Exhibit No.:	
Issue(s):	Prudence of Environmental Upgrades; Commit Status of Generating Units; Off-System Sales
Witness:	Ezra D. Hausman, Ph.D.
Type of Exhibit:	Direct Testimony
Sponsoring Party:	Sierra Club
Case No.:	ER-2014-0258
Date Revised Testimony Prepared:	December 8, 2014

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. ER-2014-0258

DIRECT TESTIMONY

OF

EZRA D. HAUSMAN, PH.D.

On Behalf of

SIERRA CLUB

****<u>Denotes Highly Confidential Information</u>****

PUBLIC

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1. BACKGROUND

Q. PLEASE STATE YOUR NAME, OCCUPATION, AND BUSINESS ADDRESS.

A. My name is Ezra D. Hausman, Ph.D. I am an independent consultant doing business as Ezra Hausman Consulting, operating from offices at 77 Kaposia Street, Auburndale, Massachusetts 02466.

Q. ARE YOU PROVIDING ANY SCHEDULES WITH YOUR TESTIMONY?

A. Yes. I am sponsoring the following Schedules:

SCHEDULE NO.	CONTENT	CONTAINS HIGHLY CONFIDENTIAL INFORMATION
EDH-1	Resume of Ezra D. Hausman, Ph.D.	No
EDH-2	"2013 Carbon Dioxide Price Forecast", Synapse Energy Economics, corrected as of February 2014.	No
EDH-3	Communications on MATS compliance deadline extension between Ameren and MDNR	No

Q. WHAT IS YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. I hold a B.A. in Psychology from Wesleyan University, an M.S. in Environmental Engineering from Tufts University, an S.M. in Applied Physics from Harvard University, and a Ph.D. in Atmospheric Chemistry from Harvard University. I have been involved in analysis of both regulated and restructured electricity markets for more than 15 years. I have provided a detailed resume as Schedule EDH-1.

I have worked as an independent consultant since March 2014. Prior to that, and starting in 2005, I was employed by Synapse Energy Economics, Inc., a research and consulting company located in Cambridge, Massachusetts, where I served most recently as Vice President and Chief Operating Officer. At Synapse, and continuing as an independent consultant, I have served as an analyst and expert in several areas related to my expertise and experience in energy economics. Specific areas include:

- State and regional energy, capacity, and transmission planning, including both utility resource planning and long-term (multi-decadal) climate-constrained resource planning;
- Electricity and generating capacity market design and analysis;
- Electric system dispatch modeling;

- Economic analysis of environmental and other regulations, including greenhouse gas regulation, in electricity markets;
- Economic analysis, price forecasting, and asset valuation in electricity markets;
- Quantification of the economic and environmental benefits of displaced emissions and market price impacts associated with energy efficiency and renewable energy; and
- Regulation and mitigation of greenhouse gas emissions from the supply and demand sides of the U.S. electricity sector.

Prior to joining Synapse, I was employed from 1998 through 2004 as a Senior Associate at Tabors Caramanis and Associates ("TCA") of Cambridge, Massachusetts. In 2004, TCA was acquired by Charles River Associates ("CRA"), where I remained until I joined Synapse in 2005. At TCA/CRA, I performed a wide range of electricity market and economic analyses and price forecast modeling studies. These included asset valuation studies, market transition cost/benefit studies, market power analyses, and litigation support. I have extensive personal experience with market simulation, production cost modeling, and resource planning methodologies and software.

I have provided testimony and/or appeared before public utility commissions and legislative committees in Nevada, Maryland, Kansas, Louisiana, Missouri, Mississippi, Vermont, Washington State, and Massachusetts, as well as at the federal level. I have provided expert representation for stakeholders at the PJM ISO and at the FERC. While most of my testimony and analytical work has centered on issues in electricity market economics, I have also brought my expertise as an atmospheric scientist to bear on cases involving greenhouse gas mitigation in the electric sector.

Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE THIS COMMISSION?

A. I submitted written, pre-filed testimony in Case Nos. ET-2014-0059, ET-2014-0071, and ET-2014-0085, each having to do with the proposed suspension of solar rebate payments under Missouri 4 CSR 240-20.100. Each of those cases resulted in a settled agreement among most or all of the parties, which was approved by the Commission. I have not previously testified in person before this Commission.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS CASE?

A. I am addressing two specific aspects of Ameren Missouri's ("Ameren" or the "Company") claimed revenue requirements for which the Company is seeking rate recovery in this case. These are:

1) The cost of capital expenditures associated with the installation of electrostatic precipitators ("ESPs") on Labadie Units 1 and 2; and

2) The costs and revenues associated with **____ **, and the off-system sales revenue calculated based on this designation.

In addition, I note that Ameren's rate request is based on a long-term resource plan that is not compliant with currently proposed federal environmental regulations—specifically, the Clean Power Plan proposed by the Environmental Protection Agency ("EPA") under §111(d) of the Clean Air Act. Ameren's filing in this matter predated EPA's release of the proposed rule, and indeed the rule is not yet finalized; however, as Ameren witness Larry Loos notes, "Currently…the EPA is poised to initiate and finalize regulations governing GHG emissions under the Clean Air Act (CAA). Regulation of greenhouse gases could have a definitive impact on the life of the Company's coal-fired plants."[1] Ameren's investments in these resources should be viewed in the light of this likely impact—that is, that the operation of these plants will be significantly affected by federal greenhouse gas rules, and they may become uneconomic to maintain and run well before the Company's currently projected retirement dates. The Company should provide this Commission with a thorough analysis of its least-cost resource plan assuming that the Clean Power Plan as currently proposed becomes law, and should explain how its current expenditures would be affected by this outcome.

[1] Schedule LWL-1, p.33.

2. Installation of Electrostatic Precipitators on Labadie Units 1 and 2

Q. WHAT IS AMEREN REQUESTING IN THIS RATE CASE REGARDING THE INSTALLATION OF ELECTROSTATIC PRECIPITATORS ON THE LABADIE UNITS?

A. According to the workpapers of Ameren Witness Laura Moore, Ameren proposes to increase the account 312 plant in-service cost associated with the Labadie unit by **__________ **.[2] My understanding is that this amount largely, if not entirely, reflects the cost of ESPs being installed on Labadie Units 1 and 2, under the assumption that they will be in service by December 31, 2014 as required for them to be included in the current rate request. Ameren proposes to recover its cost of and return on this investment, depreciating this along with the rest of Account 312 at an annual rate of **____ **, or an annual depreciation of **________ **.[3]

Q. WHY IS AMEREN INVESTING RATEPAYER FUNDS TO INSTALL NEW ELECTROSTATIC PRECIPITATORS ON THE LABADIE UNITS?

A. According to Ameren witness Michael Moehn, Ameren is installing ESPs at Labadie Energy Center "in order to comply with the Mercury and Air Toxics Standards."[4] The Company's reasoning behind this investment is described in an attachment to Ameren witness Erin Carle's response to MPSC data request No. 0316.[5] To summarize the Company's explanation provided in this response, the Mercury and Air Toxics Standards ("MATS") mandate a particulate matter emissions rate of no more than 0.015 pounds per million BTU; in addition, the Company states that, for compliance, its previous strategy of using "SO3 flue gas conditioning will not be a viable option because it inhibits mercury capture."[6] The Company states that

[2] Confidential Moore workpaper UE_DIR-UE_DIR_004-Att-Ameren Missouri Rev Req 03-2014.xls, worksheet entitled "Plant Adjustments", cell I78.
[3] Ibid, worksheet entitled "Depreciation Rate Adjustment", row 65.
[4] Direct testimony of Michael Moehn, p.12 at 17-18.
[5] MPSC_1-MPSC_0316___Erin_Carle-Att-MPSC 0316 28497 JUL 2012 REV 1.pdf.
[6] Ibid, 3rd page.

new and upgraded ESPs will enable the units to meet the PM standard and, combined with the later addition of Activated Carbon Injection ("ACI"), to meet the mercury standard.[7]

Q. ARE THE LABADIE UNITS FACING ADDITIONAL ENVIRONMENTAL RETROFIT COSTS IN THE COMING YEARS?

A. Yes. As noted above, MATS will also necessitate the implementation of ACI for mercury control. In addition, according to Chapter Five of Ameren's recently filed 2014 Integrated Resource Plan ("IRP"),[8] within the 20-year IRP period the Company is expecting to install and spend:

- Additional ESP upgrades on units 3 and 4 ($45 Million);
- ACI ($20 Million); and
- Flue gas desulfurization units to meet the Cross-State Air-Pollution Rule ($552 Million).

Ameren's IRP also anticipates capital investments of $135 Million on management of combustion residuals (ash), $69 Million on water management (intake structures and wastewater treatment), and between $185 Million and $244 Million on cooling towers.

Q. HAS AMEREN INCLUDED THE LIKELY FUTURE COSTS OF MITIGATING CO_2 EMISSIONS IN ITS ENVIRONMENTAL COMPLIANCE COSTS?

No. Ameren provides an extensive list of anticipated environmental upgrades, which the Company describes as "based on current, proposed and potential environmental regulations."[9] However, this list is conspicuously missing any cost associated with reducing CO_2 emissions, as would be required under the EPA's recently proposed Clean Power Plan, or any alternative greenhouse gas rule that might come into effect during the IRP period. I would interpret the absence of these costs as reflecting two factors. First, the Company readily acknowledges that its IRP is *not* compliant with the Clean Power Plan as proposed, the specifics of which were released by the EPA on June 2, 2014.[10] The Company claims that this was too late

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[7] Ibid.
[8] MPSC Docket No. EO-2015-0084; available at https://www.ameren.com/missouri/environment/renewables/ameren-missouri-irp.
[9] Ameren 2014 IRP, Chapter 5, p.21.
[10] Ameren 2014 IRP, Chapter 10, p.18.

in the IRP process for the rule to be given full consideration.[11] Second, and perhaps more importantly, the opportunities for capital investment in controlling CO_2 emissions from existing power plants are quite limited, in general comprising only small improvements in turbine efficiency to increase the amount of energy produced per unit of fuel burned.

A more likely impact of CO_2 regulation would be to directly or indirectly increase the cost of generation from carbon-intensive resources such as coal plants. “Directly” would mean by imposing a carbon tax or a tradable allowance system, neither of which is currently part of EPA’s proposal; “indirectly” would be any other mechanism that effectively imposes a preference for low-carbon resources, leading to curtailed operations or shutdown of existing coal plants. In my opinion, the direct approaches would be more efficient if politically more difficult to implement, but the intended effect is the same.

Q. IF THE COMPANY DOES NOT ANTICIPATE CAPITAL EXPENDITURES ON INDIVIDUAL COAL PLANTS AS PART OF ITS CLEAN POWER PLAN COMPLIANCE STRATEGY, SHOULD EPA’S PROPOSED RULE BE TAKEN INTO ACCOUNT IN ASSESSING FUTURE ENVIRONMENTAL RETROFIT COSTS?

A. Yes. Even if the Clean Power Plan does not necessitate any specific capital investments, it will affect the future economics, operations, and operating life of existing coal plants such as Labadie, and therefore it affects the economic viability and prudence of making other capital investments in these plants today. Ameren cannot reasonably assume that the Labadie units, along with its other coal assets, will operate for decades into the future unaffected by rules that specifically target CO_2 emissions from coal-fired power plants.

[11] Verbal response on Ameren 2014 IRP stakeholder conference call, November 5, 2014.

Q. DID AMEREN TAKE CO_2 EMISSIONS COSTS INTO ACCOUNT IN ITS IRP?

A. Yes, but inadequately in my opinion. Ameren examined a number of scenarios in its risk analysis;[12] however, the Company assumed there was an 85% probability of no carbon costs at all, and then divided the remaining 15% among three possible cost scenarios.

Q. IN CHAPTER TWO OF THE 2014 IRP, AMEREN CITES A 2013 REPORT BY SYNAPSE ENERGY ECONOMICS IN SUPPORT OF ITS CO_2 EMISSION PRICES. ARE YOU FAMILIAR WITH THIS STUDY?

A. Yes. Although Ameren does not specify the title of the report, I am confident that it was a study I worked on, and for which I served as a co-author. I have provided a copy of this study as Schedule EDH-2.

Q. IN YOUR OPINION, HAS THE COMPANY APPLIED SYNAPSE'S RECOMMENDED CO_2 EMISSIONS PRICES CORRECTLY?

A. No. These prices were designed and intended to represent the full range of possible future CO_2 price trajectories. As described in the Synapse report, "These price trajectories are designed for planning purposes, so that a reasonable range of emissions costs can be used to investigate the likely costs of alternative resource plans. We expect an actual CO_2 price to fall somewhere between the low and high estimates throughout the forecast period."[13]

To implement the price trajectories as Ameren has done, as together covering only 15% of the probability space for carbon regulations while assigning an 85% probability to a long-term carbon price of $0, is a gross misapplication of the Synapse analysis and report.

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[12] Ameren 2014 IRP, Chapter 9.
[13] Schedule EDH-2, p.21.

Q. TURNING BACK TO THE ESPS AT LABADIE UNITS 1 AND 2 FOR WHICH THE COMPANY ASKS RATE RECOVERY IN THIS CASE, WHAT WOULD BE THE CONSEQUENCES IF AMEREN DID NOT INSTALL THE ESPS?

A. The Company evaluated a number of compliance options to meet the numerical emissions limits under MATS, and found the ESP upgrades to be the most cost effective.[14] If the Company did not implement one of these options by the compliance deadline, the plant presumably would not meet the particulate matter emissions limitation of .015 lbs/million Btu without inhibiting mercury capture,[15] and could not legally operate beyond the compliance deadline.

