclav Smil, *How the World Really Works: A Scientist's Guide to Our Past, Present and Future*, London: Viking, 2022, ch. 3, see also Vaclav Smil, *Still the Iron Age: Iron and Steel in the Modern World*, Oxford, Cambridge, Mass.: Butterworth-Heinemann, 2016.

[46] Gates, *How to Avoid a Climate Disaster* (fn. 44), 55.

[47] Cf. Cafaro, "Beyond Business as usual" (fn.16), 202f.

[48] See, e.g., Teresa M. Mata, António A Martins, and Nidia S. Caetano, "Microalgae for biodiesel production and other applications. A review," *Renewable and Sustainable Energy Reviews* 14 (2010), 217-232; Jonah Teo Teck Chye, Lau Yien Jun, Lau Sie Yon, Sharadwata Pan, and Michael K Danquah, "Biofuel production from algal biomass," in: Oczan Konur (ed.), *Bioenergy and Biofuels*, Boca Raton et al: CRC Press, 2018, 87-117.

engines.[49] Thus, a decision must be made whether the planes of a carbon free future can (in the case of biofuels) fly largely with the existing propulsion technology or whether they need (in the case of hydrogen use) to be largely redesigned. Both the biofuels and the hydrogen would, of course, have to be produced in sufficient quantity in a climate neutral way.

A fourth question to be answered is of whether the envisioned energy systems in a scenario will be *viable* and *reliable*. Will it be possible to cover the energy demand in a dependable way? Does the scenario sufficiently guarantee *energy security*?

A fifth question to be answered is of whether the components of a scenario are *acceptable*. How are, e.g., the risks of carbon capture and storage or of nuclear energy to be evaluated?

Finally, an important sixth question to be answered is of what the *chances of implementing* the scenario are. Will it be possible to implement the scenario fast enough? What resistance against constitutive parts of the scenario is to be expected?

3.2 National Decarbonization Strategies, Transition Scenarios, and Economic Development

Climate change is a global problem which can only be solved globally. Obvious as this may sound, it is an important and morally relevant consideration for any national climate policy and climate related energy policy. For any tangible national decarbonization strategy will require sacrifices and impose costs and risks and will therefore interfere with the rights of the citizens or inhabitants of a country. Such interference can only be justified if the policies are effective, i.e., give sufficient reason to expect that they actually contribute to the solution of the problem. The citizens must demand effective policies from their governments, must support or contribute to the development of such policies according to their capabilities and must then back them.

Thus, any national climate policy and climate related energy policy must aim for the best possible global focus and relevance. It is both important and difficult to spell out what this requirement amounts to. There will be (huge) differences between countries depending on differences in wealth, capabilities, influence and power. Here, we must confine ourselves to mention only a few general points which are especially pertinent for rich countries.

First, a country must make sure that its policies actually contribute to a reduction in *global* greenhouse gas emissions. Thus, as emphasized by Dieter Helm,[50] it must avoid the mere semblance of emission reductions through the translocation of production. Rich countries which deindustrialize and shift their production to, say, China do thereby not reduce emissions but may, on the contrary, contribute to their increase. Therefore, as Helm stresses, the measurement of the emissions of a country or a region must comprise the *consumption* of products, i.e., must cover the emissions which accrue during the production and transport of the commodities consumed in the country or region.

Similar considerations apply to the decommissioning of a coal-fired power plant. Not much will be achieved if in consequence electricity from abroad has to be purchased which is produced in power plants with much lower environmental standards. If the closure of a lignite-fired power plant

[49] See, e.g., Ramesh Agarwal, Fayette Collier, Andreas Schäfer, and Allan Seabridge (eds.), *Green Aviation*, Chichester: Wiley, 2016; Emily S. Nelson and Dhanireddy R. Reddy (eds.), *Aviation: Reduction of Environmental Impact Through Aircraft Technology and Alternative Fuels*, Boca Raton et al.: CRC Press, 2017.

[50] Dieter Helm, *The Carbon Crunch: How We're Getting Climate Change Wrong – And How to Fix it*, 2nd edition, New Haven: Yale University Press, 2015; Dieter Helm, *Burn Out: The Endgame for Fossil Fuels*, New Haven: Yale University Press, 2017; Dieter Helm, *Net Zero: How We Stop Causing Climate Change*, London: William Collins, 2020.

will prompt businesses like cement mills, which have high energy needs, to move abroad in the vicinity of an even more climate-unfriendly power plant then again not much will be achieved.

