Autumn 2015

MIT CEEPR Newsletter

MIT Center for Energy and Environmental Policy Research

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MIT Center for Energy and Environmental Policy Research

As this newsletter goes to press, the international community will be only weeks away from converging on Paris, France, to negotiate details of the global climate regime after 2020. Over 40,000 participants are expected to attend this latest installment in an annual climate diplomacy ritual that dates back 21 years. Expectations for its outcome are tempered, but there still is a sense of building momentum on climate action at all levels. Against that backdrop, MIT recently released a Plan for Action on Climate Change, setting out a path for strengthened research on the causes and consequences of climate change. CEEPR was an influential hub for research on climate policy and economics long before the MIT Climate Change Conversation elevated this issue to MIT's leadership, and it will continue to play an important role by bringing reliable and balanced insights to an often politicized debate. Its trademark of rigorous empirical research is reflected in recent working papers on the international climate negotiations, green technology support, and the unintended effects of carbon pricing. Still, many other pressing issues in the energy policy arena call for undiminished attention, and we remain committed to meeting the attendant research needs. The following pages convey a sense of the broad and diverse work underway at MIT CEEPR, and we hope you find it an enjoyable read.

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Natural Gas Prices and Coal Displacement: Evidence from Electricity Markets

by: Fiona Paine

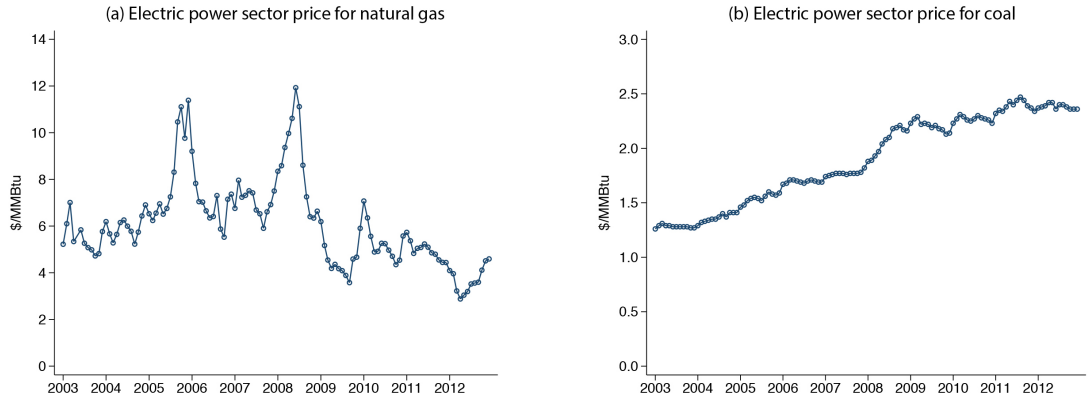


Figure 1: Fuel costs

Fuel costs, based on electric power sector price for natural gas (left) and coal (right).

Note: The authors plotted the monthly natural gas and coal prices ($/MMBtu) for the electric power sector using data from the EIA Short Term Energy Outlook Custom Table Builder at:

http://www.eia.gov/forecasts/steo/query/index.cfm?

A recent CEEPR working paper uses data from the US Environmental Protection Agency (EPA) and Energy Information Administration (EIA) along with market models to provide an in depth look at the environmental and operational effects of fuel price changes on electricity generators.[1] Plant decisions made in the short-term to switch from coal-to-natural gas due to relative price fluctuations are analyzed across different electricity markets and ownership systems. The research was conducted by CEEPR Director Christopher Knittel of the MIT Sloan School of Management, Konstantinos Metaxoglou of Carleton University, and Andre Trindade of the Getulio Vargas Foundation.

In recent years, there has been a glut of natural gas in the US due to the proliferation of fracking technology. At the same time, international coal demand has grown while US coal production has declined. Coal is a heterogeneous product, with geographical variations in price because of delivery costs. Natural gas, however, is a homogeneous product that is delivered to customers through a national infrastructure of pipelines. The result has been a rise in the price of coal relative to natural gas and thus a shift in the generation landscape. The use of coal for electricity generation in the US dropped from 51% in 2003 to 37% in 2012, while natural gas usage increased over the same time period from 17% to 30%.

A key outcome of the paper was to show how generators' response to changing coal prices depend on market structure and ownership type. More specifically, investor-owned utilities (IOUs) operating in traditional electricity markets elicited a greater response to fuel prices than both IOUs and independent power producers (IPPs) operating in restructured markets.

As the authors highlight, generators in restructured markets have less incentive to invest in natural gas capacity, limiting their ability to respond to changes in the prices of the two fuels. Using a difference-in-differences analysis, the paper shows that entities effectively reduced their investment rates after restructuring. Several characteristics of restructured electricity markets, such as increased price volatility in wholesale spot trading and the lack of long-term contracts, may contribute to the reduced investment. At the same time, traditional markets may also simply display excessive investment compared with restructured markets because of the Averch-Johnson effect, pursuant to which regulated companies engage in excessive amounts of capital accumulation to expand profit volumes.

Looking at the firm level, the paper addresses variation in generator efficiencies. Lower heat rates allow for a larger response to natural gas prices because there is a better chance of a generator becoming infra-marginal, all else being equal. Heat rates are, on average, lower and thus more efficient in traditional markets. On the environmental front, finally, burning natural gas is a cleaner choice than coal: Natural gas emits lower levels of almost all pollutants including CO_2 per unit of heat produced. According to the authors, a 70% drop in natural gas prices between June 2008 and January 2012 contributed to a 33% reduction in CO_2 emission in traditional markets and 19% reduction in emissions for restructured markets.

As we learn more about the effects of recent shifts in coal and natural gas prices in relation to market and ownership types, we can broaden our understanding of the electricity landscape. It will be interesting to see how these changes in behavior will be translated to the long term.

[1] Christopher R. Knittel, Konstantinos Metaxoglou, and Andre Trindade (2015), "Natural Gas Prices and Coal Displacement: Evidence from Electricity Markets." *CEEPR WP-2015-013*, MIT, October 2015.

Soft Cooperation in the Shadow of Distributional Conflict? Insights from the Climate Regime

by: Antto Vihma

In climate diplomacy, negotiators frequently reject "technical" initiatives that only require simple coordination, despite the affordable reputational gains they may gain from cooperation. For example, promoting the international transparency of greenhouse gas emissions through regular inventories and reporting by all major economies has been one of the key sources of disagreement in the United Nations (UN) climate regime, although the initiatives to enhance transparency would not require countries to accept legally binding obligations concerning emissions reductions or provide climate finance. Understanding this opposition even to soft forms of cooperation can shed valuable light on state behavior ahead of and during the upcoming climate summit in Paris, France (COP 21).

