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Resources

REFLECTING ON A YEAR OF RESEARCH

NEW RESEARCH

How Much Will the Inflation Reduction Act Reduce Emissions?

TRANSPORTATION

Grid Infrastructure for Electric Trucks and the Inflation Reduction Act

ENVIRONMENT

Mapping the Effects of the Coastal Barrier Resources Act

MODELING

Temperature Targets Would Yield Major Global Economic Benefits

Illustration by Nils-Peter Ekwall

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A Note from RFF's President

Looking Back at the Past Year

Monumental climate legislation emerged in the summer of last year—which also happened to mark 70 years of dedication to the mission at Resources for the Future (RFF). Whereas RFF's 70th anniversary had me thinking about the entire history of the organization, over the past few months, I've been thinking about my own legacy here and the opportunities for RFF into the future. As you may have heard in September, after seven years at the helm of RFF, I will be stepping down as president and CEO within the next several months.

Meanwhile, I continue to be filled with gratitude for the privilege of working with and leading such a remarkable team. RFF is consistently ranked #1 globally among the top institutions in the fields of environmental and energy economics and is helping decisionmakers at all levels with actionable climate solutions. We need the economy to work for people and the climate—RFF helps make that possible. I am confident that RFF will continue to flourish under new leadership and am committed to helping ensure a successful transition.

As RFF's Board of Directors launches the search for RFF's next president and CEO, and we wrap up another calendar year, it's a good opportunity for reflection. We've therefore created this winter issue of *Resources* magazine as a chance to pause and look back on the past year at RFF and our work. What you'll find among these pages are some of our favorite blog posts and podcast episodes that RFF scholars have been publishing since the last winter issue of *Resources*.

One of those pieces is particularly relevant to this year's Conference of the Parties (COP28), which marks the conclusion of the world's first global stocktake. The stocktake measures the progress of nations toward emissions-reduction goals in the Paris Agreement and considers what further actions will be needed to meet these goals. RFF's analysis has found that holding global temperature rise to well below 2°C would produce roughly $5.2 trillion per year of annualized benefits through 2300; holding the increase to 1.5°C would produce benefits of roughly $6.8 trillion per year. These are big numbers; the dollar figures demonstrate the scale of action that is warranted to address the risks created by greenhouse gas emissions and climate change.

RFF's research and policy engagement has accomplished much over the past year, and I look forward to what's next on our path toward a healthy environment and thriving economy.

With best wishes for a happy new year ahead,

Richard G. Newell
President and CEO, Resources for the Future

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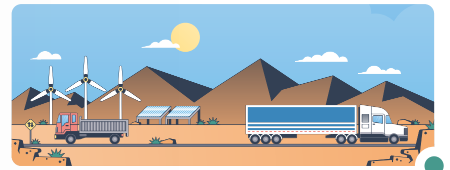

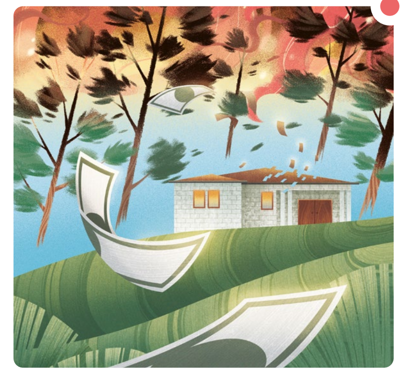

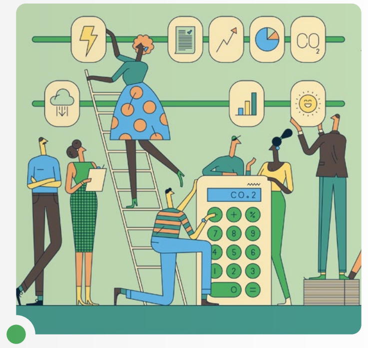

Assembling Calculations: How Much Will the Inflation Reduction Act Reduce Emissions?

Daniel Raimi talks with Resources for the Future Research Associate Maya Domeshek and Senior Research Analyst Nicholas Roy about the Inflation Reduction Act and the emissions reductions that the law could achieve, according to projections from various energy models in their analysis published recently in the journal *Science*. Domeshek and Roy discuss the projections; the law's potential costs, benefits, and effects on electricity prices; the differences among the models in their analysis; the caveats of economic models; and how decisionmakers can use modeling results to improve policy.

Daniel Raimi: Let's talk about the study that the two of you coauthored, which was published in the journal *Science*. Listeners of our show will probably have a good idea of the main provisions of the Inflation Reduction Act (IRA), so we don't need to give a lot of background on the provisions of the bill. Can you tell us about the new study?

Nicholas Roy: When the IRA was released last year, a lot of different research teams came out with modeling studies to represent what they believed the bill would do. What our study has achieved is seeing the commonalities among all these different studies. Usually, with policy analysis, we don't really get the opportunity to compare such a broad set of studies.

Our paper has nine different teams involved, four of which were releasing studies on the IRA right after the bill came out. We were one of those teams—as well as the Rapid Energy Policy Evaluation and Analysis Toolkit, Rhodium Group, and Energy Innovation—that were trying to quantify the emissions impacts of the bill.

We also included five other groups from national labs, government agencies, and universities. This was all organized by John Bistline at the Electric Power Research Institute. He made this heroic effort of coordinating all our different teams with all our different assumptions, all our different data inputs, and all our different modeling frameworks to see where you can get these common outputs and compare direct apples to apples across the different models.

Maya Domeshek: I would say that what makes this new study unique is the ability to look across so many studies and try to figure out what we can learn that is or is not robust across studies.

What are some of the headlines that have come out of this work in terms of energy and emissions outcomes?

MD: The big takeaway from the paper is that the IRA is likely to reduce US emissions. That's robust across all of the models; they all found that there would be a fall in emissions. I think the range that we state in the paper is something like 33–40 percent below 2005 levels by 2030, which doesn't quite reach the US goals in the Paris Agreement—which is 50–52 percent by 2030—but it's on the way there and much better than in the absence of the IRA.

I think the second main takeaway is that most of those emissions reductions are coming from the power sector. We see pretty dramatic decreases in emissions in the power sector across the models: something like 47–83 percent below 2005 levels by 2030.

We also got more detailed results across models, concerning how many renewables are built out, how much consumption increases, what happens to coal and gas capacity, and more.

I think the last thing that's particularly interesting is the question of electrification, because some of the models were representing the entire US energy sector, and they tried to look at what the uptake of the vehicle tax credits or other credits would mean for electrification. Some of the models projected what consumption might be in the future, whereas other models, like ours, made an assumption about what consumption was going to be. We just put a value for consumption in the model, and we didn't touch it after that.

NR: We got that assumption about projected energy consumption from the Energy Information Administration's *Annual Energy Outlook*. We got the number from a modeling team that had projected US demand for electricity back in 2021.

That's great—those are the key outcomes for the energy system and for carbon dioxide emissions. How about costs, which is a key talking point that many people care a lot about? What happens to energy costs under the IRA? When we compare those costs to the benefits that the bill gives us, what does the cost-benefit ratio look like?

NR: We can think about costs in a bunch of different ways. One method, which we use in the paper, is to look at the total energy system and sum up all the costs from the modeling exercise and see what those costs look like prior to the bill and after the implementation of the bill.

Resources Radio, a podcast produced by the *Resources* editorial team and Resources for the Future, releases new episodes weekly, in which one of the hosts—Daniel Raimi, Kristin Hayes, or Margaret Walls—speaks with a guest about a new or interesting idea that's related to things like energy policy, environmental policy, climate impacts, and environmental justice.

This interview was originally released on August 8, 2023. The transcript of the conversation has been edited for length and clarity.

IN CONVERSATION
Maya Domeshek, Nicholas Roy, and Daniel Raimi
ILLUSTRATION
Fran Labuschagne

> **"The big takeaway from the paper is that the Inflation Reduction Act is likely to reduce US emissions. That's robust across all of the models; they all found that there would be a fall in emissions."**

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below 2005 levels by 2030, compared to the US Paris Agreement goal of

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When you have something like the IRA, which mainly uses subsidies to drive decarbonization, you subtract out those subsidies from the costs on the grid. That's a big reason why we see a reduction in costs for retail prices, for example.

The prices of electricity are different from how much money is being spent by the government. The government is spending money on these climate provisions, and it's raising money from somewhere else.

We're concerned about this cost on the energy system. When we want to compare those costs on the energy system to the benefits from reducing these emissions, we have to find some similar or comparable metric. What we do here at Resources for the Future—as well as in environmental economics more generally and in benefit-cost analysis in the government—is consider what's called the social cost of carbon.

Currently, the most up-to-date research says that the social cost of carbon is somewhere near $185 per ton of carbon dioxide that's added to the atmosphere. The idea is that, with each additional ton of carbon dioxide emissions emitted into the atmosphere, society as a whole would incur a cost of around $185. If the cost per ton of carbon dioxide removed from the atmosphere, or not emitted into the atmosphere, due to this bill are lower than that value on average, then you could say that the benefits outweigh the costs.

What we find in this study is that, when we consider the cost in terms of dollars per ton of carbon dioxide that's not put into the atmosphere, we find a metric of $27–$102 per ton as the range across the studies. That $27–$102 is a lot lower than the $185. We would say that the climate benefits of this bill far outweigh the costs on the energy system.

Older social cost of carbon models, such as the Obama administration's, land within the range of our costs, at just about the same as the benefits. If you want to go back to the Trump administration and look at their estimate of $7 per ton for the social cost of carbon, you would see that the climate benefits are not worth the costs of this bill.

But in summary, across all these modeling studies, we do see that the benefits far outweigh the costs of implementing this bill.

Just to clarify, we're not going to go into the details on the social cost of carbon. Many parts of the economy will be damaged by climate change, but those costs are not accounted for in the current best estimates of the social cost of carbon. We're also not talking about the social costs of other greenhouse gases associated with the energy system, like methane and nitrogen oxides.

MD: We're also not including the other benefits of the bill, like the health benefits that we might expect from reduced fossil fuel usage.

How will the IRA affect electricity bills?

MD: The paper does not talk very much about electricity-price impacts, but almost all of the individual studies that contributed to the paper did look at price impacts, and so did we.

In another paper that we published in October, we found that the IRA is likely to decrease the price of electricity generation relative to what the price would've been in the absence of the IRA. The law also likely will decrease the volatility of the price of electricity, because the electricity sector as a whole is relying more on renewables and less on fossil fuels. Fossil fuels have notoriously volatile prices. For example, last year, when the price of gas went up due to the war in Ukraine, electricity prices all over the world also went up. A grid that's more reliant on renewables would see less of that kind of impact.

We found a decrease in volatility and decrease in electricity-generation prices. That's all happening because the government is subsidizing electricity effectively and moving us to an overall—in the long term—cheaper and cleaner grid. Whether that means cheaper or more expensive household bills is a separate question, because, first of all, electricity-generation price is not the same as the electricity price that households are paying, due to transmission and distribution costs.

Second of all, your bill depends on how much electricity you're consuming. In fact, one

Play It Again ...

Hear more of the details that couldn't fit on the page about modeling the Inflation Reduction Act. Listen to the full podcast episode:

of the things the IRA is trying to achieve is getting people to consume more electricity, because we're trying to electrify the whole economy. Reducing the price of electricity makes it easier for people to consume more units of electricity. What this means for your bill, I don't know; that remains to be seen. We do know that the implementation of the IRA is likely to decrease the price of electricity generation relative to what it would've been in the absence of the policy.

Electricity prices are set by the marginal cost of electricity generation in whatever region you're in. Do you think that the marginal cost is more likely to be set by renewables in the future, or is the marginal cost still going to be set by gas? I'm imagining that renewables are going to generate whenever they can generate and supply energy at that margin. Can you talk more about how the IRA might affect the marginal price of electricity generation?

MD: You're absolutely right that electricity prices, especially in regions of the country with a deregulated electricity sector, are set by the marginal unit that's generating. The price that you're paying over the course of the year, on average, is reflecting the marginal price in a bunch of different hours. The more hours that are shifted away from having gas as the marginal unit, the cheaper your overall average annual price is going to be. One would hope that lower demand for gas and other fossil fuels also means those prices are lower, so the marginal gas unit also is not as expensive.

NR: Something that I really liked that you pointed out, Maya, was the temporal aspect of the cost of generation. Something that economists, especially energy economists, have been interested in—particularly those at Berkeley's Energy Institute—is the idea of dynamic pricing.

The IRA subsidizes those renewable generating units, which means that, if you're going to implement something like dynamic pricing in the future, where people basically can get different prices at different hours (which is being implemented already in some aspects by some utilities), you'd be able to get an even cheaper price during certain hours than you would if you're averaging out the price across all hours. Dynamic pricing also enables more benefits for the climate, more benefits to people's electricity bills, and a more efficient system.

MD: I also want to return to this original question about the impact of the IRA on household electricity bills. Because again, in our earlier study, we looked at the distributional impact of reducing electricity prices. We find that reducing electricity prices by subsidizing them with government funds is effectively a progressive (in the technical sense) policy, because you're reducing the amount that households have to spend on a crucial good, and you're paying for it with the tax system, which is somewhat more progressive than the flat quantity of electricity that most households are consuming.

That's an important aspect and an important goal of the IRA: to keep costs down for households.

You and your colleagues in this analysis carry out excellent modeling work—but models inherently are limited representations of the real world, because you have to leave some considerations out of the analysis. What are some of the most important things you had to leave out, or you can't model for one reason or another, and how do you think those omissions might affect the outcomes?

NR: I appreciate you talking the limitations of modeling, because I think every modeler would say that they're some of the last people to trust the results of models as something that you can guarantee. As most researchers will tell you: all models are wrong; some are useful.

I think that's really important to keep in mind. A lot of things in this paper, and in the broader discussion on the IRA, aren't being captured by models. These models represent a version of a world under textbook market conditions that's heavily simplified, so we can analyze these policies in a quick but also interesting and in-depth, analytical manner.

