BIG PIVOTS

ENERGY and WATER transitions in Colorado and beyond

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Why Xcel can move so fast in building 300 miles of transmission in eastern Colorado

And Comanche 1 retiring

by Allen Best

Xcel Energy has been moving fast to develop new renewable energy located on the uncommonly windy but also sunny eastern plains of Colorado. In 2023, it expects to begin construction of 300 miles of transmission line to access the renewables.

In Wyoming, though, Phil Anschutz has struggled to develop a wind farm along Interstate 80 in the Rawlins area for export to Arizona and California.

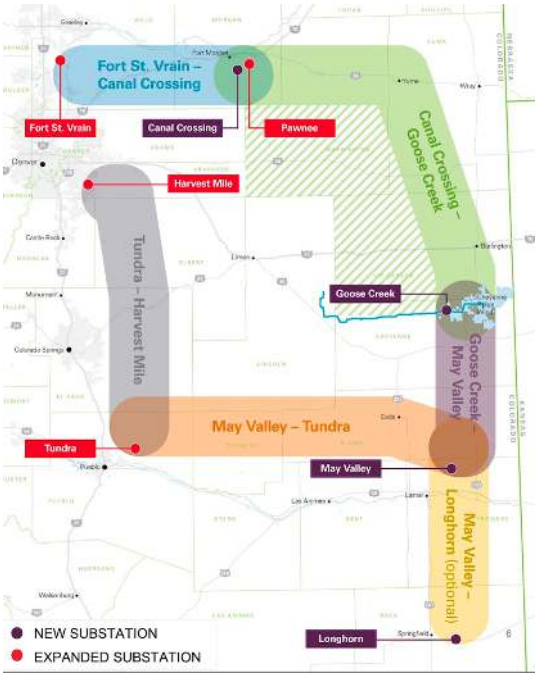
The difference? We'll get to that.

Xcel reported that it has received land-use permits from Cheyenne, Kiowa, Kit Carson, Morgan, and Washington counties. The utility says project staff will now begin seeking construction-specific permits such as for roads. Construction on the two segments—one between Brush and Cheyenne Wells, and the second between Cheyenne Wells and Lamar—can begin once these and associated permits are secured. Also needed are land rights.

Completion is expected in 2025.

Three additional segments totaling 310 miles of transmission will connect the May Valley substation north of Lamar to Pueblo and then to metropolitan Denver-Boulder. Construction on those segments is scheduled to start in 2024 and be completed by 2027.

The Colorado Public Utilities Commission approved the $1.7 billion transmission project in June. Still unclear is whether Xcel will build a 90-mile extension from the May Valley substation to the Springfield area in Baca County, in Colorado's far southeastern corner. Baca County has perhaps the best winds in eastern Colorado. Xcel estimates that extension will cost $247 million, but it must prove to the PUC that it will be necessary. If it is, that would push the total



Comanche Unit 1 ceases operation this week, and units 2 and 3 no later than 2025 and 2030

cost of Xcel's plan, called Colorado's Power Pathway, to more than $1.9 billion.

As it adds transmission and renewables, Xcel will be closing coal plants. The first to go down in this sequence will be Comanche 1, a unit at Pueblo that was commissioned in 1973. Xcel says it will cease operations of the unit by the time champagne is hoisted on New Year's Eve.

Comanche 2 will retire by 2025 and Comanche 3 no later than 2031. All are operated by Xcel, although two electrical cooperatives, CORE and Holy Cross, together own a third of the latter unit.

Also closing between 2025 and 2030 will be five units in the Yampa Valley, including the two that Xcel operates at Hayden.

Xcel had originally proposed the transmission lines to the PUC in March 2021. Some parties had objected to Xcel's full plans to spend nearly $9 billion on development of new generation, mostly in eastern Colorado, arguing that Xcel needed to instead support renewable generation closer to population centers.

But why was Xcel able to move so quickly on this while in Wyoming, the wind farm remains unbuilt?

One part of the answer involves NEPA, the acronym for the National Environmental Regulatory Act, which was passed by Congress in 1969. All projects located on public land trigger the process that requires disclosure of impacts.

Colorado's Eastern Plains are almost entirely privately owned, and the two national grasslands are well outside of renewable development plans. The wind farm in Wyoming, as well as the route of transmission line that would export the power, is partly on federal land.

In their book, "The Big Fix: 7 Practical Steps to Save our Planet," Hal Harvey and Justin Gillis argue that the law needs to be amended. In the Wyoming case, the wind farm development has been in review for 15 years. They argue that the law does not need to be scrapped. Instead, it must be revised to do what was intended originally by lawmakers. See the following interview for details.

Can solving climate really be this easy?

Well, Hal Harvey and Justin Gillis don't say it will be easy. But they soberly insist this challenge can be met.

