CHAPTER 5

This Fossil Fuel Project Is Essential

It is difficult to get a man to understand something, when his salary depends upon his *not* understanding it.

Upton Sinclair

Individual countries have strong incentives to delay GHG-reducing actions that might disadvantage their economy relative to laggards, and this is especially so if they are fossil fuel-rich. The default path in such cases involves government talking about a national energy transition – especially when under the media spotlight at international climate negotiations – but doing little domestically to cause that transition. This optimal strategy from a national perspective causes humanity to fail with the global collective action challenge of climate change.

Although the incentives are against it, political leaders occasionally emerge who want to act decisively at a national or sub-national level. Perhaps the politician is concerned and sincere, recognizing the need for political leadership and accepting the duty to act despite domestic political risks and the lack of an effective global effort. Perhaps the jurisdiction lacks its own fossil fuels or is less dependent on them because of the dominance of an alternative like hydropower or nuclear, making it easier for citizens and corporations to envision a non-fossil fuel energy system. Perhaps there is greater public support for action due to a combination of higher education, wealth, global awareness, and trust in government and public institutions.

For corporations and individuals whose real or perceived self-interest is linked to the fossil fuel path, various strategies are available to delay or undermine climate-energy policy efforts in such jurisdictions. In a previous chapter, I explained how some have followed the strategy of the tobacco industry by misleading us about the science. In this chapter, I explain the one-at-a-time technique of convincing people who want action on the climate threat to nonetheless accept that this proposed coal mine, coal-fired power plant, oil pipeline, oil extraction project, natural gas development should proceed because it is somehow clean or valuable or a tiny GHG contributor or ethical.

To succeed in the art of illusion, magicians use a technique called 'sleight-of-hand.' They divert your attention elsewhere so that you fail to see what they're actually doing. With fossil fuels, tragically, the goal of the magic act is to acquire wealth without anyone realizing you are hastening climate change with its catastrophic impacts. The sleight-of-hand succeeds if people continue to support, or at least allow, investments and activities that extract and emit carbon, even though these same people don't want climate change. The magic act diverts their attention by incessantly harping on the jobs and other benefits from fossil fuel development, while avoiding any mention of the inevitable disaster. If the jobs and wealth message is repeated enough, the effect is hypnotic.

The fossil fuel industry has deep pockets to fund professionals whose job is to convince us that a particular fossil fuel extraction, transport, or burning activity is somehow good. These people are usually well paid thanks to the money we provide when buying gasoline from an oil company and electricity from a coal-burning utility. In the cruelest of ironies, we who are still somehow dependent on fossil fuels are bankrolling the people who work to keep us on a destructive path.

An American friend of mine, Steve, who once worked in marketing, recounted to me a day in which he felt particularly inundated with fossil fuel industry messaging. In the online version of his paper he read about the jobs and tax revenue a proposed oil pipeline would generate. In that one morning, he read this same message in an op-ed, the main editorial, a news article, and an info-ad designed to resemble a legitimate news article. Later that day, driving home from work he passed a bus emblazoned with the message "powered by natural gas: the green energy future." On the same trip, a radio ad informed him that the gasoline he buys is "good for his engine and the environment." And that evening, a TV ad by his electric utility trumpeted its "clean coal powerplants that help sustain local coal mining jobs."

Because of his marketing background, Steve is attuned to the techniques of his former profession. Had he not deliberately reflected on the coordinated biases in these messages, he too would have assumed these activities were good for both the environment and the economy. He reminded me of the strategy behind the Marlboro Man and other techniques to sell harmful products. Never mention lung cancer. Never mention climate change. Inundate the viewer with images of a thriving economy, along with tax revenues supporting local schools and hospitals.

If you read the promotional material of fossil fuel corporations in support of any coal mine, oil or gas well, oil pipeline, oil refinery, coal port, or coal-fired power plant, you will never see an explanation of how this project is consistent with limiting global warming to 2 degrees Celsius. Instead, you'll find vague claims that this project is the cleanest of its kind in the world. You'll hear about its economic and social benefits. You'll even hear that this corporation cares about climate change and is doing its part by improving plant efficiency or planting trees or something equally innocuous. But you'll never find an explanation of how this project is consistent with preventing climate change.

