**About this Report**

This Energy Policy Overview Report presents a summary of recent and ongoing work related to energy policy. The programs and activities included in this report are independent efforts within the University, not directed or funded by the Consortium or its funders except where specifically noted.

**About the Consortium for Energy Policy Research**

The Consortium for Energy Policy Research works in cooperation with the Harvard University Center for the Environment to promote and support Harvard’s energy policy research. The goal of the Consortium is to help Harvard University reach its full potential for research and impact in energy policy by supporting activities that promote outreach, education, communication and capacity-building in the energy policy area.

Shell provides major support for the Consortium for Energy Policy Research at Harvard through a generous donation. Funding for the Raymond Plank Professorship of Global Energy Policy has been generously provided by Raymond Plank and the Apache Corporation.

The Consortium is housed at the Mossavar-Rahmani Center for Business and Government in the Harvard Kennedy School.
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PROGRAMS & PROJECTS
What we have in 2015 at the DOE is a research ecosystem that enshrines the distinction between ‘basic’ and ‘applied’ research...The consequence is the sad situation where researchers funded through ‘basic science’ research dollars cannot undertake any activities that might be considered ‘applied science’ research.


This is an overview of energy and related environmental activities at Harvard from the Consortium for Energy Policy Research. These programs are independently directed and funded.

**The Business and Environment Initiative**

Based at Harvard Business School, the Business & Environment Initiative (BEI) seeks to deepen understanding of environmental challenges confronting business leaders—and inspire new ideas and practical, effective solutions that make a difference in the world, both today and for future generations. BEI serves as a hub for environmentally focused research, study, and discourse at HBS. By connecting faculty, students, alumni, and practitioners, BEI catalyzes new research and make it accessible to emerging leaders and practitioners at the School and beyond.

*Michael Toffel, Faculty Chair; Jennifer Nash, Director*

**The Center for Health and the Global Environment**

From the food we eat, to the buildings we inhabit, to the natural resources on which we rely, our health depends on the health of our surroundings and our planet. To help prevent health crises before they happen and give everyone an opportunity to live a long, health life, we need forward-looking science about our rapidly changing environment — science that both anticipates problems and offers solutions. The Center for Health and the Global Environment at the Harvard T.H. Chan School of Public Health is a home for innovative researchers and educators who explore how to create environments that promote health. By focusing on environmental change through the lens of human health, the Center is able to reach people in concrete, personal terms they can relate to and understand. The Center is a trusted international leader for exploring how our environments affect our health, and how we can better steward our surroundings so we all have an opportunity to live a long, healthy life.

*Jack Spengler, Director; Aaron Bernstein, Associate Director*

**Climate Solutions Living Lab**

Under the direction of Emmett Clinical Professor of Environmental Law, Wendy B. Jacobs, the Climate Solutions Living Lab is being offered for the first time in
spring 2017. An inter-disciplinary course and project, it is designed to bring students and faculty together from across the University to generate practical solutions to thorny problems confronting non-regulated institutions, such as universities, desirous of reducing greenhouse gas emissions and in need of innovative legal, financing, and design pathways for such solutions, some but not all of which involve generation of renewable energy.

Wendy Jacobs, Director

Consortium for Energy Policy Research

The Consortium for Energy Policy Research, based at the Harvard Kennedy School’s Mossavar-Rahmani Center for Business and Government, works in cooperation with the Harvard University Center for the Environment to promote and support Harvard’s energy policy research by supporting activities that promote outreach, education, communication and capacity-building in the energy policy area.

William Hogan, Faculty Director; Louisa Lund, Program Director

Emmett Environmental Law and Policy Clinic

Harvard Law School’s Emmett Environmental Law and Policy Clinic offers Harvard Law School students—and students from other disciplines across the University campus—an opportunity to do real-life and real-time legal and policy work on local, national and international projects covering a broad spectrum of environmental and energy-related issues, including climate change mitigation and adaptation, renewable energy, protection of the Arctic and national parks, safe transportation of oil and gas, underground storage of natural gas, carbon capture and sequestration, environmental/energy justice, citizen science, and development and implementation of litigation strategies for a variety of clients. Depending on the project, students may undertake litigation and advocacy work by drafting briefs, preparing testimony, conducting research, developing strategy for regulatory reform and/or litigation, commenting on proposed regulations, drafting model legislation, and/or preparing white papers advocating for legal reform. For example, in 2016, the Clinic petitioned the federal Office of Management and Budget to reform the way that federally-sponsored research laboratories account for grants in order to create a meaningful incentive for them to conserve energy and reduce their greenhouse gas emissions. In January 2016, the Clinic submitted comments in support of EPA’s air toxics standards for power plants on behalf of SEAS Professor Elsie Sunderland and nine other scientists. In April 2016, the Clinic participated in grid modernization proceedings and an electric rate-setting case in Massachusetts through submittal of written comments and presentation of oral testimony advocating proposed criteria for evaluating energy justice and making the legal case for virtual power plants. The Clinic does much of its work on behalf of government and public interest clients or in partnership with public interest entities. The Clinic offers students a multi-disciplinary experience and welcomes students from other Harvard schools (and MIT and Tufts) to cross-register.

Wendy B. Jacobs, Emmett Clinical Professor of Environmental Law and Director

Energy History Project

The project on the global history of energy, which concluded in December 2016, was based at Harvard’s Joint Center for History and Economics and at the MIT Research Group on History, Energy, and Environment. The project explored how the historical study of energy use and transformation can widen perspectives on economic, social, and environmental processes in the past. It also served as a forum for the historical discussion of energy in all its forms in a global and comparative context, and supported a series of workshops, lectures, and events.

Harvard faculty participants Sunil Amrath, Richard Hornbeck, Ian Miller, and Emma Rothschild

Environment and Natural Resources Program

The Belfer Center for Science and International Affairs’ Environment and Natural Resources Program (ENRP) is at the center of the Harvard Kennedy School’s research and outreach on public policy that affects global environmental quality and natural resource management. ENRP’s energy policy work includes its ongoing role in the joint oversight of the Belfer Center’s energy projects, the Geopolitics of Energy Project, and the Sustainable Energy in the European Union and Sustainable Development of the Energy Sector in China initiatives. ENRP’s outreach activities include a discussion paper series; special events such as seminars, workshops, and films; and robust student support programs.

Henry Lee, Director; William Clark, Faculty Chair; Amanda Sardonis, Assistant Director
**Environmental Policy Initiative**

Harvard Law School’s Environmental Policy Initiative provides real-time legal analysis on today’s most pressing energy and environmental issues. Policy Initiative researchers share this analysis through policy-relevant presentations and papers, to reach a broad audience and to move discussion forward. The Environmental Policy Initiative (EPI) works closely with Harvard Environmental Law Program faculty and the Emmett Environmental Law & Policy Clinic, and develops strategic partnerships with other experts to forge interdisciplinary policy proposals. EPI is focused in four issue areas: regulation of the electricity sector; governance of shale oil and natural gas; greenhouse gas regulation under the Clean Air Act; and water quality policy.

Kate Konschnik, Director

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**EU Sustainability and Energy Initiative**

The aim of the EU initiative is to bring a more European perspective to energy and environment policy research while increasing the collaboration opportunities between the Harvard Kennedy School and prominent European institutions. The initiative’s research and activities focuses on the implementation of ambitious 2030 climate and energy goals and the Energy Union strategy, which aims to provide secure, affordable and climate-friendly energy for Europe.

Henry Lee, Faculty Chair; Pinar De Neve, Project Manager

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**Evidence for Policy Design (EPoD), Environmental Regulation Group**

Under the direction of Rohini Pande, EPoD’s Environmental Regulation Group uses rigorous field studies and secondary data to examine the regulation of energy and the environment in India. The group’s research explores a number of topics in this area, including the implementation of a continuous emissions monitoring system (CEMS) to measure real-time particulate matter pollution, the environmental clearance process for capital investment projects, the distributional impacts of coal-fired thermal power generation, the effect of sharing information on air pollution ratings on emissions, and the take-up and health benefits of efficient cook stoves. Sample publications include *Lower Pollution, Longer Lives: Life Expectancy Gains if India Reduced Particulate Matter Pollution* (Economic & Political Weekly, 2015) and *Truth Telling by Third Party Auditors and the Response of Polluting Firms: Experimental Evidence from India* (Quarterly Journal of Economics, 2013). The group has also produced an interactive case on the CEMS project in order to share learnings on translating research into successful policy implementation, which can be found at [http://epod.hmdc.harvard.edu/cms-case/](http://epod.hmdc.harvard.edu/cms-case/). In addition to research, the Environmental Regulation Group trains environmental and energy policymakers in the use of data and evidence for more effective policymaking.

Rohini Pande, Faculty Director

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**The Geopolitics of Energy Project**

The Geopolitics of Energy Project, based in the Belfer Center for Science and International Affairs at the Harvard Kennedy School, explores the intersection of energy, security, and international politics. The Project aims to improve our understanding of how energy demand and supply shape international politics—and vice versa. It also endeavors to inform policymakers and students about major challenges to global energy security and, where possible, to propose new ways of thinking about and addressing these issues. The Project focuses on both conventional and alternative energies, as both will influence and be influenced by geopolitical realities.

Meghan O’Sullivan, Director

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**Harvard Center for Green Buildings and Cities**

The Harvard Center for Green Buildings and Cities (CGBC) is dedicated to research that drives the development of new design strategies for sustainable building and planning. Through long-term multidisciplinary research, the CGBC addresses the global environmental challenge of climate change by focusing on buildings, which account for the vast majority of energy use and carbon pollution throughout the world. The CGBC’s goal is to transform the building industry by developing new processes, systems, and products that lead to more sustainable, high-performance buildings and an enhanced way of life for people in the built environment.

Established at the Harvard University Graduate School of Design (GSD), the CGBC draws on the extensive resources of the university, engaging prominent thinkers and practitioners from the fields of architecture, design, engineering,
landscape, and urban planning, as well as economics, business, public health, and law.

Ali Malkawi, Founding Director; Richard Freeman, Founding Co-Director

Harvard Center for Risk Analysis

The Harvard Center for Risk Analysis (HCRA), based at the Harvard T.H. Chan School of Public Health, is a multidisciplinary group of faculty, research staff, students, and visiting scholars who work together to improve decisions about environmental health. HCRA's work draws on diverse disciplines, including epidemiology, toxicology, environmental science and engineering, decision theory, cognitive psychology, applied mathematics, statistics, and economics. Areas of practical application related to energy policy include the analysis of risks from climate change and from air pollutants such as particulate matter, ozone and mercury.

James Hammitt and Joel Schwartz, Directors

Harvard China Project

The interdisciplinary Harvard-China Project, based in the School of Engineering and Applied Sciences (SEAS), conducts peer-reviewed research on China's economy, energy, atmospheric environment (both air pollution and greenhouse gases), and environmental health. The Project pursues two collaborative mandates: crossing disciplines and schools at Harvard and integrating Harvard-based research efforts with work by affiliates at Chinese universities. It has built up research capacities in a range of fields: atmospheric transport and chemistry modeling; atmospheric measurement at a station near Beijing operated jointly with Tsinghua University; bottom-up assessment of air pollution and GHG emissions; investigation of renewable and low-carbon power potentials, including grid integration; general equilibrium modeling of China's economy and energy use; modeling health impacts of pollution exposures; analyses of urban transport, land use, and environment; and integrated assessment of costs and benefits of national policies to control emissions of air pollutants and greenhouse gases.

Michael B. McElroy, Chair; Chris P. Nielsen, Executive Director; Dale W. Jorgenson, Mun S. Ho, Jing Cao, Sumeeta Srinivasan, J. William Munger, John Evans, James K. Hammitt, and Xinyu Chen, Harvard-based lead investigators of current studies. Other elements are led by researchers at Chinese universities funded by the Project.

The Harvard-China Project: China 2030/2050

This effort of the Harvard-China Project promotes collaborative research across disciplines and between Harvard and Chinese institutions on climate-related challenges, sponsored as the first anchor grant of the Harvard Global Institute (HGI) under Harvard President Drew Faust. The program includes a range of studies spanning atmospheric and climate science, energy science, economics, environmental health, history, law, and policy. It currently involves 17 faculty members from five Harvard schools and a similar number of collaborating professors in China. The program includes two major field projects: expansion of an atmospheric measurement station established in 2004 with Tsinghua University, and a household survey of transportation behavior, air quality, and environmental health valuation in the city of Chengdu involving Peking University and Nanjing University. Coordinating with the Harvard Center Shanghai, the HGI’s base in China, it also includes a number of research symposia held in China and at Harvard, a summer short course for a select cohort of Harvard and Chinese student participants, and occasional university-wide public lectures.

Michael B. McElroy and Dale W. Jorgenson, Faculty Chairs; Chris P. Nielsen, Executive Director

Harvard Electricity Policy Group

The Mossavar-Rahmani Center for Business and Government’s Harvard Electricity Policy Group (HEPG) provides a forum for the analysis and discussion of important policy issues facing the electricity industry. Founded in 1993, its objectives are to study, analyze and engage discourse on the problems associated with the transition from monopoly to a more competitive electricity market. With the involvement of scholars, market participants, regulators, policymakers, and advocates for various positions and interests, HEPG seeks to foster more informed, highly focused open debate in order to contribute to the wider public policy agenda affecting the electric sector. Through research, information dissemination, and regular seminars, HEPG facilitates discussion that leads to the development of new ideas or an expansion of the debate. Participants include electricity industry executives from public power and investor-owned utilities, independent power producers, consumer advocates, regulators, energy officials from both state and federal
governments, representatives of the environmental and financial communities, and academics.

William Hogan, Research Director; Ashley Brown, Executive Director; Jo-Ann Mahoney, Program Director

Harvard Environmental Economics Program

The Harvard Environmental Economics Program (HEEP) is a University-wide initiative that develops innovative answers to today's complex environmental issues by providing a venue to bring together faculty and graduate students from across Harvard engaged in research, teaching, and outreach in environmental, natural resource, and energy economics and related public policy. HEEP is based in the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School. The Program sponsors research projects, convenes workshops, and supports graduate education to further understanding of critical issues in environmental, natural resource, and energy economics and policy around the world. HEEP's 32 Faculty Fellows are economists in six Harvard schools who focus in whole or in part on environmental issues. HEEP regularly releases Discussion Papers—almost all of which are authored by Faculty Fellows—that are available on its web site. HEEP has 27 Pre-Doctoral Fellows in 2016-2017. HEEP Pre-Doctoral Fellows conduct a weekly luncheon at which they present their own recent research. Since the mid-1990s, Robert Stavins of Harvard Kennedy School and Martin Weitzman of the Department of Economics have led a separate, open seminar on environmental economics on Wednesday afternoons, hosting distinguished guest speakers.

Robert Stavins, Director; Robert Stowe, Executive Director

Harvard Graduate Consortium on Energy and Environment

Founded in 2009 by the Harvard University Center for the Environment, the Harvard Graduate Consortium on Energy and Environment was developed to foster a new community of doctoral students who will be well versed in the broad, interconnected issues of energy and environment while maintaining their focus in their primary discipline. Current Harvard PhD, ScD, or DDes students may apply to the program. Once admitted to the Consortium, students are required to take three courses designed to provide them with an introduction to critical aspects of energy issues and to participate in a weekly reading seminar that provides an overview of the energy field from a wide range of perspectives.

Through debate and dialogue in coursework and seminars, students will be able to identify the obstacles, highlight the opportunities, and define the discussion of an energy strategy for the 21st century and beyond. Currently there are approximately 40 students from five schools enrolled in the Graduate Consortium.

Michael Aziz, Faculty Coordinator; Eric Simms, Educational Programs Manager

Harvard Project on Climate Agreements

The goal of the Harvard Project on Climate Agreements is to help identify and advance scientifically sound, economically rational, and politically pragmatic public policy options for addressing global climate change. Drawing upon leading thinkers in Argentina, Australia, China, Europe, India, Japan, and the United States, the Harvard Project's research focuses in part on the architecture, key design elements, and institutional dimensions of a new international regime based on the 2015 Paris Agreement. This research is presented in 93 Discussion Papers (as of December 2016) and numerous other publications available on the Project's web site. The Project is based jointly in the Belfer Center for Science and International Affairs and the Mossavar-Rahmani Center for Business and Government at Harvard Kennedy School.