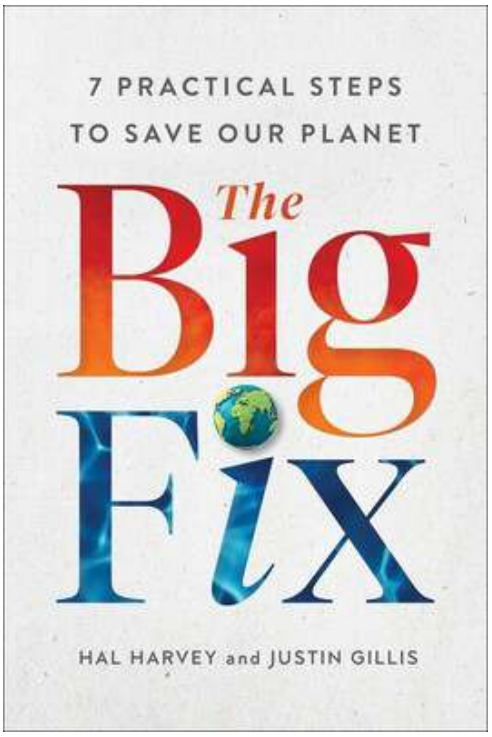
by Allen Best

In 2019, I was invited to a ceremony in Pueblo held on the asphalt parking lot at the steel mill. Evraz, the mill owner, and Xcel Energy had agreed on a deal to power the steel mill with a huge solar farm. The governor was there in his special Colorado sneakers along with the Pueblo mayor, the business executives and—just across the aisle of seats—a reporter for the New York Times. He asked the first question, and I asked the second.

Afterward, I spoke briefly to the reporter, Justin Gillis. He said he had been in Wyoming to do a story about the wind farm that Phil Anschutz wants to build.

Both the now-completed solar farm at Pueblo and the Wyoming wind farm—which is pointedly still in the permitting process after 15 years—show up prominently in the book that Gillis and Aspen native Hal Harvey have written. "The Big Fix" is simply the most absorbing book I've read about the great mystery of our time. It's a sober-eyed analysis of our predicament, the need to stop putting heat-trapping pollutants into the atmosphere, and what we must—and can—do to completely reorder the energy foundation that underlies our 21st century lives.

The book covers a broad swath of American life, from the food we eat to how we build our cities, from what we can do as individual citizens to what must happen at the federal level. They further believe that the United States has the capacity to reinvent itself and, in doing so, create a



model for the world, a pathway for other nations.

They see Colorado as a national and hence world leader in innovation. They have a worldly perspective to inform that appraisal.

Harvey and Gillis are optimists. Full disclosure: I share their bias. Still, I felt I had to challenge the two of them in an hour-long interview about the book's subtitle: "7 Practical Steps to Save our Planet."

"We don't say that it's easy," said Gillis. "We say seven practical steps. We don't say seven easy steps."

This is not a technical manual. Gillis, after all, had a career at the New York Times before he sat down to write this book. He did most of the writing or at least the rewriting. Harvey, who was born in Aspen and grew up there, is an engineer who operates Energy Innovation Policy & Technology, a non-partisan and non-profit energy and climate policy think tank with a staff of 36 based in San Francisco. It does work around the world.

This book is geared for a general audience who reads publications like the

New York Times or—well, might as well self-promote here—Big Pivots.

What quickly impressed me as I started the first of two readings of "The Big Fix" is how every page had at least one vivid statistic, one keen insight. Every page. It never bogged down.

Concrete? The world produces more than 5 tons of it for every man, woman, and child on Earth. Every year. And this single industrial process produces nearly 7% of global carbon-dioxide emissions. Another 10% can be attributed to just two other industrial sectors, iron and steel.

They also explain the inefficiency of electric motors. "An engineering embarrassment," they say, which I am guessing was the description from Harvey, the engineer.

"The Big Fix" is above all realistic. Harvey and Gillis want to see solar and wind expanded even more rapidly than is now occurring, with the electricity replacing existing combustion of fossil fuels in our transportation and our buildings. That's Energy Transition 101 at this point. They also readily concede that it is not enough. We need cost-effective technologies.

Most important, we need to move faster, much faster—and take risks.

Nuclear? That has become an element of the cultural divide in the United States. With exceptions, self-identified conservatives want to hoist it as the solution. With exceptions, self-identified liberals detest it.

Harvey and Gillis called nuclear a "vexed and vexing technology," one that may need to play a role in the energy transition. To become effective, though, costs must drop. For this to happen, the technology must achieve greater scale, not with giant plants, as are now being built with typically huge cost over-runs, but with modular factory-produced units.

This is singularly the most important takeaway from "The Big Fix." To accelerate the energy transition, say the authors, we must scale technologies and hence bring down the costs. This is not a new idea, as they point out. The Industrial Age has produced more and more consumer goods, everything from Model Ts to smart phones, all of which make our lives easier. A theme leaps out from these precedents: an initial scale-up accompanied by a sharp decline in the cost of each unit produced. They devote their first chapter to this concept. They call it The Learning Curve.

