

Resources



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Working Toward a New Social Cost of Carbon

INTERNATIONAL

An Equitable Transition to a Low-Emissions Future in the EU

FUTURE IMPACTS

Improving Discounting in the Social Cost of Carbon

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A Note from RFF's President

Making Change

Changes and uncertainty continue, and still we adapt, as the first year of the Biden administration concludes with infrastructure bill negotiations alongside ambitious plans for clean energy and climate policy through the budget process.

A highly anticipated change is slated to arrive in January, with the most important number that most people have never heard of: the social cost of carbon (SCC). Estimated as the dollars-per-ton damage associated with emitting additional carbon dioxide into the atmosphere, the SCC likely will have enormous influence on US environmental policy moving forward.

Two articles in this magazine consider the imminent changes to the SCC. One article looks at the broad context of the SCC, focusing on several methodological improvements that RFF has played a large role in developing. Another article looks at one particularly crucial component of the SCC, namely, the framework for discounting future impacts to the present. RFF's work on both discounting and the SCC generally incorporates the best available empirical data and scientific methods, and implements the recommendations established by the National Academies of Sciences, Engineering, and Medicine. More on the SCC will come from RFF in the coming months.

Other articles in this issue touch on other important changes: Elena Verdolini—our colleague from the RFF-CMCC European Institute on Economics and the Environment—and RFF's Wesley Look consider a just transition to a low-emissions economy in Europe. Matthew Wibbenmeyer describes shifting norms with wildfires and what we can do to keep people and property safe from fires and smoke across the United States. We celebrate RFF fellows as they are recognized in their field: in this case, Dallas Burtraw shares insights from his long career in environmental economics. And the *Resources Radio* podcast features a guest who encourages us to learn from the New Deal-era Civilian Conservation Corps as the Biden administration considers establishing a contemporary version.

Amid so much change, RFF continues its impartial economics research and policy engagement on issues that are critical for current environment, natural resources, and energy decisions. Within these pages, an article about RFF's environmental justice event series highlights diverse voices in economics and the environment. And RFF Board Member Vicky Bailey spotlights opportunities to engage with RFF, based on her personal experience.

RFF adapts to changing circumstances while adhering to our fundamental values of balance, rigor, independence, respect, and results. Vicky says it well: "It's important that decisionmakers have access to information that is fact based and independent, done by highly capable and committed individuals." It's a privilege for us at RFF to do our part, and we hope you join us.



All my best,

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

Resources

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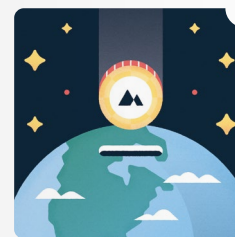
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Working Toward a New Social Cost of Carbon

The social cost of carbon (SCC) can have a major impact on climate regulations established by the US government. While vitally important, estimating the value of the SCC also is a highly technical task. The federal government is currently implementing improvements to the process that will result in an updated value this January. Calculating the inputs for SCC estimates gets complicated; for example, very long-term economic growth, population, and greenhouse gas emissions involve substantial uncertainty on long time horizons. Research from Resources for the Future aims to account for these uncertainties and employ empirical data to make the best possible estimate of the SCC using the best available science.

TEXT
 Kevin Rennert,
 Brian C. Prest,
 William A. Pizer,
 Richard G. Newell,
 David Anthoff,
 Cora Kingdon,
 Lisa Rennels,
 Roger Cooke,
 Adrian E. Raftery,
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 Frank Errickson,
 and Jordan Wingenroth

ILLUSTRATION
 Studio Muti

The social cost of carbon (SCC) often has been referred to as the most important number you've never heard of. It's the key economic measure of the benefits of mitigating climate change—an estimate, in dollars, of the economic cost (i.e., damages) that results from emitting each additional ton of carbon dioxide (CO₂) into the atmosphere. Conversely, the SCC represents the benefit to society of reducing CO₂ emissions by one ton—a number that can be used to inform policy decisions. Analogous metrics exist for the greenhouse gas pollutants methane and nitrous oxide.

The SCC has deep intellectual roots in economics. The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel was awarded to William Nordhaus in 2018 (alongside Paul Romer) for his seminal work incorporating climate change

into economic analysis, including the role of the SCC in informing policy. Textbooks often use carbon emissions and their role in causing climate change as the canonical example of an externality, which must be addressed to maximize human well-being. One specific method of addressing emissions and improving welfare comes from basic economic theory, which recommends that an optimal tax on CO₂ emissions (often called a carbon tax) should be set at a level where the SCC and the incremental cost of emissions control are equal.

But the relevance and application of the SCC goes well beyond its potential role in environmental taxation. It's been used by the US federal government for more than a decade in benefit-cost analyses that inform regulations like vehicle fuel economy standards and power plant emissions rules. The SCC also was the basis for valuing federal

tax credits for carbon capture technologies enacted in 2018 and zero-emissions credits for nuclear power in New York State. The power grid operator for New York State currently is working to include the SCC as a cost "adder" on top of energy supply bids submitted by power plants, to reflect these social costs into market prices and power distribution. Many other states have used the SCC as the basis for various types of climate policies. Even more proposed applications include influencing federal procurement decisions, determining federal royalties on oil and gas leases on federal land, and the list goes on.

In other words, while political leaders and stakeholders continue to debate both the broad outlines and fine details of policies to mitigate carbon dioxide emissions, the SCC lies in the background as a remarkably important calculation that helps inform specific proposals.

FIGURE 1 Modular Framework for Estimating the Social Cost of Carbon (SCC)

? This four-part framework produces an estimate of the SCC—which represents, in present-day dollars, the economic costs and damages of releasing one ton of CO₂.

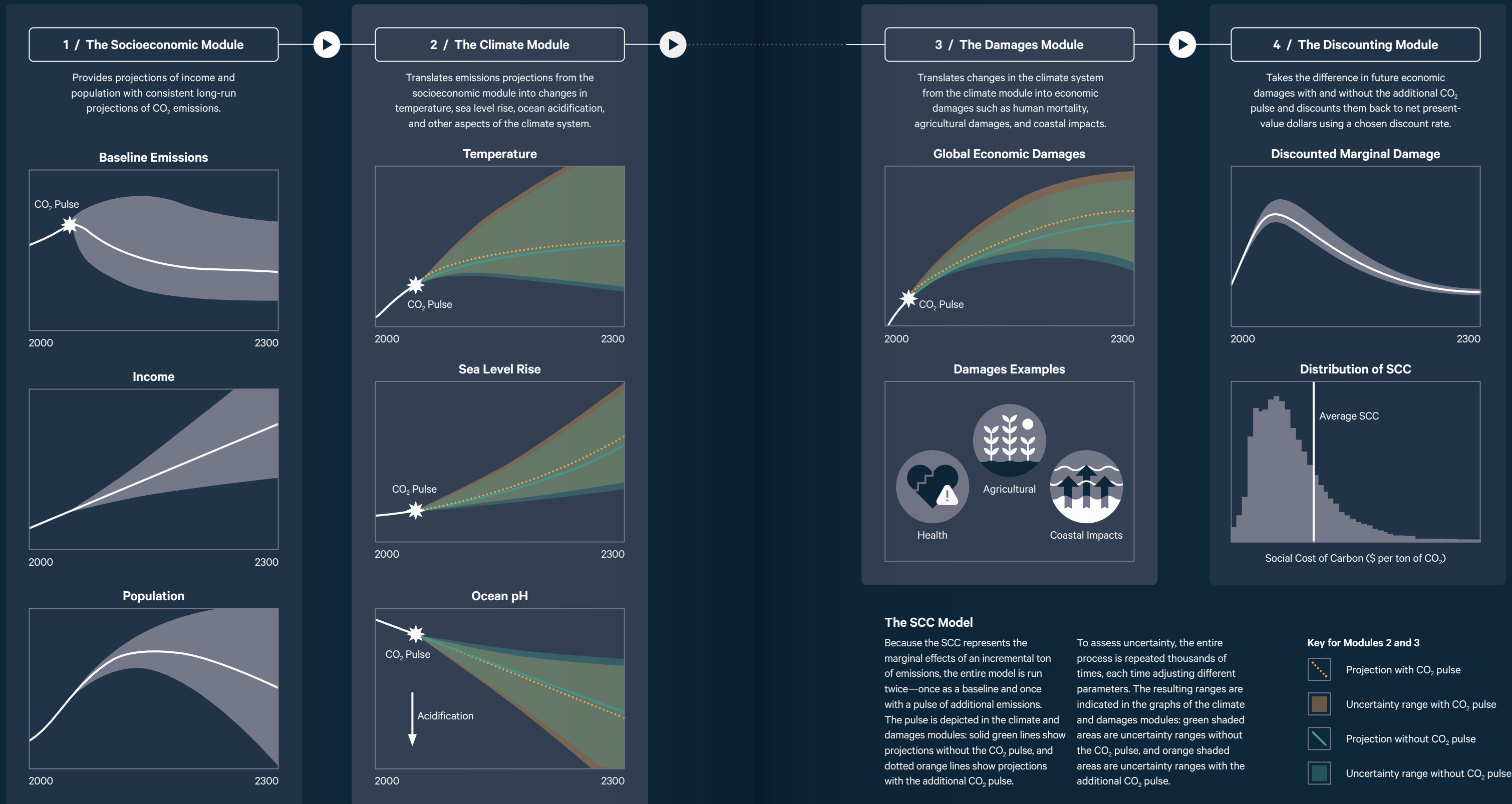
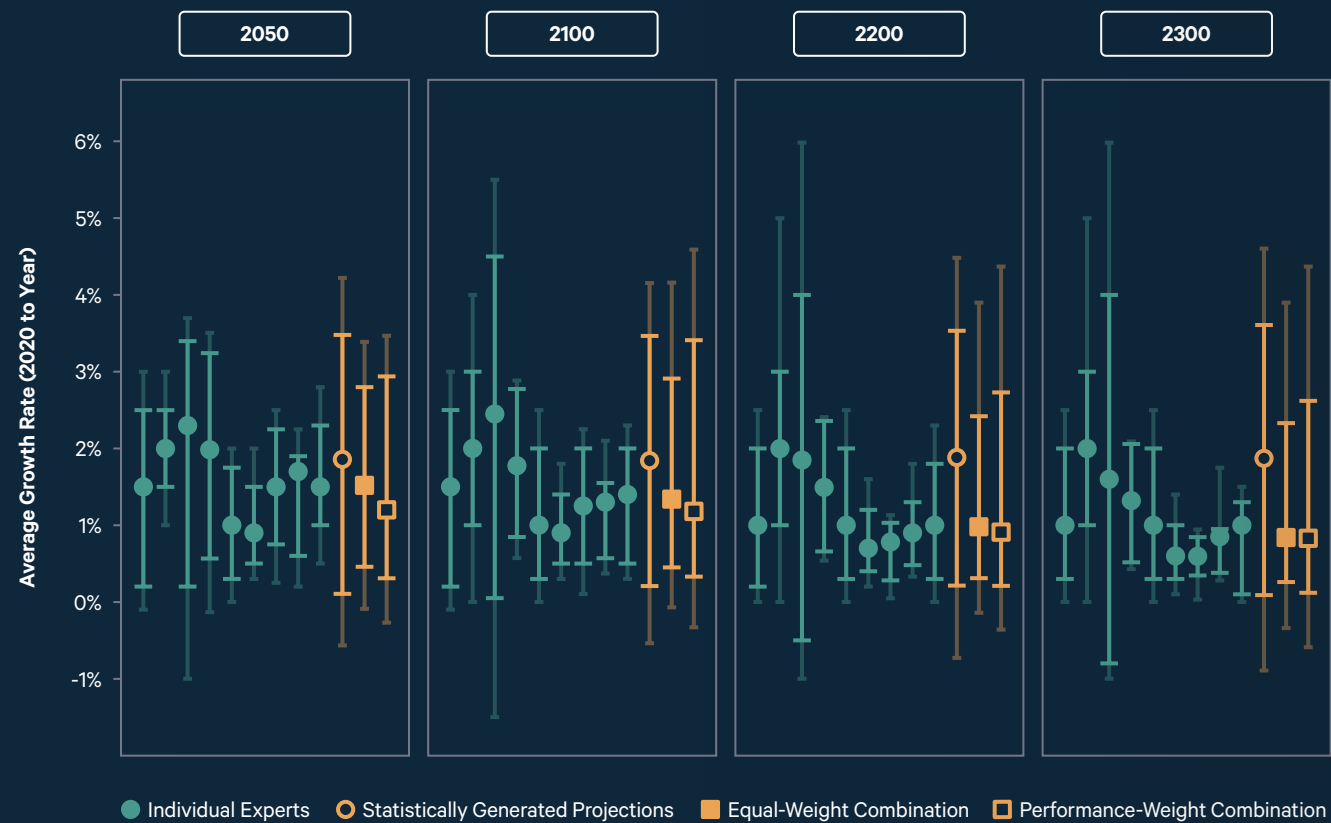


FIGURE 2

Distributions of Future Average GDP Per Capita Growth for the Major Developed Economies, Based on Econometric Sources and a Systematic Survey of Experts



Many of the factors underlying the calculation of the SCC are deeply uncertain. These factors include our understanding of the effect of climate change on economic outcomes, the time-sensitive consequences of today's emissions projected in the future, and the science of Earth's climate. The need for robust policy decisions implies that we should update the SCC over time to refine central estimates and their uncertainty as our scientific understanding progresses.

This article provides a high-level summary of important aspects of our efforts to update key determinants of the SCC, while reflecting the best available science, based on the recommendations of a landmark 2017 committee report by the National Academies of Sciences, Engineering, and Medicine (NASEM). The comprehensive details of

our work will be published in a forthcoming article in the *Brookings Papers on Economic Activity* series.

This work is particularly relevant in light of the January 20, 2021, Executive Order 13990, which reestablished the Obama-era Interagency Working Group on the SCC and directed it to update the SCC in consideration of the NASEM report. The NASEM report provides extensive guidance to improve the scientific basis, provide more transparency, and better address uncertainties in the SCC. It also recommends establishing an institutional process for updating SCC estimates approximately every five years—an update cycle that would balance the benefit of incorporating the latest research with the need for a thorough process. The next updated estimates for the SCC are anticipated for January 2022.

FIGURE 2 Circles and squares indicate medians; lines indicate the 1st, 5th, 95th, and 99th percentiles of each distribution.

“**An assessment of damages from future climate change is strongly influenced by underlying projections of socioeconomic variables such as population, economic growth, and emissions.**”

What We Know

The federal government's current interim value of \$51 per ton of CO₂ reflects the expected value of the SCC, accounting for uncertainty in the climate's warming response and five socioeconomic scenarios of economic growth, population, and emissions at a 3% constant discount rate. The NASEM report points out that prior SCC estimates by the US government—up to and including the current interim \$51-per-ton SCC value—use somewhat dated and often overly simplistic approaches.

For example, the projections that inform SCC calculations apply across a very long time horizon—from decades to centuries—which makes predictions difficult. Complex uncertainties must be considered in those projections; for instance, the outlook for socioeconomic variables depends on factors such as new technologies, the mitigation policies implemented, and the shares of different sectors and regions in the global economy. And because the effects of climate change vary regionally, the socioeconomic projections ideally should provide enough detail to account for regional heterogeneity in climate impacts.

An assessment of damages from future climate change is strongly influenced by underlying projections of socioeconomic variables such as population, economic growth, and emissions, and estimates of the SCC have been shown to exhibit significant sensitivity to the projections for these variables. But the five socioeconomic scenarios in routine use all have been treated as equally likely in prior estimates of the SCC by the US government, even though those five scenarios were not developed with any formal probabilities attached. The discounting approach also has used a constant discount rate, rather than treating the discount rate as contingent on each scenario—a distinction that becomes increasingly important as the relevant timescale shifts further into the future. To address such shortcomings, the NASEM report issued a series of recommendations, and Executive Order 13990 specifically directs the Interagency Working Group to take those NASEM recommendations into consideration when updating the SCC.

Specifically, the NASEM report proposes four “modules,” each corresponding to a step in SCC

estimation, along with an overall framework that integrates the modules and considers their various interdependencies (Figure 1). Each of the modules listed below can characterize inherent uncertainty, resulting in a distribution of estimates rather than a single value.

