12 Climate change and energy challenges

12.1 Introduction

In the 2011 edition of this work, we did not devote a separate chapter to climate change and energy, but in light of (1) the Paris Agreement on Climate Change, (2) the increased acknowledgment that energy, not dollars, or euros, or renminbi, is the "real currency" of industrial nations (Morgan 2013), and (3) the realization that neither traditional national or international environmental law, nor traditional industrial policy, can be depended upon to bring about the needed changes, the subject is addressed here.

Other environmental and industrial challenges may lend themselves more easily to suggested reforms discussed earlier throughout this work or in the last chapter where generic recommendations to improve environmental, industrial, economic welfare, and employment prospects are found, but not the challenges posed by climate change and energy.

Why are climate change and energy different? First, reducing the adverse effects of climate change requires both continuous and long-term changes in greenhouse and toxic emissions. Second, industrial policy interventions must be designed for long-term effectiveness. Short-term solutions – involving technological changes in extraction, transmission, and utilization of electricity, as well as in agriculture, forestry, and land use – make the needed long-term solutions hard, unlikely, or impossible to achieve (Sachs et al. 2015). Third, limits in the availability of useful energy (defined as *exergy* – see Sections 3.2.3 and

3.5 in Chapter 3) is reducing the prospect of high long-term growth (Ayers 2006). Fourth, perhaps more than in other areas, both supply-side (production) and demand-side (consumption) policies must be devised and coordinated. Fifth, energy demands of some economic regions (e.g., Europe) and the profit-driven need for others to supply energy (e.g., Russia) renders geopolitical concerns important. Sixth, the energy content (and un-internalized social cost of carbon) of products and services involved in trade amongst nations challenges traditional trade regimes and requires changes in global accords. And finally, incumbent industrial actors, rather than the purveyors of better (i.e., more sustainable) technologies and policies, dominate the national and global political agendas.

Jeffrey Sachs et al. (2015) have raised the need for deep decarbonization involving changes that go beyond the commitments made in the Paris Agreement. Analyses of options and prospects can be found for both the United States (E3 2014, 2015; Gerrard and Dernbach 2018) and for the European Union (Ashford and Renda 2016). The E3 reports are part of a larger U.S.-focused project on deep decarbonization, the Deep Decarbonization Pathways Project (DDPP 2014, 2015a, 2015b). See also the 2017 Wuppertal report *Realising Long-Term Transitions Towards Low Carbon Societies* and the 2017 IDDRI report *Developing 2050 Decarbonization Strategies in the EU: Insights On Good Practice From National Experiences* (Sartor et al. 2017).

Resilience or adaptation strategies are also important (Magnan et al. 2015), but they are not a substitute for longer-term prevention approaches vis-à-vis climate change and other sustainability challenges.

There are a number of myths and misconceptions, which must be dispelled if effective action is to be undertaken towards deep decarbonization. In this chapter we address nine myths (Ashford and Renda 2016) and explore the strategies and combinations of public and private sector actions that could significantly address the looming climate change and energy challenges. See also a complementary compilation of myths by Aiginger (2016).

12.2 Myths on innovation, sustainable development, and the low-carbon economy that need to be dispelled to devise effective strategies

12.2.1 Myth #1: It is possible to realize mutual gains in industrial competitiveness, reduction of GHGs, and employment

In European policy circles there is an explicit belief in this myth represented by the industrial policy strategy called Europe 2020, although it is now being seriously questioned (ESPAS 2015). The myth also persists among some optimistic industrial policy strategists on the right. We believe it is wishful thinking. What may be possible are mutual gains in *economic welfare*, reduction of GHGs, and employment. However, significant gains in private-sector profit or even GDP may not necessarily be possible or desirable, and policies will increasingly create both winners and losers, with consequent distributional effects. The limitations of both GDP and productivity as adequate metrics for economic welfare and predictors of employment are by now well recognized (see Ashford and Hall 2011a; and Section 1.1.1 in Chapter 1).*

* There is good GDP and bad GDP. All GDP measures reflect expenditures related to transactions which are as different as selling cars and treating lung disease caused by air pollution from those cars. See, inter alia, Philipsen, D. (2015), *The Little Big Number: How GDP Came to Rule the World and What to Do about It*, Princeton University Press.