They see a major government role in advancing this investigation of nuclear technology, carbon capture, green hydrogen and other technologies that today cannot compete economically, as once was the case with wind and solar.

They hope for Congressional adoption of a net-zero goal for mid-century and an agenda to get there. It's important to note that not one single Republican supported the Inflation Reduction Act, the singularly most important climate bill ever in the United States, if one that still falls short of what is needed. Lacking the full extent of federal action, they emphasize the importance of state and local action. It takes people showing up at school board meetings to advocate for electric buses or to monitor the often-arcane proceedings of state utility commissions.

The interview on Dec. 2 has been condensed and lightly edited and, in places, amended. Enjoy!

Big Pivots: Hi, guys, and thanks for your time. It's sort of amazing to be having this conversation. Justin, I believe you're in England. And Hal, are you in San Francisco this morning?

Hal Harvey: Correct.

Pivots: In September, after I started reading "The Big Fix." I wrote to Pitkin County Commissioner Greg Poschman, a mutual friend of ours, and I said, "These guys know their subject, explain it well,

and deliver nuggets on every page." I had read a third of the book then. Nothing that followed disappointed.

How did you get to know each other and then write this book?

Justin Gillis: As the editor in charge of the energy coverage for the New York Times, I had the responsibility for thinking about the climate part of the energy issue. I was introduced to Hal early. Then in 2010, I started covering the beat myself as the lead writer on climate science. Every time Hal came through New York we would get together and talk.

I was sort of scouring the world for people who not only understood this problem but understood what to do about it. Over the course of a few years, I began to think this guy has a clearer vision than anybody else about where to go and what to do, mainly because nothing Hal said was sort of Utopian or unrealistic.

Justin Gillis

I was extremely frustrated with, for example, the economists who kept saying carbon price! Carbon price! The carbon price is what we need! And I kept saying, yeah, except it's politically impossible in the United States to get that. We've been trying for 30 years. It's never going to happen.

Hal was talking about all these systems that already exist and all these ways that the government already influences the marketplace, all these rules that the public is generally unaware of but that really determine what our houses look like, what kind of cars we're able to buy, and on and on.

Over time, Hal rose to the top of the list of people that I thought really knew what they were talking about on this subject.

In 2016 or 2017, I began thinking this whole agenda of what we need to do should be put in a book because it didn't seem to exist anywhere. There were lots of good books on the science. The books on policy I didn't think were particularly good, most of them. One day at lunch, I popped the question: "Hal, do you want to write a book together?"

Pivots: Hal, what was your progression after leaving Aspen, becoming an engineer and building your own electric car recharged by solar panels? I haven't understood how you ended up becoming, as Justin described you, one of the more sober-eyed, practical people looking forward in this issue.

Harvey: I came of age during the oil crises of '73 and '77-'78, and during the latter time Jimmy Carter was president. As the military draft ended, it was replaced in 1980 by Selective Service registration requirement for young men, including me. This was because of Carter's need to build a military force to protect our access to oil. There's something sobering about putting your name down for the draft. And the purpose was clearly about protecting American access to oil.

At the same time I was excited about building solar homes. I worked for a construction company, and then, with my brother, and we designed and built (passive) solar homes and—this is back in the late-'70s again—discovered that saving energy wasn't that hard. You had to do five things: insulate well, orient the building properly, get the right window overhangs, include some thermal mass in the building, and install great windows. The incremental cost of these five steps—of building a solar home in Colorado, which has a lot of sunny days—was a couple percent more than of the cost of a conventional building.

So, on one hand, I was signing up to go to war for energy, and on the other

swinging a hammer on a solar home to avoid the need for energy. It did not compute.

By nature, I'm a tinkerer. I like taking things apart and putting them back together. I got my first car when I was 12 when I rebuilt a VW with a burned-out engine. I like machinery, and I still like playing with mechanical things.

Then I went to school at Stanford, studying engineering, and discovered that the curriculum then was incredibly thin on climate science or solar power. Just a couple of professors. Really. Now there's a whole school of sustainability at Stanford with more than 90 professors.

The last bit of the story is when you start to study energy, it leads you to a whole series of questions and then solutions. I was motivated originally by fossil fuels and the military question. But the environmental question is also either solved or a failure depending upon your energy choices. Same with conventional pollutants, like nitrogen oxides or black carbon. Same with national balance of payments as we send vast sums to the Mideast. Same with just plain trampling on the environment.

Hal Harvey

Ending our addiction to fossil fuels can solve a whole bunch of problems. That makes it pretty compelling place to spend your energies. If we quit burning fossil fuels, we solve a whole bunch of problems all at once.

Even today, here we are funding both sides of the war in the Ukraine, which is insane. Our military and financial support backs Ukraine. But Putin is using the war to run up the price of oil and natural gas, reaping vast profits in the doing. We funded both sides of the war on terror in the Middle East—devoting weapons and fighting forces to preserve access to oil and just watching while much of this money was diverted to extremists. This is insane.

We can solve a whole bunch of problems with one common solution: Get rid of our addiction to fossil fuels.