1. Socioeconomic and emissions projections
2. Physical climate system
3. Monetized climate damages
4. Discounting

Resources for the Future (RFF) created the Social Cost of Carbon Initiative in 2017 to advance research that addresses the NASEM recommendations. This effort, which focuses on improving the scientific quality and transparency surrounding SCC estimates, involves a network of partners—RFF; the University of California, Berkeley; Harvard; Princeton; the University of Washington; and others. RFF's research efforts have fully implemented most of the NASEM recommendations by doing the following: implementing a transparent, open-source computational framework; developing country-level GDP per capita, global population, and global emissions accounting for future policies and dependencies between the variables; incorporating an updated climate model used for SCC calculations; and providing an improved discounting framework. Additional work to assemble new climate damage functions from the best available literature is nearing completion.

Getting to Know the Known Unknowns

We will take a focused look at the detailed methods and results of one facet of RFF's efforts: building a new set of long-term projections for regional GDP, based on statistical evidence and an elicitation of expert predictions for the major developed economies. We'll also summarize the results of our work to generate projections for global population growth, CO₂ emissions, and temperature. The comprehensive methodological underpinnings and results of this work will be published in our contribution to the *Brookings Papers on Economic Activity* series. And further details about determining an appropriate discount rate for the SCC can be found on page 12 in this magazine.

Country-Level GDP Per Capita Projections

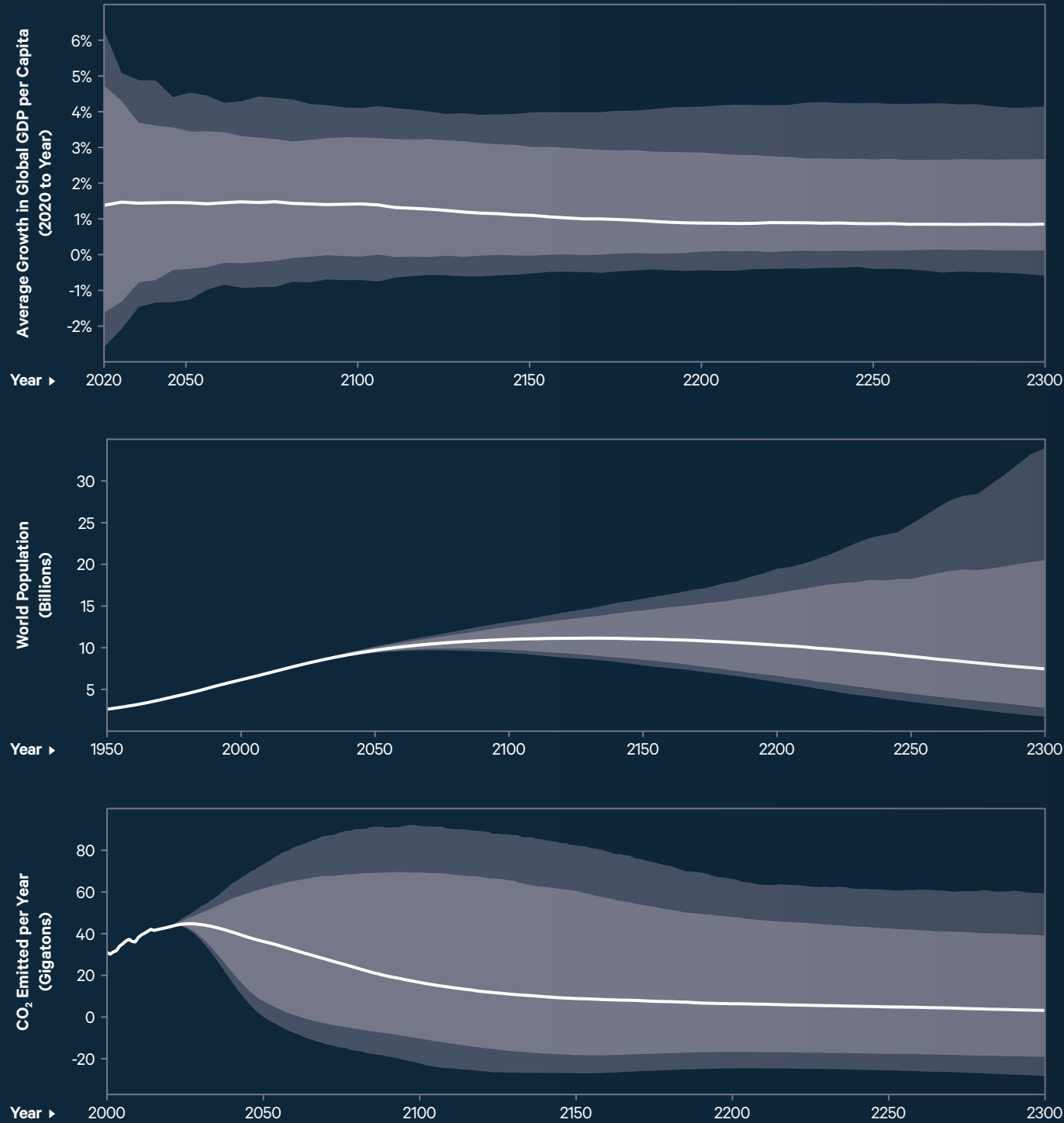
We quantified uncertainty about economic growth by generating a distribution of long-run growth projections at the country level, following a three-step approach: We started with statistically generated projections of country-level economic growth derived in recent research. Statistically generated projections based on historical data will be more informative about economic growth in the near term than in the very long term; so, with an eye toward the long term, we augmented the statistical evidence with an Economic Growth Survey that we implemented through a formal elicitation of experts. Through this second step of conducting the survey, we quantified expert uncertainty about future economic growth, focusing in particular on the very long term. In the third and final step, we combined the expert uncertainty with the statistically generated trajectories to provide projections over a nearly 300-year time horizon that reflect information from both the statistical method and the experts.

The Economic Growth Survey involved ten experts, selected based on their expertise in the fields of macroeconomics and economic growth and by the recommendations of their peers. Consistent with the statistics-based forecasts, the experts demonstrated a substantial range of uncertainty in future economic growth, beyond that typically represented in scenarios that have been employed for energy and climate analysis. However, as shown by the individual expert predictions, and as expressed in verbal comments during the elicitation, most expert participants did not expect long-run future growth to equal that projected by a purely statistical model of the past 100 years (Figure 2), which predicted nearly 2 percent growth. Combining the expert judgment with statistical projections reduced the expected future growth rate in the resulting data set.

The expert responses exhibited considerable diversity in their characterization of economic growth, with some of the widest ranges driven by their explicit inclusion of events that are not present nor fully realized in the historical record of economic growth on which statistical projections are based. When considering the major developed economies, most experts expected a deceleration of growth in global

FIGURE 3

Multi-century Projections for Model Variables, Based on Econometric Sources and Systematic Surveys of Experts



In all three graphs, the data combine statistical and expert-based projections. Shaded areas represent 90 percent and 98 percent prediction intervals.

GDP per capita, and possibly very low future growth rates (Figure 3), relative to what purely historical statistical evidence suggests.

When asked to identify their primary drivers of the potential low-growth outcomes, the experts most commonly cited climate change, followed by world conflict, natural catastrophes, and global health crises. In identifying the primary drivers of high growth, experts most often cited the rapid advancement of technology, followed by regional cooperation and advances in medical science.

Global Population Projections

To generate very long-term projections of population, we extended the existing statistical approach used by the United Nations for its official population forecasts through 2100, modifying the methodology with input from a panel of nine leading demographers. The resulting distribution of trajectories predicts a peak in median world population at about 11 billion in the middle of the next century (Figure 3), with a decline from the peak to about 7.5 billion by 2300, accompanied by wide uncertainty.

Global Emissions Projections

We also quantified the uncertainty surrounding four categories of future greenhouse gas emissions—including uncertainty about future climate policy and economic growth—through a formal expert survey. The median of the resulting trajectories suggests a roughly 60 percent reduction in CO₂ emissions by 2100 (Figure 3), with wide uncertainty that includes the possibility of net-zero global emissions as well as substantial increases from current levels. In general, the expert projections suggest that the shared socioeconomic pathways are relative outliers in their emissions projections through 2100, and the full range is largely inconsistent with the enforced requirement of shared socioeconomic pathways to converge to zero emissions in 2250.

We next ran an updated climate model with samples from the emissions projection data to evaluate projected changes in temperature. Our results suggest a median global temperature increase of 2.6° Celsius from the preindustrial level by 2100, with a continued increase in temperature through 2300. The results indicate a roughly 20 percent likelihood of staying below a

temperature increase of 2° Celsius by 2100. Our experts suggested that negative CO₂ emissions, from afforestation or direct air capture, could play a significant role in the future and allow for temperature pathways that peak and then decline.

Our approach to improving long-run projections of economic growth, global population growth, and global emissions, and combining these variables into a consistent set of interrelated projections, fully implements the near-term NASEM recommendations for the update of the SCC currently in progress. By providing these projections at the country level, our research takes significant additional steps toward meeting longer-term recommendations of the NASEM, as well.

Looking Forward to a New Social Cost of Carbon

The SCC is a vitally important metric that can guide climate policy. As such, its calculation must be supported by the best available science—including the explicit incorporation of uncertainty. Socioeconomic uncertainty, along with discounting that varies in tandem with socioeconomic uncertainty, are important drivers of the SCC. Our work provides the means and opportunity to incorporate those relationships and uncertainties into ongoing research to this important metric. The research of RFF and our collaborators fully implements the NASEM near-term recommendations for three of the four modules described above, and we’re rapidly nearing the completion of updates for the final module.

More generally, SCC-related research is an ongoing endeavor, and the SCC should be updated at regular intervals as the scientific frontier advances on multiple fronts, as recommended by NASEM. Our work speaks directly to those recommendations and provides tools that the US government can use to improve upon the simple, deterministic approaches to socioeconomic projections and discounting methodologies employed to date. Our work demonstrates how to better reflect the interrelated uncertainties that surround the future trajectories of population, income, emissions, climate, and discount rates. Preliminary results suggest that accounting for these uncertainties is likely to increase the value of the SCC considerably. ■

“
The SCC is a vitally important metric that can guide climate policy. Its calculation must be supported by the best available science—including the explicit incorporation of uncertainty.
 ”

Kevin Rennert and Brian C. Prest are fellows, William A. Pizer is the Vice President for Research and Policy Engagement, Richard G. Newell is the President and CEO, Roger Cooke is a senior fellow emeritus, and Jordan Wingenroth is a research associate at Resources for the Future. David Anthoff is an assistant professor and Cora Kingdon and Lisa Rennels are PhD students at the University of California, Berkeley. Adrian E. Raftery is a professor and Hana Ševčíková is a senior research scientist at the University of Washington. Frank Errickson is a postdoctoral research associate at Princeton University.

A summary of the research efforts that have informed this article will be published in the Brookings Papers on Economic Activity series. The work of Raftery and Ševčíková was supported by NIH grant R01 HD070936 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development. RFF’s work under the Social Cost of Carbon Initiative has been supported by the Alfred P. Sloan Foundation, the Hewlett Foundation, and individual donors.



Improving Discounting in the Social Cost of Carbon

The social cost of carbon (SCC) is a very important number due to the influence it can have on US federal regulations and other climate policies. Its sensitivity to the discount rate—a measure of a society’s preference for valuing benefits more when those benefits are received sooner rather than later—calls for careful attention to how we choose the discount rate that feeds into new estimates of the SCC. New research from Resources for the Future aims to improve the SCC by carefully, and empirically, determining the most appropriate discount rate.

TEXT Brian C. Prest, William A. Pizer, and Richard G. Newell

ILLUSTRATION James Round

The discount rate is a tool that is used to compare the value of future impacts to those experienced today; it’s important for understanding the social cost of carbon (SCC). The basic idea of discounting is simple: for a variety of reasons, people generally tend to value benefits (e.g., income, consumption) more when those benefits are received sooner rather than later. The discount rate reflects the strength of this preference, and the discount rate can have huge implications for how we evaluate impacts that occur far in the future.

In the context of climate change, the SCC is well known to be sensitive to the value of the discount rate. A higher discount rate indicates a higher value placed on immediate benefits relative to delayed benefits received in the future. For example, while the Biden administration’s interim \$51-per-ton SCC estimate is based on a 3% discount rate, changing that rate to 2% more than doubles that SCC estimate to \$121 per ton. By the same token, the Trump administration used a much higher 7% discount rate to arrive at a much lower SCC estimate of about \$6 per ton. The sensitivity of the SCC to the discount rate owes to the fact that the impacts of carbon dioxide emissions today are very long lasting, since those carbon dioxide molecules remain in the atmosphere for hundreds of years, and the warming effect of those molecules lasts even longer.

The SCC is important for US government climate policy, because higher values motivate stronger regulatory action. Formally, the SCC appears prominently in the “benefits” column of the benefit-cost analyses routinely performed by the federal government for all major regulations, such as vehicle fuel economy standards or regulations that require power plants to reduce their emissions.

Historically, the discount rates used for federal benefit-cost analyses have been guided by a policy issued by the Office of Management and Budget (OMB) in 2003 called Circular A-4. The policy recommends using two discount

rates for regulatory analysis: 3% and 7%. However, recent research has found that that these two rates are no longer appropriate, for several reasons.

First, the 3% rate was based on a calculation of average real interest rates for US Treasuries that spanned the three decades leading to 2003. Since then, market interest rates have fallen dramatically. As a result, a contemporary update to that calculation, but spanning the last three decades or so, would result in a lower discount rate of around 2%.

Second, it’s important to explicitly consider uncertainty about appropriate discount rates in the future. As demonstrated by economist Martin Weitzman, uncertainty about future discount rates suggests using lower and lower rates for longer and longer time horizons, which is particularly relevant for the very long time horizons considered in the SCC. In our recent research, which we describe in more detail below, we show how economic analysis can incorporate these uncertainties explicitly into the estimation of the SCC.

Third, the underlying 7% rate is founded on some extreme assumptions that are especially inappropriate for discounting effects over time horizons that are relevant for climate change. The original motivation for the 7% rate in the OMB’s Circular A-4 was that the costs of regulations could apply to capital investment rather than consumption, with investment having a higher rate of return due to tax distortions. Rather than addressing this cost issue by adjusting the discount rate in benefit calculations, the “shadow price of capital” approach, long recognized as conceptually correct by the OMB, can be implemented. Recent public comments from Pizer show that multiplying regulatory costs by a shadow price of capital of 1.2 would reflect a case of all costs falling on investment. The possibility of some or all *benefits* falling on investment is absent from the current OMB discounting approach.

Now that the federal Interagency Working Group (IWG) on the SCC has been reestablished, the time is right to revisit the US government’s approach to discounting in the context of SCC estimation. Perhaps recognizing the shortcomings of the

current approach to discounting, the Biden administration has issued an order that directs the OMB to update the regulatory review procedure, which includes revisions to Circular A-4. We suggest tackling three specific aspects in the revisions:

1. Focus discounting on an updated, lower consumption rate of interest.
2. For long-term decisions such as climate change and the SCC, incorporate uncertainty in the discount rate by using a discounting framework that links the discount rate to future economic growth.
3. Apply a shadow price of capital to investment impacts instead of discounting benefits at an investment rate of return. In a simplified, conservative sensitivity case, apply a 1.2 shadow price of capital to regulatory costs.

Discounting Advances in Detail

The arguments summarized above suggest that the OMB should consider revising its central consumption discount rate. Indeed, a landmark 2017 report from the National Academies of Sciences, Engineering, and Medicine (NASEM) recognizes the need for revisions and issued a series of recommendations to the IWG for future updates to the SCC.

