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
An attribute of the Paris architecture that will encourage greater ambition over time is cost-effectiveness. To enhance the cost-effectiveness of the new system, a key feature will be linkages among regional, national, and sub-national climate policies. By linkage, I mean formal recognition by a greenhouse gas (GHG) mitigation program in one jurisdiction (a regional, national, or sub-national government) of emission reductions undertaken in another jurisdiction for purposes of complying with the first jurisdiction’s mitigation program.

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 largely independently funded. The Consortium provides partial support for the Energy Technology Innovation Policy research group.

**The Brazil Initiative - Sustainable Development of the Amazon and Its Surrounding Regions: The Interplay of Changing Climate, Hydrology, and Land Use – Impacts on Hydropower Planning and Operation and Flood Risk**

This Sustainability Science Program initiative is examining the linkages between land-use and climate change impacts on the water cycle of the Amazon and surrounding regions. Human-induced climate change arising from increasing levels of greenhouse gases is expected to push the region towards a warmer and drier state. In addition, agricultural expansion and other land use transformation is continuing in the Amazon and surrounding regions as global demand for food and biofuel increases and regional economies expand. Analyses indicate that the conversion of forest and cerrado ecosystems to pastureland and agricultural crops creates warmer and drier atmospheric conditions than the native vegetation. This study will quantify the key sustainability thresholds for the hydrologic functioning of the Amazon basin and surrounding regions under different land transformation and climate change scenarios focusing on its impacts on hydropower planning and operation and flood risk.

Paul Moorcroft, *Faculty Initiative Leader*

**Business & Environment Initiative**

Based at Harvard Business School, the Business & Environment Initiative seeks to deepen our collective understanding of the urgent environmental challenges confronting business leaders and to help them use the tools of business to design effective solutions.

The BEI aspires to help leaders create the economic and political institutions that will enable firms and societies to thrive while maintaining the physical and biological systems on which they depend.

Rebecca Henderson and Forest Reinhardt, *Faculty Co-Chairs*; Melissa Paschall, *Director*
Center for Health and the Global Environment

The Center for Health and the Global Environment works to promote a wider understanding of the human health consequences of global environmental change. 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 an official Collaborating Center of the U.N. Environment Programme and works alongside many other organizations throughout the world. The Climate, Health and Energy program, one of four critical areas of focus at the Center, educates the scientific community, policymakers, industry representatives, community leaders, and the general public about the human health dimensions of climate change and energy use in order to foster healthy solutions for a low carbon future. The Center is based at the Harvard School of Public Health.

Jack Spengler, Director; Aaron Bernstein, Associate Director

The China Initiative - Sustainable Development of the Energy Sector in China: Challenges and Options

This initiative of the Sustainability Science Program addresses the environmental implications of energy policies in China and the challenges that arise when designing and implementing environmental and energy policy. The China Initiative’s research focus is on developing low-carbon pathways for sustainable development, inducing low-carbon energy technology innovation, and overcoming transmission-capacity barriers for wind power. Researchers have completed work on water resources and market mechanisms for water rights trading, buildings and energy efficiency, low-carbon development policies for Shanghai, and electrification of China’s transport sector. China Initiative researchers are collaborating with scholars at Tsinghua University and the Chinese Academy of Science (CAS) and practitioners from China’s Ministry of Science and Technology (MOST), the National Development and Reform Commission (NDRC), and the Development Research Center of the State Council (DRC). The China Initiative jointly sponsored a workshop on the use of market mechanisms to achieve a low-carbon future for China with the Center for Science, Technology and Education Policy at Tsinghua University in June 2014. Plans are
underway to hold a joint HKS-Tsinghua workshop on energy technology policy in June 2015.

Henry Lee, Faculty Initiative Leader

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 an opportunity to do real-life and real-time legal and policy work in local, national and international projects covering a broad range of environmental issues such as climate change, offshore drilling, renewable energy, hydraulic fracturing, carbon capture and sequestration, and environmental justice.

Recent projects from 2013-2014 include examining whether and how the oversight and regulation of offshore drilling in the Arctic can be improved; submittal of comments to the U.S. Department of Transportation on its Advanced Notice of Proposed Rulemaking for Oil Spill Response Plans for High-Hazard Flammable Trains; filing an amicus brief with the U.S. Supreme Court in support of the U.S. Environmental Protection Agency’s regulation of greenhouse gas emissions from power plants; preparation and circulation of a national hydraulic fracturing leasing guide for landowners, as well as investigating the authority of municipalities to regulate hydraulic fracturing directly or indirectly; filing two amicus briefs in the Massachusetts Supreme Judicial Court – one in support of a decision disapproving the use of a city’s municipal water supply as the primary source of cooling water for a proposed electric-generating facility, and the other advocating for enhanced analysis of the project’s impacts on environmental justice.
Programs & Projects

Communities; and working with the City of Boston and the City of Cambridge to address climate change adaptation at the municipal level.

Wendy B. Jacobs, Director

The Energy History Project

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

The Energy History Project website provides a hub for information on energy history. It archives the data assembled by the ‘Long-term energy and growth’ project that has worked to reconstruct historical energy consumption in Europe in a consistent manner and that provides the evidential underpinning linked to the volume Power to the People: Energy in Europe over the last five centuries.

Harvard faculty participants Richard Hornbeck and Emma Rothschild

Energy Technology Innovation Policy Research Group

The Belfer Center for Science and International Affairs’ Energy Technology Innovation Policy research group (ETIP) identifies and promotes the adoption of effective strategies for developing and deploying cleaner and more efficient energy technologies, primarily in three of the biggest energy-consuming nations in the world: the United States, China, and India. ETIP researchers seek to identify strategies that these countries can pursue, separately and collaboratively, to accelerate the development and deployment of advanced energy options that reduce conventional air pollution, minimize future greenhouse gas emissions, ease dependence on oil, alleviate poverty, and promote economic development. ETIP staff and fellows research a range of topics, including the role of the government in enabling the commercialization of capital-intensive energy technologies, the future of transportation and strategies for limiting transport emissions, the importance of integrating energy and water planning, and the
cost of wind power in China.
Laura Diaz-Anadon, Henry Lee, and Venkatesh Narayanamurti, Co-Principal Investigators

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 Energy Technology Innovation Policy research group, the Geopolitics of Energy Project, and the Sustainable Development of the Energy Sector in China Initiative. 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 Law Program Policy Initiative

Harvard Law School’s Environmental Law Program Policy Initiative provides real-time, real-world legal analysis of today’s most pressing energy and environmental issues. Policy Initiative researchers share this analysis as policy-relevant talks, podcasts, white papers, evaluation tools, and draft legislative text, to reach a broad audience and to move debate forward. The Environmental Policy Initiative (EPI) works closely with environmental law faculty at Harvard and the Emmett Environmental Law & Policy Clinic and develops strategic partnerships with other experts to design, implement, and disseminate research and ideas. EPI is focused in three issue areas: the constitutional analysis of state clean energy laws; regulatory development for shale gas; and GHG regulation under the Clean Air Act.
Kate Konschnik, Director

Evaluating the Energy Efficiency Gap: Research and Practice

This joint project of the Duke University Energy Initiative and the Harvard
Environmental Economics Program (HEEP) advances understanding of the “energy efficiency gap”—the gap between the rate of adoption of energy-efficient technologies expected from the apparent financial net benefits of such technologies and the rate at which they are actually adopted by individuals and households. The project is helping inform future research and policy by synthesizing past work and identifying key gaps in knowledge.

Richard G. Newell (Duke and former HEEP Pre-Doctoral Fellow) and Robert N. Stavins (Harvard), Co-directors

**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

**Harvard Center for Green Buildings and Cities**

The Harvard 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. The CGBC is forming strategic partnerships with peer institutions, cities, governments, and industry thought-leaders with the goal of sharing and disseminating findings and catalyzing innovations that revolutionize the built environment.

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 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 air pollutants such as particulate matter, ozone and mercury.

James Hammitt and Joel Schwartz, Directors

**Harvard China Project**

The interdisciplinary Harvard China Project, founded by the Harvard University Center for the Environment and based now 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 Project-funded 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 built and 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 and agricultural impacts of pollution...
exposures; analyses of urban transport, land use, and environment; and integrated assessment of costs and benefits of national emission controls.

Michael B. McElroy, Chair; Chris P. Nielsen, Executive Director; Dale W. Jorgenson, Mun S. Ho, Xi Lu, J. William Munger, Sumeeta Srinivasan, and Peter P. Rogers, Harvard-based lead investigators of current studies. Other elements are led by researchers at Chinese universities funded by the Project.

**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 (HKS). 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 33 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 26 Pre-Doctoral Fellows in 2014-2015, who are studying in five Harvard PhD programs. HEEP Pre-Doctoral Fellows conduct a weekly luncheon at which they present their own recent research. Since the mid-1990s, Robert Stavins of HKS 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 or ScD students may apply to the program. Once admitted to the Consortium, students are required to take three courses designed to give doctoral students 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. There are currently 51 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 Project conducts research on policy architecture, key design elements, and institutional dimensions of domestic climate policy and a post-2015 international climate policy regime. This research is presented in 65 Discussion Papers (as of November 2014) 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 HKS.

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; James Clem, Managing Director

**The India Initiative - Governance Innovations for Sustainable Development: Building Public-Private Partnerships for Sustainable Environmental Regulation and Energy Use in India**

Rapid growth causes environmental harm because the economy does not show firms and consumers the total cost of their actions. This environmental harm, such as air and water pollution, is having immense effects on both the health and economy in India. It lies jointly with government and industry to create an economy where the most profitable action is also socially best. The India Initiative, a project of the Sustainability Science Program, uses rigorous field studies, conducted in association with Indian regulators
and industry partners, to examine how public-private partnerships can enable smart policy design and enhance efficiency and compliance with environmental standards. This work includes studies on the best ways to monitor and reduce pollution from industrial plants, the costs and benefits of such reductions, the take-up of more energy-efficient technologies, renewable energy growth, and the legal channels and mechanisms necessary to enable effective reform. The Initiative’s work has grown into a sustained, deep collaboration with Indian policy-makers, and the success of this collaboration is now being reflected in policy recommendations, academic publications, and the popular press. Furthermore, because much of the research is testing solutions at-scale with government partners, there are direct channels for successful projects to be quickly adapted into policy. Projects include evaluating a pilot Emissions Trading System for particulate matter; measuring the costs and return on investment of energy efficiency improvements in manufacturing plants; studying the effectiveness of information and incentives in improving energy efficiency in urban middle-class households; evaluating options for improving electricity access; and examining how to use subsidies effectively to encourage the use of modern, less-polluting fuels in cooking.

Rohini Pande, Faculty Initiative Leader

The Innovation Initiative - Innovation and Access to Technologies for Sustainable Development: The Role of Transnational Actors and Institutions

This Initiative, a project of the Sustainability Science Program, seeks to advance understanding of how to improve the functioning of the “global innovation system” for technologies to support sustainable development. “Innovation” in this Initiative is broadly conceived to encompass not only the processes by which new technologies are invented, but also the processes by which a pool of inventions gets narrowed down for further development, produced, initially adopted, transitioned into sustained use, and then becomes either adapted so that they are better-suited to end-user needs or retired in favor of another technology. “Technologies” are treated as “knowledge of how to fulfill certain human purposes in a specifiable and reproducible way.” And “sustainable development” is defined as human use of the earth in which the well-being of people integrated across places and generations does not decline. The Initiative is conducting a comparative study of how well the innovation system functions to meet five sustainable development needs (food,
energy, health, manufactured goods, and water), with a special focus on equity. The initiative is examining specific cases of “system interventions” (e.g., policy interventions, institutional innovations, and new approaches to shaping the innovation process) intended to strengthen the global innovation system, with the broader aim of developing policy recommendations that draw from, and are generalizable across, multiple sectors. The findings will contribute to realizing the potential of science and technology to meet the most pressing sustainable development challenges.

William Clark, Faculty Initiative Leader

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 and 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, 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 cheap, 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 inter-disciplinary, 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 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. The program is devoted to the intellectual exploration of the essential and critical role that science and technology play in everyday life. The enterprise of science and technology affects virtually all areas of human life and existence and has outsize potential to improve the human condition, support global economic and social development, and promote international relations. Current research areas include energy technology innovation and diffusion strategy for the challenges of the 21st century; the roles of scientific research and technological innovation in economic growth and development, environmental sustainability, and international security; processes and mechanisms for science and technology advice to government; the role of STEM education in advancing innovation; and the evolution of information and communication technologies and other emerging technologies and their governance--the global technical infrastructure of the Internet and the government and institutional policies (e.g., privacy and cyber security) that shape their development.

Venkatesh Narayanamurti, Director; Laura Diaz Anadon, Associate Director

Sustainability Science Program

Harvard's Sustainability Science Program harnesses the University's strengths to promote the design of institutions, policies, practices,
and knowledge that support sustainable development. The Program’s approach is multidisciplinary, engaging people from the natural, social, medical, and engineering sciences, and from business, government, and civil society. It pursues its goals through three principal vehicles: 1) Capacity building, including scholarships for young Italians working on aspects of sustainable development to attend Harvard and training of doctoral and post-doctoral Fellows from around the world; 2) Research to support policy on sustainability issues of global importance; and 3) Workshops and seminars involving leading scholars, together with senior officials, from government and the private sector.”

William Clark, Nancy Dickson, and Michael Kremer, Directors

The Water-Energy Nexus

Energy Technology Innovation Policy group researchers are pursuing research related to the complex interactions between water and energy, focusing on the Middle East, China, and the United States. In the United States, research has examined the interaction of water and energy in renewable fuels, oil sands, and shale gas production. Research on the Middle East focuses on country-specific studies of decisions related to water distribution along with opportunities for increasing the availability of fresh water. For example, in 2014, researchers found that future water availability in arid regions may be assessed by considering key projects that have been identified or planned by regional experts. 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.

Laura Diaz Anadon, Faculty Chair

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 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 research includes the Infrastructure 360 Awards, the first voluntary recognition, analysis and benchmarking program for infrastructure sustainability in Latin America, in collaboration with the Inter-American Development Bank; the Zofnass Economic Process Tool, a platform that offers a fast and easy way to understand and quantify sustainability externalities in infrastructure projects; the Zofnass Planning Guidelines for contemporary city planning practice; and research on urban water management through the Next Generation Infrastructure for Sustainable Environments project. In the past, the Zofnass Program, in collaboration with the Institute for Sustainable Infrastructure, has developed the Envision™ rating system for gauging infrastructure sustainability.

Spiro N. Pollalis, Program Director; Andreas Georgoulias, Research Director
“Renewables do not need to wait” for the development of cheaper bulk energy storage technologies, argued David Keith, Gordon McKay Professor of Applied Physics at Harvard’s School of Engineering and Applied Sciences and Professor of Public Policy at the Harvard Kennedy School, in a November 3, 2014, energy policy seminar. Taking on the conventional wisdom that an electricity system with a lot of renewable energy will also require a lot of bulk energy storage capacity, Keith presented the results of his energy system modeling work done with Harvard PhD student Hossein Safaei, which suggest that “large-scale bulk energy storage is neither technically required nor cost effective to substantially cut emissions.”

Keith modeled a simplified version of optimal electricity dispatch (omitting complicating factors like transmission constraints) to see how much storage would be included in the system given varying carbon emission limits and varying costs of storage, assuming a requirement that the amount of greenhouse gas emitted per megawatt hour be cut by 70% compared to today. Keith used the model to examine how storage would be used both in the case of current storage costs, and in a hypothetical future case in which energy storage costs had decreased by 50%. He reported the following main findings:

- Even under the model’s fairly strong carbon constraints, gas can play a significant role in managing the variability brought into the system by the
How important is energy storage for decarbonization?

use of wind and solar resources, minimizing the importance of cheap bulk energy storage;

› The impact of storage cost breakthroughs on the overall cost of the electricity system is unlikely to be dramatic. In Keith’s model, even steep reductions (50%) in the cost of bulk energy storage lowered overall electricity prices by only a modest amount—reaching a high of a 10% cost reduction in the most extreme emission reduction scenario (in which emissions were reduced to zero);

› The largest impact of cheap electricity energy storage is that in scenarios with cheap storage available, wind energy plays a larger role, taking the place of other low-carbon energy sources like nuclear and solar energy.