Big Pivots: Well, let's get on to the book. Your subject is huge: how to tame greenhouse gas emissions. The book subtitle suggests it really won't be that hard but rather “Seven practical steps to save our planet.” How hard was it to distill this challenge to seven steps, and second, does that title mislead?

Gillis: Let's be clear about this. We don't say that it's easy. We say 7 practical steps. We don't say seven easy steps. We think they are (practical). I'll be honest. We were pushed into the subtitle by our book publisher. There's a bit of a marketing hype in there. No question about it.

As a reader, once you get into the book, you realize these practical steps are really political steps. These are political demands that we need to make even though in a few cases we talk about consumer action that people can take. But it's mostly politics.

Six of the seven are sectors of the economy. One of those is how we build cities, which you can argue is not really an economic sector. It's kind of a cross-cutting thing.

Then the seventh is the stuff we need to invent for the future. The practical step there is for the American public to support a much larger agenda for innovation than the one we have.

I would argue that (the subtitle) is not misleading, but I would also argue that you really have to read the book to get what we're talking about. You're not going to get it by looking at the cover.

Pivots: You say that we need more effective politics of climate change. What did you mean by that?

Harvey: You must focus your energies on things that both make a big difference and are reasonably achievable. And that's a small subset of all the efforts out there.

One of the things that pains me the most about climate change activism is the extent to which it's driven by instinct rather than rational filters.

Forty percent of the carbon in the U.S. economy goes through monopoly pipes and wires, the natural gas and electrical systems. When you have a physical monopoly, it is subject to regulation.

So, who decides whether your utility check that you write out every month, whether that money lands on dirty choices or clean choices? Who makes that decision? If you don't understand where the options are for cleaning up the grid, and who decides, then you can't assemble a decent strategy. That's elementary, but it is often neglected.

Understanding how systems work, finding the best intervention point, and pursuing it with intense focus is required. That's why we wrote the book—to add a fat dose of clarity to this question of whether we can stop climate change before it really burns us out of our homes.

Pivots: How much of this book published in 2022 was what you envisioned when you started on this journey in 2017? Were there major changes in your mental view of the world during that time?

Harvey: A lot of stuff happened along the way. The economics of clean energy got better and better, which is great. The pandemic shook the world, including our little world.

But the structure didn't change that much because the structure reflects the physical aspects of the energy economy. The energy economy consists of power plants and buildings and industry and transportation and land use. And if you're not transforming those things, you're not in the game.

Gillis: Early in our discussions we decided to write what is now the first chapter, which is called "The Learning Curve.' That came out of me and Hal sitting at his dining room table brainstorming this thing. It kept coming up, this theme of taking expensive technologies and making them cheaper. We had these vivid examples of solar and wind that really languished, as we document in the book, for 40 and 50 years before any real attempt was made to push them to scale. Wind power scaled significantly in the United States and solar power in Germany.

Once those attempts to push them to scale occurred, the price curve dramatically and rapidly declined. It dawned on us that we really have to explain this to people, and we have to go back to the beginning. Where did this idea come from? This notion that for every doubling of global output of a new technology the price will come down by a fixed amount is called Wright's Law. In the case of solar panels that turned out to be about 19% for every doubling.

We realized people must understand this, because otherwise the strategy makes no sense. People won't go for paying high

prices at first for new stuff unless they learn this. That's the biggest change from when we started the book. We realized we had to write this first chapter.

I'm happy to say that even with people who are kind of deep in the energy transition world—new colleagues here in London—who are reading the book and are finding that first chapter a bit of a revelation. A lot of people don't know where these ideas came from, what the long history is.

Pivots: You make the case that we need to invest in or move along nuclear, carbon capture, geothermal and hydrogen—all these being very expensive technologies today. Were you as open to these technologies when you started? And unclear to me is how do we decide how to allocate money for these technologies. How much rope do we give them?

Harvey: There's always room for chicanery in making projections about the future. Those technologies might be a way of avoiding the large-scale, serious choices we need to make. Or they could be an honest assessment of future possibilities. I think it's some of each right now.

Our position is that we need speed and scale. We need to push technologies that exist today that are incredibly cheap, that can be used all over the world and that scale rapidly, and that now cost less than conventional fuels. If you're not pushing speed and scale, then the fantastical technologies are irrelevant.

It's a good to explore technologies that are far into the future. It's a terrible thing to rely on them to save our bacon. If it's true innovation, you don't know what it'll cost nor how long it will take. You don't know the physical capacity of its ability to reduce climate change.

If somebody says nuclear is the sole or even dominant answer, that's the last conversation I want to have with them. They have not squarely faced the combined challenges of cost, nuclear material weapons proliferation, safety, waste disposal, siting, speed of construction, or its upside-down learning curve (it keeps getting *more* expensive).

But if somebody says advanced nuclear could contribute down the road, but we should not use it to slow down existing technologies, that's a perfectly rational answer. If they are searching for a way to solve this nest of nuclear problems, so much the better.