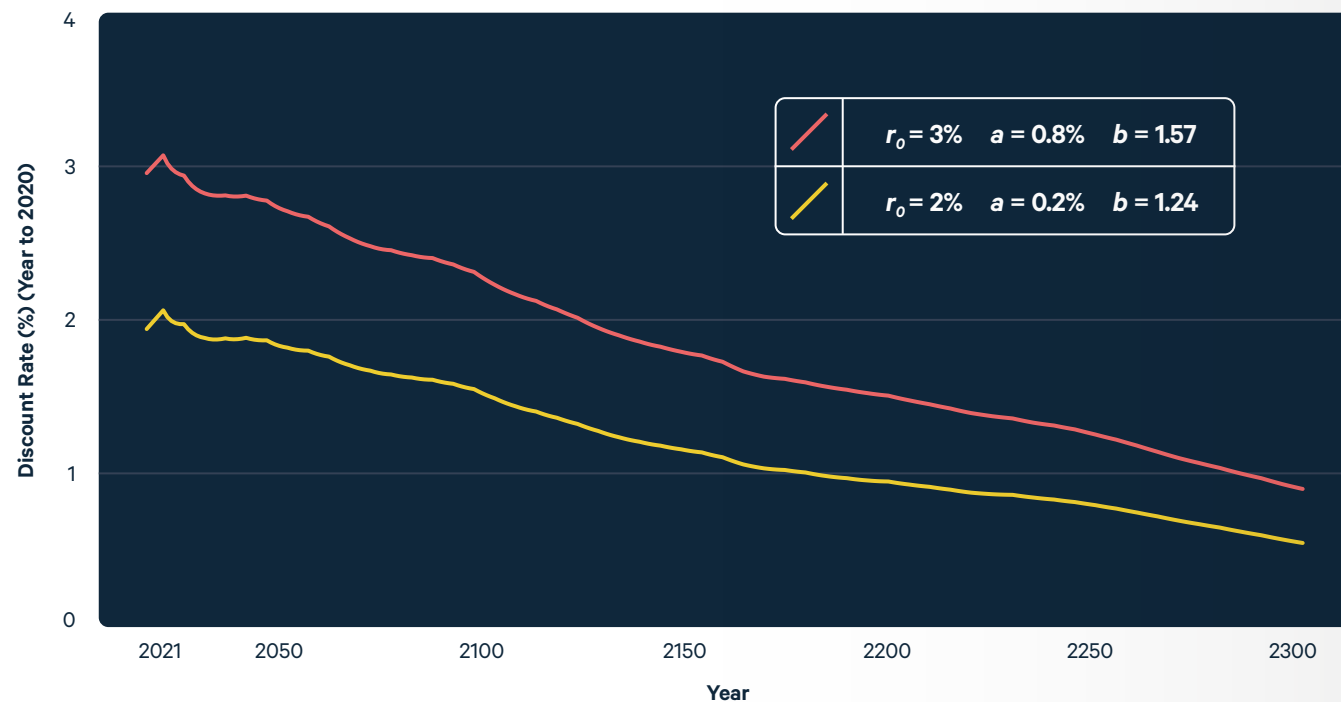
Beyond the question of the appropriate *level* of the discount rate, one of the issues recognized in the NASEM report involves deeper economic questions about how to consider *uncertainty* about the discount rate, and whether future discount rates should depend on how future economic growth unfolds. As discussed in an accompanying article on page 5 of this issue of *Resources*, recent work by Resources for the Future (RFF) and external collaborators at the University of California, Berkeley; the University of Washington; Harvard; and Princeton has made it possible for analysts to use fully probabilistic, detailed projections of population, economic growth, emissions, and the climate system in estimating the SCC.

These new probabilistic socioeconomic projections—we call them RFF socioeconomic

“**The 3% rate was based on a calculation of average real interest rates for US Treasuries that spanned the three decades leading to 2003. Since then, market interest rates have fallen dramatically.**”

”

FIGURE 1 Calibrated a and b Parameters Yield Effective Discount Rates Tied to 3% and 2% Near-Term Rates



projections—represent a major improvement over the simpler socioeconomic scenarios used in the past, but the use of these kinds of projections also raises new conceptual questions. For example, classic economic theory going back nearly a century shows that one should use a higher discount rate when economic growth is higher, and a lower rate when growth is lower. The intuition is this: Society naturally values a dollar's worth of avoided future climate impacts more if that impact is on a relatively *poor* society in the future. On the other hand, a dollar's worth of future climate impacts has less value if it falls on a relatively *rich* future society. Indeed, part of the rationale underlying the discounting of future outcomes is that the society is likely to grow wealthier over time. When uncertainty exists about the future path of income growth (as discussed on page 5 in this magazine), corresponding uncertainty exists about how much we should discount future impacts.

The relationship between uncertainty in economic growth and the discount rate is highlighted in the NASEM report, which recommends that updates to the

SCC incorporate this relationship. The recommendation stands in contrast to the US government's existing approach to the SCC, which features no such link because of its use of a fixed discount rate, such as the constant 3% value. But our work argues that the calculation of the SCC should feature the following two things: include a probabilistic set of socioeconomic projections, and apply a discount rate that's contingent on economic growth in each projection—what we call “stochastic growth discounting.”

While the NASEM report strongly recommends that the SCC should account for this relationship between economic growth and the discount rate, it was not clear at the time exactly how the strength of that relationship would be determined. For example, given two projections—one with 1% growth and another with 2% growth—how much higher should the discount rate be in the second projection? To say the same thing in technical language: What is the mathematical relationship between the discount rate and growth? Without getting into too much technical detail, this relationship between the discount

rate (r) and the economic growth rate (g) typically depends on the two parameter values in the equation $r = a + bg$, where a reflects a constant element to how much we discount impacts on society over time, and b reflects how much we discount future impacts because society has grown wealthier.

The question comes down to choosing those two values. One potential approach is to choose them *prescriptively* based on one's ethical beliefs or on surveys of the economics profession. An alternative approach is to choose them *descriptively*; for example, by choosing values such that the discount rate calculated by the equation above matches observed market interest rates—a method embraced by prominent climate economist William Nordhaus.

Each of these methods faces potential problems for the US government's calculation of the SCC. First, the US government largely has embraced descriptive over prescriptive approaches: recall that the OMB's Circular A-4 determined its 3% and 7% discount rates

descriptively by referring to observed market rates. But under the descriptive approach typically used by the US government, many different pairs of parameter values can be tuned to match any given interest market rate. For example, if growth is $g = 2\%$, both $1\% + (1 \times 2\%)$ and $0\% + (1.5 \times 2\%)$ yield a rate of 3%. Clearly, the simple method of matching a target market rate is insufficient; more information is needed to narrow down the parameter values descriptively.

This is where our research comes in, detailed in a recent paper, with implications that were first highlighted by climate economist Martin Weitzman. Weitzman noted that if uncertainty exists about the “right” discount rate, then we should use a lower and lower rate for impacts occurring further and further into the future. Exactly how much lower depends on how uncertain we are about the appropriate discount rate—the more future uncertainty, the lower the rate.

Returning to the equation $r = a + bg$, uncertainty in the discount rate is closely tied to uncertainty in economic growth, at a rate determined by the value b : higher or lower values of b imply higher or lower degrees of uncertainty in the discount rate. Recent research has presented evidence for uncertainty in both the left-hand side of this equation (interest rate uncertainty) and the right-hand side (growth uncertainty).

In particular, we calculate the parameter values that reconcile these two sources of evidence. For example, the a and b values of 0.2% and 1.24, respectively, when applied to the growth data from the RFF socioeconomic projections in a forthcoming Brookings paper, delivers a particular term structure of discount rates: a near-term effective discount rate that starts at 2% and reflects the uncertainty about that rate going into the future. The shape of this term structure is consistent with the behavior of interest rates. This leads to an effective discount rate (the technical term is the “certainty-equivalent rate”) that declines over time (Figure 1) and stays consistent with empirically estimated term structures from recent macrofinance research. Note that in application, however, the specific rate used for discounting future impacts would depend on a

particular scenario, rather than being set as a fixed declining path.

This new work provides a set of descriptively driven discounting parameters that the US government can use, and it is directly responsive to the NASEM recommendations on discounting. In addition, our new work and our forthcoming article in the *Brookings Papers on Economic Activity* series demonstrate that incorporating this empirically driven relationship between economic growth and the discount rate is crucial when estimating the SCC amid uncertain economic growth.

All told, our proposed approach to discounting includes three components:

1. Focus discounting on an updated, lower consumption rate of interest.
2. For long-term decisions such as climate change and the SCC, incorporate uncertainty in the discount rate by using a discounting framework that links the discount rate to future economic growth.
3. Apply a shadow price of capital to investment impacts instead of discounting benefits at an investment rate of return. In a simplified, conservative sensitivity case, apply a 1.2 shadow price of capital to regulatory costs.

This last sensitivity analysis, the third item in the list above, does not relate specifically to the SCC, and would be implemented generally in benefit-cost analysis. By using a shadow price of capital approach, benefit-cost analysis can address concerns about capital impacts, hew more closely to longstanding economic guidance, and avoid substantially undervaluing future benefits. Each of these advances in the approach to discounting could be incorporated in a revision to the OMB's Circular A-4, with relevance to both SCC estimation and other contexts. This integrated approach to discounting would harmonize SCC discounting and broader US government guidance on benefit-cost analysis while allowing the US government to update its treatment of the discount rate to reflect the best available science. ■



Brian C. Prest is a fellow, **William A. Pizer** is the Vice President for Research and Policy Engagement, and **Richard G. Newell** is the President and CEO at Resources for the Future.

A summary of the research efforts that have informed this article will be published in the Brookings Papers on Economic Activity series.

Equitable Transition to a Low-Emissions Future: Perspectives from Europe

A forthcoming report from Resources for the Future (RFF), the RFF-CMCC European Institute on Economics and the Environment (EIEE), and Environmental Defense Fund synthesizes insights about how the European Union can help facilitate a just transition through economic development, labor support structures, and other policy tools. EIEE's Elena Verdolini and RFF's Wesley Look expand on their findings.

TEXT Elena Verdolini and Wesley Look

ILLUSTRATION James Round

The world is reckoning with major environmental changes that call for major solutions. Decarbonizing the global economy is a prominent strategy for addressing climate change—in fact, scientific evidence and modeling show that decarbonization is the only way to avoid the economic, social, and environmental risks associated with climate change.

Decarbonization involves a transition away from fossil fuels and toward clean energy sources. To ensure positive outcomes in this clean energy transition, an important requirement must be met: policymakers must prioritize fairness for workers and communities that historically have relied on fossil fuel production as a primary source of jobs and prosperity. This focus on fairness emphasizes racial, economic, and environmental justice; equity among rural and urban communities; and support for the people

involved in the shift from fossil fuels to clean energy. Achieving these ends often is termed a "just transition."

At Resources for the Future (RFF), scholars have developed a research project that explores the federal policy options available for a just transition and provides relevant resources for decisionmakers in the United States. But because a transition to clean energy will necessitate action across the world, the researchers also have tackled similar questions in an international context. With a forthcoming report, RFF, the RFF-CMCC European Institute on Economics and the Environment, and Environmental Defense Fund have investigated the possibilities for a just transition in the context of the European Union. Two of the report's coauthors—EIEE's Elena Verdolini and RFF's Wesley Look—spoke to *Resources* magazine to expound on findings from their upcoming report.

“
This focus on fairness emphasizes racial, economic, and environmental justice; equity among rural and urban communities; and support for the people involved in the shift from fossil fuels to clean energy.
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As we transition to a clean energy society, we have the chance to get our house in order, in terms of other long-standing issues—not just addressing environmental degradation and instability, but also racial and economic justice.

BELOW Renewable energy consumption has grown, even during the COVID-19 pandemic, and renewables are expected to provide more electricity than coal in just a few years.

Science in HD / Unsplash



Resources magazine: Tell us about the work you’ve been doing on just transitions around the world—particularly your new report about the European Union. First, what do you mean when you talk about a just transition?

Wesley Look: The concept of a “just transition” is central to the global dialogue about addressing climate change. A broad definition of just transition policy includes the very climate policies aimed at reducing greenhouse gas emissions, along with policies designed to assist workers displaced due to decarbonization, local economies undergoing diversification, and low-income minority communities that have experienced racism or other forms of injustice—which includes communities that are most vulnerable to the impacts of climate change.

As we transition to a clean energy society, we have the chance to get our house in order, in terms of other long-standing issues—not just addressing environmental degradation and instability, but also racial and economic justice. For example, how do we develop policies that focus on lifting up communities that are most vulnerable to climate change impacts, while also tackling the cause of those impacts—namely, greenhouse gas emissions?

Elena Verdolini: The just transition concept was generated by trade unions and born out of industrialized countries. This concept was historically relevant in the context of industrial transitions, and it’s now a core concern in the context of addressing climate change. Importantly, the discussion is not only an issue of policies—it’s also about the definition of what a just transition is and should look like.

The term just transition can mean slightly different things in different countries (both developing and developed), cultures, and societies. It’s important to be aware of this diversity. In Europe, for instance, a just transition is not just about communities that depend heavily on coal, but also more broadly about leaving no one behind.

What are your goals with this work, and what are your top-line findings?

WL: We have been looking at just transition policies in the United States and Europe; the primary focus of the work is to provide information to policymakers on various public policy approaches to facilitating a just transition.

EV: With this research, we’d like to start a conversation about what a just transition really

is and can be, and what policy options are available to achieve it. The report contributes to an important dialogue between Europe and the United States. Hopefully in the years to come, this will grow into a bigger conversation that includes other countries—especially developing nations.

But for now, our work focuses on industrialized countries and necessarily reflects the specificities of these countries. This work has been funded in large part by Environmental Defense Fund and has led to greater engagement in the Research Network on Energy Workforce Transitions (ReNEWt), an international consortium of researchers and policy analysts. We are trying to build a community that talks about these issues, so we can develop a lexicon and toolbox that we can share with each other.

WL: Something we kept coming back to in our US work is, “What are the tools in the toolbox?” If we have a senator who wants to create just transition policy, what are the various mechanisms at their disposal? What should they be aware of to make a real difference on this issue?

One of the goals of this research is to help policymakers understand that this is a hugely complex social policy issue, and if we want to make a meaningful difference in people’s lives, we need to appreciate that complexity. For example, this is about labor policy, economic development, environmental remediation, social safety net programs, shoring up the fiscal solvency of state and local governments, and regulatory mechanisms for large natural resource industries; for instance, coal-producing companies and their liability for the cleanup of mine sites. This is also about respecting communities with a multigenerational tradition of working in a specific industry, like coal mining in Appalachia or the Upper Silesia region of Poland, for example. These deep histories have cultural underpinnings. So, we’re not only talking about the disruption of economic and industrial systems, but also transformations in people’s sense of identity and culture. A policy framework that can adequately address this challenge—and facilitate a truly just transition—must touch on each of these issues, and do so in a coordinated way.

EV: This report illustrates the tools that Europe put into place since its founding to promote cohesion and economic development across its member states. These existing tools can help us get part of the way to a just transition. Having a clear idea of what the tools are is the first important step; our focus should then move on to using these tools to push even further toward our goals.

How prepared is Europe to support its labor force through a transition away from fossil fuels? Can continental Europe facilitate a just transition, given that many of the countries are so different? Has the advent of the European Union made action any easier toward a just transition?

WL: Our recent research shows that the European Union is taking this seriously and has a strong existing framework that’s predisposed to address a just transition. It has mechanisms already in place and in development to support a just transition among EU states. The mechanisms relate to things like economic development, workforce training, investment policy, and infrastructure policy.

EV: What we think of as a unified Europe is relatively new. The first versions of Europe were the European Coal and Steel Community, established after World War II, and the European Economic Community in 1957. This actually wasn’t that long ago.

Social cohesion is a principle held by the European Union—the idea that Europe, in order to develop, has to ensure that the gap between different countries does not become too big. The reasons for this cohesion principle are plain and historical: building a common market, along with an economy that can draw these countries together, would drastically reduce the likelihood of yet another bloody war among neighbors. Throughout European history, a lot of policies address exactly the same topics that we cover in our recent report—social safety nets, rural policy, and economic development—and the seeds for those policies were planted in the 1960s. Our report shows that Europe has been addressing the issues of cohesion and fairness for many decades. These instruments can be reshuffled and employed to support a just transition.

One of the goals of this research is to help policymakers understand that this is a hugely complex social policy issue, and if we want to make a meaningful difference in people’s lives, we need to appreciate that complexity.

And we noticed, when we started working on this report, that an important change was happening at the European level—the new president of the European Commission, Ursula von der Leyen, was elected. She ran on a platform that advocates a sustainable transition, specifically related to climate. She and others working on this issue examined the policies already in place in Europe, which are summarized in our report. They restructured the policies to fit under the umbrella of the just transition concept and to support the transition of Europe toward climate neutrality.

As we discuss in the report, the EU budget historically has been used to fund and strengthen economic growth in the European Union, with an eye toward promoting the balanced growth of member states, supporting the regions that lag behind, and assisting more vulnerable communities.

Take, for instance, the EU long-term budget that's negotiated every seven years—its Multiannual Financial Framework. In the period 2014–2020, a third of the budget supported cohesion policy (also known as regional policy), which provides access to money and programs, so different regions can improve their economic development. In the same period, another third of expenses went toward a policy that has supported EU farmers for decades—the common agricultural policy.