› With current technologies, mechanical systems for energy storage (for example, pumped hydro or compressed air energy storage) are much more competitive than battery systems.

Keith noted that his model focused only on the role of bulk storage in integrating renewables into the electricity system—not only any other potential uses for storage, such as providing regulation services.

Keith’s talk was part of the Kennedy School’s Energy Policy Seminar Series.
ACTIVITIES BY TOPIC
At some point in the future, likely out of both necessity and ingenuity, the dominance of fossil fuels will give way to one or more new energy sources. The shift to these new energy sources – whether solar, wind, biomass, nuclear or something we cannot yet imagine – will bring with it its own host of peculiar security issues. The challenges in anticipating this new landscape are further complicated by another related transition: the emergence of a more multipolar energy world, where emerging economies are now the drivers of energy demand and other global trends.

Biofuels

The Energy Technology Innovation Policy research group organized and hosted a two-day workshop to examine the ways in which current public policy affects the development of advanced biofuels, with participants from academia, business, and non-governmental organizations. Issues discussed included supply chains, sustainability, and the “valley of death.” A second workshop is planned for the spring of 2015.

China

The Sustainability Science Program’s China Initiative joined with Tsinghua University to sponsor a workshop on the use of market mechanisms to achieve a low-carbon future for China. The workshop was held in China in June 2014. Participants included senior Chinese government officials as well as leading scholars from China, the United States, and Europe.

The China Initiative is working to design new analytical tools and an accounting framework for evaluating energy technology performance. As part of this effort, researchers are working to produce an open access data set on China’s energy consumption and carbon emissions from 1950 to 2013.

Other China Initiative ongoing projects include a study of low-carbon leapfrogging in a global context; transmission issues for wind generation in China; the relationship between water resources and energy-related water demand; energy efficiency and infrastructure issues; and China’s efforts to encourage the deployment of electric vehicles.

A team of HKS students, led by Professor Henry Lee, prepared a report for the Chinese Academy of Social Sciences on developing a low carbon strategy for Shanghai, addressing land use planning and transportation, building energy efficiency, and electricity consumption by end users.

The Harvard China Project and Harvard University Center for the Environment launched a Harvard-wide public lecture series titled “China 2035: Energy, Climate, and Development.” In the spring of 2014, the series included public lectures by Nobel Prize-winning economist Michael Spence, former World Bank President Robert Zoellick, and former Australian Prime Minister Kevin Rudd.
Harvard China Project researchers analyzed a number of issues related to wind power in China, including why existing wind capacity in China is used at a lower rate than wind capacity in the United States, finding that the primary reasons seem to be curtailment of wind power in favor of baseload coal capacity, differences in turbine quality, and delayed connection to the grid. (See Lu and McElroy, “Wind power in China: Current status and challenges for the future.”) Another article traced the capacity value that should be assigned to offshore wind resources serving the province (See Lu et al., “Opportunity for offshore wind to reduce future demand for coal-fired power plants in China with consequent savings in emissions of CO2.”)

Harvard China Project researchers analyzed production and consumption-based measures of CO₂ emissions in China, finding that almost 25% of China’s 2007 carbon emissions could be attributed to net exports. In addition, the report found a tendency for carbon-intensive activities to relocate within China from the more developed coast to the less developed interior. See Wang et al., “Understanding China’s carbon dioxide emissions from both production and consumption perspectives.”

Climate policy

In December 2014, the Harvard Project on Climate Agreements co-sponsored an official side event at the Twentieth Conference of the Parties (COP-20) of the United Nations Framework Convention on Climate Change (UNFCCC) in Lima, Peru, on the topic “Linkage among Climate Policies in the 2015 Paris Agreement.”

Professor Robert Stavins, Director of the Harvard Project on Climate Agreements, participated in a panel at COP-20 hosted by the International Emissions Trading Association (IETA) examining market mechanisms in the 2015 agreement.

Professor Robert Stavins, with Research Assistant Gabriel Chan, continued his work as Co-Coordinating Lead Author of the Intergovernmental Panel on Climate Change (IPCC)’s Fifth Assessment Report (“AR5”). The chapter titled “International Cooperation: Agreements and Instruments” was released with the full report in April 2014. The report and Robert Stavins received significant media coverage.
Professor Stavins delivered a presentation, “Be Careful What You Wish for—Lessons from U.S. Cap and-Trade Experience,” in Brussels, Belgium, on February 12–13, 2014. The event—a workshop, “The European Emissions Trading System—Taking Stock, Looking Forward: Options for Reform,” was co-hosted by the European Council of Academies of Applied Sciences, Technologies, and Engineering and the Mercator Research Institute on Global Commons and Climate Change. Stavins gave a broad overview of how market mechanisms have been used to tackle environmental issues in the United States.

Professors Robert Stavins and Rohini Pande co-hosted a session at IDEASpHERE on May 15, 2014, a two day event at Harvard Kennedy School attended by donors, alumni, faculty, and students. The session, “Harnessing Market Forces to Protect the Climate,” discussed using economics to address climate change. Approaches such as cap-and-trade and other market-based mechanisms have been used in Europe, India, and the United States to tackle environmental policy.

Harvard Project on Climate Agreements collaborator and Professor of Economics at Harvard University Martin Weitzman discussed the potential of carbon taxes and cap-and-trade programs to deal with climate change. He also expressed his concerns regarding geoengineering. The lecture, “Why is the Economics of Climate Change so Difficult and Controversial?” was delivered at the Mercator Research Institute on Global Commons and Climate Change (MCC) in Berlin, Germany on May 28, 2014.

The Harvard Project on Climate Agreements continued its discussion paper series with eight new papers in 2014 on topics including the relationship between temperature and economic performance (Heal and Park); the potential relationships between domestic and international climate actions (papers by Aldy and Pizer; by Helm and Schmidt; by Bohringer et al., and by Bodansky et al.); the energy efficiency gap (paper by Gerarden et al.); the possible role of natural gas in reducing carbon emissions (Carraro et al.); and the potential role of a uniform international carbon price (see paper by Weitzman). The HPCA “Viewpoints” series continued with “A Pre-Lima Scorecard for Evaluating which Countries are Doing Their Fair Share in Pledged Carbon Cuts,” by Bosetti and Frankel.

On November 5, 2014, the HLS Environmental Policy Initiative submitted comments on EPA’s Clean Power Plan, which proposes to regulate greenhouse
activities by topic

Gas emissions from existing stationary sources for the first time in U.S. history. The comments are in the form of an Energy Efficiency Evaluation Tool, which states and stakeholders can use to determine whether energy efficiency (EE) programs can be included in their emission reduction plans. The Evaluation Tool contains a series of questions that guide the evaluation of EE programs, organized around four attributes of Clean Air Act compliant emission reduction credits: quantifiable, enforceable, permanent, and non-duplicative. The Tool also integrates past EPA guidance and summarizes EE programs that have received past EPA approval to provide additional clarity to stakeholders. Finally, the Tool provides concrete suggestions for EPA to consider prior to finalizing the Clean Power Plan.

The HLS Environmental Policy Initiative has developed a website, StatePowerProject.org, which provides summaries of electricity market-related litigation with the States and filed legal briefs and judicial or administrative decisions in those cases. The site also includes background about key concepts at issue in this litigation.

On January 28, 2014, the Emmett Environmental Law & Policy Clinic at Harvard Law School filed an amicus brief in Utility Air Regulatory Group v. U.S. Environmental Protection Agency, a pivotal U.S. Supreme Court case that involved challenges to EPA’s regulation of greenhouse gas emissions from power plants under the Prevention of Significant Deterioration (PSD) program of the Clean Air Act. The brief, filed on behalf of Calpine Corporation, focused on Calpine’s experience as a company that had gone through the PSD permitting process for greenhouse gases on six occasions. In contrast to the assertions of some of the petitioners in the case, the brief argued that Calpine’s experience demonstrated that GHG PSD permitting has not resulted in excessive delays or costs and should be upheld by the Court.

Clinical Professor and Director Wendy B. Jacobs of the Emmett Environmental Law & Policy Clinic at Harvard Law School served as a Session Chair and participated in a panel discussion at the Sixth International Energy Agency (IEA) Carbon Capture and Sequestration (CCS) Regulatory Network Meeting in Paris, France in May 2014.

Across Harvard, faculty and external experts held seminars and workshops to discuss the likely impact and implications of EPA’s proposed carbon regulation based on section 111(d) of the Clean Air Act. The topic was addressed in the

› A November 2014 Harvard Business School conference focused on the topic of “engaged investment and climate change.” The conference addressed the question of how investors concerned about climate change might best influence corporate actions, ranging from divestment to active participation.

› In April 2014, Harvard President Drew Faust announced the creation of a $20 million Climate Change Solutions Fund to support research related to climate change prevention and mitigation.

Education

› The Harvard Graduate Consortium on Energy and Environment fosters a community of doctoral students who are well versed in the broad, interconnected issues of energy and environment while maintaining their focus in their primary discipline. Through debate and dialogue in coursework and seminars, students are able to identify the obstacles, highlight the opportunities, and define the discussion of an energy strategy for the 21st century and beyond. 51 graduate students from across Harvard are participating in the Harvard Graduate Consortium on Energy and Environment during the 2014-2015 academic year.

› More than thirty courses per year across the University are offered on topics closely related to energy policy, ranging from introductions to energy policy to courses on efficient building design and the geopolitics of energy.

› In 2014, the Harvard Kennedy School received a $3.5 million gift to launch a new fellowship program for future environmental leaders, the Louis Bacon Environmental Leadership Program, which will support HKS masters’ degree candidates working to develop leadership abilities to impact environmental policy and practice.

› Beginning in the 2014-15 academic year, Harvard’s Environmental Science and Public Policy Program began offering a new secondary field in energy and environment to provide an opportunity for students to supplement their work in their primary concentration with study of issues related to energy and environment.
In 2014, the Harvard University Center for the Environment awarded 11 research assistantships for undergraduate students to work with Harvard faculty and funded eight undergraduate independent research projects on topics related to energy and environment.

The Harvard Environmental Economics Program continues its pre-doctoral fellows program, with 26 pre-doctoral fellows in 2014-2015. Pre-doctoral fellows attend the HEEP Seminar in Environmental Economics and Policy and have their own Research Lunch Seminar, which allows them to present their own research and benefit from each other’s experience.

The Harvard Environmental Economics Program (HEEP) hosted a research workshop for HEEP Pre-Doctoral Fellows and alumni of the Fellows program on October 23-24, 2014, at the Harvard Kennedy School. Approximately twenty alumni and twenty current doctoral students participated. The workshop included research presentations organized into topical panels. Among the topics were environment and health, energy efficiency, and energy-technology innovation. There was also an extended session in which alumni related experiences with advice on career development, for the benefit of the current Pre-Doctoral Fellows.

In 2015, the Harvard China Initiative will begin a fellowship program for practitioners working in the Chinese government at the central, provincial or local level, or working in the private sector, to analyze the potential for policies and programs to enhance China’s environmental or energy goals.

More than fifty fellows and visiting scholars are conducted energy policy-related research throughout the University in 2014-2015.

Electricity markets and regulation

A Harvard team lead by Professor Mike Aziz of SEAS received funding from the Department of Energy’s ARPA-E program to develop a low-cost grid-scale flow battery. Professor William Hogan of HKS is working with Aziz to analyze how such a battery could be integrated into wholesale electricity markets.

The Harvard Electricity Policy Group hosted four plenary sessions in 2014, examining topics that included the EPA proposed rule 111(d) to regulate
carbon emissions for existing generation; resource diversity, uplift payments, and diverse approaches to energy and capacity markets.

› Professor William Hogan, Research Director of the Harvard Electricity Policy Group, published articles and working papers related to the California Energy Imbalance Market, some of the latest issues in electricity market design, and the relationship between market design flaws and market manipulation.

› Professor Hogan offered a new course on electricity market design in the fall of 2014.

› Professor Massimo Filippini from the University of Lugano, Switzerland, visited the Harvard Electricity Policy Group in the spring of 2014, pursuing research on energy efficiency. Current HEPG fellow Carolina Lembo, Ph.D. in International Law, is working on an electricity market recommendation for Brazil.

› At the request of the City of Boston, the Emmett Environmental Law and Policy Clinic undertook a review of the law relevant to microgrids, publishing its findings in the paper, “Massachusetts Microgrids: Overcoming Legal Obstacles.”

**Energy efficiency**

› Two student teams from Harvard’s Graduate School of Design won awards for energy efficient house design from the International Building Performance Simulation Association and from the LIXIL International University Architectural competition.

› Harvard chemistry professor Cynthia Friend, the director of the Rowland Institute, received a major grant from the US Department of Energy to support her effort to reduce energy consumption in the production of industrial chemicals.

› The Harvard Environmental Economics Program (HEEP) and the Duke University Energy Initiative (DUEI) co-sponsored, with the Centre for European Economic Research (ZEW), a workshop on the energy-efficiency gap at ZEW’s headquarters in Mannheim, Germany, on March 12-13, 2014. Eighteen economists, almost all based in Europe and actively conducting research on this topic, participated.
The Harvard Environmental Economics Program (HEEP) continued its joint project with Duke to summarize the state of knowledge on the existence of a “gap” between the implementation of energy efficiency measures and the economic potential of such measures. As part of this effort, the Harvard Environmental Economics Program launched a publicly available online bibliography of research literature on the “energy-efficiency gap,” which as of December 2014 contained almost five hundred references. In addition, HEEP discussion papers examine different aspects of the energy efficiency gap problem. (See Gerarden et al., “An Assessment of the Energy-Efficiency Gap and its Implications for Climate-Change Policy,” and Houde and Aldy, “Belt and Suspenders and More: The Incremental Impact of Energy Efficiency Subsidies in the Presence of Existing Policy Instruments.”)

A March 2014 paper from the Environmental Law Program Policy Initiative made the case for the inclusion of energy efficiency within the regulatory framework of EPA’s proposed clean air regulation. (Konschnik and Peskoe, “Efficiency Rules: The Case for End-Use Energy Efficiency Programs in the Section 111(d) Rule for Existing Power Plants.”)

Energy externalities

In 2014, researchers at the Harvard School of Public Health published the first two parts of a three-part study on the co-benefits of carbon standards, examining potential compliance approaches to the EPA 111(d) rule and the likely associated co-benefits (in terms of the health effects of reduced air pollution, in particular) of these different compliance approaches. (See Driscoll et al. and Schwartz et al.). A third part of the study, expected in early 2015, will examine environmental and ecosystems services benefits.

Harvard researchers pursued topics related to the methodology of valuing energy externalities, examining why the “value of life” calculation may differ based on age and other characteristics (see Aldy and Smyth); how to properly value health risk reductions (Robinson and Hammitt); and how to choose a discount rate for use in valuing externalities (Gollier and Hammitt).

Researchers at the Harvard China Project published numerous articles on trends in China’s emissions of mercury and other pollutants (see articles by Wang et al., Zhao et al., and Nielsen and Ho).
Researchers at the Harvard School of Public Health continued to work on understanding the health impacts of pollutants, including, for example, the impact of the use of biomass fuels on pregnancy outcomes (Wylie et al.).

Work on valuing the social cost of carbon continued, including ongoing theoretical consideration of how to value potential catastrophic impacts of climate change by Professor Weitzman (“Fat Tails and the Social Cost of Carbon,” and “Tail-Hedge Discounting and the Social Cost of Carbon”) and Martin and Pindyck’s discussion paper for the Harvard Environmental Economics Program, “Averting Catastrophes: The Strange Economics of Scylla and Charybdis.”

**Geoengineering**

The joint Harvard-MIT seminar series, “Geoengineering: Science and Governance,” continued, with talks on topics ranging from stakeholder engagement to cloud brightening.