There are various techniques for deluding us that a project is clean when, if examined from the deep decarbonization imperative, it is clearly not. One technique involves finding a 'worse-than' comparative. In the case of coal, this is not easy because it is the most carbon-intensive of the three fossil fuels. But marketers for even the dirtiest coal plant in America can ostensibly find a still dirtier plant in some corner of the world for comparison. "Our coal plant is far better than those dirty plants in China."

The worse-than comparisons are ubiquitous. Since newer coal plants are more efficient, which means they burn less coal and produce less emissions, marketers morph this simple fact into the deceptive term 'clean coal.' Branding campaigns portray new coal-fired technology with slick info-ads explaining that continued development of coal plants is good for America and the planet. In *Big Coal*, Jeff Goodell recounted the efforts of the coal industry to rebrand itself as clean in the eyes of Americans.[1] In a *Rolling Stone* article in 2010, he described the American

Coalition for Clean Coal Electricity, with its $18 million advertising campaign, as "a front group for coal companies and utilities."[2]

For those skeptical about the coal industry, it has developed a second line-of-defense. There are a few plants in the world that generate electricity from coal while capturing most of the carbon and storing it permanently deep underground in porous layers of sedimentary rock. Few companies have this. But the mere possibility enables coal promoters to present new plants as 'capture-ready,' which is nothing more than conventional coal plants with adjacent parking lots where they might one day build a CO_2 capture facility.

In contrast to coal, the natural gas industry requires less trickery for its worse-than-me claim because its power plants produce only half the carbon emissions of coal plants. And with the low prices of natural gas over the last decade, which should continue for years, the industry can further claim that switching from coal to gas does not increase electricity prices.

The natural gas industry is, nonetheless, regularly confronted by environmentalists and independent researchers who note that natural gas combustion also heats the planet. One industry response is to present its product as the 'bridging fuel' on the road to lower emissions. This is used for electricity generation but also transportation, since switching cars, trucks, and buses from gasoline and diesel to natural gas would slightly reduce emissions.

Oil's traditional dominance of the transportation sector has so far obviated the need for a worse-than comparative. Until recently, it was difficult for most people to visualize switching to cars powered by electricity, biofuels, or hydrogen. Now, however, electricity is becoming a real threat to gasoline, with the emergence of many commercial models of plug-in hybrid and battery-electric vehicles. Hydrogen might also do well in fuel cell vehicles, while cleaner forms of biofuels, especially renewable diesel, are a threat for trucks and long-distance transport by train and ship. Thus, the challenge is growing for marketers of gasoline and diesel.

In Canada, where I live, one oil industry strategy is to change our vocabulary, just like Big Brother in George Orwell's *1984*.[3] When I was training at an energy institute in the 1980s, all of our energy dictionaries and encyclopedias used the term "Athabasca tar sands" or "Athabasca bitumen" to refer to the tar sands of Alberta. Those were the only names I knew. Then one day in the late 1990s, while speaking at a conference in Canada, one of the other panelists, from the oil industry, kept correcting me when I said tar sands. "It's oil sands." Having decided this term sounded more benign, the industry was determined to change our vocabularies. I and others stubbornly stuck with tar sands, but eventually gave in if only to be understood when speaking to the public and media. The industry had the marketing power to impose its will on our language itself. More recently, I have noticed in the media that the Canadian oil industry has replaced "developing our oil sands" with "developing our energy resources" and "developing our natural resources." Even the word oil is falling out of favor. One wonders what Orwellian euphemism is next – the "green sands"?

My discussion of these issues with my friend Steve was illuminating, as he helped me understand the various techniques of marketers. But he wanted something in return. He wanted to know how energy system researchers like me could tell if a particular project, like the Keystone XL oil pipeline from the Alberta "oil sands" to the Gulf, was consistent or not with the 2 degrees Celsius (4 degrees Fahrenheit) limit. Having often heard the industry refrain, "we can't stop using oil tomorrow," Steve wanted to know what investments today and tomorrow are consistent with preventing temperatures from rising more than the 2 degrees Celsius limit, or an even tighter limit such as 1.5 degrees. He wanted to know what he should oppose and what he could allow. He wanted to know whose evidence he could trust.

* * *

John Weyant and Hill Huntingdon have directed the Energy Modeling Forum at Stanford University for over three decades. Almost no one in their field is better known than these two professors, who built the forum into the world's premier institution for coordinating studies of national and international energy markets. Their studies involve the world's leading energy-economy modeling institutes, each with its own particular model that simulates how our energy producing and using technologies are likely to evolve, given key assumptions about population and economic growth, technological innovation, costs, consumer preferences, and public policies.