Conventional cooperation theories based on neoliberal institutionalism cannot sufficiently explain such cases. If "soft cooperation", defined as coordination that does not oblige behavioral change, offers flexibility and cooperation at a low cost, why would the seemingly technical issue of measuring and reporting provoke major and long lasting controversies? Why would big developing countries not rather use it as an opportunity to realize affordable reputational and coordination gains from cooperation with industrialized countries?

Motivated by this puzzle, Dr. Antto Vihma (The Finnish Institute of International Affairs), a visiting scholar at CEEPR, and Dr. Johannes Urpelainen (Columbia University) developed a formal model to analyze negotiation dynamics. A paper titled "Soft Cooperation in the Shadow of Distributional Conflict? A Model-Based Assessment of the Two-Level Game between International Climate Change Negotiations and Domestic Politics" was published as CEEPR Working Paper WP 2015-001 earlier this year.[1]

The model is developed around the following intuition. First, it is assumed that state governments can engage in "soft cooperation" that is not characterized by distributional conflict. In the empirical case of climate negotiations, soft cooperation consists of reporting with guidelines and common accounting rules for all parties. Conversely, legally binding obligations for behavioral change are modeled as "hard cooperation," with the assumption that it features bargaining under distributional conflict. For example, hard cooperation could be about binding commitments to reduce greenhouse gas emissions, or introduction of trade tariffs. Second, it is assumed that a government's political survival is determined by a domestic audience, such as the legislature or the military elite, depending on the type of regime in place in the state. Since the domestic audience has limited information regarding the government's preferences, it uses soft cooperation as an indicator for whether the government is "moderate" or a "hardliner." In equilibrium, a negotiator's approach to soft cooperation informs the domestic audience about likely behavior in

Understanding opposition to soft forms of climate cooperation can provide important insights on state behavior during the upcoming climate summit in Paris, France (COP 21).

bargaining over hard cooperation with binding obligations.

The Working Paper proposes that countries at times reject soft cooperation in international negotiations if they worry that their domestic audiences will punish them for adopting moderate positions. If domestic audiences believe that their interests are best represented by intransigent negotiators who drive a hard bargain, then negotiators have incentives to reject even the most innocuous proposals. If the negotiators were to accept proposals for soft cooperation, their domestic audiences would worry about their willingness to compromise on other issues in the future. Since moderate negotiators might not drive hard bargains in negotiations involving a distributional conflict, such as over emissions reduction commitments, audiences would remove negotiators who appear irresolute by accepting soft cooperation. In the shadow of a distributional conflict, soft cooperation may fail due to domestic audience pressure.

To test the theory, the Working Paper conducts a comparative analysis of Indian and South African negotiation behavior in UN climate negotiations during the 2005-2009 period. At the time, reporting and international transparency had once again become one of the key "soft" issues on the agenda. The paper offers a quantitative analysis of Times of India and Johannesburg Star newspaper articles on climate negotiations, complemented with a compact qualitative case study of each country. The results are consistent with the idea that negotiators face pressures to adopt hardline positions even on issues that do not involve commitments to behavioral change. Moreover, should they ever deviate from the expected hardline position, their domestic audiences will punish them.

The strategic approach of this Working Paper to the relationship between "soft" cooperation and a distributional conflict offers an empirically falsifiable model applicable to a variety of issue areas beyond climate policy.

[1] Johannes Urpelainen and Antto Vihma (2015), "Soft Cooperation in the Shadow of Distributional Conflict? A Model-Based Assessment of the Two-Level Game between International Climate Change Negotiations and Domestic Politics." *CEEPR WP-2015-001*, MIT, February 2015.

Conflicting Objectives: How the Cash for Clunkers Stimulus Program Reduced New Vehicle Spending

by: Jeremy West

Implemented in the midst of the 2009 recession, the US Cash for Clunkers program aimed to boost sales in the struggling automobile industry. Eligible households were provided with subsidies when they scrapped their old "clunkers" and purchased a new vehicle. The argument was that this would shift expenditures "...from future periods when the economy is likely to be stronger, to the present..." (Romer and Carroll, 2010).[1] However, to serve national energy and environmental goals the policy layered on a second requirement, that the new vehicles be of sufficiently high fuel economy. A recent CEEPR working paper by Hoekstra, Puller, and West (HPW, 2015)[2] finds that this multifaceted program design actually caused Cash for Clunkers to reduce overall revenues to the industry the policy was designed to help.

Cash for Clunkers as a Stimulus Policy

The academic and policy spheres have seen significant debate regarding the merits of various federal policies aimed at stimulating the economy during the last few recessions. In 2009, with the international automobile industry floundering, policies to stimulate new vehicle sales seemed particularly promising. Indeed, more than 15 countries implemented programs similar to Cash for Clunkers to target new vehicle sales.

In the United States, federal policymakers constructed the Car Allowance Rebate System. For nearly two months during the summer of 2009, households who scrapped an eligible vehicle were subsidized up to $4500 towards the purchase of a new car or truck, provided the purchased automobile met certain fuel economy conditions. By designing the policy in this way, policymakers hoped to meet two objectives: the program would provide immediate stimulus to the struggling automobile industry, and it would help reduce American use of gas-guzzling vehicles that contribute to climate change and local air pollution.