Robert Stavins, Director; Robert Stowe, Manager

Harvard University Center for the Environment

By connecting scholars and practitioners from different disciplines, the Harvard University Center for the Environment (HUCE) seeks to raise the quality of environmental research and education at Harvard while fostering linkages and partnerships amongst different parts of the University as well as between the University and the outside world. With 250 faculty associates, the Center has one of the largest and most varied faculty communities on campus. The Center's ongoing programs support innovative faculty and post-doctoral research, provide research opportunities (independent and with faculty) and course offerings for undergraduates, bring compelling visiting scholars and lecturers to campus, and connect faculty and students from across the University through sponsored events.

Daniel Schrag, Director; Peter Huybers, Co-director; James Clem, Managing Director
Innovation and Access to Technologies for Sustainable Development

With leadership from William Clark and Laura Diaz Anadon and an international team of collaborators, this initiative seeks to advance knowledge and understanding of how to equitably improve the functioning of the “global innovation system” for sustainable development technologies. To this end, researchers carried out 18 case studies of how the current system functions to meet five sustainable development needs (food, energy, health, manufactured goods, and water). Based on these studies, the Initiative developed assessments of the efficacy of various “system interventions” (e.g., policy interventions, institutional innovations, new approaches to shaping the innovation process) intended to strengthen the global innovation system. The initiative held a capstone international conference in London in May 2016 in conjunction with the Department of Science, Technology and Public Policy at University College London bringing together project researchers, as well as leading scholars and practitioners globally. A key output of the project informed also by this international conference was a paper published in the Proceedings of the US National Academy of Science (PNAS) entitled “Making Technological Innovation Work for Sustainable Development.” Additional journal papers reporting final results are now being prepared focused on the following topics: (1) the role of transnational actors, (2) a more comprehensive model of innovation, (3) the role of socio-technical characteristics, and (4) concrete implications for the role of policy to reorient innovation systems to contribute to sustainable development.

William Clark, Initiative Leader; Laura Diaz Anadon, Kira Matus, and Suerie Moon, Co-Directors

Program on Science, Technology, & Society

Science and technology permeate every aspect of our lives, from the most private decisions about reproduction and medical treatment to the most public choices concerning risk, development, security, and the quality and sustainability of the human environment. Virtually every dilemma that confronts people and governments in contemporary societies demands significant engagement with science and technology. The Program on Science, Technology & Society at the Harvard Kennedy School provides unique resources for coping with the resulting challenges for scientific and technological innovation, civil liberties, informed citizenship, and democratic government.

Sheila Jasanoff, Director

Project on Managing the Atom

The Project on Managing the Atom (MTA), based in the Belfer Center for Science and International Affairs at the Harvard Kennedy School, brings together scholars and practitioners who conduct policy-relevant research on key issues affecting the future of nuclear weapons, the nuclear proliferation regime, and nuclear energy. A major focus of MTA research and policy engagement is how nuclear energy could be made as safe, secure, and proliferation-resistant as possible—and how the problem of radioactive waste can be successfully addressed. The Project communicates its findings through publications and through direct testimony and briefings for policymakers. The Project sponsors an interdisciplinary, international group of resident fellows and a weekly research seminar.

Matthew Bunn, Henry Lee, and Steven Miller, Co-Principal Investigators; Martin Malin, Executive Director

Regulatory Policy Program

The Regulatory Policy Program (RPP) serves as a catalyst and clearinghouse for the study of regulation across Harvard University. The program’s objectives are to cross-pollinate research, spark new lines of inquiry, and increase the connection between theory and practice. Through seminars, symposia, and working papers, RPP explores themes that cut across regulation in its various domains: market failures and the public policy case for government regulation, the efficacy and efficiency of various regulatory instruments, and the most effective ways to foster transparent and participatory regulatory processes.

Joseph Aldy, Faculty Chair; Jennifer Nash, Executive Director

Science, Technology, and Public Policy Program

The Science, Technology, and Public Policy Program (STPP) is a research, teaching, and outreach program of the Belfer Center for Science and International Affairs at the Harvard Kennedy School. Solutions to many of the world’s most challenging problems involve complex scientific and technological issues. Good policy making in these areas requires access to the frontier of scientific knowledge, not simply to translate scientific information, but to bring an appreciation for...
energy policies in China and the challenges posed by energy initiatives for environmental policy. Research is focused on the electric, transport, and industrial sectors and on analysis of the economic and administrative impacts of policies and technologies, including cap and trade, alternative fuel vehicles, investment incentives, renewable energy options, promotion of carbon capture and sequestration, and clean energy technology development and deployment. Recent publications include an article on how regional targets and improved market mechanisms could allow China’s carbon dioxide emissions to peak by 2030 (in Nature 2015, first author, Liu, “Climate Policy: Steps to China’s Carbon Peak”) and a series of papers on low carbon pathways for sustainable development and the challenges of deep decarbonization in China. The initiative convenes an annual workshop on low-carbon development policy with colleagues at Tsinghua University in Beijing.

Henry Lee, Initiative Leader

The Water-Energy Nexus

ETIP researchers are pursuing research related to the complex interactions between water and energy, focusing on the Middle East and China, and the United States over the past year. Research on the Middle East focuses on country-specific studies of decisions related to energy and water infrastructure investments, using multi-criteria decision analysis and interviews, and on the role of education institutions in the Gulf and internationally informing policy. In the United States, research has examined the consumption of water for fossil fuel extraction and energy generation in Pennsylvania. Work related to China has focused on water allocation case studies and on developing frameworks for understanding regional constraints on water resource availability for use in the energy and industrial sectors and for the potential future development of renewable energy in China. In 2014, the group examined the development of water markets as a solution to water scarcity in China, with particular focus on Water Rights Trading (WRT). Another project examined hydropolitics in large dam construction, water resource allocation, and downstream water pollution.

Venky Narayanamurti and Henry Lee, Faculty Chairs

Zofnass Program for Sustainable Infrastructure

The mission of the Zofnass Program for Sustainable Infrastructure, housed at the Graduate School of Design, is to research, develop and promote methods,
processes, and tools that define and quantify sustainability for cities and infrastructures. The Zofnass Program, in collaboration with the Institute for Sustainable Infrastructure, has developed the Envision® rating system for assessing infrastructure sustainability. The Zofnass Program, advised by an Industry Board, conducts research on the infrastructure sectors of energy, water, waste, transportation, landscape, and information. The program approaches infrastructure as a systemic interrelationship of networks where both individual infrastructure systems and the synergies between them are analyzed to achieve a holistic approach to sustainability. Current work includes the Zofnass Planning Guidelines for sustainable city planning; the Zofnass Economic Process Tool, a platform to quantify the cost of sustainable options and sustainability externalities in infrastructure projects; the Infrastructure 360 Awards in collaboration with the Inter-American Development Bank, a voluntary recognition, analysis and benchmarking program for infrastructure sustainability in Latin America; and urban water management for sustainable projects.

Prof. Spiro N. Pollalis, Program Director; Andreas Georgoulias, Research Director; Judith Rodriguez, Administrative Director
A concerning new finding from researchers in McElroy’s group is that the wind resource in China seems to have declined over the past few decades in ways that seem to be related to global warming, disrupting the monsoonal circulation—suggesting a potential negative feedback loop in which global warming itself diminishes the potential of low-carbon energy production in China.

Turning to the situation in the United States, McElroy noted that U.S. emissions reduction commitments are also ambitious, given that meeting them requires the extension of a trend of reductions tied to a constellation of recession and high gas prices that is no longer in effect. Successfully meeting these targets in the future, McElroy suggested, is likely to require significant growth in electric transportation. As a result, the United States will need to not only drastically reduce carbon emissions in the electricity sector; the country will need to do this while at the same time increasing the total amount of electricity produced.

In theory, McElroy said, there are enough renewable energy resources available in the United States to more than meet expanded electricity demand with carbon-free energy. McElroy presented data from his research group’s analysis of the wind potential in the United States, which found that the U.S. is “wind rich,” especially in the middle parts of the country, where some states have the potential to produce hundreds of times their annual electricity consumption from wind, even in an analysis that excludes urban and forested areas. McElroy acknowledged, however, that challenges exist in accommodating the variability of wind and solar resources and in connecting the electricity production from wind and solar resources to demand across the United States.

The path to utilizing the potential wind and solar resource, then, is not clear, although McElroy suggested that it might include major new transmission projects and expanded production tax credits for wind energy. Ongoing research with the Midcontinent Independent System Operator, McElroy said, is examining the potential impact of different policy scenarios, including a $100 per ton carbon tax and a variable wind production tax credit.

In a talk that suggested a contrast between China’s “amazingly detailed and extremely ambitious plans” for carbon reductions and similarly ambitious but relatively unfocused plans in the United States, Michael McElroy, Gilbert Butler Professor of Environmental Studies at the Harvard School of Engineering and Applied Sciences, presented some of his recent research related to the potential for carbon emissions reductions in the two countries.

China has seen rapid growth in wind power, nuclear power, solar, and hydro power, McElroy observed, noting that so far it has done well in meeting its carbon reduction commitments. However, he observed that China is facing some new challenges. Investment in coal power production continues, although the utilization of additional plants, on average, has declined. With coal prices poised to increase in conjunction with declining coal stocks, McElroy noted, these reductions in plant utilization may continue. Wind capacity is strong—China now has more installed wind capacity than the U.S.—however, overall, China produces less electricity from wind than is produced in the United States. One reason for this, McElroy explained, is that these wind plants are competing with power from combined heat and power coal plants, which are running primarily to provide heat and hot water, and so can’t be simply supplanted by wind electricity.
ACTIVITIES BY TOPIC
...a uniform global tax-like price on carbon emissions, whose revenues each country retains, can provide a focal point for a reciprocal common commitment, whereas quantity targets, which do not nearly as readily present such a single focal point, have a tendency to rely ultimately on individual commitments.


**Biofuels**

› Harvard economist Jim Stock and his co-authors continued to refine and explore their findings about the relationship between the requirements of the Renewable Fuel Standard and consumer prices at the pump. Their analysis suggests that costs for non-renewable fuels are passed on at the wholesale level, but a cost advantage for renewable fuels may not be appearing at the retail level. This poses a problem for the RFS as a tool for increasing the use of low-carbon fuels. (See Stock et al., in “Publications,” below).

› Harvard professors Daniel Nocera and Pamela Silver announced their creation of the “bionic leaf 2.0,” building on previous work transforming solar power into liquid fuel. The improved technology is substantially more efficient than the most efficient plants at converting sunlight into energy. The research was partially funded by Harvard President Drew Faust’s Climate Change Solutions Fund. See Liu et al., “Water Splitting-biosynthetic System with CO2 Reduction Efficiencies Exceeding Photosynthesis,” published in *Science*.

**China**

› An interdisciplinary household survey in Chengdu, China, sponsored by the Harvard Global Institute and led by Harvard-China Project Executive Director Chris Nielsen, Professor James Hammitt (of the Harvard T.H. Chan School of Public Health), and Professors Mingming Shen and Jie Yan (of the School of Government, Peking University), was completed in July 2016. The survey collected data from 2,000 households that included information about travel behavior, outdoor and indoor air pollution exposures, health, and perceptions and valuation of health risk. The data will be joined with a dataset in a similar survey conducted in 2005 to yield a time series covering Chengdu’s economic growth, urbanization, and transit development over the last 11 years.

› In May 2016, the Harvard-China Project, the Harvard Global Institute, and Energy Foundation China and its research affiliate the Innovative Green Development Program co-sponsored the symposium, “Carbon Taxes in China’s Future: Role and Feasibility,” chaired by Professor Dale Jorgenson and designed to bridge policymaking and research perspectives. The symposium included university research groups and leading representatives of government research institutes.
At the Harvard Kennedy School’s Belfer Center for Science and International Affairs, the Environment and Natural Resources Program’s Sustainable Development of the Energy Sector in China initiative has published a series of papers on low carbon pathways for sustainable development and the challenges of deep decarbonization in China (see Chen, “The Challenges and Promises of Greening China’s Economy.”) The Initiative held its third annual joint workshop with Tsinghua University in Beijing, China, in June 2016. Discussions focused on market mechanisms to reduce carbon emissions, the role of local government in low-carbon development, and energy technology innovation in the transportation sector.

In February 2016, the Harvard Project on Climate Agreements released a paper on China-U.S. cooperation on climate-change policy, jointly authored with researchers at China’s National Center for Climate Change Strategy and International Cooperation. (See Aldy et al., “Bilateral Cooperation between China and the United States: Facilitating Progress on Climate-Change Policy.”)

Climate policy

In 2016, Harvard’s Climate Change Solutions Fund awarded a second round of grants, totaling over $1 million, to Harvard faculty collaborating on ten climate research projects. Projects funded include research on solar technology, solar geoengineering and sea level change, the Paris Climate Agreement, potential new hydroelectric sites, and finding sources of natural gas loss and carbon dioxide emissions in the Boston area and designing policy and legal responses to address them.

A new Harvard Kennedy School Executive Education program, “Climate Change and Energy: Policy Making for the Long Term,” convened U.S. and international policymakers and corporate leaders in September 2016 to address implications of and policy solutions for the critical global public policy issue of climate change. This state-of-the-art program provided deep insight into the science, economics, and policy of climate change—and into related topics involving energy production and use. The program was led by Harvard Environmental Economics Project Director Robert Stavins.

The Harvard Project on Climate Agreements conducted two side-event panels at the November 2016 COP-22 meeting in Marrakech, Morocco. The events were on the topics of “The Paris Agreement’s Transparency Framework: A Building Block for Enhanced Mitigation” and “Climate Think Tank Leaders on the Implementation of the Paris Agreement.”

In February 2016, the Harvard Project on Climate Agreements released a paper on China-U.S. cooperation on climate-change policy, jointly authored with researchers at China’s National Center for Climate Change Strategy and International Cooperation. (See Aldy et al., “Bilateral Cooperation between China and the United States: Facilitating Progress on Climate-Change Policy.”)

Harvard economist James Stock and his co-authors examined federal leasing of land for coal production and the potential impacts of charging an additional royalty to reflect the negative externalities associated with the use of coal, finding that “in the absence of the CPP [Clean Power Plan], a royalty adder equal to the social cost of carbon could reduce emissions by roughly the same amount that the CPP is projected to achieve.” (See papers by Gerardon, Reeder, and Stock and by Gillingham and Stock).

In 2016, Harvard engineering professor Michael McElroy published the book, Energy and Climate: Vision for the Future. In it, McElroy distills the latest scientific knowledge about climate change and policies to address climate change into an account for the general reader.

In April 2016, the Harvard Global Institute and the Harvard-China Project hosted Al Gore, former Vice-President of the United States and Chairman, The Climate Reality Project, for a Sanders Theater address on “Confronting the Climate Crisis: Critical Roles for the U.S. and China.”

President Drew G. Faust, the Harvard Global Institute, and the Harvard University Center for the Environment organized a November 2016 symposium for faculty on the topic of “Climate Change and the Developing World,” to facilitate faculty discussion of urbanization and adaptation, food and water security, and creating solutions.
In April, 2016, Ernie Moniz, United States Secretary of Energy, came to Harvard to deliver the Robert McNamara Lecture on War and Peace, speaking on the topic, “Science and Diplomacy for Solving Humanity’s Big Issues – Iran, HEU and Climate.”

In May 2016, the Harvard-China Project, the Harvard Global Institute, and Energy Foundation China and its research affiliate the Innovative Green Development Program co-sponsored the symposium, “Carbon Taxes in China’s Future: Role and Feasibility,” chaired by Professor Dale Jorgenson and designed to bridge policymaking and research perspectives. The symposium included university research groups and leading representatives of government research institutes.

Education

The Harvard Environmental Economics Program administered its Seventh Annual Student Prize Competition in 2015-2016. In May 2016, three prizes were awarded to Harvard University students for the best research papers addressing a topic in environmental, energy, or research economics—one prize each for a senior paper or thesis, masters student paper, and doctoral student paper. Each prize was accompanied by a monetary award.