Because of that simplification, certain things don't fit into the framework we've used, and we haven't been able to implement certain things directly. Interconnection delays for renewables is one example. Some of the electricity markets have issues with getting their renewables online, even after the project has been planned and the capital for that project is ready to go. It's difficult to actually get renewable generation set up and ready to connect to the grid. You see the same thing with transmission. All this money is flowing to build renewables, and the projects are ready to be done, but actually implementing them is difficult from the perspective of interconnection and transmission. All sorts of institutions need to improve their efficiency to be able to handle this level of build-out. That's one thing that we just simply don't assess in our models, because it's an institutional question, rather than an inherently economic, analytical question.

> "Dynamic pricing also enables more benefits for the climate, more benefits to people's electricity bills, and a more efficient system."

Other things could get in the way of the IRA reaching the emissions targets. For instance, supply-chain backlogs or critical mineral shortages. During the COVID-19 pandemic, a lot of people saw prices going up because of supply-chain issues. That's probably a big part of the reason this bill was named the "Inflation Reduction Act" and not the "Emissions Reduction Act." Some resource constraints can get in the way of the process.

Another consideration is some aspects of human behavior that economic models have never really quite tried to implement. Labor shortages already are being talked about as big friction points in the implementation of the IRA. Siting and permitting is another big issue that's being discussed federally and at the state level, which sometimes comes from local opposition. Sometimes people just don't want wind turbines in their backyard. These models don't consider every backyard and every potential wind turbine. The models just say where the costs make it possible and most cost-effective to build these renewables.

Another example is related to facilitating hydrogen fuel, which depends on the US Department of the Treasury releasing guidance on exactly how these tax credits are understood to be in the law and how the US Internal Revenue Service makes the credits available. We could end up generating a little bit of hydrogen, or the Treasury rules could allow for a lot of hydrogen production, which could lead to a lot more electricity demand, which in turn actually would undo a lot of the emissions reductions that the IRA could bring about, because you could increase demand more than the increase in renewable energy generation. How Treasury ends up deciding all these rules is a big uncertainty that these models are not trying to capture.

Maybe because I'm a pessimist, I usually think about the downsides related to the risks from these uncertainties: problems with local opposition, interconnection queues, labor supply, and getting materials. Do you think it's true that most of these unmodeled aspects would tend to limit the benefits of the IRA, or could some sources of uncertainty go in the other direction and produce benefits?

NR: Some uncertainties definitely go in the other direction. I was tempted to bring an old output sheet from modeling done by the same team that we're on now, back in 2008, because that modeling projected that emissions would be a lot higher today than they are and that electricity demand would be a whole 1,000 terawatt-hours greater in the United States.

I thought it was interesting that they also under-predicted how much solar and wind would get deployed, because the capital costs were so high back then for those technologies—but the costs have come down a lot in the past decade. The same thing could happen for a lot of advanced technologies that are in development right now.

Those are the kinds of things that modelers don't like to make bets on. You don't want to make a bet on an optimistic outcome when it comes to costs.

MD: The same modeling team that wrote this recent paper also looked at the sensitivities, like how fast the models think it's possible to build out renewables.

I'd also add that I think it's useful to pay attention to the downside risks, because you do more in advance if you're preparing for downside risks than if you're just waiting for something great to happen.

Definitely. If we know what the downside risks are, then we can try to deal with them before they happen and prevent those bad things from happening.

> "I thought it was interesting that they also under-predicted how much solar and wind would get deployed, because the capital costs were so high back then for those technologies—but the costs have come down a lot in the past decade."

Maya Domeshek is a research associate, Nicholas Roy is a senior research analyst, and Daniel Raimi is a fellow at Resources for the Future.

Creating Policy with Good Thinking and Social Stakeholders

Resources magazine recently spoke with Dick Schmalensee, a longtime friend of RFF and chair emeritus of RFF's Board of Directors. Schmalensee has been a member of the Council of Economic Advisers, dean of the Sloan School of Management at the Massachusetts Institute of Technology (MIT), and a consultant to private companies—all of which helps him provide unique insights into building a healthy environment and thriving economy.

Resources magazine: How did you become interested in the role of economic research and analysis in addressing environmental issues?

Dick Schmalensee: I was a summer intern at the Council of Economic Advisers in 1967, and I had a terrific boss, Jack Carlson, who worked on environmental issues at the time. He gave me a manuscript from Resources for the Future (RFF) about water pollution. I read it and thought, "You can really do economics there. I'm an economist; I should have thought of this on my own—applying economics to the problems of the environment." That's what got me hooked and interested in RFF at the same time.

What brought you to RFF as a board member?

I think Larry Linden, whom I'd known at MIT, approached me about being on the board. I'd read work from a variety of RFF researchers, but I didn't know much about the organization. I thought it was pretty academic—people writing papers on interesting stuff without the obligation to teach. Larry got me interested, and I joined the board.

RFF has since moved to a more valuable model of focusing on active engagement. It's no longer just a really interesting think tank with a lot of smart people; it's a place that has an impact on policy.

What do you think has been RFF's greatest impact in the time you've been involved?

RFF has been an active proponent of the widespread use of cap and trade or tax systems to combat pollution. The organization played an important role in taking that idea from a fringe economics notion to something that's now mainstream. RFF spread the idea that, with good policy design, one could manage the environment without crippling the economy, which has gone a long way toward changing the prevailing mindset. That was a big deal—spreading the fundamental notion that managing the environment is an economic problem, and incentives can help mitigate pollution effectively and efficiently.

You've worked on environmental and energy issues in many different professional roles. How would you describe the value of RFF within the broader research and policy landscape?

In government, you're always solving today's problem. Fundamentally, the horizon is too short for serious analysis. For academics, the horizon is generally too long to affect policy. RFF is uniquely positioned to have the right time horizon.

As a consultant, your job is to do the best you can for your client. That's not the same as knuckling down in pursuit of truth. Think tanks can be in the position of being neutral and above the fray, yet still engaged in the policy process. What makes RFF stand out from other think tanks is the concentration of expertise: RFF has experience, a track record, and smart people who are committed to moving the policy needle. RFF can take on problems neutrally, at scale, and with impact.

Where do you see that RFF's work will be needed most, moving forward?

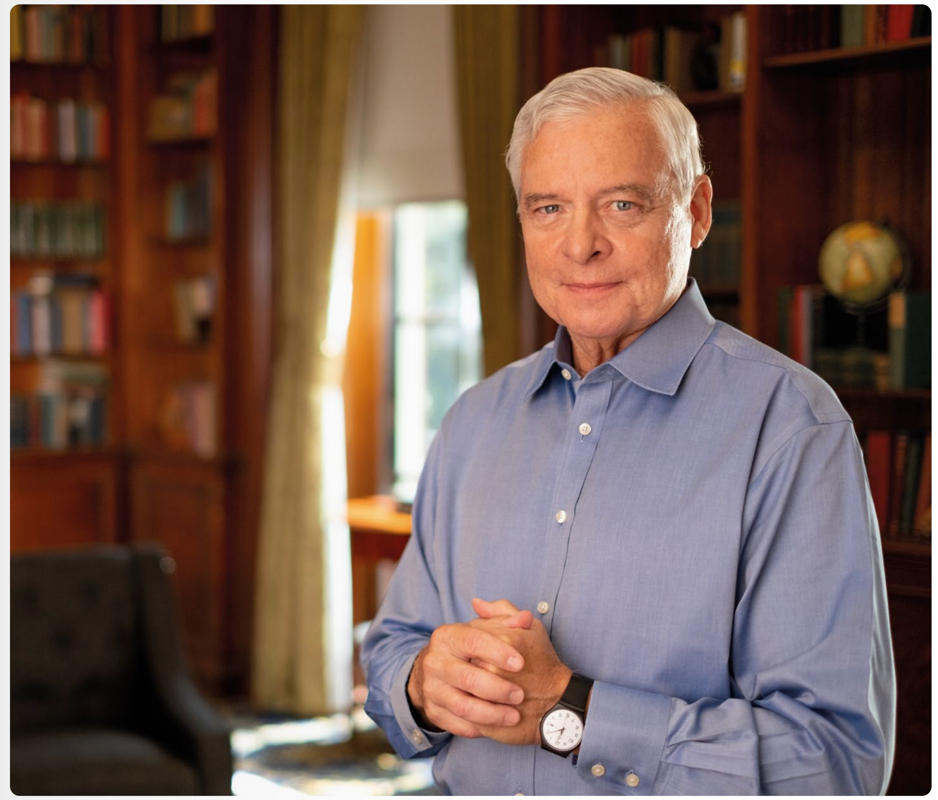
In the 1960s, environmental issues had to do with DDT and its impact on bird life, particulates in the air, lead, and so forth. The environment was something to be concerned about, but it wasn't an existential issue. Climate change is. It's so much more important than any other environmental issue that has arisen in my lifetime, and dealing with it efficiently is critical for the health of the economy.

Just look at the numbers for the amount that has to be invested in the energy transition—it's breathtaking. Somebody has to say, "Let's do this cost-effectively." We have all these other priorities to deal with: healthcare, education, poverty. We cannot afford to waste money on the transition, because the money involved is so big. I think RFF is positioned ideally to inform critical debates in this area. ■

Supporter Spotlight

In the RFF Supporter Spotlight, our partners and colleagues share their insights about climate, energy, and environmental issues and how they've made a difference by working with Resources for the Future—all in their own words.

> "RFF has since moved to a more valuable model of focusing on active engagement. It's no longer just a really interesting think tank with a lot of smart people; it's a place that has an impact on policy."

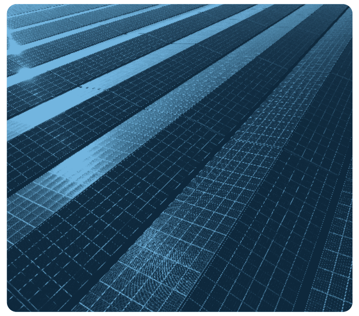


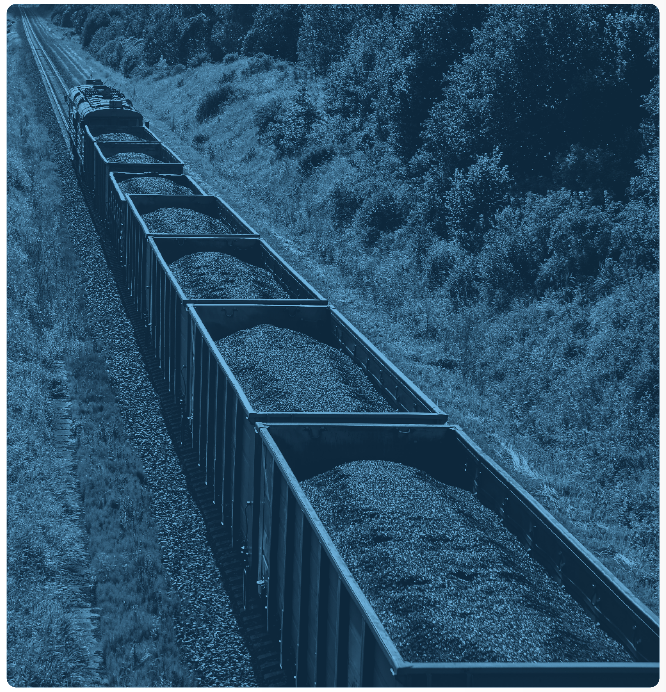
What Is An "Energy Community"?

SEARCH










The Inflation Reduction Act (IRA) offers tax credits to clean energy projects that are sited within an "energy community." But how does the IRA define energy communities? And are these communities indeed most vulnerable in the transition to clean energy?

TEXT Daniel Raimi and Sophie Pesek

The Inflation Reduction Act of 2022 (IRA) aims to transform the energy system of the United States through a variety of incentives that encourage the deployment of clean energy technologies across the electricity, transportation, and buildings sectors. One of the hallmarks of the law is that, unlike most previous federal energy legislation, it ties many incentives to labor requirements, domestic manufacturing, and location of a project.

In this blog post, we'll dig deep into that last element: location. Specifically, we'll try to unpack what it means to be an "energy community," point to some of the oddities of the IRA's definition of those communities, and discuss whether the IRA effectively targets energy-producing communities that may be most hard hit by changes in the energy landscape.

The IRA offers clean energy projects up to 10 percent additional financial incentives if the projects are sited within an "energy community." But what actually is an energy community? Three types of geographies can be considered energy communities under the IRA, each with its own qualifying criteria. Two of the definitions are pretty straightforward, while the third is more complex and even a little odd.

Brownfields

Brownfields typically are small parcels of pollution-contaminated land that, once designated by the US Environmental Protection Agency, become eligible for funding that supports cleanup and redevelopment. Because of their modest size, these locations may be attractive to developers of utility- or community-scale solar, energy storage, and even manufacturing facilities. The Environmental Protection Agency has provided technical assistance to encourage solar development on brownfields and other contaminated sites for years.

Not all brownfields, however, have relevance to energy development. For example, around 15 brownfield sites have been identified in Ann Arbor, Michigan (where Daniel lives), which could hardly be considered an "energy community," as the city has virtually no history of large-scale energy development.

Brownfields are distributed across the United States, with highest concentrations in the industrial Midwest and in the densely populated parts of the Northeast (Figure 1). Although more than 25,000 of these sites are scattered across the country, they cover just a small fraction of total US land area.

Coal Communities

Coal communities probably are the most clearly targeted of the three types of geographies defined by the IRA. Any census tract where a coal-fired power plant has closed since 2010, or a coal mine has closed since 2000, qualifies for additional incentives in the IRA, along with any adjacent tracts. As readers of this article likely know, hundreds of coal plants and mines have shuttered in the past 20 years, and the IRA likely will accelerate the pace of future coal retirements.

The benefit of designating entire census tracts as energy communities is that developers will have more flexibility in siting their facilities and could build larger-footprint infrastructure such as utility-scale wind farms. But a potential downside of this extensive geographic scope is that projects may be developed tens, or even hundreds, of miles away from affected coal communities. For example, because census tracts in rural communities can cover hundreds of square miles, a wind project developed in the southeastern California desert may do little to support a community hundreds of miles away, where a coal plant may have closed down years earlier.