Evaluating the Effects of Cash for Clunkers on Automobile Sales

Cash for Clunkers was designed to affect not only the timing of households' new automobile purchases but also the composition of new vehicles purchased. HPW provide causal evidence on how the program affected both dimensions. They exploit the program's discrete eligibility cutoff to obtain a compelling

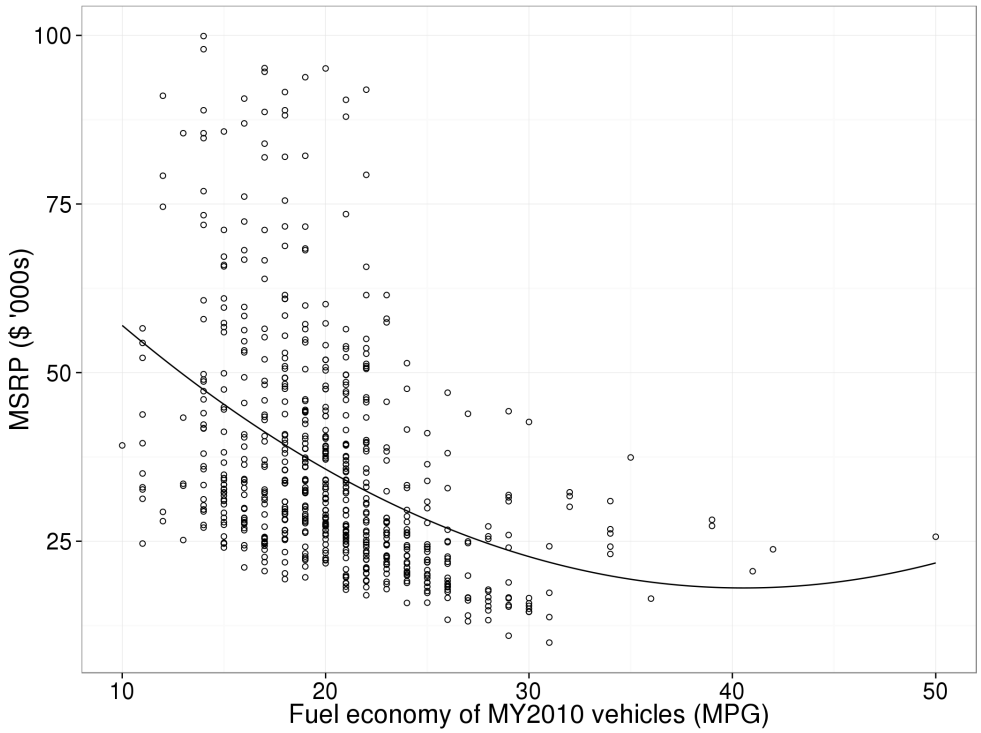


Figure 1:
The figure shows the generally negative relationship between vehicle price and fuel economy. Each point depicts a single vehicle model in 2010, plotting the model's MSRP against its EPA combined fuel economy in miles per gallon. A quadratic fit curve is also plotted.

MY2010 was selected as this model year corresponds to the set of new vehicles that were available at the time of Cash for Clunkers. To be eligible, a new car was required to have at least 22MPG, and larger subsidies were provided to households who improved their fuel economy, relative to their clunker, by at least 10MPG. Nationally, the median fuel economy of subsidized vehicles was 25MPG.

Although some models meet the fuel economy restriction and also have a relatively high MSRP, these vehicles are more of the exception than the rule. Most eligible vehicles have comparatively lower prices. This relationship is fundamentally the underlying factor for the net negative effect of Cash for Clunkers on industry revenue: to meet the fuel economy restrictions of the program, many households substituted towards vehicles that are also less expensive than those they counterfactually would have purchased.

counterfactual for the timing and type of new vehicle purchases made by subsidized households. Specifically, the program's eligibility cutoff of 18 miles per gallon serves as a natural experiment in program participation: households who owned a clunker rated at 18 MPG or lower could receive the subsidy, whereas those with a clunker at 19 MPG or higher were ineligible for subsidies.

The authors use this approach with administrative data on household vehicle ownership and purchases from the Texas Department of Motor Vehicles. First, they show that households who were "barely eligible" appear very similar to "barely ineligible" households in terms of their pre-program vehicle fleets and other household characteristics. Then, they estimate the counterfactual purchase timing for subsidized purchases; the results indicate that about 60 percent of subsidies went to households who would have bought a new vehicle during the two months of the program anyway, with the remaining subsidies pulling purchases forward from across the following eight months or so. By ten months from the start of Cash for Clunkers, there is no difference in purchase probabilities for barely eligible relative to barely ineligible households.

Next, HPW use this same eligibility cutoff-based strategy to evaluate how Cash for Clunkers affected new vehicle spending, rather than just sales counts. They use the ten month time period starting with the program, which holds constant the probability of a household purchasing any new car or truck and allows them to identify just the differences in automobile characteristics. The estimates show that barely eligible households who purchased under the program spent an average of five thousand dollars less (transaction price) on new vehicles than did barely ineligible households who purchased a new vehicle during the same ten month period of time – that is, barely eligible households were incentivized to purchase slightly earlier and spend significantly less. Assuming a similar effect size outside of Texas, these results suggest that Cash for Clunkers actually reduced aggregate new vehicle spending by around three billion dollars nationwide over a period of less than a year.

HPW show that these differences in vehicle expenditures are explained by the generally negative relationship between automobiles' fuel economy and price, as shown in Figure 1. To meet the fuel economy restrictions of Cash for Clunkers, subsidized households purchased vehicles that were higher fuel economy, but also lower performance, smaller size, and lower book value.

This Cash for Clunkers experience has implications for future policymaking. While hindsight is always 20/20, it certainly appears that the primary policy goal – stimulating revenues to the auto industry – was undermined by the "add-on" energy and environmental objective of the policy. Dual policy goals, even those that are individually worthy, can sharply undermine each other when implemented as a single policy.

[1]Christina Romer and Christopher Carroll. Did Cash-for-Clunkers work as intended? White House commentary (2010). Council of Economic Advisers.

[2]Mark Hoekstra, Steven L. Puller, and Jeremy West (2015), "Cash for Corollas: When Stimulus Reduces Spending." *CEEPR WP-2015-005,* MIT, April 2015.

E2e Insights on Weatherization and Subsidies

by: Raina Gandhi

Weatherization Program Analyses

Two recent working papers from authors Meredith Fowlie, Michael Greenstone, and Catherine Wolfram have focused on the energy-related costs and benefits of the Federal Weatherization Assistance Program through field tests with over 30,000 households in Michigan. However, this study is not an evaluation of the entire Federal Weatherization Assistance Program. The study uses the program to evaluate the energy savings of weatherization projects overall.

In the first, the authors document very low take-up of the program, which is widely believed to be privately beneficial.[1] Program participants receive a substantial home "weatherization" retrofit; all installation and equipment costs are covered by the program. Less than one percent of presumptively eligible households take up the program in the control group. This rate increased only modestly after the authors took extraordinary efforts to inform households - via multiple channels - about the sizeable benefits and zero monetary costs. These findings are consistent with high non-monetary costs associated with program participation and/or energy efficiency investments.

