MIT JOINT PROGRAM ON THE SCIENCE & POLICY OF GLOBAL CHANGE

GLOBAL CHANGES

MIT JOINT PROGRAM ON THE SCIENCE & POLICY OF GLOBAL CHANGE
FALL 2020 NEWSLETTER

OUR RESEARCH MISSION

Advancing a sustainable, prosperous world through scientific analysis of the complex interactions among co-evolving, interconnected global systems.

The pace and complexity of global environmental change is unprecedented. Nations, regions, cities and the public and private sectors are facing increasing pressures to confront critical challenges in future food, water, energy, climate and other areas. Our integrated team of natural and social scientists produces comprehensive global change projections under different environmental, economic and policy scenarios. These projections enable decision-makers in the public and private sectors to better assess impacts, and the associated costs and benefits of potential courses of action.

OUR VISION

We envision a world in which community, government and industry leaders have the insight they need to make environmentally and economically sound choices.

Toward that end, we provide a scientific foundation for strategic investment, policymaking and other decisions that advance sustainable development.

IMPACT: WHAT WE DO

The MIT Joint Program:

- Combines scientific research with risk and policy analyses to project the impacts of—and evaluate possible responses to—the many interwoven challenges of global socioeconomic, technological and environmental change.
- Communicates research findings through our website, publications, workshops and presentations around the world, as well as frequent interactions with decision-makers, media outlets, government and nongovernmental organizations, schools and communities.
- Cultivates and educates the next generation of interdisciplinary researchers with the skills to tackle ongoing and emerging complex global challenges.

IN THIS ISSUE:

SAVE THE DATE: ILP-MIT JOINT PROGRAM WEBINAR

Climate-Related Physical and Transition Risks

Nov 17, 2020 • 10am – 2pm EST • Zoom

More information

Attendance is by invitation only.

FALL 2020 GLOBAL CHANGES

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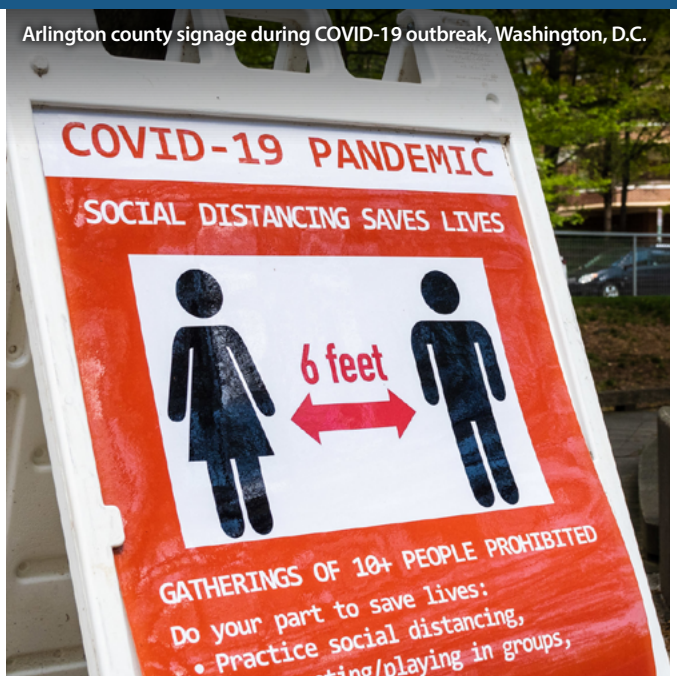
Covid-19: A teachable moment for how we confront climate change and economic challenges

For much of 2020, Covid-19 has captured the world's attention. The pandemic has impacted billions of lives, and with over a million deaths and counting, continues to drive home a profound message that the survival and well-being of our growing and complex society hinges on our willingness to confront environmental threats with global consequences. Key to protecting lives and making our communities more resilient to such threats will be an emphasis on proactive, science-based decision-making at all levels of society.

In this respect, the Covid-19 calamity presents important parallels to the risks and threats that we face from human-induced changes to climate. The scientific process, through counterfactual experimentation, has elucidated the importance and benefits of non-therapeutic measures (e.g. masks, social distancing) to slow the spread and reduce mortality rates from the virus. This scientific approach toward counterfactual evidence has long been critical to our understanding of climate-related threats to our natural ecosystems, managed resources, built environments, human health, economic prosperity and societal sustainability. Yet crucial to reducing the threats, avoiding the risks and averting the dangers is the societal responsibility to act upon scientific evidence.