A March 2014 Harvard workshop convened researchers to develop proposals for field experiments to better understand possible solar radiation management technologies.

Harvard researchers published several papers in the 2014 edition of the *Philosophical Transactions of the Royal Society* dedicated to climate engineering. Papers included a discussion of an approach to climate engineering as a way of limiting the rate of climate change, rather than completely counteracting such change (MacMartin et al.), a proposal for a small-scale experiment in solar radiation management (Dykema et al.), a report on the Harvard workshop to identify possible experiments (Keith and MacMartin), and a discussion of potential governance of climate engineering experiments (Parker).

Professor David Keith’s other published 2014 research included work on how moderate amounts of geoengineering might have different impacts on different parts of the globe (see Kravitz et al.), and an examination of how geoengineering might be adjusted based on ongoing monitoring of its impacts, in the article (with MacMartin and others) “Dynamics of the Coupled Human-Climate System Resulting from Closed-Loop Control of Solar Geoengineering.”
Activities by Topic

Geopolitics of energy

The Belfer Center for Science and International Affairs’ Geopolitics of Energy Project continued its joint study of the geopolitics of natural gas (working with researchers from Rice University and the University of California, Davis), publishing working papers on the geopolitics of natural gas in relation to Russia (Mitrova) and to Australia (Ripple).

Belfer Center researchers published numerous articles on the geopolitical implications of the unconventional oil and gas boom, with a focus on the United States, Russia, and the European Union. (See, for example, O’Sullivan, “North American Energy Remakes the Geopolitical Landscape” and “The Unconventional Energy Boom: Bad Timing for a Revanchist Russia,” and Sklamera, “EU-Russia Cooperation in a Rapidly Changing Interregional Gas Market,” and Joseph Nye “Shale Gas is America’s Political Trump Card.”)

India

Sustainability Science Program (SSP) India Project research was published in the Quarterly Journal of Economics and in the American Economic Review (first author, Duflo). Researchers examined the behavior of auditors in India charged with assessing compliance with pollution regulation, finding that structuring the auditing relationship to mitigate conflicts of interest results in better auditing and less pollution.

In India, the Central Pollution Control Board published guidelines for pollution monitoring co-authored by Sustainability Science Program Alumni Fellow Anant Sudarshan.

The SSP India Project is working with the central regulator in India to develop and pilot a Continuous Emissions Monitoring System that will feed information directly from smokestacks to regulators and the public in real time.

The flagship emissions trading system (ETS) project of the India Initiative is continuing, in partnership with India’s Ministry of Environment and Forests, several State Pollution Control Boards and other stakeholders.

The India Initiative is preparing to pilot an innovative public disclosure system in Maharashtra that will publicly post information on the environmental performance of specific plants and measure the effects of this disclosure.
SSP fellows are working on cost benefit analyses of potential air pollution control policy instruments in India; evaluating the impact of vehicle emissions standards on urban air pollution levels; developing computer models capable of projecting the likely health impacts of different emissions reduction policies in India, working with the city of Bangalore to use monthly electricity consumption data to test hypotheses about the relationship between urban growth and household consumption; and exploring potential legal approaches to the problem of air pollution in India.

In July 2014, the India Initiative co-hosted a Policy Dialogue in Delhi, India, titled “Economic Growth and Environmental Protection through Evidence-Based Policy,” with Evidence for Policy Design (Harvard), the Energy Policy Institute at Chicago, and the Institute for Financial Management and Research. The event brought together over 90 attendees to discuss the way forward for better environmental regulation in India.

Infrastructure

The Harvard Graduate School of Design’s Zofnass Program for Sustainable Infrastructure began a collaboration with the Inter-American Development Bank to create a private sector infrastructure sustainability awards program in Latin America and the Caribbean. The first awards were announced in March 2014, recognizing a wind project in the Dominican Republic, a solar plant in Mexico, and a metro line in Peru.

The Zofnass Program launched a preliminary version of a new online “Zofnass Economic Process Tool,” a platform based on the Zofnass Program’s Envision Rating System for evaluating the sustainability of infrastructure projects to promote better understanding of sustainability externalities as part of the infrastructure planning and design process.

Nuclear energy

Funded by a grant from the National Science Foundation, in 2013 the Science, Technology, and Society (STS) Program began work on a study of discourses of responsibility and blame following the Fukushima nuclear disaster. Led by Principal Investigator Sheila Jasanoff at Harvard and Senior Researcher Kyoko Sato at Stanford, this three-year project will examine how the cultural meanings of the 2011 disaster are being constructed in Japan and the United States, as
well as how, through this process, nationally specific ideas that anchor nuclear policy are being refined and modified. As part of the initial data collection phase, Sato traveled to Japan in August 2013 to conduct interviews with public officials, experts, and activists, visit Fukushima, and gather materials for media analysis.

The Belfer Center for Science and International Affairs’ Managing the Atom project continued its research program on security issues related to nuclear weapons, nuclear materials, and nuclear energy, publishing the report, *Advancing Nuclear Security: Evaluating Progress and Setting New Goals* (Bunn et al.), which outlines what was accomplished in a four-year effort launched in 2009 to secure nuclear material around the globe, and what remains to be done.

- Harvard Business School professor Joe Lassiter made the case for renewed pursuit of nuclear energy in “We Need a Miracle. New Nuclear Might Provide It.”

- Harvard School of Public Health professor James Hammitt collaborated with researchers from Nanjing and Emory Universities to investigate the aftermath of the Fukushima accident. See Huang et al., “The Effect of the Fukushima Nuclear Accident on the Risk Perception of Residents near a Nuclear Power Plant in China.”

**Oil and gas markets and regulation**

- Harvard Kennedy School professor Joe Aldy published a discussion paper, “The Labor Market Impacts of the 2010 Deepwater Horizon Oil Spill and Offshore Oil Drilling Moratorium,” finding evidence of increased employment in coastal Louisiana after the Deepwater Horizon incident, but decreased employment in gulf coast Florida after the spill.

- Students and faculty at the Law School’s Emmett Environmental Law & Policy Clinic submitted comments on an Advanced Notice of Proposed Rulemaking for Oil Spill Response Plans for High-Hazard Flammable Trains issued by the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation (DOT) in September 2014.

- In December 2013, the Emmett Environmental Law & Policy Clinic at Harvard Law School released the report “Suggested Indicators of Environmentally Responsible Performance of Offshore Oil and Gas Companies Proposing to Drill in the U.S. Arctic,” in which the Clinic developed a set of indicators that
attempts to address all aspects of offshore oil and gas operations in the Arctic.

› Clinical Professor and Director Wendy B. Jacobs of the Emmett Environmental Law & Policy Clinic at Harvard Law School presented at two insurance conferences focused on the risks associated with hydraulic fracturing in Philadelphia, PA (March 2014) and in New York, NY (May 2014).


### Renewable energy

› The U.S. Department of Energy’s Advanced Research Projects Agency–Energy (ARPA-E) has awarded a three-year, $3.75-million contract to a team of Harvard researchers to further develop a promising grid-scale battery technology they demonstrated earlier this year. The innovative organic flow battery is designed to safely and inexpensively store solar and wind energy for use when the sun isn’t shining and the wind isn’t blowing.

› Harvard China Project Research Associate Xi Lu and China Project Chair Professor Michael McElroy continued exploring different approaches to maximizing


State, local, and non-governmental energy initiatives

In September 2014, the Emmett Environmental Law & Policy Clinic at Harvard Law School released a report entitled “Massachusetts Microgrids: Overcoming Legal Obstacles”, which summarizes the conclusions of the Clinic’s research into legal constraints on the ownership structure of microgrids in Massachusetts.

In July 2014, The Emmett Environmental Law & Policy Clinic at Harvard Law School released the revised “A Landowner’s Guide to Hydraulic Fracturing,” updated to include how to address environmental and health issues in natural gas leases.

The Emmett Environmental Law & Policy Clinic and the Environmental Policy Initiative at Harvard Law School released a report in May 2014 entitled “Responding to Landowner Complaints of Water Contamination from Oil and Gas Activity: Best Practices,” which provides recommendations for state lawmakers and agencies to consider implementing to develop robust, comprehensive policies for responding to landowner complaints.

Less Than We Think;” Lassiter, “We Need a Miracle. New Nuclear Might Provide It;” Macomber, “The ABCs of Addressing Climate Change (From a Business Perspective);” Toffel and Schendler, “The Climate Needs Aggressive CEO Leadership;” and Reinhardt, “Stop Thinking of Climate Change as a Religious or Political Issue.”

› A November 2014 Harvard Business School conference focused on the topic of “engaged investment and climate change.” The conference addressed the question of how investors concerned about climate change might best influence corporate actions, ranging from divestment to active participation.

Technology innovation

› A symposium held in honor of the 75th birthday of Professor Venkatesh Narayanamurti of the Harvard Kennedy School and Physics Department addressed questions related to “Inventing the Future to address Societal Challenges.” Topics of discussion included how policymakers and researchers can better approach the “grand challenge” of energy transformation.


› The Sustainability Science Program’s Innovation Initiative is exploring the question of how inventions are evaluated to determine whether they have significant potential to promote sustainable development, in a project conducted jointly with scholars at MIT. The project will review a set of exemplary cases of evaluation, drawn from a number of areas including energy. The ultimate goal is to identify and develop evaluation methods that could also be used to assist in diagnostics and design of sustainability strategies.

› An April 2014 workshop sponsored by the Weatherhead Center for International Affairs and the Harvard Kennedy School’s Sustainability Science Program brought researchers together to discuss the topic of “Innovation and Access to Technologies for Sustainable Development: A Global Systems Perspective.” (See the report on this workshop by Harley et al.). Researchers from the Sustainability Science Program and the Belfer Center for Science and International Affairs’ Energy Technology Innovation Policy research group wrote several papers related to global and international factors affecting technology innovation, including Anadon et al., “Innovation and Access to Technologies for Sustainable Develop-
Researchers from the Energy Technology Innovation Policy research group published an overview of findings from ten separate expert elicitation exercises, suggesting approaches to increasing the effectiveness of expert elicitation as a research strategy. See Anadon et al., “Energy Technology Expert Elicitations for Policy: Workshops, Modeling, and Meta-analysis.”

Professor Bill Hogan of the Harvard Kennedy School is participating in a National Academy study on “Determinants of Market Adoption of Advanced Energy Efficiency and Clean Energy Technologies.” A report is expected to be issued in 2015.

Water-energy nexus

The Sustainability Science Program’s Brazil Initiative is working to quantify key sustainability thresholds for the hydrologic functioning of the Amazon basin and surrounding regions under different land transformation and climate change scenarios, focusing on its impacts on hydropower planning and operation and flood risk. This work includes a case study that is examining the expected impacts of climate and land-use change on the planned hydropower developments in the Tapajos River Basin. In December 2014, the Brazil Initiative held a stakeholder workshop on “Sustainable Development of the Amazon and its Surrounding Regions: The Interplay of Changing Climate, Hydrology, and Land Use—Impacts on Hydropower Planning and Operation” in Brasilia, hosted by ANEEL, the National Agency for Electrical Energy. Recent publications include Livio et al., “Climate change as a challenge to decision-makers in the management of the Brazilian hydropower systems.”

Sustainability Science Program China Initiative and ETIP fellow researchers examined the relationship between water resource endowments and energy-related water needs in China (See papers by Scott Moore, including “Hydropolitics and Inter-Jurisdictional Relationships in China;” “Modernisation, Authoritarianism, and the Environment: The Politics of
Harvard Environmental Economics Program Fellow Sabrina Howell finds evidence that small government grants can be useful to early stage, high-tech energy startups. She spoke about her dissertation research on the federal Small Business Innovation Research grant program in the Harvard Kennedy School’s energy policy seminar on December 1, 2014.

Howell undertook her research in the context of an absence of clear evidence in the economics literature about the effectiveness of such R&D subsidy programs, she explained. In theory, government support might help make up for market failures, such as the fact that the innovators themselves may create benefits that in the end are captured by copycat competitors, and the fact that innovators may face especially high costs for obtaining external financing. On the other hand, it could be that government grants simply crowd out private investment, or distort economic incentives in ways that do not contribute to energy innovation.

One can, of course, study whether government funding tends to be associated with greater innovation success. The methodological challenge is in establishing causality—a greater success caused by the government funding itself, or is it just that the best infant companies also attract the most government funding, and also are more successful in the long run?

To tackle the causality problem, Howell used certain useful features of the SBIR grant award process, in which government reviewers rank all applications and then funding is awarded to some number of the top
Evidence from R&D Grants to Energy Startups

applicants, in merit order, and in two possible phases—a small ($150,000) initial grant, and a possible second-stage grant of $1 million. Howell compared the future success (measured by venture capital funding raised, patents issued, and eventual commercialization) of those firms just above and just below the cutoff for both the early stage and larger later stage grants. She found that firms that received initial grants were approximately twice as likely as non-recipients to later succeed in attracting venture capital funding. The effect, Howell reported, was strongest for the youngest firms. The early stage grants also have large, positive effects on patenting and achieving revenue. In contrast, the larger follow-up grants did not seem to improve future firm performance.

Howell proposed a number of mechanisms that might explain why the grants are helpful. She found that the evidence suggests that the effect is not due to “certification” by the government. One piece of evidence against certification is that the venture capitalists she interviewed claim not to be influenced by government awards. Instead, she suggested that the grants are effective because they fund prototyping and proof-of-concept work that is very hard to finance externally at an early stage.

Howell concluded by discussing the policy implications of her research, which suggests that the government might do well to shift funding from the second phase to the first phase, allowing for more support for companies in the very early stages of technological innovation.
ENERGY POLICY RESEARCH AT HARVARD
FELLOWS
The case for carbon taxes has long been compelling. With the recent steep fall in oil prices and associated declines in other energy prices it is overwhelming. There is room for debate about the size of the tax and about how the proceeds should be deployed. But there should be no doubt that starting from the current zero tax rate on carbon, increased taxation would be desirable.”

– Lawrence Summers, Charles W. Eliot University Professor, in "Let This Be the Year When We Put a Proper Price on Carbon." Financial Times, January 4, 2015.
Mauricio Arias

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

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. He is contributing to the Initiative on Sustainable Development of the Amazon and its Surrounding Regions: The Interplay of Changing Climate, Hydrology, and Land Use led by Paul Moorcroft. 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.

Megan Bailey

Fellow, Harvard Environmental Economics Program
PhD Student, Public Policy

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 to be 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.

Marie-Abèle Bind

Ziff Environmental Fellow, Harvard University Center for the Environment

Research Topic: Causal inference methods to investigate the role of temperature on health

Marie-Abèle Bind is an environmental biostatistician interested in health effects from environmental exposures.

Marie-Abele earned a MSc. in Engineering (Specialization in Energy and Environment) in 2007 at one of France’s Grandes Ecoles. She then received a MSc. in Environmental Health in a one-year intensive program at the Cyprus Institute associated with the Harvard School of Public Health (HSPH). In 2014 she received a dual Doctor of Science (Sc.D) degree in Environmental Health and Biostatistics from HSPH. Marie’s dissertation focused mainly on developing and applying methods to investigate the role of epigenetics in air pollution health effects. While working toward her Sc.D degree, Marie-Abele graduated from HUCE’s Graduate Consortium on Energy and Environment and received a MSc. in Biostatistics from HSPH.