The second study found that the costs of the energy efficiency investments were about double households' energy savings.[2] Further, the energy savings projected in advance by engineering calculations are roughly 2.5 times the savings found by the study, underscoring that the results of these models must be validated in the field. Previous studies have attributed the difference between observed and expected energy savings to a "rebound effect": that households adjust their behaviors and consume more energy services than they had before the investments were made. However, the study found no evidence that households turned up their thermostats in the winter, thus providing no evidence of this rebound effect.

Even when accounting for the broader societal benefits of energy efficiency investments, the costs still substantially outweigh the benefits. The average annual rate of return is -9.5 percent when judged from society's perspective. This finding of low returns may help explain why energy efficiency investments have low take-up rates.

Targeting of Energy Efficiency Subsidies

Energy efficiency subsidies are often justified on the grounds that they help correct market distortions. A corrective tax or subsidy is "well-targeted" if it primarily affects choices that are more distorted by market failures. These distortions, however, vary across consumers.

Hunt Allcott, Christopher Knittel and Dmitry Taubinsky develop a model to study optimal subsidies for energy efficient durable goods such as air conditioners, insulation, and cars.[3] They also study the gains from "tagging," which is limiting eligibility for the subsidy to individuals subject to greater distortions. They empirically study three major energy efficiency subsidies, showing that all three are preferentially adopted by consumers who appear to be less affected by distortions: wealthy environmentalist homeowners.

This suggests that these subsidies are poorly targeted at the market failures they were designed to address. Even if the subsidies cause energy conservation, from a welfare perspective, it matters who is conserving. This calls into question the wisdom of policies such as energy efficiency resource standards, which require utilities to help consumers conserve energy but do not require that utility energy efficiency programs be well-targeted. However, they also show that tagging, perhaps by limiting subsidy eligibility to certain groups, can lead to large efficiency gains.

Installation of moisture barrier and insulation as part of the Federal Weatherization Assistance Program. *Photo courtesy of the US Department of Energy*

[1] Meredith Fowlie, Michael Greenstone, and Catherine Wolfram (2015), "Are the Non-Monetary Costs of Energy Efficiency Investments Large? Understanding Low Take-up of a Free Energy Efficiency Program." *E2e Working Paper WP-016*, E2e, January 2015.

[2] Meredith Fowlie, Michael Greenstone, and Catherine Wolfram (2015), "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistant Program." *E2e Working Paper WP-020*, E2e, June 2015.

[3] Hunt Allcott, Christopher R. Knittel, and Dmitry Taubinsky (2015), "Tagging and Targeting of Energy Efficiency Subsidies." *E2e Working Paper WP-018*, E2e, May 2015.

Faculty Affiliate: Georgia Perakis, William F. Pounds Professor of Management

by: Michael Mehling

In her research, Georgia Perakis develops optimization models for complex systems such as energy, retail, and transportation.

MIT's Center for Energy and Environmental Policy Research is delighted to welcome a new faculty affiliate: Georgia Perakis, the William F. Pounds Professor of Management and a Professor of Operations Research and Operations Management at the MIT Sloan School of Management. Perakis is a leading authority in the theory and practice of optimization and equilibrium problems, and develops optimization models for complex systems such as energy, retail, and transportation.

Born on the Greek island of Crete, Perakis developed an early fascination with mathematics. After completing her undergraduate studies in Athens, she came to the United States with a fellowship for graduate studies and eventually obtained a Ph.D. in Applied Mathematics from Brown University. Her thesis advisor was Thomas Magnanti, who later would become Institute Professor and Dean of the School of Engineering at MIT.

She joined MIT in 1995, initially as a Postdoctoral Associate and since 1998 as a member of the faculty at the MIT Sloan School of Management. An impressive list of accolades and long roster of Ph.D. students testify to her passion for both research and teaching. "This is my home – there are so many opportunities here, with different programs and centers allowing for close collaboration with industry," she says about working at MIT. "I would miss that anywhere else."

In her work, Perakis has frequently helped optimize processes in energy and transportation systems, yielding valuable insights for policy design and improvement. She also uses analytics to build systems that give price recommendations in the retail space. Using predictive analytics techniques, she has helped energy companies understand where corrosion or extreme weather are most likely to disrupt transmission and distribution grids for gas and electricity, allowing more efficient scheduling of emergency maintenance work.[1] "Utilities have only recently begun to harness data-driven optimization models to streamline their operations", she says. "But they definitely see the potential benefits."

More recently, Perakis and a team of current and former students have worked on a model to optimize subsidies for green technology. "Policy makers cannot easily predict the effect of subsidies on demand and supply of green technology", she explains, "and that makes it important to understand how consumers and producers will respond to different types of incentives." Her model offers policy makers a tool to design subsidies that achieve green technology adoption targets at the lowest possible cost.[2] Two subsequent CEEPR Working Papers build on this research by assessing the effects of competition and uncertainty on green technology adoption (see opposite page).

"Many challenges in energy and environmental policy are optimization problems", Perakis points out as she describes her work. With disruptive changes across the energy sector and growing pressure to address the threat of climate change, her work has arguably never been more important.

[1] Mallik Angulakati et al., (2014), "Business Analytics for Flexible Resource Allocation Under Random Emergencies", *Management Science*, Vol. 60, Issue 6, 1552-1573.

[2] Maxime C. Cohen et al., (2015), "The Impact of Demand Uncertainty on Consumer Subsidies for Green Technology Adoption", forthcoming in *Management Science* (published online September 14, 2015).

Subsidies for Green Technology: The Role of Competition and Flexibility

by: Fiona Paine

The effects of government policies on green technology diffusion have become an increasingly important research area in recent years. Countries have been passing different types of incentives to encourage the adoption of green technology, but their effectiveness and cost depend on a variety of factors. Two recent working papers co-authored by Georgia Perakis, the William F. Pounds Professor of Operations Research at the MIT Sloan School of Management and an affiliate of CEEPR (see profile in this newsletter) examine such factors by addressing the role of competition and flexibility in the application of green technology subsidies.

In the first paper, titled "Competition and Externalities in Green Technology Adoption", Perakis and her co-authors study the effect of competition in markets for green technology among multiple suppliers under the influence of government subsidies.[1] As they show, the effects of competition depend on demand uncertainty, the type of competition, and the level of externalities in the market. To analyze and better understand the impact of subsidies, the research team creates a model and tests its findings with data from the increasingly competitive electric vehicle industry.