We have seen encouraging and effective actions with tangible results during the Covid-19 pandemic in a number of countries and states. For climate-related risks, however, we face a more challenging situation. Our actions and preparations must be made far in advance, and the benefits are slow to evolve and materialize.

The pandemic also underscores the impact of climate and weather on human health, particularly their effect on the spread of virulent disease and the ability of humans to cope and recover. With Covid-19, seasonal and geographic attributes of climate, such as humidity, impacts the infection rate. Moreover, chronic increases in heat stress on the human body can negatively affect the immune system, and potentially compromise its ability to fight infection.



Arlington county signage during COVID-19 outbreak, Washington, D.C.

While evidence indicates that climate and weather are largely secondary factors in our fight against Covid-19, the virus also exhibits "super-spreading" tendencies, with regional-to-local environmental factors that may play a larger role. Under human-induced climate warming, these influences on a virus' ambient environment as well as negative physiological impacts may compound and amplify infection and mortality. Our research will continue to explore the extent and severity of future environments, their health-related consequences, and the actions that lead to reduced risk.

The pandemic has not only served as a teachable moment for how we confront the climate crisis and its impacts on human health, but also for how we manage our economies.

Since its emergence in late 2019, Covid-19 has substantially reduced economic activities and greenhouse gas emissions resulting from them. While a declining trend for emissions is a good sign for reaching climate goals, negative impacts of the pandemic on economic growth and emergency measures to stimulate national economies provide a complex picture for future decarbonization efforts. The slowdown in economic growth and energy demand brought about by Covid-19 may not be as beneficial as it might appear on first sight.

In a slow-growth situation, less resources are available for governments to support clean alternatives and for private companies to invest in new technologies. A prolonged slow growth scenario would also likely lead to dramatic impacts on personal finances, from sustained poverty levels to increased inequality. If the market is not growing, technologies have a harder time competing for market share because they need to push out larger fractions of incumbent energy sources.

In a high-growth situation, however, high demand and high energy prices provide substantial incentives for new innovations. Growing demand and market share can drive down the costs of new technologies. When demand for energy is growing, new energy sources mostly add to the mix rather than force an early and costly retirement of existing energy sources. That said, without proper emissions-reduction policies, the growth will not be environment-friendly.

Regardless of the pace of economic development, governments need to intervene to promote a climate sustainability agenda, but resources available for such interventions are highly affected by the Covid-19 crisis. This crisis has also exacerbated negative trends related to protectionism, populism and nationalism. For a climate problem that requires a global solution, these negative tendencies make efforts to establish global decarbonization pathways even more challenging.

The ultimate impact of Covid-19 will depend on the coherence of government policies. Three major world regions, the U.S., China and the European Union, offer some insights into the potential effects of government stimulus measures on economic growth and clean energy development. The European Union has put together a recovery plan in which carbon reduction is a crucial component. In addition to dedicating significant amounts of money to green technologies, the EU plan requires that all of its expenditures be consistent with the objectives of the Paris Agreement. This plan thus encourages technological leadership in many economic sectors where solutions for decarbonization are still under development.

In a surprising move that would require a shift in technological priorities, China has recently announced that it will become "carbon neutral" by 2060. For a country still engaged in a substantial amount of coal-based generation, achieving the stated goal will require very aggressive implementation plans and policies. These efforts will likely be driven by the strategic consideration of technological leadership and providing low-carbon solutions for the rest of the world.

The U.S. response remains to be seen. The timing of China's announcement seems to be chosen to take advantage of the lack of the U.S. climate leadership. A new U.S. administration will need to act soon and develop policies that direct Covid -19 recovery spending to provide incentives for the private sector to restore leadership in climate action. Wisely designed policies would leverage the Covid-19 crisis to accelerate the development of clean technologies and their dissemination throughout the world.

We and other Joint Program researchers are now analyzing the potential impact of Covid-19 on the environment and economy under different policy scenarios, and will publish our findings in our 2021 Global Change Outlook in the spring.

—C. Adam Schlosser and Sergey Paltsev, Deputy Directors


C. Adam Schlosser


Sergey Paltsev

MIT DEPARTMENT ACRONYMS

Due to space considerations, MIT departments, labs and centers referenced here are referred to by their acronyms.