Each year since its inception, the forum launches a new project in which academic, industry and government experts study scenarios of interest. These are numbered EMF 1, EMF 2, EMF 3, etc. Often, the EMF studies focus on climate-energy policies at the US or global level. The same modelers who coordinate their work for the Energy Modeling Forum also do this for the global assessments of the Intergovernmental Panel on Climate Change.

I told Steve to visit the Energy Modeling Forum website and skim some of the key articles pertaining to EMF 27, a 2010 study that explored pathways for keeping the temperature increase below 2 degrees Celsius.[4] In studies like EMF 27, the models run identical climate-energy policy scenarios designed to achieve the same outcome for the global temperature in 2100. Differences in the model results indicate the extent to which differences in model algorithms and assumptions are a source of uncertainty.[5]

A key takeaway from EMF 27 and similar studies is that we can only burn a small percentage of the remaining fossil fuels in the earth's crust if we are to keep the temperature increase below 2 degrees Celsius.[6] Since the carbon of burned fossil fuels goes into the atmosphere as CO_2, we can work backward from the maximum possible atmospheric GHG concentration to define the 'carbon budget,' the amount of remaining coal, oil, and natural gas we can burn.

Prior to the industrial revolution, when humans started increasing the combustion of coal, followed by oil and then natural gas, the atmospheric concentration of CO_2 was 280 parts per million. Since 1750, it has increased exponentially to pass 415 parts per million in 2019. According to climate scientists, we should have started two decades ago to hold it to 350 parts per million to have a decent chance of preventing the temperature increase from exceeding 2°C in 2100. Today, after two decades of procrastination and rising cumulative emissions, this means reducing emissions rapidly.

Our carbon budget is the rectangle in the middle of Figure 5.1. To the left is the carbon we released from 1850 to 2000 (1,020 gigatons) and from 2000 to 2015 (380 gigatons). On the right of the figure, the carbon in unexploited fossil fuels is divided into the current reserve estimates of coal, oil, and natural gas companies (745 gigatons) and additional amounts that some experts conservatively estimate still reside in the earth's crust (2,050 gigatons). The actual amount is much greater, as I explain in Chapter 7.

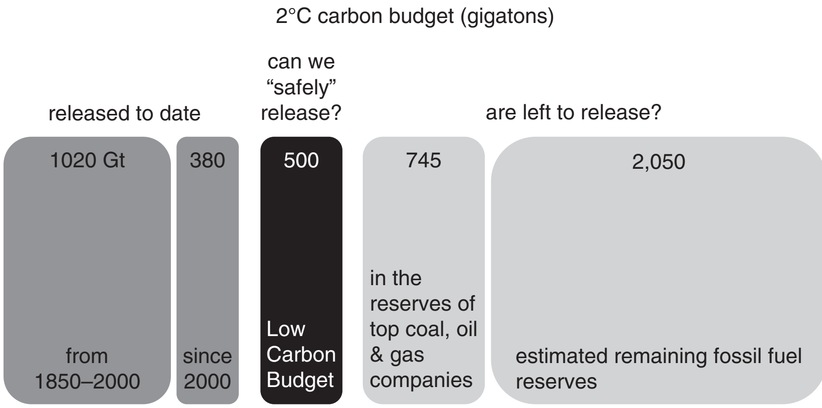

Figure 5.1 Carbon budget

This figure lumps all three forms of fossil fuels into one carbon source in order to compare them as a whole with the carbon budget. But studies like EMF 27 indicate the implications of the carbon budget for individual forms of energy. These studies show the effect of that budget on the global consumption of coal, oil, and natural gas over the next decades if we are to act effectively on the climate threat.

The general finding is unsurprising. Since our global energy system is more than 80% dominated by the burning of coal, oil, and natural gas, we need to stop building coal plants, and phase out existing ones over the next few decades (or retrofit these with carbon capture and storage). We need to rapidly phase out gasoline and diesel in transportation, meaning that global oil demand would soon start to fall. And while natural gas might still rise, as we use it to help phase out coal in electricity generation, within a couple of decades its demand too should be falling.