The European Union provides a legal and financial framework within which each country has considerable freedom in how to operationalize programs, apply funding, and prioritize projects. Many rules are established at the European level by member states using a consensus-based method; for instance, this is the case for labor rights.

But an important finding in our report is that, despite strong action at the EU level to support social and economic cohesion, European member states are heterogeneous in the actions they take at the local level: some do the bare minimum, and others go above and beyond. Wealthier countries, such as Germany, may be better positioned to address the needs of coal miners; others, like the newest member states of eastern or southern Europe, may have more difficulties. Ultimately, the effectiveness

of a program depends on the implementation of EU-level programs at the local scale of individual countries.

Can you describe some examples of unique constraints in Europe that will make a just transition less feasible? Where do we need to focus special attention, to help ensure that a just transition will be successful?

EV: The political aspect of these issues lags behind the economic development in many of these countries. For instance, miners traditionally have seen themselves as doing a service to their community and country by mining coal. But now, people are telling miners that not only is their job useless, it's also bad. And these miners are fighting back. This phenomenon goes beyond borders—it's cultural. Building a new mindset takes time.

One way to change the mindset faster is to act at a level that people may not necessarily think matters for a just transition. For instance, educational programs for younger kids are an excellent way to reform the state of mind in one generation. But people don't often think about that, because they think the problem is with the miners.

Another challenge is that it's often difficult to understand the costs of a fossil fuel-based society. We often talk about how much it's going to cost to "go green," but we never talk about how much it will cost to remain "black." There's less conversation about that, because it's very hard to quantify and hard to go against established business models. But fossil fuels are heavily subsidized, and furthermore, health costs are associated with local and global pollution. This is a challenge that Europe is trying to overcome by promoting engagement with stakeholders in the decisionmaking process and developing a vision for a climate-neutral society and economy.

Costs and financing are another big challenge, particularly in eastern and southern Europe. Money is tight for all countries; a transition requires moving money or finding new funds. One good thing that has come out of the terrible COVID pandemic is that Europe has tried to build recovery funds in a way that addresses some of these issues; for example, by earmarking funds for green projects.

“
The European Union provides a legal and financial framework within which each country has considerable freedom in how to operationalize programs, apply funding, and prioritize projects.
”

RIGHT European Commission President, Ursula von der Leyen, presents her vision to members of the European Parliament.

European Parliament



Another related challenge is administrative burden. Italy, for example, is a country that is known for having a million rules. Some of the rules go against one another, and it's not always easy to understand what you have to do to get rebates, access subsidies, and other things. The European Union provides some guidelines, but it cannot force countries to do anything. Streamlining administrative procedures is an important component of promoting a just transition.

Given these challenges, are any unique policy levers available in Europe which can effectively—or more effectively than elsewhere—support a just transition?

EV: I wouldn't say that any levers are unique to Europe, but rather that in Europe they perhaps play a unique role. In the European Union, all member states agree on the Multiannual Financial Framework, which sets the budget every seven years. The funding gets redistributed to member states based on established priorities. It's very unique that the EU budget redistributes funds from rich European regions and countries to poor European regions and countries. Perhaps this redistribution is one of the reasons why Europe has been able to push a bit more toward decarbonization.

Importantly, the EU budget renegotiation every seven years represents a longer cycle than is typical, providing arguably more stability and a more long-term perspective. This cycle is coupled with long-term climate commitments that now extend to the year 2050.

We've been coming at these topics from a Western perspective. If we think about the rest of the world, a lot of different policy tools are available. Is it possible to think about a unified global approach? Can our observations in the Western world inform global efforts?

WL: This is a global topic, and we have a lot to learn from each other as a global community.

We can draw at least two key takeaways from our recent work. First, the more we can help each other understand what kinds of creative solutions are available to meet the specific problems of a just transition, the better off we are. That said, we also need to recognize that what works in one country—or in one community—may not be appropriate nor effective in another. We highlighted this idea in our synthesis report on just transition in the United States, that there's no one-size-fits-all policy. Just transition solutions should be tailored for and co-designed by each community. ■



Elena Verdolini is a senior scientist at the RFF-CMCC European Institute on Economics and the Environment. **Wesley Look** is a senior research associate at Resources for the Future.

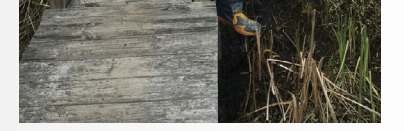
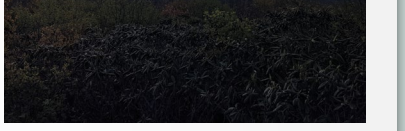


Celebrating Nature with #MyResources

In addition to their extensive economic benefits (which have been outlined in some of our scholarly research papers), outdoor spaces also provide physical and psychological perks.

Share in the fun of Resources for the Future staff and scholars who like getting out and about and have reflected on some of their favorite natural spots and national parks.

IMAGES Photos courtesy of the subjects.



→

“Most weekends for the past few years, my friends and I would squeeze into a car at 5 a.m., drive up while the sun was rising, and make it to an outlook in time for lunch. From the comradery brought on by weekend adventures, to the breathtaking granite peaks, there is nothing quite like a hike in the Whites.”

Sophie Pesek
Research Analyst

White Mountain National Forest

Yellowstone National Park

←

“In 2011, we took a two-week trip through Yellowstone and Grand Teton National Parks with our first kid, who was one year old. We loved the Tetons, but Yellowstone was such a treat. Between the colorful lakes and the cool thermal features, it was a totally magical place.”

Billy Pizer
VP for Research and Policy Engagement

The National Mall

Rock Creek Park

→

“Many of my formative memories involve hiking through the redwoods in northern California. This memory I am particularly fond of was captured during a pit stop on a road trip to Oregon. We went up the Pacific Coast Highway to see the 2017 solar eclipse, and then drove back down to move into my college apartment in Long Beach.”

Nicholas Roy
Research Analyst

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“I haven’t had the opportunity yet to go to that many national parks, but so far, Acadia in Maine is one of my favorites. I’m looking forward to my road trip out West this fall, where I’ll visit Arches, Bryce, Zion, the Grand Canyon, and other public lands. And maybe I’ll even see about staking a claim under the General Mining Act of 1872. (Mostly kidding about the last part.)”

Brian Prest
Fellow

Acadia National Park

↑

“I love that the DC area has so many great local parks. One of my personal favorites to visit with my dog is the National Mall. We frequently go for runs there to see the various monuments and memorials—and the cherry blossoms, of course!”

Sarah Tung
Marketing Specialist

↑

“We like Rock Creek Park because it’s easy to get to from the city, and there are always lots of dog friends to play with!”

Molly Robertson
Research Analyst

Redwood National Park

Grand Staircase-Escalante

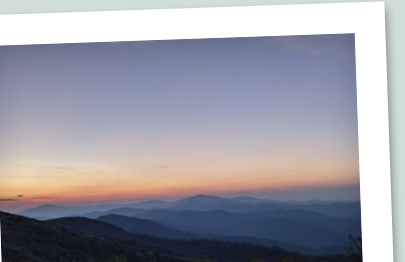
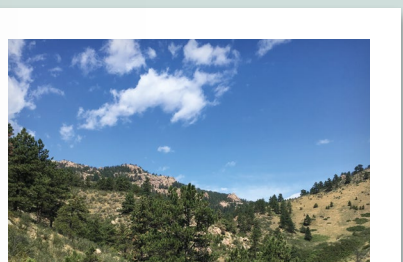
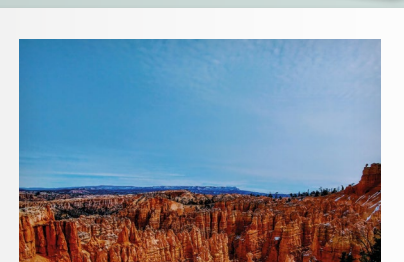
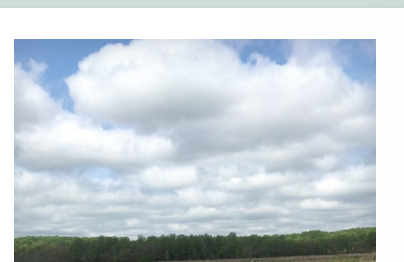
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“When I was doing work on national monuments, I visited several. Grand Staircase-Escalante is, of course, one of the most famous and controversial, —and truly spectacular.”

Margaret A. Walls
Senior Fellow

Want to see your adventures featured in Resources?

We’d love to share in your passion for the great outdoors! Send photos to wason@rff.org, and we may feature them in a future issue.



The History of the Civilian Conservation Corps

Neil Maher, a professor of history at the New Jersey Institute of Technology and Rutgers University–Newark, discusses the New Deal-era Civilian Conservation Corps and reflects on the program's relevance to contemporary environmental remediation efforts.





Resources Radio, a podcast launched in late 2018 and produced by the *Resources* editorial team and Resources for the Future, releases new episodes weekly with hosts Daniel Raimi and Kristin Hayes. Each episode features a special guest who talks about a new or interesting idea in environmental and energy policy.

Transcribed here is one such episode, in which Kristin Hayes talks with Neil Maher, a professor of history at the New Jersey Institute of Technology and Rutgers University–Newark. Maher explores the enduring legacy of the Civilian Conservation Corps, a 1930s New Deal program that employed more than three million American men in conservation jobs as the United States recovered from the Great Depression.

President Joe Biden has proposed devoting \$10 billion to form the Civilian Climate Corps, a similar program oriented around environmental justice and climate mitigation. While dozens of policymakers are on board with forming the Civilian Climate Corps, any contemporary program can learn from the successes and failures of the original corps that inspired it.

This interview was released on April 20, 2021. The transcript of the conversation has been edited for length and clarity.

Kristin Hayes: I'm really pleased to talk today about the Civilian Conservation Corps. My interest has grown since the advent of the pandemic and all the accompanying discussions about the ways in which the private sector and federal government might be able to put people back to work in this time of such terrible employment conditions.

What was the Civilian Conservation Corps (CCC)? What were its primary aims?

Neil Maher: It was a New Deal program that Franklin Roosevelt initiated during his first 100 days in office. In one of his early fireside chats, he said that we were not only facing an economic crisis; we were facing an environmental crisis, as well. He talked about deforestation and flooding, and he thought the CCC would be a way to solve both crises at the same time, while putting young men to work conserving natural resources.

And it was only men—is that right?

Yes, it was only men between the ages of 18 and 25. It functioned for nine years and did an incredible amount of work, but that issue of being all male is one of the blind spots that we can discuss more.

Yes, let's talk a little bit more about the demographics of the people involved. How many people worked through the program? What do we know about them?

Over three million young men went through the program. Their families had to be on relief rolls for the young men to qualify for the CCC, so their families were unemployed. It was 50-50 urban and rural men. And they were sent to 200-man camps that were stationed all over the country in forests and near agricultural lands and in parks. They lived there, and they traveled out into the woods to do their work.

Did they represent all races and levels of income? And it sounds like it was a pretty narrow age range: Can you say anything more about why they limited it to ages 18 to 25?

They didn't allow women to join; also, African Americans were put in segregated camps. Native Americans had a whole separate program that they were put in.

It wasn't exactly the most accessible or open program, but it did embrace a whole generation of working-class Americans, gave them employment when they didn't have jobs, and fed them. It helped their families, as well, because of the pay that these young men got, the majority of it—\$25 of the \$30-a-month paycheck—went home to their families.

How big was the set of people who were on public relief? Had they started off at various levels of income, only to find themselves on relief during the Depression?

It's hard to know. When the Depression hit, we reached a 25 percent unemployment rate; one in four Americans were unemployed. Many, many young men were unemployed. If anything, jobs were going to the breadwinners in families—the fathers. The CCC was a way to get the young men out of the house, get them off street corners, and give them jobs that would help their families and take some of the financial pressure off those families. It was working-class young men.

What did the jobs actually look like?

It began, primarily, as a tree-planting program, so the camps would plant trees in forests. They planted two billion trees, which was half the trees planted in US history up to that time.

In 1934, the Dust Bowl hit the Great Plains, and the corps expanded its work into soil conservation, conserving 40 million acres of land.

And then, in the late 1930s, it expanded again into park development work. The corps developed 800 new state parks from the ground up and basically improved every national park in the country. All told, they transformed an area that's larger than California—a massive amount of work.

That's a pretty significant legacy. Even just having that picture of the CCC's scale is impressive.

Roosevelt was very aware that a lot of people didn't know what the corps was doing. So, in the 1930s, they promoted it extensively all over the country: advertisements, news reels, magazine articles. They were very aware of the promotional efforts that were needed to get everyone on board.

Another thing I've been curious about is the training programs associated with the CCC. Were there training programs? If so, what did they look like?

Training was essential to the program. Roosevelt thought of the CCC as the conservation of two different resources—the natural resources out in the woods, on farms, and in parks, but also the human resources of these young men.

The corps argued and showed that it trained these young men while they were on the job. The young men would leave their camps and go into the forests and work with foresters, or they'd work on farms with agronomists, and they would learn about those sciences through their work.

When they came back to the camp, they could take classes after dinner. Many of those classes were vocational, like automotive classes or even learning how to type—a lot of literacy classes—but there were also classes in what were called the conservation sciences. Many of these young men, later on, went into conservation-related jobs. They were trained well.

I'm sitting here thinking, "Wow, what a marvelous program." Yet I am sure that there may be significant concerns about how it was designed or who was included. Let's talk about some of the downsides—at least looking back from the twenty-first century. What are some of the things that people criticize about the CCC?

When Roosevelt proposed it, the unions were quite alarmed because they felt that it would take work away from workers. Roosevelt then adjusted and tweaked the program in ways that would alleviate those concerns. He hired two unionists to run the program, which helped. Then, he made sure that the young men would do mostly manual labor, so it was supposed to not interfere with the more skilled labor of many of those union workers.

An African American congressman opposed the corps because it was segregated, so Roosevelt adjusted it, accounting for population percentages in each state. The program allowed African Americans to enroll according to those populations.

During the 1930s, people pushed back against the corps because of its work. In some instances, the corps undertook work that was ecologically unsound. We have to remember that the science of ecology back then was in its infancy.

Can you give some examples?

For instance, the reforestation program. They tended to plant single species of trees in straight rows. This method decreased biodiversity and made forests more prone to pest infestations and diseases.

Along the eastern seaboard, the CCC tried to control mosquitoes by draining swamps, which hurt migratory bird habitats.

To control soil, the CCC used a lot of invasive species to hold that soil—including kudzu, a Japanese invasive species that is now rampant all over the South. Kudzu also was a good fodder crop for cattle, so they thought it was the perfect solution to both hold the soil and feed cattle. But kudzu had no so-called "predators," so it obviously spread everywhere.

So, on the ecological front, there were some problems. But we have to put ourselves in the moment: in the 1930s, we weren't aware of a lot of those issues as fully as we are now.

It's funny that you mentioned those three examples, because I feel like those are three things that I can point to, from my twenty-first-century perspective, and say, "Even I, fairly removed from tree planting and kudzu, can see that's really bad." But you're absolutely right—I imagine that at the time, it seemed like a good idea.

Yes. But I also want to talk about the social and cultural missteps.

We've already mentioned the fact that it was all male. Again, African Americans were sent to segregated camps, and Native Americans were



IN CONVERSATION

Neil Maher and Kristin Hayes

ILLUSTRATION

Tom Clohosy Cole

“It began, primarily, as a tree-planting program, so the camps would plant trees in forests. They planted two billion trees, which was half the trees planted in US history up to that time.”





in a separate program. So, these social issues accompanied many of the ecological problems, creating a program that was incredibly successful through its work but also, if you look a bit deeper, had some drawbacks that I think are important to acknowledge, understand, and avoid in any future programs.

What was the perception of these jobs? Were they generally seen as desirable, or even prestigious? I don't know if you can answer that question for the entire population of three million people, since everyone's an individual, of course. But I'm curious what the historical record shows about that perception.

In the beginning, 1,500 of these camps were spread throughout the nation, all near local communities. At first, the local communities were incredibly upset because they thought the enrollees were young, urban boys—hoodlums—and these kids were coming into their towns and trying to dance with their daughters and those sorts of things.

But they soon realized that the federal dollars flowing through these camps and into these local communities were incredibly helpful and substantial. About \$5,000 a month per camp flowed to local businesses. So, as soon as that money kicked in, the locals kept an eye on their daughters but allowed the young men to come to town, and the locals supported the corps.