CEEPR	Center for Energy and Environmental Policy Research
EAPS	Earth, Atmospheric and Planetary Sciences
IDSS	Institute for Data, Systems, and Society
MITEI	MIT Energy Initiative

Dr. John Reilly steps down from Joint Program Co-Directorship

Dr. John Reilly has stepped down from his role as Co-Director effective August 31, as part of a planned, phased retirement. He will continue to serve the Joint Program on various research projects, working part-time for the foreseeable future. I will remain as Director of the Program, supported by the rest of our leadership team, research scientists and administrative staff. While we will miss having John in the Co-Director role, we are confident that he has laid the groundwork for us to continue to pursue our full research agenda unabated.

Central to John's work and Co-Directorship has been the integration of the human system, represented by sector-resolving models of the global and national economies, with the natural environmental system, represented by coupled models of the physics, chemistry, biology and dynamics of the ocean, atmosphere and land. Applying his deep understanding of the complex interactions of human society with our planet, John has sought to aid in the design of affordable policies that can effectively limit the role of human activity in detrimental environmental change, and facilitate adaptation to unavoidable change. To further inform policies, John has also worked to elucidate the pathways for large-scale transitions in our energy, agricultural and related systems that will be needed to meet the growing needs for food, energy and water in coming decades.

Since joining the Joint Program in 1998, John has overseen numerous research projects and produced 195 publications assessing global environmental and economic change under various policy scenarios, with over 100 of those publications emanating since he became Co-Director in 2010. A prime example of the breadth of his vision of integration is his leadership of our most recent Food, Water, Energy and Climate Outlook, which maps out the future of energy and land use, water and agriculture, and emissions and climate (we are planning to release a new Outlook in 2021). Throughout his time as Co-Director, he has been a highly articulate spokesperson for the Program through many appearances in print and broadcast media.

While we will miss having John around on a full-time basis, we are delighted that we will continue to benefit from his insights, sharp wit, deep knowledge base, and extensive professional network. More information about John can be found here.

We appreciate your continued engagement as we make this transition. If you have any questions, please don't hesitate to contact me at rprinn@mit.edu or our Executive Director for External Affairs, Horacio Caperan, at hcaperan@mit.edu.

Best Regards,

—Ronald G. Prinn, Director

MIT Joint Program News Releases:
Latest research developments and their implications

MIT Joint Program in the Media:
Latest coverage of our research

The following summaries are listed by primary research focus area, but may span multiple research focus areas. For full articles, please visit our website at globalchange.mit.edu.

Earth Systems

Changes and risks to interconnected land, ocean, atmosphere and biosphere systems

