

Chapter 10

Scenarios and Trends of the Future



But anyone who believes that he can draw a blueprint for the ecological salvation of the human species does not understand the nature of evolution, or even of history—which is that of a permanent struggle in continuously novel forms, not that of a predictable, controllable physico-chemical process, such as boiling an egg or launching a rocket to the moon. [5]—Nicolas Georgescu-Roegen (1975)

The first chapter of this book noted three facts:

1. The Earth is finite.
2. The laws of nature are human constructs that describe the interactions within the natural world and are defined as being the same everywhere (per the present state of knowledge).
3. The laws of society, or legal rules and social norms, are human constructs that seek to limit human interactions to a subset of all possibilities, and they are not the same everywhere.

Even people that disagree how to interpret past energy and economic trends can still agree on these facts. This book explored these disagreements in terms of how much the first two facts influence the third. We make most of our societal laws without contemplating natural laws. Examples of such societal laws are taxes on economic activities, the legal ownership of property, the definitions of murder and self-defense, and equal human rights among genders and sexual orientations.

Nonetheless, natural laws inherently influence collective social behavior in hidden ways.

The first chapter also summarized the following sequence:

- First, physical laws and constraints describe how we can use and access energy.
- Second, energy resources physically power the economy via use in machines, buildings, and other physical capital.
- Third, our interpretations of the economy inform policy.
- Fourth, policy affects social outcomes by designing markets, regulations, and taxes that affect the distribution of money.

- Finally, the rules governing where, how, and when money is distributed affect energy resource extraction and consumption, leading back to the beginning.

The previous chapter noted Vladimir Lenin's quote that "Communism is Soviet power plus the electrification of the whole country." Practically all modern-day politicians and citizens recognize the value of access to electricity, and hence useful work. But, as this book argues, they don't all understand that *how* we obtain energy from the environment and *how* we convert that energy into electricity and useful work are defining features of our societies and economies, both their growth and structure.

With this thought, we can ask a fundamental question: *Are we humans freely choosing our societal and economic organization, or does our organization emerge in response to physical laws as we interact with the natural world around us?*

I've set this up as a false choice. We don't have to explain the human economy in the context of one type of laws independent of the other.

Not only *can* we use both social rules and physical laws to assess the constraints and possibilities for future energy and economic scenarios, *we absolutely must*.

The Future Ain't What It Used to Be

The global economy has experienced many major transitions in the last 250 years. I'll summarize these into four.

The first was the transition from agrarian to fossil-fueled industrialization. It started in the United Kingdom in the late 1700s and ramped up in the United States and other Western nations in the early 1800s. This transition sparked unprecedented rates of economic growth.

The second transition spanned the two world wars, during which industrialized economies fought over control of the world's resources residing outside their individual country borders, but within the borders of their colonies. This transition marks the end of colonization. In the post-World War II era, the world knew just how destructive we could be. The atomic age had begun. While the Cold War between the U.S. and Soviet Union governed much of geopolitics, the United Nations and the Bretton Woods agreement sought stability within these newly-formed institutions for international cooperation.

The third transition occurred in the 1970s. Up to this point, rapid exponential growth seemed "normal," but it could not go on forever, and the 1970s mark the end of the most rapidly growing 30-year period in human history, the "trente glorieuses." The evidence for this transition abounds in data spanning many domains: energy, economics, and environmental. Rich and industrialized countries experienced this transition most distinctly. Industry started in earnest to take advantage of lower wages in developing countries. A new age of globalization began. The Bretton

Woods agreement ended, thus removing any direct relation between money and the stock of a physical commodity, such as gold.

This book argues that the 2000s, culminating in the 2008 financial crisis, mark a fourth major transition. This transition is marked by the end of a trend that started with industrialization: energy and food costs (as a percentage of GDP) stopped declining. This transition also marked a shift from debt-fueled growth to our current period of rich country “secular stagnation” characterized by lower GDP growth, low interest rates, and continued low wage growth. We should not necessarily interpret the current state of the economy as bad, but more as expected for a capitalist economic system reaching limits to growth. Some call this a “new normal,” others call it expected.

Each of the time periods between the aforementioned transitions represents a period of some type of normality. Each transition begets a new narrative for interpreting the past and defining future possibilities. We update both our individual and collective narratives over time.

Narratives are not fixed concepts whether we summarize global economic affairs or personal experiences. Philosopher Daniel Dennett introduced the concept of the “multiple drafts” model of consciousness. The multiple drafts concept states there is not one consciousness, but many that get updated over time. Because of this, there is no one “correct” interpretation of what one experiences. It depends on *when* you ask:

Just what we are conscious of within any particular time duration is not defined independently of the probes we use to precipitate a narrative about that period. Since these narratives are under continual revision, there is no single narrative that counts as the canonical version, the “first edition” in which are laid down, for all time, the events that happened in the stream of consciousness of the subject, all deviations from which must be corruptions of the text. But any narrative (or narrative fragment) that does get precipitated provides a “time line,” a subjective sequence of events from the point view of an observer, that may then be compared with other time lines, in particular with the objective sequence of events occurring in the brain of that observer.¹—Daniel Dennett (1991)

Just as we update our state of consciousness, over time we’ll continue to observe, learn, and update our energy and economic narratives. For example, after some number of years I might update my narrative of the four major transitions in economic development since the start of the industrial era. I might think an additional transition is required, or I might decide to remove one. All of this is okay, and it helps engender humility for thinking about future options.

A Range of Futures

David Holmgren provides one useful taxonomy for considering a range of futures. Four visions, or narratives, summarize how any given person might envision the

¹[2] [p. 136].

long-term future of humanity and our economy [7].² Holmgren is one of the founding pioneers of *permaculture*, or “permanent culture,” as a systems thinking framework for designing our social systems to have similar resilience as observed in natural ecosystems. His four future scenarios, or narratives, are as follows:³

1. “*Techno-explosion* depends on new, large and concentrated energy sources that will allow the continual growth in material wealth and human power over environmental constraints, as well as population growth. This scenario is generally associated with space travel to colonize other planets.”
2. “*Techno-stability* depends on a seamless conversion from material growth based on depleting energy, to a steady state in consumption of resources and population (if not economic activity), all based on novel use of renewable energies and technologies that can maintain if not improve the quality of services available from current systems. While this clearly involves massive change in almost all aspects of society, the implication is that once sustainable systems are set in place, a steady state sustainable society with ... [little] change will prevail. Photovoltaic technology directly capturing solar energy is a suitable icon or symbol of this scenario.”
3. “*Energy Descent* involves a reduction of economic activity, complexity and population in some way as fossil fuels are depleted. The increasing reliance on renewable resources of lower energy density will, over time, change the structure of society to reflect many of the basic design rules, if not details, of pre-industrial societies. This suggests a ruralization of settlement and economy, with less consumption of energy and resources and a progressive decline in human populations. Biological resources and their sustainable management will become progressively more important as fossil fuels and technological power declines. In many regions, forests will regain their traditional status as symbols of wealth. Thus the tree is a suitable icon of this scenario. Energy Descent (like Techno-explosion) is a scenario dominated by change, but that change might not be continuous or gradual. Instead it could be characterized by a series of steady states punctuated by crises (or mini collapses) that destroy some aspects of Industrial culture.”
4. “*Collapse*⁴ suggests a failure of the whole range of interlocked systems that maintain and support industrial society, as high quality fossil fuels are depleted

²Also see: <http://www.futurescenarios.org/> and <https://holmgren.com.au/future-scenarios-presentation/>.

³<http://www.futurescenarios.org/content/view/16/31/index.html>.

⁴Per David Holmgren’s definition, he states: “Some very influential authors such Joseph Tainter (*The Collapse of Complex Societies*, 1988) and Jared Diamond (*Collapse: How Societies Choose to Fail or Succeed*, 2005) use the term collapse to describe any ongoing reduction in complexity of the organization of civilizations. While their work is of great importance, I want to draw a distinction between what I mean by “Collapse” as the sudden failure and loss of most of the organizational complexity (such that succeeding generations retain little use or even memory of such systems) and “Descent” as a progressive if erratic process where the loss of complexity is gradual and succeeding generations have some awareness of, and knowledge from, that peak of complexity.”

and/or climate change radically damages the ecological support systems. This collapse would be fast and more or less continuous without the restabilizations possible in Energy Descent. It would inevitably involve a major “die-off” of human population and a loss of the knowledge and infrastructure necessary for industrial civilization, if not more severe scenarios including human extinction along with much of the planet’s biodiversity.”