In 2016, Harvard faculty offered more than 70 courses across the University relevant to energy policy. A consolidated listing of energy policy-related courses is available on the Consortium for Energy Policy Research website.

The Harvard University Center for the Environment’s Undergraduate Summer Research Fund gave awards to twenty-three undergraduates for the summer of 2016 to research topics including wind power policies, COP 21, and technologies for flow batteries.

The Roy Family Fellowship, administered by the HKS Belfer Center for Science and International Affairs’ Environment and Natural Resources Program, provides full tuition funding for masters’ candidates at Harvard Kennedy School with a demonstrated interest in environmental and energy issues.

Across Harvard University, more than fifty pre-doctoral, post-doctoral, and senior fellows pursued research related to energy policy on a broad range of topics.

The Harvard Graduate Consortium on Energy and Environment continues to attract doctoral students to take additional courses and seminars to complement their work in their chosen field of study. About 40 doctoral students from across Harvard are currently part of the Graduate Consortium.

Electricity markets and regulation

Harvard faculty continued their joint work aimed at better understanding the economics of battery storage and, in particular, the economic calculations relevant to Professor Mike Aziz’s innovative flow battery. (See Alles et al., “Potential Arbitrage Revenue of Energy Storage Systems in PJM during 2014.”)

The HLS Environmental Policy Initiative (EPI) created a “Power Shift” network of energy law professors and electricity practitioners. EPI launched this network in partnership with Duke University’s Nicholas Institute for Environmental Policy Solutions in 2015. The University of North Carolina’s Center for Climate, Energy, Environment, and Economics has since joined the steering committee. In 2016, EPI hosted a Power Shift workshop as a side meeting at the NARUC meeting in July in Nashville, TN, as well as two conference calls on pressing energy topics and three webinars covering the topics of RTO governance, accounting for carbon in wholesale electricity markets, and the next Administration’s energy agenda. As part of the third webinar, EPI also published a white paper on the same topic (Monast, first author, “Illuminating the Energy Policy Agenda: Electricity Sector Issues Facing the Next Administration.”)

Harvard Electricity Policy Group Research Director Bill Hogan’s work on the National Academy of Science’s Committee on Determinants of Market Adoption of Advanced Energy Efficiency and Clean Energy Technologies culminated with the fall 2016 release of the book, The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies. The book reviewed currently existing renewable energy technologies and found that for these technologies, “deployment incentives are likely to be insufficient as the primary policy mechanism for achieving timely cost and performance improvements,” and recommended significant government support for clean power technology innovation, coupled by a price on pollution to encourage deployment.

Professor Hogan continued to write about electricity market design, investigating questions related to the integration of distributed energy resources.

› Ari Peskoe, of the Harvard Law School, published the article, “Unjust, Unreasonable, and Unduly Discriminatory: Electric Utility Rates and the Campaign Against Rooftop Solar,” in which he reviewed the industry’s structure and history, concluding “that opening up the monopoly-controlled distribution system to new technologies and services provided by non-IOU entities is consistent with the history and purpose of state regulation.” At the Harvard Kennedy School, Ashley Brown approached a related topic from a different perspective, publishing a critique of “value of solar” analysis, “The Value of Solar Writ Large: A Modest Proposal for Applying ‘Value of Solar’ Analysis and Principles to the Entire Electricity Market.”

› Wendy B. Jacobs, Emmett Clinical Professor of Environmental Law at Harvard Law School, served as a Lecturer at the Applied Leadership for Renewable Energy and Energy Efficiency Program, in cooperation with the Harvard School of Public Health Center For Health and the Global Environment (CHGE) in Mexico City, Mexico.

› Professor Spiro Pollalis, Director of the Zofnass Program for Sustainable Infrastructure, published the book, Planning Sustainable Cities: An infrastructure-based approach, in 2016. The book “approaches infrastructure [including energy infrastructure] as a series of systems that function in synergy and are directly linked with urban planning.” The publication of the book was accompanied by a symposium organized by the Zofnass Program.

› Researchers at the Center for Green Buildings and Cities, based at the Harvard Graduate School of Design, pursued a range of research topics, examining ways in which building design (ventilation, building materials, insulation, etc.) can impact energy efficiency in the US and China. Through their ongoing “House Zero” project, they continued work to retrofit an existing 1940’s Cambridge house to achieve “net zero” energy consumption.

› Former Sustainability Science Program Fellow Anand Sudarshan (now on the faculty at the University of Chicago) recently published an article based on research supported by SSP and the Evidence for Policy Design Initiative, “Nudges in the Marketplace: The Response of Household Electricity Consumption to Information and Monetary Incentives.” In a survey of Indian households, he found that households reduced energy consumption in response to on-bill information about energy consumption relative to their neighbors, but that this effect disappeared when the information was accompanied by a monetary incentive.

Energy externalities

› Harvard T.H. Chan School of Public Health professor James Hammitt (Co-Director of the Harvard Center for Risk Analysis) was on the National Academy of Sciences Committee updating the social cost of carbon. The Committee’s report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, was published in early 2017.

› Jonathan Buonocore, of the Harvard School of Public Health, published their analysis of the costs and benefits of an emission standard such as that in the Clean Power Plan, balancing additional power costs against health benefits from reduced air pollution. Buonocore and his colleagues found net benefits of approximately $12 billion in their central estimate. Some parts of the country benefited more than others; however, over five years, all regions but one in their analysis experienced positive net benefits. See Buonocore et al., “An Analysis of Costs and Health Co-Benefits for a U.S. Power Plant Carbon Standard.” Jacobs, Wendy and Shaun Goho (contributing authors). “Benefits of Regulating Hazardous Air Pollutants from Coal and Oil-Fired Utilities in the United States.” Enviro. Sci. Technol. (February 5, 2016).


› HKS professor Bill Clark and colleagues at other universities published a guide to thinking about social-environmental systems from a sustainability perspective, Pursuing Sustainability: A Guide to the Science and Practice.
Harvard economist James Stock and his co-authors examined federal leasing of land for coal production and the potential impacts of charging an additional royalty to reflect the negative externalities associated with the use of coal, finding that “in the absence of the CPP [Clean Power Plan], a royalty adder equal to the social cost of carbon could reduce emissions by roughly the emissions reduction that the CPP is projected to achieve.” (See Gerardon, Reeder, and Stock; also Gillingham and Stock).

On January 20, 2016, Harvard Project Director Robert Stavins presented at a workshop in Oslo, Norway—“Potential Climate Risks in Financial Markets.” The workshop speakers offered different points of view on the effects of climate change on financial markets. Professor Stavins focused on what he determined to be a more important determinant of risk for financial markets than climate change itself—namely, climate-change policy. The goal of the workshop was to advance new research connecting financial economics and environmental economics.

Impacts associated climate change continued to be a major focus of research. Publications included Clark et al., “Consequences of Twenty-First-Century Policy for Multi-Millennial Climate and Sea-Level Change;” Hanna and Oliva, “Implications of Climate Change for Children in Developing Countries” and Wagner and Zeckhauser, “Confronting Deep and Persistent Climate Uncertainty.”

Externalities associated with shale gas production were examined from a number of perspectives. At the Law School, Kate Konschnik (and co-authors) examined issues related to induced seismicity, chemicals used in hydraulic fracturing, and oil and gas spills (Konschnik, “Regulating Stability: State compensation Funds for Induced Seismicity;” Konschnik and Dayalu, “Hydraulic fracturing chemicals reports: analysis of available data and recommendations for policy makers;” and Maloney et al., “Unconventional oil and gas spills: materials, volumes, and risks to surface waters in four states of the U.S.”) Harvard-China Project researchers examined the impact of shale gas production on demand for water (first author, Guo).

The Weatherhead Center for International Affairs sponsored a Solar Geoengineering Seminar, with speakers including Harvard faculty and researchers David Keith, Joshua Horton, Gernot Wagner, and Sheila Jasanoff, and visiting speakers David Victor (UC San Diego) and Ted Parson (UCLA Law School). Topics included a focus on governance challenges for geoengineering.

Harvard scientists Keith, Dykema, and Keutsch continued their research on geoengineering technologies, examining the potential for the use of solar radiation management materials that do not harm the ozone layer. (See Dykema et al., “Improved aerosol radiative properties as a foundation for solar geoengineering risk assessment.”)

The Harvard Project on Climate Agreements published a Viewpoints paper on the “Implications of the Paris Agreement for Carbon Dioxide Removal and Solar Geoengineering.” (Authors Horton, Keith, and Honegger).

Geopolitics of energy


HKS professor Meghan O’Sullivan gave a preview of her forthcoming book on the geopolitics of the new energy abundance in the HKS Energy Policy Seminar, highlighting ways in which changes in the oil and gas sectors could be beneficial to US interests abroad.

HBS professor Rawi Abdelal continued his work on untangling the relationship between politics and business/energy interests in an article, “The Multinational Firm and Geopolitics: Europe, Russian Energy, and Power,” focused on the “reciprocal relationship between multinational firms and geopolitical systems.”

India

Former Sustainability Science Program Fellow Anand Sudarshan (now on the faculty at the University of Chicago) recently published an article based on research supported by SSP and the Evidence for Policy Design Initiative,
“Nudges in the Marketplace: The Response of Household Electricity Consumption to Information and Monetary Incentives.” In a survey of Indian households, he found that households reduced energy consumption in response to on-bill information about energy consumption relative to their neighbors, but that this effect disappeared when the information was accompanied by a monetary incentive.

Rohit Chandra, a PhD student in Public Policy and a Fellow with the Harvard Environmental Economics Program, is completing a dissertation focused on the Indian coal industry from 1960-2005.

Belfer Center postdoctoral research fellow Ajinkya Shrish Kamat is currently investigating how R&D centers set up in India by foreign multinational companies influence capabilities across India’s technology innovation ecosystem and in what ways policy could contribute positively in this area.

Nuclear energy


Researchers from the Managing the Atom Project at the Belfer Center for Science and International Affairs have been reviewing and writing on the best current knowledge about the cost of reprocessing nuclear materials from weapons for use in nuclear energy production. Matthew Bunn and his co-authors conclude that reprocessing fuel is un-economic. See Bunn and Samore, “Cancel the Plutonium Fuel Factory,” and Bunn, Zhang, and Kang, The Cost of Reprocessing in China.

Managing the Atom Project Senior Fellow Daniel Poneman issued a special report on “American Nuclear Diplomacy: Forging a New Consensus to Fight Climate Change and Weapons Proliferation.”

Managing the Atom Project Associate John Carlson wrote the white paper, “Iran and a New International Framework for Nuclear Energy,” in which he argued that “The Iranian situation highlights the urgency of developing international consensus on the control of proliferation-sensitive parts of the fuel cycle, addressing the Iranian case and also avoiding similar cases in the future.”

Oil and gas markets and regulation

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HBS professor Rawi Abdelal continued his work on untangling the relationship between politics and business/energy interests in an article, “The Multinational Firm and Geopolitics: Europe, Russian Energy, and Power,” focused on the “reciprocal relationship between multinational firms and geopolitical systems.”
Deliver It All? Experiences of Renewable Energy Policies with Socio-economic Objectives;” and “Leadership and the Energiewende: German Leadership by Diffusion.” MR-CBG Senior Fellow Lawrence Makovich is currently working on a book on this topic.

**Technology innovation**

The National Academies of Sciences report, *The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies*, found that for currently existing renewable energy technologies, “deployment incentives are likely to be insufficient as the primary policy mechanism for achieving timely cost and performance improvements,” and recommended significant government support for clean power technology innovation, coupled by a price on pollution to encourage deployment. William Hogan was on the committee overseeing the report.

HKS professor Calestous Juma published the book, *Innovation and Its Enemies: Why People Resist New Technologies*, including a chapter dedicated to the introduction of electricity, and completion between AC and DC technologies. A conference building on the findings of the book, organized by the Science, Technology, & Globalization Project of the Belfer Center for Science and International Affairs at HKS, was held in September 2016.

A 25 member HKS delegation attended the meeting of The Arctic Innovation Lab, part of the annual Arctic Circle Assembly Conference, organized with help from the Environment and Natural Resources Program at HKS’s Belfer Center for Science and International Affairs. The HKS delegation was co-sponsored by the HKS Center for Public Leadership’s Bacon Environmental Fellowship Program. In addition to HKS, the Iceland School of Energy at Reykjavík University, the University of Iceland, the University of Greenland, and the Fletcher School at Tufts University participated in the event. The Lab showcased student proposals for addressing the current challenges faced by the Arctic.

Belfer Center for Science and International Affairs Associate Laura Diaz Anadon continued her research on energy technology innovation, publishing (with co-authors including Venky Narayanamurti and Bill Clark of the Harvard Kennedy School) “Expert Views – and Disagreements – About the Potential of Energy Technology R&D;” “Making Technological Innovation Work for Sustainable Development;” How to Fix the National Laboratories,” “The Pressing Energy

**Renewable energy**

Wendy B. Jacobs, Emmett Clinical Professor of Environmental Law at Harvard Law School, served as a Lecturer at the Applied Leadership for Renewable Energy and Energy Efficiency Program (with the Harvard School of Public Health Center For Health and the Global Environment (CHGE)), Merida, Morelia, and Mexico City, Mexico, June 4-12, 2015.

Attempts to assess the potential of renewables to meet world or regional energy needs included Liu et al., “Assessment of the economic potential of China's onshore wind electricity;” Lu and McElroy, “Global potential for wind generated electricity;” and Sherman et al., “Variations of wind potential for China and Mongolia associated with changing global climate and natural oscillations.”

Many Harvard researchers worked on the issue of how best to integrate variable energy resources (often renewables) into electricity dispatch. Harvard-China Project researchers focuses especially on integrating wind energy in China (see Chen et al., “Integrated energy systems for higher wind penetration in China;” and Zhang et al., “Reducing curtailment of wind electricity in China by employing electric boilers for heat and pumped hydro for energy storage.”) With respect to integrating renewables in general, see Han et al., “Fast unit commitment for power system planning under high penetration of variable renewables;” and Caramanis et al., “Co-Optimization of Power and Reserves in Dynamic T&D Power Markets with Nondispatchable Renewable Generation and Distributed Energy Resources.”

Harvard researchers are also focused on understanding the impacts of policies to support renewable energy, especially in Germany and California. 2015-16 Giorgio Ruffolo Doctoral Research Fellow Karoline Steinbacher examined renewable energy policies in Germany, publishing “Can the Green Economy...
Innovation Challenge of the US National Laboratories;” and (with first author Kelly Gallagher) “DOE Budget Authority for Energy Research, Development, & Demonstration Database.”

› HKS professor Venkatesh Narayanamurti and his co-author, Toluwalogo Odumosu, published the book, *Cycles of Invention and Discovery*, in which they argued for a new understanding of how technological innovation happens, calling for an abandonment of the old idea of the separation between “applied” and “basic” research.

**Water-energy nexus**

Not many speakers begin by asking the question, “Why am I still doing this presentation?” But in the case of Kate Konschnik’s recent talk in the Energy Policy Seminar, dramatic developments in the past few weeks have increased uncertainty about the future of the EPA’s new carbon emissions regulations, developed under the terms of the Clean Air Act, and known as the “Clean Power Plan.” Konschnik, who is a Lecturer on Law and Director of the Environmental Policy Initiative at the Harvard Law School, began by explaining the background.

First, the Supreme Court surprised most observers by deciding, in a 5-4 vote, to issue a “stay” on implementation of the CPP until state complaints against the plan could be fully reviewed and decided on by the Court—an action that led many to speculate that the Court would reject the CPP itself by the same vote of 5-4 when the actual case was heard. However, with the subsequent death of Justice Scalia, the likely final decision of the Court—and even when there might be nine justices to reach a decision—is once again extremely difficult to predict. The only known factor is that resolving the issue will take time—two to four years, Konschnik predicted, before a final decision is reached on whether the Clean Power Plan can be implemented.

In light of this uncertainty, Konschnik suggested, it is reasonable to ask whether a discussion of state implementation strategies may be premature. However, Konschnik argued, the current legal limbo of the Clean Power Plan is not unusual for Clean Air Act regulations, which have often proceeded in “fits and starts.” Furthermore, the states themselves have not necessarily put their planning efforts on hold—Konschnik identified twenty states which have declared their intentions to continue planning, and nine other which are still assessing their options.