On my suggestion, Steve visited the Stanford website and read some EMF 27 articles. (I didn't see the point of sending him to the 2018 IPCC report on attaining the even-more-difficult target of 1.5°C.[7] Although the report is an excellent resource, the 1.5°C target is almost impossible to achieve without a sustained global economic collapse or a magical low-cost means of extracting CO_2 or deflecting solar radiation.) Steve noted the evidence for immediate action to meet emission targets for 2050, especially if we expect rich countries to bear more of the initial costs of energy system transformation. But he wondered how he could explain to his neighbors that even though we won't stop using oil right now, we should be acting now to reduce its consumption. I suggested he estimate the time required for significant emissions reductions from all vehicles in his neighborhood, especially since we know we must have a carbon-free transportation system.

Steve is a keener. Over the next two weeks, he interviewed almost everyone on his block. After completing his survey, he sent me his calculation for the amount of time needed for carbon-free vehicles to conquer his neighborhood, and the challenges he faced with neighbors who were initially unwilling to purchase zero-emission vehicles. Steve had learned that the market penetration of a new technology takes time, first for a few adventuresome people to try it, then for the bulk of the population to accept it after witnessing that experience, and then for the transformation of the entire vehicle stock as the oldest models are retired.

Since the average vehicle lasts 15 years, virtually all cars, vans, and pick-up trucks purchased after 2040 had to be zero-emission to achieve a 75% market share by mid-century. This left only one decade to transition from a few early adopters to wider consumer acceptance. For profound technological change, this is a tight timeframe. Consider that the hybrid cars, Toyota Prius and Honda Insight, were introduced in the US in 2000, and took a decade to reach 3% of new car sales, in spite of government subsidies and high oil prices.

Figure 5.2 summarizes the results from Steve's survey and forecast. He figured that the zero-emission vehicles must attain 30% of sales within 10 years, which translates into only 10% of the total vehicle stock, and 100% within 20 years to achieve 75% of total vehicles in 2050.

As Steve's exercise shows, what must happen is straightforward. To reduce GHG emissions, we must switch to alternative technologies. These are available today, but their rate of adoption is constrained by the rate of transformation of our existing energy-using factories, buildings,

Market share of zero-emission personal vehicles	2030	2040	2050
Share of *new* cars purchased	30%	100%	100%
Share of *all* cars on the road	10%	25%	75%

Figure 5.2 Market share of zero-emission vehicles

equipment, vehicles, and infrastructure. Even if government implemented aggressive policies today that mandated a rapidly growing investment in zero-emission technologies for all of these activities, it would take decades to transform the energy system, especially since long-lived investments like buildings, industrial plant, and infrastructure require much more time for renewal than vehicles.

Through this exercise Steve also realized that emission reductions must happen everywhere at the same time. It does little good for vehicles to switch from gasoline to electricity if that electricity is generated in coal-fired power plants. The falling emissions from vehicles would be offset by rising emissions from the power plants. Thus, the electricity system needs to rapidly decarbonize at the same time. And since only a small percentage of electricity plants are retired in a given decade, it is imperative that all new electricity investments are zero-emission and that coal plants are phased out. As an example, my colleague, Jonn Axsen (and former student George Kamiya) simulated the combined effect of energy transformation in the electricity and transportation sectors in different Canadian provinces.[8] Their study shows that electric cars already reduce emissions, even in jurisdictions with coal-fired power. Since the complete phase-out of coal may take one to two decades in some wealthy countries, pushing hard now for electric vehicles synchronizes the energy transformation in these two key sectors.

The technological path for an 80% reduction of global emissions by 2050 entails greater electricity use in industry, buildings, and transportation because electricity causes no emissions at the point of consumption. On the flip side, this path has a falling demand for oil, which is obvious from the table prepared by Steve, in which gasoline vehicles fall to only 25% of the total stock by mid-century, and continue their decline thereafter.

The computer models used in the studies of the Energy Modeling Forum keep track of the stock of houses and cars on Steve's block, and virtually everything else associated with GHG emissions. They keep track of the rates at which infrastructure, buildings, industrial plants, and equipment are retired and replaced. They map how this system-wide inertia determines what things we need to do today, tomorrow, and the next day in order to achieve a 2050 emissions target. And by keeping track of all these components and how they must change over time, the models provide a reality check on the "we-are-clean" claims of industry and the "we-are-acting-in-time-to-hit-our-target" claims of politicians.