Holmgren’s scenarios provide a broad range of futures, each associated with a key symbol: techno-explosion (vision: space colonization; movie: *Star Trek*), techno-stability (vision: renewable energy; movie: *An Inconvenient Truth, An Inconvenient Sequel: Truth to Power*), energy descent (vision: trees and transition towns; movie: I don’t know of a mainstream movie representing this scenario, but there are some documentaries), and collapse (vision: chaos; movie: *Mad Max*).

These are not the only future visions, and one can easily come up with combinations. For example, the movie *Interstellar* poses that the vast majority of people live in a collapsed society (or one far down Energy Descent) while a small group of educated persons seeks to ensure the existence of *Homo sapiens* by trying to colonize other planets.

We can imagine placing any given future scenario on the two-dimensional energy and economic axes in Chap. 1. Figure 10.1 represents my placement of Holmgren’s scenarios. Techno-explosion is the extreme form of the techno-optimism and infinite substitutability economic narrative. The Blue Origin and SpaceX websites succinctly state this techno-explosion vision:

Blue’s vision is a future where millions of people are living and working in space. In order to preserve Earth, our home, for our grandchildren’s grandchildren, we must go to space to tap its unlimited resources and energy. If we can lower the cost of access to space with reusable

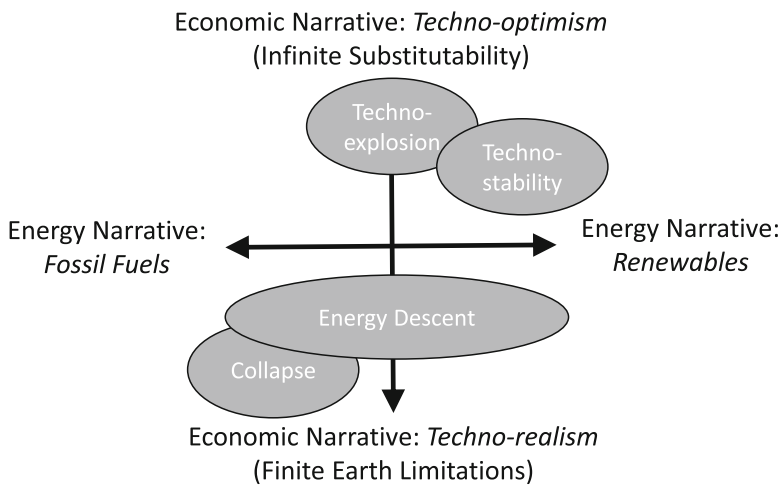


Fig. 10.1 David Holmgren’s four future scenarios (narratives) placed on the two-dimensional energy-economic narratives of this book (Fig. 1.1)

launch vehicles, we can all enable this dynamic future for humanity.⁵—Blue Origin, “Our Vision” (2020)

SpaceX designs, manufactures and launches advanced rockets and spacecraft. The company was founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets.⁶—SpaceX, “About SpaceX” (2020)

Techno-explosion need not pay heed to the energy narratives. Blue Origin recognizes the finite Earth, but instead of nurturing and living within the means of Earth, it posits that we have to leave it to save it by tapping the “unlimited resources and energy” of space. SpaceX seeks to colonize other planets to preserve our species (e.g., Julian Simon’s view of “the cosmos” as the human domain of influence).

Techno-stability represents many people’s vision of a future where we limit climate change impacts below a critical level by cost-effectively transitioning to a renewable energy and low-carbon economy. As Chap. 6 emphasized, because of their theoretical assumptions that neglect debt, time, and natural resources inputs, mainstream economic models present both of Holmgren’s “techno” scenarios as possible, even though their assumptions and theory make them inapplicable to even ask the question. Thus, most scenarios coming from energy companies, governments, and international organizations present the case to the public that a perpetual fossil fuel or renewable/low-carbon world is possible without significant change.

The Collapse scenario is one that views fossil fuels as both limited and key to our present modern lifestyles. It also views renewables as insufficient to substitute for fossil fuels that eventually cannot continue to maintain present society. We might try to substitute renewable energy technologies, but their characteristics and costs will prove this to be a fruitless exercise at the required scale. Thus, a collapse in modern lifestyles will eventually occur.

This leaves the Energy Descent scenario. A range of activities can occur in this scenario, from maintaining the fossil fuels system as much as possible to pushing renewable energy technologies as far as they can go. However, by definition, in this scenario, all of these efforts fall short of indefinitely maintaining the current size and complexity of the economy.

The Energy Descent scenario is an appropriate description for changes that began in developed countries in the 1970s following major oil supply restrictions and price shocks. This was the beginning of what Herman Daly called “uneconomic growth.”^[1] There was some type of growth, but it came at the expense of too much inequality and some continued environmental impact.

The events of the 1970s triggered earnest research into today’s modern wind turbines, solar photovoltaic panels, and electrochemical batteries. In some sense the world economy was on the brink of collapse in the 1970s, but it restructured itself in response. The same crisis and restructuring occurred in 2008 in the

⁵Blue Origin website, February 22, 2020: <https://www.blueorigin.com/>.

⁶SpaceX website, February 22, 2020: <https://www.spacex.com/about>.

Great Recession. These restructured states have generally translated to worsening livelihoods for citizens of rich countries, but they are starting from a relatively high point. For citizens of poorer and developing countries, these restructured states created opportunities for increasing livelihoods, with the economic growth in China and India being the most prominent cases.

It is important to point out the obvious: we can observe current events that exhibit tendencies from each of Holmgren's four scenarios. Techno-explosion: we do have billionaires making rockets to go into space, just like the James Bond spy movies (e.g., *Moonraker*). Techno-stability: over the last 10 years we have installed wind turbines and solar panels at increasingly rapid rates. Energy descent: over the last 50 years, rich country wage growth stagnated, income inequality increased, and both total and per capita primary energy consumption stagnated. Collapse: Venezuela since the 2008 financial crisis, and particularly since the drop in oil prices in 2015, has become a poster-child for not shifting its economy and consumer behavior from over-dependence on the sale of high-cost oil.

Each person in each generation experiences a unique set of circumstances that influence her narrative of past events and her narrative of how the future can unfold. After all, narratives are emergent beliefs that summarize a multitude of underlying processes. We use all kinds of rational arguments to support our positions among the competing narratives. As we learn more, we shift our positions.

While ultimately future details are unknowable, we can say some overall patterns, such as the scaling law patterns relating energy consumption to size of the economy (Chap. 5), are more likely than others. The remainder of this final chapter describes anticipated tendencies, trends, and battles to set the vision for humanity, our use of energy, and hence our economy.

The Battle for Control of the Superorganism

Competing Economic Memes and Models

Chapter 6 summarized arguments against neoclassical economics and its theory of growth. While many researchers, including myself, see these as reasons enough to use other existing economic approaches with more consistency in scientific and economic fundamentals, there is a larger question as to whether an alternate economic meme can supplant the neoclassical approach.

Recall that the neoclassical growth model leaves about half of economic growth unexplained by the model itself. The father of this growth model, Robert Solow, recognized this fact at its inception, and he stated as much almost 40 years after developing the initial model. He recognized . . .

...a criticism of the neoclassical model: it is a theory of growth that leaves the main factor in economic growth unexplained. There is some truth in that observation, but also some residual misconception. First of all, to say that the rate of technological progress is exogenous is not to say that it is either constant, or utterly erratic, or always mysterious. One

could expect the rate of technological progress to increase or decrease from time to time. Such an event has no explanation within the model, and may have no apparent explanation at all. Or else it might be entirely understandable in some reasonable but after-the-fact way, only not as a systematic part of the model itself.[10]—Robert Solow (1994)

Solow posits it is possible that technological progress could be described by some “reasonable but after-the-fact way,” and Chap. 6 showed that increases in energy efficiency very much seems to fit this need. In this sense, modeling technological progress as an aggregate energy conversion efficiency is a more accurate explanation than associating it with nothing specific or even nebulous ideas such as “human ingenuity.”