Materials provided by the Company suggest that this compliance deadline is April 16, 2015[16] and, as of February 2012, that Ameren's petition for a one-year extension had not been granted.[17] However, communications between the Missouri Department of Natural Resources ("MDNR") and Ameren in August 2012 (produced here as Schedule EDH-3) indicate that the Company received a one-year compliance extension at that time. Based on Schedule EDH-3, it appears that Ameren may have been working against an artificial deadline for installation of the Labadie unit 1 and 2 ESPs.

Shutting down Labadie instead of retrofitting it would produce both costs and savings for Ameren and its ratepayers. Purely from a dispatch cost perspective with no other changes to Ameren's resource mix, this would entail higher ongoing net costs of energy due to the loss of a resource with a relatively low dispatch cost. On the other hand, there would be substantial savings from avoiding not only the cost of the ESPs themselves, but numerous future environmental retrofits. Ameren would also reduce its exposure to higher fuel and emissions costs in the future, including the costs of CO_2 emissions.

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[14] MPSC_0316___Erin_Carle-Att-MPSC 0316 28497 JUL 2012 REV 1.pdf.

[15] This statement is based on my understanding of Company documents provided in response to MPSC Data Request 0316, and does not reflect any independent engineering judgment or analysis.

[16] For example, MPSC_1-MPSC_0189_E_Carle-Att-Labadie ESP CPOC 2-Pager - MAY 2014.pdf.

[17] See MPSC_1-MPSC_0189_E_Carle-Att-February 2012 Power Ops CPOC-SLPOC Rollup-LBD ESP.pptx.

For these reasons, the Company should be required to provide a complete and unbiased net present value ("NPV") analysis of the option of avoiding the retrofit costs through curtailed or suspended operations of Labadie, replacing this output with lower-emissions or zero-emissions sources of energy and expanded use of demand-side resources, decreased off-system sales, and so forth. By failing to provide such an analysis, Ameren has failed to demonstrate that the investments at Labadie are prudent, and therefore that the component of its requested rate increase that would allow it to recover the costs of those investments is just and reasonable.

Q. HAS THE COMPANY ANALYZED THE OPTION OF REPLACING LABADIE IN ITS CURRENT IRP?

A. Not adequately. In developing its 2014 IRP, Ameren considered two scenarios in which Labadie is shut down in 2023 (Plans "O" and "M"). In both cases, two other coal-fired plants are also retired, Sioux and Meramec, and the output of these resources is replaced with additional combined cycle gas units. In the case of Plan "O", a new nuclear resource is also added. However, I find this analysis to miss the mark for a number of reasons. First of all, it fails to address the potential net present value benefit specifically of shutting down Labadie, thus avoiding the ESP investment and other environmental retrofit investment costs. Second, by delaying the retirement to 2023, the scenarios fail to avoid numerous capital costs. Third, as discussed above, I find Ameren's treatment of CO_2 emissions costs to be deficient because of the low probability (15%) the Company assigns to having any such costs at all, which significantly, perhaps fatally, biases the Company's analysis against coal plant closures.

Q. HOW HAS THE EXPECTED SERVICE LIFE OF THE LABADIE UNITS BEEN AFFECTED BY THE DECISION TO INSTALL THE ESPS?

A. According to Ameren witness Larry Loos, the "probable life" of each of the Labadie units, absent the ESP investment, would be 55 years.[18] Mr. Loos' report concludes that the units would probably retire between April 2026 (Unit 1) and August 2028 (Unit 4), although the specific retirement and decommissioning

[18] Schedule LWL-1, Table 3-1, p. 13.

details and scheduling are unknown. However, Ameren has budgeted close to $400 Million in environmental and other capital investments in the Labadie plants between 2014 and 2018.[19] As shown in Mr. Loos' Schedule LWL-1, this includes $94 Million in environmental costs in 2014, much of which is included in the current rate request.[20] In order for these costs to be recoverable from ratepayers, and absent a Commission order granting accelerated depreciation or "stranded cost" recovery, the additional equipment and the upgraded plants must remain "used and useful" over their full depreciation period. Thus, based on the current investment, Ameren would expect to keep these units on line at least for another 20 years, until approximately 2034. If additional investments are made, such as the planned additional upgrades described above, the Company's preferred retirement date would likely be delayed further.

Q. DO YOU BELIEVE IT IS REASONABLE FOR AMEREN TO ASSUME THAT THE LABADIE UNITS WILL CONTINUE OPERATING AT A HIGH LEVEL UNTIL 2034 AND BEYOND?

A. I do not know how the units will operate into their seventh decade of service, and neither does Ameren. It is certainly reasonable to assume that, like all capital equipment, they will require increasing infusions of capital as they age if they are to continue running at a high level and to meet increasingly stringent environmental standards. As these costs increase, Ameren may well find that early retirement or curtailed operations is a more economic choice than continued investment. I believe it is overly optimistic to assume that they will continue to run at high capacity factors throughout this period, without even considering an alternative outcome.

Further, the risks and costs associated with burning fossils fuels and continuing to emit large quantities of greenhouse gases into the atmosphere are becoming clearer seemingly every day. This year, the International Panel on Climate Change is completing its Fifth Assessment Report,[21] and the results are alarming. The draft report leaves no doubt that climate change is occurring, and that human activity—

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[19] Ibid, p.14.

[20] "The projects that will be in service by December 31, 2014, the end of the true up period, are included in the current rate request." Response of Ameren witness Laura M. Moore to SC Data Request 001.

[21] http://www.ipcc.ch/report/ar5/index.shtml.

specifically the continued release of greenhouse gases into the atmosphere from sources such as coal-fired power plants—is the major cause.

On May 6 of this year, the Obama Administration released the Third U.S. National Climate Assessment.[22] Among the conclusions of that report are that climate change is already causing costly and disruptive impacts in the United States and elsewhere on air quality, infrastructure, water supply, agriculture, the way of life of indigenous people, ecosystems, marine life, and human health. These impacts are only expected to become more severe and costly in the years and decades to come.

In November 2014, President Obama reached an historic agreement with China for the first time to reduce carbon emissions. The U.S. and China together account for about one-third of global greenhouse gas emissions, and this agreement is likely to materially affect the negotiations at the Conference of the Parties to the U.N. Framework Convention on Climate Change to be held in Lima, Peru, in December. The goal of these negotiations is an international agreement that commits the U.S., China, and other countries to specific reductions in greenhouse gas emissions, to be accomplished through their own domestic policies.

In the U.S., the current framework for addressing greenhouse gas emissions from existing power plants is the EPA's proposed Clean Power Plan, which calls for a reduction of 30% from 2005 levels by 2030. While the implementation details and the impact of this rule are still being worked out, one thing is clear: there are going to be large and increasing costs associated with continuing to run resources, such as Labadie and Ameren's other coal-fired assets, that emit large amounts of CO_2 into the atmosphere.

As the United States begins to address this critical risk to our economy and the climate of the planet through the Clean Power Plan and other initiatives, it will likely become increasingly uneconomic to run coal plants at a high level, or perhaps at all, in the coming decades. Ameren is asking this Commission to place Missouri ratepayers at risk for investments that ignore this reality of unfolding regulations. Prior to approving ratepayer funding for extending the life of fossil fuel-burning infrastructure today, the

[22] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 148 pp.

Commission should require the Company to demonstrate that such investments are prudent in the context of future limitations on greenhouse gas emissions. This would mean analyzing the net present value costs of the retrofit vs. early replacement options under a range of future carbon cost assumptions and the possibility of curtailed or terminated unit operations before 2030.

3. COMMIT STATUS

Q. TURNING TO THE QUESTION OF COMMIT STATUS FOR AMEREN'S MERAMEC UNITS, WOULD YOU PLEASE BRIEFLY EXPLAIN THE CHANGE THE COMPANY HAS MADE AND DESCRIBE WHAT "MUST RUN" REFERS TO IN THIS CONTEXT?

A. According to Ameren witness Mark J. Peters, since the Company's last rate case, "The commit status for each generating unit at the Meramec Energy Center has been changed from must run, allowing the model to commit and de-commit the units."[23]

Put simply, generating units in the MISO system are generally dispatched in merit order based on their running costs—that is, the lowest marginal cost units are used first, and the highest marginal cost units are only used if needed to meet load peaks. This results in "least-cost dispatch" subject to transmission and operational constraints on the units. However, certain units can be designated as "must-run," meaning that they are set to operate at some minimum level whenever available, regardless of their place in the merit order. This results in a departure from short-run, least-cost dispatch, and thus increases overall production cost. However, it might be justified if it saves costs that are not represented in the dispatch algorithm.

Q. WHICH OF AMEREN'S GENERATING RESOURCES ARE DESIGNATED MUST-RUN, AND WHAT IS THE COMPANY'S EXPLANATION FOR THIS DESIGNATION?

A. According to the Company's response to MPSC Data Request 0079,[24]

[23] Testimony of Mark J. Peters, p.6 at 9-11. Mr. Peters was addressing changes in "operational data assumptions" specifically in the PROSYM model. The commitment status of Meramec and other Ameren units in market operations is discussed in confidential data responses, as referenced throughout this section.

** ____ ** ** ____ **[25] This is certainly justified in the case of the ** ________ **, but for individual ** ________ ** these costs may or may not fully offset the costs of out-of-merit dispatch. The Company has not provided any analysis of these potential savings ** ____ **.

Q. WHY DID AMEREN DECIDE TO ** ________________________ ** AS DESCRIBED BY MR. PETERS?

A. According to Ameren witness Kevin DeGraw, Meramec "…is by far the Company's oldest and least efficient base load power plant, and is one of the older coal-fired power plants in the nation."[27] In other words, of the Company's coal-fired assets, Meramec is the most expensive to operate. Mr. DeGraw further notes that "…the plant has also run much less because the economics in the market…have not supported dispatching it nearly as often as was the case historically."[28] It appears that the Company recently recognized that ** ____

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[24] Response to MPSC Data Request 0079, ¶1.
[25] Response to MPSC Data Request 0079, ¶2
[26] ** ____ ** Response to MPSC Data Request 0079, ¶3.
[27] Direct testimony of Kevin DeGraw, p.2 at 6-8.
[28] Ibid, p.3 at 12-14.

____ **[29] I have reviewed the Company's modeling input files as provided to the parties in discovery,[30] and I have found **_________________ __________ **. However, I am not privy to all aspects of the Company's modeling process.)

Q. WHAT WAS THE CALCULATED IMPACT OF REMOVING MERAMEC FROM "MUST-RUN" STATUS IN THE PROSYM MODEL?

A. As reported by Ameren, removing the must-run designation from Meramec in the PROSYM model for the test-year period (April 2013 through March 2014) resulted in a reduction of output of **________ ___ ** and reduced fuel costs of **__________ **, offset by reduced off-system sales revenue of **__________ **, resulting in net benefit of **_________ **.[31]

Based on the model output files provided by the Company,[32] I calculated independently that the avoided fuel cost would be **__________ **, as claimed by Ameren; in addition, avoided operations and maintenance (O&M) costs, which were not reported by Ameren, total **_________ **. I find that the decrease in off-system sales totals **__________ **, for a net ratepayer benefit of **__________ **.[33] The primary source of the discrepancy is Ameren's failure to consider avoided O&M costs. I do not know the source of the discrepancy in net off-system sales revenues between the model files provided by the Company and the claimed impact of removing the Meramec must-run status.

On the cost side, in addition to the loss of off-system sales revenue included in the above calculation, there may be some additional operational costs that are not captured by the model, such as increased wear on the units leading to more frequent shutdowns. However, the Company has not quantified such costs to my knowledge, and I have no independent way of estimating them.

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[29] Response to MPSC Data Request 0079, ¶4ii.
[30] Response to Sierra Club Data Request 008; Response to MIEC Data Request 1.11.
[31] Response to Sierra Club Data Request 008, ¶c.
[32] I refer specifically to the monthly output files provided by the Company in response to Sierra Club Data Request 008. Monthly output with Meramec set to must-run was provided in the file "SC_1-SC_008_S_Bector-Att-SC008 - MPSC2014PolarVMerMRws - HC.pdf", and output with Meramec set as dispatchable was provided in the file "SC_1-SC_008_S_Bector-Att-SC008 - MPSC2014PolarVSx90ws - HC.pdf".
[33] The details of these calculations are reflected in my workpapers.

Q. WHAT WOULD BE THE IMPACT OF **____________________________________ ____________________________________ **?

A. **____ ____________________ **_Ameren has not performed this analysis,[34] so the magnitude of the potential savings is unknown.

Q. WOULD CHANGING THE COMMIT STATUS OF **________________________________ ________________ ** AFFECT THE COMPANY'S PROJECTED AND ACTUAL OFF-SYSTEM SALES?

A. Yes. Ameren's estimate of off-system sales revenue is based on a PROSYM model run for which **____ ____ **. Changing this designation would alter the dispatch of the units, which would affect the volume, timing, and possibly the price of off-system sales. Units that are run out of merit order in order to support off-system sales are effectively operating at a loss to ratepayers.

Q. WHAT IS THE RELEVENCE OF THIS ISSUE TO THE COMPANY'S CURRENT RATE REQUEST?

A. Ameren is "seeking a total increase in [its] annual revenue requirement of approximately $264 million, which represents an increase in rates of approximately 9.7%."[35] This request is "substantially driven by decreases in off-system sales revenues due to lower power prices (reflecting approximately $127 million—

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[34] Response to MPSC Data Request 0079, ¶3: **____ ____ **

[35] Direct testimony of Michael Moehn, p. 5 at 8-9.

nearly half of the total increase.)"[36] These same "lower power prices" mean that the losses associated with dispatching generating units out of merit order are substantially larger than they would otherwise be.