Public perception of the CCC was very positive. Without a doubt, it was the most popular New Deal program. There's a story I came across in my work, where a boy went home for a visit—when the young men went home, they wore their CCC uniform, which was this olive-green uniform with a tie. While this boy was home, his uniform was stolen.

Oh, it was *that* prestigious.

The thief wanted to wear it around town and pretend he was a CCC enrollee. I think that says a lot—the action of borrowing a friend's uniform to make yourself look a little better says a lot about it.

ABOVE A group of men plant trees for a Civilian Conservation Corps project on the Nett Lake Reservation in Minnesota.

MPI / Getty Images

“
A new corps could help communities adapt to climate change by building climate-resilient infrastructure, like restored wetlands or green stormwater systems.
 ”

Was that something the Roosevelt administration actively made happen—did it have a role in making these jobs seem prestigious? How did the CCC develop that reputation?

I think “prestigious” might not be the best word, because it wasn't considered a high-level job. It was more that people felt very positive about these young men working for the country, and the men were doing hard manual labor. They were transforming themselves physically, which Roosevelt and his administration were very public about. People felt good putting these young boys to work in American nature and making American men out of them.

That was part of this story—the young men who came in were often thought of as Polish Americans, Irish Americans, German Americans, and the corps promoted itself as a civic melting pot where, through work in nature, these young hybrid Americans became full-fledged Americans. That was popular at the time. It would be very unpopular today, I think.

There's a problem with that nice story: African Americans couldn't transform like that, nor could Native Americans, so it left some people out of the narrative.

How would you characterize the legacy of the CCC? Did it achieve the aims that we talked about at the outset of our discussion?

The legacy is twofold. First of all, the CCC left a legacy with the young men who went through the program. I've interviewed maybe a dozen of them, just to get their take on their experiences. The analogy I keep thinking of is that enrollment was like a college experience. These young men were working-class men; they were not going to college. But this was the first time they were able to leave their families, be independent, be in a group of peers. Many of them traveled far away, because the corps assigned these young men to camps that were distant from their homes, as the corps didn't want them to be able to walk home when they got homesick. So, many of these young men saw the country for the first time—boys from New York City who were traveling out west to the Rocky Mountains to do work. They think of it with nostalgia.

The other legacy, I think, is the physical landscape that's been left behind. Any state park you go into today, there's CCC trails, CCC visitors' centers, CCC campgrounds. National parks, the same thing. The whole Tennessee Valley is peppered with CCC work. Many of the agricultural fields we see today or rely on for our farms have been affected by that rethinking of soil conservation back in the 1930s.

We could approach a conversation about what the history of the CCC might mean today in many different ways. To give one bit of context, President Joe Biden has signaled interest in starting a Civilian Climate Corps as part of his wide-ranging commitment to tackling climate change. There have even been signals that he wants to model this, to some extent, on the CCC's successes and overcome some of its challenges. What lessons can the Biden administration keep in mind, given this tremendous history, as it seeks to design a new program for today?

First, I think they should hire a historian to help them do it, and they should call me up, and I would be happy to help them. But more seriously, I think there are maybe three or four ways to think about that.

The most obvious improvement would be to make it accessible to everyone, regardless of gender, age, and race. This is incredibly important, because women and minorities are experiencing higher levels of unemployment and economic insecurity right now than the population at large.

Second, I think the program would need to be more geographically equitable. In the 1930s, the camps were spread out all over the country, but they were in rural areas, such as forests, farmland, and parks. City people did not benefit from the conservation work; urbanites still had to deal with things like pollution, toxic waste, and limited access to outdoor parks. The corps could have helped with those urban issues, so I think a Biden program would need to place those camps in cities and suburbs—not just rural areas.

Third, I think the program would need to be more environmentally just. This would entail

identifying local problems, listening to and involving local people, and trying to address those local problems. For instance, I teach in the city of Newark, New Jersey—we could benefit enormously from a corps camp in the city of Newark to help us remediate toxic waste or build community gardens.

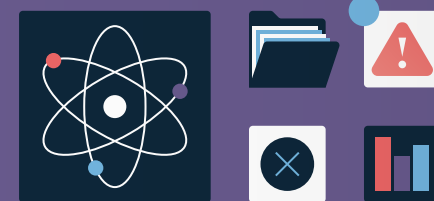
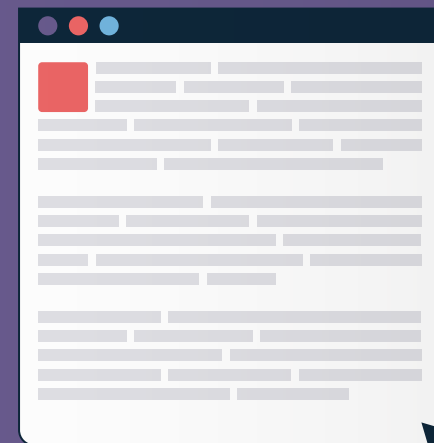
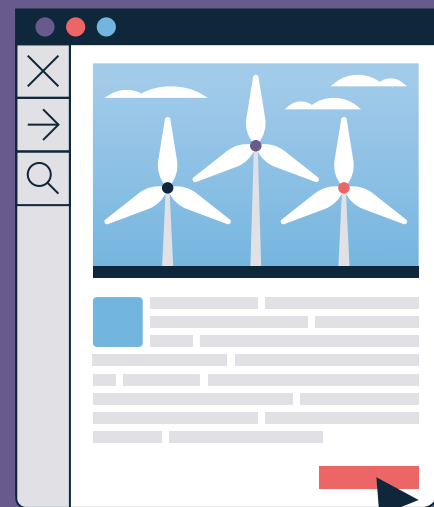
Finally, I think a new corps would need to focus on the most pressing problem today, which is climate change. This seems to be what President Biden is pushing. A new corps could help communities *adapt* to climate change by building climate-resilient infrastructure, like restored wetlands or green stormwater systems. It could also help *mitigate* climate change by developing solar and wind energy systems. All of this work could help train enrollees today in jobs in the green energy sector, just like the old CCC did for jobs in conservation fields.

A lot of what you've been mentioning, in describing the CCC, is the way that it bonded society together in some interesting ways. I wonder if you feel like that's possible today?

I feel it's possible, and I feel it's absolutely necessary. I feel strongly about that because I hear it from my students. They'd be excited to learn a new skill while feeling connected to the country, to a civic culture that I think is missing in our world right now. But I think it would have to be a bit different.

In the 1930s, there was this belief that that Americanization process was something very positive. Again, I teach in Newark, New Jersey. My campus was, at one point, the most diverse campus in the country. My students don't want to lose their identity and their culture, but they also long to feel more connected to a shared American culture. I think that, rather than it being an Americanization process, a program like this could allow people of any age to maintain their identity and the cultural connections that are so important to them, but still join together across cultural divides—to feel like they're working for a common good.

I think that's so important. We have not had that in a long time. ■



News and views from the RFF blog

Resources for the Future (RFF) releases *Resources* magazine three times a year—but for even more down-to-the-minute insights on current events about the environment, energy, and natural resources, the *Common Resources* blog has you covered. Some of our favorite recent blog posts are excerpted below. Read them in full at resources.org, and stay tuned for further coverage of landmark environmental laws and regulations, the potential of alternative fuels, the future of decarbonization, and more.

Equity and Economics in Transportation Policy

BY JOSHUA LINN

Prompting lockdown orders and deterring our freedom of motion, COVID-19 significantly altered when, where, and how we travel. Now, energy demand is picking up, vaccines are becoming more available, and plans are developing for the Biden administration to reshape the transportation sector in a clean energy future. As a result, further shifts in travel patterns are expected.

In a recent blog series, RFF Senior Fellow Joshua Linn considers the future of US transportation, reflecting on if transit systems can rebound from the pandemic, how policies can equitably boost electric vehicle use, and more.

Electric vehicles (EVs) and equity
 "Linking the [EV] subsidy to lower incomes would be consistent with President Joe Biden's goal of factoring equity into climate policy, and since

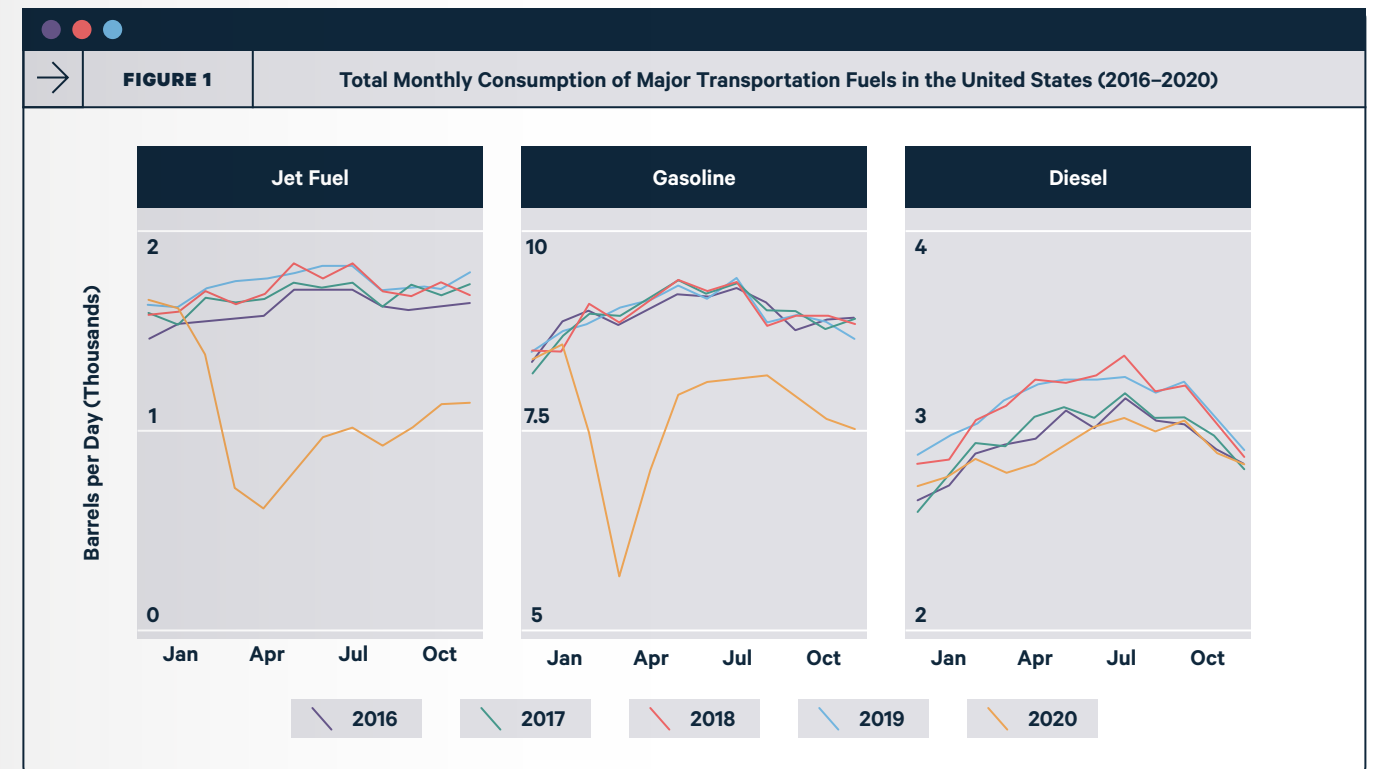
lower-income households are less likely than other households to buy plug-in vehicles, offering them larger subsidies could help boost the part of the market that's struggling the most."

Who benefits from EV subsidies
 "In the long term, subsidies can hasten the transition to EVs and substantially reduce greenhouse gas emissions. But the short term is a different story. As long as the [Zero Emission Vehicle] program is driving market shares in many states, tax credits aren't helping households directly—nor are they helping all households equitably—across much of the country."

Can public transit survive
 "The trends explored here contradict the notion that demand for public

transportation is experiencing a long-term decline. Instead, the robust long-term demand that we observe for buses and trains strengthens the case for helping these public transportation systems survive the current crisis and return to normal service levels over the next year."

Three approaches to investing in EV infrastructure
 "A lot of uncertainty exists about how future consumers will use charging stations, and investments are irreversible: once a station has been built, the costs can't be recovered by closing the station. Without telling us exactly how to proceed, economic theory makes clear that it's better to proceed slowly and gather more information to avoid wasting resources."



Science-Based Estimates for the Social Cost of Carbon Will Underpin Sound Climate Policy

BY RICHARD G. NEWELL AND MAUREEN L. CROPPER

On his first day in office, President Joe Biden signed an executive order that outlines plans for updating the federal government's estimate of the social cost of carbon (SCC). The order reconvened an interagency working group whose role is to periodically update the measure—a group that former President Donald Trump had disbanded—and tasked the group with arriving at an updated SCC by January 2022.

In a blog post published shortly after the executive order was signed, RFF President and CEO Richard G. Newell and Senior Fellow Maureen L. Cropper review key findings from

a National Academies of Sciences, Engineering, and Medicine report they co-chaired and elaborate on how the government can orient the process around established best practices.

“The [Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis] lays out the necessary actions to reestablish economic, scientific, and regulatory best practices and ensure that the social cost of carbon is grounded in transparency and applies the best possible science.”

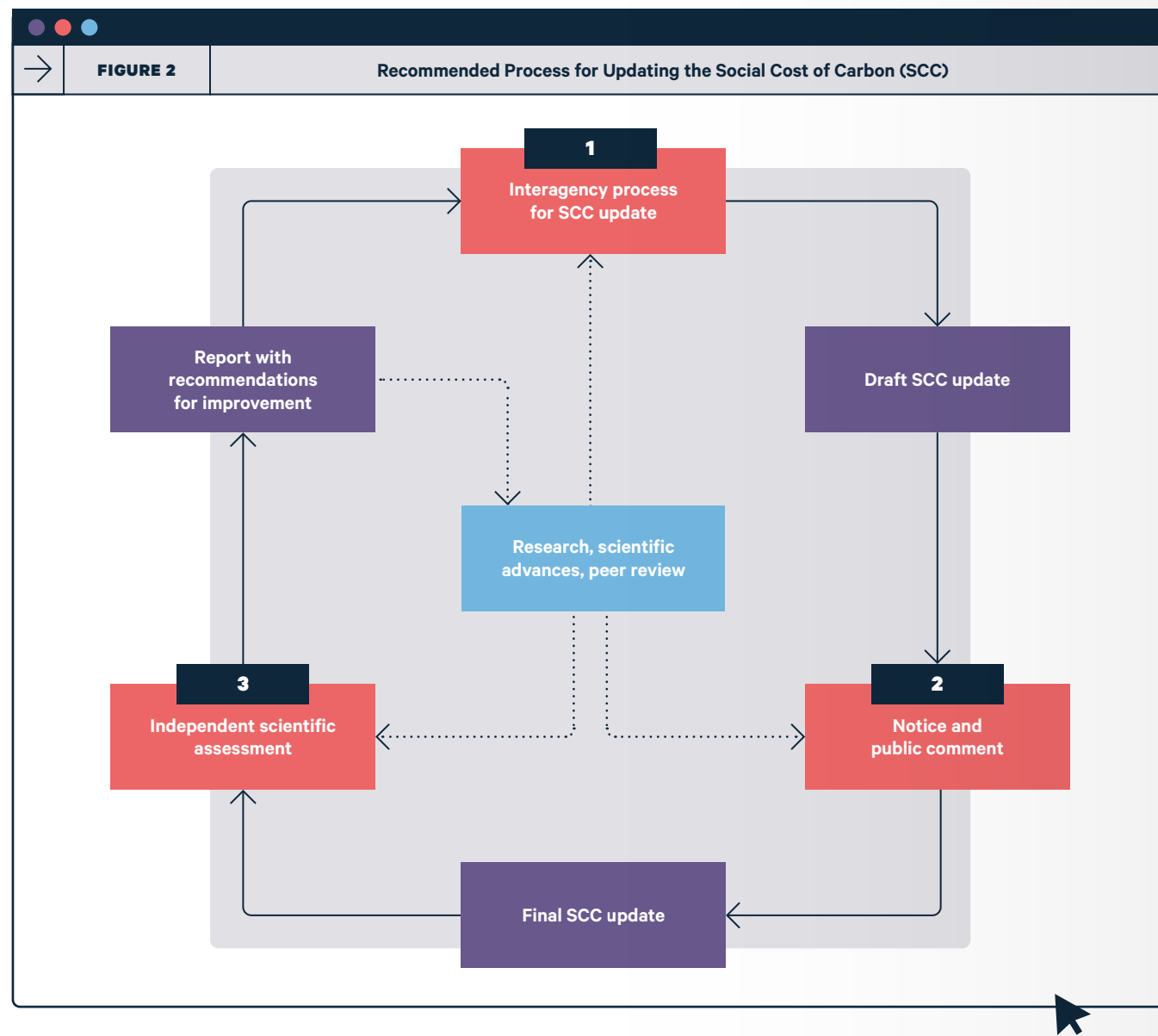


FIGURE 1 (PREVIOUS PAGE) Big dips in jet fuel and gasoline consumption coincided with the COVID-19 pandemic. But consumption of diesel fuel, which is used largely in commercial trucking, stayed consistent during lockdowns due to increased online shopping deliveries.