We can systematically (somewhat tediously) measure energy conversion efficiencies that, due to the second law of thermodynamics, are limited to well below 100%. In this interpretation, “technological progress” cannot increase indefinitely. Also, since the rate of energy extraction also cannot increase indefinitely on the finite Earth, then useful work cannot increase indefinitely (useful work = energy consumption multiplied by conversion efficiency). In turn, since gross domestic product (GDP) is a proxy for useful work, GDP also cannot increase indefinitely.

I and others claim that this physically based view of economic output is more accurate. Will it win over that of neoclassical economic growth? Does a model of economic growth, including that used to inform policy, need to accurately represent economic functionality? In other words, would an economy with a more accurate economic model of itself generally prevail over an economy with a less accurate economic model of itself?

These are questions for another book, but we can form an initial hypothesis by returning to the narrative of the economy as an evolving superorganism. Assume each economy seeks to propagate its technological memes just like each biological organism seeks to propagate its genes. Thus, per the maximum power principle, the economy that accesses more energy, and transforms it more efficiently into new structures, is more fit to survive and propagate its memes.

But how do biological organisms or economies know which option enables higher power consumption? How do they know what energy input makes them more fit? We don’t get any sense that they attempt to model themselves via scientific and economic calculations. Donald Hoffman, a professor of cognitive science, has studied the evolutionary impact of having “truthful,” or more accurate, versus “simple,” or less accurate, representations of what is really happening in the world around you.

Consider the following excerpt from Hoffman’s 2010 article:

Seeing more data takes more time. So, in the simplest version of this game, simple chooses first when competing against truth. . . .

Similarly, seeing more data takes more energy, so truth requires more energy than simple. We subtract the cost of energy from the utility that each agent gets from its territory.[9]—Justin T. Mark, Brian B. Marion, and Donald D. Hoffman (2010)

Here, lower utility is the same as lower evolutionary fitness. In addition to necessarily consuming energy in order to extract energy from the environment, an

economy must also invest some amount of time to learn more about the environment.

Hoffman also emphasizes that it takes energy just to gain more knowledge. His argument is that simpler rules take less time and energy to make a decision. Thus, in the context of evolution, organisms with simple rules based on relatively inaccurate descriptions of the environment can be more fit than organisms with more complicated rules based on more accurate descriptions of the environment.

What might a set of simple rules be for entities within the economy? Prices.

What does neoclassical economics, and the neoliberal paradigm, focus on? Prices.

Not only do neoclassical economics and neoliberal politics focus on markets that form prices, but in reality prices form when all agents generally lack full information about the cost and input requirements to make products. The prices might even be defined by the immediate whims of the buyer and seller. Even well-structured markets, where short-term whims play no major role, prices form using only a portion of the full costs.

Consider electricity markets, perhaps the most well-defined markets that exist. The market cost of supplying electricity from each power plant on the grid derives from the operating costs, such as paying for fuel and people to operate and maintain the power plant, and not from how much it costs to construct the power plant in the first place. Each power plant operator has a simple rule for bidding to produce electricity: bid to produce electricity at just above the marginal operating cost. If you bid below this number and are told to operate, there is a chance you will operate at a loss and be less fit. If you bid too high above this number, there is a chance that you will not be chosen to operate at all (because there are enough other power plants bidding lower costs), and again you will be less fit (you earn zero revenue but still have some costs).

To be explicit, we can express the battle of the economic memes via the following 3-part hypothesis. First, of all models of the economic system that we presently know, neoclassical economics is not the most accurate representation of economic growth and distribution. Second, neoclassical economics provides a relatively simple and teachable method to make choices that maximize immediate fitness. Third, economies organized via neoclassical economics are more fit, *ceteris paribus*, than those organized via other economic systems and rules.

For me, it is a bitter pill to swallow to even contemplate that this hypothesis might be true. I never imagined I would write that neoclassical economics might have some enhanced usefulness over more biophysically based approaches to economic modeling. At this time, neoclassical economics is clearly the most pervasive economic meme. As a cultural construct, it is winning the evolutionary game of self-replication.

Not only that, but markets based on marginal (or operating) costs, as promoted by neoclassical theory, are in one sense consistent with biological evolution. Evolution is not forward looking. In other words, evolution involves no long-term planning.

The same holds for markets as they drive economic actors to increasingly emphasize “now” over future outcomes. However, there is (at least) one important difference between biological evolution and technological change. Genetic

mutations are *random*. Thus, they produce marginal, but random, changes in phenotypes. The organism tests the fitness of the mutation after the fact. In contrast, memetic mutations represented as changes in technology, from machine designs to algorithms, are not purely random. Because we have evolved to think abstractly, we have created models of the economic system. Because we have these models, we know that certain types of technological changes have higher odds of increasing the fitness the economic superorganism: those that minimize operating costs.

The Continued Trend of Lower Operating Costs

Capital owners, informed by price signals from markets, are incentivized to minimize operational costs, including costs of labor, energy, and natural resource consumption. As long as capitalism governs our socio-economic organization, we should expect operating cost minimization to continue, even in an Energy Descent scenario.

One can minimize the cost of labor by two strategies. First, automate as many tasks as possible. Second, for those tasks that prove difficult to automate, move the jobs to the countries with the lowest wages.

An economy can minimize the cost of energy consumption via a few strategies. One is to maximize energy conversion efficiency. Another is to reduce the energy required to distribute physical goods, including energy, and information. This distribution cost can be reduced by forming a business that minimizes the distribution of physical items. It takes energy to distribute things that have mass (including people), and the less mass you distribute, the less you pay for energy and materials. An economic superorganism that minimizes moving mass—people, fuels, cars, everything—serves an overall goal of accumulating more mass in total. Distribution costs are also minimized by concentrating people into cities rather than dispersing them evenly over an entire region.

How do companies minimize operating costs? By inventing and deploying physical capital, or technologies, with this purpose in mind. Energy extraction technologies that serve this purpose are those such as hydropower, wind turbines, and solar panels. Thus, many people, myself included, anticipate continued investment in these technologies in locations with good natural resource flows (rain, wind, sun). As long as the economy is growing, I also expect continued investment in these renewable technologies. Even in an Energy Descent scenario, with a shrinking economy, investment in modern renewable systems could occur, but it is not guaranteed. The same should eventually hold for energy storage technologies, such as electrochemical batteries.

Of course the cost to install these technologies matters, but once you have them, they cost very little to operate. The low operational cost of hydro, wind, and solar power is not directly related to energy conversion efficiency. It derives from minimizing the two cost categories mentioned above: labor and energy (and materials).

In this sense, the more “green jobs” associated with *installing* wind, solar, and battery systems that extract environmental energy flows, the fewer “brown jobs” associated with the continuous *extraction* of energy stocks such as fossil fuels.

Don’t think of this as a statement *for* the renewable energy narrative and *against* the fossil fuel narrative. Think of it simply as an observation and description of the overall energy system as would the economy in acting as a superorganism. The superorganism is trying to maximize its net output of useful work, and it can do this by minimizing operating costs relative to output. We might think of the economic superorganism as evolving from one akin to a colony of leaf cutter ants, with relatively high labor costs to move raw materials, to one akin to a spider who first invests considerable effort in making a web infrastructure before waiting passively for its food, or energy, to be captured by its “capital.”

In the extreme case of zero operational costs, the cost of the energy system would be 100% determined by capital costs. Because machines don’t last forever due to the second law of thermodynamics, and they need to be maintained, we’ll never fully get to this world, but someday we might get very close. A spider doesn’t pay any “operational” costs to make the wind blow across its web network, but it spends energy repairing web damage caused by high winds, falling twigs, and the bugs that it catches.

In a fully capitalized electric grid, the customers’ payments for electricity no longer depend on how much they actually consume. Since there are no fuel costs, customers are essentially only paying for the capital costs of the electricity infrastructure—the concrete, steel, and other materials sitting on the ground somewhere. Just like the spider, these technologies wait to perform their function. They generate electricity when the wind blows on a turbine, water flows through a dam, or sunlight shines on a solar panel. Electricity can be stored at some times and discharged at other times as needed. But fundamentally, at some instant if people want more electricity than can be generated and released from storage, then everyone can’t get what they want. Because markets provide price signals based on operating costs, and grid operating costs would be close to zero, then the normal price-forming mechanism is not present to indicate a shortage and tell generators to increase power and consumers to reduce demand. The electricity provider, or grid operator, will need to follow some existing priority for determining how to throttle back supply to certain customers.