The university research team I lead has an energy-economy model of the US and another of Canada, and we participate in some of the studies of the Energy Modeling Forum. Like others, we produce a dizzying array of results; there are many scenarios with differing assumptions about technologies, global energy markets, and policies. But some common lessons emerge from all the models. First, as I have said, we need to be making zero-emission technology and fuel investments today, even to meet an emissions target that seems safely distant. Second, if we pace our reductions to the rate at which technologies are naturally renewed, even the cost of deep decarbonization is modest. In 2015, for example, we estimated that the cost of achieving an 80% reduction in US emissions by 2050 would be equivalent to a year and a half of lost economic growth. One of my graduate students, Sally Rudd, decided to compare these costs to other items Americans spend money on. She found that this dramatic reduction of emissions would annually cost Americans slightly more than they spend on cosmetic surgery, less than on gambling, and far less than on going out for lunch. Her punch line? "There may be no free lunch, but reducing carbon pollution costs less than lunch."[9]

Steve's case study of his neighborhood gave him insights into the challenges of the deep decarbonization transition. We have the needed zero-emission and low-emission technologies. But it takes years, even decades to replace all equipment, buildings, factories, and vehicles. Then there is the human side. Some people readily adopt new technologies. But it takes time to convince the majority of consumers to switch, even when government policies make these technologies an affordable option. Then there is the political side. Some politicians are keen to enact policies that support zero-emission technologies and penalize polluting technologies. But the fossil fuel industry and other vested interests work hard to confuse the public about the need for and benefits from these policies. And without a clear and certain global effort it is easy for naysayers to discourage unilateral efforts by individual jurisdictions.

Steve was now eager to hear more about case studies from my research team's modeling of climate and energy policy in Canada and the US. I thought he would be interested in one story in particular, since it has dominated Canadian news for almost a decade.

* * *

As one of the world's wealthiest countries, Canada is expected to be a global leader when it comes to reducing GHG emissions. However, Canada is also plentifully endowed with all three fossil fuels. The distribution of these resources is regionally diverse, and in Canada's federal system, resource ownership resides with provincial governments. This creates a tension between those provincial governments that want to develop their fossil fuel resources, and are therefore usually biased against deep decarbonization policy, and other provincial governments that place greater priority on emission-reducing policies.

In 2015–19, the Liberal government of Prime Minister Justin Trudeau pursued GHG reductions, promising that Canada would achieve its Paris commitment of a 30% reduction by 2030. But the oil sands of Alberta make a significant contribution to the Canadian economy and the Alberta government wants production to expand over the coming decades. For this to occur, new oil pipelines are needed to transport that additional output to market. From 2012 to 2015, opposition to the proposed Keystone XL pipeline from the Alberta oil sands to the Gulf of Mexico became a *cause célèbre* for environmental activists who wanted a serious deep decarbonization effort. To improve the chances of approval, the project's proponents claimed that increasing oil pipeline capacity would not cause increased oil sands output and emissions.

I was called to testify in Washington in 2013 before the US Congressional Subcommittee on Energy and Power. I explained the linkage between oil pipelines and oil output, and how approval of a pipeline like this would facilitate oil sands expansion and higher

GHG emissions from Canada. While the experience of testifying was intriguing, I noticed that the Republican congressional committee members were not listening to my responses to their questions, which were really just lengthy statements anyway. It seemed like their focus was not me, but somewhere else, perhaps the voters in their home districts or the fossil fuel companies that might contribute campaign funding.

After years of deliberation, President Obama rejected the Keystone XL application in 2015. He accepted the argument that more oil pipelines lead to more oil sands production. Not surprisingly, his decision was overturned two years later by President Trump.

Another pipeline proposal that received less attention in the US, but has been a major issue in Canada, is the TransMountain Pipeline expansion. For decades the original pipeline transported crude oil and refinery products like gasoline and diesel from Edmonton to Vancouver. In 2004, the pipeline was purchased by Houston-based Kinder-Morgan, which applied in 2013 to triple the pipeline's capacity so that diluted bitumen from the oil sands could be transported to the west coast for shipment to overseas markets. The tripling of capacity helps the ongoing oil sands expansion, although again proponents and politicians avoided all discussion of the consistency of oil sands expansion with global carbon budgets.

To shed light on the debate, my research group used results from the EMF 27 study to assess whether oil sands expansion, and thus more oil pipelines, is indeed compatible with the global carbon budget. We took the global oil demand from the EMF 27 model results where humanity keeps the temperature increase at 2°C, estimated the effect on the oil price over the next few decades, and compared this to the likely production cost of oil sands over this time. If the cost of producing oil from the oil sands, including the costs of almost completely eliminating GHG emissions in its production process, exceeded the market price of oil, oil sands expansion would be uneconomic, as would new oil pipelines.