Source: US Energy Information Administration Monthly Energy Review

FIGURE 2 (LEFT) Ideally, the US federal government's approach to estimating the social cost of carbon will involve regular review by independent experts that follows a process like this one.

Source: National Academies of Sciences, Engineering, and Medicine

“Gas has roughly half the carbon intensity of coal, so if a plant's energy input went from 0 to 20 percent gas, its emissions rate would decrease by roughly 10 percent.”

Cofiring at Coal Plants: A Cautious but Effective Regulatory Approach to Power Sector Emissions

BY MAYA DOMESHEK

Under Section 111(d) of the Clean Air Act, the US Environmental Protection Agency (EPA) can determine the Best System of Emissions Reductions for an existing pollution source; subsequently, states must set performance standards for individual sources or groups of sources that comply. But administrations have interpreted their powers under the Clean Air Act differently, and the courts could look unfavorably upon far-reaching environmental regulations that draw authority from Section 111(d).

In a recent blog post, RFF Senior Research Analyst Maya Domeshek expands on an idea first introduced in a recent issue brief she coauthored with Senior Fellow Dallas Burtraw. The brief proposes that the Biden EPA use its power to implement a “cofiring standard”

that encourages coal plants to burn a higher percentage of natural gas, which has roughly half the carbon intensity of coal.

“Coal plants all over the country already burn natural gas, often as part of warming up the turbines of the generator, often for sustained periods of generation, and sometimes at the same time as coal. Gas has roughly half the carbon intensity of coal, so if a plant's energy input went from 0 to 20 percent gas, its emissions rate would decrease by roughly 10 percent. All it would take to adapt to such a cofiring standard would be for coal plants to make small investments that increase the capacity of their gas pipeline connections.”

Empowering American Landowners with Carbon Credits

BY ANN BARTUSKA

For years, private carbon markets have allowed farmers, ranchers, and foresters to benefit financially from employing climate-friendly practices, such as cover cropping and no-till farming. But the quality of these markets varies, and many landowners have struggled to find ways to participate. Enter the Growing Climate Solutions Act of 2021, which would authorize the US Department of Agriculture to establish a program to certify that private carbon markets meet certain standards and would create a one-stop shop of information for landowners about ways they can profit from reducing emissions.

RFF Consultant Ann Bartuska writes about the potential for the Growing Climate Solutions Act to reduce agricultural emissions in a blog post she published when the legislation passed the Senate.

“Farm owners manage their lands with the assumption of multigenerational ownership, which motivates them to adopt sustainable practices. One solution that can facilitate sustainable practices is to introduce voluntary programs for buying and selling carbon credits.”

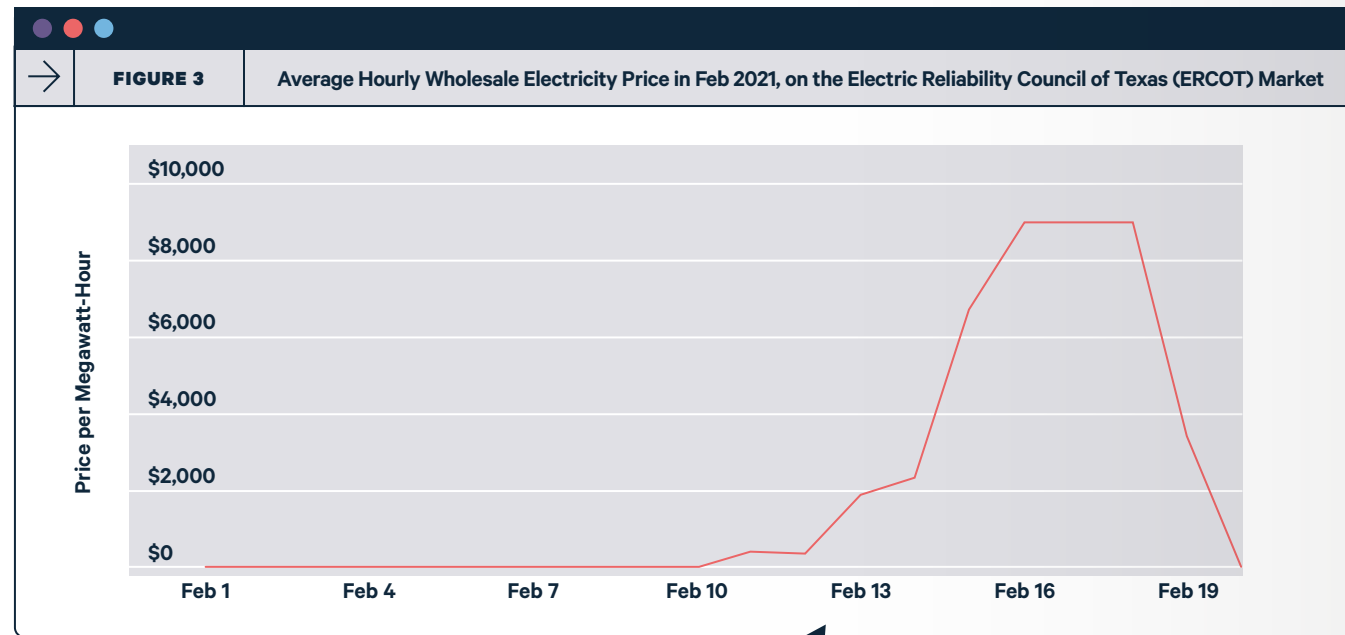


FIGURE 3 High demand and shortages in supply led wholesale electricity prices to skyrocket in Texas this year. Prices reached \$9,000 per megawatt-hour in February 2021; the average price in 2020 was about \$22 per megawatt-hour.

Source: ERCOT, via Wall Street Journal

MAR 2021

What Happened in Texas? Understanding the Blackouts and Drawing Lessons for the Power Grid

BY KAREN PALMER AND KATHRYNE CLEARY

An unusually intense winter storm hit Texas this February, prompting outages in millions of households, sending energy bills skyrocketing, and leading to dozens of deaths. The unique grid system in Texas likely exacerbated the crisis, but state and federal policymakers continue to grapple with what reforms are necessary to avert similar disasters in the future.

After the storm, RFF’s Kathryn Cleary and Karen Palmer provided insights in a Q&A on the blog, reflecting on the state’s isolation from interstate electrical grids, possible strategies for integrating renewables, and necessary preparations as climate change intensifies.

“For Texas, the prospect of greater interconnection with the rest of the US grid does raise the prospect of federal regulation—that’s what causes hesitancy in the state. But Texas already exports other forms of energy. With greater

connection to the US grid, the state could potentially export electricity.”

“Texas has been here before. Outages already have been associated with cold weather, both in 1989 and 2011. Both of those events resulted in some studies that recommended weatherization—and those recommendations were not adopted. Perhaps part of the reason for inaction has been due to the infrequency of these kinds of extreme weather events. What’s different now is that we recognize that the climate is changing.”

“The first step toward a solution is for grid operators to prioritize resilience and long-term planning for the future. Doing so requires understanding the potential sources of disruption and their associated risks, and enacting solutions that reduce those risks cost-effectively.”

“The unique grid system in Texas likely exacerbated the crisis, but state and federal policymakers continue to grapple with what reforms are necessary to avert similar disasters in the future.”

JAN-FEB 2021

The Potential of Hydrogen Fuel in Decarbonization Efforts

BY JAY BARTLETT AND ALAN KRUPNICK

Policymakers, researchers, and industry leaders have long been curious about hydrogen, which could potentially serve as a zero-emissions fuel. Lately, momentum has picked up. A bipartisan infrastructure bill that passed the Senate this August includes \$8 billion for boosting clean hydrogen and establishes four “regional clean hydrogen hubs” across the United States.

As costs decline and technologies develop, RFF’s Jay Bartlett and Alan Krupnick explore the potential for hydrogen in a recent series of blog posts. They focus in particular on green hydrogen, produced through water electrolysis using power from nuclear or renewable sources, and blue hydrogen, produced from natural gas and coal while capturing the carbon dioxide

emissions—and they reflect on the contexts in which decarbonized hydrogen could be most effective and cost-efficient.

“Reducing emissions in oil refining and ammonia production
“About 80 percent of dedicated hydrogen production is used as a feedstock in either oil refining or ammonia production. Reducing feedstock emissions in these two applications would considerably shrink the emissions footprint of hydrogen.”

“Evaluating zero-carbon “green” hydrogen against renewable and nuclear power
“The motivations for producing green hydrogen relate to three main advantages:

it can provide cheap long-term storage, be used in combustion heating, and serve as a zero-carbon feedstock for industrial processes.”

“The right policies can incentivize cleaner “blue” hydrogen
“We cannot predict which form of decarbonized hydrogen—whether green hydrogen, low-emissions blue hydrogen, or a different production method—would be the most efficient means of displacing gray hydrogen. Establishing incentives that require life-cycle greenhouse gas emissions reductions, but do not constrain technology options, thus is the most effective policy pathway.”

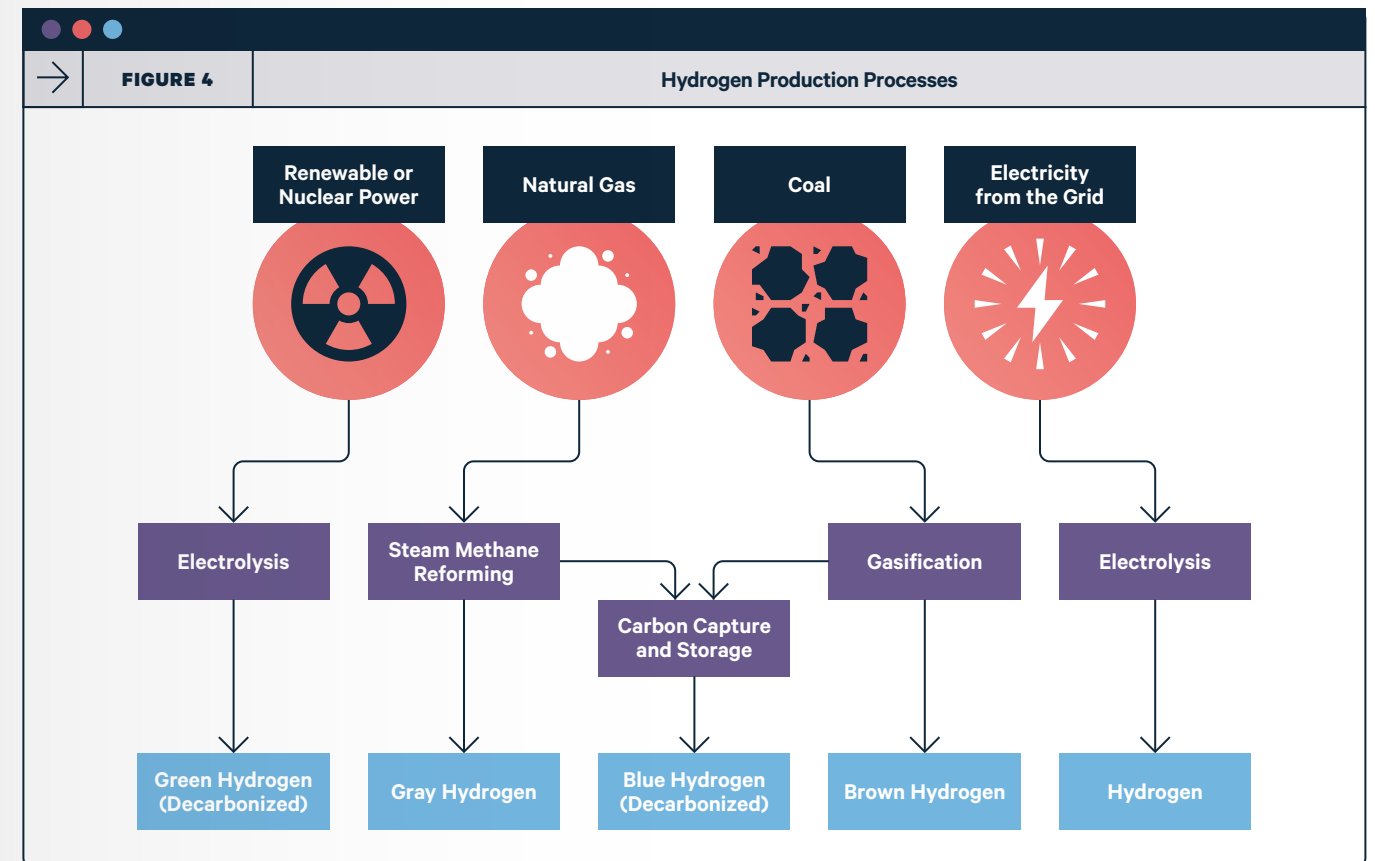


FIGURE 4

FIGURE 4 Hydrogen can be produced through various processes. The resulting carbon dioxide emissions vary depending on the method of production.



This summer, the Association of Environmental and Resource Economists—an international professional organization dedicated to ideas, research, and training in environmental and resource economics—awarded a fellowship to RFF Senior Fellow Dallas Burtraw. The fellowship recognizes Burtraw as having made significant contributions to advancing this field of economics. He joins nine other RFF-affiliated scholars who have received this distinction since 2005: Board of Directors Co-Vice Chair Robert N. Stavins; Board Member Catherine L. Kling; Senior Fellows Maureen L. Cropper, Alan Krupnick, and Karen Palmer; and University Fellows Lawrence H. Goulder, Charles Kolstad, William Schulze, and V. Kerry Smith. To acknowledge the new recognition, Burtraw shares some broad insights on the field as he’s observed it, the evolution of related research over the years, and how scholars might build on this research moving forward.

Six Themes in Environmental and Resource Economics

TEXT Dallas Burtraw

ILLUSTRATION James Round

My Resources for the Future (RFF) family and the Association of Environmental and Resource Economists as an institution provide the community without which my work wouldn’t be possible. In my years at RFF, I have seen our work together fall into six thematic contributions.

1 Encouraging Incentives

Investigating the potential efficiency of incentive-based approaches to environmental regulation—such as cap and trade, emissions prices, or tradable performance standards—and understanding that the benefits of these approaches could be enormous.

2 The Importance of Engaging with Other Disciplines

The early application of integrated assessment, working across disciplines. One perspective articulated by Lester Lave has been very influential for me: Scientific integrity means not only internal integrity within one’s discipline, with all the associated standards of rigor that apply—but also external integrity, to those outside one’s profession, such that one has the responsibility to say what can be concluded from the available data, even if the science is not yet settled, and even if it feels risky to do so.

3 Reducing Pollution Effectively

Integrated assessment provided economic support for the virtual elimination of sulfur dioxide emissions, which was the number one environmental public health threat of my generation. Economics played a big role in solving this problem through the adoption of cap and trade (what Rob Stavins called “the great experiment”), which accelerated progress on sulfur dioxide reductions. Nonetheless, further consideration of this big success leads to my next theme.

4 Bringing Economic Ideas to the Regulator

Our success in eradicating sulfur dioxide emissions wasn’t all due to cap and trade. Fully half of sulfur dioxide emissions reductions were driven by other regulatory authorities under the Clean Air Act.

Reductions in other air pollutants depended little on the formal pricing of pollution; instead, these other reductions relied primarily on various types of regulation. We can draw a lesson from our experience of the last century and apply that lesson to the most pressing environmental challenge of the next generation: climate change.

I would argue that, rather than thinking we can solve the climate crisis by giving shape to something like emissions pricing fully formed at birth, economics can have its biggest influence if we apply good economic ideas in diverse regulatory settings. By aiming for a sequence of policy successes through incremental improvements to regulations, we can achieve greater efficiency and stepwise environmental gains. We may expect these successes to enable the emergence of new technological options and new constituencies that, in turn, enable and support a broader application of economic ideas.