In total, these coal-plant and coal-mine provisions cover about 20 percent of the total US land area. Figure 2 maps out the census tracts that are eligible, with light gray indicating retired plants, darker gray indicating closed mines, and black where both apply.

Jobs and Tax Revenue

The third, and most expansive, definition of an energy community is where things start to get kind of weird. The IRA defines this third type of energy community as a metropolitan or non-metropolitan statistical area (as defined by the Office of Management and Budget) where "0.17 percent or greater direct employment or at least 25 percent of local tax revenues [are] related to extraction, processing, transport, or storage of coal, oil, or natural gas," and unemployment is at or above the national average in the previous year.

Here's why that definition is a little odd. First, because unemployment rates change frequently, it's not quite clear whether an energy community will stay an energy community—and continue to be eligible for the bonus tax credit—if its unemployment rate falls below the national average. Presumably, the US Departments of Energy and the Treasury will need to answer this question and find a workable solution.

The second surprising detail about this definition is the relatively low employment rate necessary for an area to be eligible. The sectors mentioned in the law (which we classify in Table 1) collectively employed about 0.59 percent of the US workforce in 2020. These data indicate that many "energy communities" will have substantially less energy-related employment than the US average, which would be odd indeed.

Importantly, statistical areas can be really, really large. For example, most of Alaska, Montana, Nebraska, Nevada, and large swaths of other states belong to a single non-metropolitan statistical area. As a result, the areas covered by the IRA as energy communities represent a whopping 82 percent of total US land area. With the provision that qualifying areas must have higher-than-average unemployment (we use as a baseline the US average in 2021, 5.3 percent), the number of eligible regions shrinks considerably—but the collective area still accounts for 39 percent of US land.

In addition, the qualifying regions don't map neatly onto locations where we would consider many energy communities to occur: although they cover many oil-, gas-, and coal-dependent communities in Texas, New Mexico, West Virginia, and Pennsylvania, the qualifying regions omit all or most of North Dakota, Wyoming, and Oklahoma, where fossil fuel production plays a key role in local economies. What's more, regions with little or no fossil fuel production, such as large swaths of Michigan, Oregon, and Washington State, are included. Figure 3 illustrates these results, with light pink indicating areas with at least 0.17 percent fossil fuel employment but lower-than-average unemployment, and dark pink indicating eligible areas.

> **"Coal communities probably are the most clearly targeted of the three types of geographies defined by the Inflation Reduction Act."**

Figures 1–3 (Right)

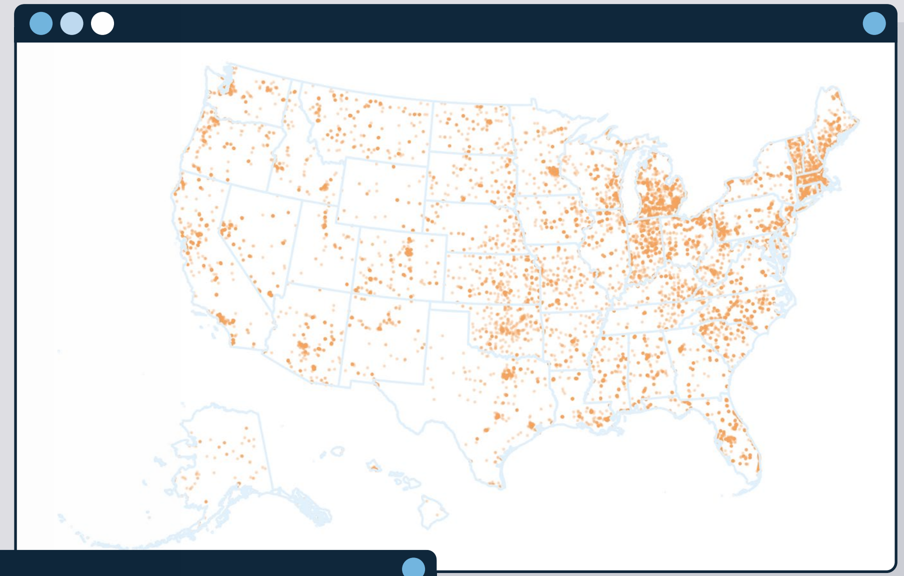
Sources
- Figure 1: US Environmental Protection Agency.
- Figure 2: US Energy Information Administration, Form EIA-860 surveys (retired coal plants). US Mine Safety and Health Administration, Data Set 13: "Mines Data Set" (closed coal mines).
- Figure 3: US Census County Business Patterns for employment; US Bureau of Labor Statistics for statistical area definitions. Includes areas with at least 0.17 percent of employment from fossil fuels at any time from 2010 to 2020 and unemployment greater than 5.3 percent in 2021.

Notes
- For retired coal-fired power plants, exact coordinates don't exist from 2010 to 2012. Instead, their ZIP codes are matched to the census tract with which they share the most land-area overlap.
- To calculate the percentage of the workforce directly employed in the energy sector, we sum the employment in North American Industry Classification System (NAICS) codes listed in Table 1, then divide by total employment. However, the law does not define which NAICS codes to use, nor whether to divide their sum by total employment or total labor force (which includes unemployed workers). The specific language in the IRA is, "extraction, processing, transport, or storage of coal, oil, or natural gas (as determined by the Secretary)." Two of these codes (213 and 486) include some non–fossil fuel activities, but overwhelmingly consist of jobs in the coal, oil, and natural gas sectors.
- Counties don't map perfectly to statistical areas in New England. In these maps, we show county-level data for New England.

FIGURE 01

Brownfield Site Locations in the United States

Brownfield



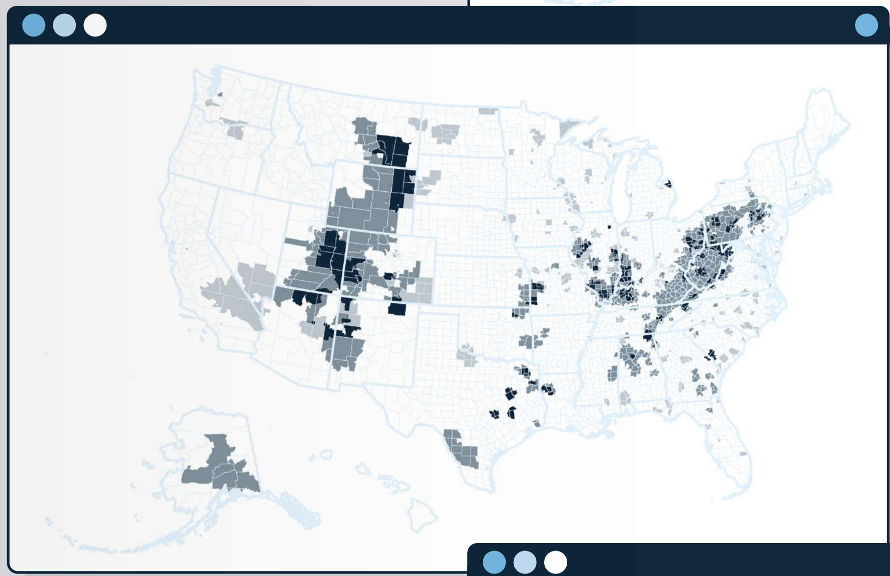


FIGURE 02

Coal Plants Retired from 2010 to 2021 and Coal Mines Closed from 2000 to 2022

Retired coal plant

Closed coal mine

Retired plant and closed mine

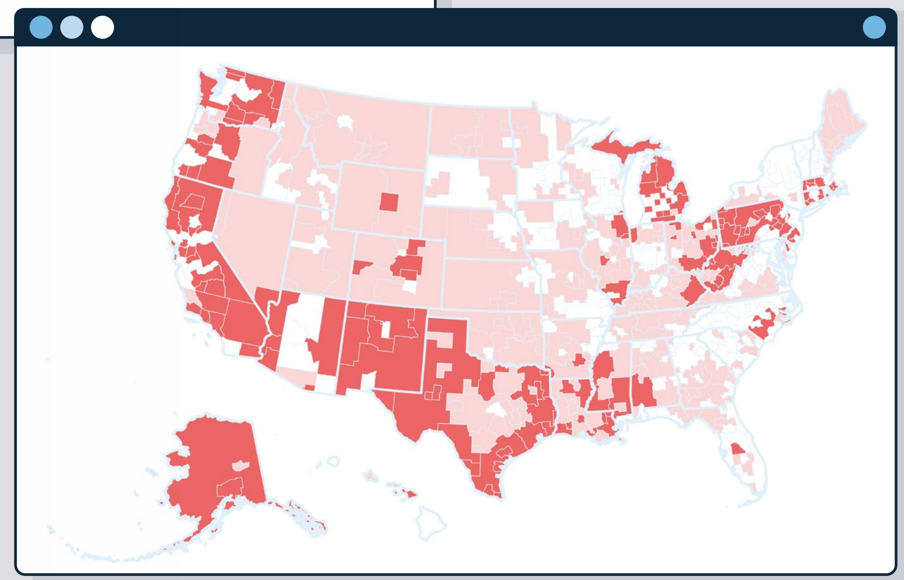


FIGURE 03

Statistical Areas with At Least 0.17 Percent of Employment from Fossil Fuels

≥0.17% fossil fuel employment

≥0.17% fossil fuel employment and higher-than-average unemployment

TABLE 01

North American Industry Classification System (NAICS) Codes Included for Fossil Fuel Employment and Tax Revenue

NAICS Code	Title
211	Oil and gas extraction
2121	Coal mining
213	Support activities for mining
23712	Oil and gas pipeline and related structures construction
324	Petroleum and coal products manufacturing
4247	Petroleum and petroleum products merchant wholesalers
486	Pipeline transportation

OK—here's where it gets really weird. An energy community also may be one where fossil fuels provide at least 25 percent of local tax revenue. As we've written previously with coauthors, this issue of public finance is hugely important. Nationwide, fossil fuels directly contribute about $138 billion in revenue to federal, tribal, state, and local governments each year.

But here's the problem: no one knows how much revenue local governments get from fossil fuels. Although we have estimated fossil fuel revenues at a national level, no nationwide database provides this information at the local level, and most local government budgets do not have line items for facilities or infrastructure related to coal, oil, and natural gas. For example, while many states and localities have line items for property taxes from oil and gas production, most do not report revenues from oil and gas pipelines, refineries, or fuel storage facilities. (Researchers at Resources for the Future and the University of Michigan, however, are working to develop estimates for how energy infrastructure—including clean energy sources—contribute to local government revenue for up to a hundred counties in the United States. But trust us, it ain't easy!)

What's more, the text of the IRA is both overly inclusive and overly exclusive. The law stipulates "tax revenues related to" fossil fuels. But by using the phrase "tax revenues," the law leaves out tens of billions of dollars that are generated each year from fossil fuel production on public lands, much of which funds local schools or state-run higher education. (A great example is the University of Texas System.) And by using the phrase "related to," the law implies that not only direct revenue from fossil fuels should be included, but also indirect and induced revenues. Talk about data that don't exist! Estimating direct revenue from fossil fuels is hard enough; trying to do the same thing for indirect revenue (such as tax revenue from purchases made by oil companies) and induced revenue (such as tax revenue from the restaurants where oil workers eat) is even harder.

Finally, the use of metropolitan and non-metropolitan statistical areas is far from ideal. Although calculating area-wide employment is straightforward, doing so for tax revenues is a herculean task. Calculating tax revenues would involve gathering data for every county government, city government, school district, and other taxing entity (e.g., library districts or fire districts) within a statistical area. For many areas—especially the big rural ones—this data crunching means trying to aggregate data (which don't exist!) across hundreds of taxing entities. So, please spare a thought for the analysts in the Department of the Treasury who will need to sort this out.

This difficulty with the data is one reason why, in a recent public comment, Daniel suggested focusing these types of analysis on the county level. Although focusing on counties won't solve every problem, the strategy would afford simpler analysis and, in all likelihood, enable resources to be better allocated to the energy communities that need those resources the most.

FIGURE 04

Our Estimate of "Energy Communities" as Defined by the Inflation Reduction Act

Brownfield

Retired coal plant

Closed coal mine

Retired plant and closed mine

≥0.17% fossil fuel employment and higher-than-average unemployment

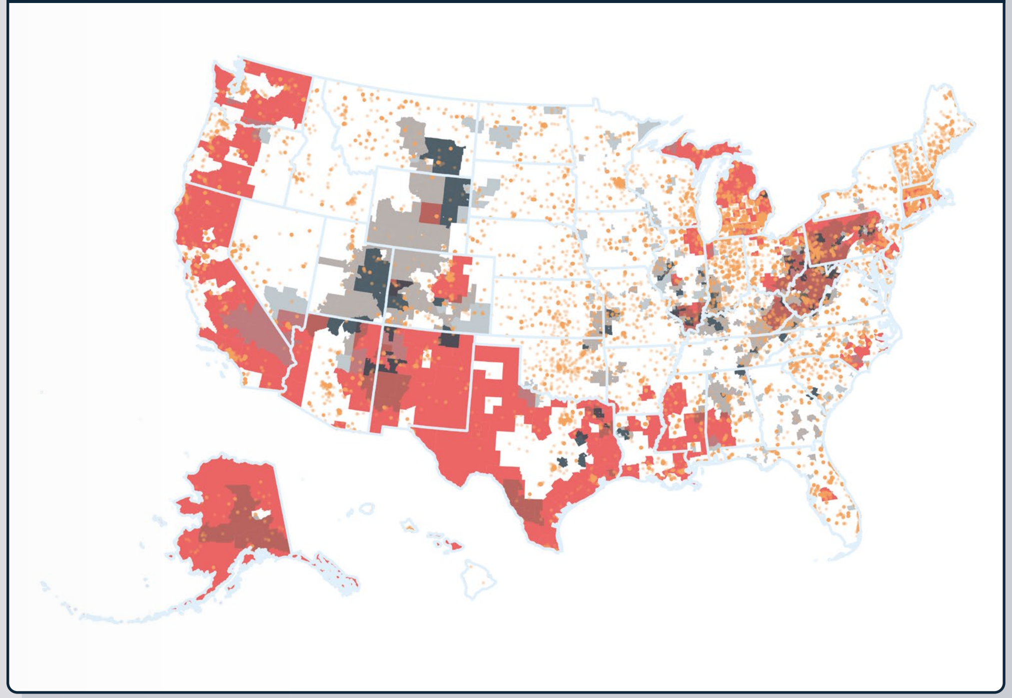


Figure 4
Data Sources: See captions for Figures 1–3.