The price of oil depends in part, however, on the production decisions of the Organization of Petroleum Exporting Countries (OPEC), a price-influencing cartel of major oil producers. If OPEC tried to sustain its current production level, while the global demand for oil fell, the price of oil would fall below $30 per barrel for decades. With its low production costs, OPEC would outcompete other producers. If, however, OPEC reduced its output in line with the declining demand for oil, to sustain a constant 40–45% market share of oil production (as it has been for 25 years) then the price of oil would settle at higher levels, probably in the $45 range.

Research by ourselves and others showed, however, that even if OPEC followed this latter strategy, ensuring a higher oil price, oil sands expansion would still be uneconomic. The reason, as we showed in a paper entitled "Global carbon budgets and the viability of new fossil fuel projects," is that deep decarbonization policies would increase the oil sands cost of production.[10] Since this source of oil produces more GHG emissions during production than most sources, what is already a high cost source of oil would see its production cost rise above $50 per barrel, either because of paying a carbon tax on production emissions or paying to eliminate these.

* * *

Governments and fossil fuel corporations avoid the cognitive dissonance caused by simultaneously discussing their fossil fuel expansion and GHG reduction commitments. This is why more citizens need to 'connect the dots' between the two, as I next explained to Steve.

An effort to stop the expansion of fossil fuel infrastructure, such as an oil pipeline, is referred to as a supply-side action. While stopping a pipeline ultimately requires a government decision, citizen efforts to influence that decision range from campaigns to disinvest from fossil fuel companies to acts of peaceful civil disobedience that hinder the construction of fossil fuel projects. In the case of Steve and his neighbors, their potential role as decarbonizing consumers is a demand-side action. Such actions may happen without any policy effort by government. But as the last 30 years have shown, humanity is not going to spontaneously walk away from fossil fuels in time to avert dramatic climate impacts. Government policy is required.

Figure 5.3 depicts government policy options to motivate GHG-reducing actions by individuals and firms. At the top tier, government can choose between non-compulsory and compulsory policies. With non-compulsory policies, it tries to convince people to voluntarily change their technology choices and behavior for reasons of altruism or financial self-interest. Labels on appliances and vehicles inform buyers of the benefits of a more efficient model. Subsidies to products like efficient fridges also focus on self-interest. Governments and advocacy groups also apply moral suasion to encourage individuals and businesses to voluntarily reduce their emissions, efforts known as 'corporate social responsibility' and 'green consumerism.' Finally, because government owns buildings, vehicles, transit systems, and more, it can reduce its emissions via internal investment and management practices.

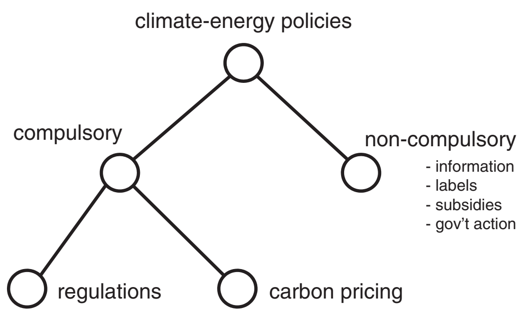

Figure 5.3 Climate-energy policy

All of these non-compulsory policies are attractive to politicians because they don't have to compel anyone to do anything. But if emissions reductions are costly or inconvenient, these policies have negligible effect. Non-compulsory policies played a role in reducing smoking because the harm is 'internalized' – we do it to ourselves. With second-hand smoke and GHGs, where our emissions harm others, we need compulsory policies.

Most governments have tried to look sincere by applying non-compulsory policies for much of the last three decades, extolling the virtues of low-emission lifestyles and technology choices, and doling out subsidies to lure some people to more energy-efficient devices. But if we look at what happened to emissions while governments were doing this, we know that compulsory policies are necessary for the energy transition.

The diagram shows compulsory policies divided into two major categories: regulations and carbon pricing (also called standards and emissions pricing). Our economy is rife with regulations that govern everything from the efficiency of your fridge to the emissions from your vehicle. We can rely exclusively on regulations to reduce GHG emissions if we want. This is a scary thought to people who prefer less government. They fear a swarm of bureaucrats scrutinizing and controlling everything they purchase or do.