"If you're not pushing speed and scale, then the fantastical technologies are irrelevant."

The key point is that if you don't simultaneously argue for massive deployment of wind, solar, offshore wind, heat pumps, and electric vehicles (while arguing for nuclear), then you're not really serious about the problem.

Gillis: Hal and I pretty much agree that the current generation of nuclear technology is certainly not the answer. It doesn't have much to contribute to solving this problem, mainly because the industry has simply failed to perform. There is no learning curve in nuclear. If anything, there seems to be a reverse learning curve. It seems to be getting more expensive through time.

Should we go build a bunch of nuclear plants in hopes of lowering the cost? That's probably not going to work with this current generation of technology.

We have a bunch of existing nuclear plants. Should we allow those to shut down prematurely? I would say no, and I think Hal would, too. They're going away eventually because they're wearing out. But we can keep them running a while longer.

People are trying to invent a more modular form of nuclear technology that would have Wright's Law characteristics,

that would be mostly manufacturable in a factory. That, in theory, would result in them getting cheaper through time as you scaled up. We think it's worth some money to try that. We don't think it's potentially the only answer.

And we would also say that our patience is not unlimited. There are other possibilities that could deliver the dispatchable power that nuclear potentially can play.

We're on a deadline of 2050 to squeeze carbon emissions out of the economy. If the nuclear industry is not performing by the early 2030s, we'll need to go to plan B and plan C.

We cannot fall in love with any technology. We need to be agnostic. We need to push aggressively until we have an answer to the question: Is this a scalable technology whose cost is going to fall through time to a point where it becomes affordable?

We need to spend quite a bit of public and private money on all these technologies to answer that question. The ones that don't meet the grade, we need to put a bullet in their heads and move on to other technologies. That's not necessarily easy, because each of these technologies has its own political constituency. There's no magic here to what we're prescribing. It's a difficult path. But we think that's the way we need to do this

Pivots: How much would your book have changed had your deadline for this manuscript been after the Inflation Reduction Act was passed in August instead of before?

Harvey: Not a huge amount. What the Inflation Reduction Act can do is accelerate the transition, using technologies that exist already. Electric vehicles, for example, and solar and wind and offshore wind. That's a great thing, because they're on a steep learning curve, as Justin says, so that makes them all cheaper.

But there's much more than the Inflation Reduction Act in this year's set of big victories. There's the Infrastructure Bill. There's the ratification of the Kigali amendment to the Montreal Protocol, phasing out hydrofluorocarbons (themselves massive greenhouse gases). There's the tax on methane. The European Union has its Fit for 55 policy, a massive climate change bill that is bigger than the Inflation Reduction Act, with a goal of a 55% reduction in carbon emissions by 2030 compared to 1990. The new energy efficiency standards will force electric vehicle sales in Europe, which is the second largest car market in the world. And China, building more renewables than the rest of the world combined. And more coal, too: we have work to do!

But with the IRA, it's great to have the United States at the table. It's great to show some leadership there. And it will make a big difference.

Of course we are worried about implementation because it's a lot of money to cast out in a short amount of time.

Gillis: Congress just improved the economics of a lot of these existing

technologies that we are talking about. They did not remove many of the hurdles that we talk about in the book: the resistance over land use, the public opposition to building new wind and solar power plants, the difficulty of siting all these facilities that we need. Those problems are all still there. In fact, many of them are getting worse.

A paperback version of the book is going to come out in June, and we have the chance to rewrite it slightly. I'm going through right now, figuring out what sentences to change. It's less because of the IRA than you would imagine.

That said, this is an extremely important bill. It's the biggest thing the United States has ever done on climate. It restores our national credibility on this subject to a significant extent in talking to the rest of the world. But it's not the magic fix. Our job is not over. These laws are really the first course, and we must get through a whole meal here.

Pivots: Do you think the IRA was well designed with the rigorous controls to protect taxpayers' money that you say are needed?

Harvey: In some ways yes, in some ways no. It's mostly done with tax credits. And tax credits generally benefit people that have enough money to buy a new car anyway, for example. Some elements of the bill are a little bit insane. The way it treats hydrogen is quite insane.

Pivots: Why?

Harvey: Because the subsidy is so rich that you can use solar electricity to separate hydrogen atoms, to split them from water, and then burn that hydrogen to make electricity. You get paid for making hydrogen even if all you did was convert electricity to electricity at an incredibly expensive and inefficient rate. There's a set price for hydrogen credits, but there's no cap on how many can be issued. You can imagine people gaming this one. It's inevitable.

Still and all, it's a good bill. It's even a great bill. But it doesn't mean there aren't a few quirks that need to be addressed. I think (Congress) will have a clean-up bill on some of these issues.

Pivots: Justin, in your previous comments you alluded to the need for regulatory reform to lower the bar for siting of necessary infrastructure. In the book you make the case that the National Environmental Policy Act requirements need to be modified. Why, if there is such a broad across-the-aisle agreement about the need, has this been so hard to do?

