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JOHN BYRNE YOUNG-DOO WANG
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Drivers for Change

Job Taminiau, Young-Doo Wang, and John Byrne

Introduction

The range of challenges reflected upon in the preceding chapters shows how "green energy" is not only a movement for technological change, but it also encapsulates social well-being and progress along a much broader set of dimensions. Conventional challenges such as national security concerns, economic instability, critical infrastructure development, and environmental risk reduction are combined with more fundamental and philosophical narratives of community revitalization, livelihood creation, and a paradigmatic shift in the nature–society relationship toward sustainability. The book, therefore, not only provides an overview of the various challenges presented by a transition to a green energy economy but also highlights its substantial promise.

The contemporary configuration of the modern energy economy maintains a *modus operandi* that ineffectively addresses negative consequences of its operation or inadequately incorporates other perspectives that allow for alternative-energy development. While working toward an alternative-energy future, the practical and philosophical narratives offered by the movement for a green energy economy tackle several of the critical issues that modernity faces. While currently critical components of the modern energy economy, these issues, when properly addressed, can form a driving force toward sustainability. Conceptually, these issues can be divided into five key categories, namely ecology, society, economy, technology, and policy. Several of the main moving parts within these five key categories are considered in this book, and together, they shape a picture that presents a fundamental choice: we face a policy choice between a twentieth-century energy infrastructure (reliant on conventional energy sources and associated with a particular way of life) and a new, "green" energy infrastructure with which to advance into the twenty-first century.

Key drivers for change, which constitute a collective pushing force that provides pressure and elevates the urgency of the policy choice, can be identified in the five key categories of ecology, society, technology, policy, and economy. As such, the choice will be determined by the extent we are able to recognize and act upon these five key drivers of change. Within their associated category, these drivers can be conceptually outlined as follows: (a) the extent we recognize—and, more importantly, maintain action *within*—the boundaries that our ecological surrounding presents; (b) an economic driver, as our increasing dependence on abundant flows of primary energy destabilizes the modern energy economy; (c) a social driver that elucidates the need to expand benefits of change to the global population rather than the developed nations alone; (d) our dependence on technological advancement to explore new frontiers that pose daunting and potentially insurmountable challenges forms a technological driver; and (e) the policy landscape increasingly incorporates long-term environmental and social considerations, thus introducing wholly new, alternative energy development pathways. The convergence of these drivers presents a potential framework of change that opens the door toward a green energy economy.

The green energy economy, however, is still a relatively new concept with much work yet to be done in areas such as research and development (R&D), policy refinement, and market maturation. In the following pages, by considering the concept of the five key drivers, this chapter explores and outlines some of the work that is yet to be done. It will become clear that when acted upon, the window of opportunity these drivers offer can substantially accelerate the transition to a green energy economy and fundamentally alter the way we live our lives.

Ecological Promises and Threats

The twentieth century witnessed a rapid expansion in all facets of life. Often termed the "Great Acceleration,"[1] society saw enormous increases in aspects such as population, gross domestic product (GDP), and automobile use. This strong growth realized substantial benefits and continues to shape the world as we know it today. However, society increasingly grapples with the negative consequences of this growth as issues such as increase in carbon dioxide (CO_2) emissions, pollution, energy use, and water use aggravate concomitantly. As the world faces this spectacle of breakneck-speed development, we are beginning to understand that such a "business-as-usual" development pathway will quickly breach the ecological limits that constitute a safe operating space for human activity.[2,3] In fact, modern society has lost all sense of staying within a space of operation that allows for long-term sustainable interaction with our ecological surroundings. Instead, driven by an expansionist mindset of continuous growth, modern society expands into all natural frontiers in the quest for new resources.

Fueled by copious amounts of energy, modern society not only affects the biological fabric of the natural environment—deforestation, desertification, ocean acidification, and declining biodiversity are just some of the environmental issues modernity faces—but is also actively appropriating the natural environment itself.[4,5] Modern society seeks to transform inherently natural functions, such as genetic reproduction and makeup as well as climate and weather stability, into dimensions available for human decision making.