Daniel Raimi is a fellow at Resources for the Future. **Sophie Pesek** was an RFF senior research analyst and is a PhD student at the University of California, Santa Barbara.

Putting It All Together

When we combine the maps above, the result seems to indicate that the IRA will designate about 50 percent of US land area as an energy community (Figure 4). This percentage excludes brownfield sites, which individually take up very little land area.

So, let's ask a big-picture question: Do these definitions in the IRA target the energy communities that are likely to be hardest hit by a transition to a net-zero energy system?

Because of the imprecision of the selected geographies, and the overly expansive definition of "energy communities" (especially as related to the employment metric), the answer appears to be no. In the coming weeks and months, perhaps new legislation or additional efforts by the Treasury Department can narrow the scope of the targeted regions and ensure that IRA incentives on this front can be more effective.

And, as joint work between Resources for the Future and Environmental Defense Fund has pointed out, clean energy will not be a one-for-one replacement for fossil energy in the communities that rely on coal, oil, and natural gas as their economic drivers. Although clean energy can and will play an important role in some communities, federal policy that enables an equitable energy transition will need to include broader economic development, workforce development, public benefits, and other programs, so that today's energy communities can thrive tomorrow.

The federal Interagency Working Group on Energy Communities understands this point, and its efforts—including Rapid Response Teams that will work with specific regions where fossil fuels play a central role in the local economy—aim to provide a broad set of tools that energy communities can take advantage of. But as the United States and the world march toward a net-zero-emissions economy in the years and decades to come, a much larger effort will be needed to build an energy system that is more sustainable and equitable, including for the communities that historically have supplied the energy that's driven global prosperity to date. ■

The Big Picture

How Can Disasters Damage Local Budgets?

The budget of a local government depends on property taxes, sales taxes, and revenues from fees that the municipality charges for certain services. Money in the budget goes toward local public services such as education and infrastructure—and when a disaster strikes, such as a wildfire or a hurricane, that money needs to help fund local repairs and recovery.

Resources for the Future Fellow Yanjun (Penny) Liao has studied the fiscal health of local governments after they've experienced a disaster. She and colleagues (including University Fellow Carolyn Kousky) have found that balancing the budget is harder for local governments that deal with disasters. And in the case of hurricanes, the negative effects on local finances hit harder in lower-income areas than in higher-income areas. ■

Right
Win McNamee / Getty Images

Temperature Targets Would Yield Major Global Economic Benefits

New modeling from Resources for the Future shows that accelerating cuts to greenhouse gas emissions in the near future will produce major economic benefits and other long-term positive outcomes.

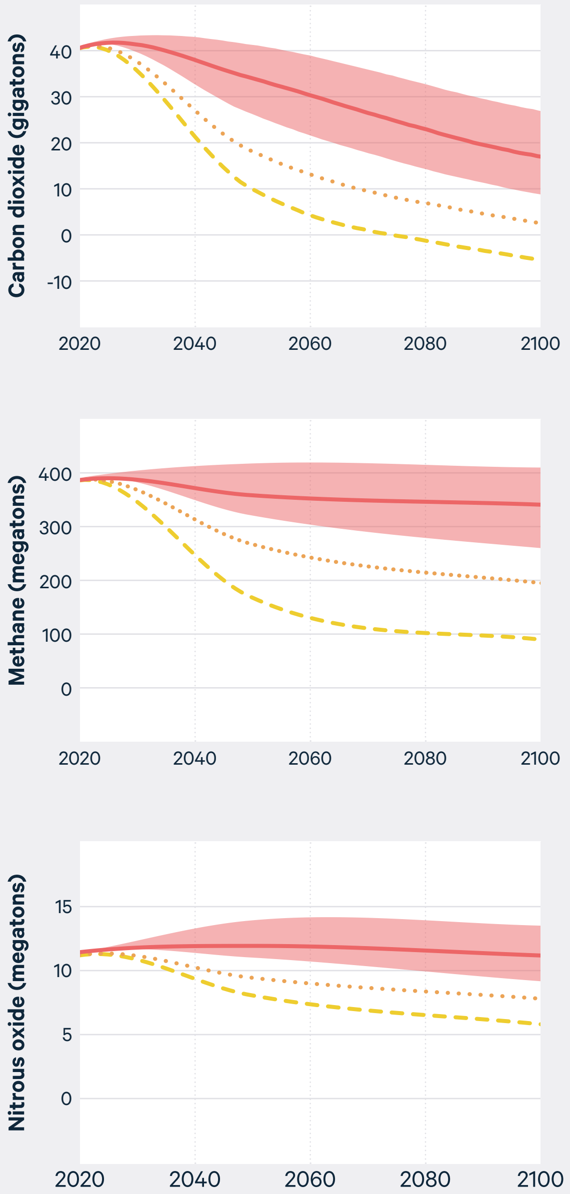
TEXT
Jordan Wingenroth, Brian C. Prest, and Kevin Rennert

The 2023 Global Stocktake from the Intergovernmental Panel on Climate Change, which wrapped up at this year's Conference of the Parties (COP28), offers a great chance to not only look back and measure progress toward the Paris Agreement goals but also look ahead and consider the benefits of achieving them. While estimating the economic benefits of achieving Paris Agreement goals is no small task, the RFF-Berkeley Greenhouse Gas Impact Value Estimator (GIVE) model, developed to estimate the social cost of carbon, is a natural tool for the job. In a recent RFF issue brief, we used GIVE to estimate that the benefits of achieving the Paris Agreement targets—both the 1.5°C and "well below" 2°C goals—could amount to hundreds of trillions of dollars when expressed in monetary terms.

One of the strengths of the GIVE model is the way it considers uncertainty about future greenhouse gas emissions. For carbon dioxide, nitrous oxide, and methane, the model includes possible emissions trajectories that range from the most rapid reductions and optimistic net-zero (or even net-negative) greenhouse gas scenarios to what other models often term "business-as-usual" scenarios—or worse. These emissions scenarios lead to a wide range of temperature predictions, with a median or "best guess" falling at about 2.5°C in 2100. We arrived at our estimates of the benefits of reducing

Figure 01

Annual Global Net Emissions of Greenhouse Gases from the GIVE Model, Including Pathways for Reaching the 1.5°C and "Well Below" 2°C Paris Agreement Goals



Key

GIVE Model | 2.0°C | 1.5°C

Lines represent median values. Shading indicates the 33rd to 67th percentile range. The GIVE model is the RFF-Berkeley Greenhouse Gas Impact Value Estimator model.

Figure 02

Global Surface-Temperature Change Relative to 1850–1900 from the GIVE Model, Including Pathways for Reaching the 1.5°C and "Well Below" 2°C Paris Agreement Goals

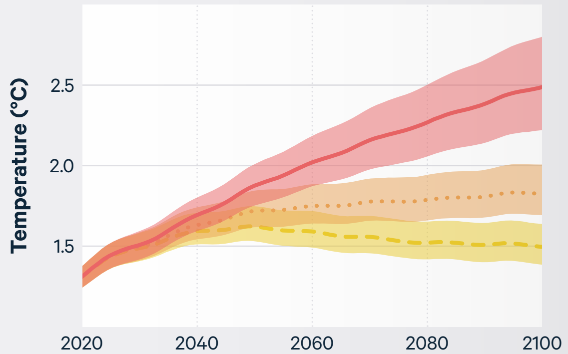
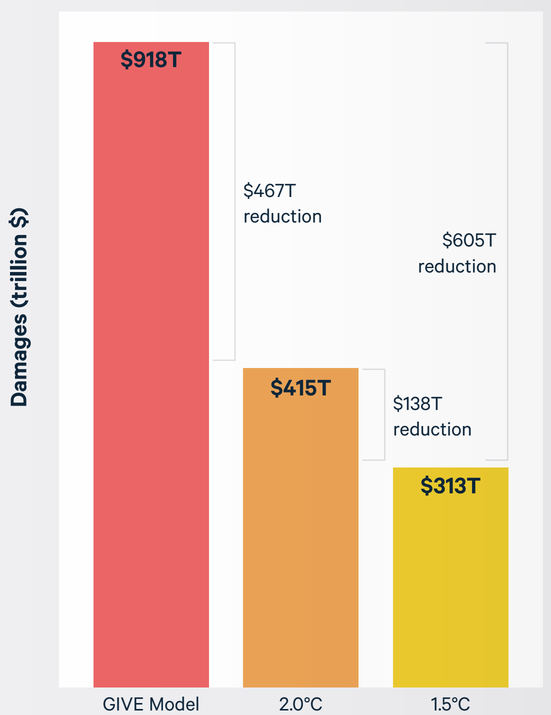
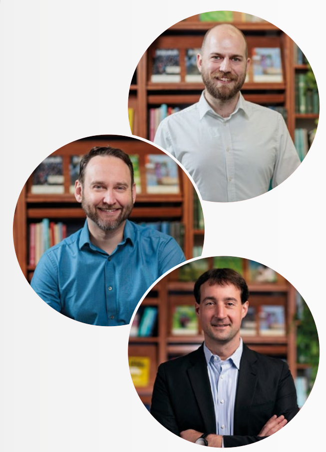


Figure 03

Cumulative Expected Present Value of Total Climate Damages from the Baseline GIVE Model through 2300, along with Models That Follow the 1.5°C and "Well Below" 2°C Pathways



> **"Limiting temperature increases to the Paris Agreement goal of well below 2°C is expected to prevent about half of climate damages."**



Jordan Wingenroth is a research associate, **Brian C. Prest** is a fellow, and **Kevin Rennert** is a fellow at Resources for the Future.

emissions by putting a "lid" on our baseline set of emissions trajectories (Figure 1), which we then calibrated to yield temperature pathways that line up with the goals from the Paris Agreement.

The central values from the baseline GIVE model suggest a gradual decline in annual carbon dioxide emissions, with the median reaching half of present-day emissions toward the end of the twenty-first century. Annual methane emissions are projected to decline much more slowly, with the median values staying well above 300 megatons per year, and nitrous oxide emissions are not projected to decline meaningfully within the century.

Compare those results to the "well below" 2°C scenario, which approaches net-zero global carbon dioxide emissions by the end of the century, with methane emissions cut in half and nitrous oxide emissions reduced by about a third relative to present-day levels. Also consider the 1.5°C scenario, which reaches net-zero global carbon dioxide emissions before 2080. This more ambitious scenario also cuts annual methane emissions by three-quarters and halves annual nitrous oxide emissions by 2100.

Next, we project what these scenarios mean for global temperature rise through 2100, which the GIVE model handles with a lightweight but well-tested climate model called the Finite Amplitude Impulse Response model. Figure 2 shows these temperature pathways, with the lines representing median trajectories and shaded areas spanning the 33rd to 67th percentiles.

The baseline GIVE model suggests a central outcome of 2.5°C above preindustrial levels in 2100, with a range of 2.2–2.8°C. The "well below" 2°C scenario rises more gradually, with its median temperature pathway reaching 1.8°C in 2100. Looking at temperatures for the 1.5°C scenario, one notices more of an arc, or an "overshoot." This overshoot is not surprising, given that present-day temperatures are nearing that threshold, and further temperature increases in the near term are almost inevitable.

However, although temperature rise is likely to exceed the 1.5°C threshold, negative emissions could be deployed to reverse course and meet the goal by 2100, as demonstrated by the negative emissions trajectories in the 1.5°C scenario in Figure 1 and the corresponding declining median temperature trajectory in Figure 2. The median temperature for this pathway returns to 1.5°C by 2100 after peaking above 1.6°C in 2050.

For the baseline GIVE model, more than $900 trillion in expected discounted climate damages are projected to accumulate between 2020 and 2300—the time horizon included in the GIVE model. Although this is a striking figure, the global GDP in 2022 alone was more than $100 trillion. After using a discounting approach that converts uncertain predictions of future economic growth and damages into present-day values, we find that the more than $900 trillion of present-value losses amounts to about 3 percent of present-value GDP over the same time frame. This estimate likely reflects a lower bound because it does not include other climate harms, such as biodiversity loss, decreased labor productivity, and wildfire.

As shown in Figure 3, meeting the "well below" 2°C goal from the Paris Agreement would cut projected climate harms in half to $451 trillion, implying an estimated benefit of $467 trillion for achieving the 2°C Paris Agreement target. Both of those figures are equivalent to about 1.5 percent of present-value GDP. Achieving the more ambitious 1.5°C goal would yield an additional $138 trillion in benefits and limit the damages to about 1 percent of present-value GDP.

Estimating the economic harms of climate change is a complex endeavor because the climate affects society at all levels, from individual health to global geopolitics. Even so, a scientifically rigorous understanding of the monetized social benefits of following through on the ambitions of the Paris Agreement will be key to informing climate policy actions. Limiting temperature increases to the Paris Agreement goal of well below 2°C is expected to prevent about half of climate damages—and that's relative to the GIVE baseline projection of 2.5°C in 2100, which already embodies some arguably optimistic emissions reductions. The benefits relative to business-as-usual scenarios would be even greater; but in either case, our findings demonstrate that accelerating cuts to greenhouse gas emissions in the near future will serve society well for many decades to come. ■

Grid Infrastructure for Electric Trucks and the Inflation Reduction Act

Electrifying medium- and heavy-duty vehicles, and the transportation sector more broadly, calls for major investments in electricity infrastructure. The Inflation Reduction Act supports some of these investments, but in other ways falls short.

TEXT Nafisa Lohawala and Beia Spiller   ILLUSTRATIONS James Round

In the first two blog posts of this series, we discuss how the Inflation Reduction Act (IRA) affects medium- and heavy-duty electric vehicle (MHD EV) adoption and manufacturing. The federal government has shown support for electrifying the largest vehicles, though the cost and efficacy of these incentives in supporting widespread electrification still is an open question. What's clear, however, is that electrifying the transportation sector will require significant investments in existing electricity infrastructure to ensure that the grid can charge a growing fleet of vehicles.