We are not used to this concept for electricity consumption, as we normally get charged money for each kilowatt-hour we consume, no matter when or how fast we consume it. However, some of us are used to “throttling” when using other network-based services: mobile data plans, for example. Most of us pay a lump sum for mobile data per month, and we’re allocated a certain amount of data usage, and perhaps a maximum rate of usage (i.e., bandwidth). Some families limit wireless bandwidth in the home among multiple users so that the teenage kid doesn’t use all the bandwidth playing online video games. This throttling already occurs at a neighborhood or regional level in times of stress on the electric grid, and in emergency situations it takes the form of a rolling blackout where large regions are sequentially cut off from power for a few hours at a time.

Thus, we can look for future trends in regions with high percentages of renewable electricity. In these regions electricity providers might tend to offer rate plans and provide service in a similar manner as mobile phone plans. Those who pay less will be first to get throttled, if and when the need arises. It is easy to imagine, if electricity access is seen as a right, that this might upset advocates for low-income households, but concepts already exist to assist them make home energy payments.

As this book has discussed, with the economy acting as a superorganism, it does not distribute energy equally to all of its parts. Just like biological organisms, due to internal physical constraints as well as constraints on extracting energy from the environment since 1970, the global economy has become larger by associating the average unit of GDP (and piece of capital as shown for the U.S.) with a slower rate of energy consumption (Fig. 5.2). Also, the U.S. economy shows a prominent example of wages stagnating when per capita energy consumption stagnated (see Chap. 7 and Fig. 9.3). Because most people work and earn a wage, but very few people study energy and economics, it is understandable that almost no one makes this connection between money and energy. Workers are operating costs to companies. Thus, it is much easier for political discussions to center on the debate of “people versus profits.” Unfortunately, this debate usually occurs out of the context of energy constraints. While this political debate is not new, we can expect it to continue.

The Battle of Pitchforks Versus Profits

In the context of reducing operating costs, the most prevalent and ongoing battle is that between labor and capital. Karl Marx focused on the conflict between capitalists attempting to pay workers as little as possible and workers attempting to collect their “proper share” of economic proceeds. The battle between capitalists and workers lives on today, and perhaps always will. From the biophysical perspective, economic processes depend on the consumption of environmental resources, and capitalists and workers largely fight over the proceeds derived from using the natural resources that none of us created.

Just how much profit do capital owners have to allocate to labor to keep the masses from taking up their proverbial pitchforks to storm the mansions of the top 1–10%? Politicians and labor advocates often talk about the need for good paying jobs, in the energy sector or otherwise. I’ve heard this jobs plea provoke a skeptical statement such as: “Capital has been substituting for labor for over 500 years. Get used to it!” This statement implies that since the dawn of capitalism, the purpose of the economy has not necessarily been to create good jobs.

Ever since sugar cane production on the Island of Madeira in the 1400s, capitalists have sought higher production and lower costs by substituting capital, or property, for *paid* labor. In the context of capitalism, slaves on Madeira and U.S. plantations were treated as “capital” assets to be owned, bought, and sold, not as laborers to be paid wages. Since the outlaw of slavery, capitalism has been inventing its way back toward a system in which laborers are again paid as little as slaves.

This reduction of labor costs is why Marx thought capitalism sows the seeds of its own destruction. He thought capitalists would alienate workers to such an extent that workers eventually would revolt and destroy capitalism itself.

For at least a couple of centuries, people have predicted the eventual demise of capitalism. However, as Chap. 8 noted, over the last 50 years, more countries have tended to move toward rather than away from capitalism and markets. Of course, this does not mean that a one-world capitalist government is inevitable. I do not know whether the people will gather with their pitchforks to overtake the top 1%, whether the top 1% will suppress the masses to the point of starvation, or whether energy constraints will lead to such high debt that capitalism collapses itself. Any one or a combination of these situations could arise. They are not precluded by the laws of nature. But how can we imagine any of these situations from the viewpoint of an outside observer?

Nicholas Georgescu-Roegen offers one perspective:

The exosomatic evolution [use of technology and energy that are separate from the human body] brought down upon the human species two fundamental and irrevocable changes. The first is the irreducible social conflict which characterizes the human species. Indeed, there are other species which also live in society, but which are free from such conflict. The reason is that their “social classes” correspond to some clear-cut biological divisions. The periodic killing of a great part of the drones by the bees is a natural, biological action, not a civil war.[5]—Nicholas Georgescu-Roegen (1975)

Think about his bee example. Honey bees don’t hibernate over winter during which they feed and keep warm by consuming the honey they’ve made over spring and summer. Drone bees don’t work. They exist to fertilize the queen bee’s eggs. In winter, after the drone bees have fertilized the eggs, they are kicked into the cold to die as the hive no longer needs them. If they stayed they’d consume honey but serve no further purpose for the hive.⁷ As Georgescu-Roegen implies, we outside human observers don’t consider this drone neglect as genocide or mass murder. We just call it a natural response to physical constraints and a programmed result of evolution.

What would an outside observer think about how we *Homo sapiens* treat members of our species who can no longer procreate or increase economic production? This question is not in the mindset of most people, including politicians and economists, who assume energy resources and the physical environment don’t affect our social decisions. One politician, however, did contemplate this question in April 2020 during the coronavirus (COVID-19) pandemic. In a television interview where he discussed the tradeoffs of stay-at-home orders between saving lives and declining economic activity, Lieutenant Governor Dan Patrick of Texas, at the age of 70, suggested that it was better for someone of his age to risk their life to keep the present and future U.S. economy strong for his children and grandchildren:

⁷Debbie Hadley. “Sexual Suicide by Honeybees, August 7, 2019: <https://www.thoughtco.com/sexual-suicide-by-honey-bees-1968100>, “How Honey Bees Keep Warm in Winter,” October 7, 2019: <https://www.thoughtco.com/how-honey-bees-keep-warm-winter-1968101>.

But 500 people out of 29 million and we're locked down, and we're crushing the average worker. We're crushing small business. We're crushing the markets. We're crushing this country. . . . there are more important things than living. And that's saving this country for my children, and my grandchildren and saving this country for all of us. And I don't want to die, nobody wants to die, but man, we got to take some risks and get back in the game, and get this country back up and running.⁸—Dan Patrick, Lt. Governor of Texas (2020)

Would an alien, observing us while orbiting Earth, conclude that any neglect of elderly and mentally or physically challenged members of our species can be explained by our genetic programming and reactions consistent with natural laws? Would an alien see these acts as social failures or productive measures to grow the economic superorganism? Of course we don't yet even know if extraterrestrial aliens exist, and thus we certainly can't answer what they would think of human society.

We can, however, imagine the minimization of labor costs at the extreme: a fully automated artificially intelligent robot society with no humans (or at least no need for humans). I will not speculate on the timing or likelihood of this ultimate outcome, as there is no consensus from experts in the field of artificial intelligence. (Refer back to Chap. 8 for the rationale for superintelligent system overtaking humanity.) But many trends point in the direction of more automation: increasingly capable artificial intelligence algorithms; increasing computational speed and ubiquity of physical devices communicating via wireless internet (e.g., 5G communications and possibly beyond); increasing automation of extraction, manufacturing, and transportation machinery (e.g., autonomous vehicles); automatic stock trading algorithms; laws that give corporations the rights of people.

Recall Richard Adams' relationship between social power and control over the environment. If human-independent self-aware artificially intelligent systems obtain more control over the physical environment than humans, then humans could become subordinate to these robot overlords.

Let's come back to the present situation, before the artificial intelligence singularity, in discussing technological "progress" via automation, employment, and pay to workers.

In his book *Prosperity Without Growth*, Tim Jackson summarizes this problem as the "productivity trap."^[8]

The Productivity Trap

Jackson describes the productivity trap as follows:

... So there is a huge premium on any strategy that might increase the availability and the quality of employment.

⁸Weinberg, Tessa, 'More important things than living,' Texas' Dan Patrick says in coronavirus interview, April 21, 2020, *Fort Worth Star Telegram*, <https://www.star-telegram.com/news/politics-government/article242167741.html>.