This understanding—that human activity now wields a force equal to or greater than even geological or climatic processes—led Crutzen and Stoermer[6] to argue that our age is the time of the "Anthropocene." In this, physical earth systems and their functions have been taken over by human decision making, allowing society to choose to actively modify the natural order at every level of nature. For example, Vitousek et al.[7] show that 30–50 percent of the world's land surface has been transformed to meet human needs, and Daly[8] calculates that humans appropriate a significant amount of the photosynthetic capacity of the planet. This notion of the "Anthropocene" reflects an important philosophical transformation. While social organization was previously centered around the natural order, and more importantly, restrained by it, the separation of society away from the natural order created a nature–society relationship in which the value of our ecological surrounding itself is reduced to a reservoir available for extraction and exploitation. As Mumford[9] notes, within this new relationship, "the realities are money, prices, capital and shares: the environment itself, like most human existence, was treated as an abstraction. Air and sunlight, because of their deplorable lack of value in exchange, had no reality at all." Without a "language" and "currency" (Kammen, this volume, Chapter 3) to conceptualize the natural world, to understand the consequences of its degradation, and to value mitigative action as beneficial, the current configuration of modern society lacks the notion of staying within ecological boundaries. This leads to the realization that a notion of sustainability needs to be injected into the nature–society relationship.

The sketched situation forms a driver for change: it is becoming clear that ecological damage forms a threshold barrier to the modern energy project that we are fast approaching, if not already transgressing. The challenge that ecological limits introduce in the policy choice is finding a way to halt the negative consequences of the "Great Acceleration" and establish a basis for interaction that can be termed "sustainable." While the struggle among the different sources of energy (fossil fuels, nuclear, renewables) and their associated technologies allows for a significant opportunity to substantially change the energy landscape (Klare, this volume, Chapter 2), our choices need to be informed of this more fundamental challenge. Energy decision making itself needs to be conducted differently to allow for an acceleration in the transition to a green energy economy and to establish a new relationship with energy (Byrne et al., this volume, Chapter 1).

Realizing Economic Security

The ongoing global economic downturn leads nations around the world to debate means to revitalize economic progress. To address contemporary economic ailments, nations consider options ranging from Keynesian economic stimulus to draconic austerity measures. However, a major case can be made for a transition to a green energy economy as the pathway away from current economic hardship.

The modern energy project establishes a path-dependence that makes society vulnerable to economic shock. The guiding principles of the twentieth-century energy infrastructure, as summarized by Sovacool,[10] established a culture of abundance through large, cheap, highly technical, and short-term solutions to be decided upon by experts and bureaucrats. The dependence on large-scale, "abundant energy machines"[11] and abundant flows of primary energy commodities creates a structure that is difficult to change. It is this path-dependent nature that reduces resiliency and adaptability even though the "old" guiding principles are now contested.[12]

The adverse ecological, social, and economic consequences of the dependence on primary energy commodities (oil, coal, natural gas, nuclear power), however, reveal the crucial need for resiliency and adaptability. Economic security, for example, is degraded due to the price volatility of these energy resources. The price of uranium oxide (U_3O_8), for instance, increased by 403 percent ($11.04–55.64 per million pounds) over 2000–2011.[13] Oil, natural gas, and coal demonstrate similar price volatility.[14,15] This volatility comes with a substantial social cost,[16] as price volatility can spill over into non-energy commodity markets,[17] which can degrade essential livelihoods support markets such as the agricultural market.[18]

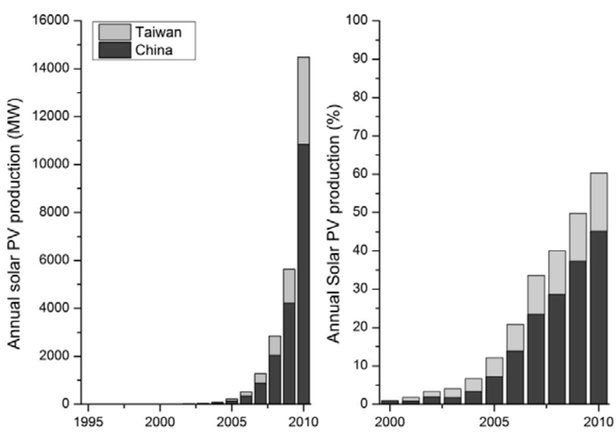
In the context of volatile and rising conventional energy prices, the concept of the green energy economy offers solace. A green energy strategy utilizes domestic energy resources, shortens the length of the supply chain, lowers the risk of political dependence on energy and security conflicts, and reduces ecological damage. These economic and environmental benefits motivate energy efficiency spending and savings[19] and form an economic driver for change toward a twenty-first-century energy infrastructure. A comprehensive strategy that accelerates implementation of renewable energy and energy efficiency technologies can further advance such economic benefits.[20,21,22]