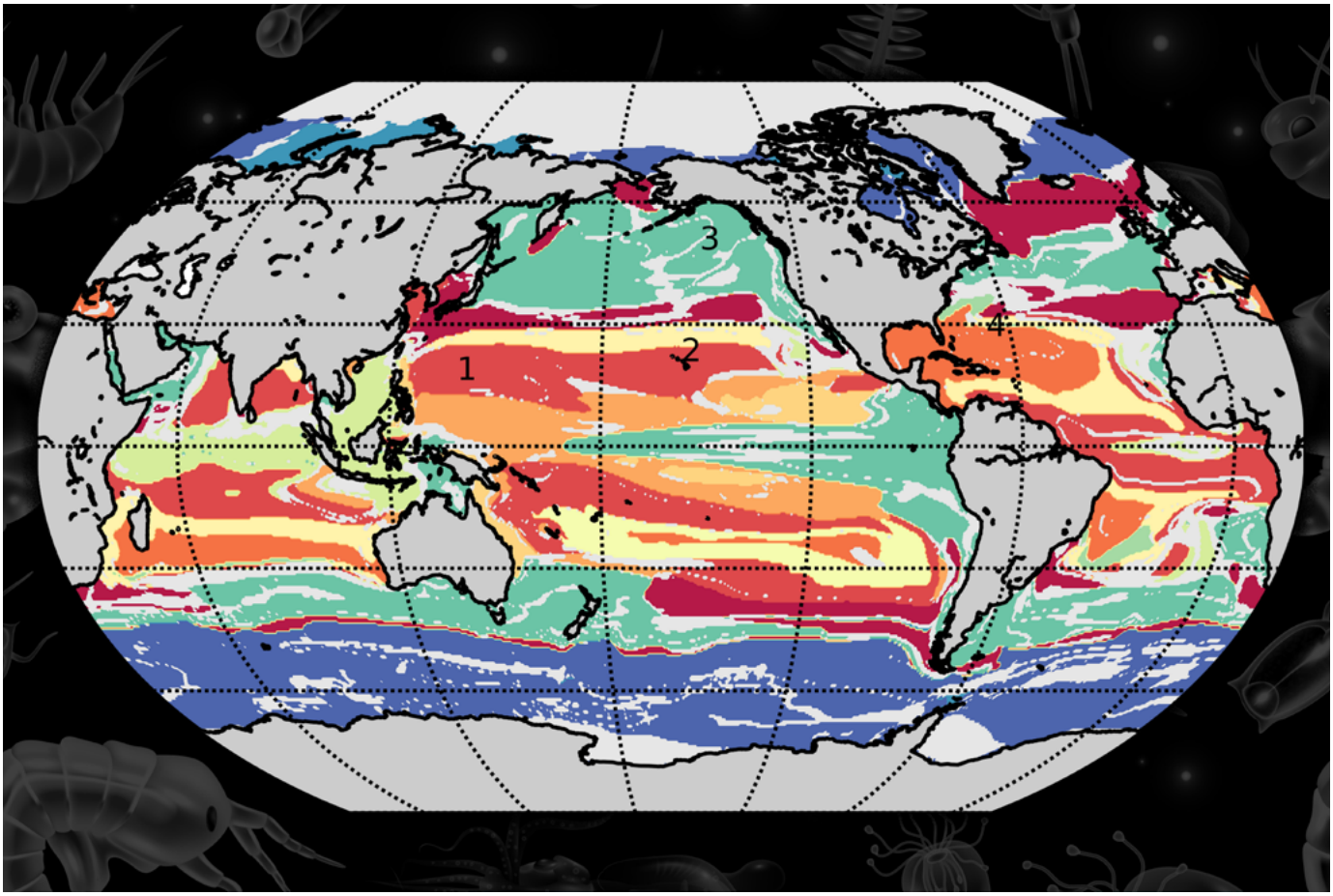
Machine learning helps map global ocean communities

An MIT-developed technique could aid in tracking the ocean's health and productivity

A machine-learning technique developed at MIT combs through global ocean data to find commonalities between marine locations, based on interactions between phytoplankton species. Using this approach, researchers have determined that the ocean can be split into over 100 types of "provinces," and 12 "megaprovinces," that are distinct in their ecological makeup.

COMMENTARY We cannot ignore the links between COVID-19 and the warming planet (*The Hill*)
How climate change can increase the likelihood of a pandemic and amplify its toll on humans

Unfinished business after five decades of ozone-layer science and policy (*Nature Communications*)
The Montreal Protocol has begun to heal the Antarctic ozone hole, but recent research shows that new unexpected emissions are undermining the Protocol's success



A machine-learning technique developed at MIT combs through global ocean data to find commonalities between marine locations, based on interactions between phytoplankton species.

Managed Resources

Changes and risks to managed agriculture, water, land and energy systems

The future of oil amid Covid-19 and climate change

MIT Joint Program Deputy Director Sergey Paltsev featured in Civic Series webinar

With the emergence of Covid-19, all bets are off when it comes to oil projections, at least for the next decade or two, said Paltsev. Over the longer term, he envisioned that the main factors driving oil production and consumption levels will likely be climate policy, a transition to low-carbon energy sources, the setting of midcentury net zero emission targets by major oil and gas companies, and geopolitics.

Oil wells in Carlsbad, New Mexico

PODCAST **A decade in energy (*MIT Energy Initiative*)**
Joint Program Co-Director Emeritus John Reilly and other experts on how U.S. energy market has changed in the 2010s

Nuclear faces its own energy transition (*Petroleum Economist*)
The fuel may appear to be in terminal decline, but it remains the focus of Great Power competition, suggesting it is not dead yet

"The Nile Is ours" (*Slate*)
A fight over the world's longest river is a preview of climate change diplomacy

Infrastructure & Investment

Physical and transition risk; adaptation and resilience to climate change and extreme events

Can financial disclosure of climate risk accelerate climate action?