Second, a country must avoid measures which are counterproductive. An example for this may be the premature shut-down of nuclear power plants even if this requires additional or prolonged electricity generation by coal-fired power plants.[51] Such a policy was an integral part, if not the most important aim, of the original design of the German *Energiewende* and was re-enacted in response to (the fears raised by) the nuclear accident in Fukushima in 2011. We will cover nuclear energy in more detail below. Here, we would like to stress that whether or not a measure is counterproductive may involve intricate normative questions whose clarification is an important task of climate related energy ethics. Concerning the example, a candid and careful evaluation of the risks of the further use of existing nuclear power plants in a rich country against the risks of the additional or further use of advanced coal-fired power plants is needed. Those who criticize the premature shut-down of nuclear power plants as counterproductive stress not only the increase in and connected dangers of greenhouse gas emissions, but also the thousands of additional premature deaths caused by the particulate matter emitted by the added or maintained coal-fired power plants.[52]

Third, it is important to distinguish whether a measure could be a part of a target scenario or only be a part of a viable and justifiable transition scenario. Again, whether a transition scenario is viable and justifiable involves a mixture of many 'factual' and normative questions. Consider, e.g., the current state of the above-mentioned battery-based e-mobility. The production and disposal of the required lithium batteries involves high greenhouse gas emissions so that its current use in electric cars constitutes not much of an improvement in comparison to cars with advanced combustion engines (and if the electricity with which the batteries are loaded is generated by coal-fired plants the footprint of the electric car will be even worse). Thus, the (current) battery driven electric car could not be part of a viable scenario of truly decarbonized energy systems. Could it be part of a viable and justifiable transition scenario? This will be the case if the technology prepares the way to the decarbonized energy system in due time. The technology cannot be a part in a transition scenario if it will lead to lock-in of a technology which will not be sufficiently free of climate gas emissions. It can be part of the scenario if it is to be expected that it will prepare the way to a sufficiently carbon free car traffic and contribute to a pioneering infrastructure of, say, charging points and quick charging systems. Probably, for the time being, other technological solutions of the decarbonization of car traffic must be pursued as well. The important point to note is that a policy pursuing a seemingly climate-friendly technology may be misguided.

Thus, fourth, possible candidates that form part of a transition scenario must be carefully evaluated. This pertains, e.g., to the proposal to use natural gas as a transition energy. Natural gas, it is argued, should quickly replace coal as this would lead to substantial reductions of the global CO_2-emissions. In the meantime, via massive research and development, the considerably more efficient renewable energies of the future should be developed.[53]

There are several problems connected with this proposal. First, it seems not to be guaranteed that the climate record of natural gas is better than that of coal. While the burning of natural gas

[51] This is argued, e.g., by Reinhard Wolf, "Why wealthy countries must not drop nuclear energy: coal power, climate change and the fate of the global poor," *International Affairs* 91 (2015), 287-301; Rauli Partanen, Janne M. Korhonen, *The Dark Horse: Nuclear Power and Climate Change*, Asikklala, Turku: Author's Edition, 2020, 65-76.

[52] See also Pushker A. Kharecha, James E. Hansen, "Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power," *Environmental Science and Technology* 47 (2013), 4889-4895.

[53] Helm, *The Carbon Crunch* (fn. 44).

does indeed involve less CO_2 than the burning of coal, the production, transport, refining and distribution of natural gas are connected with considerable methane emissions which are both difficult to measure and to control.[54] While methane stays in the atmosphere much shorter it is a much more potent climate gas than carbon dioxide. Thus, the respective climate impacts are difficult to compare. The near-term warming effects of gas-powered plants may be worse than those of coal-fired plants if the connected methane leakages are high.[55] Second, the implementation of gas-powered plants on a grand scale will probably lead to the lock-in of a further fossil fuel-based infrastructure and will create expectations and incentives to make use of the new plants over their full lifetime. This would make it impossible to combat climate change in the required time frame. Third, it is not unproblematic to postpone the implementation of new technologies for the sake of the more efficient technologies of the future, especially if the implementation needs time due to necessary changes in infrastructure and habits. This risks that the new technologies will come too late. Besides, it may miss potentials for improvement which suggest themselves in the context of the use of the technologies. Finally, as there may always be potential for even more efficiency improvements, the strategy may have a built-in incentive for constantly delaying implementation.[56]

Fifth, climate related energy policies must be comprehensive, ambitious, realistic and error friendly. The policies must pertain to all parts of the energy sector and must aim at decarbonizing it as soon as possible. This will require the development and implementation of new methods and technologies and supportive measures to make the new technologies economically competitive.[57] It will not only require making the existing electricity generation carbon free, but a massive scale up of electricity production in order to use this electricity for the decarbonization of traffic, for the climate friendly production of hydrogen, possibly for the production of synthetic fuels, for heating and in industrial processes. The buildup of renewable energies like photovoltaic and wind will require new power grids which are not only able to take up potentially huge but varying amounts of decentrally produced electricity but are also able to quickly carry the electricity to different parts of a country or region and thus to balance the regional differences in wind and sunshine.