Considering the imminent investment cycle in power generation, a green energy strategy can capitalize on a window of opportunity for transformational change.[23] While still in its early stages, the green energy economy has its champions. Germany, for instance, initiated a policy portfolio that, for over twenty-five years, has supported its domestic photovoltaic (PV) energy market.[24] This market now provides substantial economic benefits and forms a strong pillar of the German economic and manufacturing base. The United States already has a substantial renewable energy and energy efficiency sector that provides for millions of skilled, well-paying jobs (Wendling and Bezdek, this volume, Chapter 4).

Similarly, the untapped potential of energy efficiency can, when addressed, substantially increase economic performance (Laitner, this volume, Chapter 5).

Both developing and industrialized nations face a lingering and growing challenge: exacerbated by the global economic downturn, creating employment opportunities that are sufficient in number for a burgeoning population while also offering adequate wages and livelihoods remains a challenging objective. Success along this dimension can contribute immensely to the public's well-being while augmenting social interest for an even greater commitment to sustainability at the highest levels. While a full-fledged green energy economy will require a more fundamental commitment, a green energy manufacturing strategy can provide vital economic benefits as it anchors the middle class and provides millions of jobs (Rynn, this volume, Chapter 6). An example of this line of reasoning can be found in China's PV manufacturing strategy. In 2006, China redirected its attention in a significant way to the PV market by utilizing its strong manufacturing base as a means to enhance competitiveness. In 2010, together with Taiwan, their market share was about 60 percent of the global PV production market (or 14 GWp of the global 24 GWp) (Figure 1). While this manufacturing strategy targets the European and American markets, as China's actual implementation of the technology domestically is still very low, it offers illustration into the advancement of the twenty-first-century technologies and the effect of a policy choice toward such technologies.

Figure 1
Overview of the PV Production Capacity of China and Taiwan. Left Figure: Annual Solar PV Production in MW. Right Figure: Market Share of Global PV Production



Source: Authors. Data as compiled by Earth Policy Institute (EPI). Data retrieved from http://www.earth-policy.org/data_center/C23.

Reshaping the Way We Live: The Need for New Communities

The challenges of lagging development—such as poverty, disease, and social conflict—stress a social driver to extend the benefits of energy development to the global population. Poverty, for instance, has declined in both relative percentages as well as absolute numbers over 1981–2005,[25,26] but progress has been unevenly distributed, with the majority of progress taking place within China. Energy poverty (the lack of access to energy), similarly, is a key issue within this context as it forms a considerable restraint on socioeconomic development.[27] With about 1.4 billion people who lack access to electricity and 2.7 billion who rely on traditional biomass for their energy needs,[28] expanding energy access is a major twenty-first-century issue. However, energy development along the same trajectory of the modern energy project is likely to further strain ecological limits and further increase economic insecurity and energy dependence. The priority of advancing economic well-being and socioeconomic development, thus, needs to be synergistically intertwined with socioecological progress. These concerns suggest a need for energy development globally to be linked more clearly and deliberately to the green energy economy concept.

In order to expand the benefits of a green energy economy to wider shares of the global population, a re-arrangement of development toward sustainability is required. With more than half of the world's population living in urban areas and the expectation that half of Asia's population and half of Africa's population will live in urban areas by 2020 and 2035, respectively,[29] the social organization of city life will be a key aspect in realizing such a re-arrangement. The relation to energy in urban settings is abstract as cities rely on external sources of energy and the organization of life in cities (e.g., transportation options and the built environment) limits individual agency to pursue alternative energy development. The concept of "eco-cities" can comprehensively address such challenges, as it reshapes what constitutes the urban life (Roaf, this volume, Chapter 7). Keeping social and environmental considerations in mind from the outset, such as emphasizing walkable communities, improves living conditions and urban welfare, as it reduces economic stress, increases resiliency, and enhances environmental performance.