These investments span the entirety of the electric system. From the local distribution grid to the power plants that generate our electricity, infrastructure investments will be necessary to ensure that reliable and clean power can be supplied to vehicles when they need it. In this blog post, we outline the needed investments and discuss how the IRA supports some of the investments—but fails to address others.

Investments in the Electric System for Widespread Adoption of Medium- and Heavy-Duty Electric Vehicles

Renewable Generation

Even though MHD EVs have zero tailpipe emissions, they charge their batteries with electricity, which means that they still have the potential to produce harmful emissions indirectly if the electricity comes from fossil fuels. Renewable electricity generation, such as solar or wind power, emits little to no greenhouse gases; thus, using renewable sources to power electric trucks helps reduce the carbon footprint of the transition to MHD EVs. Both utility-scale renewables and distributed solar (particularly when paired with storage) can provide the much-needed clean electricity.

Transmission

Transmission lines, which transport electricity over long distances from power plants to local distribution networks, are a key piece of infrastructure that is particularly important for integrating renewables into the grid. As more renewables come online to support the expanded demand for charging, a concomitant expansion of transmission capacity likely will be required.

Distribution

MHD EVs have massive batteries; thus, even a single fleet's depot is likely to exceed the capacity that's available locally. Depending on the extent of MHD EV deployment, the local distribution network will need upgrading to ensure that sufficient capacity can meet the charging demand. These upgrades could involve installing additional transformers and upgrading or expanding existing distribution lines and substations.

Reliability

The widespread adoption of electric trucks can challenge grid reliability, particularly if the charging of these vehicles is not properly managed. Because these trucks and buses have such massive batteries, a fleet of 100 heavy-duty trucks charging simultaneously could reach electrical loads that are similar to a sports stadium. Unless the local system is built up adequately, this type of charging could lead to grid overload and potential blackouts. Additionally, the strain on the network could lead to equipment failures and power outages.

Investing in the US Electric Grid with Funding from the Inflation Reduction Act

The IRA includes various incentives that can facilitate investment in the electric system and reduce the associated costs borne by electric utilities. Expanding and integrating renewable energy into the electric system is one area in which the IRA takes significant action.

Renewable energy credits—specifically, providing production and investment tax credits for clean energy—incentivize investments in both distributed and utility-scale generation capacity. Furthermore, the IRA increases the investment tax credit for solar and wind facilities by 10 to 20 percentage points when those facilities are located in low-income communities, in "energy communities," or on Native American reservations.

> "The widespread adoption of electric trucks can challenge grid reliability, particularly if the charging of these vehicles is not properly managed."

> "The main way in which the Inflation Reduction Act does *not* support the transition to medium- and heavy-duty electric vehicles is by ignoring the distribution system and the massive costs involved in supporting increased numbers of these vehicles."

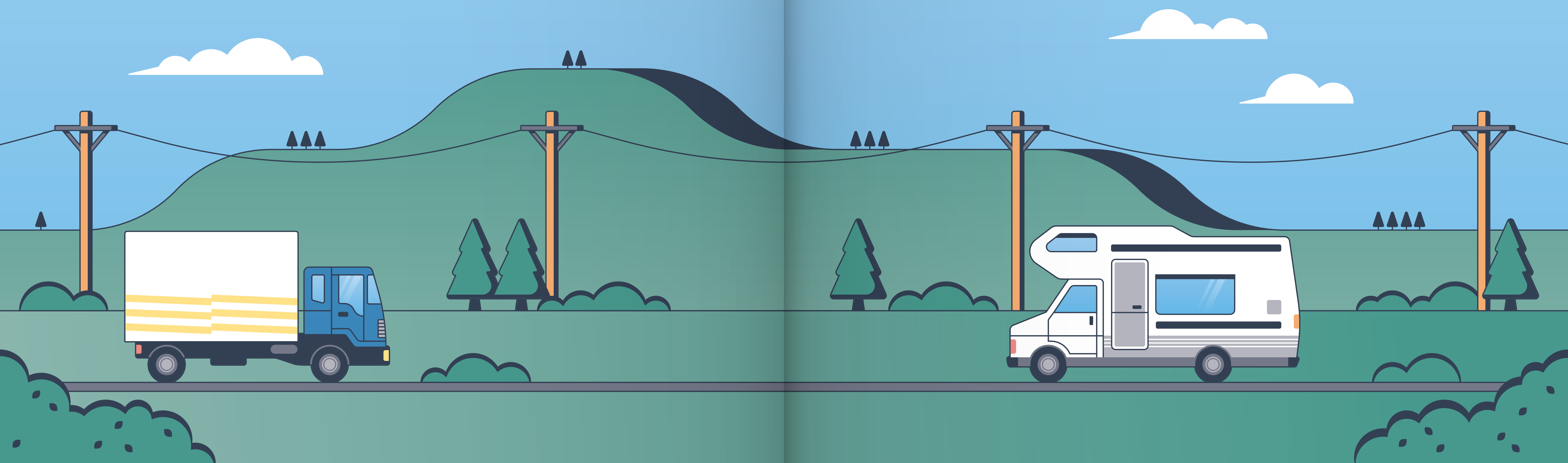
The IRA also takes some action on integrating renewables by providing grants and financing for transmission expansion and grants for the planning, analysis, and modeling of the transmission and integration of offshore wind.

Indirectly, IRA funding that targets the expansion of generation capacity also mitigates problems with grid reliability, by ensuring that sufficient generation capacity can meet an anticipated increase in demand for electricity.

Incentives Missing from the Inflation Reduction Act

The main way in which the IRA does *not* support the transition to MHD EVs is by ignoring the distribution system and the massive costs involved in supporting increased numbers of these vehicles.

For example, the IRA does not provide funds to local utilities to help pay for wiring infrastructure (i.e., extending distribution-line capacity so a depot can electrify) or upgrades to the local system. Usually, a fleet is responsible for things like wiring costs (unless utility programs can socialize these costs across ratepayers, such as the EV Fleet program in California), but this expense can add millions of dollars to a fleet's up-front cost of transitioning to electric. For broader distribution upgrades, a utility most likely will



> One promising technology that can help manage peak demands is charging management software, which allows fleets to schedule their charging sessions optimally for both the fleet and the electric grid.

allocate those costs to the commercial class of customers instead of all ratepayers, which would increase electricity rates that the fleets would pay for vehicle charging.

In the absence of government funds for upgrading distribution systems, both the up-front and operating costs of MHD EVs may increase, thereby reducing the incentive for fleets to electrify. As detailed in our recent report, fleets already face high costs and challenges to electrify; adding more costs will further hinder the government's goals for electrifying the transportation sector.

Furthermore, the IRA does not incentivize MHD EV fleets to mitigate their impact on the electric system. Reducing the peak demand of these fleets can help not only improve grid reliability but also reduce costs by avoiding the construction and maintenance of expensive power plants and other infrastructure to meet the highest potential demand. If fleets do not mitigate their peak demands, then the amount of needed grid investments will grow, leading to a higher total cost of ownership for MHD EVs.

One promising technology that can help manage peak demands is charging management software, which allows fleets to schedule their charging sessions optimally for both the fleet and the electric grid. For example, charging management software can alleviate pressure on the grid by reducing the speed of charging in periods of high demand and shift these charging sessions to times when the grid is less likely to experience congestion. By working within the operational requirements of the fleet, charging management software allows for real-time optimization of charging patterns, which keeps distribution costs down while providing the power that a fleet needs to conduct its operations.

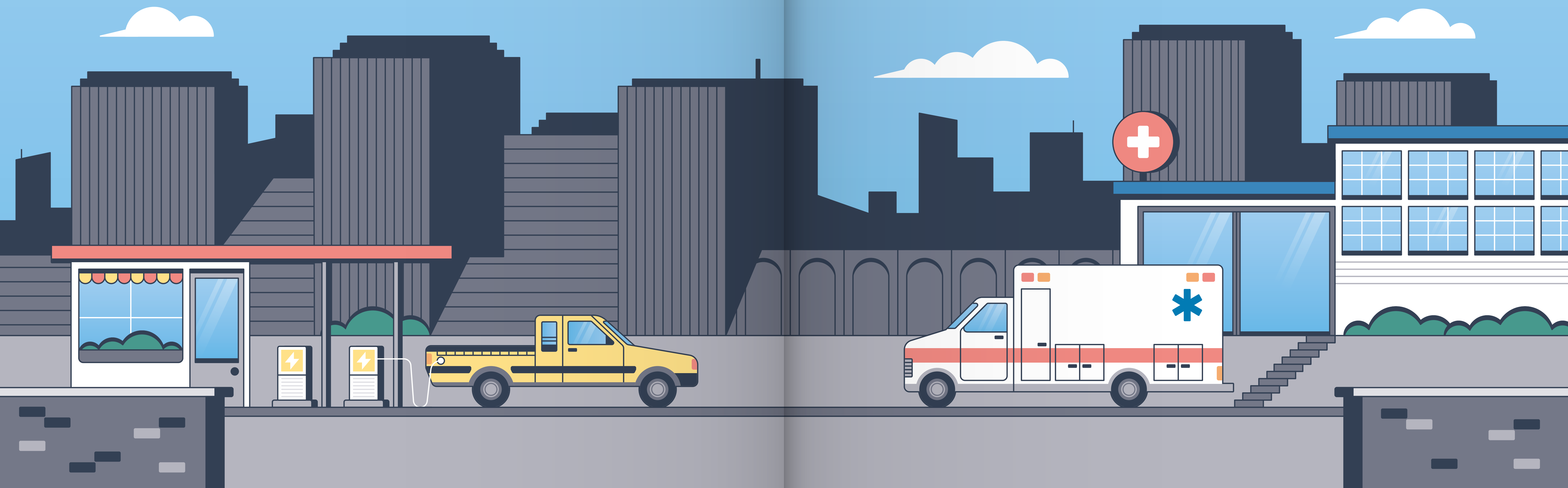
Yet, nothing in the IRA incentivizes managed charging. For example, the IRA does not require fleets to adopt charging management software as a condition for receiving tax credits for vehicles or charging stations, nor does the law provide subsidies for the adoption of this software. Future policies in this direction could help reduce peak demand and ensure grid reliability while keeping electricity tariffs low.

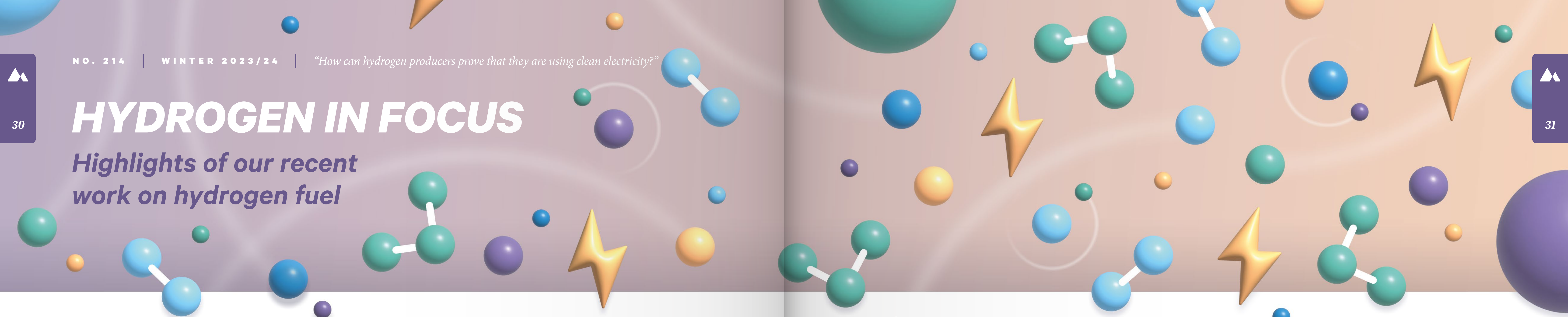
Conclusions

The IRA provides significant incentives for renewable energy expansion, which can help ensure that future increases in demand for electricity by MHD EVs are met using clean electricity. The law also takes some action to help with renewables integration and transmission expansion.

However, by providing neither funds for expanding the distribution grid nor incentives for fleets to mitigate their peak demand for electricity, the IRA ignores the fact that the distribution system will require significant investments and will cost a lot of money to upgrade. Without more comprehensive government incentives and funding, the total cost of ownership for MHD EVs may increase as more electric trucks and buses enter the vehicle fleet. In that case, state governments likely will need to step in to fill that gap if they want to achieve their own MHD EV adoption goals. ■

Nafisa Lohawala is a fellow and **Beia Spiller** is a fellow and director of the Transportation Program at Resources for the Future.





HYDROGEN IN FOCUS

Highlights of our recent work on hydrogen fuel

1

What's New with Hydrogen?

The video series In Focus gives researchers at Resources for the Future (RFF) a platform to share insights related to current events in energy and the environment. The series launched this past year; since September 2022, In Focus videos have tackled topics that range from climate optimism to carbon dioxide removal.

In February this year, the US Department of Energy took a step forward in its much-anticipated Regional Clean Hydrogen Hubs program by encouraging 33 of 79 funding applicants to submit full project proposals. The time was ripe for a related video in our In Focus series: Aaron Bergman, an RFF fellow, discussed the current and potential uses of hydrogen and how the federal government is supporting the development of hydrogen technologies. Transcribed here is Bergman's video, in which he gives the lowdown on recent developments in the hydrogen industry.

The In Focus video was originally released on February 10, 2023. This transcript has been edited for length and clarity.

Hydrogen is a unique element that allows you to store and transport energy and burn that energy—but when you burn hydrogen, you create water instead of creating carbon dioxide. Hydrogen already is used a lot in the chemicals industry, fertilizer, and refining. But a lot of new potential uses exist, as well.

You could use hydrogen to make green steel, which is steel that's produced without carbon dioxide emissions. You could use hydrogen in transport, or for long-term energy storage in the electric system. Sometimes the wind won't blow, and the sun won't shine, and you need a way to provide electricity. If you have stored hydrogen, you can put that hydrogen through generators to produce more electricity.