5 The Rise of Auctions

Acknowledging that economic value stems from scarcity, we have come to appreciate

that the formation of emissions markets creates substantial value. Economists of my generation inherited a conventional assumption: that the created value would accrue to incumbent firms, through the free allocation of tradable emissions allowances among entities that historically have been able to deposit pollution into the environment for free. We recognized striking implications for both efficiency and equity that made the conventional assumption obsolete, and we shattered the old idea. This change in thinking led to auctions playing a role in initially distributing emissions allowances.

6 Reforming Environmental Markets

The advent of auctions for initially distributing tradable allowances in emissions markets—as opposed to the free allocation of allowances—allows for features such as price floors and price steps that automatically adjust allowance supply in response to changes in allowance prices. These features enable both demand and supply of emissions allowances to respond to changes in prices, just like any other commodity market. Hence, environmental markets begin to embody a hybrid of emissions taxes and caps—which gets us closer to resolving the endless parlor room debate about which approach works better.

In a policy context, we recognize now that either the tax or cap-and-trade approach must be flexible in the face of fluctuations in technologies and costs; thus, the two approaches become quite similar. Further, either approach must enable and amplify the efficiency and achievements of direct regulations, rather than imagining their replacement. This incremental infusion of economic ideas into the regulatory framework enables a sequence of policy successes that can improve efficiency and lead to the environmental improvement that we aim for.

I like to think that these six ideas, considered thoughtfully together, can help us as economists help the world. ■

“

This incremental infusion of economic ideas into the regulatory framework enables a sequence of policy successes that can improve efficiency and lead to the environmental improvement that we aim for.

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Dallas Burtraw is the Darius Gaskins Senior Fellow at Resources for the Future.



NO. 208 | FALL 2021 | "Vulnerability is about the susceptibility of people, which is ... amplified by disasters."

Exposure: Environmental Justice Research, Policy, and Advocacy

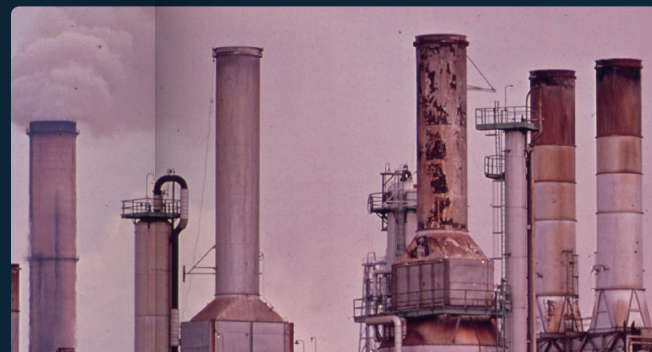
Several Resources for the Future (RFF) events this summer, in a webinar series about environmental justice, focused on the history of environmental justice and contemporary efforts to mitigate inequity. The series is a collaboration between RFF and the Urban Institute, a social and economic policy research nonprofit.

TEXT Margaret A. Walls



Environmental justice is an imperative that is finally getting its national policy due. For many low-income neighborhoods, households of color, tribal communities, and other marginalized groups, environmental injustice compounds a legacy of social, economic, and political disenfranchisement. Recent presidential executive orders, appointments, and proposed legislation acknowledge the disproportionate burdens of negative environmental conditions and exposures, and reduced access to environmental benefits and amenities, placed on these populations.

Since the groundbreaking publications *Toxic Wastes and Race in the United States* (1987) and *Dumping in Dixie* (1990) first brought environmental justice issues to the fore, scholars have supported activists and journalists by investigating the mechanisms that create and perpetuate environmental inequities and quantifying the extent of the problems. These combined efforts have led to improved monitoring and outcome tracking and some progress at addressing persistent pollution. But inequities persist—and as the United States reckons with the climate crisis, designing policies that benefit all communities will be crucial.



The images shown here are from the Documerica Project, a photography project run by the US Environmental Protection Agency in 1971–1977, for which the agency hired photographers across the United States to “pictorially document the environmental movement in America.”

National Archives and Records Administration





Some recommended readings from the series:

Toxic Wastes and Race in the United States report by the United Church of Christ Commission on Racial Justice

Dumping In Dixie: Race, Class, And Environmental Quality by Robert Bullard

From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement by Luke Cole and Sheila Foster

“Which Came First? Toxic Facilities, Minority Move-In, and Environmental Justice” by Manuel Pastor, Jim Sadd, and John Hipp

“The Rise of the Environmental Justice Paradigm” by Dorceta Taylor



Keep an eye on [rff.org](https://www.resourcesforthefuture.org) for updates about two more events in the *Exposure* series, which explores the intersections between environmental justice and research.

RFF hosts events regularly. If you missed one, it's not too late: visit [rff.org/events](https://www.resourcesforthefuture.org/events) for full recordings of past events.

This summer, Resources for the Future (RFF) and the Urban Institute hosted four events in a multipart webinar event series called *Exposure*, which explores the current state of environmental justice research across disciplines, examining how research can inform policy and identifying remaining gaps in knowledge. With panels of experts from research institutions and environmental justice advocacy communities, we've been diving deep into issues related to cumulative environmental impacts, environmental justice screening tools, energy equity and transitions, benefit-cost analysis and regulatory design, disaster and climate adaptation, and the design of climate policies. The event series asks: How can research, in partnership with environmental justice community engagement, inform better policy design and public investments to remedy inequities—past and present?

Lessons from History and a Look to the Future

Reflecting on the historical trajectory of environmental justice activism, event participants reviewed the history of empirical research that has informed legal recourse to date, policy change, and campaigns to raise the visibility of these issues.

The struggle continues: “When you control for income and race, race is the stronger predictor of exposure to environmental hazards and other harmful toxic exposures,” says Sheila Foster, a professor of law and public policy at Georgetown, where she's the Associate Dean for Equity and Inclusion.

“Economists have found evidence that minorities are being steered into less desirable neighborhoods,” says Lala Ma, an assistant professor of economics at the University of Kentucky. “People don't face the same choice sets.”

“We need to be taking a preventative or precautionary approach that takes in cumulative impacts,” University of Southern California Professor Manuel Pastor says, acknowledging the struggle and pointing to constructive opportunities. “Many bad ideas become policy.

Many good ideas, like recognizing that climate change is real—they don't happen unless political coalitions make them happen.”

Energy Equity and Transitions

This panel discussion covered energy justice, energy poverty, green jobs, and communities that will confront unique challenges during the clean energy transition. Environmental justice applies to both the business and consumer ends of the energy system: communities dominated by fossil fuel workers and the individuals burdened by inequities in household energy services.

For instance, energy poverty—the lack of access to reliable and affordable energy sources—occurs across the country. “We're living in the United States of energy insecurity,” says Tony Reames, an assistant professor at the University of Michigan who is currently serving as a senior advisor to the US Department of Energy's Office of Economic Impact and Diversity. “One in three US households faces some kind of energy insecurity; one in five US households faces the eat-or-heat trade-off.”

University of Michigan Associate Professor Catherine Hausman points out that the federal response to energy disparities to date has fallen short, including efforts like the Low Income Home Energy Assistance Program and the Weatherization Assistance Program. “They've been hard for people to access and offer less energy savings than predicted,” she says.

Pilar Thomas has watched energy poverty playing out among Native Americans. “If just giving money to people were going to solve the problem, then the past practice of subsidies would have solved the problem,” Thomas says. “How do we get communities positioned to take advantage of where this stuff is going?”

Chandra Farley, a director at the Partnership for Southern Equity, thinks about the future: “No matter what the transition is, we need to understand up front that disproportionate negative impacts will fall to those who are already marginalized,” she says. “We need to not just mitigate impacts but also transform systems.”

Climate Impacts, Adaptation, and Resilience

Who stands to win—or lose—as a result of climate change? Panelists at the event reviewed what we know about research on the impact of natural disasters on communities, grassroots advocacy, and related policy challenges and solutions. The impacts of temperature increases, sea level rise, and extreme weather events often hit low-income neighborhoods and communities of color particularly hard. Government policies can exacerbate these problems, because investments in hazard mitigation and the disbursement of disaster aid often disproportionately benefit wealthier households and neighborhoods.

Eric Tate, an associate professor at the University of Iowa, clarifies: “Vulnerability is about the susceptibility of people, which is revealed and amplified by disasters.”

“Loans are typically the first line of defense for disaster victims in the United States, but research has shown that over half of applicants to our disaster loan program are denied because they don't meet debt-to-income or credit score requirements,” says Carolyn Kousky, a flood insurance expert, university fellow at RFF, and executive director of the Wharton Risk Center at the University of Pennsylvania. “With climate change worsening extreme impacts, we really need to prioritize our investments in risk reduction, so we can protect people ahead of time.”

“Long term, we want to see low-income households be equipped to deal with extreme heat [and other disasters] in a more sustainable way,” adds Sonal Jessel, the Director of Policy at WE ACT for Environmental Justice, “and in a way that's not contributing to the climate crisis at the same time.”

Despite much that's discouraging, we can find reason for optimism—and avenues for our efforts. “I think that an entire revolution needs to happen in engineering,” says Earthea Nance, an associate professor at Texas Southern University and certified floodplain manager who was trained as an engineer. “If anybody's going to start the revolution, I will sign up

and help. If we don't make changes, things like environmental justice and equity are going to remain peripheral issues, and the disparities that we see are likely to perpetuate.”

Infrastructure Investments and Equitable Benefit-Cost Analysis

The federal government applies benefit-cost analysis and related economic decision tools to determine which people, projects, and locations receive funds that facilitate improvements to infrastructure. Decisions made with these tools can be helpful when it comes to allocating scarce resources for investments in hazard mitigation, climate adaptation, and water infrastructure. But because property values play a major role in the calculation of benefits, the tools can lead to inequitable outcomes.

“There's a whole legacy of [flood control] programs,” says RFF Senior Fellow Leonard Shabman. “Those projects are 50 to 60 years old in many cases, in need of repair, and often in low-income and disadvantaged communities that can't afford repair and rehabilitation.”

But it's possible to incorporate good financial decisionmaking at all levels of government. “We need to think more innovatively about the benefits and costs of projects, learning from the global private sector,” says Carlos Martín, a fellow at the Brookings Institution. “To advance equity and secure community buy-in, we need to ensure that even benefit-cost analysis itself is subject to discussion.”

Amy Chester of Rebuild by Design likewise sees all kinds of reform as fair game. “Until we make the decision that we want to transform the way we build and choose projects and elect our representatives,” Chester says, “we're going to keep doing these piecemeal things like adding an agency or tinkering with existing community benefit agreements.”

Chrishelle Palay, director of the Houston Organizing Movement for Equity (HOME) Coalition, says, “I see the value of fundamentally changing how the federal government has prioritized property over people and planet.” ■



Many good ideas, like recognizing that climate change is real—they don't happen unless political coalitions make them happen.



Margaret A. Walls is a senior fellow at Resources for the Future.

Trends and Solutions in Wildfire Management

After a centuries-long history of intentionally suppressing wildfires in the United States, particularly in the western part of the country, land managers now are recognizing that new strategies of coexisting with fires may be necessary—and more realistic.

TEXT Matthew Wibbenmeyer

Big, destructive wildfires used to be rare enough that they were remembered for decades. But over the past several years, apocalyptic images from wildfires have become a mainstay on the news in the late summer and fall: “firenado” of 100-mph-plus wind and flame, neighborhoods reduced to ashes in minutes, and eerie orange skies above scorched earth.

Thanks to the combination of fire suppression, climate change, and an increasing number of ignition sources, wildfire activity throughout the western United States has climbed steadily over the past several decades, outpacing our ability to contain it. From the 1970s to the 2010s, areas burned in large forest fires have increased by more than 1,200 percent. The

giant, ferocious fires of the past several years continue the trend.

The Tunnel Fire—which in 1991 destroyed nearly 3,000 structures in Oakland—had held the record as the most destructive fire in California history for decades. But in 2017, a series of fires erupted in California’s wine country, with the Tubbs Fire breaking that earlier record in terms of structures destroyed. The same year, the Thomas Fire in Ventura and Santa Barbara Counties consumed some 280,000 acres—at that time, the largest fire in state history. Shortly thereafter, in 2018, the Camp Fire in northern California destroyed more than 18,000 structures and killed 85 people, leveling the town of Paradise. Wildfires engulfing thousands of homes now are a regular

occurrence: in 2020, four fires in California reached that level of destruction.

California, the hardest hit state, has repeatedly broken its own wildfire records. But the explosion of wildfire activity has not been confined to the Golden State. The three largest fires in Colorado history occurred in 2020. Similarly, western Oregon suffered wildfires without precedent in size and ferocity; 600,000 acres burned west of the Cascade Crest in 2020—approximately 10 times the annual number of acres burned historically in that region from 1984 to 2018.

As heavy as property losses have been, damage to structures is not the only impact—nor the most significant—associated with wildfires.

For several weeks during the fall of 2020, as wildfires raged from the city of Los Angeles to the state of Washington, smoke blanketed much of the West Coast. Air quality ranked as the worst in the world, temporarily displacing a dozen Asian cities, with Air Quality Index numbers in Portland topping 500. (For reference, numbers above 150 are considered dangerous, even for healthy people.) And the smoke did not stay on the West Coast; it spread east across the country, with haze visible in New York. Wildfire smoke in 2021 isn't looking much better. While Air Quality Index numbers have been more moderate thus far in major cities, the total population affected by wildfire smoke (based on daily population numbers situated within smoke plumes) as of this summer exceeded the same metric for the summer of 2020—which had been the worst of the past 15 years.

Wildfire smoke is made up of gases and fine particulate matter (also known as soot), which can be hazardous to health, especially for older people and children. Exposure to fine particulate matter—known as PM_{2.5}, because the particles are smaller than 2.5 micrometers in diameter—is linked to lung and heart problems. Even short-term exposure to dense PM_{2.5} pollution can lead to increased risk of serious illness. One study estimates that wildfire smoke results in about 500 additional deaths among elderly Americans each year. Severe smoke also can disrupt business, as people seek shelter indoors from the harmful impacts of smoke. While PM_{2.5} pollution has declined nationally in recent decades, the western United States has seen an increase, with as much as half the region's PM_{2.5} pollution now coming from wildfires.

Wildfires also disrupt energy systems in the western United States. Several of California's most destructive fires, including the Camp Fire, were ignited by power lines owned by Pacific Gas & Electric, the utility that distributes electricity to much of the northern part of the state. Since the Camp Fire, Pacific Gas & Electric has on several occasions responded to hot, dry wind conditions by shutting off power to hundreds of thousands of households and businesses rather than risk a repeat incident. Southern California Edison, which serves much of the southern part of the state, also has been taking no chances; for example, the

company has shut down portions of its system when high winds are expected.

Given the scale of damages in an incident like the Camp Fire, these power shutdowns—known as Public Safety Power Shutoffs—may be prudent when fire danger is very high. Nonetheless, these shutoffs are extremely costly. When power is shut off, businesses and schools are forced to close, households and grocery stores can lose perishable frozen foods, and vulnerable people may lose the power they need to run medical devices. Michael Wara of the Stanford Woods Institute for the Environment estimates that a shutoff event in October 2019 cost California's economy as much as \$2.5 billion. Power supply shutoffs have to this point primarily been a California phenomenon; but in September 2020, Portland General Electric cut power to more than 5,000 Oregonians due to weather conditions that carried the threat of wildfire.

Why More Fires?

The outbreak of western wildfires is hardly just bad luck. It's a result of our decreasing ability to prevent or control fires as several trends conspire to worsen fire conditions.

Wildfires are a natural part of many ecosystems in the western United States, which count on burns to renew the land and maintain species diversity. Historically, large amounts of land were burned every year, in part because Indigenous people used fires to maintain the landscape for productive purposes, and which to some degree accounts for the low level of wildfires over the last century.

Throughout much of the last century, federal and state land management agencies viewed wildfire as an adversary and sought to suppress fires entirely. The US Forest Service, in particular, regarded wildfire as a threat to timber harvests. In 1935, the Forest Service established the "10 AM" policy, which set the goal of extinguishing all fires by 10:00 on the morning after each fire was discovered. As the twentieth century progressed, ecologists learned more about the role of fires in healthy ecosystems, leading to changes in attitude—and policy—toward fire within management

IMAGE (PREVIOUS PAGE)
A forest fire rages along the side of a mountain in Montana.

Getty Images

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agencies. However, ending the “war on fire” has been neither easy nor immediate.