As Konschnik explained, there are many variables and alternatives for states to consider in making their CPP compliance plans. For example, states can comply by limiting the rate of carbon emissions from the power sector (a “rate-based approach”) or by limiting total carbon emissions from this sector (a “mass-based approach”). They can adopt plans tailored for trading with other states, or plans for compliance without trading. For states that choose to use carbon allowances, these can be allocated free of charge or auctioned.

Further complicating state decisions, Konschnik explained, is a kind of “game theory” dimension to the problem—the best approach for any individual state may depend on what all the other states are doing—but since everyone is planning more or less at the same time, it’s impossible to know with certainty what moves other states will make before committing to a compliance pathway. Konschnik has already noticed certain patterns, however, which could point to potential problems for states. For example, Konschnik notes, she has heard many states express interest in selling emissions reduction credits (ERCs) to other states—but no states which express much interest in buying ERCs. Other considerations that may impact choices made by states could have to do with political calculations. Where new legislation aimed at CPP compliance will be hard to pass, states may opt for approaches that do not require legislative action—simplifying the compliance process, but potentially making certain compliance strategies, such as auctioning of emission reduction credits, harder to adopt.

...The success of the COP21 Paris meeting, and of every future COP, must be evaluated not only by levels of national commitments, but also by looking at how the various commitments will lead to the proliferation of non-fossil energy systems, and ultimately to the point when zero-carbon energy systems become the obvious choice for everyone.

– Daniel Schrag, Sturgis Hooper Professor of Geology, Professor of Environmental Science and Engineering at Harvard University, and Co-Director of the Harvard University Center for the Environment, and of the Science, Technology and Public Policy Program at the Belfer Center for Science and International Affairs at the Harvard Kennedy School, with co-authors Peter Clark et al., in “Consequences of Twenty-First-Century Policy for Multi-Millennial Climate and Sea-Level Change.” Nature Climate Change 6, no. 4 (April 2016): 360–69.

**Mauricio Arias**

Giorgio Ruffolo Post-doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School

*Research Topic:* Tradeoffs between hydropower and river alterations in the Amazon River Basin

Dr. Mauricio Arias’s work at Harvard is based at the Harvard’s Department of Organismic and Evolutionary Biology. His research aims at creating science-based linkages between the hydrological cycle, ecosystems, and society in order to promote sustainable management of water resources. He has studied physical, biological and chemical properties of freshwater ecosystems in Colombia, the United States, China, New Zealand, and most recently in Cambodia, where he carried out his doctoral research. Mauricio is investigating the effect of hydropower operations in river flows and how hydrological alterations through the Amazon basin could be mitigated while maintaining electricity generation needs. Mauricio holds a Bachelor of Science (Magna Cum Laude) and a Masters of Engineering in Environmental Engineering Sciences from the University of Florida. He recently completed a PhD in Civil Engineering from the University of Canterbury in New Zealand, where he was awarded UC’s International Doctoral Student Scholarship. Mauricio’s doctoral research focused on the Mekong River Basin, where he quantified the impacts of hydropower development and climate change on the hydrology and ecology of the Tonle Sap, Southeast Asia’s largest lake and one of the most productive freshwater fisheries on the planet. His faculty host is Paul Moorcroft.

**Sarah Armitage**

Fellow, Harvard Environmental Economics Program

Pre-doctoral Fellow, Harvard Environmental Economics Program

PhD student in Political Economy and Government

Sarah’s research interests center around the economics of environmental regulation, energy economics, and industrial organization. She holds an M Phil in Economic and Social History from the University of Cambridge, where she was a Gates Cambridge Scholar, and a BA in history from Yale University. She previously worked as a consultant with the
Fellows

Patrick Behrer

Pre-doctoral Fellow, Harvard Environmental Economics Program
PhD student in Public Policy

Patrick Behrer holds an AB in economics from Harvard University and a MS in resource economics from Colorado State University. While an undergraduate at Harvard, Patrick won the Harvard Environmental Economics Program’s 2010 James M. and Cathleen D. Stone Prize for the Best Senior Thesis. He also spent a year in New Zealand as a Fulbright Fellow studying environmental policy. His research interests lie in the valuation of ecosystem services and the institutional or programmatic design necessary to fully integrate the value of these services into a modern economy. Additionally, he is interested in land use policy and creative mechanisms for financing conservation projects, particularly in developing countries.

Jonathan Buonocore

Program Leader, Climate, Energy, and Health, Center for Health and the Global Environment

Research topic: Evaluating the impacts, benefits, and tradeoffs of technology and policy choices in energy, transportation, agricultural practices, and climate change mitigation and adaptation.

Presently, Jonathan is working with the Climate, Energy, and Health team to better understand the health and environmental risks of hydraulic fracturing in Pennsylvania’s Marcellus Shale, and also researching the health and climate benefits of renewable energy, energy efficiency, and other carbon mitigation methods. By exploring the tradeoffs between different technologies, methods of pollution control, and policy options, Jonathan and the team will develop research-based recommendations designed to help policymakers, investors, leaders of industry, and residents of affected areas make informed decisions that will support public health and a healthy environment. Jonathan is also working with Center faculty to estimate the health impacts of particulate exposure due to fires in Indonesia, including particulate matter that crosses international boundaries.

Megan Bailey

Research Topic: Greenhouse gas policies

Megan Bailey seeks to evaluate the environmental efficacy and economic efficiency of policy options for curbing greenhouse gas emissions, such as carbon taxes and cap-and-trade systems, at both national and international levels. Additionally, she is interested in the non-market valuation of ecosystem services, particularly those at risk of being lost via ecological collapse. Megan holds a BS in ecology, evolution, and organismal biology; a BA in art; and an MA in international relations from California State University, Fresno. She is the recipient of a National Science Foundation Graduate Research Fellowship.

Anca Balietti

Anca Balietti is a Post-Doctoral Research Fellow at Evidence for Policy Design (EPoD) at the Harvard Kennedy School. Anca graduated with a Master’s of Science in Financial Engineering and Risk Management at HEC Lausanne, Switzerland. She then obtained her PhD from the University of Zurich, where her research focused on the economics of climate change mitigation. Her research interests are environmental and resource economics, market failures, real options, and health and development economics. Anca is currently working on several projects focused on the impact of environmental policy interventions on the health and wealth levels of individuals in India, Bangladesh, and Peru.

Fellows

Environmental consulting firm Industrial Economics, Inc. (IEc), and as a research assistant at MIT’s Center for Energy and Environmental Policy Research (CEEPR).

Megan Bailey

Pre-doctoral Fellow, Harvard Environmental Economics Program
PhD student in Public Policy

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Lizzie Burns

Research Fellow, Harvard School of Engineering and Applied Sciences
Research Topic: Geoengineering

Lizzie Burns is a Research Fellow at Harvard, where she works for Professor David Keith on issues related to geoengineering. Lizzie is passionate about working on issues of climate change, and previously spent a summer interning for the White House Council on Environmental Quality. She also previously worked for the nonprofit organization, Opportunity Nation. Lizzie earned a Master in Public Policy degree from the Harvard Kennedy School and a Bachelor of Arts degree from Williams College.

Daniel Edward Callies

Predoctoral Research Fellow, Science, Technology, and Public Policy Program
Research Topic: The ethics, legitimacy, and justice of solar radiation management

Daniel Callies is a predoctoral research fellow in the Belfer Center’s Science, Technology, and Public Policy Program, a PhD candidate in political science at Goethe University Frankfurt am Main, a predoctoral researcher at Goethe University’s Cluster of Excellence “Normative Orders,” and a research associate at the Agenda for International Development. His dissertation addresses moral and political concerns surrounding climate engineering. He studied philosophy at San Diego State University where he was awarded his BA in 2008 and his MA in 2012. His research focuses on normative and applied ethics, global justice, and climate justice.

Rohit Chandra

Fellow, Harvard Environmental Economics Program
PhD Student in Public Policy

Rohit Chandra’s research focuses on the history, evolution, and dynamics of energy markets in India. In particular, he looks at the multiple roles of the state as owner, regulator, consumer, and planner. His dissertation focuses in particular on the Indian coal industry, constructing a state capitalism framed history of the industry from 1960-2005. He graduated from the University of Pennsylvania with a degree in electrical engineering and has worked at the Centre for Policy Research in New Delhi and the Center for Advanced Study of India in Philadelphia.

Cuicui Chen

Fellow, Harvard Environmental Economics Program
PhD Candidate in Public Policy
Research Topic: Industrial organizations, environmental economics, microeconomic theory

Cuicui Chen is interested in firms’ behavior under market-based regulations. In her dissertation she is investigating how electric generating companies have learned over time to comply with (or better yet, take advantage of) the Acid Rain Program, the first large-scale market-based environmental regulation in U.S., and how that learning process might have been affected by Public Utilities Commissions’ regulation and deregulation. Cuicui is also using insights from microeconomic theory in the study of international climate agreements. She graduated from Tsinghua University in 2010 with a Bachelor’s degree in Environmental Engineering, and from the Massachusetts Institute of Technology in 2012 with a Master of Science degree in Technology and Policy.

Marinella Davide

Giorgio Ruffolo Research Fellow in Sustainability Science/Environment and Natural Resources Program
Research Topic: EU climate change policy, international climate negotiations, energy poverty

Marinella Davide is a predoctoral research fellow on topics related to EU climate and energy policy and international negotiations. She is a PhD candidate in Climate Change Management at the Ca’Foscari University of Venice, where she investigates the linkages between climate change, poverty reduction and sustainable development. Her current research focuses on the impacts of the contributions undertaken under the recently-adopted Paris Agreement (the so-called INDCs) on poverty and inequality. Since
John DeVillars
Senior Fellow, Mossavar-Rahmani Center for Business and Government

Research Topic: Getting Ahead of the Mob and Calling It a Parade: Electric Utility Leadership for a Clean Energy Economy

John DeVillars is a clean energy and environmental professional with substantial leadership experience in both the public and private sectors. He is currently Chairman of BlueWave Capital LLC, a solar energy development and investment firm with $200M in utility-scale assets in North America, the Caribbean, and South Africa and a residential solar loan program offered in selected markets in the United States. Mr. DeVillars has held several executive positions in the public sector including New England Administrator of the U.S. Environmental Protection Agency, Massachusetts Secretary of Environmental Affairs, Chief of Operations to the Governor of Massachusetts, and Chairman of the Board of the Massachusetts Water Resources Authority. At E.P.A. Mr. DeVillars launched a number of nationally-recognized initiatives including the establishment of the nation’s first regional Center for Environmental Industry and Technology; the Urban Environment Initiative which targeted EPA resources to address inner city health and environmental challenges; and the Clean Charles Initiative, a multi-stakeholder effort which has led to the Charles River reaching swimmable water quality standards. As the Commonwealth’s Environmental Secretary, he directed 3,500 employees and the $400 MM operating and capital budgets of five regulatory and natural resource agencies and pioneered advances in pollution prevention, air quality, wildlife protection, and market-based approaches to financing and regulating environmental activities. As Chairman of the MWRA Board of Directors, Mr. DeVillars was deeply involved in the six-billion-dollar cleanup of Boston Harbor, at the time the largest public works project in New England’s history. Mr. DeVillars has won numerous awards for his public service including the Nature Conservancy’s President’s Award for national environmental leadership. He serves as a member of the Board of Directors of several private companies and non-profit organizations including the E.P.A.’s National Advisory Council on Environmental Policy and Technology.

Sebastian D. Eastham
NOAA Climate and Global Change Fellow, 2015-2017

Sebastian David Eastham is an environmental scientist interested in the transport and impacts of pollutants and trace species over long distances through the atmosphere.

Sebastian received an MEng in aerospace and aerothermal engineering from Cambridge University in 2011, with a dissertation on nuclear fuel cycle optimization. Between 2011 and 2015 he studied at MIT’s Laboratory for Aviation and the Environment, working on a PhD in aeronautics and astronautics dedicated to the human health impacts of high altitude emissions. This work included integration of stratospheric chemistry and physics into the Harvard GEOS-Chem atmospheric model, development of a health impacts model and assessment of the long-term surface air quality and UV radiation impacts of both aviation and proposed sulfate aerosol geoengineering techniques. He received his PhD from the MIT Department of Aeronautics and Astronautics in 2015.

Sebastian will be working with Daniel Jacob in the School of Engineering and Applied Sciences to investigate the failure of Eulerian atmospheric models to reproduce observed synoptic-scale transport of pollution in narrow plumes and quasi-horizontal layers. Although a typical response to low model fidelity has been to increase global grid resolution and thereby incur significant computational cost, Sebastian is exploring the theoretical causes for enhanced numerical dissipation in these atmospheric structures. The goal of this research is to identify new and efficient modeling techniques capable of accurately reproducing and maintaining the observed high chemical gradients over global distances without requiring prohibitively fine global grid resolutions. By enabling accurate representation of long-distance pollutant transport and chemistry, Sebastian hopes to improve model accuracy with regards to inter-continental impact attribution.
Fabio Farinosi

Giorgio Ruffolo Doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School

Research Topic: Vulnerability of hydropower generation to changes in climate, hydrology and land use in Brazil

Fabio Farinosi’s fellowship research is based at the Harvard’s Department of Organismic and Evolutionary Biology. He is a doctoral student in the Science and Management of Climate Change Programme at Ca’ Foscari University in Italy. His research assesses the impacts of global changes in climate, combined with regional changes in land use and hydrology in the Amazon, on flood risk and hydropower generation in Brazil. The project aims to provide policy makers with a better understanding of the expected future impacts and enhance long-term mitigation strategies. Fabio is contributing to the collaborative Initiative on Sustainable Development of the Amazon and Its Surrounding Regions: The Interplay of Changing Climate, Hydrology, and Land Use, led by Professor Paul Moorcroft.

Orit Farkash-Hacohen

Visiting Fellow, Harvard Electricity Policy Group

Orit Farkash-Hacohen is a visiting fellow with the Harvard’s Electricity Policy Group (HEPG) at the Harvard Kennedy School. Prior to her appointment, Orit served as Chair of the Israeli Electricity Authority (PUA) between 2011 and 2016 and was the first woman to be appointed to this position. In her capacity as the PUA’s chair Farkash-Hacohen was the spearhead of the Israeli government’s resolution to introduce private players into the electricity market. Following 80 years of a complete monopoly in the electricity market, Orit led a historic change, bringing in private power producers in significant numbers (40%). The PUA set up and enforced regulations to support investment, forcing the introduction of private power producers into the market. Farkash-Hacohen was also instrumental in cultivating the private solar industry and opposed natural gas contracts negotiated under effectively monopoly conditions. She led the PUA during the biggest gas shortage Israel had ever known in 2011-2013 and pushed forward energy efficiency arrangements and a better resource allocation between the market players. Prior to this position Farkash-Hacohen served as the Chief Legal Advisor to the Authority (2003-2011). Before that, since 1998, she was a leading litigator at the Israeli Antitrust Authority, handling antitrust law violations and implementations. Previously, she was an attorney in one of Israel’s prominent law firms. Farkash-Hacohen holds an MPA from Harvard’s Kennedy School (2007) and an LLB from the Hebrew University in Jerusalem. Her professional internship took place at the Israel Supreme Court in Jerusalem, where she clerked for Justice Dorner.

Under the guidance of Prof. Bill Hogan and Prof. Ashley Brown, Orit is writing a paper reflecting her unique professional experience in her last position as the Israeli PUA Chair in introducing private players into poorly structured and monopolistic electricity and gas markets. The paper elaborates the inefficiencies borne by the public as a result of the gas supply monopoly and looks for institutional lessons regarding the proper role and authority of independent and professional regulatory bodies.