Marie-Abele is working with Donald Rubin of the Department of Statistics to explore how temperature increases due to climate change will impact cardiovascular morbidity and mortality, especially in susceptible populations. Most epidemiological studies have focused on associations between temperature and health outcomes rather than causal effects. Marie-Abele plans to estimate causal temperature health effects. Within the field of causal inference, mediation analysis has become a valuable tool to examine pathways, especially in epidemiological research. She will extend previous causal effects derivations to settings with mortality outcomes and formalize mediated effects. Moreover, there is a recent interest for epigenomics data to examine new pathways. She will also examine the causal temperature effect on epigenome wide data in order to identify new biological mechanisms.
**Christian Binz**

*Giorgio Ruffolo Postdoctoral Research Fellow, Mossavar-Rahmani Center for Business and Government, HKS, and Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, HKS*

*Research Topic:* Low-carbon leapfrogging in China: An international innovation system perspective

Christian Binz works at the interface between evolutionary economic geography and transition studies. His post-doctoral research examines the geography of sustainability transitions in the water and energy sector. Christian aims at developing new theories on how international linkages shape innovation in clean-tech industries and the technological leapfrogging potential of latecomer economies. He is contributing to collaborative work with the Sustainability Science Program’s China Initiative. Christian holds a Masters in Economic Geography from the University of Bern in Switzerland and received his PhD through a Sino-Swiss Science and Technology Collaboration project between the Swiss Federal Institute of Aquatic Science and Technology and the Research Centre for Eco-Environmental Sciences at the Chinese Academy of Sciences in Beijing. His dissertation focused on the emergence of on-site water recycling industries in China and Europe and developed a new analytical perspective on how environmental innovation processes interrelate between developed and emerging economies. He worked as a visiting post-doctoral Research Fellow at UC Berkeley’s National Engineering Research Center for Re-Inventing the Urban Water Sector. His research on environmental innovation and sustainability transitions has been published in various journals including *Research Policy* and *Technological Forecasting and Social Change*, as well as in books by the International Water Association and UNEP. His faculty hosts are Henry Lee and Laura Diaz Anadon.

**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

Jonathan Buonocore is working with the Climate, Energy, and Health team at
Jonathan is working with the Center for Health and the Global Environment to better understand the health and environmental risks of hydraulic fracturing in Pennsylvania’s Marcellus Shale. 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, leaders of industry, and Pennsylvania residents make decisions that will support public health and a healthy environment. Additionally, Jonathan is working on an assessment of the health co-benefits of different options for a U.S. EPA carbon standard on existing power plants. He 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.

**Estelle Cantillon**

**Visiting Professor of Public Policy, HKS; Visiting Scholar in Sustainability Science**

**Research Topic:** Creation and development of emissions markets: Insights from the EU ETS

Estelle Cantillon is a FNRS senior research associate and professor at the Solvay Brussels School where she teaches environmental economics in the Masters programs and advises doctoral students in market design, industrial organization, and environmental economics. Her research lies at the boundary between market design and industrial organization. She has published on auctions, procurement and competition in the financial industry. Her current research spans school choice and environmental market design. Estelle is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Rohini Pande. Estelle is a member of the executive committees of the European Economic Association and the European Association for Research in Industrial Economics, an Associate Editor at the Rand Journal of Economics, a member of the Economics Council of OXERA, a consultancy, and a member of the steering committee of Re-Bel (Rethinking Belgium). She has recently launched a European-wide research network, Matching in Practice, whose goal is to foster developments at the interface between theory, empirics, experiments and policy on allocation and admission procedures in education. Estelle holds a Ph.D. in economics from Harvard University and has held prior appointments at Yale University and Harvard Business School before joining the faculty at the Solvay Brussels School in 2004. Her faculty host is Rohini Pande.
Gabe Chan

Research Fellow, Energy Technology Innovation Policy research group
Fellow, Harvard Environmental Economics Program
PhD Student, Public Policy

Research Topic: Innovation economics and policy in the energy sector using quantitative social science methodology

Gabe Chan is a public policy PhD student and a Doctoral Research Fellow in the Energy Technology Innovation Policy group and the Harvard Environmental Economics Program and a former fellow of the Sustainability Science Program at the Harvard Kennedy School of Government. His research focuses on innovation economics and policy in the energy sector using quantitative social science methodology. His interests lie in the interaction of government policy with radical technical change as well as in developing and applying cutting-edge statistical methodology to empirical questions in innovation economics, such as the estimation of technological spillovers from public R&D. Gabe is a recipient of the Belfer Center Science, Technology, and Public Policy Fellowship (2012-2014), the Giorgio Ruffolo Sustainability Science Fellowship (2011-2012), and the Vicki Norberg Bohm Fellowship (2010), and he is a graduate of the Harvard Graduate Consortium on Energy and the Environment (2012). Prior to coming to Harvard Gabe graduated from the Massachusetts Institute of Technology in 2009 where he received Bachelor of Science degrees in earth, atmospheric, and planetary science and political science. In 2007 and 2009, Gabe worked at the U.S. Department of Energy, where he worked in the Climate Change Technology Program (CCTP), an interagency group tasked with prioritizing the federal government’s investments and policies for mitigating climate change through accelerated technology innovation and deployment.

Rohit Chandra

Fellow, Harvard Environmental Economics Program
PhD Student, Public Policy

Research Topic: The history, evolution and dynamics of energy markets in South Asia, particularly in India

Rohit Chandra’s research focuses on the history, evolution, and dynamics of energy markets in South Asia, particularly in India. He has looked primarily at coal, electricity and natural gas markets and their supply chains, governance, and
distortions. He is also interested in natural resource economics in developing countries and the economic effects of resource extraction on local communities. He graduated from the University of Pennsylvania in 2010 with a BSc in electrical engineering and has worked in New Delhi for two years at the Centre for Policy Research.

Sushanta K. Chatterjee

Giorgio Ruffolo Post-doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS (resident in September 2014)

Research Topic: The renewable energy policy dilemma in India: Should the Renewable Energy Certificate mechanism compete or merge with the Feed-in-Tariff scheme?

Sushanta K Chatterjee is Joint Chief for Regulatory Affairs with the Central Electricity Regulatory Commission in India. His work focuses on public policy and regulation, including renewable energy. He deals with power sector reforms and was centrally involved in India’s Electricity Act of 2003. He contributed to the conceptualization of the Renewable Energy Certificate mechanism in India. Sushanta is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Rohini Pande. He has a PhD in Management from the University of Petroleum and Energy Studies in India and completed a dissertation on “Policy Instruments for Promotion of Renewable Energy Generation: Development of a Suggestive Framework for Indian REC System.” He has an MBA from Indira Gandhi National Open University with a specialization in Finance and a Post Graduate Diploma in Information Technology and Management from the Indian Institute of Public Administration. He co-authored The Electricity Sector in India: Policy and Regulation (Oxford, 2012). His has published on topics including the electricity laws of India and renewable energy. He is a member of various Government Committees. His faculty host is Rohini Pande.
Cuicui Chen

Fellow, Harvard Environmental Economics Program  
PhD Student, Public Policy

Research Topic: Social learning, technology diffusion, reputation

Cuicui Chen is a doctoral student in Public Policy at the Harvard Kennedy School. She is interested in industrial organization, game theory, and environmental economics. She obtained a Bachelor's degree in environmental engineering and a certificate in computer applications from Tsinghua University in 2010, and a Master of Science degree in technology and policy from Massachusetts Institute of Technology in 2012.

Xinyu Chen

Postdoctoral Fellow, Harvard China Project

Research Topic: Opportunities and solutions to accommodate higher penetration of renewables in China; joint simulation and optimization of power, heat and electrified transportation systems

Xinyu Chen received his B.Sc. and Ph.D. degree from Department of Electrical Engineering in Tsinghua University in China, in 2009 and 2014, respectively. His research interests include load forecasting, smart grid strategies, and wind power integration. He is currently working on the large-scale simulation and optimization of China’s power system, heating system, and electrified transportation to better integrate wind power, with potential applications to policy.

Ross Collins

Doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS

Research Topic: Evaluating infrastructure policy for sustainable development: How will interventions impact the development trajectory of countries over time?

Ross Collins is a PhD candidate in the Engineering Systems Division at the Massachusetts Institute of Technology. His research concerns large-scale infrastructure system design that is commensurate with sustainable
development. His work uses simulation and scenario planning to model interdependent water and energy infrastructures in Saudi Arabia, in an attempt to uncover strategies that are robust – along social, economic and environmental dimensions – to future uncertainties. The strategy formulation process combines technology detail with macroeconomic analysis, including the state-of-the-art in sustainable development theory and long-term policy analysis. This work is part of a larger collaboration between MIT and the King Abdulaziz City for Science and Technology, called the Center for Complex Engineering Systems. Ross is contributing to collaborative work with the Initiative on Innovation and Access to Technologies for Sustainable Development led by William Clark. Ross also works part-time for the global energy consulting firm IHS CERA, organizing their Energy Innovation Pioneers program each year at CERAWeek, one of the largest executive energy conferences in the world. Before entering MIT as a doctoral student, he worked for former Congressman (now Senator) Edward Markey on the Natural Resources Committee in the U.S. House of Representatives. Ross holds an S.M. in Technology & Policy from MIT, an M.S. and B.S. in Systems Engineering and B.A. in Economics, both from the University of Virginia. Research there included tradeoff exploration of different geographic configurations of photovoltaic installations, risk-scoring of critical infrastructures for the Virginia Department of Transportation and the U.S. Department of Homeland Security, and economic analysis of workforce disruptions during pandemic flu outbreaks. His faculty host is William Clark.

**Tim Cronin**

*NOAA Climate and Global Change Fellow, Harvard University Center for the Environment*

*Research Topic: Arctic Atmospheric Convection in a Warmer World*

Tim Cronin is a climate scientist interested in the interactions between clouds, sea ice, and severe storms in a warmer Arctic.

Tim earned a B.A. in Physics from Swarthmore College in 2006, and received a Ph.D. in Climate Physics and Chemistry from MIT in June 2014. His dissertation research used simple column models of the atmosphere, interacting with a land surface, to explore a collection of problems in climate science. One of the papers he published developed a theory for the sensitivity of near-surface temperatures to changes in land surface properties, which is relevant for understanding how
anthropogenic land use and land cover change may have resulted in past and future climate change. Tim has also worked on trying to understand why it rains preferentially over islands in the tropics, and whether geologic changes around Indonesia have implications for climate changes over the past 3-5 million years. During the 2011-2012 academic year, he was a Martin Society Fellow for Sustainability, and his work has also been funded by the NSF.

As an Environmental Fellow, Tim is working with Eli Tziperman of the Department of Earth and Planetary Sciences on the interaction between clouds and sea ice in the Arctic, in climates that are warmer than present. His project has application to warmer climates of the distant past, as well as climates of the future. Tim will also explore the potential for the formation of hurricane-like storms over a warmer Arctic ocean that has lost much of its sea ice; such storms would be highly relevant to the impacts of climate change on both human and natural systems in the future Arctic.

**Archana Dayalu**

*Ph.D. Candidate, Department of Earth & Planetary Sciences*

*Student Research Fellow, Harvard China Project*

*Research Topic: Biogenic and anthropogenic CO₂ fluxes from North and East China estimated from atmospheric CO₂ data*

Archana Dayalu received her B.S in Chemistry and B.A in Environmental Studies from the University of Washington in Seattle in 2006. After working as a consultant in contaminated site remediation for a few years post-undergrad, she was drawn back to graduate school to pursue her interests in atmospheric chemistry, climate change, and energy policy. Archana is a member of the Harvard Center for the Environment Graduate Consortium on Energy and the Environment, and in her spare time she is a contributing editor at Policyleab.org, an online forum for early career scientists to link and communicate their research to the broader society.
Claudia Doblinger's research focuses on the interface of public policies, regulation, and firm-level technological innovation. In her post-doctoral research, she is evaluating the effect of public R&D funding for renewable energy in Germany by comparing innovation effects among recipient and non-recipient firms. Furthermore, she is interested in examining knowledge flows and partnerships among start-ups and incumbents that operate in low-carbon energy industries. Claudia holds a Diploma (Master of Science equivalent) in Business Administration from the University of Regensburg, Germany. During her studies, she gained valuable work experience during internships at several international companies and the International Trade Center (UNCTAD/WTO). Claudia earned her Ph.D. in Innovation and Technology Management at the University of Regensburg, Germany in 2013. Her dissertation focused on exploring the contribution of change-actors to new technology adoption and diffusion by dominant incumbents in the U.S. electric energy system. Furthermore, drawing on novel data from a large-scale survey among new ventures and mature firms that operate in the German renewable energy industry, she examined the firm-level behavioral and innovation effects of demand-pull policies and the inherent regulatory uncertainty. Her research has been published in the Journal of Product Innovation Management and Energy Policy. Her faculty hosts are Venkatesh Narayanamurti and Laura Diaz Anadon.

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. He worked as researcher in environmental economics, natural resource management, and disaster risk reduction at the Fondazione Eni Enrico Mattei and the Euro-Mediterranean Center for Climate Change. There, he was involved in several research projects addressing natural hazard risk and impact analysis, policy assessment and implementation, water management, and analysis of climate change adaptation strategies. He collaborated with the European Environmental Agency as a member of the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation. Fabio completed an internship at the United Nations Environment Programme – Regional Resource Centre for Asia and the Pacific in Bangkok, Thailand. During this experience he carried out a study on community-driven rural development and community-based adaptation to climate change in Thailand. He has also worked in the private sector as an economic consultant. Fabio has a Master's degree in Environmental Economics and a degree in Business Administration from Ca' Foscari University. During his studies, he spent a semester at the Nova University of Lisbon, Portugal and was awarded a scholarship for the Globalization Programme at Venice International University. His faculty host is Paul Moorcroft.

**Nathan Fleming**

*Fellow, Harvard Environmental Economics Program*

*PhD Student, 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.
Benjamin Franta

Research Fellow, Science, Technology, and Public Policy Program, Belfer Center for Science and International Affairs, HKS
USAID Research and Innovation Fellow
PhD Candidate in Applied Physics, Harvard SEAS

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

Benjamin Franta is a predoctoral research fellow at the Harvard Kennedy School’s Belfer Center developing case studies on climate change preparedness in the Philippines. His work focuses on urban and rural areas in the Philippines that have experienced recent extreme typhoons and is being done in conjunction with the Manila Observatory and USAID. He is a Ph.D. Candidate in Applied Physics at the Harvard School of Engineering and Applied Sciences working on intermediate band photovoltaics and a graduate of the Harvard Graduate Consortium on Energy and the Environment. He has degrees in physics, mathematics, archaeological science, and applied physics from Coe College, the University of Oxford, and Harvard University.

Todd Gerarden

Fellow, Harvard Environmental Economics Program
PhD Student, 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 B.S. 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.
Shibani Ghosh

Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS (resident in September 2014)

Research Topic: Exploring legal avenues to tackle air pollution in India

Shibani Ghosh is a public interest lawyer specializing in environmental and access to information laws. She is associated with the Centre for Policy Research in New Delhi, a think tank, where her area of research is domestic environmental law and regulation and where she coordinates a research project on principles and rules in Indian environmental law funded by the Indian Council for Social Science Research. She is also a Visiting Faculty at the TERI University, New Delhi and Royal Institution of Chartered Surveyors (RICS) School of Built Environment, Amity University in Noida, where she teaches environmental law. Shibani is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Rohini Pande. She has been involved in litigation on various environmental issues including wildlife protection and environmental regulatory approvals granted to infrastructure projects. Shibani is a Rhodes Scholar and holds a Masters in Science in Environmental Change and Management and a Bachelors in Civil Law (a graduate degree in law) from the University of Oxford. She has an undergraduate degree in law (B.A. LL.B. (Hons.)) from the National University of Juridical Sciences in Kolkata. She was previously associated with the Legal Initiative for Forest and Environment (LIFE), a New Delhi-based environmental law firm, and has worked as a legal consultant with the Central Information Commission, a quasi-judicial body set up under the Right to Information Act, 2005. In 2011, she was awarded the first DoPT-RTI fellowship by the Department of Personnel and Training, Government of India to undertake research on the implementation of the Right to Information Act 2005. Her faculty host is Rohini Pande.