The distinction between policies directed toward increasing traditionally defined competitiveness and those directed towards enhancing economic welfare is that the former is profit-driven and best informed by GDP, while the latter is human-needs (or end-use functions) driven – including employment – and described by other and broader metrics – see i24c (2016a). The term "competitiveness" is now commonly used in policy discussions. However, an alternative use of the term is that it is not restricted to profit, increases in GDP, or market share derived from the usual private-sector-dominated metrics, but rather also includes societal measures of economic and social welfare, including employment. See especially Aiginger et al. (2013), who argue for a more comprehensive definition of competitiveness.

12.2.2 Myth #2: Technological innovation in products and services is essential to achieving deep decarbonization in industrial nations. It is argued that there is a serious "innovation deficit"

In order to sensibly discuss the diffusion/innovation debate, it is useful to recount the sources of greenhouse gas emissions. Transportation/mobility, housing/shelter, and food/nutrition not only account for ~ 80 percent of Europe's resource use and ~ 60 percent of its household expenditures (i24c 2016a), they are also the areas of economic activity that consume energy and materials, and provide services that lead to significant greenhouse gas (GHG) emissions and environmental contamination. The United States is not very different (Houser 2013). The energy/electricity industry extracts, refines, produces, and transmits energy that powers the industrial system, and the industrial system supplies the materials and physical capital that are essential for the economic system to function successfully.

By design, the world is driven by what Daly (2008) calls a "throughput mentality," where externalities that accompany the production and consumption of goods and services are rarely or insufficiently internalized. Both production and consumption are encouraged and subsidized, creating a pseudo-equilibrium, which occasionally collapses as a result of a financial bubble (Ayres 2015; Stiglitz 2010). The rules under which industrial economics operate do not favor conservation, energy efficiency, or the essential determinants of growth.* Not only is there a serious absence of rules dealing with the various compromises to sustainability, there is a deficit of monitoring, enforcement, and compliance of the rules that do exist.

Beyond improvements addressing the externalities contributing to GHGs emissions and pollution (what comprises an overarching environmental policy approach), the policies are not directed towards transformation of the industrial system involving (1) a very low carbon system, (2) low-waste value chains associated with the economic activities mentioned above, and (3) a circular economy related to enhancing dematerialization and de-energizing the production of goods and services (see Ekins et al. 2015). These could comprise a re-designed industrial policy approach. Together they constitute an integrated sustainable industrial policy for the environment, a kind of industrial ecosystem, as some have called it. While both innovation and diffusion might be important for improving both the environment and economic welfare, they are not magic bullets, nor is the optimal balance among them likely to be the same for addressing the different sources of GHG emissions. Both supply-side and demand-side policies are in need of reexamination and re-design.

* For a provocative report addressing the necessity of a new approach, see Stiglitz (2015) "Rewriting the Rules for the American Economy: An Agenda for Growth and Shared Prosperity." See also Dernbach (2011) "Creating the Law of Environmentally Sustainable Development."

There are a number of reports and studies addressing the goal of decarbonization, but Ahman and Nilsson's (2015) stands out for its conciseness and focus on manufacturing.

Despite considerable evidence that a diffusion deficit rather than an innovation deficit characterizes the need to deploy existing technological approaches, articles and reports continue to reinforce the latter. Especially revealing is the article in *Foreign Affairs* by Sivaram and Norris (2016) entitled "The Clean Energy Revolution: Fighting Climate Change with Innovation." The emphasis is to support R&D on the power grid, citing the importance of the Breakthrough Energy Coalition, involving twenty-eight investors from ten countries, unveiled by Bill Gates and President Obama's announcement of the formation of Mission Innovation involving a twenty-country commitment focusing on power generation and transmission, and arguing for future public–private partnerships to advance the needed innovation.

Romm (2016) offers a convincing debunking of this perspective, arguing that "the truth is that we have dawdled so long on serious climate action that we must rapidly slash CO_2 emissions, which requires over 100 times more money spent on deployment [diffusion] than R&D." Further, based on the history of successful innovation, Romm argues that we should not expect that breakthrough technologies can be developed in time. Looking a little deeper at the debate, when the term R&D is used, sometimes advocates are arguing for basic R&D, and sometimes moving technologies from bench or lab up to practical scale are intended by that term, such as what is reflected in the U.S. ARPA-E endeavor. The difference is important. It is crucial that semantics do not obscure important differences in what is being advocated or planned. A focus and clarity on the details of specific projects, and what is being specifically recommended, would help the policy planning process. In this regard, the reader is referred to a recent report by i24c (2016b, p. 32) in which it is stated that in "the energy sector, Europe has no ideas deficit, but in many instances, a deployment [diffusion] deficit."