But it doesn't have to be this way. We can design regulations that oblige industry to reduce its emissions or shift to a broad category of technologies (like zero-emission electricity generation) and then let businesses decide how to achieve it, perhaps with those who find reductions more expensive paying those who find it cheaper to do more. In the next chapter, I explain and provide real-world examples of this more flexible regulatory approach.

Since economists focus on economic efficiency, they prefer policies that achieve our environmental objectives as cheaply as possible, leaving us with more money for education, healthcare, social services, cosmetic surgery, monster homes, expensive watches, luxury cars, whatever we prefer. Lots of evidence shows that if forced to pay for our pollution, we'll pollute less. With carbon pricing, we can decide for ourselves how and by how much we'll reduce our emissions. You see the price of gasoline gradually rising while the price of ethanol or renewable electricity remains stable. You decide your next car will run on ethanol or electricity instead of gasoline. Your neighbor decides to stick with gasoline, paying more because of the added emissions charge. The net effect is that emissions fall as desired. Government stays in the background, allowing each person to decide their response to the emissions charge based on their preferences.

This free choice for businesses and individuals is good not just because of our beliefs in individual freedom and responsibility. It's also good because each of us may have different costs of reducing emissions: old factory versus new factory, suburban commuter versus inner-city dweller, inhabitants of cold climates versus hot climates. Emissions pricing allows everyone to decide on their technologies, fuels, investment, and lifestyle based on their unique costs and preferences. As a result, we reduce emissions at the lowest possible cost and least possible inconvenience.

When it comes to carbon pricing, there are two main options: carbon tax and cap-and-trade. A carbon tax is the easiest to explain. Since government already taxes energy, it simply adjusts its tax rates to match the carbon content of each fossil fuel: high for coal, low for natural gas, medium for oil products like gasoline. A second option for emissions pricing is to set an emissions cap and distribute tradable permits that in total sum to the cap. By allocating tradable permits (sometimes called allowances) government replicates the individual freedom of the carbon tax. Those who find it relatively cheap to reduce emissions might do additional reductions, leaving them with surplus permits they can sell to those who find reductions relatively costly. The permit trading price gives the same emissions pricing signal to everyone, just like the carbon tax. Government stays out of the decision. I elaborate on the pros and cons of these policy options in the next chapter.

* * *

Had the international community achieved global agreement on national commitments to stay within 2°C, and had that agreement included an effective compliance mechanism, then each country would domestically apply one or a combination of carbon pricing and regulations to meet its commitment and avoid non-compliance penalties (probably international carbon tariffs). If this occurred, the demand for coal, oil, and eventually natural gas would decline, just as shown in studies reported by the IPCC and the Energy Modeling Forum.

In this world, there would be no need for citizens like Steve to worry about climate-energy policy or the proposed projects of the fossil fuel industry. Only economically viable projects in a decarbonizing economy would proceed. Of course, such projects may have local impacts and risks that citizens may be concerned about. Environmental assessment processes would still be required. But the contribution of such projects to GHG emissions would be of no concern, since citizens would already know that humanity has implemented deep decarbonization policies.

Unfortunately, that is not the world in which Steve and the rest of us find ourselves. So we need to be vigilant, as Steve now is. His investigation of the small picture, the cars on his block, and the big picture, global studies by Stanford's Energy Modeling Forum, has given him a level of awareness that won't help him sleep at night. Yet, he says he feels empowered. Although not an expert, he is now better equipped to deal with fossil fuel advocates and politicians trying to convince him to accept the continued extraction and burning of fossil fuels in a world that is not yet on a path to climate success, not by a long shot.

Steve now understands that "fossil fuels are clean" is a marketing ploy. He knows that we already have commercially available technologies and energy forms to shift our energy system on to the deep decarbonization path. He knows what must be happening today in his country and his region as part of the global effort to avert a climate disaster. We cannot be allowing new projects that 'lock-in' the extraction and burning of fossil fuels.[11] Our new electricity plants, new factories, new buildings, and new vehicles must be zero-emission or close to it. And this energy transition won't happen without compulsory climate-energy policies.

Steve can now 'connect the dots' for himself and friends to help counter the effect of those who are preventing us from addressing this threat. As Figure 5.4 shows, he knows that to keep the temperature increase to no more than 2 degrees Celsius, we need to return atmospheric concentrations of CO_2 to 350 parts per million. Steve also knows that for this to happen, CO_2 emissions must fall 50% globally by 2050 and 80% in richer countries. He knows that this can only happen if every major investment today is on the path to CO_2-free technologies and fuels.