The built environment undergoes substantial and rapid change, especially in the developing world. China, for instance, annually adds about 1.7 billion square meters (18.3 billion square feet) of new floor space.[30] Without a new strategy to construct such new urban settings, energy use and consumption will increase concomitantly. Such a strategy can capitalize on the evolution in buildings toward "regenerative" capacities and improved environmental performance (Syrett, this volume, Chapter 8). Innovative and smart urban design and planning utilizing such state-of-the-art buildings can thus support sustainability across the board.

The organization of social space is, next to the built environment, tremendously dependent on the transportation modalities that are available in day-to-day life.[31]

Shaping urban communities around the automobile as the primary means of transportation can pressure urban design with a high demand for physical space, high costs for oil imports, and substantial pollution and health consequences. To transition to more sustainable transportation options, urban design needs to not only reconsider the organization of transportation modalities (e.g., the layout of roads, subways, and rail systems) but also consider innovative options to fundamentally change the design plan of cities (Newman and Schipper, this volume, Chapter 9).

Changing the Technology Base

The twentieth-century energy infrastructure depends on a momentum of technological advancement to contain and reduce negative environmental and social consequences. Constructed along the guiding principles mentioned earlier, the pursuit for energy, however, engages ever more challenging environmental circumstances with increased technological complexity. The assumption that these new natural and technological frontiers can be understood, and more importantly, controlled, to minimize environmental and social harm reflects a "strategy of resilience"[32]—an expectation that gained experience and knowledge from previous adverse consequences allows for the aversion of such consequences in the future.

An important consideration within the concept of sustainability, however, is the notion of stability. Ever more demanding natural and technological frontiers to exploit previously unattainable resources—whether drilling for deep offshore oil, splitting or fusing the atom, or extracting shale gas and oil—reveal a flaw in this strategy in that the complexity and scope of the new setting makes previously acquired experience insufficient. The assumption that we can design technological complexity with the required level of precision to address "known unknowns" as well as "unknown unknowns" is brought back into reconsideration by the breakdown of the nuclear reactor in Fukushima, Japan, and the Deepwater Horizon oil spill in the Gulf of Mexico. These events highlight the existing instability within technologically complex centralized systems under ever-challenging circumstances.

The increased complexity and sophistication of such energy systems have created a situation in which human authority can no longer be trusted to appropriately deal with unexpected situations, thus elevating the need for additional technological fail-safes. Technological redundancy measures and "passive" measures, for instance, are put in place to deal with adverse consequences. The trained professionals' inability to fully comprehend the dynamics of the technological systems might, in the event of disturbance within the system (as in Fukushima with a combined natural disaster in the form of an earthquake and flood wave and technological failure), lead to a situation in which the operators can't stop the technological cascade or unwittingly worsen the situation. Simple cause-and-effect cascades can thus become catastrophic accidents further limiting the stability of the system. Beck's concept of the "risk society" illustrates this nicely.[33]

Systems that revolve around "authoritarian technics"[34]—that is, systems of operation that draw on inventions of a high order and create complex machines but allow a lower degree of human control—face such a problem of instability. These types of considerations need to be included within the decision-making structure when choosing among technologies (Saul and Perkins, this volume, Chapter 13). When such considerations are firmly incorporated within energy decision making, other alternative technologies become more attractive. The rapid development of these alternative technologies forms a technology driver that opens up a window of opportunity for the implementation of the green energy economy concept. High-efficiency PV (Barnett amp; Wang, this volume, Chapter 10), for instance, allows for an alternative pathway of provision of energy when incorporated within decision making.[35] Similarly, fuel cell technology developments (Prasad, this volume, Chapter 11) allows for a resiliency in the energy system when used as a storage device. When applied in a comprehensive, smart, and innovative strategy, the twenty-first-century energy technologies can synergistically augment each other's functioning. Intermittency issues within a green energy system, for example, can be addressed with energy storage technology capable of storing excess energy for times of high demand (Yonemoto, Hutchings, and Jiao, this volume, Chapter 11).