As explored in Chapter 6, the technology innovation *process* consists of invention, innovation, and diffusion. There are a number of analysts – e.g., Amory Lovins (2011) and Robert Ayres (2016) – who argue that many technologies already exist that could be defused into use. However, they suffer from inadequacies in appropriate market and regulatory signals, insufficient market demand, and/or lock-in due to inappropriate policies and agency capture by incumbent technology providers.[*] Further, more than *technological* innovation is needed. Institutional, organizational, and societal/social innovation are also essential and should be always kept in mind by policymakers in order to avoid missing the bigger picture of what innovation can do for long-term societal well-being.[†]

12.2.3 Myth #3: Innovation per se fuels the industrial state and creates jobs

Much innovation in products and processes simply employs more material (natural and physical capital) and energy, while fostering increases in GDP. Yet, as the labor content of production decreases, jobs are displaced, contributing to un- or underemployment in both blue- and white-collar professions (Brynjolfsson and McAfee 2014; Autor 2014; Autor et al. 2017; Acemoglu et al. 2014). As discussed under Myth #2, the United States, like Europe, may be suffering from a "diffusion deficit." A more nuanced innovation policy taking into account effects on employment of invention, innovation, and diffusion needs

* See Bhattacharjee and McCoy (2012) for an extensive incentives analysis influencing the diffusion of energy technologies. For earlier work focusing on options for achieving reductions in GHGs, see Pacala and Socolow (2004) and Blok et al. (2012). See also Erickson et al. (2015) and Marchant (2018).

† For example, Sachs et al. (2015) examine DDPPs without modeling new technologies, only looking at the ones commercially available or currently being tested.

to be adopted so that interventions in the appropriate part of the innovation cycle, e.g., deployment rather than basic R&D, can be used to achieve positive consequences for employment (Dechezleprêtre et al. 2016; Goldman Sachs 2016).

12.2.4 Myth #4: Governments cannot pick winners. Winners pick governments

The U.S. experience with aircraft, computers, the internet, space technology, and pharmaceuticals (to name just a few examples) clearly demonstrates the power of government funding of research, e.g., see the U.S. examples of DARPA and ARPA (Mazzucato 2014; Bonvillian and Van Atta 2011). In a recent contribution, Mariana Mazzucato convincingly argued that state-funded research (e.g., the ARPA-E in the U.S.) is achieving major breakthroughs in at least one of the key technologies that will provide a contribution to decarbonization, i.e., batteries for energy storage. In addition, while private sector efforts such as Elon Musk's Tesla have made important steps towards the production of "an existing, pretty powerful battery technology," ARPA-E has been pursuing technological innovation in the purest sense by "creating new ways of doing" things, which "have the potential to be significantly better" (Mazzucato 2016). Bill Gates himself acknowledged that only the state, in the form of public institutions like ARPA-E, can lead the way to an energy breakthrough (Gates 2012).

12.2.5 Myth #5: Industrial policy is synonymous with innovation policy

An industrial policy not only encompasses invention, innovation, and diffusion, it also envisions, *inter alia*, the training – and re-education – of scientists, engineers, data and ICT specialists, service and health care providers, etc., in addition to well-conceived employment and social policy options (Ashford and Hall 2011a and b). Trickle-down theory – often accompanied by the mantra "a rising tide raises all boats" – embodies the belief that economic advance in the private sector benefits the society and workers have been basically discredited. The economic crisis of 2008 stands out as a stark reminder of what a deregulated financial market results in. In a recent commentary on the relationship between industrial policy and innovation policy, with an aim to establish an "industrial compact" focusing on system changes envisioning techno-economic and sociotechnical transformations, Steward (2015, p. 17) argues that the industrial compact should be "broad [in] scope, have purposive directionality, deliver system transformation and rely on network capabilities"* and not expect that enhancing industry profit alone will benefit others in the society.

12.2.6 Myth #6: Regulation inhibits beneficial innovation

There is overwhelming empirical evidence that regulation – especially stringent regulation and standards – properly designed, has stimulated new products, processes, and work practices that would not otherwise have occurred (Ashford et al. 1985; Ashford and Hall 2011b; Porter and van der Linde 1995; Pelkmans and Renda 2014; also see OECD 2016 for a recent comparison of regulatory stringency among OECD nations). However, often transformative, disruptive innovation comes from outside the incumbent producers or providers, which implies that care must be taken in order to prevent incumbents and

* Steward, F. (2015). "Policies and Practices to Promote Work Enhancing Pathways in the Transition to a Low Carbon Economy." See also: Vivideconomics (2015) "Understanding European Industrial Competitiveness and Drivers of Innovation in the New Global Economy," prepared for i24c.