Meiyu Guo

Visiting Fellow, Harvard China Project
PhD Student, Department of Geography and Resource Management, The Chinese University of Hong Kong

Research Topic: Environmental enforcement and compliance on shale gas development in the United States and China

Meiyu Guo is a PhD candidate in Geography and Resource Management at the Chinese University of Hong Kong and a visiting fellow in the Harvard China Project.
Santosh Harish

Post-doctoral Research Fellow, Sustainability Science Program, Mossavar Rahmani Center for Business and Government, HKS, and at the Abdul Latif Jameel Poverty Action Lab (J-PAL) South Asia (resident in April 2014)

Research Topic: Adapting to chronic power outages in India: Modeling residential demand for energy services with unreliable supply

Santosh Harish's research interests lie in energy and environmental policy in developing countries. Santosh is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Rohini Pande. At J-PAL South Asia, he works on energy and environment projects with Professors Rohini Pande and Michael Greenstone, including the evaluation of a pilot emissions trading program for Indian industry. Santosh received his PhD from the Department of Engineering and Public Policy at Carnegie Mellon University (2014). His dissertation research focused on the generation and distribution aspects of providing reliable electricity access in rural India. This work included the development of a consumer surplus-based method of incorporating consumer interruption costs in electrification planning, and a study on the rural-urban disparity in supply rostering schedules. His research has been published in *Energy Policy*, *Energy for Sustainable Development*, and *Economic and Political Weekly*. He received his undergraduate degree in Metallurgical and Materials Engineering from the Indian Institute of Technology Madras (2010). His faculty host is Rohini Pande.

Pedram Hassanzadeh

Environmental Fellow, Harvard University Center for the Environment

Research Topic: Jet streams and atmospheric blocking events in a warming climate

During his two-year fellowship, Pedram is working with Brian Farrell of the Department of Earth and Planetary Sciences and the School of Engineering and Applied Sciences to study jet streams and atmospheric blocking events in a
warming climate. The improved understanding of the blocks will be then used to investigate changes in some types of weather extremes, such as heat waves, cold spells, and heavy precipitation in a warming climate.

**Mun Ho**

*Visiting Scholar, Harvard China Project*
*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, D.C. 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.

**Joshua Horton**

*Postdoctoral Research Fellow, Science, Technology, and Public Policy Program, Belfer Center for Science and International Affairs, HKS*

*Research Topic: Geoengineering Policy*

Josh Horton conducts research on geoengineering policy and governance issues. His current research interests include liability and compensation, solar geoengineering as an emergency response, international relations and disciplinary IR, and procedural mechanisms for regulating possible geoengineering field experiments. Before joining the Belfer Center, Josh worked as an energy consultant for a global consulting firm. He holds a Ph.D. in political science from Johns Hopkins University.
Sabrina Howell

*Fellow, Harvard Environmental Economics Program*

*PhD Student in Economics, Political Economy and Government Program*

Sabrina’s research focuses on innovation and entrepreneurial finance, particularly in the energy sector and in China. One of her current projects examines the impact of government grants to energy startups, focusing on how the grants affect firms’ subsequent venture capital investment. Another explores how the rapid imposition of fuel economy standards in China disincentivized domestic automotive companies from upgrading their technology. A third project studies applications and judging data from the largest clean energy startup incubator and prize program, the Cleantech Open. Sabrina is a recipient of a National Science Foundation Graduate Research Fellowship. Prior to Harvard, she worked in Houston for Charles River Associates and in Washington, D.C. as a senior policy analyst at Securing America’s Future Energy (SAFE). While at Harvard, she served as the summer intern for the Special Assistant to the President for Energy and the Environment at the White House National Economic Council. Sabrina holds a BA in Economics and East Asian studies from Yale University.

Zheng Hu

*Visiting Fellow, Harvard China Project*

*PhD candidate in Energy & Environmental Policy, University of Delaware*

*Research Topic: Energy optimization in China*

Zheng Hu, a PhD candidate in Energy & Environmental Policy at the University of Delaware, has a background in economics and is a visiting scholar at the Harvard China Project. He studies electricity optimization for China based on economic growth, grid structure, demand-side management, and China’s emission targets. He is also working on China’s energy efficiency policy, especially the adoption of electric vehicles.
**Junling Huang**

*Postdoctoral Research Fellow, Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, HKS*

*Research Topic: Renewable energy, electricity markets, energy storage technology*

Junling Huang studies the value of emerging battery storage technologies in enhancing opportunities for electricity systems, with particular focus on the United States and China. The overarching theme for his research is to develop a strategy for developing and deploying a cleaner and more efficient electricity system. Junling Huang received his Ph.D. from School of Engineering and Applied Sciences at Harvard University in 2014 and a B.S. from School of Physics at Peking University in 2009.

**Joern Huenteler**

*Pre-doctoral Research Fellow, Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, HKS*

*Research Topic: Innovation policy for emerging energy technologies*

Joern Huenteler is a pre-doctoral research fellow in the Energy Technology Innovation Policy research group at the Kennedy School and a PhD candidate in the Department of Management, Technology, and Economics at ETH Zurich. In his doctoral dissertation, Joern examines the effects of market support policies (i.e., subsidies) on innovation processes in emerging energy technologies to better understand under what conditions they are suitable to achieve innovation policy objectives. He focuses on biofuels, wind power and solar PV. Joern holds a joint graduate degree in mechanical engineering and economics from RWTH Aachen University, Germany, and an MSc in power engineering and engineering thermophysics from Tsinghua University.
Eunjee Lee

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

Research Topic: Unsteadiness of the Amazonian hydrologic cycle? The roles of land-cover and climate change

Eunjee's fellowship work is based at Harvard's Department of Organismic and Evolutionary Biology. She is exploring the sustainability of the hydrologic cycle associated with changes in climate and land cover in the Amazon and the surrounding regions. Eunjee is contributing to collaborative work with the 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. Her research interests include: 1) investigation of unsteadiness of the hydrologic cycle using a modeling tool for atmosphere-biosphere interactions; 2) integrated assessment of the impact of climate change and water; and 3) engaging the scientific community to improve the use of scientific knowledge in science policymaking. Prior to joining Harvard, Eunjee received her Sc.D. in Atmospheric Sciences from the Massachusetts Institute of Technology (MIT) in 2011 and worked as a post-doctoral research associate at the MIT Center for Global Change Science. Her dissertation investigated the role of meteorology-driven seed dispersal in the plant migration process and the impacts of anticipated climate change on natural biogeography and ecosystems. Eunjee is a recipient of the Martin Fellowship for Sustainability (2008) and the MIT Presidential Fellowship (2005). She also holds a master's degree in Chemistry from Ohio State University, and a bachelor's degree in Chemical Engineering from Seoul National University. Her faculty host is Paul Moorcroft.

Carolina Lembo

Research Fellow, Harvard Electricity Policy Group, Mossavar Rahmani Center for Business and Government, HKS

Research Topic: Electricity access and market design in developing countries

Carolina Lembo is currently working with Bill Hogan and Ashley Brown of HKS. Her research interests are energy regulation, sustainable development and climate change negotiations. She holds a PhD in International Law from the University of São Paulo, a L.L.M. in International Economic Law and Policy from the University of Barcelona and a Ms. in State Law from the University of São Paulo.
Paulo. Previously she has been working as a manager of the Infrastructure Department of the Federation of Industries of the State of São Paulo, the major industry chamber in Brazil, where she managed a multi-disciplinary infrastructure department with focus on domestic policy and international projects, writing white papers, coordinating publications and organizing conferences with the Brazilian government and international organizations.

**Changyi Liu**

*Visiting Scholar, Harvard China Project*

*Assistant researcher, National Climate Center, China Meteorological Administration*

*Research Topic: Climate impact assessment, climate change, and renewable energy*

Changyi Liu received an economics PhD from the graduate school of the Chinese Academy of Social Sciences, now works as an assistant researcher in the National Climate Center of the China Meteorological Administration, and is a visiting scholar at the Harvard China Project. His research interests include climate impact assessment and adaptation, climate change and clean energy (renewable energy and energy demand management), atmospheric environment and health, all from both economic and policy perspectives.

**Zhu Liu**

*Giorgio Ruffolo Post-doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS*

*Research Fellow, Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, HKS*

*Research Topic: Options for a low-carbon pathway for China's sustainable development*

Zhu Liu’s research focuses on energy sustainability in China. Specifically, his work explores options for a low-carbon pathway for China’s sustainable development. Zhu is contributing to collaborative work with the Initiative on Sustainable Energy Development in China led by Professor Henry Lee. He conducted his doctoral study in ecology at the Institute of Applied Ecology of the Chinese Academy of Sciences (CAS) and graduated with highest honors.
Zhu received his PhD from the University of the Chinese Academy of Sciences (2013), the new educational form of CAS. Zhu was a visiting student at the University of Cambridge (2012). He holds a bachelor’s degree in geology from Northwest University (2007) and a master’s degree in ecology from China Agricultural University (2009). His research on energy and climate has been published in *Nature, Nature Climate Change, PNAS*, and other professional journals.

**Stephanie Lo**

*Fellow, Harvard Environmental Economics Program*

*PhD Student, Economics*

Stephanie Lo’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 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 BA in economics in 2010 and spent 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.

**Xi Lu**

*Research Associate and Lecturer, Harvard School of Engineering and Applied Sciences*

*Research Associate, Harvard China Project*

Research Topic: Technological and economic potentials of renewable and low-carbon energy sources

Xi Lu works in the Harvard China Project and the energy research group led by Prof. Michael McElroy. His major research involves meteorology-related renewable energy sources, especially wind power and its relationship to the power generation system in China and the U.S. He has published papers in *Science, PNAS, Environmental Science & Technology, Renewable Energy*, and *Energy Policy* on topics including technological and economic potentials for wind energy, variation challenges of wind-generated electricity, and...
the environmental implications of coal-to-gas fuel switching in the U.S. power system. He is also exploring general challenges and opportunities in low-carbon energy systems, especially in the electric power sector. Before entering Harvard, he worked for CH2M-HILL as an environmental scientist and was involved in the environmental consulting projects for the Beijing 2008 Olympic Games and for many multinational clients in the energy industry.

Danielle Medek

Environmental Fellow, Harvard University Center for the Environment

Research Topic: Effects of climate change on human nutrition

Danielle Medek is an ecophysiologist with interests in medicine, plant ecophysiology and global change. She earned her PhD and her Bachelor of Medicine and Bachelor of Surgery (MBBS) at The Australian National University.

During her two-year fellowship, Danielle is working with Samuel Myers at the Harvard School of Public Health to investigate the effects of climate change on human nutrition. In particular, her work focuses on how rising CO2 may influence crop nutrient content and thereby the global burden of disease from nutrient deficiency.

Jonathan Moch

Ph.D. candidate, Department of Earth and Planetary Sciences
Student Research Fellow, Harvard China Project

Research Topic: Mechanisms behind extreme air pollution events in China; feedbacks between climate and atmospheric chemistry; understanding the climate impacts of short-lived greenhouse gases

Jonathan Moch holds an AB from the Department of Geosciences and from the Woodrow Wilson School of Public and International Affairs at Princeton University, with minors in Environmental Studies and Chinese Language and Culture. Prior to arriving at Harvard, he worked at the World Resources Institute (WRI) as the China FAQs Project Specialist in WRI’s Climate and Energy Program. He is currently working on better understanding extreme pollution events in China and improving radiative forcing estimates of black carbon.
Francisco Monaldi

Roy Family Fellow, Environment and Natural Resources Program/Geopolitics of Energy Project
Visiting Professor, Harvard Kennedy School

Research Topic: National oil companies in Latin America

Francisco Monaldi teaches a graduate course on the political economy of oil during the spring semester and does research on national oil companies in Latin America.

He is a full Professor (on leave) at the Instituto de Estudios Superiores de Administracion (IESA) in Caracas, Venezuela, and Co-founder and Director of IESA’s Center on Energy and the Environment. Professor Monaldi is a leading scholar on the politics and economics of the oil industry in Latin America and developing countries.


Nathaniel Mueller

Environmental Fellow, Harvard University Center for the Environment

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

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.
Janhavi Nilekani

*Giorgio Ruffolo Doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS Fellow, Harvard Environmental Economics Program*  
*PhD Student, 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.

Pascal Noel

*Fellow, Harvard Environmental Economics Program*  
*PhD Student, Economics*

Pascal Noel is a PhD student in economics. His research interests include optimal energy taxation and the impact of energy investment incentives. Pascal received a BA in economics and in ethics, politics, and economics from Yale in 2006 and an MSc in economics from the London School of Economics in 2007. He worked for two years as a research assistant on The Hamilton Project at Brookings. From 2009 to 2011 he was a senior policy advisor on the National Economic Council at the White House.

Jisung Park

*Fellow, Harvard Environmental Economics Program*  
*PhD Student, Economics*

Jisung Park is a PhD Candidate in the economics department at Harvard University, where he specializes in Public Finance, Environmental Economics, Development, and Labor Economics. His research focuses on applications of economic
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-1661) 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).

Fábio Pereira

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

Research Topic: Conceptual evaluation of surface hydrology in the Tapajos River Basin and implications of climate and land use changes for its hydropower operations

Fabio Pereira’s fellowship research is based at Harvard’s Department of Organismic and Evolutionary Biology. He is implementing a large scale distributed hydrological model for the Tapajos River Basin in Brazil in conjunction with a coupled biosphere-atmosphere model to explore the implications of climate and land-use change for hydropower operations. Fábio is contributing to collaborative work with the Initiative on Sustainable Development in Amazonia: Land Use and the Hydrologic Cycle led by Professor Paul Moorcroft. Fábio holds a PhD in Water Resources Engineering from Lund University (2013) in Sweden. He received his master’s degree in Water Resources Engineering from Federal University of Rio Grande do Sul (2010) and his bachelor’s degree in Civil Engineering from Federal University of Alagoas (2008). His PhD thesis explored potential effects of the expansion of agricultural lands in the Amazon on the local hydrological cycle using environmental modeling. He was awarded an Erasmus Mundus scholarship to the Lund University (2010) and a doctoral
studentship from the Crafoord Foundation (2012). He worked as a consultant and his projects included dredge impact and recovery assessment, water quality management, and preparation of environmental impact assessment reports. His faculty host is Paul Moorcroft.

Cristine Russell

Senior Fellow, Environment and Natural Resources Program
Adjunct Lecturer, 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 HKS Shorenstein Center on the Press, Politics, and Public Policy and teaches an HKS 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.

Dongbo Shi

Research Fellow, Science, Technology, and Public Policy Program, Belfer Center for Science and International Affairs, HKS

Research Topic: Regulation and pollution abatement in India/Determinants of pricing behavior in India's wholesale electricity markets

Dongbo Shi is a Ph.D. student in public policy and a research fellow of the China Institute for Science and Technology Policy at Tsinghua University. He studies public policy and management, focusing on issues of research and innovation policy. His research topics also cover policy innovation and industrial policy.
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 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 Masters in Environmental Science from the Yale School of Forestry and Environmental Studies.

Morena Skalamera recently completed her PhD in political science and international relations at the University of Trieste. Her PhD dissertation dealt with European-Russian energy cooperation and was funded by the International University Institute for European Studies (IUIES) with a grant to carry out research abroad. Her dissertation was primarily focused on understanding the lack of binding institutionalization of the E.U.-Russia energy relationship despite the high degree of interdependence between the two sides. She holds a BA and MA (summa cum laude) in political science and international relations from the University of Trieste.

During her tenure at the Belfer Center, she will be conducting research on a new project, “The Sino-Russian Gas Relationship and China’s disruptive rise in Energy and Geopolitics.” Her areas of expertise and interest include energy cooperation between the E.U. and Russia; global energy governance; geopolitical and strategic issues arising from the unequal distribution of global energy resources (in particular, natural gas); the role of technological breakthrough;
Sino-Russian energy cooperation; and the making of the United States’ foreign and security policies.

**Sumeeta Srinivasan**

*Visiting Scholar, Harvard China Project*
*Preceptor of Geospatial Methods, Department of Government, Harvard*

*Research Topic:* Transportation and land use change in rapidly urbanizing cities

Sumeeta Srinivasan is interested in the relationship between transportation, land use and the environment in cities and regions. She is particularly interested in land use change and energy demand in rapidly urbanizing cities in China and India. Her interests also include the effects of climate change and sustainable urban growth.