Congress recently passed two important laws that include provisions for hydrogen: the Bipartisan Infrastructure Law, which sometimes is called the Infrastructure Investment and Jobs Act, and the Inflation Reduction Act. Both of these laws will have a large impact on hydrogen.

The Bipartisan Infrastructure Law allocates almost $9.5 billion for various hydrogen demonstration projects. One of the big projects provides about $8 billion to the US Department of Energy to create "hydrogen hubs," which will demonstrate technologies that produce or use hydrogen. In the Inflation Reduction Act, Congress passed two different tax credits that will impact hydrogen.

The first is the 45V tax credit, which grants a certain number of dollars per kilogram of hydrogen produced. This number depends on the amount of emissions that's produced while creating the hydrogen.

The law also affects the 45Q tax credit. Some methods of generating hydrogen produce a lot of carbon dioxide; for example, the production of hydrogen from natural gas. The 45Q tax credit provides subsidies if that carbon dioxide gets stored. This credit has been around for a while. Congress, through the Inflation Reduction Act, increased the value of the credit to about $85 per ton, which is quite significant.

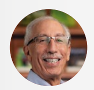
Aaron Bergman
RFF Fellow

2

H, Too

RFF Fellow Aaron Bergman and Senior Fellow Alan Krupnick joined an episode of the *Resources Radio* podcast in February to discuss hydrogen technologies and the policy landscape for hydrogen fuel. They also provided an update on the Regional Clean Hydrogen Hubs program, which the US Department of Energy has launched to support a domestic industry for clean hydrogen by funding regional networks of hydrogen producers and consumers.

"The program is supposed to help demonstrate the production, processing, delivery, storage, and end use of clean hydrogen and serve as a basis of development for a clean hydrogen market."



Alan Krupnick
RFF Senior Fellow

3

45V Tax Credit

How can hydrogen producers prove that they are using clean electricity? This question has become a thorny issue for the US Department of the Treasury, the agency that the Inflation Reduction Act has charged with implementing the 45V tax credit for clean hydrogen fuel. Verifying that producers use clean electricity is a requirement to be eligible for the credit.

RFF Fellow Aaron Bergman compared proposals for the implementation of 45V that would answer the question of verification, in a series of issue briefs that were released in the summer and fall this year. These proposals for implementation have different implications for US greenhouse gas emissions, deployment of new renewable energy generation, and federal spending. Bergman's issue briefs were shared with the US Department of the Treasury as the agency considered how to implement the credit.

"The 45V tax credit is a big deal, with potentially billions of dollars at stake to jump-start a domestic clean hydrogen industry." ■

Aaron Bergman
RFF Fellow

> **"Hydrogen is a unique element that allows you to store and transport energy and burn that energy—but when you burn hydrogen, you create water instead of creating carbon dioxide."**

ILLUSTRATION
James Round

Further Reading ...

Check out his intro blog post to fuel up on Aaron Bergman's series of issue briefs about the 45V tax credit:

Geeking Out on Geography

Mapping the Effects of the Coastal Barrier Resources Act

TEXT Alexandra Thompson

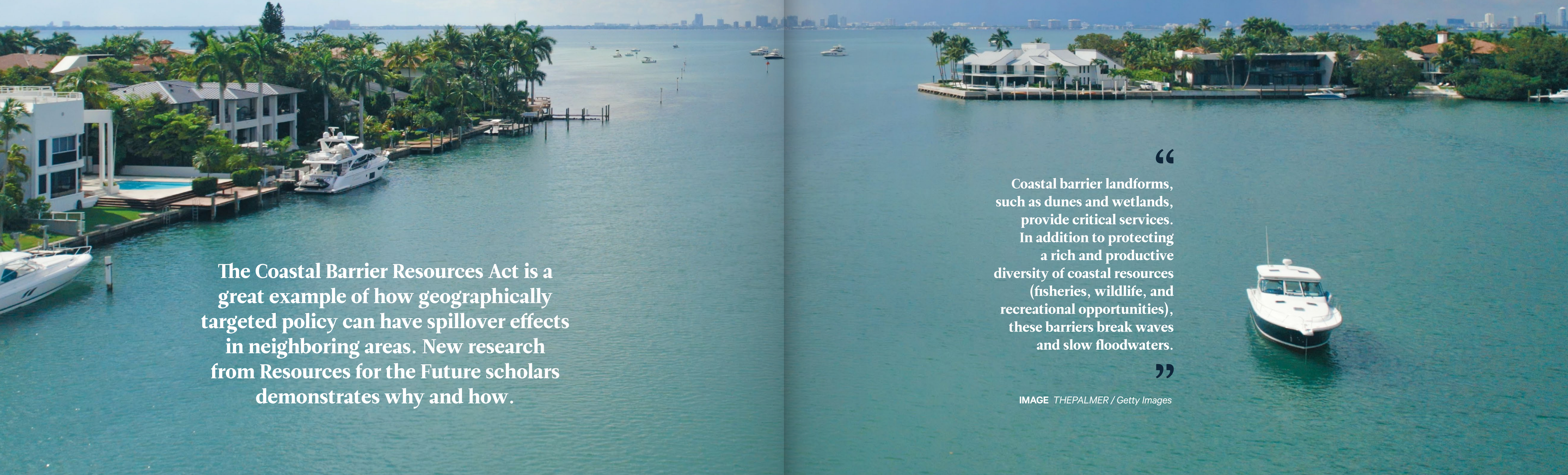


IMAGE *THEPALMER / Getty Images*

The Coastal Barrier Resources Act is a great example of how geographically targeted policy can have spillover effects in neighboring areas. New research from Resources for the Future scholars demonstrates why and how.

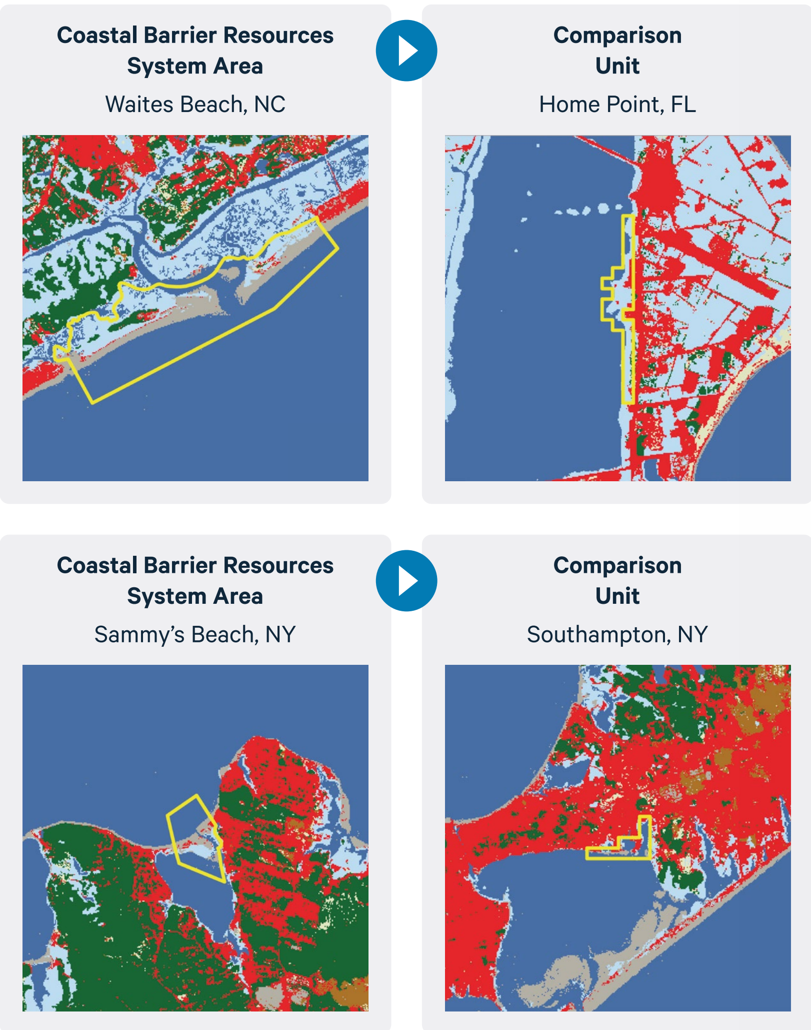
Renowned pioneer in modern geography Waldo Tobler posited his first law of geography in 1970: "Everything is related to everything else, but near things are more related than distant things." Seemingly simple and intuitive, this observation is the basis for the complex spatial mathematical models that were developed decades later, such as spatial autocorrelation and interpolation. However, the lesser-known second law of geography Tobler proposed in 1999 has profound implications when we examine the effects of policies and boundaries on people and environments: "The phenomenon external to a geographic area of interest affects what goes on inside."

Researchers at Resources for the Future (RFF) have leveraged these principles to analyze the effects of a long-standing law that's intended to address some of the challenges associated with coastal development: the Coastal Barrier Resources Act of 1982. Coastal barrier landforms, such as dunes and wetlands, provide critical services. In addition to protecting a rich and productive diversity of coastal resources (fisheries, wildlife, and recreational opportunities), these barriers break waves and slow floodwaters. These latter processes protect coastal communities from storm-surge flooding and sea level rise—hazards that will increase in frequency and intensity with climate change. The Coastal Barrier Resources Act aims to protect undeveloped coastal barriers, preserve the ecosystem services that coastal barriers provide, and reduce federal expenditures on damages from natural disasters. To achieve these goals, the policy removes all federal incentives and financial assistance for development within a set of designated coastal barriers. This decreased support has increased the cost of developing these coastal lands by

> "Coastal barrier landforms, such as dunes and wetlands, provide critical services. In addition to protecting a rich and productive diversity of coastal resources (fisheries, wildlife, and recreational opportunities), these barriers break waves and slow floodwaters."

Figure 1

Selection of Areas within and outside the Coastal Barrier Resources System, for Comparison When Evaluating the Policy Impact of the Coastal Barrier Resources Act



Land Cover, 1985

- Developed
- Cropland
- Grass/Shrub
- Tree Cover
- Water
- Wetland
- Barren

- Treatment or Control Unit

transferring some of the risk from federal taxpayers to individual property owners.

The law has established the Coastal Barrier Resources System (CBRS), which is a set of designated areas along the Atlantic and Gulf Coasts where federal infrastructure spending, the availability of federal flood insurance, and federal aid after a disaster are prohibited. The Coastal Barrier Resources Reauthorization Act of 2000 includes provisions for digitally mapping the system, and the public now can explore CBRS areas in the interactive Coastal Barrier Resources System Mapper.

With the rapidly increasing need for coastal community resilience against climate change impacts, these coastal barriers are now more valuable than ever. In a new working paper, Hannah Druckenmiller, Yanjun (Penny) Liao, Sophie Pesek, Margaret Walls, and Shan Zhang analyze the long-term outcomes of applying CBRS designations to coastal land. Using spatial data science tools, the authors identified whether and how much these long-term outcomes can be attributed to the passage of the Coastal Barrier Resources Act—both the CBRS areas themselves and neighboring areas. The study examines the impact of the policy on development density, property values, damages from flooding, local tax revenues, and demographic change.

One approach to identifying the effects of the Coastal Barrier Resources Act could have been to simply compare outcomes inside and outside of CBRS designations. However, this approach could not have identified whether the policy itself caused those outcomes, because differences between CBRS and non-CBRS areas could have existed before the policy was implemented. So, to isolate the causal impact of the policy, the authors developed a novel method to select specific comparison areas (known as "counterfactuals") that would have closely resembled CBRS areas at the time those CBRS areas were designated. Figure 1 shows CBRS areas (left column) beside their corresponding counterfactual areas (right column).

"The CBRS areas were selected based on a specific set of criteria consisting of various geomorphic and development features," Liao says. "A proper comparison between areas where the policy was applied and the counterfactuals must account for the nonrandom characteristics that led to the designation of CBRS areas in the first place, which makes those areas distinct from any other average coastal location."

The study combined a machine learning technique called "regionalization" with propensity score matching to identify areas that are suitable for comparison. Differences in present-day outcomes between the CBRS designations and counterfactual areas can be attributed to the policy. To identify areas that have comparable features to CBRS sites, the authors wrangled and leveraged a wealth of high-resolution data on land cover, elevation, infrastructure, socio-demographics, and proximity to protected areas.

Almost 40 percent of the US population lives in coastal areas, according to the National Oceanic and Atmospheric Administration. How might past and potential CBRS designations affect these communities? What are the spillover effects? After all, land use changes don't occur in a vacuum, and Waldo Tobler's assertion can apply: "The phenomenon external to a geographic area of interest affects what goes on inside."

In their analysis, the authors identified neighboring areas that could have been affected by the policy by drawing a two-kilometer buffer around both CBRS and counterfactual areas. Because we again can reference Tobler's insight, "Everything is related to everything else, but near things are more related than distant things," the authors used what's called a spatial lag model to examine how policy impacts could vary according to a site's distance from the coastal barrier.

"The core challenge of this project was that CBRS designations were hand-selected by natural resources planners, meaning that we could not consider the CBRS selection as random in our analysis," Druckenmiller says. "We needed a way of finding counterfactual areas that closely resembled the CBRS areas at the time of their designation, so that we could make inferences about the effects of the policy based on a divergence in outcomes between the two types of land areas. We developed a method using spatial machine learning that relied on identifying counterfactual areas that were statistically indistinguishable from the CBRS areas when those areas originally were selected."

These creative and novel methods allowed the researchers to answer important questions about the impacts of CBRS designations, including on neighboring communities. First, they've found that the Coastal Barrier Resources Act has been effective in achieving its main goal: the policy has decreased development density within the designated areas by about 85 percent. Second, some of this development has been displaced to neighboring areas. Third, by conserving natural lands within the CBRS, the policy has provided natural amenities and flood protection to neighboring communities, which show up as higher property values and reduced flood damages.

"The importance of protecting land through methods like designating CBRS areas can be very important for communities," Walls says. "People in coastal communities experience myriad spillover effects from protected lands, such as changes in local revenues derived from property taxes and reduced susceptibility to the disastrous effects of hurricanes."