Nathan Fleming

Fellow, Harvard Environmental Economics Program
PhD student in Public Policy

Research Topic: Understanding how access to natural resources affects national security and potentially drives conflict

Nathan Fleming is interested in natural resource economics and security studies. Specifically, he is interested in understanding how access to natural resources affects national security and potentially drives conflict. He also has a related interest in manufacturing firm strategies for securing critical materials. He began his career as a mechanical engineer. He designed aircraft engines at General Electric for five years before returning to school to earn SM degrees in mechanical engineering and Technology & Policy at MIT.
Todd Gerarden
Fellow, Harvard Environmental Economics Program
PhD student in Public Policy
Research Topic: Renewable energy investment incentives and energy efficiency
Todd's interests lie at the intersection of energy and environmental economics, public economics, and industrial organization. His current research focuses on energy efficiency and government incentives for renewable energy investment. Todd obtained a BS in Mechanical Engineering from the University of Virginia in 2010. He is a recipient of the EPA STAR Fellowship and a Truman Scholar. Before beginning doctoral studies, Todd worked at the White House Office of Science and Technology Policy and Resources for the Future.

Gianfranco Gianfrate
Giorgio Ruffolo Research Fellow in Sustainability Science, Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, Harvard Kennedy School
Research Topic: Innovation financing, carbon finance, and the integration of environmental footprint metrics in corporate valuation
Gianfranco Gianfrate writes and researches on topics related to innovation financing, carbon finance, and the integration of environmental footprint metrics in corporate valuation. Prior to joining the Belfer Center, Gianfranco was an Assistant Professor of Finance at Bocconi University (Milan, Italy) and a manager at Hermes Investment Management (London, UK). Gianfranco is a research affiliate of the Aspen Institute and of SovereigNET at Tufts Fletcher School. He holds a PhD in Business Administration from Bocconi University.

Anna P. Goldstein
Postdoctoral Research Fellow, Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, Harvard Kennedy School

Research Topic: Movement of clean energy technology from the lab to the marketplace
Anna Goldstein’s research at the Belfer Center focuses on ways that governments, universities, and corporations can accelerate the movement of clean energy technology from the lab to the marketplace. Anna received her PhD in 2014 in Chemistry with an emphasis in Nanoscale Science and Engineering from the University of California, Berkeley, where she investigated nanomaterials for use in energy applications, such as artificial photosynthesis and electrochemical energy storage.

Yue Guo
Postdoctoral Research Fellow, Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School
Research Topic: The social acceptance of new energy technology innovation
Yue Guo is a postdoctoral research fellow with the Project on Managing the Atom. He received his PhD degree in Public Management from Tsinghua University, China, in July 2015.

Olli Heinonen
Senior Fellow, Belfer Center for Science and International Affairs, Harvard Kennedy School
Olli Heinonen’s research and teachings include nuclear non-proliferation and disarmament, verification of treaty compliance, enhancement of the verification work of international organizations, and transfer and control of peaceful uses of nuclear energy.
Before joining the Belfer Center in September 2010, Olli Heinonen served 27 years at the International Atomic Energy Agency in Vienna. Heinonen was the Deputy Director General of the IAEA, and head of its Department of Safeguards. Prior to that, he was Director at the Agency’s various Operational Divisions, and, as inspector, including at the IAEA’s overseas office in Tokyo, Japan, Heinonen led teams of international investigators to examine nuclear programmes of concern around the world and inspected nuclear facilities in South Africa, Iraq, North Korea, Syria, Libya and elsewhere, seeking to ensure that nuclear materials were not diverted for military purposes. He also spearheaded efforts to implement an analytical culture to guide and complement traditional verification activities. He led the Agency’s efforts to identify and dismantle nuclear proliferation networks, including the one led by Pakistani scientist A.Q. Khan, and he oversaw its efforts to monitor and contain Iran’s nuclear programme.

Heinonen is the author of several articles, chapters of books, books, in publications ranging from the IAEA and nuclear non-proliferation issues, to regional nuclear developments. His writings and interviews have been published in various newspapers and magazines including: Foreign Policy, The Wall Street Journal, the Guardian, the Bulletin of the Atomic Scientists, Arms Control Today, Der Spiegel, Le Monde, the Helsingin Sanomat, the New York Times, the Mehr news, Die Stern, the Haaretz, the New Statesman, the Washington Post, the BBC, and Time. His policy briefings have been published by the Belfer Center, the Atlantic Council, the Nautilus Institute, the Institute for Science and International Security, the Nonproliferation Policy Education Center, the Washington Institute for Near East Policy, and the Carnegie Endowment.

Olli Heinonen studied radiochemistry and completed his PhD dissertation in nuclear material analysis at the University of Helsinki.

Evan Herrnstadt
Kernan Brothers Environmental Fellow, 2015-2017
Evan Herrnstadt is an economist interested in the design and performance of energy and natural resource markets.

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Mun Ho
Visiting Scholar, Harvard China Project, SEAS
Visiting Scholar, Institute for Quantitative Social Science
Research Topic: Economic effects of environmental policies in the U.S. and China

Mun Ho is an economist in the Harvard China Project’s integrated research of the environmental, health and economic impacts of emission control options in China. He has a PhD in economics from Harvard University and is also a visiting scholar at Resources for the Future in Washington, DC. He and others at the China Project have developed an economic growth model of China to study the impact of environmental policies and carbon taxes, and studied household energy demand patterns. He also works with Dale Jorgenson of the Economics Department in studying the distributional impacts of carbon policies in the U.S.

Stuart Iler
HEEP Pre-Doctoral Fellow
PhD student in Public Policy
Stuart is interested in environmental and energy economics and policy, and in
Andrea Innamorati
Research Fellow, Environment and Natural Resources Program

Andrea Innamorati is a Senior Policy Advisor for the Italian Ministry of Environment. He represented Italy in numerous intergovernmental processes, including the intergovernmental negotiations on the 2030 Agenda.

Andrea has a Master’s-level education in Sociology from the University “La Sapienza” in Rome, where he researched consumption patterns and mass communication and their impact on the future of our planet. His research will focus on the 2030 Agenda and on how the sustainable development goals will be integrated into existing policy tools and strategic frameworks at the EU level.

Mehul Jain
Center for Public Leadership Fellow, Harvard Kennedy School

Mehul Jain is a graduate of the Environmental Engineering Program from the Massachusetts Institute of Technology. Over the past four years of his career he has worked on issues of policy, governance, environment, education and development with the World Bank, particularly focusing his attention to the National Ganga River Basin Clean-up project in India. Leveraging his experience in the development sector, Mehul has also advised politicians from Haryana, Rajasthan, Bihar and Uttar Pradesh. Making development the centerpiece of election campaigns he has been able to provide strategic insight to the associated political parties. These engagements have also allowed him to advise and run effective social media campaigns for the parties. A couple of these campaigns have been lauded as the most successful election campaigns in India. In the past, Mehul has also consulted for organizations such as CSE, TERI, PATH and UNICEF. He is currently pursuing the MPA/ID program at the Kennedy School.

Ajinkya Shrish Kamat
Postdoctoral Research Fellow, Science Technology and Public Policy Program/Innovation and Policy Project, Belfer Center for Science and International Affairs, Harvard Kennedy School

Ajinkya Kamat is a postdoctoral research fellow in the Belfer Center’s Science Technology and Public Policy Program’s Technology & Innovation project. His research interests include policy issues related to higher education and research institutions, industrial R&D, startups and linkages among different players in a technology innovation ecosystem, with main focus on India and China. Ajinkya is currently investigating how R&D centers set up in India by foreign multinational companies (MNCs) influence capabilities across India’s technology innovation ecosystem and in what ways policy could contribute positively in this area.

He earned his PhD in physics from the University of Virginia in May 2015. Ajinkya also holds an MSc in physics from Indian Institute of Technology Bombay, India and a BSc in physics from the University of Mumbai, India, where he secured the top rank at the university.

Melissa Kemp
National Science Foundation Environmental Fellow, 2015-2017

Melissa Kemp is an evolutionary biologist who uses the fossil record and historical data to investigate species responses to global change phenomena.

Melissa earned her BA in biology from Williams College in 2010 and her PhD in biology from Stanford University in 2015.
At Williams, she studied the phytogeography of Indo-Pacific clownfish and the population genetics of chorus frogs. Her doctoral dissertation assessed the impact of environmental perturbations on the ecology and evolution of Caribbean lizards at three scales: (1) the regional scale, by evaluating and modeling extinction processes; (2) the community scale, by elucidating the interplay of species richness and species abundance over time; and (3) the species-scale, by assessing genetic responses to biotic and abiotic perturbations.

As an Environmental Fellow, Melissa will work with Jonathan Losos of the Department of Organismic and Evolutionary Biology to investigate how past global change forces have altered species distributions in Anolis lizards. This will reveal population trajectories before, during, and after environmental perturbations are encountered, and provide a framework for evaluating future range shifts.

Shefali Khanna

HEEP Pre-Doctoral Fellow
PhD student in Public Policy

Shefali’s interests lie at the intersection of environmental policy and energy sector development in emerging economies, specifically on the role of renewable energy and energy efficiency incentives in expanding energy access and improving reliability. She graduated from the University of Maryland, College Park, with a BA in Economics and spent two years working as a research assistant at Resources for the Future, where her research focused on residential energy efficiency and vehicle fuel economy standards in the U.S. She also assisted the World Bank in updating its protocol for estimating global health damages from ambient air pollution.

Jing Li

HEEP Pre-Doctoral Fellow
PhD student in Economics

Jing’s research is focused in industrial organization and environmental economics. Jing’s current projects are on network effects in the adoption of electric vehicles and on biofuel regulation. Jing graduated from the Massachusetts Institute of Technology in 2011 with a BS in Economics and a BS in Mathematics and Computer Science.

Zhenyu Li

Postdoctoral Research Fellow, Science, Technology, and Public Policy Program/Water-Energy Nexus Project, Belfer Center for Science and International Affairs, Harvard Kennedy School

Research Topic: Application of innovative membrane technology and renewable energy for water desalination and reuse

Dr. Zhenyu Li is a postdoctoral research fellow for Water-Energy Nexus project in the Belfer Center’s Science, Technology, and Public Policy Program. Before joining the Belfer Center, Zhenyu was a research scientist in Water Desalination and Reuse Center at King Abdullah University of Science and Technology in Saudi Arabia.

His research focuses on the application of innovative membrane technology and renewable energy for water desalination and reuse. He holds a PhD in biotechnology from Prince of Songkla University, Thailand.

Stephanie Lo

Pre-doctoral Fellow, Harvard Environmental Economics Program
PhD student in Economics

Stephanie’s research interests include the intersection of behavioral economics, macroeconomics, economics of environmental regulation, and energy economics. She is particularly interested in measuring the macroeconomic implications of changes in environmental policy and the subsequent changes in energy usage and pricing. She is also interested in using behavioral economics to understand the potential for unintended firm behavior resulting from environmental regulations. Stephanie graduated from Harvard with a B.A. in economics in 2010 and spent the past two years trading natural gas at a proprietary trading firm, spending a significant portion of her time trying to understand environmental regulations and their impact on firm-level decisions of drillers and producers in the industry and overall effect on natural gas supply and pricing.
The framework defines an electric system climate policy challenge as closing the gap between expected electric system CO2 emission footprint and the CO2 emission footprints aligned with the recommendations of climate scientists within the available window of opportunity.

The research finds that meeting the climate policy challenge requires a developed economy electricity sector to lead by example. To do this requires supporting the electricity needs of a modern electric intensive lifestyle while meeting CO2 emission footprint policy targets.

A case study of California electric climate policy initiatives employs the CO2 emission footprint analysis framework as a metric for policy evaluation. The case study identifies California electricity sector climate initiative shortcomings and examines lessons regarding climate policy formulation, implementation and evaluation.

The research concludes with an assessment of the least cost combination of demand and supply side options that can move the US electricity sector to demonstrate how to support the electricity needs of a modern electric intensive lifestyle while meeting CO2 emission footprint policy targets.

Zhimin Mao

Giorgio Ruffolo Postdoctoral Research Fellow in Sustainability Science, Environment and Natural Resources Program, Belfer Center for Science and International Affairs, HKS

Zhimin Mao is a Postdoctoral Fellow at the Belfer Center's Environment and Natural Resources Program with a focus on China's low carbon development. Prior to joining the Belfer Center, Zhimin was a Ph.D. fellow at the Pardee RAND Graduate School and an assistant policy analyst at the RAND Corporation. Her research interests include climate change adaptation, energy and environment policy, and economic development. Her RAND experience includes interdisciplinary research on decision making under deep uncertainty, energy and climate change policy, and international development. Example projects include two World Bank-funded projects: one to enhance the climate resilience of Africa’s energy and water infrastructure, and
the other to help Ho Chi Minh City evaluate its flood control plan in the face of global climate change. Other research experience includes analyzing technical and economic tradeoffs of various plant configurations of concentrated solar power in India for investors and policy makers; development of an indicator system that evaluates a country’s Food-Energy-Water security index; as well as several projects related to China’s urban development, natural resources, and environment governance challenges. Prior to RAND, she worked at the Heinz Center, the University Corporation for Atmospheric Research, and the Asian Development Bank.

Laura J. Martin
Ziff Environmental Fellow, 2015-2017

Laura Jane Martin is a historian and ecologist who studies the cultural and political dimensions of ecological management. Laura earned an ScB in biophysics from Brown University in 2006, an M.S. in natural resources from Cornell University in 2010, and a PhD in natural resources from Cornell in 2015. While at Cornell, she received national fellowships in both the sciences and the humanities. Through fieldwork, she studied the impact of human activities on the ecology and evolution of wetland species, publishing in Journal of Ecology, Conservation Biology, Trends in Ecology and the Environment, and elsewhere. Through archival research, she investigated the history of ecological restoration in the 20th century United States. Her current work is situated at the nexus of environmental history and science & technology studies.

As an Environmental Fellow, Laura will work with Peter Galison from the Department of the History of Science. She plans to develop her dissertation research into a book that explores how ecological restoration became such a widespread and important environmental practice. She will also begin a project on the use of counter-terrorism technologies for international biodiversity protection. By fostering conversations among scientists and humanists, Laura hopes to generate research that can guide 21st century environmental management.

Leonardo Maugeri
Senior Fellow, Geopolitics of Energy Project, Belfer Center for Science and International Affairs, Harvard Kennedy School

Leonardo Maugeri is currently a Senior Fellow with the Geopolitics of Energy Project and the Environment and Natural Resources Program at the Harvard Kennedy School’s Belfer Center for Science and International Affairs. One of the world’s foremost experts on oil, gas, and energy, Maugeri has been one of the most distinguished top managers of Eni, the largest Italian company, which is also ranked number 6 among the largest international oil companies. At Eni, he held the position of Senior Executive Vice President of Strategies and Development (2000–2010) and eventually became Executive Chairman of Polimeri Europa, Eni’s petrochemical branch (March 2010–June 2011). In 2008, Maugeri promoted the strategic alliance between Eni and the Massachusetts Institute of Technology (MIT), which—among other outcomes—led to the establishment of the Eni-MIT Solar Frontiers Center in 2010.

Nathaniel Mueller
National Science Foundation Postdoctoral Fellow

Research Topic: Statistical modeling of the relationship of climate and crop yield

Nathan Mueller is an applied ecologist who studies how agricultural systems influence – and are influenced by – global environmental change. During his two-year fellowship, Nathan is working with Peter Huybers of the Department of Earth and Planetary Sciences and Noel Michele Holbrook of the Department of Organismic and Evolutionary Biology to improve statistical models relating climate to crop yield. His work also investigates the interaction between changing agricultural management practices and climate using recently compiled time-series data.
**Fellows**

**Janhavi Nilekani**

*Giorgio Ruffolo Doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School*

*Fellow, Harvard Environmental Economics Program*

*PhD Student in Public Policy*

Janhavi Nilekani is a Giorgio Ruffolo Doctoral Research Fellow in the Sustainability Science Program and a doctoral candidate in the Public Policy Program at Harvard’s Kennedy School of Government. Her research focuses on evaluating the relative costs and benefits of different policy instruments for controlling environmental pollution, with an emphasis on India. Janhavi is contributing to collaborative work by the Initiative on Building Public-Private Partnerships to Promote Sustainable Development in India led by Professor Rohini Pande. Janhavi received her BA, cum laude, in economics and international studies and the Ronald Meltzer/Cornelia Awdziewicz Economic Award from Yale University in 2010. She has worked as a research associate on a pilot emissions trading program for Indian industry at the Jameel Poverty Action Lab-South Asia (2011-2012). Her faculty host is Rohini Pande.