**Anish Sugathan**

*Giorgio Ruffolo Post-doctoral Research Fellow, Sustainability Science Program, Mossavar-Rahmani Center for Business and Government, HKS*

*Research Topic:* Evaluation and design of emission control policies for the Indian power sector

Anish Sugathan’s research interest is in the area of institutional reforms and economic governance enabling sustainable development, specifically in energy policy, environmental regulation, and the electricity sector in India. His research focuses on the evaluation and design of emission control policies for the Indian power sector. Anish is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Professor Rohini Pande. He has contributed to collaborative projects on techno-economic evaluation of the uranium supply-chain at the National Institute of Advanced Studies, has developed labor migration models for India at the Centre for Development Studies, and has worked on the indigenous design and development of several power generation and emission abatement technologies while working as a research engineer at Bharat Heavy Electricals Limited. He holds an undergraduate degree in electronics and communication engineering from the University of Kerala. He is a Fellow (PhD) of the Indian Institute of Management Bangalore in the area of corporate strategy and policy and a recipient of a SAP Labs India scholarship supporting doctoral studies. His doctoral research assessed firm-level productivity changes in the Indian power sector.
sector following deregulation and explores the influence of quality of institutions on corporate governance practices in India. His faculty host is Rohini Pande.

**Kavita Surana**

*Fellow, Science, Technology, and Public Policy Program, Belfer Center for Science and International Affairs, HKS*

*Research Topic: Energy innovation institutions*

Kavita's research at the Belfer Center focuses on innovation, adoption and diffusion of new technologies in emerging and developing economies. Her interests lie on understanding factors that influence successful innovation institutions in energy and beyond and on the role of government policies in promoting technology innovation. Prior to her fellowship, she worked as a consultant on deregulated power markets for two years. Kavita earned a Ph.D. in materials engineering from the University of Grenoble, France, while working at the French Atomic Energy and Alternative Energies Commission (CEA), where her doctoral research focused on technologies for energy conversion and storage, particularly solar cells.

**Richard Sweeney**

*Fellow, Harvard Environmental Economics Program*  
*PhD Student, Public Policy*

Richard Sweeney's interests typically lie at the intersection of environmental economics and energy policy. He graduated from Boston College in 2004 with a BS in economics and political science and then studied post-Communist transition at C.E.R.G.E. in the Czech Republic on a Fulbright scholarship. Rich also spent two years as a research assistant at Resources for the Future, where his research involved electricity regulation, climate policy design, and the economics of renewable energy.
Behnam Taebi

Research Fellow, Project on Managing the Atom/International Security Program, Belfer Center for Science and International Affairs, HKS
Assistant Professor, Delft University of Technology, The Netherlands

Behnam Taebi is an Assistant Professor of Philosophy at Delft University of Technology (The Netherlands), and a Research Fellow at Harvard Kennedy School’s Belfer Center for Science and International Affairs. His research interests are in energy ethics, nuclear ethics and responsible innovation of shale gas. He studied Material Science and Engineering (2006) and received his Ph.D. in Philosophy of Technology (2010). Taebi is currently working on ‘ethics and governance of multinational nuclear waste repositories’ (with a personal grant awarded by the Dutch Research Council). He is the leading editor of a forthcoming volume on The Ethics of Nuclear Energy (Cambridge University Press) and a special issue of Journal of Risk Research on “Socio-Technical Challenges of Nuclear Power Production.” Taebi is currently based in Cambridge (Massachusetts), where he spends a sabbatical year at Harvard University. He is involved in the Belfer Center’s Project on Managing the Atom and International Security Program.

Tian Tang

Giorgio Ruffolo Doctoral Research Fellow, Sustainability Science Program / Energy Technology Innovation Policy research group, Mossavar Rahmani Center for Business and Government and Belfer Center for Science and International Affairs, HKS

Research Topic: The impacts of transmission barriers on wind power diffusion in China

Tian Tang is a Ph.D. candidate in public administration at Syracuse University. Her research focuses on assessing the impacts of energy policies on the development and deployment of renewable energy technologies in China and the United States, and analyzing how these policies interplay with key actors in the electricity sector – including electric equipment manufacturers, power generators, and transmission and distribution operators – to drive the technological changes. Her dissertation examines what has led to the technological change in wind power industry in China and US from a technological
Fellows

learning perspective. Tian is contributing to collaborative work with the Initiative on Sustainable Energy Development in China led by Professor Henry Lee. She is extending her previous work on China’s wind industry to explore how the inadequacy of transmission grids affect the penetration of wind power in China. Tian is a recipient of the Maxwell Fellowship (2011-2013), AEON Education and Environment Fund Scholarship (2009), and the Outstanding Graduate Awards from Tsinghua University and the City of Beijing (2008). She received a Bachelor of Law and a Bachelor of Economics from Tsinghua University (2008). She holds a Master of Public Management from School of Public Policy and Management in Tsinghua University (2011). Her faculty hosts are Henry Lee and Laura Diaz Anadon.

Joy Vazhayil Pathrose

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

Research Topic: Key policy elements of India’s transition matrix for sustainable development involving public private partnerships

Joy Vazhayil Pathrose belongs to the Indian Administrative Service and has wide-ranging experience in the areas of energy management, finance and taxation, project management, education, agriculture, and developmental administration at the levels of the State and Central Government in India. His research focuses on the key policy elements of a transition matrix for India’s sustainable development trajectory, involving public private partnerships. Institutional and policy innovation are examined to identify the framework for achieving sustainability objectives. Joy is contributing to collaborative work with the Initiative on Public-Private Partnerships to Promote Sustainable Development in India led by Professor Rohini Pande. He received his PhD from the Indian Institute of Technology Delhi in 2012. His doctoral research is on the methodology of hierarchical multi-objective optimization of India’s energy strategy portfolios incorporating climate change mitigation targets. He holds a Bachelor of Technology in Electronics and Communication Engineering from the University of Kerala and Master of Business Administration in Public Service (International) from Birmingham University. He obtained MPhil in Public Administration from Panjab University with a dissertation on the framework for equitable apportionment of emission reduction commitments to mitigate global warming. He is a recipient of the Highly Commended Award at the...
Literati Network Awards for Excellence for his paper in the *International Journal of Energy Sector Management* (2012). He has authored seven books, including 3 works of poetry in Malayalam. His faculty host is Rohini Pande.

**Haikun Wang**

*Visiting Scholar, Harvard China Project  
Associate Professor, School of Environment, Nanjing University*

*Research Topic: Energy metabolism in China*

Haikun Wang is a professor in the Nanjing University School of Environment. He received his PhD at Tsinghua University in 2010. His research focus is energy consumption and related impacts on greenhouse gas emissions, air pollution and human health in China, with particular emphasis on urban areas. He is also interested in the field of regional climate change mitigation and adaptation.

**Charles Willis**

*Environmental Fellow, Harvard University Center for the Environment*

*Research Topic: How climate change will affect continental scale patterns of biodiversity and phylogenetic diversity in North America*

Charles G. Willis is an evolutionary ecologist interested in the impacts of climate change on plant biodiversity in North America.

During his two-year fellowship, Charlie is working with Charles Davis of the Department of Organismic and Evolutionary Biology to explore how climate change will affect continental-scale patterns of biodiversity and phylogenetic diversity in North America. His work incorporates a large-scale climatic niche modeling effort to assess which plant species will be winners and losers under future climate change scenarios, and whether these species are concentrated in specific branches of the tree of life.
Lei Xu

Research Fellow, Science, Technology, and Public Policy Program/Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, HKS

Lei Xu is a Ph.D candidate at the School of Public Policy and Management in Tsinghua University, China. His research interests mainly focus on innovation policy and management including sustainability transition, innovation systems, innovation finance, university entrepreneurship as well as science policy.

Yige Zhang

Ziff Environmental Fellow, Harvard University Center for the Environment

Research Topic: Resolving the Late Miocene CO2 Climate Sensitivity “Paradox” Using Biomarkers and Their Stable Isotopes

Yige Zhang is a geochemist interested in understanding how the Earth evolved chemically, and using various geochemical tools to study climate change of the geological past.

Yige earned his B.S. in geochemistry at Nanjing University, China (2007), a M.S. in Marine Sciences from the University of Georgia in 2009. His M. Phil. (2011) and Ph.D. (2014) in Geology and Geophysics are from Yale University. During his PhD, his research focused on climate reconstructions and modeling of the Cenozoic greenhouse – icehouse transition, including the Oligocene, Miocene and Pliocene epochs. He used geochemical proxies from marine sediments to understand ocean temperatures, atmospheric CO2 levels and continental ice volume over a series of global climate change events.

As an Environmental Fellow, Yige will be working with Ann Pearson from the Department of Earth and Planetary Sciences. He plans to develop improved atmospheric CO2 estimates in the Miocene, using organic geochemistry methodologies and novel approaches to isotope-ratio mass spectrometry. His goal is to resolve the Miocene CO2 climate sensitivity “paradox,” an issue confronting his field in which current reconstructions show a puzzling relationship between stable, or even increased, CO2 concentrations during substantial
surface seawater cooling. Yige hopes to resolve this climate sensitivity puzzle, which currently suggests that CO2 either played a minor role or that our proxy methods for measuring CO2 levels during that period are flawed.

**Yan Zheng**

*Visiting Scholar, Harvard Fairbank Center for Chinese Studies and Harvard China Project*

*Associate Research Fellow, Climate Change Economics Department, Institute for Urban & Environmental Studies (IUE), Chinese Academy of Social Sciences (CASS)*

*Research Topic: Planning for climate change adaptation in urban areas of China and the U.S.*

Yan Zheng is an associate research fellow at the IUE of CASS, and currently a visiting scholar at the Fairbank Center for Chinese Studies and at the Harvard China Project of Harvard University. She earned her doctorate in economics in 2006 at the Graduate School of CASS. Her main research interests include international climate regime building, climate change and equity, adaptation governance, resilient cities, and climate migration.
A more nuanced way of looking at China’s carbon emissions may be key to finding a way to curb them in the future, Giorgio Ruffolo post-doctoral research fellow Zhu Liu argued in a February 2014 Energy Policy Seminar. It is well known that China’s carbon emissions are large and on an upward trajectory, Dr. Liu said. A common approach to analyzing emissions is found in the “IPAT” equation, which analyzes CO2 emissions as the combined effect of three factors: population, improvements in wealth, and available technology. Viewed in this framework, China’s carbon emission reduction options seem limited. China’s population growth is already small, and the option of reducing GDP growth is not appealing in a country in which many still live in poverty.

The only remaining category in this analysis is technology, and it is on this—using technology to decrease the energy intensity of production—that China has focused, moving to increase the energy efficiency of certain key sectors (coal-fired power generation and iron, steel, and cement production) by replacing small, inefficient plants with larger new plants. The results, assuming this project is fully carried out, are approximately 3000 Mt of CO2 reductions, an amount, Liu pointed out, that dwarfs the 80 million tons of CO2 reductions achieved by developed countries under the Kyoto Protocol between 1990 and 2008.
However, Dr. Liu noted, there are significant limitations to this approach—in particular, once the plant replacements are done, they are done, leaving China still a long way from the levels of emissions reductions called for by climate models.

So is the only choice for China either exceeding target carbon emission levels or cutting the growth of GDP? Dr. Liu suggested that a more fine-grained analysis might reveal other options. Specifically, Liu suggested a “footprint” perspective on carbon emissions—rather than a simple focus on where carbon emissions are produced (often in rural, relatively impoverished areas of China) Liu analyzed where the products and services associated with such emissions are consumed.

Dr. Liu highlighted a few insights that emerged from this analysis:

› Although many carbon emissions come from relatively poor areas in China, footprint analysis reveals that wealthy cities, such as Beijing and Shanghai, have a much larger carbon footprint than the relatively poor rural areas where much of the carbon is emitted in the course of manufacturing products for urban consumption.

› 20-25% of China’s carbon emissions are tied to international exports.

› The construction sector is responsible for the lion’s share of China’s carbon footprint. Within this category, metal smelting and pressing is responsible for the plurality of emissions. This is of particular importance because of the role the construction sector plays as an engine of China’s economic growth. Using this kind of fine-grained analysis, Liu suggested, it may be possible for China to find a way to move towards, not an overall reduction of consumption, but more green consumption patterns as a means of curbing future carbon emissions.


This summary was originally published as an online HKS News item, February 10, 2014
Suppressed prices in real-time markets provide inadequate incentives for both generation investment and active participation by demand bidding. An operating reserve demand curve developed from first principles would improve reliability, support adequate scarcity pricing, and be straightforward to implement within the framework of economic dispatch.

China 2035: Energy, Climate, Development. Organized jointly by the Harvard University Center for the Environment and the Harvard China Project, this lecture series explores the challenges China is expected to face over the next two decades at the intersection of economic development, demands for energy, and environmental degradation, including the potential impacts of climate change. Spring 2014 speakers were Kevin Rudd, former prime minister of Australia; Robert Zoellick, former president of the World Bank, and Michael Spence, former Dean of FAS.


Future of Energy Speaker Series. A series of lectures for a University-wide audience organized by the Harvard University Center for the Environment. 2014 speakers include former senator Jeff Bingaman; S. Julio Friedmann, Deputy Assistant Secretary, Clean Coal Program, Office of Fossil Energy, U.S. Department of Energy; and M. Granger Morgan, University and Lord Chair Professor of Engineering, Head and Professor, Department of Engineering and Public Policy, Carnegie Mellon University.

Geoengineering Science and Governance Seminar Series. This seminar series, held jointly by the Harvard University Center for the Environment (HUCE) and MIT’s Joint Program on the Science and Policy of Global Change, will explore the science, technology, governance and ethics of solar geoengineering. In bringing together international experts, participants will learn some of the greatest challenges and hear opinions on how this technology could and should be managed.

Harvard China Project Seminar. Monthly talks by external and internal speakers on energy and environmental science, economics, law, and policy in China. These talks, usually held in the School of Engineering and Applied Sciences, are open to students, researchers and faculty across fields and schools at Harvard and surrounding universities.

Harvard Energy Journal Club. Weekly graduate student-run sessions to review the latest technical knowledge related to energy. Topics discussed included CO2 capture technology, the geology of petroleum, advanced solar,
Seminars & Lecture Series

climate skepticism, and geothermal energy.

› Managing the Atom Seminar. Research by fellows and others on nuclear security and nuclear energy issues presented in a weekly seminar series during the academic year.

› 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.

› 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.
Taking up the thread of two previous seminars on the potential role of large-scale electrical energy storage in a future energy mix, Michael Aziz, Gene and Tracy Sykes Professor of Materials and Energy Technologies, explained how his ongoing work on the development of an organic mega flow battery could change the current energy storage landscape, in a November 10, 2014 seminar.

Currently, the cheapest energy storage is not battery storage, but large-scale mechanical storage, such as pumped hydro or underground compressed air energy storage—technologies that are just not available unless the surrounding geography is right, Aziz explained. Battery storage can theoretically be located anywhere, but technologies available in the market each have their own limitations. Conventional batteries are impractical for large-scale energy storage because they come with the expensive but unnecessary (for utility storage purposes) capability of rapidly discharging their entire energy store. Flow batteries can be adjusted to provide an optimal balance of storage and rate capabilities, but the flow batteries that are currently available rely on rare and expensive elements, such as Vanadium. In many cases, toxicity or flammability are potential safety issues.

Referring back to the previous week’s energy policy seminar presentation from David Keith, Aziz noted that Keith’s research, though suggesting that
the amount of storage needed for a low-carbon grid is less than often supposed, still suggests a market for significantly more bulk energy battery storage than is currently available—a growth from almost nothing (0.1%) up to a potential 4% of total generation capacity, assuming the cost could be lowered significantly. California has adopted a storage procurement mandate for its major utilities, attempting to prepare for projected rapid load fluctuations as a greater share of the grid comes to depend on solar energy. In this context, Aziz detailed the promising results of his lab’s work on a new kind of flow battery which uses an organic compound called a quinone (one of the key elements of the photosynthesis process), research which is funded through ARPA-E. The materials necessary for this battery are readily available, Aziz said, at one-third or less of the cost of the elements used in the currently most successful flow batteries, are non-toxic (closely related to a compound found in rhubarb), and use a water solution (and are therefore non-flammable). The prototype battery is still being fine-tuned, but Aziz sees a “fighting chance” to bring capital costs into the target range of between $100 and $150 per kilowatt hour of storage capacity, both through technical fine-tuning and through measures like identifying cheaper sources of raw materials and potentially retrofitting other types of flow batteries to use the new quinone solution.