MIT panel discussion explores best practices

Panelists described how their organization has been affected by climate-related financial risk and the steps it's taking to address it, how climate and economic scenarios could be useful in better understanding climate-related financial risks, and potential research that an institution like MIT could pursue to advance the state of knowledge in this area.

Bank of Canada: Climate change and energy transition pose substantial economic risks

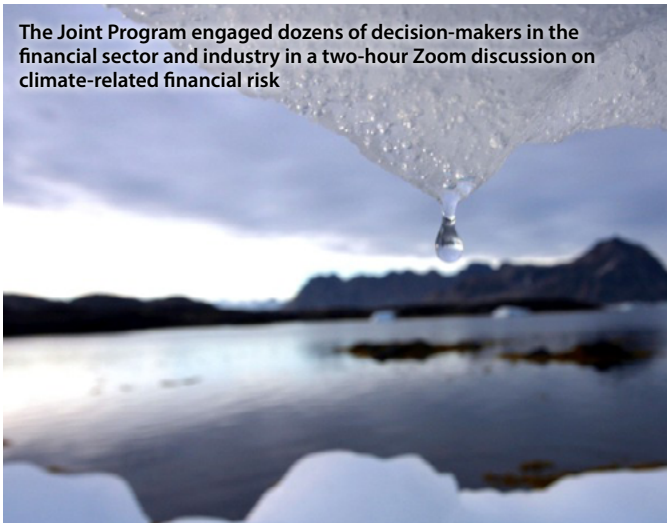
MIT Joint Program economic model powers Bank's scenario analysis

A new study by the Bank of Canada that employs the Joint Program's Economic Projection & Policy Analysis (EPPA) model shows that the physical and transition risks ahead are considerable, and will need to be addressed by multiple stakeholders in private and public sectors. It also underscores the critical importance of scenario analysis in gauging the financial and economic risks and opportunities of climate change.

MIT Joint Program welcomes V-Square Quantitative Management as new program sponsor

Collaboration to advance science-based financial decision-making

Recognizing the critical value of scientific research and risk and policy analysis to its financial management strategy, V-Square Quantitative Management (VSQM) has joined the MIT Joint Program as a program sponsor. A global asset management firm and a sustainability analytics platform, VSQM is headquartered in Chicago.



The Joint Program engaged dozens of decision-makers in the financial sector and industry in a two-hour Zoom discussion on climate-related financial risk

Energy Transition

National and global projections of the future energy mix; prospects for different sectors and technologies

Scaling up low-carbon energy: Economic, geopolitical, and environmental impacts

MIT webinar features presentations by Joint Program Deputy Director Sergey Paltsev and Founding Co-Director Emeritus Henry Jacoby

The energy sector is facing unprecedented challenges, with the global Covid-19 pandemic complicating an already challenging transition toward a low-carbon future. To explore viable pathways to achieving that goal, Paltsev, Jacoby and a panel of industry representatives discussed challenges and opportunities in scaling up low-carbon energy.

Bridge fuel or bridge too far?

Cheap shale gas could prolong energy transition

Could the widespread availability of cheap natural gas enable the U.S. to continue to lower its power-sector CO_2 emissions over the long term, buying time for zero-carbon energy technologies such as solar and wind to overcome their intermittency challenges and become reliable, economical substitutes? Or might its relatively low cost lead to more extensive use, higher emissions, and a much longer energy transition?

COMMENTARY **The paths to net zero: How technology can save the planet (*Foreign Affairs*)**
A perspective by Joint Program faculty affiliate Valerie Karplus

COMMENTARY **Estimating the Pace of Low-Carbon Technology Adoption (*T&D World*)**
How fast and under what conditions can the world scale up a new technology? John Reilly distills the findings of a Joint Program study

Mapping complex pathways to global decarbonization (*MIT Industrial Liaison Program*)
MIT Joint Program Deputy Director Sergey Paltsev helps decision-makers meet aggressive decarbonization goals


The AES Corporation, based in Virginia, installed the world's largest solar-plus-storage system on the southern end of the Hawaiian island of Kauai. A scaled-down version was first tested at NREL.