At the heart of the problem [of available quality employment] lies an issue we have already identified as a key dynamic in capitalism – the pursuit of increasing labour productivity; the desire continually to increase the output delivered by each hour of working time. Though it's often viewed as the engine of progress, the relentless pursuit of increased labour productivity also presents society with a profound dilemma.

As each hour of working time becomes more productive, fewer and fewer hours of labour are needed to deliver any given level of economic output. In fact, with labour productivity continually rising, aggregate demand must rise at the same rate if the total number of employed hours is to stay the same. As soon as demand falls – or even stagnates – then unemployment rises.

With labour productivity continually rising, there is only one escape from this 'productivity trap', namely to reap the rewards in terms of reduced hours worked per employee – or in other words to share the available work amongst the workforce.⁹—Tim Jackson (2017)

As capitalism spurs innovation that saves labor costs to produce economic goods and services, the total output of the economy must increase to keep everyone fully employed. From the perspective of the finite Earth/techno-realistic and Energy Descent narratives, growth will eventually cease as technological change cannot indefinitely overcome natural resource limits. The social dilemma is that labor-saving innovation could continue (at least for a while), and we'd need fewer working hours for a stagnant or declining economic output. Thus, if employment fulfills an individual's need to feel like he or she is a worthwhile member of society, then each person would need to work fewer hours to make room for all willing employees to provide enough individual contribution.

A targeted reduction in working hours is not a crazy idea. It is part of German policy that kept unemployment from significantly rising in the Great Recession of 2008–2009. The policy is called *Kurzarbeit*, or short-time working. In this policy “If an employer wants to cut working hours to save money, the state covers up to two-thirds of the wages that staff would otherwise lose.”¹⁰ This government involvement on behalf of its citizens is compatible with supporting the country's profit-seeking companies. In contrast, facing the same recessionary pressures, companies in the U.S. tend to fire employees in the downturn before hiring back some when growth resumes. Thus, there is much less employment stability in U.S., and unemployment fluctuates much more than in Germany. Higher taxes in Germany support the *Kurzarbeit* policy that stabilizes employment. Lower taxes in the U.S. still support some social safety net, such as limited unemployment insurance that was expanded during the 2008–2009 Great Recession, but employers are forced to fire and hire more employees along with the ups and downs of the business cycle.

Even when economic times are good, economists even 100 years ago, including John Maynard Keynes, thought higher labor productivity would allow people to work less and spend time with friends and family.¹¹ This has happened to a degree. The average annual work hours for U.S. workers fell from 2030 in 1951 to 1770 in

⁹[8] [p. 145].

¹⁰Daniel Schäfer, “Keeping the lights on,” *Financial Times*, November 10, 2009 at: <https://www.ft.com/content/bd1e8620-ce2e-11de-a1ea-00144feabdc0>. Also see Jackson [8, p. 146].

¹¹Jackson [8, p. 145].

1982. Since the 1980s, however, there has been practically no change in work hours. In 2017, the average U.S. worker worked 1760 h [3].¹²

But as this book has pointed out, since the 1970s, too many Americans have continued to work a similar or increasing number of hours with stagnant or decreasing compensation. They might justifiably want to change the economic system for the reasons Karl Marx anticipated. To the techno-optimistic narrative, this is crazy. The capitalist economic superorganism is the goose that keeps laying golden eggs, and all other options lead to worse tyrannical outcomes. The techno-realistic narrative says this goose has not discovered alchemy. It just converts energy and food into regular eggs within the bounds of natural laws. This struggle between a stagnating economy and human dignity of work poses difficult but important questions for the future: should we kill the superorganism before it kills us, and replace it with something more amenable to people? Or, is the superorganism the best way for us to survive?

Kill the Superorganism?

Evolutionary pressures drive the economy as a superorganism to consume more resources, process more information, accumulate more capital, and convert energy to useful work more efficiently. From this viewpoint, the superorganism is not about people. It's not for or against people; it's just indifferent. For most of the history of industrialization, this indifference provided generally positive unintended consequences for human prosperity. This story, supported by much data, is often promoted by the combined fossil fuel and techno-optimistic narratives. In the last half century, however, the indifference to humans has shifted toward negative unintended consequences, mostly in developed economies. This story, also supported by much data, is often promoted by the combined renewable and techno-realistic narratives.

We are caught in a conundrum. On the one hand the individualistic and profit-seeking structure of the economic superorganism is what drives innovation, creativity, and the ability to both create and solve energy and environmental problems. We seem to want this feature. On the other hand, the biophysical nature of the superorganism means that physical limits and natural laws constrain its space of solutions such that we might not be able to solve all social and environmental problems simultaneously. We might not want these physical constraints, but we have to deal with them.

¹²University of Groningen and University of California, Davis, Average Annual Hours Worked by Persons Engaged for United States [AVHWPEUSA065NRUG], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/AVHWPEUSA065NRUG>, accessed February 29, 2020.

Historically, within the lifetimes of the current older generations, citizens, governments, and corporations banded together through events such as the Great Depression and the two World Wars. This created societal traditions and shared identities. People want to hold onto these traditions. This is a very human concept. The superorganism doesn't think much of history and tradition, it just does what it does today, using market price signals to govern individual decisions.

Jackson ends his book with a statement on the tension between human tradition and economic innovation:

The tension between [innovation and tradition] exists for a reason. Innovation confers advantages in the evolutionary adaptation – allowing us to respond flexibly to a changing environment. This ability is more critical now than ever. But tradition and conservation also serve our long-term interests. In evolutionary terms they allowed us to build security and establish a meaningful sense of posterity.

The point is not to reject novelty and embrace tradition. Rather it is to seek a proper balance between these vital dimensions of what it means to be human. A balance that has been lost in our lives, in our institutions and in our economy.¹³—Tim Jackson (2017)

The reason why a balance is needed was expressed by Carsten Herrmann-Pillath. In essence, the economic superorganism uses markets to enable more degrees of freedom. Since more degrees of freedom increase the odds of extracting more primary energy via exploration and increasing energy efficiency, then *the policy conclusion* is that:

...enhancing the scope of markets always and necessarily enhances and leverages the dissipation of energy. ...Second, technological knowledge is a physical phenomenon, and hence we cannot approach technological progress independent from the question how far the production and the use of knowledge itself are part and parcel of energetic dissipation in the economy. Then, we cannot view technology as a substitute for energy, as this is typically assumed in environmental and resource economics. *Thus, if neither markets nor technology are means to resolve the environmental challenges of today, those positions in ecological economics are vindicated which argue that fundamental changes of the values and institutions of capitalism are necessary to establish a sustainable global economic system* [6].—Carsten Herrmann-Pillath (2015) (emphasis added)

In stating “changes of the values and institutions of capitalism are necessary,” Herrmann-Pillath expresses why Jackson and others think we increasingly face the need to balance policies that seek to increase economic growth with those that seek to increase livelihoods for people. Between World War II and the 1970s, in rich economies there were many decisions that achieved both goals. Since then, we've had a harder time finding these win-win situations. Due to the biophysical reality of how the economy operates, it is not entirely our fault. While we are partly in control of many important factors, such as how to distribute energy and money among people, we are completely in control of none of them.

Recall from Chap. 4 that both economic and physical principles inform us that we should not expect perfect income inequality. Most citizens in rich countries were satisfied with a certain level of inequality leading up to the 1980s, but they have

¹³[8] [p. 226].

become less satisfied in the last couple of decades. We also know that tax policy affects income distribution, but that tax policy alone does not overcome physical constraints to economic growth.

If we enter an Energy Descent scenario, then a more human-centric strategy could include policies, similar to the German *Kurzarbeit*, in which the same number of workers were used to produce a declining economic output. *This policy specifically worsens labor productivity*, the exact opposite approach of the human-indifferent economic superorganism, but it has a better chance of ensuring social cohesion. To reiterate, the tradeoff is lower incentive for innovation, but in Jackson's words, this is how we might achieve prosperity without growth—human prosperity without physical and economic growth.

Climate Change

Battle over Carbon: The Price Is Not Right

Why hasn't the economic superorganism addressed the issue of climate change? After all, orthodox economic theory and the neoliberal paradigm state that when you have a problem, you make a market to address it. In the case of climate change, why not simply make a market to price greenhouse gas (GHG) emissions?