Aziz’s talk was part of the Kennedy School’s Energy Policy Seminar Series.
How will countries provide the reliable, affordable energy needed to fuel a growing world economy and lift billions of people out of poverty, without causing catastrophic climate change and other environmental disasters?...for that revolution to arrive in time will require a dramatic acceleration in the pace at which new or improved energy technologies are invented, demonstrated, and adopted in the marketplace.

January 2014

January 29, 2014

January 30, 2014
Canada’s Tar Sands Exposed: Exploring the Human and Environmental Costs. Eriel Deranger, Athabasca Chipewyan First Nation activist; Garth Lenz award-winning environmental photographer; and Divest Harvard panel.

January 31, 2014
The Electric Modern: Tokyo in the Age of Global Energy. Ian Miller, Associate Professor of History; Andrew Gordon, Folger Fund Professor of History, Moderator. Japan Forum talk.

February 2014

February 3, 2014

February 6, 2014
China’s Carbon Dioxide Emissions: Various Scales and Perspectives. Wang Haikun, Associate Professor, School of Environment, Nanjing University; Visiting Scholar, Harvard China Project. China Project Seminar.

February 7, 2014
Beyond Capital: The Climate Crisis as a Challenge to Social Thought. Dipesh Chakrabarty, University of Chicago. The History and Economics Seminar Series.

February 7, 2014
EVENTS

February 7, 2014

February 10, 2014
Environmental and Technology Policy Options in the Electricity Sector: Interactions and Outcomes. Carolyn Fischer, Senior Fellow and Associate Director, Center for Climate and Electricity Policy, Resources for the Future. ETIP/Consortium Energy Policy Seminar Series.

February 11, 2014
The Most Important Topic Political Scientists Are Not Studying: Adapting to Climate Change. Debra Javeline, Associate Professor of Political Science, University of Notre Dame. Chaired by Dustin Tingley, Sack Associate Professor of Political Economy. The Weatherhead Center for International Affairs and HUCE.

February 11, 2014
‘Losing Containment: Filming in the Nuclear Waste Sites,’ a special series on post-disaster Japan. Peter Galison, Pellegrino University Professor; and Robb Moss, Professor and Chair of Visual and Environmental Studies. Moderated by Susan Pharr, Director, Program on U.S.-Japan Relations.

February 11, 2014
Bring Your Own: Climate as Site. A talk and discussion on artists’ engagement with the environment and climate change.

February 12, 2014

February 13, 2014
Crossing the 2014 Climate Divide: Scientists, Skeptics & the Media. Suzanne Goldenberg, US Environment Correspondent for The Guardian; Naomi Oreskes, Professor of History of Science; and Peter Frumhoff, Director of Science and Policy, Union of Concerned Scientists. Environment and Natural Resources Program panel discussion.
February 18, 2014


February 18, 2014

**Community Assembly and Dis-assembly with Global Change.** Lizzie Wolkovich, Assistant Professor, Organismic and Evolutionary Biology, Arnold Arboretum. Arnold Arboretum Research Talk.

February 19, 2014

**Science and Technology of Unconventional Fossil Fuel Production.** Robert L. Kleinberg, Schlumberger. Solid Earth Physics Seminar and SEAS Applied Mechanics Colloquium.

February 19, 2014

**The Economics of Attribute Based Regulation: Theory and Evidence from Fuel Economy Standards.** Koichiro Ito, Boston University, and James M. Sallee, University of Chicago. Seminar in Environmental Economics and Policy.

February 19, 2014


February 20, 2014

**Challenges of Balancing the Chinese Power System with Large-Scale Renewable Penetration.** Zhang Ning, Research Associate, Department of Electrical Engineering, Tsinghua University; Visiting Scholar, Harvard China Project. China Project Seminar.

February 20, 2014


February 20, 2014

**Geoengineering’s Brave New World.** Scott Barrett, Lenfest-Earth Institute Professor of Natural Resource Economics, School of International and Public
**EVENTS**

Affairs, Earth Institute, Columbia University. Geoengineering: Science and Governance Lecture Series.

**February 20-21, 2014**


**February 24, 2014**


**February 25, 2014**


**February 26, 2014**

**Gas-driven Fracturing – Influence of Gas Composition and State.** Derek Elsworth, Penn State University Solid Earth Physics Seminar and SEAS. Applied Mechanics Colloquium.

**February 26, 2014**

**A New Meta Analysis of the WTP/WTA Disparity.** James Hammitt, Harvard University and Tuba Tuncel, Toulouse School of Economics. Seminar in Environmental Economics and Policy.

**February 26, 2014**

**A New Climate Agreement in 2015: Opportunities and Challenges.** Robert Stowe, Executive Director, Harvard Environmental Economics Program; Manager, Harvard Project on Climate Agreements.

**March 2014**

**March 3, 2014**

**Rethinking Electricity Distribution Regulation.** Ignacio Perez-Arriaga, Visiting Professor, Center for Energy and Environmental Policy Research (CEEPR), MIT; and Professor & Director of the BP Chair on Energy & Sustainability, Instituto de

March 6, 2014


March 6, 2014

**Climate Change and the Food System: Moving to Next-Generation Models and Tools.** Cynthia Rosenzweig, NASA Goddard Institute for Space Studies. Harvard Climate Seminar.

March 6, 2014

**Climate Change in the American Mind.** Dr. Anthony Leiserowitz, Director, Yale University Project on Climate Change Communication. Environment and Natural Resources Program Seminar.

March 6, 2014

**Black Carbon Tendencies in the Arctic.** Sangeeta Sharma, Physical Scientist, Science and Technology Branch, Environment Canada. Environmental Science and Engineering Seminar.

March 8, 2014

**The Harvard Leadership Conference.** The conference brings together world leading experts from Harvard and beyond in the fields of Education, Health, Government, Climate Change and Internet Security. It highlights the challenges and opportunities waiting to be seized and disrupted in these fields.

March 10, 2014


March 10, 2014

**Carbon Technocracy: East Asian Energy Regimes and the Industrial Modern.** Victor Seow, Cornell Department of History. STS Circle at Harvard.
**Events**

March 10, 2014

**Pipelines and Energy Infrastructure in Developing Countries: Risks and challenges.** Tom Dimitroff, Fellow, Vale Center on Sustainable International Investment, Columbia University; Founding Partner, Infrastructure Development Partnership; Editor, Risk and Energy Infrastructure. Environment and Natural Resources Program Seminar.

March 11, 2014

**Challenges to the Sustainability of China’s Evolving Growth Model.** Michael Spence, former Dean of FAS and Nobel Laureate in Economics and currently a Professor of Economics at the Stern School of Business, New York University. China 2035: Energy, Climate, and Development Lecture Series.

March 12, 2014

**What Can We Hope to Know About the Future of the Energy System?** M. Granger Morgan, University and Lord Chair Professor of Engineering; Head and Professor, Department of Engineering and Public Policy, Carnegie Mellon. Future of Energy Lecture Series.

March 13, 2014

**Exploration of Marine Cloud Brightening.** Phil Rasch, Chief Scientist for Climate Science, Pacific Northwest National Laboratory. Geoengineering: Science and Governance Lecture Series.

March 14, 2014

**Quantifying the health benefits of a global treaty on mercury emissions.** Elsie Sunderland. Environmental Science and Engineering Seminar.

March 20 – March 21, 2014


March 24, 2014

**The Water-Energy Nexus in Oman and Abu Dhabi: A View from the Agricultural Sector.** Mattijs Van Maasakkers, Post-Doctoral Fellow, Science, Technology and

March 26, 2014
**Can Negotiating a Uniform Carbon Price Help to Internalize the Global Warming Externality?** Martin Weitzman, Harvard University. Seminar in Environmental Economics and Policy.

March 26, 2014

March 27, 2014
**Next Generation Compliance and Enforcement at EPA.** Cynthia Giles, Assistant Administrator for the Office of Enforcement and Compliance Assurance, US Environmental Protection Agency. Hosted by the Regulatory Policy Program.

March 28, 2014
**Conference: Dynamics of Transformational Environmental Policy Reform.** Facilitated by Australian Studies Chair Mike Young. Sponsored by HUCE.

March 28 – March 29, 2014

March 31, 2014

March 31, 2014
April 2014

April 2, 2014

Turkish Politics, Energy Politics: Near and Long Term Perspectives. Dr. Tuncay Babali, Ambassador of Turkey to Canada, Former WCFIA Fellow. Co-sponsored by WCFIA and CMES.

April 2, 2014


April 2, 2014


April 2, 2014

Natural Gas Prices and Coal Displacement: Evidence from Electricity Markets. Christopher Knittel, MIT; Konstantinos Metaxoglou, Carleton University; and Andre Trinidad, Getulio Vargas Foundation. Seminar in Environmental Economics and Policy.

April 3, 2014


April 4, 2014


April 4, 2014

As China Goes, So Goes the Planet: Domestic and International Implications of China’s Environmental Crisis. Judith Shapiro, American University. Fairbank Center for Chinese Studies.
April 9, 2014
**China, Development & the World Economy.** Robert Zoellick, Former President, World Bank; Chairman, International Advisors, Goldman Sachs. Q&A discussion led by Michael McElroy, Gilbert Butler Professor of Environmental Studies and Chair of the Harvard China Project. China 2035: Energy, Climate, Development Lecture Series.

April 9, 2014
**Advanced Materials and Nanotechnology for Energy, Water, and Environmental Applications.** Xing Xie, Civil and Environmental Engineering, Stanford University. Environmental Sciences and Engineering Seminar.

April 14, 2014
**Geoengineering the Climate.** David Keith, Gordon McKay Professor of Applied Physics (SEAS); Professor of Public Policy (HKS). ETIP/Consortium Energy Policy Seminar Series.

April 14, 2014
**Climate Change and Business.** Conversation with Former President of Mexico Felipe Calderón. Harvard Business School.

April 16, 2014
**Environmental Inspections in India.** Rohini Pande, Harvard University. Seminar in Environmental Economics and Policy.

April 17, 2014
**The Long and Winding Road to Clean Energy.** Jeff Bingaman, Distinguished Fellow, Stanford Law School; former Senator of New Mexico; and chairman of the Senate Energy and Natural Resources Committee. Future of Energy Lecture Series.

April 21, 2014

April 21, 2014
**Years of Living Dangerously: Film Screening/Talk.** Dan Abbasi (HBS ‘98). Harvard Business School.
**Events**

**April 21, 2014**

*Perspectives on Mexico’s Energy Reform: Opportunities for Innovation and Investment.* Leonardo Beltrán Rodríguez, Deputy Secretary for Energy Planning and Transition, Mexican Secretariat of Energy. Sponsored by the Harvard University Center for the Environment and the Harvard University Mexican Association of Students.

**April 23, 2014**

*Averting Catastrophes: The Strange Economics of Scylla and Charibdis.* Robert Pindyck, MIT. Seminar in Environmental Economics and Policy.

**April 24, 2014**

*Measuring Green Development with Indices: China’s Case and Cross-country Comparisons.* Li Xiaoxi, Professor and Founding Director, School of Economics and Resource Management, Beijing Normal University; Visiting Scholar, Department of Economics, Harvard University. Harvard China Project Seminar.

**April 25, 2014**

*Energy History and the History of the Future.* Paul Warde, University of East Anglia. Sponsored by the Joint Center for History and Economics and HUCE.

**April 28, 2014**

*Early Modern Climate Science: The View from British North America.* Joyce Chaplin. STS Circle at Harvard.

**April 30, 2014**

*Imagining China’s Future: Politics, the Economy and Climate Change.* Kevin Rudd, former Prime Minister of Australia. China 2035: Energy, Climate, and Development Lecture Series.

**April 30, 2014**

*Eastern Pacific Emitted Aerosol Cloud Experiment: Recent Findings and New Directions.* Lynn Russell, Professor of Atmospheric Chemistry, Scripps Institution of Oceanography Geoengineering: Science and Governance Seminar.
**May 2014**

**May 2, 2014**  
**Resource Nationalism and National Oil Companies in Latin America Workshop.** (Private all-day workshop.)

**May 2, 2014**  
**Will the US Learn the Lessons from Fukushima?** Edwin Lyman, Senior Scientist, Union of Concerned Scientists. Project on Managing the Atom Seminar Series.

**May 5, 2014**  

**May 5, 2014**  
**O Brave New World! Entering an Age of Climate Change Beyond 400 ppm.** Ralph Keeling, Scripps Institute of Oceanography. Video commentary presented by former US Vice President Al Gore. Moderated by Daniel Schrag, Director, Harvard University Center for the Environment. HUCE special event.

**May 14, 2014**  

**May 16, 2014**  
**America’s Unconventional Energy Boom and How It is Changing the Way the World Works.** Meghan O’Sullivan and Holly Morrow. HKS Ideasphere Discussion.

**May 19, 2014**  

**July 2014**

**July 9 – 11, 2014**  
**GSD Executive Education Course: Daylighting Buildings.** This course focuses on daylighting in an architectural context, stressing the integration of daylight
with other sustainable design concerns such as solar gain control, electric lighting energy use, and occupant comfort, demonstrating how they can collectively act as form-givers for architecture.

July 14 – 15, 2014

**GSD Executive Education Course: Energy Simulation.** This course explores the use of computerized energy simulation in pursuit of high-performance building design.

July 17 – 18, 2014

**GSD Executive Education Course: The Walkable City.** This comprehensive two-day course addresses the most effective arguments, techniques, and tools for reshaping places in support of walking, biking, and transit.

July 22 – 23, 2014

**GSD Executive Education Course: Climate Resilient Design: Buildings, Neighborhoods, and Infrastructure.** The program covers climate change basics that designers need to understand in order to address projects at the scale of buildings, neighborhoods, and communities.

**September 2014**

September 8, 2014


September 15, 2014

**Climate realism.** Armond Cohen, Executive Director, Clean Air Task Force ETIP/Consortium Energy Policy Seminar.

September 16, 2014


September 17, 2014

**Climate Engineering Research and Stakeholder Engagement at the IASS.** Mark Lawrence, Scientific Director at the Institute for Advanced Sustainability

**September 19-20, 2014**

*Inventing the Future to Address Societal Challenges.* Symposium in honor of the 75th birthday of Professor Venkatesh Narayanamurti.

**September 22, 2014**


**September 29, 2014**


**September 30, 2014**

*Climate Change Diplomacy – The Road to Paris 2015.* Jairam Ramesh, former Minister of Environment and Forests for India and India’s Chief Climate Negotiator. Belfer Center Seminar.

**September 30, 2014**

*India’s Nuclear Energy Policy and Climate Change.* Jairam Ramesh, former Minister of Environment and Forests for India and India’s Chief Climate Negotiator. Managing the Atom seminar.

**October 2014**

**October 1, 2014**

*The IAEA’s Nuclear Safeguards Culture: What is it and Does it Matter?* Trevor Findlay, Senior Research Fellow, MTA/ISP.

**October 1, 2014**

*Moving up the Energy Ladder: The Effect of an Increase in Economic Well-Being on Fuel Consumption Choices of the Poor in India.* Rema Hanna, Harvard University, and Paulina Oliva, University of California, Santa Barbara. Seminar in Environmental Economics and Policy.

**October 2, 2014**

*China, India, and the Global Struggle for Oil in Sudan and South Sudan.* Luke
E V E N T S


October 3, 2014

October 6, 2014

October 8, 2014
The President’s Effort to Combat Climate Change Without Congress: What is EPA Proposing to Do and is it Legal? Jody Freeman, Cox Professor of Law (HLS) and Director, Environmental Law Program; and Richard Lazarus, Aibel Professor of Law (HLS). Moderated by Daniel Schrag, Hooper Professor of Geology; Professor, SEAS; Director, HUCE.