The authors estimate that the current system of CBRS lands has led to a 7 percent reduction in claims to the National Flood Insurance Program, which adds up to approximately $112 million per year. Finally, the authors estimate roughly zero effect of the Coastal Barrier Resources Act on revenues from county property taxes in counties that contain CBRS lands. While some revenue loss occurs because of the reduced development on CBRS lands, those losses largely get offset by the increased development and property values on neighboring lands.

These methods tackle the central problem that comes with a nonrandom assignment of comparison sites, which complicates a broad class of place-based policies. Thus, the techniques in this study could be adapted to assess the impacts of, for example, designating conservation areas; programs for economic development that target specific areas like Opportunity Zones, Promise Zones, or state-designated enterprise zones; or policies that distribute aid based on community risk of natural hazards. ■

"Almost 40 percent of the US population lives in coastal areas, according to the National Oceanic and Atmospheric Administration. How might past and potential Coastal Barrier Resources System designations affect these communities?"

Alexandra Thompson is a senior research associate and the Geographic Information System Research Coordinator at Resources for the Future.

Top of the Stack

A recurring segment on *Resources Radio* is "Top of the Stack," when podcast cohosts ask each guest what is on the top of their literal or metaphorical reading stack.

Guests sometimes give a broad idea of how their reading habits inform their life and work; for example, Binghamton University Professor Neha Khanna says, "I start every day by reading the newspaper, no matter where in the world I am. If I happen to be in a place that I'm not usually in, I try to find the local newspaper, and I scour it for environmental stories. That's how I keep myself relevant to the field, and a lot of my work has come out of reading the newspaper."

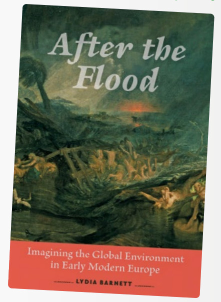
In many cases, podcast guests make specific recommendations based on what they've been reading, watching, or listening to. Maybe one of these selections from the past year can help inform your reading list. ■

Want to hear more?

Head over to the RFF website to discover our extensive archive of *Resources Radio* episodes.

Photo Credit
Jessi Jezewska Stevens
by Nina Subin

After the Flood by Lydia Barnett



"It's a history of the way that Enlightenment European philosophers thought about Noah's flood and how that allowed them to conceptualize the world. I think it's an interesting book to read in the context of people who work on climate change, because it's all about trying to understand how people in the past—in Europe, specifically—thought about weather and how much and in what way they could affect the world around them."

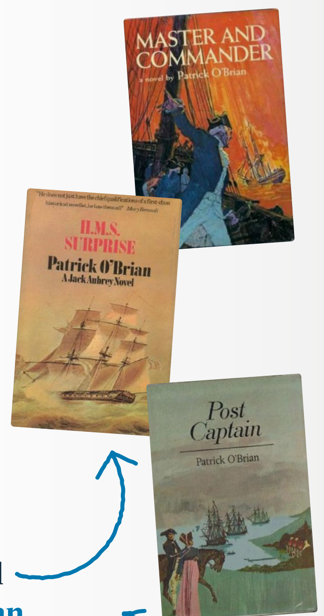
Maya Domeshek
Research Associate
Resources for the Future

Field Trip with Lillian Cunningham

"One thing I really like about this podcast is the idea that, when you're trying to achieve a goal—as well-intentioned as that goal can be—it's really important to think about the individuals who are going to be affected directly and to take those considerations into account as you build your governance structures."

Nicholas Roy
Senior Research Analyst
Resources for the Future

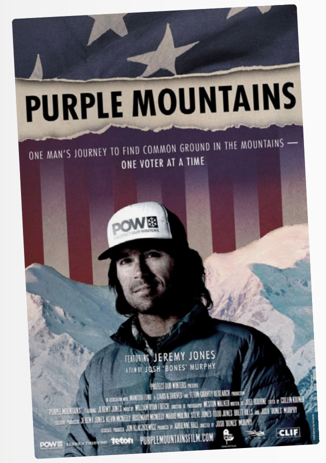
Aubrey–Maturin series of nautical historical novels by Patrick O'Brian



"One way to describe this series of 20 books is that it's about the British Navy during the Napoleonic Wars. It's swashbuckling historical fiction. One of the main characters is a spy, a doctor, and an amateur naturalist. It's both poetic and scientifically substantive about the environment. It's a serial of 20 books; one flows into the next. If you end up liking the first book, good news: There are 19 more."

James Boyd
Senior Fellow, Associate Vice President for Research and Policy Engagement, Resources for the Future

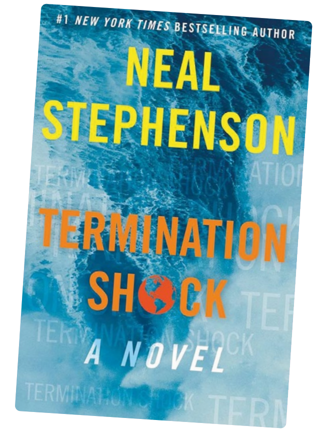
Purple Mountains Dir. Josh Murphy



"*Purple Mountains* is a movie done by a professional snowboarder named Jeremy Jones about how to get different types of people on board with climate change. He's someone who spent his whole life in the mountains, assessing snow, and seeing the changes. He started an organization called Protect Our Winters with this idea of getting people who enjoy the outdoors to get engaged on climate change. One of the most exciting things in the movie is seeing the different types of people who are interested in the outdoors who have different political persuasions. There's a real potential to broaden the coalition of people to support climate change mitigation and carbon dioxide removal."

Gregory Nemet
Professor, University of Wisconsin–Madison

Termination Shock by Neal Stephenson



"If we are not successful with accelerating the rate of launching new clean energy projects, I think it's worth reading this book by Neal Stephenson, who describes in quite vivid, sensational, and, at times, humorous detail what geoengineering will be required to address the climate situation. It's a romp through a very different perspective of the near future."

James L. Connaughton
Chair of the Board
Nautilus Data Technologies

"The Tragedy of Stopping Climate Change" by Jessi Jezewska Stevens

"It's an essay written by a novelist and writer that was published in *Foreign Affairs* in 2021, in which she reflects on the role her profession could play in telling the climate story—what writers should do and what stories there are to tell."

Michael Pahle
Head of the Climate and Energy Policy Working Group, Potsdam Institute for Climate Impact Research

Here We Are: Notes for Living on Planet Earth by Oliver Jeffers

"I have a five-year-old and a three-year-old, and a lot of my reading time is reading with my kids. I like to introduce different concepts to them at their level. I've really enjoyed this book, which I found to be a really nice introduction, appropriate for young children, to concepts that touch on living in a community, sustainability, and working with the planet. For anyone with young children, I would recommend it."

Eric Kort
Associate Professor, University of Michigan

Disclosing Wildfire Risks in Home Sales

New research finds that disclosing wildfire risks to potential homebuyers in California reduces sale prices.

TEXT
Emily Joiner, Lala Ma, Margaret A. Walls, Matthew Wibbenmeyer, and Connor Lennon

ILLUSTRATION
Weitong Mai

Damages from wildfires in the United States are on the rise. Of the top 10 costliest wildfires in terms of insured losses, eight have occurred since 2017. One reason for the rising costs of wildfires is the growing number of people and property in harm's way. The wildland-urban interface, where the built environment meets or intermingles with areas of wildland vegetation—including areas with high potential for fire hazards—is by some accounts the fastest-growing land area in the United States.

Whether people fully understand the risk of wildfire when choosing to live in the wildland-urban interface is an open question. If they do understand, housing prices should reflect that risk; houses in locations where the risk of wildfire is higher should sell for less, all else being equal. However, these houses may not sell for less if homebuyers don't fully understand the risk of wildfire. This potential gap in understanding offers a strong argument for the disclosure of wildfire risk to homebuyers. Disclosure could enable homebuyers to make more informed decisions when purchasing a house.

"Whether people fully understand the risk of wildfire when choosing to live in the wildland–urban interface is an open question."

Above Sequoia National Forest, near Porterville, California, where recent wildfires have burned and otherwise threatened the endangered giant sequoia trees, which can grow to about 300 feet tall and live longer than 3,000 years

Ashley Cooper / Getty Images

Regulating the Disclosure of Wildfire Risk

California is one of only two states (along with Oregon) that require a house seller to disclose the risk of wildfire. In California, disclosure depends on the hazard level (moderate, high, or very high) that is assigned to a house by the California Department of Forestry and Fire Protection and the local, state, or federal jurisdiction responsible for preventing and suppressing fires. In so-called State Responsibility Areas, the disclosure of wildfire risk is required if a house's hazard level is moderate or higher. In so-called Local Responsibility Areas, disclosure is required only if a house's hazard level is very high. A large area of very high hazard exists in the northern part of California that is east and north of the Sacramento Valley, but areas of very high hazard exist in other parts of the state, as well (Figure 1).

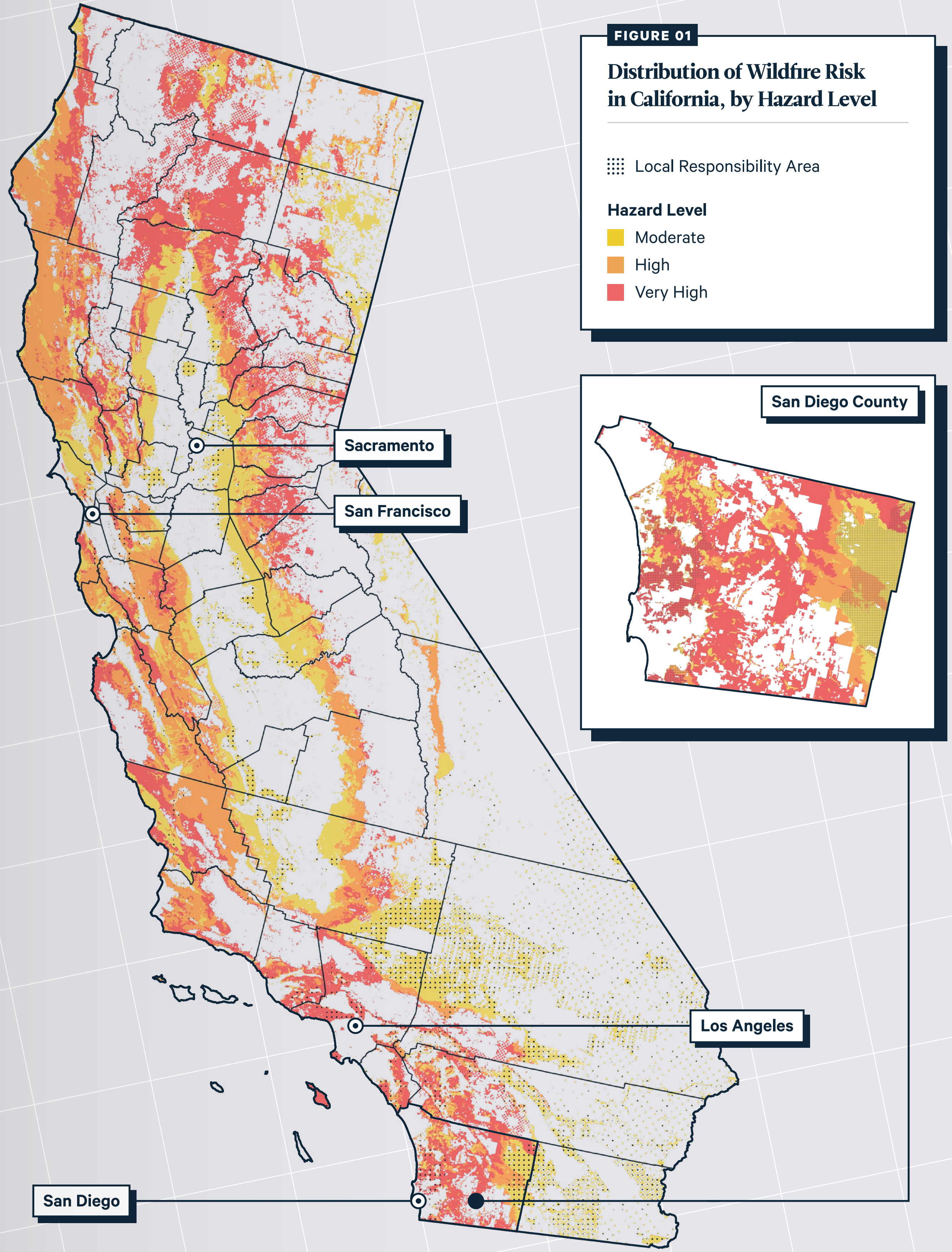
Very high hazard areas exist in various parts of California. The inset map of San Diego County in Figure 1 illustrates geographic variation in terms of hazard levels and state or local responsibility. In Figure 1, all areas that are not colored represent either areas with a low level of wildfire hazard or land for which the federal government is responsible.

Disclosure of Wildfire Risk Decreases House Prices in California

In a recent working paper, we set out to analyze how California's disclosure requirements affect housing prices. We used data on property sales for single-family

> "Whether people fully understand the risk of wildfire when choosing to live in the wildland–urban interface is an open question."

FIGURE 01
Distribution of Wildfire Risk in California, by Hazard Level



Climate Hits Home

In May, podcast host Margaret Walls spoke with Kimi Barrett, a research and policy analyst at Headwaters Economics and member of the federally established Wildland Fire Mitigation and Management Commission, about the effects of climate change on wildfires in the western United States, the ecological benefits of wildfires, and how local and state governments in the West are mitigating wildfire risks.

This episode of *Resources Radio* was part of a series called Climate Hits Home, in which guests discussed the risks and effects of climate change in specific parts of the United States and how local communities are finding solutions to address those effects. Other topics tackled by the series include sea level rise in Norfolk, water availability in Phoenix, urban heat islands in Las Cruces, and flooding in Appalachia.

Barrett explains, "It's not just that climate change exacerbates wildfire risk. It's also the fact that people continue to build homes in places that we know are going to experience wildfire."

Image
Wildfire risk can affect home prices, insurance rates, and insurance availability. Wildfire smoke, as well, poses a health risk to people and communities—not just due to the particle pollution that can cause respiratory and cardiovascular problems, but also because burnt manufactured materials produce smoke that contains toxic chemicals.

shutterjack / Getty Images

homes from January 2015 to March 2022; we obtained these data through the Zillow Transaction and Assessment Database.