Given this change in its operating environment and the decrease in the value of off-system sales, it is incumbent on a prudent utility to analyze the costs and benefits **______________________________ ______________________________** Ameren's **____________________________** is imprudent, so its request for a rate increase due to loss of off-system sales revenue is not justified.

4. Clean Power Plan

Q. TURNING NOW TO THE CLEAN POWER PLAN, WOULD YOU PLEASE BRIEFLY DESCRIBE WHAT THIS PLAN IS AND WHAT IT REQUIRES OF THE STATE OF MISSOURI AND OF AMEREN MISSOURI?

A. The Clean Power Plan, as proposed by EPA on June 2, 2014, sets specific limits for carbon emissions intensity ("state goals") of affected electric generating units ("EGUs") in each state under §111(d) of the Clean Air Act. (EPA has also proposed to allow states to convert the rate-based, emissions intensity goals into equivalent mass-based goals.) EPA determined these limits based on the energy mix in each state after applying four "building blocks" for reducing carbon emissions from affected EGUs. Under §111(d) of the Clean Air Act, each state is required to develop a state implementation plan that would lead to compliance with EPA's overall standard; the specific measures Missouri would implement to meet its obligation would be determined by the state. Although specific implementation details are up to each state, EPA's methodology for computation of the state goals provides an illustrative scenario of the use of the four building blocks, demonstrating one approach to meeting each state's goal.

Under the proposed plan, Missouri's fossil-fired generating resources would be required to decrease emissions intensity from a 2012 emission rate of 2,010 lbs/MWh to a 2030 emission rate of 1,544 lbs/MWh.[37] EPA's illustrative scenario for how Missouri could achieve these reductions is as follows:[38]

[36] Ibid, p.5 at 11-13.

- Make efficiency improvements to coal-fired power plants, reducing CO_2 emissions intensity by 6 percent, from 2,085 lbs/MWh in 2012 to 1,959 lbs/MWh in 2030;
- Increase capacity factor of NGCC units from 27% to 70%, increasing output of NGCC units from 4,855 GWh in 2012 to 12,782 GWh in 2030; with a concurrent reduction in generation from the state's coal plants, from 72,940 GWh in 2012 to 65,013 GWh in 2030;
- Preserve the 5.8% of nuclear generation deemed to be "at-risk";
- Increase renewable energy production from 1,299 GWh in 2012 to 2,764 GWh in 2030; and
- Increase cumulative energy efficiency savings from 0.55% in 2012 to 9.92% in 2029.

For perspective, Missouri's 2009 Energy Efficiency Investment Act sets a cumulative goal of 9.9% energy efficiency by 2020, well before the year specified in EPA's illustrative scenario; Missouri also has a renewable energy standard of 15% of energy sales by 2021, or approximately 12,500 GWh, far in excess of EPA's number. Achieving these state goals alone would go a long way towards meeting the Clean Power Plan requirements – *if* the clean resources are used to displace carbon-intensive coal generation, and coal generation is significantly curtailed as a result.

Q. THE GOALS AND REQUIREMENTS YOU HAVE DESCRIBED ARE FOR ALL AFFECTED EGUS IN THE STATE OF MISSOURI. HOW WILL THEY AFFECT AMEREN'S OPERATIONS AND COSTS, SPECIFICALLY?

A. EPA has set goals for the EGUs in each state, and the implementation of these goals will be subject to a state implementation plan that has yet to be developed. However, as noted above, the emissions reductions are entirely predicated on reducing the emissions, and thus the operations, of affected fossil fuel-fired power plants. Owners and operators of affected EGUs, such as Ameren, will have to reduce the output of

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[37] EPA Technical Support Document (TSD) http://www2.epa.gov/sites/production/files/2014-06/documents/20140602tsd-goal-computation.pdf. Calculations shown in http://www2.epa.gov/sites/production/files/2014-06/20140602tsd-state-goal-data-computation.xlsx, and http://www2.epa.gov/sites/production/files/2014-09/cpp_state_goal_rate_calculation_viewer_-_final_3_0_0.xlsm.

[38] See plan description, technical support documents, and illustrative calculations at http://www2.epa.gov/carbon-pollution-standards. Specific data sources as noted in Footnote 37.

their affected coal-fired units under the plan, and probably will have to pay for their remaining greenhouse gas emissions in some manner

The implications for Ameren are:

- Some of the Company's coal units will likely retire earlier than they would otherwise; and
- Cost recovery on coal plants in general will be effectively spread over fewer MWh of energy, making them more expensive for ratepayers.

Q. WHAT ARE THE IMPLICATIONS OF THESE OUTCOMES ON THE INVESTMENT DECISIONS FOR WHICH THE COMPANY IS REQUESTING RECOVERY IN THIS CASE AND LIKELY FUTURE RATE CASES, SUCH AS THE LABADIE ESPS?

A. The implications are that any investments in coal plants today should be examined very carefully, in the light of future curtailed operations, possible early shut-down, and direct or indirect carbon emissions costs. Failing to do so will unreasonably and imprudently bias the analysis towards uneconomic investments in coal plants. Ameren has failed to provide this analysis, and has therefore inadequately supported its rate request for the Labadie ESPs.

Q. HAS AMEREN TAKEN EPA'S PROPOSED RULE INTO ACCOUNT IN ITS LONG-TERM RESOURCE PLAN?

A. No. Ameren's 2014 IRP is not compliant with the Clean Power Plan as proposed, and no evaluation of the investments at issue in this case in the context of the Clean Power Plan have been provided to the Commission.

5. Conclusions and Recommendations

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. Ameren has failed to show that its environmental compliance plan is the least-cost option for meeting environmental requirements while maintaining reliability. Specifically,

- Ameren has produced and is enacting a plan that the Company knows is not compliant with U.S. EPA's Clean Power Plan, as currently proposed. The Company's request that ratepayers continue to fund life-extending upgrades on coal units that may not be viable under upcoming federal regulations, without even investigating this possibility, is unreasonable.

- The Company has not adequately demonstrated that continued investment in its aging coal fleet, including the Labadie ESPs at issue in this case, are justified in the current and reasonably foreseeable economic and policy environment in which they will operate.
- The Company's projection of decreased off-system sales revenue is compromised by its failure to analyze the costs and benefits of **____ ____ _______________________**
- In Ameren's planning process underlying this rate request, including justifying the cost of the Labadie ESPs, the Company has assumed an extremely long life for its coal units, running at high capacity factor, without regard to proposed federal regulations that are specifically designed to reduce pollution from fossil fuel-fired power plants. This will increase the operating cost and reduce the output of coal-fired generating plants. Ameren has not provided analysis of the implications of its decisions assuming the currently proposed Clean Power Plan, or other greenhouse gas regulation, comes into effect.

Q. WHAT ARE YOUR RECOMMENDATIONS FOR THIS COMMISSION?

A. Given the deficiencies outlined above, I recommend that the Commission deny the part of Ameren's request for rate recovery of depreciation of the Labadie ESPs **__________ ** as well as any return on this investment, unless or until the Company resolves these deficiencies and presents the Commission with an adequate justification for the prudence of these expenditures.

I further recommend that the Commission deny Ameren's request to recover the $127 Million increase in annual revenue requirements associated with decreased off-system sales revenue, unless and until Ameren fully evaluates the costs and benefits of **____ ____ ** Ameren should be directed to provide modeling analysis demonstrating how each individual unit would operate and the resulting costs and revenues with and without a must-run designation. If there are specific operational reasons why **____**, the Company should fully explain these reasons. Absent such demonstration and explanation, the Commission can only find that Ameren's unit commitment practices are imprudent, and ratepayers should not bear the cost of these uneconomic transactions.

Finally, I recommend that the Company be put on notice that any future rate requests will be contingent on the Company producing a least-cost, Clean Power Plan-compliant resource plan demonstrating that the Company's resource investments are consistent with likely federal carbon regulation, quantifying the costs and benefits of these investments to ratepayers under the assumption that the rules, as currently proposed by the U.S. EPA, become law.

Q DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Ezra Daskal Hausman, Ph.D.

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SUMMARY

I am an independent consultant in energy and environmental economics.

I have worked for over 15 years as an electricity market expert with a focus on market design and market restructuring, environmental regulation in electricity markets, and pricing of energy, capacity, transmission, losses and other electricity-related services. I have performed market analysis, offered expert testimony, led workshops and working groups, made presentations and participated on panels, and provided other support to clients in a number of areas, including:

- Economic analysis, price forcasting, and asset valuation in electricity markets, including dispatch model analysis and review of modeling studies
- Electricity and generating capacity market design
- Integrated Resource Planning and portfolio analysis
- Economic analysis of environmental and other regulations, including cap-and-trade regulation of CO_2, in electricity markets
- Quantification of the economic and environmental benefits of displaced emmissions associated with energy efficiency and renewable energy initiatives
- Mitigation of greenhouse gas emissions from the supply and demand sides of the U.S. electric sector.

I have prepared reports and offered other expert services on these and other related topics for clients including federal and state agencies; offices of consumer advocate; legislative bodies; cities and towns; non-governmental organizations; foundations; industry associations; and resource developers.

I previously served as Vice President and Chief Operating Officer of Synapse Energy Economics, Inc. of Cambridge, Massachusetts. In addition to my consulting portfolio, this management role entailed responsibility for day-to-day operations of the company including overseeing finance, HR, communications & marketing, quality assurance, client service, and professional development of staff. I had overall responsibility for ensuring that project managers and project teams had the tools, information, and training they needed to successfully serve our client's needs and produce high-quality deliverables on time and on budget. I was also a resource available to any of our clients to address any issues of customer service, quality, or any other issues that may arise.

I hold a Ph.D. in atmospheric science from Harvard University, an S.M. in applied physics from Harvard University, an M.S. in water resource engineering from Tufts University, and a B.A.degree in psychology from Wesleyan University.

PROFESSIONAL EXPERIENCE

Ezra Hausman Consulting, Newton, MA. President, March 2014 – Present.
I provide research, analytical, and regulatory and litigation support services based upon my 15+ years experience in the electric power industry.

Synapse Energy Economics Inc., Cambridge, MA.
Chief Operating Officer, March 2011 – February 2014;
Vice President, July 2009 – February 2014;
Senior Associate, 2005-2009.
Conducted research, wrote reports, and presented expert testimony pertaining to consumer, environmental, and public policy implications of electricity industry regulation. Focus of work included:

- Economic analysis of electricity industry regulation and restructuring
- Efficient pricing of generating and transmission capacity
- Long-term electric power system planning and market design
- Price forecasting and asset valuation
- Impact of air quality and environmental regulations on electricity markets and pricing
- Energy efficiency and renewable energy programs and policies, including avoided emissions analysis
- Market power and market concentration analysis in electricity markets
- Consumer and environmental protection
- Regulation and mitigation of greenhouse gas emissions.

Charles River Associates (CRA), Cambridge, MA. Senior Associate, 2004-2005
CRA acquired Tabors Caramanis & Associates in October, 2004.

Tabors Caramanis & Associates, Cambridge, MA. Senior Associate, 1998-2004
Modeling and analysis of electricity markets, generation and transmission systems. Projects included:

- Several market transition cost-benefit studies for development of Locational Marginal Price (LMP) based markets in US electricity markets
- Long-term market forecasting studies for valuation of generation and transmission assets,
- Valuation of financial instruments relating to transmission system congestion and losses
- Modeling and analysis of hydrologically and electrically interconnected hydropower system operations
- Natural gas market analysis and price forecasting studies
- Co-developed an innovative approach to hedging financial risk associated with transmission system losses of electricity

- Designed, developed and ran training seminars using a computer-based electricity market simulation game, to help familiarize market participants and students in the operation of LMP-based electricity markets.
- Developed and implemented analytical tools for assessment of market concentration in interconnected electricity markets, based on the "delivered price test" for assessing market accessibility in such a network
- Performed regional market power and market power mitigation studies
- Performed transmission feasibility studies for proposed new generation and transmission projects in various locations in the US
- Provided analytical support for expert testimony in a variety of regulatory and litigation proceedings, including breach of contract, bankruptcy, and antitrust cases, among others.

Global Risk Prediction Network, Inc., Greenland, NH. Vice President, 1997-1998
Developed private sector applications of climate forecast science in partnership with researchers at Columbia University. Specific projects included a statistical assessment of grain yield predictability in several crop regions around the world based on global climate indicators (Principal Investigator); a statistical assessment of road salt demand predictability in the United States based on global climate indicators (Principal Investigator); a preliminary design of a climate and climate forecast information website tailored to the interests of the business community; and the development of client base.

Hub Data, Inc., Cambridge, MA. Financial Software Consultant, 1986-1987, 1993-1997
Responsible for design, implementation and support of analytic and communications modules for bond portfolio management software; and developed software tools such as dynamic data compression technique to facilitate product delivery, Windows interface for securities data products.

Abt Associates, Inc., Cambridge, MA. Environmental Policy Analyst, 1990-1991
Quantitative risk analysis to support federal environmental policy-making. Specific areas of research included risk assessment for federal regulations concerning sewage sludge disposal and pesticide use; statistical alternatives to Most-Exposed-Individual risk assessment paradigm; and research on non-point sources of water pollution.

Massachusetts Water Resources Authority, Charlestown, MA. Analyst, 1988-1990
Applied and evaluated demand forecasting techniques for the Eastern Massachusetts service area. Assessed applicability of various techniques to the system and to regional planning needs; and assessed yield/reliability relationship for the eastern Massachusetts water supply system, based on Monte-Carlo analysis of historical hydrology.