It is unclear and a matter of dispute how quickly and how extensively the electricity needs can be covered by renewable energies like wind and solar. This pertains both to the amount of electricity which can reliably be produced by these renewables and to the strategies to deal with the intermittency of wind and sunshine (of which the buildup of suitable power grids is just one). It is here that realistic and candid assessments, and a careful evaluation of the involved risks are needed. For instance, energy security must not be endangered. The attempt to back up the renewables with a baseload from gas-powered plants may fulfill the requirement of energy security but may risk a lock-in of emissions from fossil fuels and thus run counter to the mitigation of climate change.

Sixth, the governments of rich countries must massively invest in research and development concerning the technologies needed for truly decarbonized and otherwise climate friendly energy

[54] Jonathan Stern, *Methane Emissions from Natural Gas and LNG Imports: An increasingly urgent issue for the future of gas in Europe*, Oxford: The Oxford Institute for Energy Studies, 2020.

[55] Xiaochun Zhang, Nathan P. Myhrvold, and Ken Caldeira, "Key factors for assessing climate benefits of natural gas versus coal electricity generation," *Environmental Research Letters* 9 (2014), 114022; see also Nathan P. Myhrvold, Ken Caldeira, "Greenhouse gases, climate change and the transition from coal to low-carbon electricity," *Environmental Research Letters* 7 (2012), 014019.

[56] Steigleder, "The Tasks of Climate Related Energy Ethics" (fn. 13).

[57] Gates, *How to Avoid a Climate Disaster* (fn. 44).

systems and must create an environment which facilitates the demonstration and possible roll out of pertinent innovations.[58] This must in all probability include a credible policy of gradual increases in the prize of carbon in fossil fuels and other commodities via a system of carbon taxes and tariffs or cap and trade.[59] Such measures will possibly best work when done jointly on an international level.[60] As the effects of these measures will be regressive, they must be carefully designed in order to avoid hardships for poor people.

Above, we already hinted to a possible dilemma between economic development and mitigation. From the perspective of a poor country, there might be an imperative to favor economic development with the help of energy dense and relatively cheap fossil fuels. For this constitutes a proven means of overcoming energy poverty and poverty in general, and the acquired economic wealth will enable the country to better protect itself from ('adapt to') the consequences of climate change. At the same time, it is uncertain whether a global transition to climate friendly energy systems and the necessary curtailing of greenhouse gas emissions in agriculture, land use and food production will be achieved in due time so that climate change can be stopped at a level tolerable for the inhabitants of the poor country. However, from a collective or global perspective these individually well-founded considerations will lead to a global catastrophe if they lead to a commonly employed strategy of 'rapid development through extensive fossil fuel use' of poor countries. If (i) it will not be possible to fulfill the global energy needs with renewable energies in due time, or if (ii) it is improbable that a poor country could develop with energy sources which are characterized by low energy and power densities in due time, or if (iii) a poor country will not be able to pay for and to employ the massive amount of wind turbines and photovoltaic panels needed to fulfill its energy needs and if (iv) current development aid already founders on much smaller tasks than a corresponding buildup of the required renewable energy-based infrastructure in a poor country, it will only be possible to avoid a catastrophe if an energy and power dense low carbon energy source could be employed in sufficient quantity in due time. As far as we can see, there is currently only one candidate for such an energy source: nuclear energy.

4 Is There a Need for Nuclear Energy?

It seems to be nearly impossible to have an unagitated discussion of nuclear energy. On the one hand it is increasingly argued that we will not be able to mitigate climate change successfully without nuclear energy.[61] The reasons for this claim were already hinted to. Nuclear energy is both energy

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[58] Gates, *How to Avoid a Climate Disaster* (fn. 44), ch. 10 and 11.