Policy Scenarios

Environmental and economic change under different climate, air pollution, and economic policies


Global warming

COMMENTARY **Can a pandemic aid the fight against global warming? (*The Hill*)**
Joint Program Founding Co-Director Emeritus Henry Jacoby and coauthors explore challenges and opportunities ahead

COMMENTARY **Counterfactual experiments are crucial but easy to misunderstand (*Scientific American*)**
With COVID-19, as with climate, we need to explore a variety of possible futures in order to set policy

COMMENTARY **The Trump administration cooks the climate change numbers once again (*The Hill*)**
The potential dire consequences of manipulating the Social Cost of Carbon

COMMENTARY **Five science questions to be asked at the debates (*Yale Climate Connections*)**
Journalists, moderators and the public have an important opportunity to question the presidential and vice presidential candidates in the upcoming TV debates

Regional Analysis

Science and policy studies at subnational, national and multinational levels

Decarbonize and diversify

How energy-intensive economies can survive and thrive as the globe ramps up climate action

By taxing fossil fuels (e.g., through a production or carbon tax), countries like Russia could redistribute that revenue to the development of human capital to boost other economic sectors, thereby making up for energy-sector losses due to global climate policies. The resulting GDP increase for Russia could be on the order of 1-4 percent higher than it would be without diversification.

Diversification and cooperation in a decarbonizing world

New World Bank book reviewed by MIT Joint Program Deputy Director Sergey Paltsev presents climate strategies for fossil-fuel-dependent countries

A new book takes stock of what the decarbonization of the world economy means for fossil-fuel-dependent countries and explores how they can prepare for a future of permanent decline in global fossil-fuel demand. The book is particularly relevant today, as countries respond to the COVID-19 crisis which offers once-in-a-generation moment for countries to shape sustainable and resilient growth pathways.

MIT and Wyoming explore climate-friendly economic growth

Joint Program Deputy Director Sergey Paltsev and Research Scientist Jennifer Morris among MIT researchers sharing expertise

Recently, representatives from the Wyoming Governor's Office, University of Wyoming School of Energy Resources, and Wyoming Energy Authority met with faculty and researchers from MIT in a virtual, two-day discussion to explore avenues for the state to strengthen its energy economy while lowering CO_2 emissions.

Renewables and the Russian economy (*PV Magazine*)
Taking Russia as an example, an MIT study has examined the likely impact on oil, gas and coal exports and the opportunities the energy transition could offer

Human capital development in Russia through increased per-student expenditure could lead to long-term benefits in manufacturing, services, agriculture, food production, and other sectors. Seen here: Russian students from Tyumen State University.

New Research Projects

Assessing Future Socioeconomics in Climate Modeling

Sponsor: EPRI
Leader: Jennifer Morris
Duration: 6 months

The objectives are to (a) evaluate future socioeconomic and greenhouse gas emissions uncertainty, in particular, uncertainty regarding socioeconomic structure (region, sector, demand, energy and technology); and (b) contribute to a multi-model evaluation and comparison of climate model behavior and climate change response uncertainty. To that end, the project will develop probabilistic global socioeconomic and greenhouse gas emissions projections using MIT probabilistic global economic and emissions modeling capabilities, and perform a multi-model comparison exercise evaluating climate modeling performance using climate/Earth-system model evaluation experiments recommended by a National Academy of Science study on the social cost of carbon.

Multi-Sector, Multi-Resource Interactions with Multiple Forcers

Sponsor: DOE - PNNL
Leaders: Jennifer Morris, Adam Schlosser
Duration: 9 months

This project supports an overall development strategy toward an integrated, interoperable model system utilizing components developed by PNNL, MIT and the PCHES group to explore regional multi-sectoral dynamics of energy, land and water systems in the US. The project seeks to advance the modeling capabilities, tools and approaches of the research groups in preparation for jointly examining multi-sector, multi-resource responses to multiple forcers. The MIT work is focused on: advancing the economic, household, and renewable energy specification in MIT's detailed economic-electricity model; and exploring approaches for scenario discovery based on probabilistic socio-economic ensembles.

Economy-Wide Modeling of Energy/ Environment Policy Scenarios

Sponsor: RTI
Leader: Mei Yuan
Duration: 1 year

This project continues a collaborative effort with RTI that is providing analytical support to the Environmental Protection Agency's Climate Economics Branch. The objective is to simulate environmental policy impacts on the US using a recursive-dynamic, computable general equilibrium modeling framework. For certain applications, the model incorporates linkage to partial equilibrium representations of the electricity sector from the National Renewable Energy Laboratory's Regional Energy Deployment System (ReEDS) to facilitate robust energy and environmental policy analyses.