Somerville High School, Somerville, MA. Math Teacher, 1986-1987
Courses included trigonometry, computer programming, and basic math courses.

EDUCATION

Ph.D., Earth and Planetary Sciences. Harvard University, Cambridge, MA, 1997

S.M., Applied Physics. Harvard University, Cambridge, MA, 1993

M.S., Civil Engineering. Tufts University, Medford, MA, 1990

B.A., Wesleyan University, Psychology. Middletown, CT, 1985

FELLOWSHIPS, AWARDS AND AFFILIATIONS

President, Burr Elementary School Parent Teacher Organization, 2005-2007

UCAR Visiting Scientist Postdoctoral Fellowship, 1997

Postdoctoral Research Fellowship, Harvard University, 1997

Certificate of Distinction in Teaching, Harvard University, 1997

Graduate Research Fellowship, Harvard University, 1991-1997

Invited Participant, UCAR Global Change Institute, 1993

House Tutor, Leverett House, Harvard University, 1991-1993

Graduate Research Fellowship, Massachusetts Water Resources Authority, 1989-1990

Teaching Fellowships:

> **Harvard University:** *Principles of Measurement and Modeling in Atmospheric Chemistry; Hydrology; Introduction to Environmental Science and Public Policy; The Atmosphere.*
>
> **Wesleyan University:** *Introduction to Computer Programming; Psychological Statistics; Playwriting and Production.*

Professional affiliations

> *Member, American Association for the Advancement of Science*
>
> *Member, American Economic Association*

EXPERT TESTIMONY AND SERVICES

United States District Court for the Eastern District of Missouri (Civil Action No. 4:11-CV-00077) – Ongoing
Expert witness on behalf of the United States Department of Justice on clean air act enforcement case.

Missouri Public Service Commission (File No. ER-2014-0258) – Ongoing
Expert witness on behalf of the Sierra Club in Ameren Missouri rate case.

Arizona Corporation Commission (Docket No. E-01345A-11-0224) – 2014
Expert witness on behalf of the Sierra Club regarding Arizona Public Service petition for rate treatment for acquisition of an additional ownership share of the Four Corners generating units.

Missouri Public Service Comission (Docket No. ET-2014-0085) – 2013
Testimony on behalf of the Missouri Solar Energy Industries Association regarding Union Electric (d/b/a Ameren Missouri) motion to suspend payment of solar rebates.

Missouri Public Service Comission (Docket No. ET-2014-0059 and ET-2014-0071) – 2013
Testimony on behalf of the Missouri Solar Energy Industries Association regarding Kansas City Power and Light Company's motions to suspend payment of solar rebates.

Puget Sound Energy (PSE) – 2012-2013
Expert participant in PSE's 2013 IRP stakeholder process on behalf of the Sierra Club.

Washington Utilities and Transportation Commission (Docket Nos. UE-111048 and UG-111049) – 2011
Testimony on behalf of the Sierra Club regarding the cost of operating the Colstrip power plant and other power procurement issues.

Kansas Corporation Commission (Docket No. 11-KCPE-581-PRE) - 2011
Presented written and live testimony on behalf of the Sierra Club regarding Kansas City Power and Light request for predetermination of ratemaking principles.

Vermont Department of Public Service - 2011
Provided scenario analysis of the costs and benefits of various electric energy resource scenarios in support of the state Comprehensive Energy Plan.

Massachusetts Department of Energy Resources – 2009-2011
Served as expert analyst and modeling coordinator for analysis related to implementation of the Massachusetts Global Warming Solutions Act.

Iowa Office of Consumer Advocate – 2010-Present
Assisted Consumer Advocate in evaluating a proposed power purchase agreement for the output of the Duane Arnold nuclear power station.

Missouri Public Service Commission (Docket No. EW-2010-0187) – 2010
Expert participant on behalf of the Sierra Club in stakeholder process to develop a "demand side investment mechanism" in Missouri.

Louisiana Public Service Commission (Docket No. R-28271 Subdocket B) – 2009-2010
Expert participant on behalf of the Sierra Club in Renewable Portfolio Standard Task Force considering RPS for Louisiana.

Joint Fiscal Committee of the Vermont Legislature – 2008-2010
Serving as lead expert advising the Legislature on economic issues related to the possible recertification of the Vermont Yankee nuclear power plant.

Town of Littleton, NH – 2006-2010
Serving as expert witness on the value of the Moore hydroelectric facility.

Nevada Public Service Commission (Docket No. 08-05014) – August 2008
Presented prefiled and live testimony on behalf of Nevadans for Clean Affordable Reliable Energy regarding the proposed Ely Energy Center and resource planning practices in Nevada.

Mississippi Public Service Commission (Docket No. 2008-AD-158) – August 2008
Presented written and live testimony on behalf of the Sierra Club regarding the resource plans filed by Entergy Mississippi and Mississippi Power Company.

Kansas House of Representatives - Committee on Energy and Utilities – February 2008
Presented testimony on behalf of the Climate and Energy Project of the Land Institute of Kansas on a proposed bill regarding permitting of power plants. Focus was on the risks and costs associated with new coal plants and on their contribute to global climate change.

Vermont Public Service Board (Docket No. 7250) – 2006-2008
Prepared report and testimony in support of the application of Deerfield Wind, LLC. For a Certificate of Public Good for a proposed wind power facility.

Iowa Utilities Board (Docket No. GCU-07-1) – October, 2007 – January 2008
Presented wrtten and live testimony on behalf of the Iowa Office of Consumer Advocate regarding the science of global climate change and the contribution of new coal plants to atmospheric CO_2.

Nevada Public Service Commission (Docket No. 07-06049) – October 2007
Presented prefiled direct testimony on behalf of Nevadans for Clean Affordable Reliable Energy regarding treatment of carbon emissions costs and coal plant capital costs in utility resource planning.

Massachusetts General Court, Joint Committee on Economic Development and Emerging Technologies – July 2007
Presented written and live testimony on climate change science and the potential benefits of a revenue-neutral carbon tax in Massachusetts.

Town of Rockingham, VT – 2006-2007
Served as expert witness on the value of the Bellows Falls hydroelectric facility.

South Dakota Public Utilities Commission (Case No EL05-22) – June 2006
Minnesota Public Utilities Commission (Docket TR-05-1275) – December 2006
Submitted prefiled and live testimony on the contribution of the proposed Big Stone II coal-fired generator to atmospheric CO_2, global climate change and the environment of South Dakota and Minnesota, respectively.

Arkansas Public Service Commission (Docket No. 06-070-U) – October 2006
Submitted prefiled direct testimony on inclusion of new wind and gas-fired generation resources in utility rate base.

Federal Energy Regulatory Commission (Docket Nos. ER055-1410-000 and EL05-148-000) – May-Sept 2006

- Participant in settlement hearings on proposed capacity market structure (the Reliability Pricing Model, or RPM) on behalf of State Consumer Advocates in Pennsylvania, Ohio and the District of Columbia
- Invited participant on technical conference panel on PJM's proposed Variable Resource Requirement (VRR) curve
- Filed Pre- and post-conference comments and affidavits with FERC
- Participated in numerous training and design conferences at PJM on RPM implementation.

Illinois Pollution Control Board (Docket No. R2006-025) – June-Aug 2006
Prefile and live testimony presented on behalf of the Illinois EPA regarding the costs and benefits of proposed mercury emissions rule for Illinois power plants.

Long Island Sound LNG Task Force – January 2006
Presentation of study on the need for and alternatives to the proposed Broadwater LNG storage and regasification facility in Long Island Sound.

Iowa Utilities Board (Docket No. SPU-05-15) – November 2005
Whether Interstate Power and Light's should be permitted to sell the Duane Arnold Energy Center nuclear facility to FPLE Duane Arnold, Inc., a subsidiary of Florida Power and Light.

PUBLICATIONS AND REPORTS

Hausman, E., *Risks And Opportunities for PacifiCorp in a Carbon Constrained Economy*, Produced on behalf of the Sierra Club, October 2014.

Hausman, E., *Risks And Opportunities For PacifiCorp - State Level Findings: Oregon*, Produced on behalf of the Sierra Club, October 2014.

Luckow, P., E. Stanton, B. Biewald, J. Fisher, F. Ackerman, E. Hausman, *2013 Carbon Dioxide Price Forecast*, Synapse Energy Economics, November 2013.

Stanton, E., T. Comings, K. Takahashi, P. Knight, T. Vitolo, E. Hausman, *Economic Impacts of the NRDC Carbon Standard: Background Report prepared for the Natural Resources Defense Council*, Synapse Energy Economics for NRDC, June 2013

Comings T., P. Knight, E. Hausman, *Midwest Generation's Illinois Coal Plants: Too Expensive to Compete? (Report Update)* Synapse Energy Economics for Sierra Club, April 2013

Stanton E., F. Ackerman, T. Comings, P. Knight, T. Vitolo, E. Hausman, *Will LNG Exports Benefit the United States Economy?* Synapse Energy Economics for Sierra Club, January 2013

Chang M., D. White, E. Hausman, *Risks to Ratepayers: An Examination of the Proposed William States Lee III Nuclear Generation Station, and the Implications of "Early Cost Recovery" Legislation*, Synapse Energy Economics for Consumers Against Rate Hikes, December 2012

Wilson R., P. Luckow, B. Biewald, F. Ackerman, and E.D. Hausman**,** *2012 Carbon Dioxide Price Forecast*, Synapse Energy Economics, October 2012.

Fagan B., M. Chang, P. Knight, M. Schultz, T. Comings, E.D. Hausman, and R. Wilson, *The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region*. Synapse Energy Economics for Energy Future Coalition, May 2012.

Hausman, E.D., T. Comings, "*Midwest Generation's Illinois Coal Plants: Too Expensive to Compete?* Synapse Energy Economics for Sierra Club, April 2012.

Hausman, E.D., T. Comings, and G. Keith, *Maximizing Benefits: Recommendations for Meeting Long-Term Demand for Standard Offer Service in Maryland*. Synapse Energy Economics for Sierra Club, January 2012.

Keith G., B. Biewald, E.D. Hausman, K. Takahashi, T. Vitolo, T. Comings, and P. Knight, *Toward a Sustainable Future for the U.S. Power Sector: Beyond Business as Usual 2011* Synpase Energy Economics for Civil Society Institute, November 2011.

Chang M., D. White, E.D. Hausman, N. Hughes, and B. Biewald, *Big Risks, Better Alternatives: An Examination of Two Nuclear Energy Projects in the U.S.* Synpase Energy Economics for Union of Concerned Scientists, October 2011.

Hausman E.D., T. Comings, K. Takahashi, R. Wilson, and W. Steinhurst, *Electricity Scenario Analysis for the Vermont Comprehensive Energy Plan 2011.* Synapse Energy Economics for Vermont Department of Public Service, September 2011.

Wittenstein M., E.D. Hausman, *Incenting the Old, Preventing the New: Flaws in Capacity Market Design, and Recommendations for Improvement.* Synapse Energy Economics for American Public Power Association, June 2011.

Johnston L., E.D. Hausman, B. Biewald, R. Wilson, and D. White. *2011 Carbon Dioxide Price Forecast.* Synapse Energy Economics White Paper, February 2011.

Hausman E.D., V. Sabodash, N. Hughes, and J. I. Fisher, *Economic Impact Analysis of New Mexico's Greenhouse Gas Emissions Rule.* Synapse Energy Economics for New Energy Economy, February 2011.

Hausman E.D., J. Fisher, L. Mancinelli, and B. Biewald**.** *Productive and Unproductive Costs of CO_2 Cap-and-Trade: Impacts on Electricity Consumers and Producers.* Synapse Energy Economics for National Association of Regulatory Utility Commissioners, National Association of State Utility Consumer Advocates, National Rural Electric Cooperative Association, and American Public Power Association, July 2009.

Peterson P., E. Huasman, R. Fagan, and V. Sabodash, *Report to the Ohio Office of Consumer Counsel, on the value of continued participation in RTOs. Filed under Ohio PUC Case No. 09-90-EL-COI*, May 2009.

Schlissel D., L. Johnston, B. Biewald, D. White, E. Hausman, C. James, and J. Fisher, *Synapse 2008 CO_2 Price Forecasts.* July 2008.

Hausman E.D., J. Fisher and B. Biewald, *Analysis of Indirect Emissions Benefits of Wind, Landfill Gas, and Municipal Solid Waste Generation.* Synapse Energy Economics Report to the Air Pollution Prevention and Control Division, National Risk Management Research Laboratory, U.S. Environmental Protection Agency, July 2008.

Hausman E.D. and C. James, *Cap and Trade CO_2 Regulation: Efficient Mitigation or a Give-away?* Synapse Enegy Ecomics presentation to the ELCON Spring Workshop, June 2008.

Hausman E.D., R. Hornby and A. Smith, *Bilateral Contracting in Deregulated Electricity Markets.* Synapse Energy Economics for the American Public Power Association, April 2008.

Hausman E.D., R. Fagan, D. White, K. Takahashi and A. Napoleon, *LMP Electricity Markets: Market Operations, Market Power and Value for Consumers.* Synapse Energy Economics for the American Public Power Association's Electricity Market Reform Initiative (EMRI) symposium, "Assessing Restructured Electricity Markets" in Washington, DC, February 2007.

Hausman E.D. and K. Takahashi, *The Proposed Broadwater LNG Import Terminal Response to Draft Environmental Impact Statement and Update of Synapse Analysis.* Synapse Energy Economics for the Connecticut Fund for the Environment and Save The Sound, January 2007.