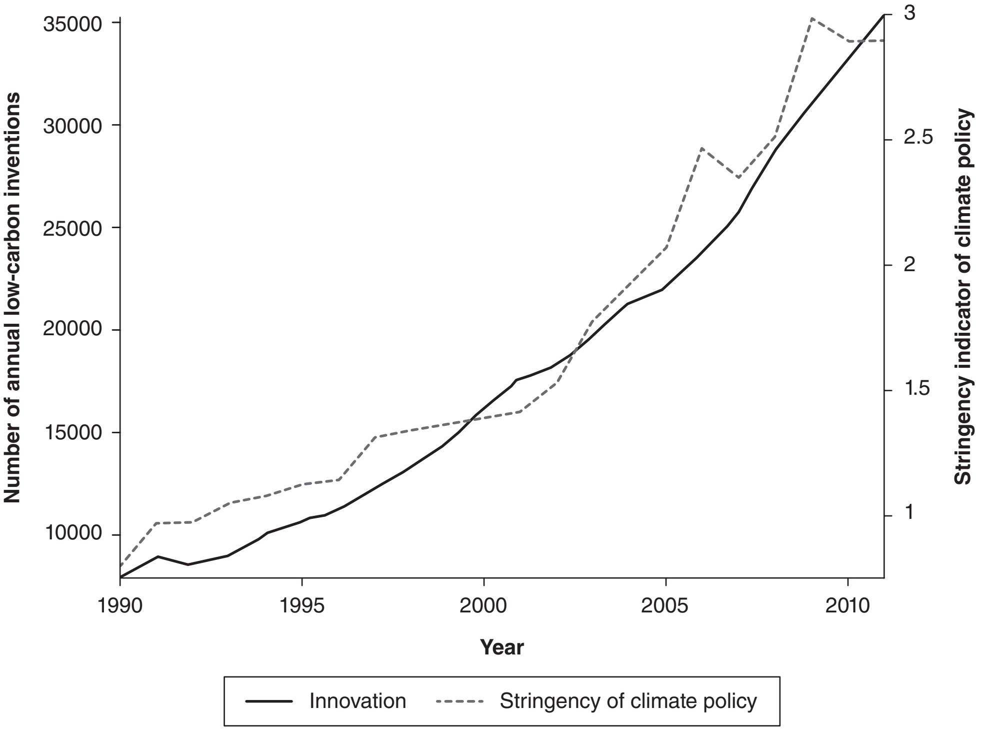

Figure 12.1 Innovation and stringency of climate change policies

Source: Dechezleprêtre et al. (2016, p. 7). Data from the PATSTAT database and OECD Climate policy stringency indicator (2014). Individual countries are weighted by their GDP in order to calculate the average policy stringency across the OECD.

special interests from unduly influencing both the industrial and the regulatory policy process – see the extensive discussion in Section 8.3 in Chapter 8 and Wilson and Tyfield (2018). Negotiated agreements and self-regulation need to be viewed with appropriate scrutiny (Ashford and Caldart 1999; Coglianese 2015). In relation to decarbonization, Dechezleprêtre et al. (2016) map the correlation between the number of low-carbon inventions for which patent protection has been sought by inventors located in OECD countries between 1990 and 2012, with an indicator of the stringency of climate change policy developed by the OECD (Botta and Kozluk 2014). Figure 12.1 presents the graph and shows how innovation efforts and the stringency of policy follow a similar trajectory.

12.2.7 Myth #7: Carbon leakage presents a practical disincentive and limits to what regulation can achieve in terms of decarbonization

"Emissions leakage" is generally defined as the increase in foreign emissions that results as a consequence of domestic actions to reduce emissions that encourages the export of manufacturing abroad (Fischer 2015, p. 298). Not only may foreign producers use cheaper (and dirtier) energy sources, they may also be generally less efficient than first-world domestic firms in their manufacturing operations. The consequence is usually that the global prices for energy go down as other [exporting] countries consume more fossil fuels. The competitiveness implications can be significant, as can the impacts on world trade activities (Carbon Trust 2009; Fischer 2015; Mavroidis and de Mello 2015; Wu and Salzman 2014; Trujillo 2018). "China's exports are eight times as carbon-intensive as those of the EU and three times as those of the US" (Atkinson et al. 2011, as quoted in Fischer 2015, p. 305).