**Dayea Oh**

*Pre-doctoral Fellow, Harvard Environmental Economics Program*

*PhD student in Public Policy*

Research Topic: Energy economics, Electric power market design

Dayea's research interests are energy economics and industrial organization. She is especially interested in the electricity market, on the regulation design and improving the efficiency and stability of the power grid. Prior to enrolling at Harvard, Dayea studied mathematical economics at Rice University and applied economics at Cornell University. Her master's thesis was about welfare analysis of California renewable electricity policies, where she claimed the interaction effects between the federal level fiscal incentives and state level regulations designed to encourage renewable electricity producers are in fact negative when they coexist.

**Lucy Page**

*Research Fellow, Evidence for Policy Design (EPoD)*

Lucy Page is a Research Fellow at Evidence for Policy Design (EPoD) at the Harvard Kennedy School, where she works with Professor Rohini Pande. Lucy is interested in the intersection of environmental and development economics, particularly in the economic impacts of climate change. At EPoD, her research explores the impacts of India's environmental clearance regulations and the design of policies governing reconstruction after natural disasters, focusing on reconstruction of housing following the 2015 earthquake in Nepal. Prior to joining EPoD, Lucy consulted with the EPA and the World Bank on climate change economics while at Industrial Economics, Inc., studied wildlife management in Mongolia, and wrote a senior thesis on the impacts of temperature on the rate of occupational accidents in the US. Lucy holds a BA in Mathematics from Williams College.

**Nick Obradovich**

*Postdoctoral Fellow, Science, Technology, and Public Policy Program*

Research Topic: Climate change impacts and adaptation

Nick Obradovich is a postdoctoral fellow in the Belfer Center's Science, Technology, and Public Policy Program. He studies climate-change politics and the potential impacts of climate change on social systems. He is also a research scientist at the MIT Media Lab and a Human-Environmental Systems Fellow at Scripps Institution of Oceanography.

Nick received his PhD in political science from the University of California, San Diego and his BS, summa cum laude, in Economics and Environmental Studies from Santa Clara University.
Jisung Park

Fellow, Harvard Environmental Economics Program
PhD student in Economics

Jisung Park is a PhD candidate in the economics department at Harvard University, where he specializes in environmental economics, public, and labor economics. His research focuses on how climate change may affect human development, including labor productivity and human capital impacts of heat stress.

Jisung is also an economics and public service tutor at Eliot House, one of Harvard’s undergraduate houses, and teaches Principles of Economics (Ec-10) with Greg Mankiw, as well as American Economic Policy (Ec-1420) with Martin Feldstein, Larry Summers, and Jeff Liebman. He has also taught Environmental Economics (Ec-1665) with Robert Stavins.

A native of Lawrence, Kansas, and Seoul, South Korea, he received his undergraduate education in economics and political science from Columbia University (’09), and attended Oxford for two successive Masters programs in Environmental Change and Management (’10) and Development Economics (’11) on a Rhodes Scholarship (New York District, 2009).

Wei Peng

Giorgio Ruffolo Postdoctoral Research Fellow in Sustainability Science, Environment and Natural Resources Program

Research fields: Energy-air pollution-water-carbon nexus; Integrated assessment; China’s energy governance

Wei’s research focuses on integrating air quality, water and climate concerns into China’s energy strategy. She examines a variety of energy policies in China, and studies potential synergies and tradeoffs to simultaneously achieve air pollution, water conservation and carbon mitigation goals. She is also interested in the distributional effects of energy and environmental policies. She holds a PhD in Public Policy from the Woodrow Wilson School of Public and International Affairs at Princeton University and a BS in Environmental Sciences from Peking University in China. She was a Woodrow Wilson Scholar and Princeton Energy and Climate Scholar.

Ari Peskoe

Senior Fellow in Electricity Law, Environmental Policy Initiative, HLS

Research Topic: Interplay between federal and state regulators over the electricity sector and regulation of distributed energy resources

Ari Peskoe is the Senior Fellow in Electricity Law at the Policy Initiative. He currently focuses on the roles of federal and state regulators and tracks legal challenges to state electricity policies. In addition, Ari also researches emerging regulatory structures for distributed energy resources, particularly rooftop solar. Prior to the Policy Initiative, Ari was an associate at a law firm in Washington, DC, where he litigated before the Federal Energy Regulatory Commission about the western energy crisis. He received his JD from Harvard Law School and graduated from the University of Pennsylvania with degrees in electrical engineering and business.

Daniel Poneman

Senior Fellow, Belfer Center for Science and International Affairs, Harvard Kennedy School

Daniel Poneman is a Senior Fellow with the Belfer Center. Prior to his appointment in October 2014, Poneman had been Deputy Secretary of Energy since 2009, in which capacity he also served as Chief Operating Officer of the Department. Between April 23, 2013, and May 21, 2013, Poneman served as Acting Secretary of Energy.

Poneman’s responsibilities at the Department of Energy spanned the full range of President Obama’s all-of-the-above energy strategy, including fossil and nuclear energy, renewables and energy efficiency, and international cooperation around the world. He led 2009 negotiations to address Iran’s nuclear program and participated in the Deputies’ Committee at the National Security Council. He played an instrumental role in the Department’s response to crises from Fukushima to the Libyan civil war to Hurricane Sandy, and led the Department’s efforts to strengthen emergency response and cybersecurity across the energy sector.

Poneman first joined the Department of Energy in 1989 as a White House Fellow. The next year he joined the National Security Council staff as Director of Defense...
Policy and Arms Control. From 1993 through 1996, Poneman served as Special Assistant to the President and Senior Director for Nonproliferation and Export Controls at the National Security Council. Prior to assuming his responsibilities as Deputy Secretary, Poneman served as a principal of The Scowcroft Group for eight years, providing strategic advice to corporations on a wide variety of international projects and transactions. Between tours of government service, he practiced law for nine years in Washington, D.C. – first as an associate at Covington & Burling, later as a partner at Hogan & Hartson.

Poneman received AB and JD degrees with honors from Harvard University and an M.Litt in Politics from Oxford University. He has published widely on energy and national security issues and is the author of Nuclear Power in the Developing World and Argentina: Democracy on Trial. His third book, Going Critical: The First North Korean Nuclear Crisis (coauthored with Joel Wit and Robert Gallucci), received the 2005 Douglas Dillon Award for Distinguished Writing on American Diplomacy. Poneman is a member of the Council on Foreign Relations.

Tao Ren

*Predoctoral Research Fellow, Science, Technology, and Public Policy Program*

Tao REN is a predoctoral research fellow in the Belfer Center's Science, Technology, and Public Policy Program, a Ph.D. candidate in public policy at Tsinghua University (THU), and a research fellow at THU’s Center for Science, Technology, and Education. He researches topics related to intergovernmental relationships, collaborative governance, process of decision-making, and social network analysis. His doctoral dissertation analyzes why and how Chinese government departments coordinate with each other in the field of low-carbon policy by conducting social network analysis.

Kevin Rowe

*Pre-doctoral Fellow, Harvard Environmental Economics Program*

Kevin Rowe is a PhD student in Public Policy at Harvard University, a Pre-doctoral Fellow of the Harvard Environmental Economics Program, and a PhD Affiliate of Evidence for Policy Design (EPoD). He is interested in environmental and energy economics and policy, particularly in developing countries. Prior to beginning his PhD, Kevin was a Research Fellow at EPoD at Harvard, where he worked on randomized field evaluations of reforms to air and water pollution control policies in India. Kevin has a Master in Public Policy from Harvard University and a Bachelor of Arts in Government from Hamilton College. Following his undergraduate degree, Kevin was a Thomas J. Watson Fellow and worked at the World Resources Institute.

Cristine Russell

*Senior Fellow, Environment and Natural Resources Program & Adjunct Lecturer in Public Policy*

Research Topic: The future of science writing and how to improve news media coverage of controversial science, environment, energy and health issues.

Cristine Russell is an award-winning freelance journalist who has written about science, health, and the environment for more than three decades. She was a former national science reporter for The Washington Post and The Washington Star and currently writes for publications such as Columbia Journalism Review. She is the immediate past President of the Council for the Advancement of Science Writing, and a past president of the National Association of Science Writers. She is an honorary member of Sigma Xi, the scientific research society, and has a biology degree from Mills College. She was a Spring 2006 Fellow at the Harvard Kennedy School Shorenstein Center on the Press, Politics, and Public Policy and teaches a Harvard Kennedy School class on “Controversies in Climate, Energy and the Media.” Her research focuses on the future of science writing and how to improve news media coverage of controversial scientific issues. She is organizing workshops for reporters and scientists and planning a book on current controversies in science, health, and the environment.

Trisha Shrum

*Fellow, Harvard Environmental Economics Program*

Trisha Shrum’s research interests include climate change and energy policy as seen through the disciplinary lenses of environmental and behavioral economics. Her dissertation work uses behavioral experiments to better understand...
stand how people incorporate and utilize information to make economic decisions on energy consumption and climate change mitigation. She graduated from the University of Kansas with bachelor’s degrees in Ecology and Evolutionary Biology and Environmental Science and with a minor in Economics. She went on to work on climate change and energy policy as a research fellow at the Kansas Energy Council and earned her Master’s in Environmental Science from the Yale School of Forestry and Environmental Studies.

Afreen Siddiqi
Visiting Scholar, Science, Technology, and Public Policy Program, Belfer Center for Science and International Affairs, Harvard Kennedy School

Dr. Afreen Siddiqi is a visiting scholar with the Science, Technology, and Public Policy Program at Harvard Kennedy School’s Belfer Center for Science and International Affairs. She is also as a research scientist at the Massachusetts Institute of Technology (MIT). Her research expertise is at the intersection of technology, policy, and international development. She combines quantitative tools and qualitative methods for complex socio-technical systems analysis. Her work includes a focus on investigating how water and agriculture sectors impact energy consumption and implications for energy policy. She is examining critical linkages between water, energy, and food security at urban, provincial, and national scales in the Middle East and North Africa, and analyzing the hydro-power portfolio in the Indus basin of Pakistan.

Dr. Siddiqi has an SB in Mechanical Engineering and an SM and PhD in Aerospace Systems, all from MIT. She has been a recipient of the Amelia Earhart Fellowship, Richard D. DuPont Fellowship, and the Rene H. Miller Prize in Systems Engineering. She has engineering experience in National Instruments (in Austin, Texas) and Schlumberger (in Houston, Texas), consulting experience with BP, Lockheed Martin, and Aurora Flight Systems, and teaching experience at MIT and Universita della Svizzera Italiana in Switzerland.

Alexandre Strapasson
Giorgio Ruffolo Research Fellow in Sustainability Science, Belfer Center for Science and International Affairs

Alexandre Strapasson is a research fellow, working on sustainable energy transitions, with a special interest in complex systems and global dynamics. His research focuses on the role of bioenergy to help decarbonize the EU energy system. Prior to joining Harvard, he was an honorary research fellow at Imperial College London and a visiting lecturer at IFP Energies Nouvelles in France. He was one of the lead modelers of the “Global Calculator” project (www.globalcalculator.org), and a joint Principal Investigator of the “EU Land Use Futures” project developed in collaboration with the former UK Department of Energy and Climate Change (DECC) and the Foreign and Commonwealth Office (FCO). Alexandre was also Director of the Department of Bioenergy at the Brazilian Ministry of Agriculture, and a Consultant in energy and climate change of the United Nations Development Programme (UNDP). He holds an MS. in Energy from the University of São Paulo (USP), and a Ph.D. in Energy and Environment from Imperial College.

Daniel Stuart
Pre-doctoral Fellow, Harvard Environmental Economics Program
PhD student in Public Policy

Daniel is interested in energy and environmental economics, public economics, and industrial organization. Prior to his Ph.D. studies, he worked as a research assistant at the Massachusetts Institute of Technology and as a Pre-Doctoral Fellow at the Energy Policy Institute at Chicago. Daniel received a B.A. in Economics with Honors from Swarthmore College.

Shauna B. Theel
Louis M. Bacon Environmental Leadership Fellow, Center for Public Leadership, Harvard Kennedy School

Shauna B. Theel has worked over the last several years in media positions in the energy space. First, as Climate and Energy Program Director at Media Matters for America, a not-for-profit, web-based media watchdog, Shauna was editor for all
energy and environment work and managed long term projects capturing data on the amount and nature of media coverage on climate change and clean energy. The first action of the Senate Climate Action task force was to take a study she had overseen on climate coverage to the broadcast networks, which then covered climate change more in one Sunday show than they had in the last three years of Sunday shows. After this position, she served as Deputy Director, Digital Media at American Wind Energy Association, the trade association for the U.S. wind industry. In this position, she coordinated blogs, op-eds, letters to the editor and developed the organization’s social media strategy and outreach plan. She graduated magna cum laude from the University of California, Berkeley.

**Mauricio Tolmasquim**

*Visiting Fellow, Harvard Electricity Policy Group, Harvard Kennedy School*

Mauricio Tolmasquim, who was President of Empresa de Pesquisa Energetica (Brazil’s energy and planning authority) from 2006-2016, was responsible for establishing energy auctions to enable energy expansion and price reductions. During his term, Brazil successfully launched 32 power auctions, contracting 77 GW of new generation capacity. Previously, as Deputy and Interim Minister of the Ministry of Mines, Tolmasquim led the technical working group responsible for the institutional reform of the power sector, shifting the focus toward long-term agreements. He also spearheaded the study in support of Brazil’s Intended Nationally Determined Contributions (INDCs) submitted to the UNFCCC in 2015. He participated in the World Economic Forum’s Global Agenda Council on a New Energy Architecture. His awards include recognition by Wind Power Monthly as one of the Global Top 30 People in the Wind Sector. During his time as an HEPG Visiting Fellow, Tolmasquim is working on research into renewable energy policy.

**Jeff Y. Tsao**

*Research Fellow, Science, Technology, and Public Policy Program*

Jeff Tsao is a “late-career” research fellow in the Belfer Center’s Science, Technology, and Public Policy Program. His Ph.D. was in Applied Physics at Harvard, and most of his career has been in research, management, and “community organizing” in the areas of semiconductor materials, solid-state lighting, and energy economics. His current interests are shifting towards the “engineering and applied science” of research: developing/applying the social science of human/group creativity to understanding/improving research processes at the individual, group, institution, and policy levels.

**Daniel Velez-Lopez**

*Pre-doctoral Fellow, Harvard Environmental Economics Program*

PhD student in Public Policy

Daniel’s current research focuses environmental and energy policy both in the United States and the developing world. He is particularly interested in how features of developing countries such as liquidity constraints or missing financial markets affect the value of information for individuals and firms and their ability to adapt to changes in their environment. He is also interested in studying the effectiveness and efficiency of second-best environmental policies such as daily driving restrictions that are common in developing countries.

**Pu Wang**

*Giorgio Ruffolo Postdoctoral Research Fellow in Sustainability Science, Belfer Center for Science and International Affairs, Harvard Kennedy School*

Research Topic: Cap and trade systems for greenhouse gas emissions in China and China-US cooperation on climate change policies

Pu Wang received his PhD degree from Cornell University in 2014, in the field of natural resources. His research is motivated by the great potential of market-based environmental policies in addressing social and environmental challenges associated with climate change. In particular, he is interested in the application of market-based policies in the context of socio-economic inequalities. As a postdoctoral fellow, his research focuses on cap and trade systems for greenhouse-gas emissions in China and China-U.S. cooperation in climate change policies.
Kaho Yu

Associate, Geopolitics of Energy Project, Belfer Center for Science and International Affairs, Harvard Kennedy School

Research Topic: China’s gas expansion, the eastward shift of Russian energy strategy, and the geopolitical implications for the Asia-Pacific region

Kaho’s research focuses on the geopolitics of China’s energy security, “Belt and Road Initiative”, Sino-Russian energy cooperation, and China’s role in global energy governance. In particular, his research at Harvard seeks to understand the development of China’s gas expansion under the framework of President Xi Jinping’s “Belt and Road Initiative,” the eastward shift of Russian energy strategy, and the geopolitical implications for Asia-Pacific. In addition to his appointment at Harvard, Kaho serves as a Research Fellow at the Center for International Energy Security Studies at Chinese Academy of Social Science, European Center for Energy and Resources Security at King’s College London, Renmin University Chongyang Institute and Asian Energy Studies Centre at Hong Kong Baptist University. Since 2013, he has been teaching a master course on Geopolitics of Energy at the Chinese University of Hong Kong. He is now finishing his PhD at King’s College London and the thesis topic is “From energy diplomacy to global governance: A case study on China’s energy security in the 21st century.” In addition, Kaho observes Chinese energy policy and Eurasian energy geopolitics closely and regularly produces energy strategy reports in both Chinese and English. He is also one of the authors of the Blue Book of World Energy of the Chinese Academy of Social Science.
In a discussion in the Harvard Kennedy School's Energy Policy Seminar moderated by Professor Henry Lee, Professor Matthew Bunn (of HKS) and Joe Lassiter (of HBS) pondered the future of nuclear energy, and how likely it might be to play a significant role in reducing future carbon emissions.