Steve can now see through the misinformation campaigns. He is now able to respond to the numerous rationalizations for why *this* fossil fuel project is essential.

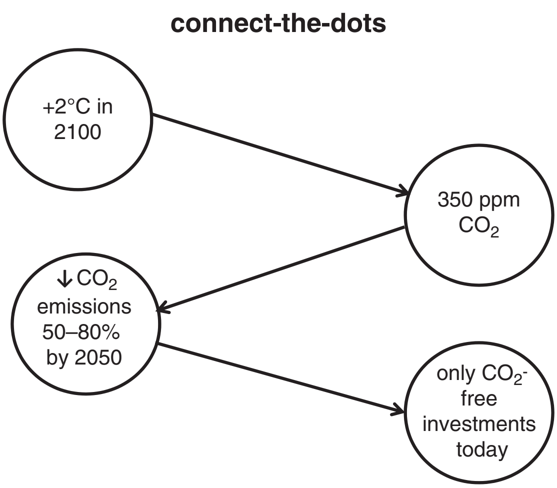

Figure 5.4 Connect the dots

When they say, "We're not going to stop using oil tomorrow, so this project should proceed," Steve sees that if this project proceeds, we certainly won't stop using oil in time to avert a catastrophe. If, instead, we enacted compulsory transportation policies of rising stringency, and work to spread these to developing countries, using globalization campaigns that likely require carbon tariffs, oil sales would decline as plug-in hybrids, battery-electric, biofuel, and other clean vehicles captured market share. We won't stop using all oil tomorrow. But we must try to stop most new investments to extract carbon from the earth's crust.

When they say, "We need the jobs and tax revenue from this fossil fuel project," Steve now knows that if we capped or priced carbon pollution, we would use more electricity, biofuels, and hydrogen in our vehicles, and these would be produced using solar, wind, wood, grains, hydro, perhaps nuclear power, and perhaps some fossil fuels with carbon capture and storage. And, of course, all of these alternatives would also produce jobs and tax revenues.

When they say, "Electric, ethanol, biodiesel, and hydrogen cars and trucks are expensive, unreliable, and inconvenient," Steve now knows that these options may appear relatively expensive today, but that is only because fossil fuels have a huge subsidy by using the atmosphere as a free dump. The economics change once we correct this terrible oversight with carbon pricing or regulations. Then we'll see these alternatives become cheaper and more reliable as they compete with each other in the rapidly growing market for low- and zero-emission vehicles.

When they say, "There is no point reducing our emissions until the Chinese, Indians, and other developing countries act," Steve now sees that there is no point in developing countries reducing emissions until the richer countries take serious action. As this happens, the leaders of developing countries know that voters in these well-off countries will require that their efforts not be nullified by rising emissions in other countries. Carbon tariffs will likely follow, and we need to be open about this now. If we allow the fossil fuel industry to paint our domestic efforts as globally futile, these efforts will be thwarted.

When they say, "Our oil, coal, or gas is ethical because when you buy from us your money doesn't go to terrorists," Steve now wonders, "How ethical is it to harm current and future generations with climate change simply to enrich yourself?"

These are just some of the justifications for continuing on our high-risk path. The false logic and biased evidence are easily refuted, but informing the public is not easy. This is why people who understand the need to act quickly on the climate threat must lobby for and support compulsory policies, domestically and globally, and actively help their neighbors, friends, and family achieve this same understanding.

And whether we refer to the challenge as a climate emergency or a deep decarbonization urgency or an energy transformation necessity, we must understand that success requires a policy transition as well. Climate-concerned jurisdictions, followed quickly by all jurisdictions, must shift from the all-too-common milquetoast policy stringencies that tinker at the edges of our fossil fuel-dominated economies toward policies that cause the rapid GHG reduction that is essential. A slight reduction in coal burning, a bit more biofuels in gasoline, improved energy efficiency of fossil fuel-burning devices will not do the job. We need now to enact and sustain transformative policies that phase out coal in electricity generation, gasoline in transportation, natural gas and heating oil in buildings, and a host of other wholesale transitions.

Implementing and sustaining such policies in the realm of real-world politics will not be easy. Which is why we must be willing to compromise on our preferred compulsory policy, where this accommodation might increase our chance of political success. In the world of climate-energy policy, we must heed Shakespeare's warning that, "Striving to better, oft we mar what's well."[12]