Hausman E.D., K. Takahashi, D. Schlissel and B. Biewald, *The Proposed Broadwater LNG Import Terminal: An Analysis and Assessment of Alternatives.* Synapse Energy Economics for the Connecticut Fund for the Environment and Save The Sound, March 2006.

Hausman E.D., P. Peterson, D. White and B. Biewald, *RPM 2006: Windfall Profits for Existing Base Load Units in PJM: An Update of Two Case Studies*. Synapse Energy Economics for the Pennsylvania Office of Consumer Advocate and the Illinois Citizens Utility Board, February 2006.

Hausman E.D., K. Takahashi, and B. Biewald, *The Glebe Mountain Wind Energy Project: Assessment of Project Benefits for Vermont and the New England Region*. Synapse Energy Economics for Glebe Mountain Wind Energy, LLC., February 2006.

Hausman E.D., K. Takahashi, and B. Biewald, *The Deerfield Wind Project: Assessment of the Need for Power and the Economic and Environmental Attributes of the Project.* Synapse Energy Economics for Deerfield Wind, LLC., January 2006.

Hausman E.D., P. Peterson, D. White and B. Biewald, *An RPM Case Study: Higher Costs for Consumers, Windfall Profits for Exelon*. Synapse Energy Economics for the Illinois Citizens Utility Board, October 2005.

Hausman E.D. and G. Keith, *Calculating Displaced Emissions from Energy Efficiency and Renewable Energy Initiatives*. Synapse Energy Economics for EPA website 2005

Rudkevich A., E.D. Hausman, R.D. Tabors, J. Bagnal and C Kopel, *Loss Hedging Rights: A Final Piece in the LMP Puzzle*. Hawaii International Conference on System Sciences, Hawaii, January, 2005 (accepted).

Hausman E.D. and R.D. Tabors, *The Role of Demand Underscheduling in the California Energy Crisis*. Hawaii International Conference on System Sciences, Hawaii, January 2004.

Hausman E.D. and M.B. McElroy, *The reorganization of the global carbon cycle at the last glacial termination.* Global Biogeochemical Cycles, *13*(2), 371-381, 1999.

Norton F.L., E.D. Hausman and M.B. McElroy, *Hydrospheric transports, the oxygen isotope record, and tropical sea surface temperatures during the last glacial maximum*. Paleoceanography, *12*, 15-22, 1997.

Hausman E.D. and M.B. McElroy, *Variations in the oceanic carbon cycle over glacial transitions: a time-dependent box model simulation*. Presented at the spring meeting of the American Geophysical Union, San Francisco, 1996.

PRESENTATIONS AND WORKSHOPS

American Public Power Association: Invited expert participant in APPA's roundtable discussion of the current state of the RTO-operated electricity markets. October 2013.

California Long-Term Resource Adequacy Summit (Sponsored by the California ISO and the California Public Utility Commission): Panelist on "Applying Alternative Models to the California Market Construct." February 26, 2013.

ELCON 2011 Fall Workshop: "Do RTOs Need a Capacity Market?" October 2011.

Harvard Electricity Policy Group: Presentation on state action to ensure reliability in the face of capacity market failure. February 2011.

NASUCA 2010 Annual Conference: "Addressing Climate Change while Protecting Consumers." November 2010.

NASUCA Consumer Protection Committee: Briefing on the Synapse report entitled, "Productive and Unproductive Costs of CO_2 Cap-and-Trade." September 2009.

NARUC 2009 Summer Meeting: Invited speaker on topic: "Productive and Unproductive Costs of CO2 Cap-and-Trade." July, 2009.

NASUCA 2008 Mid-Year Meeting**:** Invited speaker on the topic, "Protecting Consumers in a Warming World, Part II: Deregulated Markets." June 2008.

Center for Climate Strategies: Facilitator and expert analyst on state-level policy options for mitigating greenhouse gas emissions. Serve as facilitator/expert for the Electricity Supply (ES) and Residential, Commercial and Industrial (RCI) Policy Working Groups in the states of Colorado and South Carolina. 2007-2008.

NASUCA 2007 Mid-Year Meeting**:** Invited speaker on the topic, "Protecting Consumers in a Warming World" June 2007.

ASHRAE Workshop on estimating greenhouse gas emissions from buildings in the design phase: Participant expert on estimating displaced emissions associated with energy efficiency in building design. Also hired by ASHRAE to document and produce a report on the workshop. April, 2007.

Assessing Restructured Electricity Markets An American Public Power Association Symposium: Invited speaker on the history and effectiveness of Locational Marginal Pricing (LMP) in northeastern United States electricity markets, February, 2007.

ASPO-USA 2006 National Conference: Invited speaker and panelist on the future role of LNG in the U.S. natural gas market, October, 2006.

Market Design Working Group: Participant in FERC-sponsored settlement process for designing capacity market structure for PJM on behalf of coalition of state utility consumer advocates, July-August 2006.

NASUCA 2006 Mid-Year Meeting**:** Invited speaker on the topic, "How Can Consumer Advocates Deal with Soaring Energy Prices?" June 2006.

Soundwaters Forum, Stamford, CT: Participated in a debate on the need for proposed Broadwater LNG terminal in Long Island Sound, June 2006.

Energy Modeling Forum: Participant in coordinated academic exercise focused on modeling US and world natural gas markets, December 2004.

Massachusetts Institute of Technology (MIT): Guest lecturer in Technology and Policy Program on electricity market structure, the LMP pricing system and risk hedging with FTRs. 2002-2005.

LMP: The Ultimate Hands-On Seminar. Two-day seminar held at various sites to explore concepts of LMP pricing and congestion risk hedging, including lecture and market simulation exercises. Custom seminars held for FERC staff, ERCOT staff, and various industry groups. 2003-2004.

Learning to Live with Locational Marginal Pricing: Fundamentals and Hands-On Simulation. Day-long seminar including on-line mock electricity market and congestion rights auction, December 2002.

LMP in California. Series of seminars on the introduction of LMP in the California electricity market, including on-line market simulation exercise. 2002.

Resume updated October 2014

2013 Carbon Dioxide Price Forecast

November 1, 2013

(Minor corrections February 2014)

AUTHORS

Patrick Luckow
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CONTENTS

1. Executive Summary

Prudent planning requires electric utilities and other stakeholders in carbon-intensive industries to use a reasonable estimate of the future price of carbon dioxide (CO_2) emissions when evaluating resource investment decisions with multi-decade lifetimes. However, forecasting a CO_2 price can be difficult. While several bills have been introduced in Congress, the federal government has yet to legislate a policy to reduce greenhouse gas emissions in the United States.

Although this lack of a defined policy that sets a price on carbon poses a challenge in CO_2 price forecasting, an assumption that there will be no CO_2 price in the long run is not, in our view, reasonable. The scientific basis for attributing climatic changes to human-driven greenhouse gas emissions is irrefutable, as are the type and scale of damages expected to both infrastructure and ecosystems. The need for a comprehensive U.S. effort to reduce greenhouse gas emissions is clear. Any policy requiring or leading to greenhouse gas emission reductions will result in higher costs to the electricity resources that emit CO_2.

The Synapse 2013 CO_2 price forecast is designed to provide a reasonable range of price estimates for use in utility Integrated Resource Planning (IRP) and other electricity resource planning analyses. The current forecast updates Synapse's 2012 CO_2 price forecast, published in October 2012.[1] Our 2013 forecast incorporates new data that have become available since 2012, in order to provide useful CO_2 price estimates for utility resource planning purposes.

1.1. Key Assumptions

Synapse's 2013 CO_2 price forecast reflects our expert judgment that near-term regulatory measures to reduce greenhouse gas emissions, coupled with longer-term cap-and-trade or carbon tax legislation passed by Congress, will result in significant pressure to decarbonize the electric power sector. The key assumptions of our forecast include:

- A federal program establishing a price for greenhouse gases is the probable eventual outcome, as it allows for a least-cost path to emissions reduction.
- Initial climate-focused policy actions are more likely to take a regulatory approach, e.g. Section 111(d) of the Clean Air Act. In the longer-term, federal legislation setting a price on emissions through a cap-and-trade policy or a carbon tax will likely be prompted by one or more of the following factors:
    - New technological opportunities that lower the cost of carbon mitigation;

[1] Wilson et al., "2012 Carbon Dioxide Price Forecast," October 2012. http://www.synapse-energy.com/Downloads/SynapseReport.2012-10.0.2012-CO2-Forecast.A0035.pdf.

- A patchwork of state policies that achieve state emission targets for 2020, spurring industry demands for federal action;
- A series of executive actions taken by the President that spur demand for Congressional action;
- A Supreme Court decision that permits nuisance lawsuits, making it possible for states to sue companies within their boundaries that own high-carbon-emitting resources, and creating a financial incentive for energy companies to act; and
- Mounting public outcry in response to increasingly compelling evidence of human-driven climate change.

Given the growing interest in reducing greenhouse gas emissions by states and municipalities throughout the nation, a lack of timely, substantive federal action will result in the enactment of diverse state and local policies. Heterogeneous—and potentially incompatible—sub-national climate policies would present a challenge to any company seeking to invest in CO_2 emitting power plants, both existing and new. Historically, there has been a pattern of states and regions leading with energy and environmental initiatives that have in time been superseded at the national level. It seems likely that this will be the dynamic going forward: a combination of state and regional actions, together with federal regulations, that are eventually eclipsed by a comprehensive federal carbon price.

We expect that federal regulatory measures together with regional and state policies will lead to the existence of a cost associated with greenhouse gas reductions in the near term. Prudent utility planning requires that utilities take this cost into account when engaging in resource planning, even before a federal carbon price is enacted.

1.2. Study Approach

To develop the 2013 CO_2 price forecast, Synapse reviewed several key developments that have occurred over the past year. These include:

- Proposed federal regulatory measures to limit CO_2 emissions from new power plants and administrative initiatives to advance regulation for existing units;
- Updates to the U.S. carbon price used to assess the climate benefit of federal rulemakings;
- Revisions to the Northeast's Regional Greenhouse Gas Initiative (RGGI) CO_2 policy and the first allowance auctions under California's AB 32 Cap-and-Trade program;
- The results of a multi-year Energy Modeling Forum (EMF) research effort on the costs of U.S. emissions abatement from nine integrated assessment modeling teams; and
- Carbon price forecasts from the most recent IRP efforts of 28 utilities.

1.3. Synapse's 2013 CO_2 Price Forecast

Based on analyses of the sources described in sections 3 through 9, and relying on our own expert judgment, Synapse developed Low, Mid, and High case forecasts for CO_2 prices from 2013 to 2040. Figure ES-1 (below) shows the range covered by the Synapse forecasts. These projections assume that state and regional policies will combine with federal regulatory measures to put economic pressure on carbon-emitting resources in the next several years such that the costs of operating a high-carbon-emitting plant increase—followed later by a broader federal, market-based policy. In states other than the RGGI region[2] and California, we assume a zero carbon price for the next several years; by 2020, we expect that federal regulatory measures will begin to put economic pressure on carbon-emitting power plants throughout the United States. All annual carbon prices are reported in 2012 dollars per short ton of CO_2.[3]

Each of the forecasts shown in Figure ES-1 represents a different level of political will for reducing carbon emissions, as described below.

- The **Low case** forecasts a carbon price that begins in 2020 at $10 per ton, and increases to $40 per ton in 2040, representing a $22 per ton levelized price over the period 2020-2040. This forecast represents a scenario in which federal policies—either regulatory or legislative—exist but are not very stringent.
- The **Mid case** forecasts a carbon price that begins in 2020 at $15 per ton, and increases to $60 per ton in 2040, representing a $34 per ton levelized price over the period 2020-2040. This forecast represents a scenario in which federal policies are implemented with significant but reasonably achievable goals.
- The **High case** forecasts a carbon price that begins in 2020 at $25 per ton, and increases to approximately $90 per ton in 2040, representing a $52 per ton levelized price over the period 2020-2040. This forecast is consistent with the occurrence of one or more factors that have the effect of raising carbon prices. These factors include somewhat more aggressive emissions reduction targets; greater restrictions on the use of offsets; restricted availability or high cost of technological alternatives such as nuclear, biomass, and carbon capture and sequestration; more aggressive international actions (thereby resulting in fewer inexpensive international offsets available for purchase by U.S. emitters); or higher baseline emissions.