Gillis: NEPA, which was passed in 1969, requires a pretty detailed environmental assessment every time the federal government proposes to take or permit some action that could have an effect on the environment. It's a little bit of a bizarre law, because there are no actual standards you have to meet. It's just a requirement to do the research and to consider alternatives. That has morphed over the years into gargantuan hurdles when you're

going to build big projects that involve federal land.

Let's be clear about this. It has not been an issue in a lot of solar projects that are going up in the East. In North Carolina you can build an 80,000-acre solar farm, because you're basically dealing with the locals for the permits.

The American West has a strange land pattern. Everybody out there will know what I'm talking about, the checkerboard pattern, where the railroads got every other section of land and the federal government kept the rest. You have all these ranches, and much of the land is partially owned by the federal government, and the ranchers lease the land.

The case in Wyoming is really interesting. You have a right-leaning billionaire in Denver, Phil Anschutz, and his right-hand guy, Bill Miller, who want to build what would be the country's largest wind farm. Anschutz is fundamentally an oil man. These guys are seeing the future and saying, "This is where society wants to go. We'd like to help."

So they're trying to put up this truly colossal wind farm in this superb spot in Wyoming, one of the windiest places in the country, and it has taken them well over 15 years to get the permits that they need under NEPA. Even as we sit here today they still don't have all their permits.

The power line has been an even bigger problem. It would allow them to export the power they've got to run a new power line down to a spot outside Las Vegas where they can hook into the grid that takes power to California.

In the book, we call for a carefully thought-out reform, not just in NEPA. There's a whole suite of land-use policies where, if we just leave them as is, it will take us 30 to 40 years to do that which really needs to be done over the next 10 years.

I'm not sure Hal agrees with me on all of this. I believe like the NEPA reform in Congress needs to be led from the left. We need a Brian Schatz (senator from Hawaii) or somebody like that to take the leadership. The fear among the environmental groups is that if you open it up, the Republicans will do their best to kill all standards of environmental review and we'll have nothing. Hal and I agree that that should not be allowed to happen.

We need a national conversation in which not everybody can take the position that I'm not going to have this in my backyard.

What we do want are deadlines and speed. These decisions need to be made more quickly. We can't drag them out for 10 and 15 and 20 years. That probably means beefing up the staffing and the federal agencies that do these reviews. They're stretched very thin. And it's also true that you don't want to put wind and solar farms in many places.

We need a national conversation in which not everybody can take the position that I'm not going to have this in my backyard. That's what is happening now or starting to happen.

Pivots: What sections of the book were most challenging to either research or to write, and why?

Harvey: I would say the industry chapter. It's really a bunch of sectors: concrete, steel, aluminum, glass, chemicals, pulp and paper, fertilizer, and so forth. Because this is a heterogeneous set of industries and because capital stock turnover is very slow—a factory or a power plant can last 50 years, but that is generally too long for the climate—t's hard to divine a single metric to show your improvement.

Some things are easy to apply public standards: With cars, are they electric or not? There are only about 30 big manufacturers. It's a limited audience.

But if you try to do the same with industry—say the plastics industry—what do you measure? You might want to regulate tons of carbon per ton of plastic. You might measure the inputs of ethylene. You might measure recyclability. So that's just a hard question.

This is where carbon pricing might make the biggest difference—in heterogeneous areas A lot of these industrial companies make money based on the status quo. They have deep investments in capital stock. They're not interested in energy and climate improvements. It's not a sector hungry for change the same way that electronics and software are. You don't hear about disrupting aluminum or glass, even fertilizer.

That was the hardest chapter. I think we landed it pretty well, but there's no question, this part of the energy picture needs more work.

Gillis: The first chapter was also fairly hard to write, because we had to excavate this history of Ted Wright and Wright's Law. Nobody had really done that before. It involved going back to his original diaries. We managed to track down multiple volumes of his diaries and his original writings. Once we had the material, it almost wrote itself. But the digging out that material was difficult and involved quite a bit of leg work.

Harvey: I have to correct Justin on two facts here. First, he uses "we" in terms of digging it all out when it was "he" who did it. And second, this idea that it wrote itself belies his own reality.

Gillis: What? When I get into a fever of writing, I say it kind of wrote itself, but it is a fever, I guess.

Pivots: Writing a book in tandem strikes me as a greater challenge than having a marriage. Any advice you would impart to other potential team book writers?

Harvey: Join with somebody who's brilliant, like Justin. He knows his business. That's number one.

The other thing, somebody told me a long time ago: You can always improve your writing, no matter how good you are. You can do better. And so you should never be defensive.

Sometimes Justin would send me something I wrote so I can review his edits. And there's not a single word that I originally wrote left. If I held out in protest, out of a jealousy, I would be completely failing to take advantage of Justin's brilliance in conveying an important and complex idea.

Be open minded. Be patient. Don't take things personally. And always know there's room for improvement.