A biological organism has no choice but to be influenced by the physical "markets" governing energy exchanges with its environment. Via natural selection, evolutionary forces favor phenotypes relative to their environment. However, as far as we know, *Homo sapiens* is the only living species that contemplates its own existence 10s, 100s, or even 1000s of years into the future.

If we can control the superorganism, then we can make it contemplate our future risk to ourselves from climate change. However, if the economic superorganism acts like a biological organism, it would neither plan ahead several generations nor pursue actions that reduce immediate energy consumption.

The maximum power principle claims organisms maximize average power flow over daily to annual cycles, not centuries. Thus, while creating any price-forming market into the economic superorganism might seem natural, creating one that encourages "too much" contemplation of the future might go against the maximum power principle, and thus be rejected. This is the crux of why it is hard to establish a market price on carbon for the purpose of reducing global GHG emissions.

Nonetheless, some regional economies, such as states in the U.S. (e.g., Regional Greenhouse Gas Initiative) and countries of the European Union (EU Emissions Trading System), have established markets for GHG emissions.¹⁴

¹⁴The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory market-based program in the United States to reduce greenhouse gas emissions. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey,

In 1990, under the Acid Rain Program, a cap and trade system was established to reduce sulfur dioxide emissions in the U.S. Thus, in principle the same concept could exist for GHGs, but there are fundamental challenges for establishing a GHG market via a cap and trade system. The cap would be a decreasing annual limit on GHG emissions, governed by certificates that allow entities to emit GHGs.

This regulatory constraint on economic activity, or degrees of freedom, would express findings from climate science. Businesses and countries could continue economic trade, but now with the requirement to buy and sell the declining number of certificates that give the right to emit GHG emissions. But here's the rub: climate change and energy consumption involve fundamental physical processes that affect the economy. However, the neoclassical economic paradigm detaches prices from the physical nature of the economy (refer back to Chap. 6) and theorizes that market prices are based on the preferences of consumers.

Given the propensity for people to prefer consumption now versus later, and given how few people understand climate science, economic theory, and the role of physical resources in the economy, how are consumers going to perceive any proper integration of GHG emissions prices into the cost of the goods and services they buy? They might revolt because they don't understand how GHG pricing affects all of the items they buy. The 2018 *gilets jaunes*, or "yellow vests," protests in France show the difficulty in raising energy prices, at least in the short term, that would occur with pricing GHGs.¹⁵

The second best option to establishing a global (or regional) GHG market is a regulated carbon price. In 2019, scores of renowned economists, including 27 Nobel Laureates, signed onto the policy of a steadily increasing carbon price in the form of a revenue-neutral carbon fee whose proceeds are given back to citizens as a dividend.¹⁶ This dividend attempts to prevent protests such as those of the yellow vest movement. Organizations have coalesced around this idea, such as Citizens Climate Lobby and the Climate Leadership Council (CLC), the latter supported by some oil and gas companies and both supported by some conservative political leaders. Why? As stated by the CLC leadership, "A well-designed carbon fee checks every box of conservative policy orthodoxy."¹⁷

New York, Rhode Island, and Vermont to cap and reduce CO₂ emissions from the power sector. See <https://www.rggi.org/>. European Union Emissions Trading System, https://ec.europa.eu/clima/policies/ets_en.

¹⁵Angelique Chrisafis, "Who are the gilets jaunes and what do they want?", *The Guardian*, December 7, 2018 at: <https://www.theguardian.com/world/2018/dec/03/who-are-the-gilets-jaunes-and-what-do-they-want>.

¹⁶Climate Leadership Council, Economists' Statement on Carbon Dividends, *The Wall Street Journal*, January 17, 2019 <https://clcouncil.org/economists-statement/>.

¹⁷George P. Shultz and Ted Halstead, "The winning conservative climate solution," *Washington Post*, January 16, 2020 at: https://www.washingtonpost.com/opinions/the-winning-republican-climate-solution-carbon-pricing/2020/01/16/d6921dc0-387b-11ea-bf30-ad313e4ec754_story.html.

The “revenue-neutral” idea is key for conservative support. While the government would establish a fee on GHG emissions, the fees do not increase the size of government or its revenues because the fees are to be distributed back to citizens via “equal lump-sum rebates.” Thus, consumers get the price signal they need to buy low-carbon products, and while the costs of energy and other products might go up, low-income citizens are more than compensated via the dividends. Because people with more money tend to buy more things, and the production of more things triggers more emissions, I have my doubts as to whether this idea would lead to lower emissions or not. The carbon fee does provide the incentive to produce individual low-carbon products, but because the dividend shuffles money from high consuming individuals (high incomes) to lower consuming individuals (lower incomes), there is no overall incentive to consume less in total. The assumption, or hope, is that total consumption can continue to increase while total GHG emissions decrease as the dividends indirectly induce low-carbon investment faster than increases in overall economic activity. It is not obvious that this sequence will hold true, and this remains a major open research question.

At the scale of the U.S., Chinese, and global economies, so far there is neither a GHG market nor a predetermined trajectory that establishes an economy-wide carbon price. There also has been no turnaround in the trend of increasing U.S. income inequality. Thus, this is how the think tank New Consensus and a group of U.S. congresspeople arrived at the concept of the Green New Deal as a third major option to reduce GHG emissions.

In Case of Crisis: Break Glass, Enact Plan

In 2019, U.S. House Resolution 109 called for “the Federal Government to create a Green New Deal” (GND) as a vision for how to solve contemporary social and environmental problems while hedging against the worst effects of climate change.¹⁸ It recognized the following socio-economic issues in the United States:

1. life expectancy declining while basic needs . . . are inaccessible to a significant portion of the United States population
2. a 4-decade trend of wage stagnation, deindustrialization, and antilabor policies
...
3. the greatest income inequality since the 1920s,

All three issues are discussed in this book.

Inspired by the public investment of the original New Deal of the 1930s, the House Resolution “. . . recognizes that a new national, social, industrial, and economic mobilization on a scale not seen since World War II and the New Deal

¹⁸ Accessed March 1, 2020: <https://www.congress.gov/116/bills/hres/109/BILLS-116hres109ih.pdf>.

era is a historic opportunity ...” to create the Green New Deal to address social problems related to income inequality via large-scale investment in low-carbon and energy efficient infrastructure.

In one sense we can view the Green New Deal as a vision to inspire a plan to overcome the inability of the economic superorganism to incorporate an overarching price signal to reduce greenhouse gas emissions. If we aren’t making a market, then perhaps we can make a plan, or we can just start doing stuff to reduce GHG emissions.

At the global scale, there is one example where countries coalesced around a plan to limit certain air emissions. The Montreal Protocol, adopted in 1987, phased out the use of stratospheric ozone-depleting substances, such as chlorofluorocarbons (CFCs) that were used in refrigerators and air conditioners. Since ozone in the stratosphere blocks most of the ultraviolet-B radiation from the sun, a growing hole in the ozone layer exposed more people to more radiation and risk of skin cancer. The Montreal Protocol is the only worldwide treaty signed by all member countries of the United Nations. Some think we can make a carbon reduction plan just like the Montreal Protocol formed a successful plan that reduced CFCs. Unfortunately, the scale of GHGs affecting climate is much larger than the scale of CFCs affecting the ozone layer. Climate change presents a much harder social and political problem because it presents a much harder technological problem.

Is it easier to make a carbon market or a carbon plan? For climate policy, this is a major future energy-economic battle: prices versus plans.

The more you think about it, there is little difference between low-carbon planning and setting up an information-processing market that spits out carbon prices. In some sense, the reason there is no worldwide market to price carbon is because the necessary process to define the rules of that market is itself a very grand plan. The worldwide plan is so grand it has not yet happened, despite 25 conferences to date (the Conference of Parties, 1995–2019) of the United Nations Framework Convention on Climate Change. Markets are not predetermined commandments given by the gods. They are creations of man, and historically they have promoted an increasing number of degrees of freedom to grow the economy as a superorganism.

By forcing ourselves to reduce GHG emissions, we remove some degrees of freedom.