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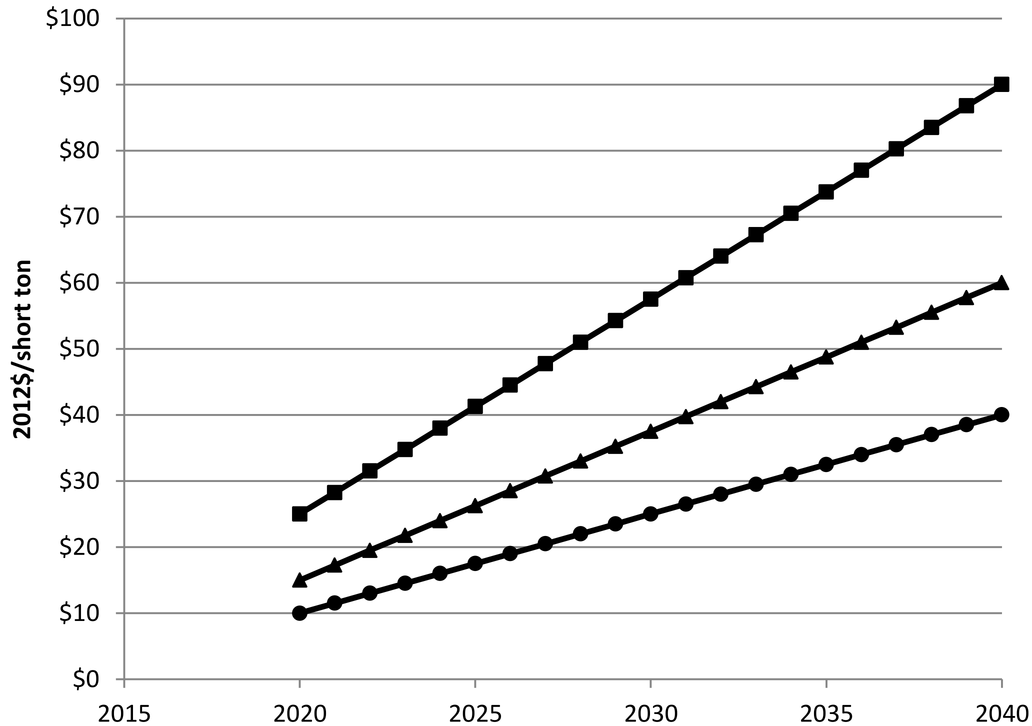
[2] Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

[3] Results from public modeling analyses were converted to 2012 dollars using price deflators taken from the U.S. Bureau of Economic Analysis, and are available at: http://www.bea.gov/national/nipaweb/SelectTable.asp. Consistent with U.S. Energy Information Administration and U.S. Environmental Protection Agency modeling analyses, a 5 percent real discount rate was used in all levelization calculations.

ES-1: Synapse 2013 CO_2 Price Trajectories



2. Structure of this Report

This report presents Synapse's 2013 Low, Mid and High CO_2 price forecasts, along with the evidence assembled to inform these forecasts:

- Section 3 discusses broader concepts of CO_2 pricing.
- Sections 4 through 8 discuss existing state and federal legislation, potential future legislation, recent cap-and-trade results from the research community, and a range of current CO_2 price forecasts from utilities.
- Section 9 presents Synapse's 2013 Low, Mid, and High CO_2 price forecast, along with a comparison to recent utility forecasts.

Unless otherwise indicated, all prices are in 2012 dollars and CO_2 emissions are given in short tons.

3. WHAT IS A CARBON PRICE?

There are several co-existing meanings for the term “carbon price” or “CO_2 price”: each of these meanings is appropriate in its own context. Here we give a brief introduction to five common types of carbon prices, along with a quick guide to which of the carbon price estimates reviewed in this report are based on which of these meanings. (Note that the definition of an additional term—the “price of carbon”—is ambiguous because it can at times mean several of the following.)

Carbon allowances (sometimes called credits or certificates, and best known for their use in policies called “cap and trade”): Allowances are certificates that give their holder the right to emit a unit of a particular pollutant. A fixed number of carbon allowances are issued by a government, some sold and, perhaps, some given away.[4] Subsequent trade of allowances in a secondary market is common to this policy design. The price that firms must pay to obtain allowances increases their cost of doing business, thereby giving an advantage to firms with cleaner, greener operations, and creating an incentive to lower emissions whenever it can be done for less than the price of allowances. The number of allowances—the “cap” in the cap-and-trade system—reflects the required society-wide emission reduction target. A greater reduction target results in a lower cap and a higher price for allowances. In the field of economics, pricing emissions is called “internalizing an externality”: The external (not borne by the polluting enterprise) cost of pollution damages is assigned a market price (thus making it internal to the enterprise).

In this report: The Northeast’s RGGI and California’s Cap-and-Trade Program are both carbon allowance trading systems. In addition, the Kerry-Lieberman, Waxman-Markey, and Cantwell-Collins bills all proposed policy measures that included carbon allowance trading.

Carbon tax: A carbon tax also internalizes the externality of carbon pollution, but instead of selling or giving away rights to pollute (the allowance approach), a carbon tax creates an obligation for firms to pay a fee for each unit of carbon that they emit. In theory, if the value of damages were known with certainty, a tax could internalize the damages more accurately, by setting the tax rate equal to the damages; in practice, the valuation of damages is typically uncertain. In contrast to the government issuance of allowances, with a carbon tax there is no fixed amount of possible emissions (no “cap”). A cap-and-trade system specifies the amount of emission reduction, allowing variation in the price; a tax specifies the price on emissions, allowing variation in the resulting reductions. In both cases there is an incentive to reduce emissions whenever it can be done for less than the prevailing price. In both cases there is the option to continue emitting pollution, at the cost of either buying allowances or paying the tax. While some advocates have claimed that a tax is administratively simpler and reduces bureaucratic, regulatory, and compliance costs, a general aversion to new taxes has meant that no carbon tax proposals have received substantial support in recent policy debate.

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[4] Whether or not allowances are initially given away for free or sold, they represent an opportunity cost of emissions to the holder.

Effective price of carbon (sometimes called the notional, hypothetical, or voluntary price): Carbon allowances and carbon taxes internalize the climate change externality by making polluters pay. However, many other types of climate policies work not by making polluting more expensive per se, but instead by requiring firms to use one technology instead of another, or to maintain particular emission limitations in order to avoid legal repercussions. Non-market-based emission control regulatory policies are called "command and control." For any such non-market policy there is an "effective" price: a market price that—if instituted as an allowance or tax—would result in the identical emission reduction as the non-market policy. An effective price may be used internally within a firm, government agency, or other entity to represent the effects of command and control policies for the purpose of improved decision making. Renewable Portfolio Standards, energy efficiency measures, and other policies designed to mitigate CO_2 emissions impose an effective price on carbon.

In this report: Utility carbon price forecasts are effective prices used for state-required IRPs and internal planning purposes. The U.S. Environmental Protection Agency's (EPA's) proposed carbon pollution standard for new sources of electric generation is a non-market-based policy that would represent an effective price.

Marginal abatement cost of carbon: An abatement cost refers to an estimate of the expected cost of reducing emissions of a particular pollutant. Estimation of a marginal abatement cost requires the construction of a "supply curve": all of the possible solutions to controlling emissions (these may be technologies or policies) are lined up in order of their cost per unit of pollution reduction. Then, starting from the least expensive option, one tallies up the pollution reduction from various solutions until the desired total reduction is almost achieved, and then asks: what would it cost to reduce emissions by one more unit to achieve the target? The answer is the "marginal" cost of that level of pollution reduction; a greater reduction target would have a higher marginal cost. The marginal abatement cost of carbon is not a market price used to internalize an externality. Rather, it is a method for estimating the price that, if it were applied as a market price, would have the effect of achieving a given emission reduction target. In a well-functioning cap-and-trade system, the allowance price would tend towards the marginal abatement cost of carbon.

In this report: We do not analyze any marginal abatement costs in this report—see the *2012 Synapse Carbon Dioxide Price Forecast* for further information. McKinsey & Company has been a consistent producer of this type of analysis, an example being their 2010 report *Impact of the Financial Crisis on Carbon Economics: Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve*.

Social cost of carbon: Whereas the marginal abatement cost estimates the price of stopping pollution, the social cost of carbon estimates the cost, per unit of emissions, of allowing pollution to continue. The social cost of carbon is the societal cost of current and future damages related to climate change from the emission of one additional unit of pollutant. Estimating the uncertain costs of uncertain future damages from uncertain future climatic events is, of course, a tricky business. If enough information were available, a marginal abatement cost for each level of future emissions (the supply of emission reductions) could be compared to a social cost of carbon for each level of future emissions (the demand for emission reductions) to determine an "optimal" level of pollution (such that the next higher unit of emission reduction would cost more to achieve than its value in reduced damages). More commonly, the social cost of carbon is used as part of the calculation of benefits of emission-reducing measures.

In this report: The U.S. federal government's internal carbon price for use in policy making is estimated as the social cost of carbon.

4. FEDERAL CLIMATE ACTION IS INCREASINGLY LIKELY

In the near term, comprehensive federal climate legislation appears unlikely to come out of a divided Congress. The Executive Branch, however, is moving forward with regulatory actions to limit greenhouse gas emissions. Following a directive issued by President Obama, EPA released revised CO_2 performance standards for new power plants on September 20, 2013.[5] In June 2013, President Obama also instructed EPA to use its Clean Air Act authority to propose CO_2 standards for existing power plants by June 2014 and to finalize these standards by June 2015.[6] While this report is focused on electric sector CO_2 policies, similar regulatory measures have been proposed for the transportation, buildings, and industrial sectors; policies enacted in other sectors include vehicle efficiency standards set to rise to 54.5 miles per gallon by 2025 for new cars and light-duty trucks, and new energy efficiency standards for federal buildings set to reduce energy consumption by nearly 20 percent.[7,8]

We continue to expect that a federal cap-and-trade program for greenhouse gases is the most likely policy outcome in the long term, because it permits reductions to come from sources that can mitigate emissions at the lower cost. While state and regional policies combined with federal regulatory actions appear to be more likely than a federal cap-and-trade policy in the near term, according to a WRI analysis these local measures are unlikely to be able to meet long-term goals of reducing total greenhouse gas emissions to 83 percent below 2005 levels by 2050, even in the most aggressive of scenarios.[9]

[5] EPA. "2013 Proposed Carbon Pollution Standard for New Power Plants." Available at: http://www2.epa.gov/carbon-pollution-standards/2013-proposed-carbon-pollution-standard-new-power-plants.

[6] Memorandum from President Obama to Administrator of the Environmental Protection Agency, Power Sector Carbon Pollution Standards (June 25, 2013). Available at: http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards.

[7] Vlasic, Bill. "US Sets Higher Fuel Efficiency Standards." *The New York Times*. August 28th, 2012. Available at: http://www.nytimes.com/2012/08/29/business/energy-environment/obama-unveils-tighter-fuel-efficiency-standards.html.

[8] "Energy Efficiency Design Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings." A Rule by the Department of Energy. July 9th, 2013. Available at: https://www.federalregister.gov/articles/2013/07/09/2013-16297/energy-efficiency-design-standards-for-new-federal-commercial-and-multi-family-high-rise-residential#h-9.

[9] See WRI's analysis of these scenarios in the 2013 report "Can the U.S. Get There From Here?: Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions." Available at: http://www.wri.org/publication/can-us-get-there-from-here.

4.1. Regulatory Measures for Reducing Greenhouse Gas Emissions

Clean Air Act

As a result of the 2007 Supreme Court finding in *Massachusetts v. EPA*, greenhouse gas emissions were determined to be subject to the Clean Air Act and (in a later ruling) to contribute to air pollution anticipated to endanger public health and welfare. In 2009, EPA issued an "endangerment finding," obligating the agency to regulate emissions of greenhouse gases from stationary sources such as power plants.[10] EPA released draft New Source Performance Standards (NSPS) in April 2012 and revised NSPS standards on September 20, 2013. The revised standards limit CO_2 emissions from new fossil-fuel power plants to 1,000-1,100 pounds of CO_2 per MWh (lbs/MWh)—a level achievable by a new natural gas combined-cycle plant. The exact limit of CO_2 emissions within that range depend on the type of plant and period over which the emission rate would be averaged.[11]

Under Section 111(d) of the Clean Air Act, the EPA is required to propose standards for existing power plants by June 2014, but there remains substantial uncertainty over what form these regulations will take. Unit-specific emission rates standards, such as the NSPS for greenhouse gases, are only one of several plausible options. Unit-specific standards could apply to power plants based on categories by fuel type and technology type, each with its own maximum emission rate. Units that are not in compliance could undertake upgrades to improve efficiency; however, these kinds of upgrades can be expensive, can only achieve small, one-time changes to emission rates, and could trigger New Source Review/Prevention of Significant Deterioration (NSR/PSD) provisions, increasing the cost further.[12,13]

Other regulatory design options for existing plants under 111(d) include maintaining a state-wide average maximum emission rate, and market-based (e.g. cap-and-trade) approaches. More flexible mechanisms like these could lower the cost of compliance, but could also result in additional legal challenges as compared to a simpler but more rigid system of unit-specific regulation.[14] An Edison Electric Institute white paper on potential regulation of existing sources notes that "because of concerns about legal challenges to the guidelines, EPA may be reluctant to incorporate a wide range of

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[10] EPA. "Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act." Available at: http://www.epa.gov/climatechange/endangerment/.

[11] EPA. "Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units." Available at: http://www2.epa.gov/sites/production/files/2013-09/documents/20130920proposal.pdf.

[12] EEI. "Existing Source GHGH NSPS White Paper," Page 5. Available at: http://online.wsj.com/public/resources/documents/carbon04232013.pdf.

[13] Tarr J., Monast J., Profeta T. "Regulating Carbon Dioxide under Section 111(d) of the Clean Air Act." The Nicholas Institute. January 2013. Available at: http://nicholasinstitute.duke.edu/sites/default/files/publications/ni_r_13-01.pdf.

[14] Fine, Steven and MacCracken, Chris. "President Obama's Climate Action Plan: What It Could Mean to the Power Sector." ICF International. August 2013. Available at: http://www.icfi.com/insights/white-papers/2013/president-obama-climate-action-plan.

compliance flexibility mechanisms in the guidelines, but may be more receptive to such mechanisms if proposed by the states in compliance plans."[15]

End-use energy efficiency may be an important part of a comprehensive compliance strategy in a regulation that averages emission rates across states. States may be able to achieve emissions reductions at a lower cost through the structures of their existing energy efficiency resource standards.

Methods for demonstrating compliance with 111(d) may be similar to existing regulations: in a process similar to Section 110 of the Clean Air Act, under which EPA sets National Ambient Air Quality Standards (NAAQS), states will be required to submit State Implementation Plans (SIPs) that specify how they intend to comply with 111(d). EPA can then decide whether a proposed SIP meets the terms of the regulation; in the absence of an acceptable SIP, EPA can impose a Federal Implementation Plan (FIP). Under the schedule outlined by President Obama in his Climate Action Plan, regulations for existing sources under 111(d) will be finalized by June 2015, and states would be required to submit SIPs to the EPA by June 2016.