Choosing a Green Energy Future

Informed by the previous four drivers, a final driver for change is shaped by the changing developments in the policy agenda. Policy agendas around the world are increasingly recognizing the causes for environmental and social distress and many attempts have been made to formulate response strategies. Such "mainstreaming" of environmental and social considerations into the overall policy narrative[36,37] has the potential to minimize contradictions between policies, to introduce specific new considerations into an overall evaluation of policy, and to review the potential alternative energy development strategies in this light.

A main consideration within this context is that these new policy responses are focusing on the long-term, on the order of several decades. The European Union's (EU) *Energy Roadmap 2050* outlines several potential scenarios for energy development in the European Union until the year 2050.[38] Similarly, the EU's *Roadmap for Moving to a Competitive Low-Carbon Economy in 2050*[39] demonstrates how long-term policy response strategies can support environmental and social objectives. Many other countries around the world are also busily working to articulate their own strategies for the future. South Korea, for instance, has sought Green Growth as an official strategy for economic and environmental progress. Within the United States, a diversity of initiatives at the state and local level are complemented by a number of policies and programs at the federal level to promote renewable energy.

Such strategies and scenarios inform long-term development challenges and opportunities and allow for the conceptualization of alternative energy futures.

The complications, challenges, and opportunities that various energy futures offer, moreover, reveals both the difficulties associated with the modern energy system and elucidates potential practical pathways toward a green energy transition (Horn, this volume, Chapter 14). To achieve the goals set forth in such long-term strategies, the appropriate use of sound policy is crucial. Policy can substantially accelerate the implementation of renewable energy technologies, for instance.[40] China's strategy outlined earlier is an example of how policy support can considerably accelerate the advancement of a twenty-first-century technology. Similarly, Spain's aggressive PV policy support strategy realized enormous growth in the sector at extremely rapid rates.[41]

The varying ambitions of different countries toward achieving a clean energy future can be augmented by recognizing the potential of integrated green energy approaches (Lund, this volume, Chapter 15) and of collaboration between and across countries. Through this type of negotiated approach to tackling emerging challenges and forging solutions and innovations, communities can build on unique talents, capture complementarities, and help avoid expensive and time-consuming duplications of effort. A policy strategy for the future, therefore, supports the wider development of human resources and social capital and directs it as a creative and innovative force for economic and technical shifts. A policy portfolio that pursues a green energy future thus suggests the possibility for larger social transformation as a function of long-term strategies.

The Rise of the New Energy Economy

The evolution of the green energy concept to date has already motivated industries and governments to shift their focus and has altered lifestyles in substantial ways. While the final form of this change is uncertain and the stakes remain high, momentum is offered by five key drivers of change. The plethora of efforts currently underway suggest that the green energy economy is one of promise: the promise of new resources, new relationships, and finally new opportunities for shared progress and prosperity.

As to its fruition, however, the promise is hindered by many barriers. From the preceding chapters, it has become abundantly clear that thinking in terms of alternative technologies alone is not enough. The journey toward a New Energy Economy is fundamentally a social one in which options need to be considered from a range of different perspectives that complement the technical viewpoint with considerations of ecology, society, economy, and policy. Effectively, the combined implementation of these various vantage points changes the societal relationship to energy and fundamentally alters the energy discourse.

Such a new line of action emphasizes the local and human aspects to energy development. Day-to-day experience within a green energy economy is thus fundamentally reshaped as it will take place in new communities, revolving around new ways of interaction (e.g., walk-able communities, shared energy generation) and allows for a sense of agency in the articulation of future energy development pathways. During such a transition, the twentieth-century technology base finds that their functional niche is continually diminishing as new technologies arise that engage in the competition for the future.

The combined picture that arises from the preceding chapters is one of a choice between a twentieth-century energy infrastructure and a twenty-first-century energy infrastructure. This book offers an account of the potential of the green energy economy concept as a viable alternative energy strategy that can be positioned as a more appropriate energy infrastructure for the twenty-first century and beyond. To capitalize on this potential, society will need to recognize the fundamental drivers of change detailed in this book and action will need to be formulated that advances a more secure and resilient future energy economy. Such a New Energy Economy offers a promise for the future that emphasizes sustainability as we advance into the twenty-first century.

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