[59] See, e.g., Shi-Ling Hsu, *The Case for a Carbon Tax: Getting Past Our Hang-Ups to Effective Climate Policy*, Washington, DC: Island Press, 2011; Paul Ekins, "Policies and conclusions," in: Paul Ekins, Michael Bradshaw, Jim Watson (eds.), *Global Energy: Issues, Potentials, and Policy Implications*, Oxford: Oxford University Press, 2015, 538-568, 562f. For a skeptical view on carbon pricing, see Anthony Patt, *Transforming Energy: Solving Climate Change with Technology Policy*. New York: Cambridge University Press, 2015, ch. 4

[60] Cf. William Nordhaus, "Climate Clubs: Overcoming Free Riding in International Climate Policy," *American Economic Review* 105 (2015), 1339-1370; William Nordhaus, "The Climate Club: How to Fix a Failing Global Effort," *Foreign Affairs* 99,3 (2020), 10-17.

[61] See, e.g., Mark Lynas, *Nuclear 2.0: Why a Green Future Needs Nuclear Power*, Cambridge: UIT, 2013; Michael H. Fox, *Why We Need Nuclear Power: The Environmental Case*, New York: Oxford University Press, 2014; Wade Allison, *Nuclear is for Life: A Cultural Revolution*, York: York Publishing Services, 2015; Scott L. Montgomery and Thomas Graham Jr., *Seeing the Light: The Case for Nuclear Power in the 21st Century*, Cambridge: Cambridge University Press, 2017; Steven Pinker, *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress*,New York: Penguin Books, 2018; Partanen and Korhonen, *The Dark Horse* (fn. 52); Shellenberger, *Apocalypse Never* (fn. 5); Gates, *How to Avoid a Climate Disaster* (fn. 44).

and power dense and low carbon. Thus, it could supplement the renewables like wind and solar. This is both important for solving the intermittency problem and the capacity problem of wind and solar. It is doubtful that the existing and future electricity needs could be covered by wind and solar (or other renewables). (There might be exceptions for countries who have, say, huge resources for waterpower or of terrestrial heat at their disposal.) As already mentioned, massive amounts of additional electricity will be needed for bringing down the greenhouse gases in the energy sectors different from power generation, e.g., in order to produce hydrogen in a climate friendly way and to use it not only for energy storage, but also as a fuel or as a component of synthetic fuels or in order to use the electricity for the heating and cooling of buildings. Nuclear energy could also be used for the high energy needs in industrial heating, e.g., for the production of steel and cement, and in desalination. Furthermore, nuclear energy could ensure that the energy needs connected with climate friendly economic development can be met. It is criticized that the proponents of a strategy of 100% RE (renewable energy) underestimate the quantity and quality of the energy needs in poor countries.[62]

The direct reply to such arguments consists in the claims that, first, nuclear energy is not carbon free or low carbon and that with the depletion of high-grade uranium the greenhouse gas intensity of the nuclear fuel cycle will so much increase that before long the climate record of a nuclear power plant will not be better than that of a gas-fired plant, second, that the available global resources of uranium are probably too limited for allowing nuclear energy to be a long-term energy strategy, third, that nuclear power plants are so unreliable that they are unsuitable for overcoming the intermittency of renewables like wind and solar, fourth, that due to the long planning and permission processes and construction times nuclear plants are unfit to solve the global needs of climate friendly energy in due time, fifth, that nuclear energy is utterly expensive and therefore economically uncompetitive and that, sixth, the operation of nuclear power plants and of the connected infrastructure is technically so demanding that they are inadequate for the economic development of poor countries.[63]

These are, of course, arguments which need detailed scrutiny. As it is not possible to do this here, we will refrain from simply listing the replies of the proponents of a nuclear strategy. Suffice it to say that part of the strategy is to pursue so called advanced nuclear reactor concepts almost all of which include the use of breeders which do not need prior enrichment but would use (fertile) uranium-238 or thorium-232 and could reuse and better exploit the spent nuclear fuels of the last 60 years. Besides improved safety features and plans for 'maintenance-free' constructions, a main focus of the advanced nuclear reactor concepts is to standardize construction. The lack of standardization in nuclear power planning and building is considered to be the main cost driver of nuclear reactors.[64]

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[62] See Peter J. Loftus, Armond M. Cohen, Jane C.S. Long, and Jesse D. Jenkins, "A critical review of global decarbonization scenarios: what do they tell us about feasibility?" *WIREs Climate Change* 6 (2015), 93-112; B.P. Heard, B.W. Brook, T.M.L. Wigley, and C.J.A. Bradshaw, "Burden of proof: A comprehensive review of the feasibility of 100% renewable-electricity systems," *Renewable and Sustainable Energy Reviews* 76 (2017), 1122-1133; Partanen and Kohonen, *The Dark Horse* (fn. 45), 43-65; Shellenberger, *Apocalypse Never* (fn. 5), 22-249, 274-279.