Bunn and Lassiter were in agreement that some of the new types of nuclear plants currently on the drawing board might have significant advantages over the currently prevalent light water reactors, with the potential to be cheaper to build and safer to operate. But Bunn warned that past proposals have failed to meet such goals.

How fast might such plants become widely available? Here, the perspectives of Professor Lassiter and Professor Bunn differed. Professor Lassiter, reviewing information provided to private investors (and presumably considered plausible by these investors who invested more than $1.6 billion over the past 10 years), sees projections that new nuclear could be competitive with coal in terms of cost and scalability in a relatively short period of time (the next 10-15 years), at least outside the United States. A new approach, “test-then-license,” Lassiter noted, has the potential to help speed up the development of new technologies—as part of an overall effort to “de-militarize” the existing nuclear technology development, licensing, construction and procurement processes that Lassiter sees as being absolutely necessary to significantly reduce the cost and increase the speed of nuclear deployment. Three of the more promising new ventures have recently announced their intention to develop their first prototypes and go to market in China, Indonesia and Canada using very different strategies than would be permitted in the United States.

Professor Bunn, however, noted that in the United States official government thinking is that the timescale for development of these new technologies is likely to be much slower—and that costs might well be higher given the United States recent experience, quoting Admiral Rickover’s observation that “Paper reactors will always beat real reactors.” Bunn presented data from a survey of industrial, government, and academic nuclear experts, most of whom projected that nuclear costs in 2030 would be even higher than today.

Professor Bunn went on to review the growth rates of nuclear power that would be needed in order for nuclear energy to play a significant role in meeting carbon emissions reduction targets. New nuclear plants would need to be built at about ten times the pre-Fukushima rate in order for nuclear to supply even 1/15th of the carbon-free energy needed to meet generally accepted carbon reduction goals, Bunn noted—a rate that would match the International Atomic Energy Agency’s most optimistic growth forecast.

There are “reasons for pessimism” about achieving this kind of nuclear build rate anywhere in the world, Bunn noted. In the United States, getting notoriously risk-averse utilities to invest in nuclear technology at this rate, given the availability of plentiful low-cost natural gas, would make progress even more unlikely. On the other hand, the capacity of nuclear energy to reduce particulate emissions while increasing energy production—a pressing problem in countries like China, India, and Indonesia—provides additional incentives for accelerated deployment of existing and development of new nuclear power alternatives outside the United States.

If nuclear power is to become more widespread, Bunn noted, good governance and regulation will be especially important. Current light water reactors remain vulnerable to human error and accident. And while Bunn and Lassiter agreed that safer (perhaps much cheaper) plants may be on the horizon, the speakers could only agree that the United States was likely to be a follower, not leader in the deployment of the next generation of nuclear plants.

SEMINARS & LECTURE SERIES
A smart deal to tackle climate change could abet tax and regulatory reform – which most Republicans support – by swapping a market-based carbon tax for sectoral regulatory policies – which most Republicans oppose. Such an approach could make even greater reductions in tax rates politically feasible and demonstrate that Republicans are in favor of smarter environmental policy, not simply opposed to all climate change policies.

Utility Executives and Those Who Regulate Them Can Do To Accelerate Adoption of Clean Energy,” organized by Senior Fellow John Devillars.

› **Regulatory Policy Program Seminar.** The New Directions in Regulation seminar series, organized and hosted by the Regulatory Policy Program, represents the preeminent forum in the country for engaging scholars and practitioners in an exploration of emerging trends in regulation. Since 1998, the Regulatory Policy Program has held more than 200 seminars, led by leading scholars from Harvard and around the world.

› **The Science & Democracy Lecture series,** co-sponsored by HUCE and the Harvard Kennedy School Program on Science, Technology & Society, explores the benefits and potential harmful consequences of scientific/technological breakthroughs.

› **Seminar in Environmental Economics and Policy.** A weekly seminar from the Harvard Environmental Economics Program featuring presentations by researchers from within and outside Harvard on topics including risk analysis and climate change, the costs and benefits of environmental regulation, and climate change and economic growth.
Finding a way to recreate the culture of the great industrial laboratories of past decades, such as Bell Labs, may be the key to sparking inventions that can address serious problems like finding affordable sources of energy in an age of climate change, argued Venkatesh (Venky) Narayanamurti, Benjamin Peirce Research Professor of Technology and Public Policy, Professor Physics at Harvard, and former Dean of the School of Engineering and Applied Sciences.

However, the interdisciplinary, innovation-fostering culture of the 20th century industrial laboratories is a long way from where we are today, in part because of policymakers’ reliance on an outdated but powerful paradigm for thinking about research as properly segregated into “basic” and “applied” work. The current paradigm, Narayanamurti explained, was created by the influential 1945 report, *Science: The Endless Frontier*, which popularized the paradigm of scientific research as divided into “basic” and “applied” categories, with a special need for government support of basic research. This dichotomy, along with a linear, progressive conception of how science works, is steering policymakers in the wrong direction when it comes to research funding, Narayanamurti argued.

Change will require new thinking, Narayanamurti said, observing that, “Until you give an intellectual rationale, you can’t change the political discourse.” In his new book, *Cycles of Invention and Discovery: Rethinking the Endless Frontier*, written with co-author Toluwalogo Odumosu, Narayanamurti attempts to construct an intellectual framework powerful enough to replace this old paradigm, one in which research is understood broadly, and in which science and engineering are treated equally as bodies of knowledge that feed off each other, without a pecking order, and with a focus on the new categories of “invention” and “discovery,” rather than the old categories of “basic” (or, ever worse, “pure”) research and applied research.

The model for the new paradigm, Narayanamurti suggested, can be found in the work of great research labs, such as Bell Labs in its heyday, which produced an impressive array of innovations, including solar cells, wireless technology, the C computer language, and radio astronomy. There, talent was organized by task, with teams that combined scientists and engineers in an environment that fostered both collaboration and competition, rewarded excellence, and provided the “freedom to fail and the patience to succeed,” Narayanamurti (whose career includes 20 years at Bell Labs and at Sandia National Laboratories) explained.

A precondition for these kinds of efforts, Narayanamurti said, is that research funding should be stable and separated from short term profits. The era of the great labs ended, Narayanamurti said, when the Bell monopoly (which had allowed for a steady stream of funding for lab research) was ended. In the current era of competition, government may be the source most capable of providing the kind of steady, reliable funding that such research needs.

Recently, under the leadership of Steve Chu and Ernie Moniz, the Department of Energy has taken steps to try to re-create some of the interdisciplinary research capabilities of the old labs, through programs like ARPA-E (the Advanced Research Projects Agency-Energy) and the DOE’s “innovation hubs.” While these efforts show some promise, Narayanamurti noted, funding for these efforts is subject to continual attack, in part because policymakers continue to try to view and divide the research into the old categories of “basic” and “applied.”

Professor Narayanamurti spoke as part of the Kennedy School’s Energy Policy Seminar Series. Photo by Paul Sherman. Text by Louisa Lund.
EVENTS
Reducing wind curtailment and accelerating grid connection, in comparison, requires reform efforts in China’s electric power system to make both the generation and transmission systems more renewable-friendly.

– Xi Lu, Harvard-China Project Research Partner and Associate Professor at Tsinghua University; Michael B. McElroy, Gilbert Butler Professor of Environmental Studies at Harvard University; and Chris P. Nielsen, Executive Director, Harvard-China Project; with co-authors Haikun Wang, Wei Peng, and Shiyang Liu, in “Challenges faced by China compared with the US in developing wind power.” Nature Energy 1:6 (2016).
**March**

March 3, 2016  
**Water and Climate Change: Adaptation, Uncertainty, Decision Scaling and the Implications for China.** Casey Brown, University of Massachusetts. Harvard-China Project Seminar.

March 7, 2016  

March 10, 2016  

March 11, 2016  
**A Conversation with Lord Browne: The New Energy Environment.** A breakfast conversation between Lord Browne, Executive Chairman of L1 Energy and former CEO of BP, and Meghan O’Sullivan, Jeane Kirkpatrick Professor of the Practice of International Affairs and Director of the Geopolitics of Energy Project, on the consequences of the new energy environment for society and his new book, *Connect*.

March 21, 2016  
**Electricity Market Developments in Mexico.** Jeffrey Pavlovic, Managing Director of Electric Industry Coordination in the Undersecretary of Electricity in the Mexican Ministry of Energy. HKS Energy Policy Seminar.

March 28, 2016  
March 29, 2016
Confronting Climate Change: A Conversation with Leaders at the Forefront of Climate Change Action and Environmental Advocacy. Panel presented by the Harvard Kennedy School Center for Public Leadership and the Belfer Center’s Environment and Natural Resources Program.

March 30, 2016

March 31, 2016

April 4, 2016

April 5, 2016

April 6, 2016

April 7, 2016

April 7, 2016

April 8, 2016

April 8, 2016

April 11, 2016

April 13, 2016
Global Commons. Surabhi Ranganathan, Kings College, University of Cambridge. Hosted by The Energy History Project.


April 14, 2016
April 14, 2016
**Science and Diplomacy for Solving Humanity’s Big Issues - Iran, HEU and Climate.** Ernest Moniz, United States Secretary of Energy. Moderated by Graham Allison, Professor of Government and Director, Belfer Center for Science and International Affairs. The Robert McNamara Lecture on War and Peace.

April 14, 2016
**The Moral Imperative for Climate Action: Religious Perspectives.** Panel discussion. Climate Justice Series.

April 18, 2016
**Nuclear Energy: Obstacles and Possibilities.** Matthew Bunn, Professor of Practice, HKS, and Joseph Lassiter, Senior Fellow, Senator John Heinz Professor of Management Practice in Environmental Management (Retired), HBS. HKS Energy Policy Seminar.

April 18, 2016
**Weighting Climate Change from Space.** Dr. Isabella Velicogna, University of California, Irvine. EPS Colloquium Series.

April 19, 2016

April 21, 2016

April 22, 2016

April 25, 2016
**Efficiency and Equity Implications of China’s National Cap-and-trade System.** Pu Wang, Sustainability Science Fellow in the Energy Technology Innovation Policy research group at the Belfer Center for Science and International Affairs. HKS Energy Policy Seminar.

April 27, 2016
**Controlling Carbon Emissions from U.S. Power Plants: How a Tradable Performance Standard Compares to a Carbon Tax.** Warwick McKibbin, Australian National University; Adele Morris, Brookings Institution; and Peter Wilcoxen, Syracuse University. Seminar in Environmental Economics and Policy.

April 28, 2016
**Power Market Mechanism Design in China.** CHEN Qixin, Professor, Department of Electrical Engineering, Tsinghua University. Harvard-China Project Research Seminar.

April 29, 2016
**Emissions Trading in Urban China.** Iza Ding, Department of Government. China Climate Seminar.

May 2, 2016
**Energy Cooperation in China’s “One Belt One Road” Initiative.** Kaho Yu, Belfer Center for Science and International Affairs. HKS Energy Policy Seminar.

May 5, 2016
**Haze Pollution in Northern China from a Modeling Perspective.** Gao Meng, Center for Global and Regional Environmental Research, University of Iowa. Harvard-China Project Seminar.
**May 6, 2016**


**May 12, 2016**


**May 13, 2016**

*Approaching the Anthropocene: Perspectives from the Humanities and the Sciences.* A panel discussion featuring Pamela Templer, Associate Professor, Biology, Boston University; Fredrik Albritton Jonsson, Associate Professor, History, University of Chicago; Sophia Roosth, Associate Professor, History of Science, Harvard University; and Daniel Schrag, Professor of Geology; Professor of Environmental Science and Engineering; Director, HUCE; Director, Science, Technology and Public Policy Program, Harvard Kennedy School, presented by HUCE and the Environmental History Working Group.

**May 20, 2016**

*Dampened land carbon uptake by air pollution in China.* Xu Yue, Yale University. Atmospheric Sciences Seminar.

**September 2016**

**September 13, 2016**

*Solar Geoengineering Seminar.* Speakers including David Keith, SEAS and HKS; Joshua Horton, HKS; Gernot Wagner, SEAS and HUCE; and Sheila Jasanoff, HKS.

**September 14, 2016**


**September 16, 2016**

*Environmental and Energy Applications of Graphene Oxide Nanoarchitectures.* Chad Vecitis, Environmental Engineering, SEAS. Atmospheric & Environmental Chemistry Seminar.

**September 19, 2016**

*Coastal Water Quality, Climate Change & Ocean Acidification along the U.S. Northeast.* Scott Doney, Woods Hole Oceanographic Institution (WHOI). EPS Colloquium Series.

**September 20, 2016**

*The Competing Imaginaries of Solar Geoengineering.* Jeremy Baskin, University of Melbourne. STS Circle at Harvard.

**September 21, 2016**


**September 23, 2016**


**September 26, 2016**

*Studying the Greenland Ice Sheet: Implications for Climate Past and Present.* Dorthe Dahl-Jensen, Niels Bohr Institute, University of Copenhagen. EPS Colloquium Series.
**Events**

September 26, 2016  

September 26, 2016  
**A Vision for Asian Collective Energy Security.** Nobuo Tanaka, President, Sasakawa Peace Foundation; Executive Director (2007-11), International Energy Agency (IEA); and Professor, Graduate School of Public Policy (GRASPP), University of Tokyo. Presented by the Environment and Natural Resources Program at the Belfer Center and the Program on US-Japan Relations at the Weatherhead Center for International Affairs.

September 28, 2016  
**China Electricity Sector Reform: An Update and Challenges Going Forward.** Mun HO, Visiting Scholar, China Project. Harvard-China Project Research Seminar.

October 2016  

October 3, 2016  
**Governments as Partners: The role of collaboration in U.S. cleantech startup innovation.** Claudia Doblinger, University of Regensburg, Germany. HKS Energy Policy Seminar.

October 3, 2016  
**Normalization by Other Means: The failed techno-diplomacy of light water reactor export to North Korea.** Christopher Lawrence (Harvard, STS). STS Circle at Harvard.

October 5, 2016  
**Carbonaceous Aerosol Emissions: From National to City Scale in China.** Zhao Yu, Nanjing University. China Project Seminars Series.

October 6, 2016  

October 8, 2016  
**13th Annual HBS Energy Symposium: Shaping the Future of Energy.** A symposium convening utilities, startups, executives innovating in the energy ecosystem, and academics at HBS to identify the key trends that are shaping the industry. Organized by the Energy & Environment Club at Harvard Business School.

October 11, 2016  
**Energy Demand Forecasting: Model Development, Uncertainty Analysis and Forecasting.** Bin Yan, Post-doctoral Fellow, Harvard Center for Green Buildings and Cities. CGBC Research & Innovation Talk.

October 12, 2016  
**Methane Emissions from the Oil and Gas Sector.** Mark Boling, Southwestern Energy/V+ Development Solutions. Harvard Environmental Policy Initiative lunch discussion.

October 14, 2016  
**Modeling and Evaluating the Impacts of Air Pollution and Climate Policies.** Noelle Selin, MIT. Atmospheric & Environmental Chemistry Seminar.

October 17, 2016  

October 17, 2016  
**In the Climate Policy Trenches: Lessons from the British Columbia Carbon Tax and Other Climate Policies.** Mark Jaccard, Simon Fraser University. Canada Program Seminar.