While the UN Paris Agreement was officially signed by almost all countries in 2016, it includes no binding reductions in GHG emissions. It is a plan with no teeth. Because a binding worldwide plan is thus far unachieved, an increasing number of states, cities, businesses, and investors are committing to renewable energy and GHG reduction goals.¹⁹ Their thought is that if country-level governments can’t commit to lower carbon emissions, then maybe lower-level governments and

¹⁹America’s Pledge. “Across America, states, cities, businesses, universities, and citizens are taking action to fight climate change, grow the economy, and protect public health. America’s Pledge brings together private and public sector leaders to ensure the United States remains a global leader in reducing emissions and delivers the country’s ambitious climate goals of the Paris Agreement.” <https://www.americaspledgeonclimate.com/>.

companies can do it themselves. Even in the U.S., where President Trump plans to officially pull out of the Paris Agreement, in 2019 “1 in 3 Americans [lived] in a city or state that has committed to, or achieved, 100% clean electricity” by some year before 2050 [4]. This goal also holds for 12 U.S. states and six major utilities that operate across 17 states.²⁰

The Green New Deal recognizes the failure to establish a carbon price via a top-down market or regulatory approach. Therefore, its proponents seek to act from the bottom-up, at the level of communities that are taking action: “. . . a Green New Deal must be developed through transparent and inclusive consultation, collaboration, and partnership with frontline and vulnerable communities, labor unions, worker cooperatives, civil society groups, academia, and businesses . . .”²¹ Community level projects are more politically popular, but it is hard to select enough effective projects to make the large impact needed to reduce the vast majority of GHG emissions by the year 2050.

An article in *The New York Times Magazine* stated this conundrum:

The question is whether any policy is both big enough to matter and popular enough to happen.²²—David Leonhardt (2019)

While economy-wide carbon pricing is a big enough idea to matter, it is not yet popular enough to happen.

Attacking issues of income inequality and social justice via an array of community-led low-carbon energy investments in a Green New Deal can be popular, but each project might be too slow to develop and too small to matter, even when you add them all up. Make no mistake, the accumulated concentration of GHGs in the atmospheric is indeed the sum of contributions from billions of small individual activities, and it will also take changes to billions of individual actions to reduce GHG emissions rates to below 20% of 2000 levels by 2050. In response to the vision of the Green New Deal, some organizations have started efforts to see just how to “really” act on a Green Real Deal.²³

Absent a carbon price as simple signal for all economic actors to watch, it is unclear how any well-intentioned set of ideas, whether the Green New Deal or a carbon fee and dividend, can proactively reduce global GHG emissions. Thus, the system-wide pricing of GHG emissions is perhaps the ultimate ongoing, and future, energy and economic battle.

²⁰See Figure 3 and Table 1 of [4].

²¹Accessed March 1, 2020: <https://www.congress.gov/116/bills/hres/109/BILLS-116hres109ih.pdf>.

²²David Leonhardt, “The Problem With Putting a Price on the End of the World,” *The New York Times Magazine*, April 9, 2019, <https://www.nytimes.com/interactive/2019/04/09/magazine/climate-change-politics-economics.html>.

²³For example, the Energy Futures Initiative, <https://energyfuturesinitiative.org/> and The Green Real Deal report: <https://energyfuturesinitiative.org/grd-report> and <https://energyfuturesinitiative.org/s/GRD-EFI-Part-2-2.pdf>.

Pricing or not, a low-carbon transition requires both building a lot of new energy infrastructure while getting rid of a lot of old infrastructure. But if governments at the state and community levels, and eventually the country level, start investing in infrastructure from which we are all supposed to benefit, who should own it and directly receive some of the proceeds? As Chap. 6 notes, the U.S. World War II manufacturing effort, often used as an analogy for a low-carbon transition, involved the U.S. government effectively paying to double the scale of U.S. manufacturing. After the war, private companies owned this capital that they didn't pay for themselves. Should the same thing happen again if we embark on a low-carbon transition? Who should own the infrastructure?

The Battle for Capital: Public Versus Private Ownership

Some ideas associated with the original New Deal and the Green New Deal strike at the heart of debate over the form of the economic system: who owns capital.

If the private ownership of capitalism is failing to address climate change and wealth inequality, then, as implied by the Herrmann-Pillath quote in this chapter, the problem might be more than the lack of a price. Perhaps the problem is the system itself.

By calling out for public ownership of energy infrastructure, the Green New Deal directly mimics the original New Deal and seeks to have all citizens benefit from a collective ownership whether that be at community, state, or national levels. But there are important differences between today and the 1930s.

First, the New Deal occurred in a United States that was relatively empty of people, relatively full of nature, and low on employment.

The abundance of untapped rivers provides one energy-related example for “full of nature.” In 1930, the U.S. had a total of 7000 MW of hydropower capacity. The Hoover Dam, an iconic feat of engineering, funded and owned by the U.S. government, added only 800 MW of capacity by 1938.²⁴ As indicated by Fig. 4.19, most big hydropower plants were constructed in the 1950s and 1960s. In 2018 the U.S. had about 80,000 MW of installed hydro capacity, with less than 3000 MW added since 2000. Further, due to tapping out the best rivers and competing demands for water, annual hydroelectric generation has been about the same since 1974.²⁵

Aside from many rivers to dam, in the 1930s the oil age was just beginning as production ramped up in East Texas. If you're fighting a major depression, it's good to have as much cheap oil and undammed river reach as you can handle.

While there is practically no scope to build new large U.S. hydroelectric stations, there is certainly sufficient scope to put a lot of people to work building wind farms,

²⁴Using data from Energy Information Administration form 860.

²⁵See Table 7.2A Electricity Net Generation: Total (All Sectors), U.S. Energy Information Administration, Monthly Energy Review <https://www.eia.gov/totalenergy/data/monthly/>.

solar farms, and the transmission and other electric grid infrastructure to integrate them. That said, another difference between today (early 2020) and the time of the New Deal is that U.S. is more full of people, electricity demand has plateaued (Fig. 3.5), and employment in 2019 was as high as any time in history, even though many are underemployed and ill-paid.

Converting all cars and light trucks to electric vehicles could increase electricity consumption by about 25%, but a U.S. more full of people creates higher opposition to new transmission lines, and other infrastructure, that are necessary for a 100% renewable and/or zero-carbon grid. Companies have struggled to build long-distance transmission lines across multiple political boundaries. These efforts suffer from "...the majority-minority problem which affects many ideas in a democratic society. A majority may benefit from a project such as a transmission line which helps provide renewable energy, but small minority groups may lose from such a project and will thus fight harder than the majority."²⁶

Whether publicly or privately owned, it is unclear how much infrastructure local land owners and governments will tolerate when it crosses, but does not directly benefit, their territory. In the U.S., the Federal Energy Regulatory Commission (FERC) approves the siting of interstate natural gas pipelines, and thus can overrule states that oppose them. However, FERC does not have this same authority for interstate electricity transmission lines. Thus, we can expect a future battle over whether to grant FERC authority to approve transmission lines.

At perhaps an extreme form of public ownership resides the idea of the U.S. government buying private U.S. fossil fuel companies to reduce the profit-seeking incentive to extract their reserves and thus emit GHGs. In 2017 one group estimated that 1.15 trillion dollars could buy out the 25 largest U.S. oil and gas companies, plus all publicly traded coal companies.²⁷ Their rationale? If the U.S. Federal Reserve can spend trillions of dollars via quantitative easing, or QE, to bail out banks after the 2008 financial crisis, then why not do something similar to bail out investors in fossil fuels. To them, this is "QE for the planet."

In addition, following the 2008 financial crisis, the U.S. government did actually take ownership, partially or fully, of companies such as General Motors, insurance company A.I.G., and mortgage lenders Freddie Mac and Fannie Mae. So these precedents, and others, exist for governments of capitalist economies, even that of the U.S., to partially or fully nationalize private companies for some period of time.

At smaller scales, the idea of public and collective ownership has many appeals. For example, whether via cooperatives, where the owners are the customers, or municipal utilities, owned by local governments that are accountable to its citizens

²⁶Ethan Pratt, "Clean Line Energy and America's Infrastructure Problem," July 24, 2019, <https://www.energycentral.com/c/uu/clean-line-energy-and-america%E2%80%99s-infrastructure-problem>.

²⁷Gar Alperovitz, Joe Guinan and Thomas M. Hanna, "The Policy Weapon Climate Activists Need," *The Nation*, April 26, 2017 <https://www.thenation.com/article/archive/the-policy-weapon-climate-activists-need/>.

as customers, most economic benefits from energy system ownership flow to the people that use it.