Gillis: What Hal is not saying is that same thing applies to my own copy. Writing is really the art of the second thought. You rarely get it right on the first try, and people will just become too wedded to their own prose.

The ability to approach it each time while reading and seeing it the way a reader would is a difficult skill. Once you're enmeshed in it, once you wallow around while trying to write something complex, you almost become—as we used to say in journalism—contaminated. You lose your ability to see it with cold eyes.

As for writing together, you want people with sort of different but complementary skills. And then you want to figure out each other's strong suit. Hal let me be the last fingers on the keyboard for probably 80% or 90% of this book. But there was an awful lot of me saying, "Hal, what's our position on X? What do we really think about the potential of geothermal energy?" And I would bow to his expertise on that

because he spent many more years that I have looking at these questions.

It’s probably hazardous for people to get into joint writing projects where their skills, interests and knowledge overlap too much. That's probably not a great team. You want a team where you're bringing different building blocks to the table, which I think we were.

Pivots: What part of your book do you think perturbs the environmental communities the most?

Harvey: Well, when we talk about NEPA reform or speeding up permitting. It's anti-constitutional for environmental groups to take away or soften in any way their most powerful tool, which is, as Justin said, a process but an outcome, too.

I need to emphasize again and again. We're not talking about weakening it. We're talking about reforming the way it's administered.

Then being open-minded about nuclear. To most people it's a fissure line between pro and anti. It's like abortion or something. And I always say, don't fall in love with any technology. Learn as much as you can about the attributes of every technology and choose accordingly. We're not defenders of nor antagonists to nuclear power. We say it has to overcome five obstacles in order to be a realistic large-scale option in the future. And if you disagree with those obstacles, you had better explain why. You can love nuclear power and still recognize that there are problems.

Gillis: The American environmental movement was essentially built on saying no to things. And the landmark, profoundly important environmental laws that were passed in the 1970s gave them a lot of ability to say no. We’re in a moment where,

if we're going to get out of this crisis, we need to say yes to a whole lot. We need to build a whole lot of new stuff.

Are there going to be environmental sacrifices as we do that? Absolutely. Some of these conflicts could be resolved more artfully with better laws. But some of these conflicts are real. The fight between solar power in the California desert and protection of the desert tortoise—that's real.

All over the world we have conflicts between what you might call the global crisis, the need for a rapid build-out of renewable energy versus local environmental protection. We're seeing this in Britain where the Conservative Party, even though they want to fix climate change, took a hard line against onshore wind.

We will have awkward, bumpy steps to get most of the way there.

It just signals the profundity of the moment we're in**.** Just calling yourself an environmentalist no longer means that you get a sort of free pass on having to make hard decisions. We are in a moment that demands hard decisions from all of us.

Pivots: You say the single most important thing Congress can do is to set an explicit national goal of cutting greenhouse gas emissions to net-zero in the middle of the century. Do you actually have optimism that this can happen?

Harvey: I think we get there in a non-optimized way. In other words, I think we're going to come close with the electric grid. I think the EV transition is going to be faster than most people realize. That's a bigger challenge. And then industry is going to require a much bigger push than we have right now, although the Infrastructure Act offers a lot of help for transforming industry. We will have awkward, bumpy steps to get most of the way there.

Gillis: I think it will happen, but the question is whether it will happen in a timely way.

This is a way of asking the larger question. We're seeing a big political demand for change. It's getting more intense. But the politics are still at least 20 years behind the problem.

By the time we, the public, wake up and really demand change and push it through our elected representatives and through Congress, it may be too late to salvage a livable planet. I think we'll ultimately get there. But we're in a race against time, and the politics are still difficult.

The Republican Party has almost been cowed into silence on this issue. You'll notice they didn't campaign against Joe Biden's big climate law in this last election. They figured out that it's a loser for them with the American public. The public wants this stuff.

But it's not like Republicans are being helpful. It's not like they're being constructive counterparties to a dialogue about what to do and how fast can we go.

Pivots: Hal, you mentioned buildings and heat pumps. My question is about the technology and the learning curve, about the scaling in production of heat pumps to bring the costs down and bringing it closer to parity with natural gas in upfront costs, not even considering the longer-term cost savings. Do you see advances coming down the pike in this technology that will make this an easier push?

Harvey: During the next 10 to 15 years I think I see three kinds of advances. One is technological, changing or optimizing the refrigerant, and much more digitization, so that they know when to turn off and when to turn on. And how to size them.

There will be innovations in business models. Should there be a price guarantee if you have a solar farm plus a heat pump,

but together they don't suffer escalation in electricity prices, for example. Or should the heat pump be owned by the utility instead of by the landowner? How you do heat pumps in big buildings is a big question, too.

Third, let me also emphasize the need for integrated system thinking. Colorado has very strong, clean electricity standards that are growing in strength. Bundling low-cost electricity with heat pumps enhances each of them. For example, you can use the building as a thermal storage during times of bright sun but also extreme cold. Thermal mass is a pretty magical way to increase the comfort in a building that we seem to have forgotten.