October 18, 2016  
**Looking Up: How Coalitions of Bottom-up Organizations are Driving Action for Sustainable Development.** Rachel Kyte, CEO of Sustainable Energy for All and Special Representative of the UN Secretary-General. Discussion panelists William Clark, HKS; Henry Lee, HKS; Michael Mehling, Center for Energy and Environmental Policy Research (CEEPR), MIT. Moderator Sheila Jasanoff, HKS. Co-sponsored by HUCE and the John A. Paulson School of Engineering and...
### Events

**October 19, 2016**

**China’s Evolving Vulnerability to Climate Change Impacts: A Spatial Analysis of its Infrastructure System.** Xi (Sisi) HU, Environmental Change Institute, University of Oxford; visiting fellow, Harvard-China Project Research Seminar.

**Pre-Release Screening & Discussion: Before the Flood.** Sponsored by HUCE.

**New Challenges in Governing Geoengineering.** David Victor, Professor, School of Global Policy and Strategy; Director, Laboratory on International Law and Regulation, UC San Diego. Solar Geoengineering Seminar, at the Weatherhead Initiative on Climate Engineering.

**Energy Access in Remote Communities: A Practitioner’s Experience.** Anshuman Lath, Co-Founder, Gram Oorja, Harvard South Asia Institute Science and Technology Series.

**October 20, 2016**


**Nudging Toward A Cleaner Future: Behavioral Insights into Energy and Environment.** Student organized Workshop at HUCE.

**In Search of the Lost Development: Sustainability, Competitiveness and Economic Growth in Brazil.** Rogerio Studart, Universidade Federal do Rio de Janeiro. DRCLAS Brazil Studies Program event.

**Climate Change Displacement: Finding Solutions to an Emerging Crisis.** Mary Robinson, former UN High Commissioner on Human Rights and former UN Special Envoy on Climate Change, and Martha Minow, Dean, HLS. Sponsored by the Harvard Environmental Law Program Clinic, the Immigration and Refugee Program, and the International Human Rights Clinic.

**November**

**Rare Earths in China: Changing Landscape Points to an Uncertain Future for Applied Sciences.** Science & Democracy Lecture presented by The Program on Science, Technology and Society.

November 2, 2016

November 3, 2016
Planning Sustainable Cities Conference. Hosted by the Zofnass Program for Sustainable Infrastructure.

November 3, 2016

November 7, 2016

November 8, 2016

November 9, 2016

November 11, 2016

Moderator Kate Konschnik. Hosted by the Environmental Law Society and Environmental Law Review.

November 15, 2016

November 15, 2016

November 15, 2016
Living with Water: A Conversation on Climate Change and Resilient Cities. Henk Ovink, Special Envoy for International Water Affairs for the Netherlands (United Nations), Sherpa to the High Level Panel on Water (United Nations) and Principal of Rebuild by Design (HUD, Hurricane Sandy Rebuilding Task Force). Hosted by the Climate Governance Initiative.

November 16, 2016

November 16, 2016
Harvard Global Institute Symposium: Climate Change and the Developing World. Rebecca Henderson, John and Natty McArthur University Professor; Jennifer Leaning, Francois-Xavier Bagnoud Professor of the Practice of Health and Human Rights; and Dan Schrag, Sturgis Hooper Professor of Geology and Professor of Environmental Science and Engineering, will moderate panel discussions on urbanization and adaptation, food and water security, and creating solutions.
Events

November 17, 2016
Constraints on the Social Discount Rate Derived from Ethical Ambiguities and Uncertainty about Future Climate Change. Stephan Lewandowsky, Professor of Cognitive Psychology, School of Experimental Psychology and Cabot Institute, University of Bristol HUCE Special Seminar.

November 21, 2016

November 28, 2016

November 30, 2016

November 30, 2016
The Air Pollution Impacts of the United States’ Natural Gas Transition. Jennifer Burney, Assistant Professor, School of Global Policy and Strategy, University of California, San Diego. HUCE Special Seminar.

December

December 5, 2016
How Should Regulators Incorporate Claims of Value that are Exogenous to the Actual Supply & Delivery of Electricity? Travis Kavulla, Commissioner, Montana Public Service Commission, and President and Chairman of the Board of Directors of the National Association of Regulatory Utility Commissioners. HKS Energy Policy Seminar Series.

December 5, 2016
Next Generation Tools for Utility Regulators To Advance a Clean Energy Economy. Senior Fellow John DeVillars’ fourth study group session with guest speaker Travis Kavulla, Commissioner of the Montana Public Service Commission and Chairman of the National Association of Utility Regulatory Commissioners. M-RCBG Senior Fellow’s Seminar.

December 5, 2016
The Well Tempered City: Climate Change, Health, Poverty and Our Urban Future. Steve Curwood, host, NPR's Living on Earth; Jack Spengler, Director, Center for Health and the Global Environment; Jonathan Rose, author, The Well Tempered City; and the student winner of Courtyard Design Contest. Sustainability for Health Leadership Series

December 7, 2016
Long-Term Trend and Spatial Pattern of PM2.5-Induced Premature Mortality in China. Wang Haikun, School of Environment, Nanjing University. Harvard-China Project Research Seminar.

December 8, 2016
Climate Engineering: Anticipating Future Governance Challenges. Ted Parson, Professor of Environmental Law; Faculty Co-Director, Emmett Institute on Climate Change and the Environment, UCLA Law School. Solar Geoengineering Seminar, presented by the Weatherhead Initiative on Climate Engineering.

December 13, 2016
“Don’t let the perfect be the enemy of the good,” Professor Robert Stavins, Albert Pratt Professor of Business and Government and Director of the Harvard Project on Climate Agreements, said in the Energy Policy seminar on Monday, setting the stage for his thoughts about the recent Paris climate talks.

The talks started out on a solid footing, Stavins observed, with significant “impetus to take action” provided by recent joint US-China announcements of carbon reduction plans—plans which, taken together, “cover nearly 40% of global carbon emissions,” much more than the 14% covered by the Kyoto Protocol’s current commitment period.

Key accomplishments in Paris, Stavins noted, included greatly broadening the group of countries included, reaching countries responsible for 97% of global emissions, establishing transparency requirements, and allowing for linkages between national policies.

The talks themselves, therefore, were clearly a success, Stavins concluded, resulting in a “landmark climate accord” that “provides a broad foundation for meaningful future progress.”

However, he continued, the success of the Agreement itself in bringing about adequate actions to reduce carbon emissions “may not be known for decades.” Successful carbon reductions will depend on successful policy actions by the individual parties to the agreement (187 countries), the speaker explained. It is too soon to tell what will happen overall—in the United States, notably, meeting carbon emissions reductions goals is uncertain, particularly with the Supreme Court’s recent stay of implementation of the Clean Power Plan, one of the foundational carbon reduction policies here. On the other hand, the unexpected extension of wind and solar tax credits point, in part, towards a new route to carbon emissions reductions in the U.S.

One of the major determinants of whether the efforts of individual nations will collectively add up to a set of adequate and affordable carbon emissions reductions may well be whether “linkages” can be established between heterogeneous approaches to emissions reductions adopted by different nations. That is, will each country really be on its own, focused only on internal carbon reductions, or will there be opportunities in the system to trade or otherwise link carbon reduction goals so that the cheapest emissions opportunities can be fully pursued? Stavins explained the potential challenge here—it would be simple enough to link multiple cap and trade systems, or carbon pricing systems, but many countries may rely on performance standards or technology standards to reduce emissions—it will be more difficult, and in some cases infeasible, to link such systems, Stavins suggested. The means for creating linkages will be one of the focuses of the Harvard Project on Climate Agreements over the next few years.

Other issues of continuing focus will include considering what institutions will provide the most helpful forum for continuing the development of international climate cooperation—the UNFCCC (United Nations Framework Convention on Climate Change) is currently the default forum, but other possibilities include the Major Economies Forum and the G20.

Professor Stavins spoke as part of the Kennedy School’s Energy Policy Seminar Series. Photo by Paul Sherman. Text by Louisa Lund.
SELECTED PAPERS & PUBLICATIONS
Being honest and accurate about the links between (desirable) economic growth and (desirable) CO₂ emissions reductions puts our focus and emphasis where it ought to be: finding better ways to have both.


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G


Horton, Joshua B., David W. Keith, and Matthias Honegger. “Implications of the Paris Agreement for Carbon Dioxide Removal and Solar Geoengineering.”


Mei, Yanyang, Qingfeng Che, Qing Yang, Christopher Draper, Haiping Yang, Shihong Zhang, and Hanping Chen. “Torrefaction of different parts from a corn stalk and its effect on the characterization of products.” Industrial Crops and Products 92 (15 December 2016): 26-33.


SELECTED PAPERS & PUBLICATIONS


S


Skalamera, Morena. “Revisiting the Nabucco Debacle.” Problems of Post-Communism 0, no. 0 (August 11, 2016): 1–19.


Stavins, Robert N. “Are the Pope’s Critiques of Markets on Point or Somewhat Misguided?” The Environmental Forum, February 2016.


In a world in which three degrees of warming is considered the “most likely” result of a doubling of carbon dioxide concentration in the atmosphere, what should make us worry more: a “likely” temperature impact range of 2.0°-4.5°C, or a “likely” range of 1.5°-4.5°C? The counterintuitive but analytically correct answer is that the wider temperature range of 1.5°-4.5° is more worrisome, even though it includes a lower temperature possibility, according to Gernot Wagner, a Research Associate at Harvard’s School of Engineering and Applied Sciences and a Fellow at the Harvard University Center for the Environment, and Richard J. Zeckhauser, Frank P. Ramsey Professor of Political Economy at Harvard Kennedy School. Wagner presented the findings of a paper on problems of “persistent climate uncertainty” co-authored with Zeckhauser in the October 24, 2016, Energy Policy Seminar.

The “likely” range of warming associated with a doubling of carbon dioxide in the atmosphere was first identified in a 1979 National Academy of Sciences report to be 1.5°-4.5°, Wagner said. In 2007, the IPCC tightened the range to 2.0°-4.5°, but then returned in the 2013 report back to the old 1.5°-4.5° “likely” range.

Taking these reported temperature ranges at face value as a starting point for analysis, Wagner and Zeckhauser asked how we should understand the significance of this reversion to greater levels of uncertainty in the predicted temperature effects of carbon dioxide. This revision of the range to expand the lower-end likely range is not good news for the earth, Wagner explained, because it suggests that our estimates of likely temperature impacts are even less reliable than we thought, and that we are not making meaningful progress towards greater precision. Given this persistent uncertainty, Wagner continued, if we’re analyzing, for example, the cost per ton of CO2 of keeping warming below 2°C by 2100, that optimal carbon price increases with the widened “likely” range for climate sensitivity.

The uncertainty of the temperature impact prediction is amplified, Wagner added, by further uncertainties about what the consequences of increased temperatures will be on the environment and the global economy.

ACKNOWLEDGEMENTS
Twenty years ago, in the Clinton Administration, both of us helped launch a program to build a factory to turn the excess plutonium from dismantled nuclear weapons into fuel for nuclear reactors. At that time, the full life-cycle cost estimate to make this plutonium-uranium mixed oxide (MOX) fuel was expected to be less than $2 billion dollars. Now, however, with official cost estimates ballooning to over $30 billion, it is clear that the project has become too expensive. It is time to stop throwing good money after bad and pursue cheaper alternatives that will serve our national security better.

John French ’66 and Elaine Abbott French (EDM ’73); Gilbert Butler ’59; Robert Ziff ’88, Daniel Ziff and Dirk Ziff, for support for the Environmental Fellows Program.

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Harvard University Center for the Environment, for support for the Harvard Project on Climate Agreements, the Harvard Energy Journal Club, and the Energy History Project.

The Harvard University Climate Change Solutions Fund, for its support for the Harvard-China Project, the Harvard Project on Climate Agreements, and the PowerShift electricity network and the Harvard Environmental Policy Initiative.

The Heinz Endowments, for support for the Climate, Energy, and Health Program at the Center for Health and the Global Environment.

Hui Fund for Generating Powerful Ideas, in the Ash Center for Democratic Governance and Innovation at the Harvard Kennedy School, for support for the Environment and Natural Resources Program in the Belfer Center for Science and International Affairs at the Harvard Kennedy School and for support for the Sustainability Science Program in the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School for its 2016 workshop on low-carbon development with Tsinghua University; for support for the Harvard-China Project; and for support for the Harvard Project on Climate Agreements.

The International Emissions Trading Association for support for the Harvard Project on Climate Agreements.

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Despite decades of recommendations that geoengineering research should be pursued, “The government has effectively decided that the best course here is ignorance,” Professor David Keith said in his presentation in the HKS energy policy seminar, which examined some recent research in this area, as well as sources of resistance to such research.

Keith argued that some of the most common arguments advanced against geoengineering research actually provide reason to support such work. For example, he argued, arguments that geoengineering itself, while it might reduce global warming, would do nothing to address other negative impacts of carbon emissions, such as ocean acidification. In fact, Keith explained, by slowing down certain impacts of warming, such as the release of additional CO2 into the atmosphere through the melting of permafrost, geoengineering can have an impact on carbon concentrations themselves.

Furthermore, Keith explained, recent research suggests that some of the negative impacts feared from solar geoengineering may not be inevitable. For example, solar geoengineering methods may not have to damage the ozone layer. Sulfuric acid, which is what is most commonly thought of for use in geoengineering, can accelerate ozone destruction (though it is not yet clearly established what the magnitude of such effects would be); however, Keith notes, some new models he and his colleagues have been working on suggest that other materials could be used to scatter light—which could either reduce the impact on the ozone layer or, potentially, help to repair the ozone layer.

Keith emphasized that the modeling that suggests this possibility “could be totally wrong.” It is this uncertainty, he observed, that makes research including small-scale experiments potentially so useful.

Keith emphasized that his argument is not that geoengineering does not have significant risks. He argued that further research may reveal that it either cannot or should not be employed. However, he noted that there would be considerable benefits to know even such a discouraging answer sooner rather than later, enabling policy makers and scientists to better assess options. In fact, Keith noted, calculations of the value of having more information about geoengineering, even if this information only shows that geoengineering is not a good idea, have found significant value attached to greater knowledge. While the exact figure varies depending on your assumptions, it is “easy to get a value in the trillions of dollars NPV over the century,” Keith reported.

Given the potential benefits of geoengineering research, why does it meet with resistance? One factor, Keith suggested, is fear of “moral hazard.” Keith noted that many people assume that geoengineering will be treated as a substitute for other actions—making people less likely to take other steps to address climate change—but he observed that there is no a priori reason to assume this will be the case. It is also possible that further exploration of geoengineering would increase the likelihood of action in other areas—just as a patient put on blood pressure medication may also be inspired to make healthy lifestyle changes.

Keith spoke as part of the Kennedy School’s Energy Policy Seminar Series.
Photo by Paul Sherman. Text by Louisa Lund.
Secretary of State John Kerry talks about the impact of climate change on global health at a Harvard Global Health Institute event at the Art Museums. Harvard climate and health experts came together at the event to help shape the Institute’s global health and climate change initiative. Photo by Jon Chase, Harvard Staff Photographer.

Professor Dan Schrag at the Arctic Circle conference. Photo from www.articcircle.org.

HBS's energy/sustainability coordinator, Julia Musso, shows off radishes on the green roof of the McCollum Center at HBS. Photo by Kris Snibbe, Harvard Staff Photographer.

Rob Stavins talks about the Paris climate talks inside the his office in the Taubman Building at the Harvard Kennedy School at Harvard University. Photo by Kris Snibbe, Harvard Staff Photographer.

Lily Wilkinson ’18 (from left), and Dallas Hogan ’18 test the effectiveness of biodiesel made from used vegetable oil from Annenberg Hall’s dining hall during an undergraduate teaching lab in the Science Center at Harvard University. Photo by Kris Snibbe, Harvard Staff Photographer.


Former Vice President Al Gore, left, greets Michael B. McElroy, Gilbert Butler Professor of Environmental Studies, before speaking at Sanders Theater on climate change and China. Photo by Jon Chase, Harvard Staff Photographer.