Performance standards for new and existing sources will affect decisions made by utilities regarding operation, expansion, and retirements. Enforcement of the Clean Air Act creates an opportunity cost of greenhouse gas abatement: prudent utilities will take Clean Air Act compliance into consideration in their planning, either explicitly as a maximum allowable emissions rate, or implicitly as an effective carbon price. An NRDC analysis of the impacts of 111(d) implementation estimated compliance costs under this policy at $7.53 per ton of CO_2 avoided.[16]

Other regulatory measures put economic pressure on carbon-intensive power plants

A suite of current and proposed EPA regulations require pollution-intensive power plants to install environmental controls for compliance. The cost of complying with environmental regulations reduces the profitability of the worst polluters, sometime rendering them uneconomic. These policies demonstrate momentum towards appropriately regulating or pricing environmentally harmful activities in the electric sector. To the extent that plants with high emissions of other pollutants also have high carbon emissions, these policies would tend to *lower* the future CO_2 price necessary to achieve a given reduction; as more pollution-intensive plants retire in response to other EPA regulations, the necessary carbon price is reduced. Specific regulatory measures include:

- *National Ambient Air Quality Standards (NAAQS)* set maximum air quality limitations that must be met at all locations across the nation. EPA has established NAAQS for six pollutants: sulfur dioxide (SO_2), nitrogen dioxides (NO_2), carbon monoxide (CO), ozone, particulate matter—measured as particulate matter less than or equal to 10

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[15] Edison Electric Institute. "Existing Source GHG NSPS White Paper," Page 2. Available at: http://online.wsj.com/public/resources/documents/carbon04232013.pdf.

[16] Natural Resources Defense Council. "Closing the Power Plant Carbon Pollution Loophole: Smart Ways the Clean Air Act Can Clean Up America's Biggest Climate Polluters," March 2013. Available at: http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf.

micrometers in diameter (PM10) and particulate matter less than or equal to 2.5 micrometers in diameter (PM2.5)—and lead.

- *The Cross State Air Pollution Rule (CSAPR)*, finalized in 2011, establishes the obligations of each affected state to reduce emissions of NO_x and SO_2 that significantly contribute to another state's PM2.5 and ozone non-attainment problems. CSAPR was vacated by the U.S. Court of Appeals for the District of Columbia on August 21, 2012. In June 2013, the U.S. Supreme Court announced that it would review CSAPR. Even if EPA fails to salvage CSAPR through the courts, the Agency must still promulgate a replacement rule to implement Clean Air Act requirements to address the transport of air pollution across state boundaries. In the meantime, the court left the requirements of the 2005 Clean Air Interstate Rule in place.
- *Mercury and Air Toxics Standards (MATS)*: The final MATS rule, approved in December 2011, sets stack emissions limits for mercury, other metal toxins, organic and inorganic hazardous air pollutants, and acid gasses. Compliance with MATS is required by 2015, with a potential extension to 2016. Many utilities have already committed to capital improvements at their coal plants to comply with the standard.
- *Coal Combustion Residuals (CCR) Disposal Rule:* On June 21, 2010, EPA proposed to regulate CCR for the first time either as a Subtitle C hazardous waste or Subtitle D solid waste under the Resource Conservation and Recovery Act. Under a Subtitle C designation, the EPA would regulate siting, liners, run-on and run-off controls, groundwater monitoring, fugitive dust controls, and any corrective actions required. In addition, the EPA would implement minimum requirements for dam safety at impoundments. Under a solid waste Subtitle D designation, the EPA would require minimum siting and construction standards for new coal ash ponds, compel existing unlined impoundments to install liners, and require standards for long-term stability and closure care.
- *Steam Electric Effluent Limitation Guidelines (ELGs):* On June 7, 2013, EPA released eight regulatory options for new, proposed steam-electric ELGs to reduce or eliminate the release of toxins into U.S. waterways. A final rule is required by May 22, 2014.[17] New requirements will be implemented in 2014 to 2019 through the five-year National Pollutant Discharge Elimination System permit cycle.[18]

Other regulations which may raise costs for carbon-intensive resources include Regional Haze rules and cooling water rules under the Clean Water Act.

[17] See U.S. Environmental Protection Agency website. Accessed February 21, 2013. Available at: http://water.epa.gov/scitech/wastetech/guide/steam-electric/amendment.cfm.

[18] See U.S. Environmental Protection Agency. Steam Electric ELG Rulemaking. UMRA and Federalism Implications: Consultation Meeting. October 11, 2011. http://water.epa.gov/scitech/wastetech/guide/upload/Steam-Electric-ELG-Rulemaking-UMRA-and-Federalism-Implications-Consultation-Meeting-Presentation.pdf.

4.2. Proposed Cap-and-Trade Legislation

Over the past decade, there have been several Congressional proposals to legislate cap-and-trade programs, with the goal of reducing greenhouse gas emissions by up to 83 percent below recent levels by 2050 through a federal cap. Such programs would allow trading of allowances to promote least-cost reductions in greenhouse gas emissions.

Comprehensive climate legislation was passed by the House in the 111th Congress: the American Clean Energy and Security Act of 2009, also known as Waxman-Markey or H.R. 2454. However, the Senate did not vote on either of the two climate bills before it in that session (Kerry-Lieberman APA 2010 and Cantwell-Collins S. 2877). Waxman-Markey was a cap-and-trade program that would have required a 17 percent reduction in emissions from 2005 levels by 2020, and an 83 percent reduction by 2050.[19] Further analysis of these proposals is provided in Synapse's 2012 Carbon Dioxide Price Forecast.

Congressional interest in climate policy has been ongoing. In March 2012, Senator Bingaman introduced the Clean Energy Standard Act of 2012 (S. 2146), which would have required larger utilities to meet a percentage of their sales with electric generation from sources that produce less greenhouse gas emissions than a conventional coal-fired power plant. Credits generated by these clean technologies would have been tradable with a market price. In February 2013, Senators Sanders and Boxer introduced new comprehensive climate change legislation, the Climate Protection Act of 2013. This bill proposed a carbon fee of $20 per ton of CO_2 or CO_2 equivalent content of methane, rising at 5.6 percent per year over a ten-year period. The bill has not yet been brought to a vote.

We expect that federal cap-and-trade legislation will eventually be enacted but that it is unlikely to happen in the near term. In contrast, federal carbon regulations are in effect or under development today, and the economic pressure—or opportunity cost—that they create may be represented as an effective price of greenhouse gas emissions. Regulatory measures may be successful in achieving near-term targets of 17 percent below 2005 levels by 2020, but according to a WRI analysis are unlikely to meet long-term goals of reducing total greenhouse gas emissions to approximately 80 percent below 2005 levels by 2050, even in the most aggressive of scenarios.[20] A broader approach will be increasingly attractive in order to meet these goals at lower costs, and our judgment indicates this is most likely to take the form of a federal cap-and-trade system.

[19] U.S. Energy Information Administration (EIA); Energy Market and Economic Impacts of the American Power Act of 2010 (July 2010). Available at http://www.eia.gov/oiaf/servicerpt/kgl/index.html. EIA; Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009 (August 2009). Available at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html.

[20] See WRI's analysis of these scenarios in their 2013 report "Can the U.S. Get There From Here?: Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions." Available at: http://www.wri.org/publication/can-us-get-there-from-here.

5. STATE AND REGIONAL CLIMATE POLICIES

Since the October 2012 release of our 2012 CO_2 price forecasts, there have been significant updates to the two existing regional and state cap-and-trade programs, the Northeast's RGGI and California's Cap-and-Trade Program under AB32. In addition, a total of 20 states plus the District of Columbia have set greenhouse gas emissions targets as low as 80 percent below 1990 levels by 2050.[21]

Recent Revisions to RGGI

RGGI is a cap-and-trade greenhouse gas program for power plants in the northeastern United States. Current participant states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Pennsylvania, Québec, New Brunswick, and Ontario are official "observers" in the RGGI process. RGGI recently marked five years of successful CO_2 allowance auctions, with Auction 21 resulting in a clearing price of $2.67 per ton.[22] RGGI is designed to reduce electricity sector CO_2 emissions to at least 45 percent below 2005 levels by 2020.[23]

When RGGI was established in 2007, the expectation was that the CO_2 emissions allowance auction would generate revenues for consumer benefit programs such as energy efficiency, renewable energy, and clean energy technologies. While RGGI has provided significant revenues for consumer benefit, its allowance prices have generally remained near the statutory minimum price. External influences, including changes to fuel prices, caused a shift from coal and oil to lower-carbon natural gas generation. Compared to those external factors, the effect of the original RGGI cap requirements were relatively minor in meeting the goals of reducing CO_2 emissions in the power sector.[24]

In 2012 and 2013, the RGGI states evaluated a number of plans for tighter emissions caps with the goal of raising allowance prices. In February of 2013, participating states agreed to lower the CO_2 cap from 165 million to 91 million short tons in 2014, to be reduced by 2.5 percent each year from 2015 to 2020. RGGI analysis indicates that with these lower caps, allowance prices will rise to $4.16 per short ton in 2014, increasing to $10.40 per ton in 2020.[24]

California's Cap-and Trade-Program under AB32

With the goal of reducing the state's emissions to 1990 levels by 2020, California's Global Warming Solutions Act (AB32) has created the world's second largest carbon market, after the European Union's

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[21] "Greenhouse Gas Emissions Targets." Center for Climate and Energy Solutions. Accessed September 13, 2013. Available at: http://www.c2es.org/us-states-regions/policy-maps/emissions-targets.

[22] RGGI Auction 21 results available at: http://www.rggi.org/market/co2_auctions/results/Auction-21

[23] RGGI. "RGGI States Propose Lowering Regional CO_2 Emission Cap 45%, Implementing a More Flexible Cost-Control Mechanism." February 2013. Available at: http://www.rggi.org/docs/PressReleases/PR130207_ModelRule.pdf.

[24] Environment Northeast. "RGGI at One Year: An Evaluation of the Design and Implementation of the Regional Greenhouse Gas Initiative." February 2010. Available at: http://www.env-ne.org/public/resources/pdf/ENE_2009_RGGI_Evaluation_20100223_FINAL.pdf.

Emissions Trading System. The first compliance period for California's Cap-and-Trade Program began on January 1, 2013 and covers electricity generators, CO_2 suppliers, large industrial sources, and petroleum and natural gas facilities emitting at least 27,600 tons of CO_2e per year.[25,26] On August 16, 2013, the California Air Resources Board held its fourth quarterly allowance auction, resulting in a clearing price of $11.11 per ton.[27] This first phase of the program includes electricity generators and large industrials. Phase II, beginning in 2015, will also include transportation fuels and smaller industrial sources.

6. ASSESSMENT OF CARBON PRICE FOR FEDERAL RULEMAKING

In 2010, the U.S. federal government began including a carbon cost in regulatory rulemakings to account for the climate damages resulting from each additional ton of greenhouse gas emissions;[28] updated values were released in 2013.[29] The 2013 Economic Report of the President acknowledges that these values will continue to be updated as scientific understanding improves.[30]

An Interagency Working Group on the Social Cost of Carbon—composed of members of the Department of Agriculture, Department of Commerce, Department of Energy, Environmental Protection Agency, and Department of Transportation, among others—was tasked with the development of a consistent value for the social benefits of climate change abatement. Four values were developed (see Section 3 for more explanation of the "social cost of carbon" methodology). These values--$11, $36, $55, and $101 per ton of CO_2 in 2013, rising over time— represent average (most likely) damages at three discount rates, along with one estimate at the 95th percentile of the assumed distribution of climate impacts.[31,32,33,34] While

[25] "CO_2e" refers to CO_2-equivalent, the combination of CO_2 and an equivalent value for other greenhouse gases.

[26] CARB 2013a. "California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms to Allow for the Use of Compliance Instruments by Linked Jurisdictions." July 2013. Available at: http://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf. Legislated value is 25,000 metric tons, converted here to short tons.

[27] CARB 2013b. "CARB Quarterly Auction 4, August 2013: Summary Results Report." August 21, 2013. Available at: http://www.arb.ca.gov/cc/capandtrade/auction/august-2013/results.pdf.

[28] Interagency Working Group on the Social Cost of Carbon, U. S. G. (2010). Appendix 15a. Social cost of carbon for regulatory impact analysis under Executive Order 12866. In Final Rule Technical Support Document (TSD): Energy Efficiency Program for Commercial and Industrial Equipment: Small Electric Motors. U.S. Department of Energy. URL http://go.usa.gov/3fH.

[29] Interagency Working Group on the Social Cost of Carbon (2013) Technical Support Document – Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Available at: http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

[30] 2013 Economic Report of the President (2013). Chapter 6. March 2013. Available at: http://www.whitehouse.gov/sites/default/files/docs/erp2013/ERP2013_Chapter_6.pdf.

[31] These values represent recently revised costs for the SCC. Originally, these values were $5, $21, $35, and $65 per metric tonne for the year 2010 in 2007 dollars.

[32] In a 2012 paper, Ackerman and Stanton modified the Interagency Working Group's assumptions regarding uncertainty in the sensitivity of temperature change to emissions, the expected level of damages at low and high greenhouse gas concentrations, and the assumed discount rate, and found values for the social cost of carbon ranging from the Working Group's level up to more than an order of magnitude greater. Similarly, Laurie Johnson and Chris Hope modified discount rates and methodologies and found results up to twelve times larger than the Working Group's central estimate.

subject to significant uncertainty, this multi-agency effort represents an initial attempt at incorporating the benefits associated with CO_2 abatement into federal policy.