In fact, the export of manufacturing (e.g., from the EU and the U.S. to China) and services (e.g., to India) has been accelerated and intensified by the absence of enforceable or enforced regulations in those locations, allowing domestic importers in developed countries to "trade on the externalities" and thereby increase their profits, with negligible reduction of prices to consumers – as well as a reduction of jobs at home. Trade rules should allow discrimination between products and services that are attended by undesirable side effects like adverse health, safety, environmental, or climate change effects (see the WTO asbestos decision in 2000), as well as adverse employment effects (see Copaldo (2014) on the development on the Trans-Atlantic Trade and Investment Partnership (TTIP)). In a recent publication, the World Economic Forum (WEF 2015) also acknowledged that sustainable and effective trade policy, including most notably a prominent role of decarbonization in regional and bilateral trade agreements, is one of the enabling factors of long-term decarbonization (WEF 2015).

If enough major economies could agree on a coordinated approach to carbon pricing or a uniform global price on carbon that spreads coverage broadly enough – which is not the case with nations acting independently – carbon leakage would become a less important issue (Fischer 2015, p. 298).

Barring the adoption of a global price for carbon in the near future, the concerns of especially developed countries wanting to curtail global GHG emissions may very well turn to international trade to address their concerns for adverse effects on their international competitiveness, namely (1) subsidies for the development and deployment of cleaner technologies, so-called green subsidies (Charnovitz 2014), and (2) border carbon adjustments (BCAs) (Condon and Ignaciuk 2013; Andersen 2017). While countervailing duties may well be allowed under Section XX of the GATT to prevent the import of goods produced with inappropriately high energy (disadvantaging developing countries), subsidies for environmental improvements are no longer exempt from "actionable subsidies" prohibited by the WTO. Trade scholars have uniformly called for a revision to the WTO trade rules, specifically the Subsidies Code (Charnovitz 2014; Condon and Ignaciuk 2013; Fischer 2015; Mavroidis and de Mello 2015; Wu and Salzman 2014; WTO n.d.). See the discussion on trade options in Chapter 11.

12.2.8 Myth #8: Trade in non-energy-related goods and services is a win-win proposition for all parties

The experience with both NAFTA and the WTO have clearly demonstrated not only a loss of health, safety, and environmental protection, but also a worsening of wages, working conditions, and human and working rights in one or both trading partners (Greider 1998; Scott et al. 2017). Money flows from the developing world to the developed world where returns on investment are the highest. Trade does indeed primarily benefit the private-sector exporters and importers, contributing to wealth and income inequality, but not always with benefit to consumers and workers. EU trade initiatives (TTIP and other policies) need to be carefully assessed – and changed if necessary – for their potential to contribute to mitigating global climate change, as well as their adverse impact on employment.*

* See Autor et al.'s (2016) important study on "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade."

12.2.9 Myth #9: Nations can "go it alone"

It is clear that a multilateral effort is needed for significant, high-risk industrial development, combining skills, insight, and financial capital and joint risk taking – such as has been suggested for a "Global Apollo Programme to Combat Climate Change" (King et al. 2015). With real and uncertain costs in transitioning to different energy futures, collaborative efforts should be pursued wherever possible in order that long-term goals not be undercut by short-term competitive advantage and free-riding (see Gallagher 2014). In illustrating the global nature of clean energy technology and the importance of technology transfer (diffusion), Gallagher (2014) argues that (1) clean energy technology innovation has globalized – it is no longer a national process, (2) the most important barriers are cost, lack of policy, and insufficient access to finance, and (3) the best incentives are market-formation policies and the provision of affordable finance.

12.3 Recommended interventions

The dispelling of these nine myths suggests a way forward towards a constructive global climate change mitigation and prevention strategy, as well as geopolitical solution. Elements of that strategy include specific interventions such as fuel efficiency or emission standards for vehicles. Others include the support of basic and applied research in industry or by government. Still others attempt to influence the consumption or conservation of energy. What has been obvious is that while some pathways are useful to pursue, fundamental problems that do not lend themselves to technical or technological interventions remain. These include: (1) political influence and technical dominance of incumbents; (2) trade conflicts traceable to "carbon leakage"; and (3) geopolitical accords.