[63] See, e.g., Shrader-Frechette, *What will work* (fn. 29); Benjamin K. Sovacool, *Contesting the Future of Nuclear Power: A Critical Global Assessment to Atomic Energy*, New Jersey: World Scientific, 2011.

[64] ETI (Energy Technology Institute). *The ETI Nuclear Cost Drivers Project: Full Technical Report*, Birmingham: Energy Systems Catapult, 2020.

The opponents of nuclear energy consider such concepts as being far-fetched, unrealistic, or dangerous. The perceived dangers of nuclear energy are of course the main reasons for opposing the technology. And the opponents of nuclear energy will probably not be calmed by the prospect of large numbers of future breeder reactors. Concerning nuclear energy, we are confronted with the remarkable phenomenon that the technology is both considered to be a very, if not the most, dangerous energy source and the safest energy source available. While many people hold that nuclear power plants are true killers because the radiation connected with the plants and the waste causes cancer in their vicinity and the nuclear accidents, especially at Chernobyl in 1986 and at Fukushima in 2011, killed (or will kill) hundreds of thousands people, others hold that the increased radiation levels connected with nuclear power plants and standardly stored nuclear waste are minimal and well below the variations in normal background radiation and that so far there are only 62 known deaths caused by the Chernobyl reactor accident and no known death directly caused by the Fukushima reactor accidents (as opposed to the deaths caused by the evacuation measures).

Needless to say, the members of the two camps often have strong opinions about the other side. The not-(really)-to-be-feared-side tends to consider the members of the to-be-feared-side to be irrational or ideologically fixated. The to-be-feared-side tends to consider the members of the not-(really)-to-be-feared-side to be ignorant, callous or economically interested. Sometimes members of one camp defect to the other side and their stories resemble stories about a religious conversion.

One may consider overcoming the divide hopeless. However, to answer the question of whether it is at least unlikely that a climate catastrophe can be avoided without a massive scale-up of nuclear energy is of the utmost importance. One may consider the clarification of the potential role of nuclear energy in climate change mitigation to be one of the most important questions of climate related energy ethics and energy politics. If so, there is both a need and an obligation to answer this and related questions as carefully and as impartially as possible. This will require a careful and impartial evaluation of the risks and chances of the existing and potential new technologies of nuclear reactors and will require an unbiased evaluation of the risks of ionizing radiation, of the problem of nuclear waste and the risks of nuclear proliferation. This will in turn require to take seriously the basic concerns of the respective camps. While one may be justified to hold certain elaborations of the other side to be alarmist, conspirational, ignorant or superficial, it would probably be wrong to hold that the other side lacks any justified concern. Besides, the (re)evaluation of nuclear energy will require to weigh the connected risks with the risks of climate change. This will constitute a challenge because risk ethics is still an underdeveloped field of normative ethics.[65] The use of diverse precautionary principles[66] and the emphasis on precaution can be understood as attempts to circumvent the theoretical deficits of risk ethics. This will possibly not work when faced with the task of evaluating the nuclear strategy because it may not be obvious how and on what side precaution must finally be exercised.

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[65] See, e.g., Madeleine Hayenhjelm and Jonathan Wolff, "The Moral Problem of Risk Impositions: A Survey of the Literature," *European Journal of Philosophy* 20, S1 (2012), E26-E51; Sven Ove Hansson, *The Ethics of Risk: Ethical Analysis in an Uncertain World*, Basingstoke: Palgrave Macmillan, 2013; Sven Ove Hansson, 'Risk', *Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta (Fall 2018).

[66] See Daniel Steel, *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy*, Cambridge: Cambridge University Press, 2015; Hartzell-Nichols, A *Climate for Risk* (fn. 1).

5 Conclusion

In this article we have tried to show that climate related energy ethics is not yet an established discipline, but an urgent task. For its fulfillment it is important to realize that it is necessary and utterly difficult to decarbonize the global energy systems and make them otherwise climate neutral as fast as possible and that we do not yet know in sufficient detail how to do this. Climate ethics and climate related energy ethics must take on the challenge to contribute to the search for solutions. For both the general requirements and the possible detailed steps necessary to solve the problems involve numerous morally normative questions. Therefore, *on the solution side* climate ethics and climate related energy ethics must become much more 'fact'-oriented. On the one hand, they must try to contribute to the orientation of the general multidisciplinary requirements. On the other hand, they must specialize in order to contribute to the many detailed problems in all parts of the energy sector and to evaluate the different strategies for solving the problems. We have argued that currently one of the most important tasks of climate related energy ethics consists in the clarification of the potential role of nuclear energy in climate mitigation. The careful and impartial examination of the involved problems may itself constitute a moral obligation.

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