The electric vehicle market offers a good case study: Consumers who buy electrical vehicles are offered a federal tax rebate of up to $7,500, a consumer subsidy that has been in effect since December 2010 and affords consumers the option to choose between different cars, creating competition. The model takes into account both demand uncertainty and positive externalities in different competitive scenarios. In this context, externalities refer to the monetary value of the CO_2 reduction from switching to an electric vehicle, or more generally the benefit to the environment of green technology use.

Specifically, the paper found that in a market with smaller externalities, suppliers are worse off from competition while the government benefits. Competition thus allows the government to reduce its expenditures by decreasing rebates while suppliers have a lower expected profit. When externalities are large, however, consumers are always better off from competition: Competition results in larger available quantities and lower effective prices for customers.

Which party benefits from competition does not solely depend on the level of the externality: demand uncertainty and supplier asymmetry also play a role. When demand is deterministic and suppliers are identical, the entire benefit is absorbed by the government, meaning consumers are not impacted by competition. With asymmetric competition, by contrast, consumers share some of the benefit of competition with the government. Regardless, demand uncertainty always works in favor of customers.

Government subsidies for green technology are also studies in the second paper, titled "Consumer Subsidies with a Strategic Supplier: Commitment vs. Flexibility".[2] In that paper, Perakis and a team of co-authors investigate the effect of policy shifts over time on industry production decisions. They develop a model based on two-period games with uncertain demand to gain insight into the interaction between the government and an industry player, and test the model with data from solar subsidy programs. In Germany, where a flexible policy framework is in place, the feed-in-tariff incentivizing solar technology deployment was changed four times in 2012 alone. This contrasts with the US, where the subsidy of $7,500 for consumers purchasing electric vehicles has stayed constant since 2010.

As the paper shows, the commitment of a government along with the timing of policy decisions has an impact on industry. By anticipating a policy change, a supplier might actually decrease production targets, thereby increasing the cost of the subsidy program. A fixed policy commitment enables industry to have higher production earlier on the time horizon and thus is (on average) a cheaper option than a flexible subsidy policy; the exception is when there is negative demand correlation across time periods. At the same time, the flexible policy scenario causes lower variance in total sales, probably due to the fact that additional spending can reduce uncertainty at the adoption level for green technology. In addition, the supplier actually has a higher expected profit with flexible subsidies, whereas consumer benefits from policy changes depend on the price elasticity of demand. Overall, the timing of decisions clearly affects the risk-sharing between government and suppliers, ultimately affecting the cost of the subsidy program.

A better understanding of the effects of subsidies on the green technology market is critical to help governments design better and more efficient policy, making this an area that warrants further research.

[1] Maxime C. Cohen, Georgia Perakis, and Charles Thraves (2015), "Competition and Externalities in Green Technology Adoption." *CEEPR WP-2015-007*, MIT, May 2015.

[2] Jonathan Chemama, Maxime C. Cohen, Rubel Lobel, and Georgia Perakis (2015), "Consumer Subsidies with a Strategic Supplier: Commitment vs. Flexibility." *CEEPR WP-2015-008*, MIT, May 2015

2015 Spring Research Workshop

by: Michael Mehling

Twice a year, the MIT Center for Energy and Environmental Policy Research (CEEPR) hosts workshops in Cambridge, Massachusetts, for a select audience drawn from industry, government, and academia to discuss recent research output and help shape the ongoing research agenda. On May 21 and 22, the 2015 Spring Research Workshop brought together around 70 participants for a timely discussion of trends and developments in the energy space. Use of large datasets to infer behavioral patterns and policy implications featured in the first session, followed by an update on carbon capture and sequestration in the United States and abroad. After lunch, participants engaged in a discussion on environmental rulemaking for the transportation sector and the substantial challenges of meeting infrastructure needs for transmission and distribution of oil, gas and electricity in North America. John Deutch, MIT Institute Professor and former United States Deputy Secretary of Defense and Director of Central Intelligence, rounded out the first day with a keynote address on the upcoming Department of Energy's 2015 Quadrennial Energy Review (QER). On the second workshop day, participants engaged in a lively debate on the technical possibilities and policy incentives for demand response in electricity markets, and learnt about recent efforts to increase access to sustainable and affordable energy in the developed world. Attendees left with a sense of substantial transformation across the energy sector, but also of new technology options and market opportunities. Clearly, the debate is far from over.

UPCOMING WORKSHOPS

May 12-13, 2016, Cambridge, MA
July 7-8, 2016, Paris, France (tbc)
September 8-9, 2016, Berlin, Germany (tbc)
November 17-18, 2016, Cambridge, MA

CEEPR Associates can access recorded presentations and conference materials on the Associates-only section of the CEEPR website.

EPRG-CEEPR European Energy Policy Conference 2015

by: Michael Mehling

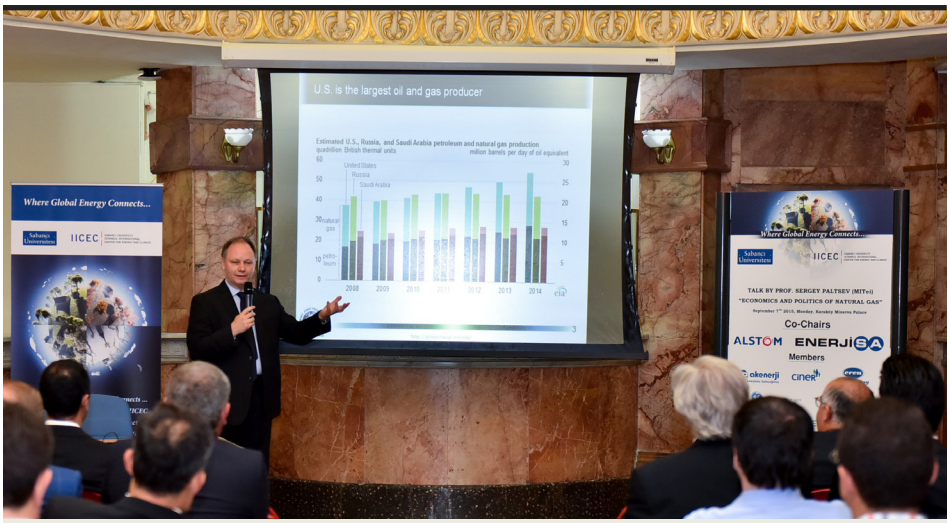
Since 2000, the MIT Center for Energy and Environmental Policy Research (CEEPR) has partnered with the Energy Policy Research Group (EPRG) at the University of Cambridge in the United Kingdom to convene an annual European Energy Policy Conference at varying locations in Europe. On July 9 and 10, CEEPR and EPRG joined forces with Royal Dutch Shell plc to host the 15th instalment of this event in London, United Kingdom. Reflecting the disruptive trends affecting various areas of the energy sector, and acknowledging the importance of the upcoming international climate summit in Paris (COP21), the organizers titled the 2015 conference "Building a Sustainable Future Energy System: More Energy, Better Energy Management, Less CO_2". Over 100 participants from 16 countries gathered at the venue, the venerable Langham Hotel in the heart of London's West End, to discuss the prospects and implications of a global energy transition in Europe and beyond. Across six substantive sessions, panelists drawn from academia, government, and the private sector commented on a variety of issues ranging from carbon markets and the evolving role of natural gas to energy market design and regulation. Presenters also provided an update on carbon capture and sequestration, discussed recent trends in low-carbon transportation, and discussed the geopolitical and security implications of evolving energy markets. Keynote addresses by Erik Bonino, Chairman of Shell UK, and Jeremy Bentham, Head of the Shell Scenarios team, rounded out a stimulating and forward-looking event. As always, presentation documents and other conference materials are available to CEEPR Associates through the password-protected section of the CEEPR website.