Assessment of Electric Power-Grid Network Damage Under a Changing Climate and Society

Sponsor: Iberdrola (via MITEI)
Leader: Adam Schlosser
Duration: 6 months

This project aims to elucidate the main climate-change-related threats for the electrical networks and main infrastructures affected, and how to define an adaptation pathway over time. It seeks to establish methods, identify the computational framework, and provide a demonstration of how a prediction system could be exercised in a risk-based assessment to identify proactive solutions toward electric network resilience, reliability and sustainability. These methodologies help the transition from the current reactive state-of-practice to a new energy planning and operations paradigm in which one can proactively anticipate damage to energy system equipment, predict associated outages and lack of service, and recommend optimal mitigation strategies.

Economic analysis of the Hard-to-Abate Sectors in India

Sponsor: Shell (via MITEI)
Leader: Sergey Paltsev
Duration: 1 year

This project assesses the participation and contribution of India's hard-to-abate sectors (such as cement, iron and steel, chemicals, refineries and fertilizer production) to the country's decarbonization efforts. The project identifies existing emissions contributions of hard-to-abate sectors in India and their likely future trajectory of development under the currently proposed policy regime. To understand the near-term (i.e., up to 2030) options for emissions reduction in hard-to-abate sectors, the project assesses their potential for improved energy efficiency, accelerated electrification, and a larger share of natural gas usage. To evaluate medium-term (i.e., up to 2050) options, the project simultaneously considers several advanced technologies related to CCS and/or alternative fuels and feedstock and assesses long-term policy options to accelerate a transition in these hard-to-abate sectors.

Plausible Energy Futures: Phase I - A Framework for Evaluating Options, Impacts and National Energy Choices

Sponsor: International Energy Agency (via MITEI)
Leader: Sergey Paltsev
Duration: 1.5 years

This project focuses on developing a system- and pathway-level lifecycle assessment (LCA) tool, which is called the Sustainable Energy Systems Analysis Modeling Environment (SESAME), a publicly available, open-access model with multi-sector representation. To provide economy-wide scenarios for the SESAME tool, an economy-wide, multi-sector, multi-region computable general equilibrium (CGE) model (the MIT Economic Projection and Policy Analysis model (EPPA)) will be employed. Case studies focused on Norway and Singapore will be performed to demonstrate the capability of the tool, which will be developed at the MIT Energy Initiative.

Peer-Reviewed Studies & Pending Reprints

Seasonal source variability of carbonaceous aerosols at the Rwanda Climate Observatory (*Atmospheric Chemistry and Physics*)

Elucidating ecological complexity: Unsupervised learning determines global marine eco-provinces (*Science Advances*)

Impacts of climate change policies worldwide on the Russian economy (*Climate Policy*)

Biomagnification of methylmercury in marine plankton ecosystems (*Environmental Science and Technology*)

Will using newer input-output data for general equilibrium modeling provide a better estimate for the CO_2 mitigation cost? (*Economic Systems Research*)

Is there warming in the pipeline? A multi-model analysis of the Zero Emissions Commitment from CO_2 (*Biogeosciences*)

The role of shale gas in shaping the U.S. long-run CO_2 emissions (*Energy & Environment*)

Global CO_2 impacts of light-duty electric vehicles (*Transportation Research Part D*)

The role of synthetic biology in atmospheric greenhouse gas reduction: Prospects and challenges (*BioDesign Research*)

A comprehensive quantification of global nitrous oxide sources and sinks (*Nature*)

Mid-century changes in the mean and extreme climate in the Kingdom of Saudi Arabia and implications for water harvesting and climate adaptation (*Atmosphere*)

Joint Program Reports

342. The Changing Nature of Hydroclimatic Risks across South Africa

343. Challenges in simulating economic effects of climate change on global agricultural markets

Student Work

Evaluating Electricity Generation Expansion Planning in Ghana

Impacts of Emission Policies in China on Air Pollution and Human Health

Extratropical Storm Tracks and the Mean State of the Atmosphere

Milestones

Susan Solomon earns Killian Award, MIT's highest faculty honor

BBVA Foundation awards **Kerry Emanuel** the Frontiers of Knowledge Award in Climate Change

Climate scientist Kerry Emanuel elected as a foreign member of the Royal Society

Megan Lickley awarded MIT Martin Fellowship, Class of 2019-2020

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(b): see p 4(b)
(c): see p 4(a)

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