For more than a decade, using the concept of "wedges" of different interventions, not including nuclear energy, scholars have argued that technologies then currently available were more than sufficient to reduce greenhouse gas emissions (Pacala and Socolow 2004; Blok et al. 2012). With very little having been done to apply those technologies in the interim, the task has become increasingly difficult. In a book edited by Gerrard and Dernbach (2018),* Marchant (2018) has focused on identifying a catalogue of legal interventions addressing:

- Standards for carbon reduction
    - minimum efficiency standards for appliances
    - emission standards for transport
- Expedited approval for superior technologies
- Carbon taxes
- Tradeable permits
    - permits
    - cap-and-trade
- Technology mandates
    - ZEV
    - bans on incandescent lighting
    - renewable portfolio standards (RPS)

* See also an earlier paper by Dernbach (2007) for interventions addressing transit, transportation, fuel taxation, electricity pricing, residential/commercial building efficiency, and freight regulation affecting mostly energy efficiency/conservation and demand-side consumption. See also Dernbach (2016).

- Government procurement
- R&D funding
- Subsidies
- Incentive programs (beyond subsidies, e.g., customer/consumer rebates)
- IP (patent policy interventions)
- Competition/prizes
- Land use
- Soft law (certification, labeling, private standards, building codes)

With the possibly undeserved optimism about cap-and-trade over carbon taxes and undeserved pessimism about government being effective at picking winners, it is a valuable listing. Surprisingly, market dominance by incumbents as a major impediment to progress and the need for anti-trust law is not featured, although Ashford and Renda (2016) have given the need to address these barriers a major emphasis. Options for interventions that use trade rules are provided by Trujillo (2018).

Finally, very little attention by many energy policy commentators – with the important and prominent exceptions of Ayers (2006, 2015), Hoffmann (2011), and Morgan (2013) – is given to the important issue of what effects policies that reduce fossil fuel dependence and use will have on economic growth. See Section 3.2.3 in Chapter 3 for a fuller discussion of how exergy, the useful part of available energy that can be harnessed for economic activity, is diminishing (Ayres 2015).

Ulrich Hoffmann (2011, p. 1) provides a valuable summary of *The Fallacies of Green Growth*:*

> Many economists and policy makers advocate a fundamental shift towards "green growth" as the new, qualitatively-different growth paradigm, based on enhanced material/resource/energy efficiency and drastic changes in the energy mix. "Green growth" may work well in creating new growth impulses with reduced environmental load and facilitating related technological and structural change. But can it also mitigate climate change at the required scale (i.e. significant, absolute and permanent decline of GHG emissions at global level) and pace? The UNCTAD Discussion Paper argues that growth, technological, population-expansion and governance constraints as well as some key systemic issues cast a very long shadow on the "green growth" hopes. One should not deceive oneself into believing that such evolutionary (and often reductionist) approach will be sufficient to cope with the complexities of climate change. It may rather give much false hope and excuses to do nothing really fundamental that can bring about a U-turn of global GHG emissions. The proponents of a resource efficiency revolution and a drastic change in the energy mix need to scrutinize the historical evidence, in particular the arithmetic of economic and population growth. Furthermore, they need to realize that the required transformation goes beyond innovation and structural changes to include democratization of the economy and cultural change. Climate change calls into question the global equality of opportunity for prosperity (i.e. ecological justice and development space) and is thus a huge developmental challenge for the South and a question of life and death for some developing countries.

* Hoffmann's (2011) paper reviews the fallacies of green growth in coping with climate change and the implications for development space. Drawing on ample empirical data and examples, the paper analyses the environmental effectiveness, economic efficiency, and social-political acceptability of the main elements in the green growth toolbox.

Alfredsson et al. (2018, p. 1) remind us that "affluence is a primary driver of GHG emissions" and that "improving the standard of living of the world's poor will consume a major portion of the two-degree carbon budget." Paradoxically, much of the world needs to increase their energy use and consumption, and simply transferring wealth from the advanced societies to the neediest can actually increase GHG emissions since income levels are the primary determinants of energy consumption and GHG emissions (Alfredsson et al. 2018, paraphrasing Hubacek et al. 2017). Thus, the energy challenge has become the poster child of a "wicked problem."

In the next chapter, we address more generic suggestions for achieving sustainable development problems that include but go beyond energy and climate disruption. They also include concerns for economic welfare and employment.

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