However, the opposite also holds. Costly choices also affect the citizens of municipalities and owners of cooperatives. As shown by the example investments (in renewables) by the municipal utility of Georgetown, Texas (Chap. 9) and investments (in nuclear power) by regulated utilities of Georgia and South Carolina (Chap. 3), big bets can cost much more than planned. As shown by the investment and subsequent bankruptcy from a private investor buyout of a Texas power company (Chap. 3), private companies also can make big bets that go awry.

Neither public nor private investors always make good or bad decisions. Past performance is no guarantee of future results, but a common future trend is the size of investment. For energy, the packaging of smaller individual investments is becoming more favorable, and big bets are getting rarer.

The Struggle for Size: No More Megaprojects

In the case of a government buying out fossil fuel assets and companies, these would be extremely large investments in *removing* capital assets (e.g., fossil reserves) from the economy. In the opposite sense, developed economies will likely continue to face headwinds against making large single energy investments that *add* new capital, whether private or public. For energy, the era of the megaproject seems over.²⁸

Certain types of energy investments have at least one characteristic in common: they can be pursued in relatively small increments less than 10s of millions of dollars, instead of a few billion dollars at a time. This holds for an individual hydraulically fractured and horizontally drilled oil or natural gas well. This holds for a solar photovoltaic panel or wind turbine. This holds for storage systems from batteries that store electricity to tanks that store propane. This holds for smart grid devices and algorithms that turn electrical devices off at times of peak electricity demand and turn them on at times of low demand. This even holds for natural gas power plants that can be installed in increments of 10s of MW.

In economies with no more growth in energy consumption, it is too risky to plan for one large and expensive energy generation or extraction project. Even if investing the same amount of money in aggregate, you can minimize financial risk by investing in multiple small investments distributed among several projects. Thus, there is less chance that any given investment puts an investor into bankruptcy or insolvency.

In the last several years, the U.S. has seen dozens of coal power plant retirements, and these occur in relatively large chunks of 100s or 1000s of MW at a time (the entire U.S. has about 1,100,000 MW of power plant capacity). Nuclear power plants

²⁸Jeffrey Tomich, "Is the era of the utility megaproject over?", *EE News*, August 3, 2017, <https://www.eenews.net/energywire/2017/08/03/stories/1060058301>.

will be up for retirement in the next few decades, and a few have already been decommissioned. These also come in chunks of 1000s of MW. In all likelihood these will not be replaced with new coal or current-generation nuclear power plants. A series of the smaller investments, of the types mentioned in this section, will fill in the gaps.

In Case of No Price or Plan to Stop Bleeding, Apply Pressure

Since there is not yet a large enough market to set a carbon *price*, and there is not yet a grand enough binding carbon-reducing *plan*, another p-word describes a third approach: *pressure*.

Consumers are increasingly using whatever social influence they have to pressure private companies and investors to disclose their exposure to climate change and make choices consistent with lowering GHG emissions. In response, companies are increasingly investing in low-carbon energy supplies to power their operations.

These types of activities fall into the “environment” aspect of the so-called environmental, social, and governance, or ESG, investing. Even BlackRock, in 2019 the world’s largest investment manager, jumped on the ESG train. Depending on your viewpoint, investment managers are either late to the station or they’re added very much needed inertia to low-carbon efforts from the investing community.

In a letter to shareholders, BlackRock CEO Laurence Fink stated his firm was increasingly including ESG criteria into their investment products.²⁹ Some environmental advocates were not impressed, as they stated that “BlackRock continues to be the largest global investor in coal, oil, and natural gas extraction . . .”³⁰ When you are the world’s largest investor, you have a good chance to also be the world’s largest investor in fossil fuels. Seemingly in response to pressure from “climate activists, investors, legislators, and other thought leaders,” BlackRock’s 2020 client letter announced the beginning of a major divestment from “thermal coal.”

Environmental groups like the Sierra Club are still skeptical and want investors like BlackRock to develop more definitive low-carbon thresholds for investment, to act on faster time lines, and to vote for pro-climate shareholder resolutions (rather than merely abstain).³¹

²⁹Larry Fink’s Chairman’s Letter to Shareholders from BlackRock’s 2018 Annual Report. Accessed March 7, 2020 at: <https://www.blackrock.com/corporate/investor-relations/larry-fink-chairmans-letter>.

³⁰Sierra Club press release, “BlackRock CEO Larry Fink Faces Protest at Annual Shareholder Meeting for Lack of Action on Climate Change,” Thursday, May 23, 2019, accessed March 2, 2020 at: <https://www.commondreams.org/newswire/2019/05/23/blackrock-ceo-larry-fink-faces-protest-annual-shareholder-meeting-lack-action>.

³¹Sierra Club, “BlackRock Responds to Demands for Stronger Climate Action with Bold New Commitments,” January 14, 2020, accessed March 7, 2020 at <https://www.sierraclub.org/>

How fast can even the largest investment firms be “pressured” to accelerate a low-carbon energy transition? This is a great question and a fundamental energy-economic trend to watch going forward. Whether investment management firms are tentative or realistic, BlackRock doesn’t overplay its “constructive role” when it states government action is still “required:”

A successful low-carbon transition will require a coordinated, international response from governments aligned with the goals of the Paris Agreement, including the adoption of carbon pricing globally, which we continue to endorse. Companies and investors have a meaningful role to play in accelerating the low-carbon transition. BlackRock does not see itself as a passive observer in the low-carbon transition. We believe we have a significant responsibility – as a provider of index funds, as a fiduciary, and as a member of society – to play a constructive role in the transition.³²—BlackRock (2020)

Summary

So here we have it. Practically all countries of the world signed the Paris Agreement in 2016 to limit GHG emissions enough to have a good chance to limit global warming to 1.5°C, but they won’t make any binding commitments. The biggest investors, biggest energy companies, and most famous economists claim we should set up some sort of carbon price, but it hasn’t happened even though these are among the firms and individuals that many people believe have legislators under their thumbs. Somehow collectively we don’t create the low-carbon system that practically all individual companies and countries claim to desire.

There seems to be a paradox. The low-carbon energy solutions appear at hand, yet the economy does not take the steps to actually lower greenhouse emissions. The paradox exists only if we force a false choice between the endpoints of the each of the energy and economic narratives of this book. The paradox vanishes if we think of the global economy as a superorganism.

The most certain way to reduce greenhouse gas emissions is to reduce consumption of physical resources, but we seem unwilling (so far) to self-impose this constraint. One of the main reasons is because the techno-optimistic and infinite substitutability economic narrative, which dominates economic thinking, and thus, also policy design, says we don’t have to. It does not contemplate physical constraints on long-term growth.

[press-releases/2020/01/blackrock-responds-demands-for-stronger-climate-action-bold-new-commitments](https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter). BlackRock 2020 Client Letter, “Sustainability as BlackRock’s New Standard for Investing,” accessed March 2, 2020 at: <https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter>.

³²BlackRock 2020 Client Letter, “Sustainability as BlackRock’s New Standard for Investing”, accessed March 2, 2020 at: <https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter>.

In contrast, the techno-realistic narrative assumes the finite Earth can and will eventually constrain increases in consumption and economic growth. In the short term we try to grow the economy by substitution and increasing our options, but in the long-run physical constraints restrict both growth and our options for growth.

From an evolutionary perspective, each entity (person, company, country) within the economic superorganism competes against the others within a physical world, and in doing so seeks to remove constraints on itself. This is how the superorganism considers the techno-optimism narrative, and why it ignores the energy narratives of fossil fuels versus renewable energy. It minimizes constraints by using some combination of all types of energy technologies. At the same time the superorganism realizes its physical nature, and will not be surprised at an end to growth. It expects it. The difficult questions relate to whether or not we should plan for the end of growth and if so, what such a plan even looks like. Plans can look like additional constraints on options, but one can also enact plans to remove as many constraints as possible.

There are tradeoffs between short-term versus long-term thinking, between markets versus plans, between applying versus removing economic constraints, and between worldviews that consider the economy as a physical system versus those that don't. Too often people use the energy and economic narratives to speak past each other rather than engage in thoughtful conversations on these tradeoffs.

I hope this book better enables these conversations.

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