CEEPR Director Christopher Knittel discusses the role for natural gas in the EU energy transition.

The Economics and Geopolitics of Natural Gas

by: Tony Tran

On September 7, 2015, MIT CEEPR Senior Research Scientist Sergey Paltsev visited Istanbul, Turkey, for an invited lecture on the economics and geopolitics of natural gas at Sabanci University. Turkey's strategic geopolitical location, bridging fossil resources and demand centers, offers wide opportunities for playing an increasingly important role in providing energy security and establishing the energy distribution hub. New pipeline projects that will bring natural gas from Russia and Azerbaijan are under construction. Several projects for piping natural gas from Turkey to Europe are also under discussion.



MIT CEEPR Senior Research Scientist Sergey Paltsev addresses energy industry executives, energy association representatives, professors and graduate students at Sabanci University in Istanbul, Turkey. *Photo courtesy of Sabanci University*

The global energy system continues to pose both diverse challenges and opportunities. In his talk, Dr. Paltsev highlighted a number of recent economic and geopolitical developments that are shaping natural gas markets across the globe. These include: Saudi Arabia's actions which resulted in global oil price reductions, which have, in turn, led to lower natural gas prices and changed the prospects for liquefied natural gas (LNG) projects in the US and Australia; efforts by the European Union to reduce its dependence on Russian gas and the emergence of Iran (due to sanctions relief provided in the nuclear deal) as a potential alternative supplier; potential for natural gas exports from Russia to China; natural gas pricing reform in China; and climate change policies designed to lower greenhouse gas emissions and keep more coal, oil, and natural gas in the ground.

While examining the impacts of the changing oil prices on natural gas development in different regions of the world, Dr. Paltsev considered US projects for LNG exports that were once very attractive due to the difference between US and Asian prices in 2011-2014. A drop in oil prices and oil-linked natural gas prices during the second half of 2015 has changed the prospects for these new projects. As LNG projects have a long lifetime, developers must assess long-term prospects for international natural gas prices. With certain additional supply from Australia and other countries, and uncertain additional demand from China, India, and other Asian countries, these potential projects would be entering the LNG market under new conditions, where Asian natural gas prices will not be at as high a premium as they were in 2011–2014.

European natural gas demand is even more uncertain due to climate policy aspirations and recent geopolitical developments. Recent tensions over Ukraine force Europe to actively seek alternative suppliers, creating some opportunities for additional LNG supplies and pipelines that will by-pass Russia. In addition to the Trans Adriatic Pipeline (TAP), there are several other projects under consideration, such as the Tesla Pipeline and the reverse flow of the Eastring Pipeline. Recent discoveries of natural gas in the East Mediterranean also provide potential to increase the available volumes for the EU destination.

With a re-start of nuclear generation in Japan and slight increases in demand in South Korea, longer-term natural gas price dynamics will be affected by natural gas developments in China and India. Recent policy in China targets an increase in the contribution of natural gas to the nation's energy supply. Historically, China's natural gas prices have been highly regulated with a goal to protect consumers. The old pricing regime failed to provide enough incentives for natural gas suppliers, which often resulted in natural gas shortage. Dr. Paltsev provided an overview of the natural gas pricing reform aimed at creating a more market-based pricing mechanism.

In addition, Dr. Paltsev emphasized the need to become knowledgeable about traditional fuels such as natural gas, oil, and coal while making investments in alternative energy options. "If you're trying to understand the role of renewables, solar, wind, geothermal, carbon capture and sequestration, and biofuels, you need to understand their main competitors," he said. "Because if you are serious about doing something different, you need to understand the economics of the current producers, the resources, how the markets are going to evolve in the future, and the prospects of the so-called traditional fuels."

Sergey Paltsev's talk can be viewed at: https://www.youtube.com/watch?v=ukMSp1o8dlM

Ten Years of the Renewable Fuel Standard

by: Fiona Paine

In October, a group of experts gathered at the Brookings Institution to discuss the Renewable Fuel Standard, a policy to promote biofuels that was enacted ten years ago. Participants in the event assessed the success of the legislation and evaluated its effects on greenhouse gas emissions, food prices, and fuel prices.

The Renewable Fuel Standard (RFS) sets a minimum amount of renewable fuels to be blended into the ground transportation fuel supply. These levels are broken down into subcategories including setting a minimum quantity of advanced renewable fuel or cellulosic fuel.

Starting the discussion, Terry Dinan from the Congressional Budget Office spoke about the challenges facing the RFS. Currently the RFS standards are met by E-10, which is a blend of corn based ethanol (10%) and gasoline (90%). In the future, a rapidly growing share of cellulosic-based fuels – which are more capital intensive than corn ethanol – will be mandated. In order to meet the RFS mandate, the percentage of biofuel in gasoline will have to increase. However, a switch away from E-10 to fuels with a higher percentage of biofuel will involve a major infrastructure investment, posing a challenge known as the "blend wall".

Next, the conversation moved to the impact of the RFS on food and fuel prices. Bruce Babcock of Iowa State University referenced current research that suggests neither food nor fuel prices have remained unaffected by the RFS. There was some disagreement as to whether the RFS has increased the price of food in developing countries, specifically in Africa.