October 8, 2014

October 15, 2014

October 16, 2014
Energy, Peace, and Conflict in the Eastern Mediterranean. A panel discussion with: Sir Michael Leigh, Senior Advisor, German Marshall Fund; Dr. Marina Ottaway, Senior Scholar, Woodrow Wilson International Center, Middle East
Program; Dr. Brenda Shaffer, Visiting Researcher, Georgetown University. Center for Eurasian, Russian and East European Studies (CERES).

October 16, 2014

Stepping Off the Gas: The Future of Transport Fuel in the United States. Yossie Hollander, entrepreneur and philanthropist with over 40 years of experience of building successful software companies. Moderated by Henry Lee, Director of the Environment and Natural Resources Program. Belfer Center event.

October 17, 2014


October 18, 2014

HBS Energy Symposium. 11th Annual Energy Symposium at Harvard Business School, featuring over 60 industry executives as speakers including 20+ CEOs and 20+ partners from top PE/VC firms. Harvard Business School.

October 20, 2014


October 20, 2014


October 20, 2014

Are the Negotiations for a Global Climate Change Agreement Stalled? If So, What Can Be Done? The Hon. Stéphane Dion, Member of Parliament, Canada. Canada Program Seminar.

October 22, 2014

EVENTS

October 22, 2014
Designing for Nuclear Values: An Ethical Perspective on Nuclear Reactor Design. Behnam Taebi, Post-Doctoral Research Fellow, MTA/ISP. Managing the Atom Seminar.

October 24, 2014

October 26, 2014
Faculty Forum on Divestment. James Anderson (CCB), James Engell (English/Comparative Literature), Stephen Marglin (Economics), and Naomi Oreskes (History of Science).

October 27, 2014

October 27, 2014–October 28, 2014
Zofnass Program Symposium. Bringing together public officials, infrastructure engineers, planners and design professionals and academia to share “next generation” perspectives on sustainable energy infrastructure.

November 2014

November 3, 2014
How Important is Energy Storage for Decarbonization? David Keith, Gordon McKay Professor of Applied Physics (SEAS); Professor of Public Policy (HKS) ETIP/Consortium Energy Policy Seminar.

November 5, 2014

November 6, 2014
Catastrophic Risks: The Downsides of Advancing Technology. Martin Rees, Institute of Astronomy, Cambridge University; Astronomer Royal; President, Royal Society (2005-2010). With panelists Sven Beckert, Laird Bell Professor of
History; George Daley, Children’s Hospital Boston/Harvard Medical School; Jennifer Hochschild, Henry LaBarre Jayne Professor of Government; Daniel Schrag, Director, Harvard University Center for the Environment. Moderated by Sheila Jasanoff, Pforzheimer Professor of Science and Technology Studies. Science and Democracy Lecture Series.

November 6, 2014

November 7, 2014
**Harvard Center for Green Buildings and Cities Inaugural Challenge Conference.** The first of an annual series of conferences that convenes visionaries from diverse disciplines to articulate the global environmental challenge of climate change and new strategies for sustainable building and planning. Participants included President Drew Gilpin Faust and GSD Dean Mohsen Mostafavi. Harvard Graduate School of Design.

November 7, 2014
**Spiritual and Sustainable: Religion Responds to Climate Change.** An interfaith conference focused on addressing the issues and challenges of maintaining a sustainable planet. Moderated by Dan McKanan, Ralph Waldo Emerson Unitarian Universalist Association Senior Lecturer in Divinity, Harvard Divinity School.

November 7, 2014
**Assessing Climate and Health Impacts of Aggressive Policies for the US Transportation and Energy Sectors.** Drew Shindell, Professor of Climate Sciences, Duke University. Environmental Science and Engineering Seminar.

November 10, 2014

November 12, 2014
**Nuclear Safeguards 101: Evolution or Revolution?** Laura Rockwood, Senior Research Fellow, Project on Managing the Atom. Managing the Atom Nuclear 101 seminar.
EVENTS

November 13, 2014
“The Last Mountain” – Film Screening & Talk. Discussion with Eric Grunbaum, producer of “The Last Mountain.” Host Tina A. Grotzer. Harvard Graduate School of Education.

November 14, 2014
New Directions in Energy History. Discussants John R. McNeill, Georgetown University, speaking on “Ecological Teleconnections of the Industrial Revolution” and former HUCE Environmental Fellow Christopher F. Jones, Arizona State University, on “The Forgotten King: Coal, Energy, and History.” Also featuring commentary from Paul Warde, University of East Anglia and Ian J. Miller, Harvard University. Energy History Project.

November 17, 2014

November 19, 2014

November 18, 2014

November 24, 2014
Carbon Capture and Sequestration: Obstacles and Possibilities. Panel discussion with Ric Redman, President & CEO, Summit Power Group, LLC and David Keith, Gordon McKay Professor of Applied Physics (SEAS); Professor of Public Policy (HKS). Energy Policy Seminar Series.
November 24, 2014

December 2014

December 1, 2014

December 2, 2014

December 3, 2014

December 3, 2014
Lessons learned about unconventional energy:
Cases from around the world

Why has shale gas and coal bed methane development taken off in some countries but not in others? Comparing experiences in the US, China, Australia, and Indonesia, Geopolitics of Energy Fellow Holly Morrow argued that there is not one “cookie cutter“ policy configuration that leads to success or failure. Rather, Morrow argued, a series of conditions need to be satisfied to make successful development of these resources possible.

Morrow began by sketching some of the common characteristics of the two forms of unconventional gas she is studying, shale gas and coal bed methane (CBM). Both are resources that produce gas from “low permeability“ rocks. By definition, unconventional energy is harder to extract than conventional energy. Typically, it requires that many more wells be drilled. And in the case of both shale gas and coal bed methane, experimentation and adjustment may be needed to adapt the technologies to the variables of specific sites.

The successful deployment of shale gas or coal bed methane production depends on many factors beyond the bare technical knowledge of how to extract the gas. The shale gas extraction technique of hydraulic fracturing, or “fracking,” Morrow pointed out, was a well-known technique in the
United States for many years before it resulted in significant increases in natural gas production. However, in the case of coal bed methane, despite widespread knowledge of the basic engineering principles at work, Australia, China, and Indonesia have all had very different experiences in trying to develop this industry—ranging from enormous success in Australia to disappointing results in China and Indonesia.

What is important to the success or failure of the development of these technologies? The key factors Morrow discussed have to do with having conditions that allow for the kind of persistent on the ground experimentation that may be needed to make unconventional gas extraction work. These conditions include getting the prices and the players right. Attractive natural gas prices can help get the ball rolling, as they did in the US with the deregulation of the natural gas industry or in Australia with exposure to international LNG markets. It may also help to give smaller, independent players a chance to engage—the independents played a key role in the US development of shale gas, for example. In contrast, in China, the dominant position of large oil and coal companies for which coal bed methane gas extraction is a distraction from their core business may be an important factor in the slow development of CBM in China.

Overall, Morrow emphasized the importance of recognizing that although the basic technology may be well understood, the application of these unconventional technologies to specific geographies is an ongoing innovation challenge, and one that may face special difficulties for first movers. Government policy thus needs to focus on overcoming the initial hurdle of proving the resource can work, after which the herd dynamic of the industry will take over and build momentum.

_Holly Morrow spoke as part of the Kennedy School’s Energy Policy Seminar Series._

_This summary was originally published as an online HKS News item, September 23, 2014._
SELECTED PAPERS & PUBLICATIONS
Emission targets implicitly tend to obey a formula that quantifies three major principles: all countries should rein in their emissions, but rich countries should accept bigger cuts than poor countries; countries where emissions have recently increased rapidly should be given some time to bring them back down; and no country or group of countries should suffer disproportionately large economic costs.


Bodansky, Daniel, Seth Hoedl, Gilbert Metcalf, and Robert Stavins. “Executive Summary: Facilitating Linkage of Heterogeneous Regional, National, and


Goldthau, Andreas. “Sorting fact from fiction on Europe's shale gas ‘bonanza’.” Europe’s World (February 24, 2014).


Goldthau, Andreas and Michael LaBelle. “Governance of Unconventional Gas in Bulgaria.” Oil, Gas and Energy Law Intelligence 12:3 (June 2014).


Jordaan, Sarah, Laura Diaz Anadon, Erik Mielke, and Daniel P. Schrag. “Regional Water Implications of Reducing Oil Imports with Liquid Transportation Fuel
Alternatives in the United States.” *Environmental Science and Technology* 47.21 (November 5, 2013): 11976-11984.


“A Landowner’s Guide to Hydraulic Fracturing – Addressing Environmental and Health Issues in Natural Gas Leases.” Emmett Environmental Law & Policy Clinic,


MacMartin, Douglas, Ben Kravitz, David Keith, and Andrew Jarvis. “Dynamics of the Coupled Human-Climate System Resulting from Closed-Loop Control of Solar Geoengineering.” *Climate Dynamics* 43.1/2 (July 2014): 243-258.


Moore, Scott M. “Pollution Without Revolution.” *Foreign Affairs* (June 11, 2014).


P

Parker, A. “Governing solar geoengineering research as it leaves the laboratory.” Phil. Trans. R. Soc. A 372 (2014).

R


Reinhardt, Forest. “Stop Thinking of Climate Change as a Religious or Political Issue.” Harvard Business School Working Knowledge (September 24, 2014).


S

SELECTED PAPERS & PUBLICATIONS


Stavins, Robert N. “Spurring the Rest of the Planet.” *Politico* (December 10, 2014).


W

Wang, Haikun, Yanxia Zhang, Xi Lu, Chris P Nielsen, and Jun Bi. “Understanding China’s carbon dioxide emissions from both production and consumption perspectives.” *Renewable & Sustainable Energy Reviews* (Submitted 2014).


X


“Has the Clean Development Mechanism stimulated additional wind development in China?” asked Energy Technology Innovation Policy research group fellows Gabe Chan and Joern Huenteler in a November 17, 2014, energy policy seminar. In a world in which “emission offsetting mechanisms are a central element of major climate policies around the globe,” Chan and Huenteler suggest that it is a good idea to learn as much as possible from the program that has been the largest generator of offset credits to date.

As Chan and Huenteler explained, from 2005 through 2012, the Clean Development Mechanism (a product of the Kyoto Protocol) provided additional funding for investment in emissions-offsetting projects. The intention of the CDM was to provide crucial funding for projects that would not otherwise have been financially viable. The majority of these projects (58%) were in China, including 1507 wind power projects with a total of about $107 billion of investment.

Presumably, Chan and Huenteler reasoned, if the CDM wind projects were truly additional, they would be inherently less profitable than projects that were built without funding from the CDM—either because they used more costly technologies, or because they were built in areas with less robust winds. Accordingly, they examined China's wind energy projects for evidence of differences between CDM and non-CDM projects.

From 2006-2012, Chan and Huenteler found, approximately 20% of China's annual wind investment was made without to the ability to generate CDM credits. The researchers compared the estimated profitability of these projects
with the CDM projects, incorporating data on turbine size, electricity tariffs and wind resources in the construction location, taking advantage of the Harvard China Project’s comprehensive wind speed database for China.

By all three measures, Chan and Huenteler found little difference between the CDM and non-CDM projects. Interestingly, however, this was not because the wind data showed the CDM projects to be more profitable than anticipated—if anything, calculations of profitability using the Harvard wind speed data showed projects were likely to be less profitable than projected. Nevertheless, the researchers argued, it is hard to credit these projects with being truly “additional,” given that other projects of indistinguishable profitability were successfully built without CDM funding.

Chan and Huenteler left open the possibility, however, that the collective impact of CDM funding in China did create, overall, more investment in wind than might otherwise have happened.

Given the difficulty of existing rules to establish the additionality of individual CDM projects, Chan and Huenteler suggested that in planning for future offsetting mechanisms, policymakers should consider incorporating comparisons between proposed projects and similar existing projects outside of an offset system into the benchmarking measure of additionality.

The talk was part of the Kennedy School’s Energy Policy Seminar Series.

This summary was originally published as an online HKS News item, November 21, 2014.
ACKNOWLEDGEMENTS
...carbon standards that have stringent CO2 emissions reductions targets but are flexible and include new investments in energy efficiency, offer greater and more widespread health co-benefits than the other alternatives examined here. ...carbon standards focused strictly on power plant retrofits could increase emissions and [offer] little to no health co-benefits nationwide.

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Paul Zofnass, ’69, MBA ’73 and Joan Zofnass, for support for the Zofnass Program for Sustainable Infrastructure.
Clean Energy Technologies: Learning by Doing and Learning by Waiting

How much should we spend to subsidize the deployment of currently-available renewable technologies? For the moment, nothing, said Raymond Plank Professor of Global Energy Policy William Hogan, arguing that priority ought to be put on funding basic research to improve our current renewable energy options, not on subsidizing large-scale deployment of technologies that are not on track to be cost competitive.

The cost of transforming the energy system to address the climate problem will be “significant but worth it,” Hogan said. But he argued that dedicating money to speeding the deployment of existing wind and solar technologies is a mistake, given the current significant gap between the costs of these technologies and the cost of natural gas generation.

Professor Hogan began by examining the cost-competitiveness of renewable energy, presenting an “apples to apples” comparison of the levelized cost of energy from different sources, based on data from the Energy Information Administration, adjusted by backing out all subsidies, adding in externalities costs for conventional pollutants and for CO2, and setting background economic assumptions (such as the cost of capital) at equal levels for all energy sources. The comparison showed that even with the inclusion of the externalities costs, renewables like wind and solar are still significantly more expensive than energy from gas (in the range of an additional 37% in the case of the lower-cost options such as on-shore wind, to an additional 83% in the case of solar pv, with significantly higher costs associated with offshore wind and solar thermal energy).
But if renewable energy is not cost-competitive today, could it be made competitive by cost savings developed in the course of deployment (“learning by doing”)? The answer depends in part on how fast learning by doing can be expected to work, Hogan said. But under most common assumptions (using a model developed by William Nordhaus), the appropriate premium is relatively low (too low to make up for the current cost-competitiveness gap, in most cases).

However, this does not mean that renewable energy can never be competitive. As Hogan explained, the alternative to deployment subsidies is not technology stasis. Waiting by itself provides time for technological innovations in other sectors of the economy to take hold and make new cost savings possible in the renewables area. And even more can happen if “waiting” is interpreted to include support for basic research.

How long will we have to wait for renewables to approach competitiveness with other energy sources? The answer, Hogan said, depends a great deal on whether or not a country imposes a price on carbon, a step which immediately increases the competitiveness of zero-carbon energy. With no carbon price in place, the best strategy would be to wait for 35-40 years to allow the technology to advance before subsidizing deployment. With a carbon price, the optimal “wait” time in the analysis declined to 9-12 years.

Professor Hogan spoke as part of the Kennedy School’s Energy Policy Seminar Series.
CAPTIONS

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India’s Chief Climate Negotiator and the 2014 fall Fisher Family Fellow, Minister Jairam Ramesh, delivers an address titled “Climate Change Diplomacy: The Road to Paris 2015.” Photo courtesy of the Belfer Center for Science and International Affairs.

p.47
Afreen Siddiqi (3rd from left) visits a self-contained solar/hydroponic system in Jordan. Jade Salhab. Photo courtesy of the Belfer Center for Science and International Affairs.

p.85
Venkatesh Narayanamurti and John Holdren. Martha Stewart. Photo courtesy of the Belfer Center for Science and International Affairs.
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Robert Stavins. Thomas Kohler, MCC/ZEW. Photo courtesy of the Belfer Center for Science and International Affairs.

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During “China, Development & the World Economy,” Robert Zoellick, (left) Former President, World Bank; Chairman, International Advisors, Goldman Sachs speaks with Michael McElroy, Gilbert Butler Professor of Environmental Studies and Chair of the Harvard China Project at Harvard University. The event took place in the Science Center. Kris Snibbe/Harvard Staff Photographer.

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Laura Diaz Anderson discusses her book with co-author Matthew Bunn. Photo courtesy of the Belfer Center for Science and International Affairs.
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