As a society, we traded it in for switchable fossil fuels instead of a nice, naturally modulated heat cycle. Better heat pumps, better business models, and system optimization will all have to progress, and they will.

Pivots: How do you see Colorado's decarbonization efforts? Are we perhaps just a little too full of ourselves thinking that we're in the front tier of states in our decarbonization effort?

GIllis: We actually put a lot of Colorado in the book, as I think you figured out, on purpose, because Colorado is a microcosm for all these issues that are playing out around the country.

I made my first reporting stop in Colorado in 2017. In that time that we've been watching, Colorado has come a very long way. Polis was elected in 2018 and just got re-elected. He started his campaign in a coffee shop in Pueblo that's powered by solar panels, if I recall correctly. You had a dramatic series of bills pass in that Democratic legislature under Polis. And the Republican Party in Colorado, sensing where the public is, has not fought this that hard. You certainly have resistance out among the co-ops and in the rural parts of the state. I see Colorado as being in the vanguard here.

There's a long way to go. You have to meet those goals. It's still an oil-and-gas producing state. You've got all those emissions to think about. You're sort of nowhere on industry in Colorado, just as we're nowhere on industry in the whole world. We think Colorado is an example for other states to look at right now.

Harvey: On the grid side, Colorado's at the forefront, doing a great job, although more could be done.

I had the CEO of a major utility say, "Is there any reason why a utility cannot be the principal engine for decarbonizing the economy?" That's a great question. Utilities have skilled workers in every town and city in the country. They have a 100% information on your electricity use. They have a 100% billing efficacy. They're already overseen by public bodies. They're custom-made for being the engines to decarbonize the economy, and we're only starting to use them that way. Colorado is doing a great job there.

In terms of industry, not so much. Not yet in terms of heat pumps.

Transportation is the one that worries me the most. Coloradans love their F-150 trucks, and it's cold there, and electric vehicles don't like cold. And most people don't even turn off their trucks when they go shopping because they don't want to wait two minutes for it to warm up when they return. So we have a ways to go until car dealerships start featuring electric vehicles.

And then sprawl. It's heartbreaking to see land use in the Metro Denver area. It makes it impossible to get around on a bicycle or an electric bike. Electric bikes are game changers, but they're not like infinity machines.

I would say Colorado has made some great steps, but there's more to go.

Pivots: Who are the most influential thinkers on this subject? And how do you read Vacliv Smil?

Harvey: He's a smart guy. He's not an engineer. He's not a scientist. He's an historian. And he's a Gloomy Gus. He finds fault in everything. It's not hard to expose problems. It's an important thing to do, but it's no way to run a political shop or a government.

You have to think about possibilities, and you have to scope them out. If you foreclose every one of them because they're too hard, you didn't contribute much.

Gillis: He's obviously brilliant. There may be nobody with a better grasp of the energy, food, and water nexus and its role in world history. But I agree with Hal that a lot of his discourse about this problem has not been helpful.

It's weird. He will say that ultimately civilization has to run on solar power, because it's the only renewable flux large enough to run human civilization. But he doesn't seem to have the imagination to think we can get from here to there in any reasonable timeframe. So yeah, I'm also fairly frustrated with the guy.

If you take Smil's argument that nothing is ready for prime time, Hal and I just don't believe that's true. We think there's a whole bunch of tech that's ready for prime time, even though it is true that we need more than we have. We lay that out in the book. But the idea that we don't have the means at hand to go like a lot faster now is just flat-out wrong. We can show that it's wrong. Entire countries are doing it.

Harvey: Do you want names of a couple of other smart energy folks? Michael Webber at the University of Texas. Leah Stokes at Santa Barbara. And then there's John Holdren, the former science adviser to President Obama.

Justin Gillis: I think you must put Amory Lovins on this list. He was way, way, way ahead of his time so far ahead that people often think he's crazy, but then 30 years later we come around realizing that he was right about X, Y, and Z.

Pivots: One final question. The world operates on the rule of threes right? What are the three messages you wish to convey to readers of Big Pivots, three takeaways?

Gillis: We need to make the transition from green consumers to green citizens. Your citizenship is what's needed most here, not changes in your buying choices, even though those are good things to do.

Harvey: You need to know the best policy forum in which to invest your energy for the highest possible return—and there are fantastic opportunities to make a difference. But it takes a day or two of research to figure out the best one for yourself. For example, public utilities commissions matter a lot more than state legislators in most jurisdictions.

Gillis: Decisions are being made all around you every day to perpetuate the fossil fuel economy, and a lot of those decisions are quite local—the local school board is deciding to buy diesel buses instead of electric buses, the local county commission is deciding to buy gasoline cars instead of electric cars. There are things you can do that take just a little bit of time but that might make a difference.

Harvey: Just to add two words, literally two words: Virtuous Snowballs. Once you get some positive things going, glom on. Keep going. Scale!

Pivots: Thanks, guys.

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