Timothy Searchinger from Princeton University discussed biofuels from a land-use perspective. He called into question the validity of models that use life cycle analysis for biofuels. On his view, biofuels are an inefficient use of land. "On 75% of the world's land, the benefit of using solar cells today, compared to optimistic views of cellulosic ethanol in the future, is a minimum of 100 times more energy." He went on to state "the only way biofuels can reduce greenhouse gas emissions is if you estimate that land is practically free from a carbon standpoint."

Speaking last and taking a broad view of the RFS compared with other policy options, Christopher Knittel, Professor of Energy Economics at the MIT Sloan School of Management and Director of the MIT Center for Energy and Environmental Policy Research (MIT CEEPR), pointed out that "economists largely agree that the most efficient way to reduce greenhouse gas emissions is through a carbon tax or a cap and trade program". According to his calculations, the RFS is about 2.5 times more expensive than cap and trade or a carbon tax. The average cost per ton of carbon abated is $90 for the RFS compared with the social cost per ton of carbon, which is around $40.[1,2,3,4]

Overall, the panel seemed to agree that the Renewable Fuel Standard has not been successful in its goal of reducing greenhouse gas emissions. Even worse, the policy has been economically inefficient. On a more positive note, however, the expected side effects of rising fuel and food prices did not materialize, at least not in line with the most pessimistic forecasts. In any case, the discussion of how best to adapt and improve this piece of legislation is sure to continue in the future.

[1] Christopher R. Knittel, Ben S. Meiselman, and James H. Stock (2015), "The Pass-Through of RIN Prices to Wholesale and Retail Fuels under the Renewable Fuel Standard." *CEEPR WP-2015-010*, MIT, July 2015.

[2] Stephen P. Hollard, Jonathan E. Hughes, Christopher R. Knittel, and Nathan C. Parker (2013), "Unintended Consequences of Transportation Carbon Policies: Land-Use, Emissions, and Innovation." *NBER Working Paper No. 19636*, NBER, November 2013.

[3] Christopher R. Knittel and Aaron Smith (2012), "Ethanol Production and Gasoline Prices: A Spurious Correlation." *CEEPR WP-2012-006*, MIT, July 2012.

[4] Stephen P. Holland, Jonathan E. Hughes, Christopher R. Knittel, and Nathan C. Parker (2011), "Some Inconvenient Truths About Climate Change Policy: Distributional Impacts of Transportation Policies." *CEEPR WP-2011-016*, MIT, August 2011.

CEEPR Director Christopher Knittel participated in a panel discussion on the Renewable Fuel Standard at the Brookings Institution on October 16, 2015.

Expectations for the Upcoming Paris Climate Summit

by: Olivia Zhao

An engaged audience of MIT faculty, researchers, students, and members of the public during the Q&A portion of MIT CEEPR's panel discussion on COP21.

On November 5, the MIT Center for Energy and Environmental Policy Research (CEEPR) joined the MIT Joint Program on the Science and Policy of Global Change and the Program on Science, Technology, and Society at Harvard University to convene a discussion on the upcoming United Nations Climate Change summit in Paris. A panel of experts shared what they realistically expect out of the summit, officially referred to as the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), or "COP21".

Henry D. Jacoby, a Professor in the MIT Sloan School of Management, outlined projected emissions based on the voluntary mitigation contributions pledged by countries ahead of the Paris summit. Given the expectation of continued emissions growth in the developing world, he expressed concern about achieving the summit's goal of limiting global temperature increases to 2° Celsius and warned that "if we can't stop the growth of greenhouse emissions in the period between 2015 and 2040, worse things than 2° Celsius will lie in the rearview mirror." Jacoby presented a three-pronged goal for COP21: (1) Credible review procedures and a harmonized accounting system to assess countries' progress in achieving their commitments; (2) durable cycles to periodically re-evaluate and strengthen emission reduction efforts; (3) the ability to finance initiatives in developing countries, whose emissions goals are often conditional on external aid.

Michael Grubb, Professor of International Energy and Climate Change Policy at University College London, shifted the focus to regional emissions differences. Grubb highlighted the imprudence in generalizing climate policy without considering the individual national context, and suggested that COP21 would mark a switch to broader climate policy that includes action by both developed and developing nations. He expressed optimism, speaking with "90 percent confidence that Paris will reach a deal" due to a favorable geopolitical context, such as China's domestic action against emissions growth. Grubb ended by emphasizing the responsibility of the UNFCCC to also encourage bilateral and plurilateral agreements between nations or regions to curb emissions.

Valerie J. Karplus, a Professor at the MIT Sloan School of Management and director of the Tsinghua-MIT China Energy and Climate Project, explained how Chinese emission reductions result from a conversation about mitigation as well as the interplay of energy-intensive industry investments, resource needs, household consumption, and the health effects of conventional air pollution. Karplus has worked on modeling the effects of a proposed carbon pricing system on emissions, atmospheric chemistry, air quality, and health. Karplus said that China's pledge to peak emissions by 2030 is credible and consistent with their pollution and economic modernization goals. She cautioned, however, that success will require institutional changes to balance growth with low carbon goals.

Common themes in the discussion included the need for a trusted and transparent emissions reporting regime and mechanisms to leverage climate finance from the private sector. Although much attention is focused on emissions mitigation, other themes such as adaptation, loss and damage, and technology transfer underscore the complexity of negotiations faced by the international community as it converges in Paris.

This MIT CEEPR event can be viewed at: https://www.youtube.com/watch?v=4sjToCSigYA

Evaluating Regulation Outcomes

by: Olivia Zhao

On October 21, Richard Schmalensee, Professor and Dean Emeritus at the MIT Sloan School of Management and former CEEPR Director, spoke at a seminar hosted by Resources for the Future in Washington, D.C. A group of experts on energy and environmental policy had been convened to discuss outcomes of federal environmental regulations and lessons learned from the analysis of rulemaking by agencies such as the Environmental Protection Agency (EPA), the Department of Energy, and the Department of the Interior.