Because wildfire risk is highly correlated with amenities that contribute to the value of a house, such as scenic views and access to outdoor recreation areas, separately identifying the market effects of amenities from the effects of risk can be difficult. To address this challenge, we compared sales data from both sides of boundaries between areas that have different disclosure requirements. Though these requirements can change abruptly at a boundary, the amenities that correlate with the risk of wildfire should vary continuously. We compared the sale price of houses that are close to a boundary, and in the same hazard level, but which have different disclosure requirements.

In our analysis, we also accounted for property characteristics (such as the size of a house) and neighborhood characteristics (such as the distance to protected public lands). Through this approach, we isolated the effects of wildfire risk disclosure on the sale prices of otherwise similar properties.

We find that the disclosure of wildfire risk decreases the sale price of a single-family home by an average of 4.3 percent. This difference in sale price equates to a $23,700 reduction in the willingness of homebuyers to pay for high-hazard homes, considering that the median sale price of houses in our sample that are near a boundary is $557,000. Our results are driven by sales in Southern California, where the negative effect of disclosure is as high as 6 percent. Additionally, the magnitude of the price discount increased in 2020 and 2021; these years followed a period of large, high-damage fires.

What's Ahead for Disclosing Wildfire Risk in the Housing Market

Our results suggest that disclosure matters to homebuyers and that, without disclosure, homebuyers do not fully incorporate the risk of wildfire into their decision to purchase a house. The results also lend credence to efforts to increase disclosure about all kinds of natural hazards. Even though the Federal Emergency Management Agency has mapped flood risk for a long time, the disclosure of flood risk, including maps of flood risk and whether a home has flooded previously, varies widely across states.

First Street Foundation recently has developed risk factors for both flood and fire at the level of individual properties across the United States, and this information has been incorporated into listings that are managed by the real estate websites Redfin and Realtor.com. Whether these risk factors will be a valuable tool for circulating information about risk remains to be seen. Risk information that is communicated through listings also may not be as salient as an official disclosure—and, without disclosure requirements, realtors may opt to withhold risk information from prospective buyers.

Risks also can be reflected in the price of insurance. Protection from fire damage is provided through homeowners insurance; because many different factors affect insurance premiums, homeowners may not easily understand how wildfire risk specifically contributes to premium costs. This complexity means that communicating the risk of wildfire through the insurance market may be less transparent than disclosure that occurs during property sales. As western states like Colorado grapple with the impacts of wildfires, California's disclosure laws have been viewed as a guide for how to ensure that buyers are aware of risk. Our findings offer support for following California's lead.

One acknowledgment is that, although we examined the short-term effect of risk disclosure on housing prices, disclosure also may have long-term effects that not only could change who chooses to live in risky areas, but also whether any housing is developed in those areas at all. This question deserves more research.

Ultimately, reducing exposure to wildfire risk will take a multipronged approach that includes disclosure requirements, risk-based insurance premiums, and the effective use of local land and policies that mitigate wildfire. ■

> "We find that the disclosure of wildfire risk decreases the sale price of a single-family home by an average of 4.3 percent."

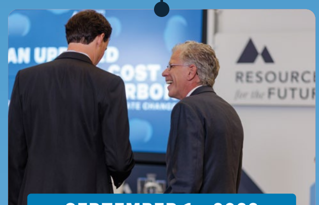
Emily Joiner is a senior research analyst, **Margaret A. Walls** is a senior fellow and director of the Climate Risks and Resilience Program, and **Matthew Wibbenmeyer** is a fellow at Resources for the Future. **Lala Ma** is a university fellow at Resources for the Future and associate professor at the University of Kentucky. **Connor Lennon** is a data scientist and econometrician at Colaberry.

A Year of Events
Experts and Audiences Connect at Resources for the Future

Resources for the Future hosts virtual and in-person events to help bring to life the most timely environmental, energy, and natural resource issues.

Resources for the Future (RFF) considers events as an important part of our mission. They're an opportunity to connect experts, journalists, and the general public; exchange views and ideas; and strengthen networks among researchers, industry, and government. RFF hosted 30+ events in the past year, including conferences, workshops, live panel discussions, webinars, and conversations with leaders in energy and the environment.

SEP · OCT · NOV · DEC · JAN · FEB · MAR · APR · MAY · JUN · JUL · AUG · SEP



SEPTEMBER 1 • 2022

An Updated Social Cost of Carbon: Calculating the Cost of Climate Change

This event revealed RFF's new social cost of carbon—the economic cost of emitting an additional ton of carbon dioxide into the atmosphere. The new estimate was published in the journal *Nature* on the same day.

OCTOBER 20 • 2022

Net-Zero Economy Summit

This summit gathered leading voices in government, business, research, and the media to discuss the climate challenge—and celebrate RFF's 70th anniversary. The event included a talk from US National Climate Advisor Ali Zaidi.

DECEMBER 5 • 2022

VALUABLES Consortium Capstone Celebration

This event marked the conclusion of a six-year collaboration between RFF and NASA, which brought together interdisciplinary groups of researchers to study the societal benefits of using satellite data in decisionmaking.

DECEMBER 8–9 • 2022

Energy Insights 2022

This two-day conference, which was cohosted by RFF and the Alfred P. Sloan Foundation, brought together experts in research, government, business, and nongovernmental organizations to discuss the future of US energy policy.

JANUARY 18 • 2023

Big Decisions 2023

This RFF Live event series is an annual occurrence that gathers experts in government, industry, research, and journalism to explore the biggest priorities in climate, energy, and environment that are likely to see major action in a given year.

MARCH 16 • 2023

Looking Ahead: Unpacking the EIA 2023 Annual Energy Outlook

At this event, officials from the EIA—the US Energy Information Administration—presented key findings from the agency's annual projections of domestic energy markets.

APRIL 11 • 2023

Modernizing Regulatory Review: Exploring OMB's Updated Benefit-Cost Guidance

Panelists discussed the federal government's new guidelines from the US Office of Management and Budget (OMB) for conducting benefit-cost analyses of federal regulations.

MAY 19 • 2023

Unplugging Emissions: Exploring New EPA Rules on Climate and Health

Panelists from institutions including RFF, the US Environmental Protection Agency (EPA), and Harvard University discussed three new regulations proposed by the EPA during a webinar.

JUNE 20 • 2023

Financing the Energy Transition: A Policy Leadership Series Event

As part of this event, Richard G. Newell discussed with Jigar Shah, director of the Loan Programs Office at the US Department of Energy, strategies for funding a transition to clean energy.

JUNE 27 • 2023

Policy Road Map to Accelerate Responsible BECCS Deployment

Ernest Moniz, CEO of the Energy Futures Initiative and former US Secretary of Energy, discussed bioenergy with carbon capture and storage (BECCS)—a method of removing carbon dioxide from the atmosphere.

JULY 25 • 2023

Changing Climate, Changing Forests: Exploring the US Forest Service's 2020 RPA Assessment

Terry T. Baker and Rita Hite joined three other panelists to discuss the latest Resources Planning Act (RPA) assessment of US forests and rangelands from the US Forest Service.

JULY 31 • 2023

The 45V Hydrogen Tax Credit: Considerations for US Treasury Guidance

During this event, members in industry and government discussed the challenges and considerations in the implementation of the 45V tax credit for the production of clean hydrogen.

SEPTEMBER 28–29 • 2023

Solar Geoengineering Futures

During this two-day RFF conference, an interdisciplinary group of experts explored big questions surrounding solar radiation modification and the potential consequences of solar geoengineering related to climate change.

DISCOVER MORE!

Head to the RFF website to find out more about our events from the past year, and be the first to find out about events we're planning for the future.

Three new regulations have been announced by the US Environmental Protection Agency early this year to help achieve the policy goals of the Clean Air Act.

The regulations target harmful air pollutants and greenhouse gas emissions.

TEXT
Karen Palmer and Matt Fleck

IMAGE
Ron and Patty Thomas / Getty Images

Power-Sector Pollution Targeted by New Regulations from the US Environmental Protection Agency

This spring, the US Environmental Protection Agency (EPA) announced three regulations that affect the US power sector. All three would fulfill directives in the Clean Air Act. Of the three, EPA first released the so-called “Good Neighbor Plan,” which aims to address emissions of nitrogen oxide that the wind blows across state lines. The second proposal includes a review of and amendments to an existing EPA rule, the Mercury and Air Toxics Standards. The third proposal (yet to receive a moniker) would limit the amount of greenhouse gases that power plants are allowed to emit.

EDITOR’S NOTE
The status of each proposed rule has been updated since the original publication of this article on June 19, 2023.

In a related event, Resources for the Future (RFF) hosted a trio of experts to examine the contents, context, and implications of these proposed regulations—along with the next steps in the regulatory development process.

Good Neighbor Plan Aims to Reduce Traveling Emissions

The Clean Air Act requires EPA to set air-quality standards for pollutants that are detrimental to public health and the environment. One of the regulated pollutants, ground-level ozone, forms when nitrogen oxide combines with other pollutants. Power plants and certain industrial processes can emit nitrogen oxide, which is part of the reason that EPA has targeted those emitters with the Good Neighbor Rule.

Some states effectively limit their own emissions of nitrogen dioxide and fulfill EPA’s air-quality standards within their own boundaries. However, if wind carries nitrogen dioxide over state lines, then these traveling emissions can push other well-behaving states over the established air-quality limits.

“That failure is not supposed to happen,” said Chris Hoagland during the RFF Live event. Hoagland is the director of air and radiation at the Maryland Department of the Environment. “The Good Neighbor Plan is a measure to address the problem of traveling emissions and requires all states to reduce the pollution that they are causing downwind.”

EPA finalized the Good Neighbor Plan in March 2023; since then, several states have appealed the rule in court. EPA has concluded the public comment period for a revised version of the rule, and an interim rule is in effect for some states. Additional revisions to the rule and developments in the appeals process are expected.

Revised Mercury Rule Pinpoints Lingering Sources of Pollution

While EPA regulates a range of pollutants through the Mercury and Air Toxics Standards, mercury has been the agency’s focus due to the severe negative impacts of the chemical on human health. Overall, the federal regulation of mercury pollution has been a success: between 2008 and 2020, mercury emissions from US power plants have decreased by 90 percent. But disparities in mercury levels among communities remain, particularly in regions of North Dakota and Texas, where a large amount of lignite coal (known as "brown coal") is mined and burned and serves as a stubborn source of mercury pollution.

"EPA has had weaker standards for lignite coal in earlier iterations of the Mercury and Air Toxics Standards," said Elsie Sunderland, a professor at Harvard University, during the event. "The proposal would strengthen those rules."

The benefits of mercury regulation may be higher than EPA has estimated, noted Sunderland. More comprehensive estimates of these benefits could help this proposal withstand legal challenges. EPA has concluded the public comment period for this proposal, but the rule has yet to be finalized and is not yet in effect.

Greenhouse Gas Regulation Balances Legal Challenges and Technological Feasibility

The Clean Air Act requires EPA to regulate greenhouse gas emissions, but the agency's previous attempts to regulate emissions from power plants have encountered legal challenges. The new proposal would replace a rule that a US circuit court annulled in 2021. "EPA also had to consider the 2022 Supreme Court decision in *West Virginia v. EPA*," said Carrie Jenks during the event. Jenks is executive director of the Environmental and Energy Law Program at Harvard Law School. "The ruling constrained how EPA could regulate greenhouse gas emissions."

Rather than setting emissions standards that focus on the outcomes of a transition to a greater reliance on sources of renewable energy, EPA's proposal has focused on strategies for reducing emissions that are achievable, cost-effective, and tailored to existing power plants according to the type of fuel that the plants use, how frequently the plants generate electricity, and the expected retirement dates of the facilities.

The proposed rule would require coal-fired power plants that are going to operate beyond 2040 to capture 90 percent of their carbon dioxide emissions by 2030. Large natural gas plants that are going to operate at full capacity beyond 2040 can fulfill the emissions standards in either of two ways: capture 90 percent of carbon dioxide emissions by 2035, or blend natural gas with hydrogen in increasing proportions. "These natural gas–fired plants probably need to decide by 2031 which path they're going to take," said Jenks.

EPA's approach with the new proposal—focusing on actions that individual power plants can take—is more consistent with how the agency has interpreted the Clean Air Act in the past. "I think that gives people comfort that EPA is staying within their lane," said Jenks. EPA has concluded the public comment period for this proposal, and the agency is expected to finalize the rule in early 2024.

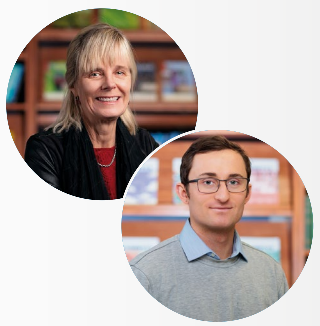
Contextualizing the Proposed Rules

The proposed amendments to the Mercury and Air Toxics Standards align with the Biden administration's focus on fusing environmental justice and climate policy, said Sunderland. "When we think about mercury, we want to think about the people who are most vulnerable to local pollution from utilities," she said.

The Inflation Reduction Act, a law that uses tax credits and other subsidies to promote a major shift in how the United States produces and consumes electricity, also provides context for the Good Neighbor Plan and the proposed rule for greenhouse gas emissions from power plants. "The government is coming at the problem of climate change from different directions—through direct incentives and tax policies, and also through regulation," said Hoagland. "Climate change is an enormous problem. It makes sense that the government is deploying all available tools to address it."

The timing of the rule announcements may simplify the deployment of these tools. "It's helpful for state regulators and power plant operators to know the different programs across different [pollutants] that they have to plan for," said Hoagland. "EPA deliberately has been trying to do these things together, so that everybody can plan them all at once." ■

> "The US Environmental Protection Agency's approach with the new proposal—focusing on actions that individual power plants can take—is more consistent with how the agency has interpreted the Clean Air Act in the past."



Karen Palmer is a senior fellow and **Matt Fleck** is a staff writer and reporter at Resources for the Future.

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