In dry forests of the western United States—like the ponderosa pine forests of the Sierras, the northern Rockies, and the east side of the Cascades—fires historically maintained ecological diversity across the landscape. Low-intensity, spontaneous fires kept the undergrowth relatively open and sustained forests that contained tall, old pines. Occasionally, more intense fires would create patches where new growth could compete with older trees for sunlight. The diverse landscape, itself a product of fires, served to regulate the threat, providing natural breaks in vegetation that could halt the spread of fires and prevent large, high-intensity fires from becoming the norm.

But, lacking periodic fires, the landscape eventually became more homogeneous. Park-like forests gave way to understories of dense vegetation, which more often carried fires high up into the forest canopy, turning low-intensity ground fires into much more dangerous crown fires. As the climate has warmed, opportunities for this kind of dangerous fire have become more frequent. Climate change has caused dry vegetation to predominate for larger portions of the year—in part because snowmelt occurs earlier—creating more opportunity for fires. In the chaparral shrublands of southern California, fire season has begun stretching into the fall, when warm Santa Ana and Diablo winds blow in from the desert, during which even a minor ignition potentially becomes a fast-spreading conflagration.

Climate change has increased fire activity even in wet parts of the Pacific Northwest. The western slope of the Cascade Range in Oregon and Washington historically was too wet to sustain wildfires. There, forests dense with fuel have been the norm, rather than sparse understories, due to a legacy of fire exclusion. But whereas the dampness of these fuel-laden forests historically minimized any fire risk, the events of last September showed that, under climate change, these forests are now potentially dangerous vectors of fire.

As we continue to better understand the underlying causes of increased wildfires, we can design better strategies for containing

and minimizing the damage. The devastating consequences in recent years are, of course, one more reason to address climate change aggressively—among a long list of reasons. But the history of wildfires in the United States makes it clear that we've been mistaken in our historic aims to suppress fires entirely, and natural burns are healthy for the ecology of the region. Therefore, we need strategies to help us coexist more safely with fires.

Moving Forward with Forest Management

Ironically, suppressing wildfires in western US forests has led to the accumulation of flammable brush and young trees in forest understories that historically lacked tinder and had more open space. Forest managers can reduce fire risk by thinning this brush and vegetation on the forest floor, thereby minimizing the fuels that feed wildfires. This type of “fuel treatment” frequently happens through mechanical thinning projects, in which small trees or other fuels are physically removed from the forest, or through controlled burns, in which fires intentionally are set during favorable conditions to burn away the fuels from the forest floor. Removing understory vegetation in these forests reduces opportunities for low-intensity ground fires to become high-intensity crown fires, which are significantly more destructive and difficult to contain.

Fuel treatments also may reduce the negative health impacts of smoke. While controlled burns themselves emit smoke, their use can be limited to times when the emissions will not push pollution to dangerous levels and when wind is unlikely to blow smoke toward population centers. By tolerating low levels of smoke from controlled burns, we may be able to avoid the severe fire and smoke events that seriously damage health.

So, why haven't fuel treatments solved the fire problem? A major reason is funding. Fuel treatments can be expensive, especially because pricier mechanical thinning often is needed to reduce excessive fuels before the less expensive controlled burns can be implemented safely. Another major reason is the backlog: A huge amount of land needs



IMAGE A firefighting aircraft drops fire retardant on the landscape in California.

Getty Images

fuel treatments. According to the US Forest Service, up to 80 million of the agency's nearly 200 million acres of land need forest restoration such as fuel treatments. Even spending about \$350 million per year on fuel treatments, the Forest Service reaches just 1.4 million acres per year.

Fuel treatments also are subject to significant political pushback. Controlled burns do produce smoke and sometimes can be viewed as risky due to their potential for escaping the planned boundaries. Mechanical thinning projects are seen by some as logging under a different name.

Notably, the effectiveness of fuel treatments in reducing fire risk differs from place to place. In the chaparral of southern California, a recent increase in fire activity has resulted from climate change and an increase in the number of ignition sources (e.g., campers, power lines) rather than an increase in fuels.

In such places, broadscale reintroduction of managed fires is not needed. Instead, those areas—and elsewhere in the western United States—need strategies for humans to coexist with the increased threat of wildfires under climate change.

Living with Fire

Regardless of our contemporary efforts, the United States is unlikely to return to the low-wildfire environment of the last century—in large part due to the combined factors of climate change and the ecological history of fires. Forest and land management can make a difference, but communities in high-risk areas also need to prioritize strategies for adapting to new realities.

Gilbert White, a twentieth-century American geographer who conducted early research on managing flood risk in floodplains, wrote that

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Given the realities of climate change and the sprawl of housing in dangerous areas, the risk of major wildfires is not going to evaporate. One way or another, people need to adapt.

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“floods are acts of God, but flood losses are largely acts of man.” Similarly, the risk that wildfires pose to private property depends in large part on where and how homes are built.

Between 1990 and 2010, the number of homes in wildland-urban interface areas grew by 40 percent across the United States. By 2050, California is expected to add about 600,000 homes in high-hazard areas. Not only will more homes be at risk in wildfire-prone areas, but the demands on fire management will grow disproportionately as a consequence: firefighters must work harder to defend homes and lives.

The most obvious fix is for communities to limit exposure by discouraging development in fire-prone areas—and encouraging development in lower-risk areas. Siting new houses out of harm's way serves a long-term solution by displacing high-risk development. After all, buildings don't move; new homes in high-hazard areas create risk that we then live with indefinitely.

But this solution is more easily said than done. Most cities on the West Coast have faced shortages of affordable housing in recent years, as jobs and amenities pulling new residents to these cities have not met with increased housing construction. As a result, development often gets pushed to outlying areas, where land is cheaper but fire hazards are greater. By allowing or encouraging increased density in low-hazard areas, we might see a decrease in the rate of construction in high-hazard areas.

Location isn't everything, though. Communities can limit exposure to fire risk by requiring buildings to meet fire-resistant standards and making sure that owners maintain their properties to minimize fire risk. Building materials—such as fire-safe shingles, fire-safe tiles, and fire-resistant siding—can reduce risk of loss. Moreover, most structural losses in fires are due to embers that ignite a home or nearby vegetation: homeowners can reduce risk of damage by keeping roofs and gutters clean and by keeping areas near their home free of vegetation.

One way communities can ensure fire-safe buildings is through building codes. California is a leader in this regard. In 2008, the state required new homes built in high-

hazard areas to meet stringent fire-safe specifications. These efforts already have made a difference. Data collected by CAL FIRE, the state's fire management agency, indicate that within the area burned by the 2018 Camp Fire, 52 percent of homes built in high-hazard areas after 2008 were damaged or destroyed, compared to almost 80 percent of homes built before 2008.

Adapting to wildfires will require more than just reducing risk to homes; the past several years have demonstrated that fires present a variety of risks. As wildfire activity continues to rise across the western United States, smoke will become an increasing health threat. Accelerating work to restore woodlands and reduce fuels in US forests could help. However, smoke is likely to remain a serious concern in the near term. Communities can prepare by investing in air filtration systems in public buildings and schools. State and federal governments can help families purchase household air filtration systems in heavily affected areas by providing financial assistance.

Significant work can be done by the electricity sector to adapt to the threat of wildfires. According to the courts, utilities may be held liable if their electrical equipment ignites a fire. These utilities need to invest significantly in equipment and vegetation maintenance to reduce the potential for dangerous ignitions. In the meantime, utilities can avoid large-scale, disruptive shutoffs by helping create largely self-sufficient “microgrids” that allow more targeted power shutoffs in the highest-risk locations.

Given the realities of climate change and the sprawl of housing in dangerous areas, the risk of major wildfires is not going to evaporate. One way or another, people need to adapt.

No single strategy will work. Virtually all the changes we need will be costly, and some of them may be a tough sell to developers and communities. But the alternative to decisive action is predictable outcomes: more fires; more property destruction; and more damage to human health, both direct and indirect. A rational fire management policy may be expensive—but it's much more affordable than business as usual. ■



Matthew Wibbenmeyer is a fellow at Resources for the Future. A version of this article was published in the second quarter 2021 issue of the Milken Institute Review.

Creating Crucial Connections to the Environment

Resources magazine recently spoke with Vicky Bailey, a former commissioner with the Federal Energy Regulatory Commission (FERC), assistant secretary at the Department of Energy, and corporate executive in the energy sector. She's currently a Resources for the Future (RFF) board member, having been a friend and supporter of RFF for more than twenty years after meeting then-RFF President Paul Portney at an energy forum. Below are excerpts from the conversation, which touched on the importance of fact-based information, Bailey's childhood influences, and more.

Resources magazine: Why are you interested in improving environmental policy and decisionmaking, and how are your efforts currently focused toward that end?

Vicky Bailey: Growing up in Indiana, I was involved in 4-H—where you get to hang around animals and learn about agriculture—and in Girl Scouts. I had the opportunity to experience the outdoors and learned to respect and appreciate the environment. In addition, my experience as a regulator and policymaker has impressed upon me the role of public opinion and perception in decisionmaking. It's important that people understand the "Why should I care?" They need to understand why they should be involved and make sure that they have access to facts. It's not easy, but RFF has a role to play in that.

From your perspective, why should people care about environmental and natural resource issues?

From the crops we grow to the air we breathe, all of it is interrelated. One of my mentors and dear friends, the late Senator Richard Lugar, was a farmer. He would talk about how crops are affected by the environment, and he recognized that being good stewards of our environment is important. We have a lot of natural resources, and we have ways to use them responsibly and not ignore our impacts on the environment. Each of us has a part in being good stewards of our environment.

What continues to keep you engaged throughout your many years of involvement with RFF?



Supporter Spotlight

In RFF's Supporter Spotlight, we hear directly from donors about their commitment to issues in climate, energy, and the environment; how they make a difference; and why they support Resources for the Future—all in their own words.

“We have a lot of natural resources, and we have ways to use them responsibly and not ignore our impacts on the environment. Each of us has a part in being good stewards of our environment.”



ABOVE Vicky Bailey with her mentor and friend, Richard Lugar (R-IN), who represented Indiana as a senator for 36 years.

Courtesy of Vicky Bailey

I think the policy engagement and economic research that RFF does so well are important now and will be in the future. I've had the opportunity to see the building blocks of decisionmaking and recognize that the path to decisionmaking is not certain: that's when RFF's critical thinking and analysis is even more helpful. I see RFF informing the process by which environmental decisionmaking gets done and providing the tools for sound policy. That's what keeps me engaged and intellectually stimulated at RFF.

Given your experience in many different professional roles, how do you see the value of the independent research and analysis that RFF provides?

In my different roles, we've talked about the three e's—energy, environment, and economy—and the nexus and balance

among them. I see the value of RFF's independent research in encouraging balanced decisionmaking. It's important that decisionmakers have access to information that is fact based and independent, done by highly capable and committed individuals. That has been important to me through the years—as a FERC commissioner, assistant secretary, and corporate executive.

Finally, what makes RFF special? What do you think sets RFF apart from other organizations?

You're no stronger than the people that work in your organization, and I think the level of intellectual rigor at RFF is incredible. I have a great deal of respect for that. RFF also has a strong adherence to independence. We recognize that we can't afford to let that independence erode. That's the only way we can get in front of a congressional committee or a company and say, "This is what the facts tell us, and what our research and analysis tell us." RFF holds on to that strongly, and I think people value it. ■

Four Ways You Can Support RFF



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3 Give through a donor-advised fund

Donate through a DAF account at a community foundation or financial institution to support RFF while receiving favorable tax benefits.



4 Give through a will, trust, or gift plan

Include RFF in your estate plans to provide meaningful, long-lasting support.

Discover other ways to give at www.rff.org/donate/ways-giving or contact Tommy Wrenn at twrenn@rff.org



What's at the Top of Your Stack?

A recurring segment on *Resources Radio* is “Top of the Stack,” when podcast hosts Daniel Raimi and Kristin Hayes ask each guest what is on the top of their literal or metaphorical reading stack. If changing circumstances feel hard to handle, these recommended readings may provide a new and helpful perspective.

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We need to start thinking about the environment that's all around us, and connected to us, and connects us with other people who might not be the same as us.

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“This book is making the argument that environmentalists need to stop talking about an environment that is ‘out there’ and separate from us, like wilderness. We need to start thinking about the environment that's all around us, and connected to us, and connects us with other people who might not be the same as us.”

Neil Maher
Professor, New Jersey Institute of Technology and Rutgers University-Newark

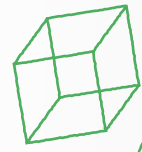
Stop Saving the Planet!: An Environmentalist's Manifesto by Jenny Price



The Bicycling Big Book of Cycling for Beginners by Tori Bortman

“I bought a bike just after the pandemic shutdown, in March last year. Riding it through the fall and winter, I've discovered that it needs maintenance. I'm learning how to properly take care of my bike, so I can stay fit and stay mentally vigorous in the middle of the pandemic.”

David Miller
Former Mayor of Toronto



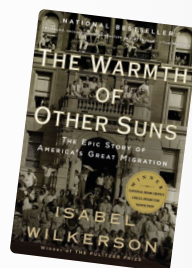
The Box: How the Shipping Container Made the World Smaller by Marc Levinson

“It sounds like an incredibly boring topic: containerized cargo. But, wow—when you read it, you realize how the innovation of containerized shipping completely changed trade and the world economy. I was blown away by the depth of importance of this one innovation—certainly nothing like getting a vaccine in 10 months, but a pretty basic idea that completely changed the world economy.”

Severin Borenstein
Professor, University of California, Berkeley, and the Energy Institute at Haas

“Reading about people moving from the South during the Great Migration ties into this idea of what housing people are consuming and what happens when jobs shift and transition. It provides good historical context for where and how people live, which can impact all types of things related to environmental justice, energy justice, and climate change.”

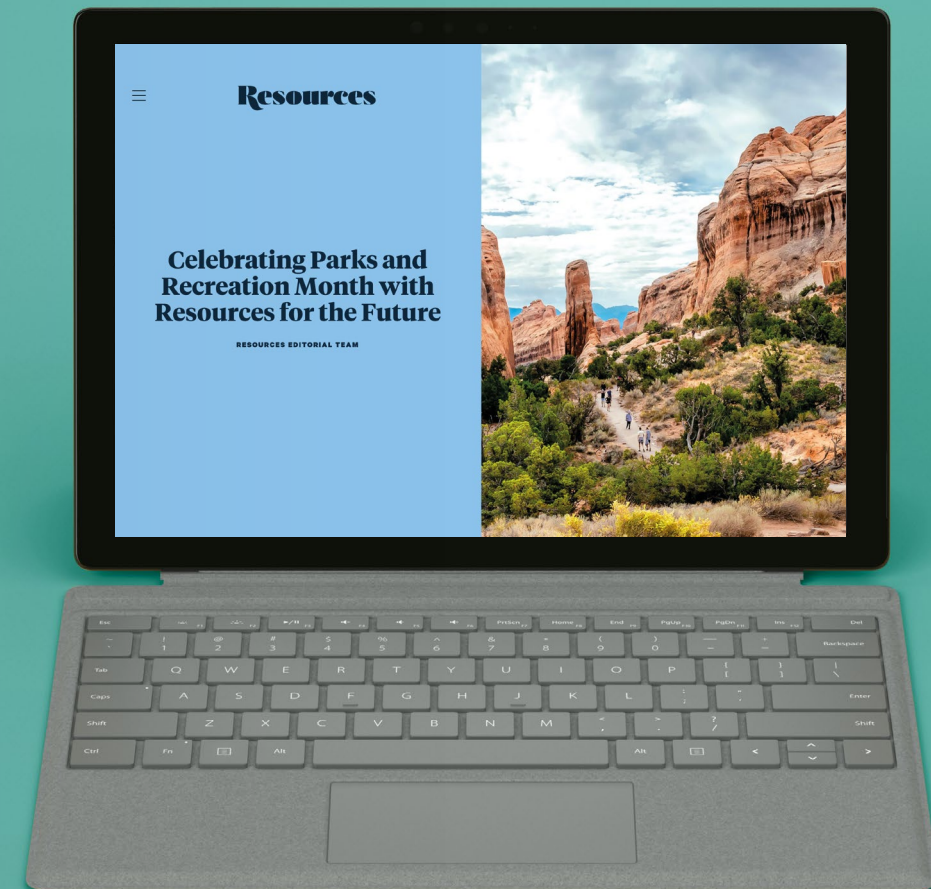
Tony Reames
Assistant Professor,
University of Michigan



The Warmth of Other Suns by Isabel Wilkerson



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Read more about options to support RFF on page 49 of this issue.