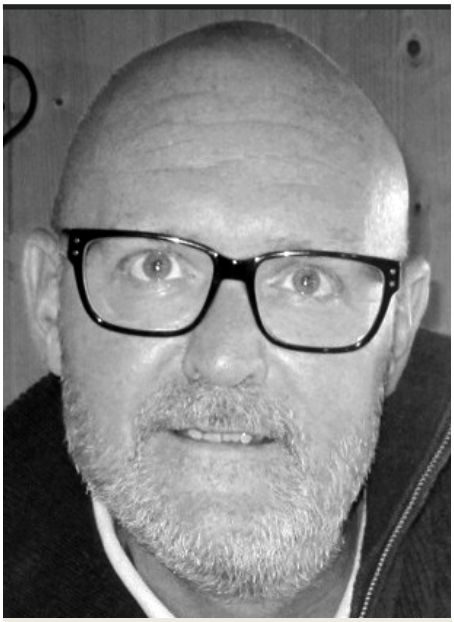
In his remarks, Schmalensee highlighted the importance of revisiting policies after their enactment to assess whether initial goals were met, and why certain unintended or surprising effects have arisen. Unfortunately, ex post analysis and "looking back at what actually happens as opposed to what is expected to happen … is not reasonably standard practice in regulation." He acknowledged the reasons why ex ante analysis fails; characterizing uncertainty and expectations for the future is inherently difficult. Such analyses must also balance creating a simple and transparent narrative that is accessible to policy makers without sacrificing considerations of uncertainty about the future.

Policies concerning energy and the environment receive extensive analysis before issuance to examine costs, benefits, and possible outcomes. However, less rigorous attention is granted to the actual realized outcomes. Did the policy achieve substantial gains? Did the actual gains align with the anticipated gains? Were initial cost and benefit estimates accurate? Were there surprising outcomes, and if so, why aspect of the policy may have caused them? In order to learn from the past and craft more effective regulations, panelists agreed that these types of questions will have to receive greater attention going forward.

Dean Emeritus Richard Schmalensee, MIT

Tom Sudmann Therkildsen

by: Michael Mehling



Tom Therkildsen (1960 - 2015)

With great sadness, MIT CEEPR faculty and staff learned of the passing of a long-time friend and supporter, Tom Therkildsen of Statoil ASA. "Tom was one of our most thoughtful and engaged partners in the energy industry– he will be sorely missed", said CEEPR Director Christopher Knittel at a recent staff meeting. During his time at Statoil, Tom served in a number of senior roles, including that of Manager of the CEO's Office, and most recently was a Senior Adviser at Statoil's Corporate Sustainability Unit. He previously held high-ranking political appointments in the Norwegian Government, serving as State Secretary in the Office of the Norwegian Prime Minister and in the Norwegian Ministry of Finance, and as Political Adviser to the Norwegian Ministry of Energy and Industry. Tom started his career at the University of Bergen, however, where he was an Assistant Professor, Fellow, and later Chief Information Officer. For his colleagues at CEEPR, the affinity for academia remained apparent in how Tom approached his engagement with MIT. As Loren Cox, a former CEEPR Director, remembers: "what Tom admired about MIT programs and workshops was an atmosphere where ideas were openly debated – and debate encouraged." His keen intellect, warm generosity and humor enriched any debate he participated in, and his unfaltering optimism left few untouched. Everyone at CEEPR will remember Tom with great fondness, and extends their deepest sympathies to his family.

Notable Changes

Over the past six months, CEEPR has hosted several Visiting Scholars for research on a variety of topics in the fields of energy and environmental policy.

Between May and June, **Konstantinos Metaxoglou**, an Assistant Professor in the Economics Department at Carleton University, visited CEEPR to pursue research regarding fuel choices and investment decisions by power plants, carbon emissions, and the coal-to-gas shift in the electricity sector. This collaboration contributed to CEEPR working papers 2015-013 and 2015-011.

At the end of August, **Stephen Zoepf** joined CEEPR as a postdoctoral associate. Previously an MIT Ph.D. student under the guidance of Christopher Knittel, Stephen will now conduct research on emerging modes of transportation industries, such as ride-sharing, and their economic and policy implications.

In September, CEEPR hired **Danielle Dahan** as an MIT graduate student research assistant. In collaboration with local utility partners, she will be working on a research project evaluating ratepayer-funded programs for energy efficiency and renewable energy, with a view to identifying potential improvements.

In October, CEEPR welcomed **Christian Stoll** as a MIT Visiting Student. Christian, a graduate student from the Technical University Munich School of Management, will spend the fall semester at MIT collaborating with CEEPR faculty on research regarding power-to-gas technologies and wind farm integration into the electric grid.

Finally, in November, CEEPR hired two undergraduate students, **Olivia Zhao** and **Fiona Paine**, through the MIT Undergraduate Research Opportunities Program (UROP) to assist with energy policy research by CEEPR faculty and research affiliates, and to provide support in the center's events and outreach activities.

Recent Working Papers

WP-2015-013
Natural Gas Prices and Coal Displacement: Evidence from Electricity Markets
Christopher R. Knittel, Konstantinos Metaxoglou, and Andre Trindade, October 2015

WP-2015-012
Progress and Problems in Reforming the Swaps Marketplace
John E. Parsons, July 2015

WP-2015-011
How do Carbon Emissions Respond to Business-Cycle Shocks?
Hashmat Khan, Christopher R. Knittel, Konstantinos Metaxoglou, and Maya Papineau, August 2015

WP-2015-010
The Pass-Through of RIN Prices to Wholesale and Retail Fuels under the Renewable Fuel Standard
Christopher R. Knittel, Ben S. Meiselman, and James H. Stock, July 2015

WP-2015-009
The Simple Economics of Asymmetric Cost Pass-Through
Robert A. Ritz, June 2015

WP-2015-008
Consumer Subsidies with a Strategic Supplier: Commitment vs. Flexibility
Jonathan Chemama, Maxime C. Cohen, Ruben Lobel, and Georgia Perakis, May 2015

WP-2015-007
Competition and Externalities in Green Technology Adoption
Maxime C. Cohen, Georgia Perakis, and Charles Thraves, May 2015

WP-2015-006
Vehicle Miles (Not) Traveled: Why Fuel Economy Requirements Don't Increase Household Driving
Jeremy West, Mark Hoekstra, Jonathan Meer, and Steven L. Puller, May 2015

E2e Working Papers

WP-021
Asymmetric Information in Residential Rental Markets: Implications for the Energy Efficiency Gap
Erica Myers, revised September 2015

WP-020
Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program
Meredith Fowlie, Michael Greenstone, and Catherine Wolfram, June 2015

All listed publications and referenced working papers in this newsletter are available on our website at ceepr.mit.edu/working-papers

MIT CEEPR

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A panel discussion during the 2015 EPRG-CEEPR European Energy Policy Conference in London.