As of May 2012, these estimates had been used in at least 20 federal government rulemakings, for policies including fuel economy standards, industrial equipment efficiency, lighting standards, and air quality rules.[35, 36] In the first rule in which the revised 2013 values were used—improving energy efficiency in microwave ovens—the net present value of benefits over a 30-year timeframe increased by $400 million as a result of the increase in effective carbon price.[37] While a carbon price for federal rulemaking assessments is a fundamentally different kind of cost metric than the others discussed in this report, it nonetheless represents a dollar value for greenhouse gas emissions currently in use by the U.S. federal government.

7. RECENT CO_2 PRICE FORECASTS FROM THE RESEARCH COMMUNITY

The Energy Modeling Forum (EMF), a working group of government and private modeling teams, has been convening to explore energy system issues since the late 1970s. The group recently completed its EMF 24 analysis with the objective of evaluating what CO_2 price trajectories are consistent with proposed emission reduction targets under different technology scenarios. This analysis also incorporated several complementary policies in a cap-and-trade proposal, including: transportation emissions reduction through vehicle gas mileage standards; renewable portfolio standards in the electric sector; and mandates that all new coal facilities employ carbon capture and storage (CCS) technology—a

[33] Frank Ackerman and Elizabeth A. Stanton (2012). "Climate Risks and Carbon Prices: Revising the Social Cost of Carbon." *Economics: The Open-Access, Open-Assessment E-Journal*, Vol. 6, 2012-10. http://dx.doi.org/10.5018/economics-ejournal.ja.2012-10.

[34] Laurie T. Johnson, Chris Hope. "The social cost of carbon in U.S. regulatory impact analyses: an introduction and critique." *Journal of Environmental Studies and Sciences*, 2012; DOI: 10.1007/s13412-012-0087-7.

[35] Robert E. Kopp and Bryan K. Mignone (2012). "The U.S. Government's Social Cost of Carbon Estimates after Their First Two Years: Pathways for Improvement." Economics: The Open-Access, Open-Assessment E-Journal, Vol. 6, 2012-15. http://dx.doi.org/10.5018/economics-ejournal.ja.2012-15.

[36] See, for example, "Rulemaking for Microwave Ovens Energy Conservation Standard: Technical Support Document." May 2013. Available at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/37

[37] Brad Blumer (2013). "The social cost of carbon is on the rise." The Washington Post, June 6th, 2013. Available at: http://articles.washingtonpost.com/2013-06-06/business/39789409_1_carbon-dioxide-emissions-obama-administration.

policy similar to EPA's proposed NSPS for coal plants. Nine modeling teams participated in this study.[38,39]

Results from the EMF 24 exercise show a range of CO_2 price trajectories depending on availability of new technologies, policy type, model baseline trajectories, and other more structural characteristics of the models. One question asked by this study that is of particular relevance to users of the Synapse CO_2 price forecast is: which economic sectors would emissions reductions come from in an economically efficient approach to emissions mitigation? Consistent with earlier EMF analyses, the electric sector was found to be the largest contributor to CO_2 emissions reductions across all models.

Under a cap-and-trade scenario designed to reduce energy system emissions 50 percent below 2005 levels by 2050, most of the EMF 24 models reduced electric sector emissions by 75 percent by 2050. Under an 80 percent emissions reduction scenario, most of the additional emissions reductions came from other sectors. Although CO_2 prices are higher under the 80 percent scenario, most electricity customers are not paying these prices, as the electricity sector is largely decarbonized before 2050.

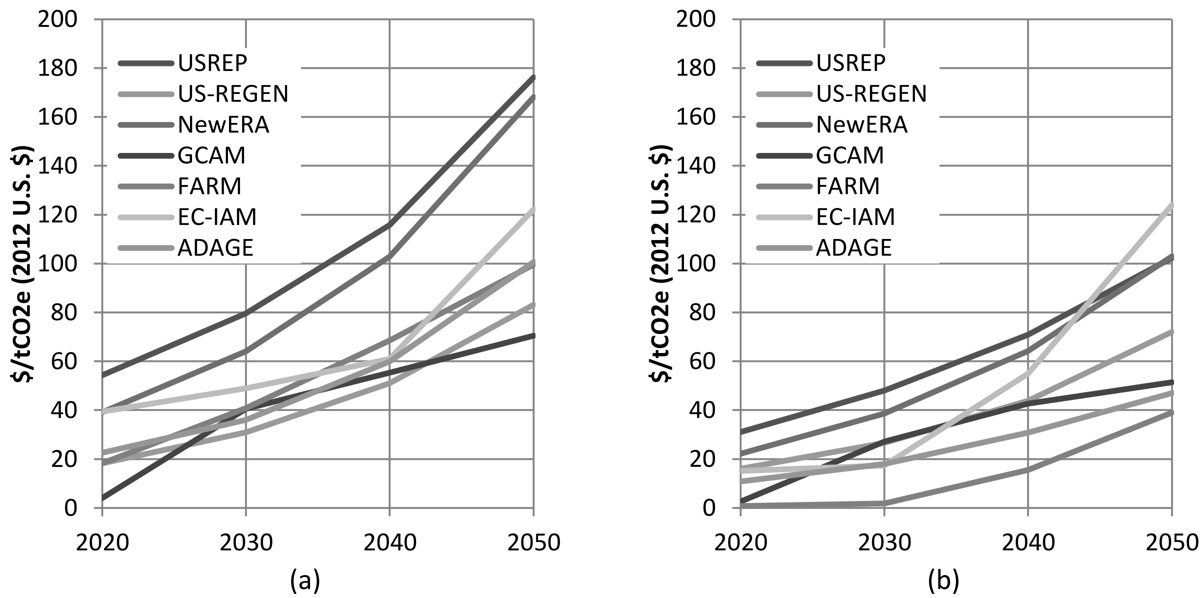
CO_2 prices estimated by the EMF 24 models show substantial variation. While it is difficult to distinguish the roles of model structure and model assumptions in this variation, the results present a reasonable range across which prices may fall. Under the most optimistic technology assumptions, with low-cost renewables, high levels of energy efficiency, and availability of new nuclear and CCS, CO_2 prices in 2020 fell between \$10 per tCO_2 and \$40 per tCO_2. In contrast, prices fell between \$20 per tCO_2 to \$80 per tCO_2 under the most pessimistic assumptions. Complementary policies, such as renewable portfolio standards or fuel economy standards, reduce carbon prices, as indicated in Figure 1.

Universally, the models show that substantial emissions reductions are not achievable in the absence of a policy. Even in the most optimistic technology scenario, the most aggressive emissions reductions from any model in the absence of a policy was 0.19 percent per year, resulting in emissions 7 percent below 2005 levels in 2050.

[38] Clarke, L.C., A.A. Fawcett, J.P. Weyant, V. Chaturvedi, J. MacFarland, Y. Zhou, "Technology and U.S. Emissions Reductions Goals: Results of the EMF 24 Modeling Exercise," (forthcoming). *The Energy Journal.*

[39] Fawcett, A.A., L.C. Clarke, S. Rausch, J.P. Weyant. "Overview of EMF 24 Policy Scenarios," (forthcoming). *The Energy Journal*.

Figure 1: Allowance prices from EMF study under (a) 50 percent cap-and-trade policy and with (b) the addition of several complementary policies (optimistic CCS/nuclear technology assumptions) [35,36]



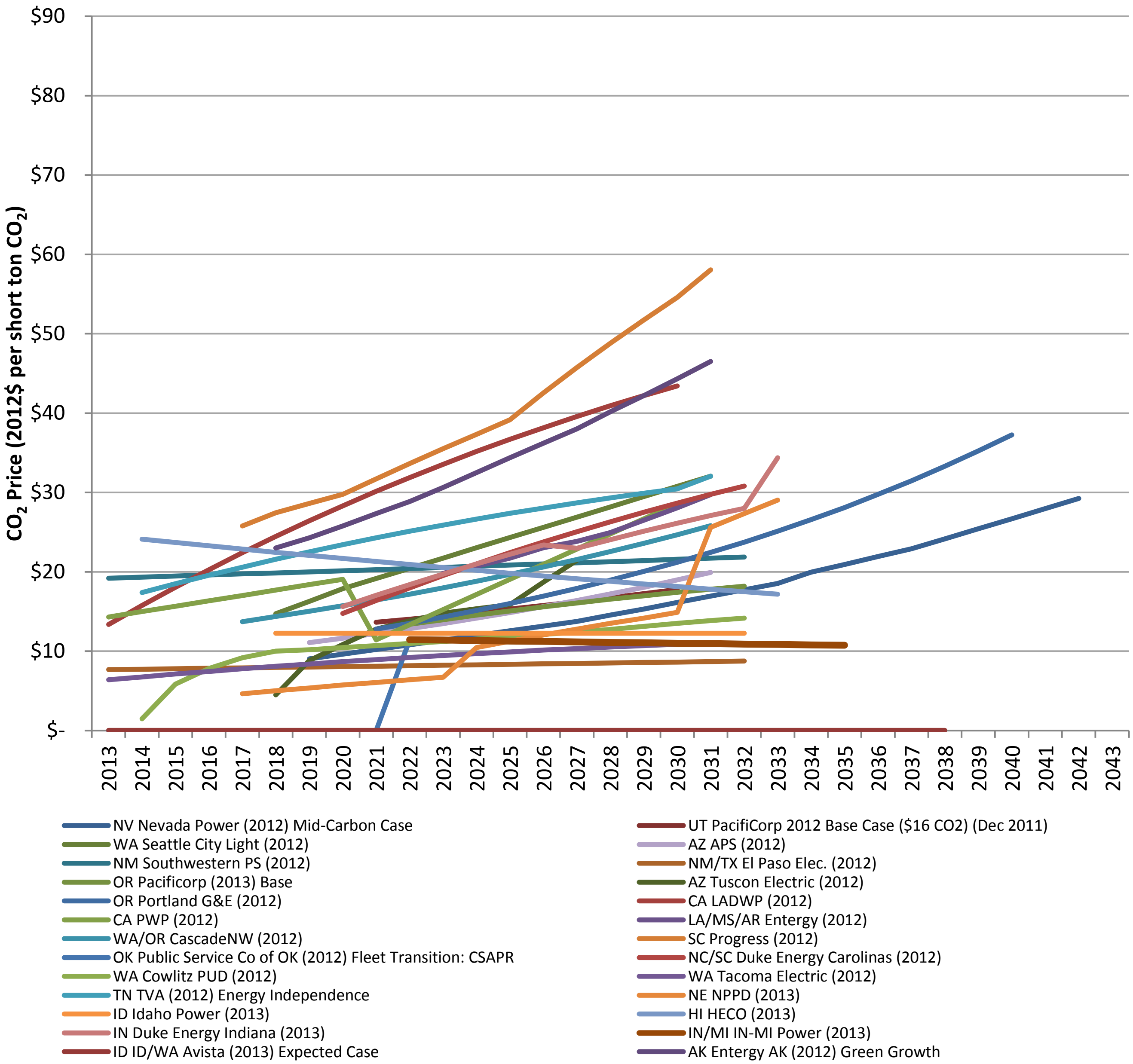
8. CO_2 PRICE FORECASTS IN UTILITY IRPS

A growing number of electric utilities include projections of the costs that will be associated with greenhouse gas emissions in their resource planning procedures. Figure 2 summarizes the reference case values (often described as their "mid" or "central" values) of publicly available forecasts used by utilities in resource planning over the past two years.[40]

Despite ongoing obstacles to a federally legislated CO_2 price and challenges in Congress to addressing climate or energy policy in a meaningful way, many utilities are including an effective price for carbon in their planning. The majority of utility reference case carbon price forecasts start in the 2015-2020 timeframe, and rise gradually (in real terms) throughout the study period.

[40] Where a utility has released multiple IRP or IRP updates in the past two years, we have included only the most recent value. The IRPs shown here represent those publicly available by internet as of the October 2013.

Figure 2: Utility Reference Case Forecasts from 2012 and 2013



9. Overview of the Evidence for a Future CO_2 Price

Our CO_2 price forecasts are developed based on the data sources and information presented above and reflect a reasonable range of expectations regarding future efforts to limit greenhouse gas emissions. The following items have guided the development of the Synapse forecasts:

- **Regulatory measures limiting CO_2 emissions from power plants will be implemented in the near term**. The EPA is required to propose emissions standards for existing power plants under Section 111(d) of the Clean Air Act by June 2014. Standards for new power plants were proposed on September 20, 2013. These actions represent an effective price that will affect utility planning and operational decisions.

- **State and regional action limiting CO_2 is ongoing and growing more stringent**. In the Northeast, the RGGI CO_2 cap has been tightened, resulting in higher CO_2 prices for electric generators in the region. California's Cap-and-Trade Program, which represents an even larger carbon market than RGGI, has held many successful allowance auctions, and has been successfully defended against numerous legal challenges.

- **A price for CO_2 is already being factored into federal rulemakings.** The federal government has demonstrated a commitment to considering the benefits of CO_2 abatement in rulemakings such as fuel economy and appliance standards.

- **Ongoing analysis of emissions caps suggests a wide range of possible prices.** Important factors include the stringency of any future climate policy, the existence of complementary policies, technology availability, and how quickly old capital stock can be phased out in favor of new technologies.

- **Electric suppliers continue to account for the opportunity cost of CO_2 abatement in their resource planning.** Prudent planning requires utilities to consider adequately the potential for future policies. The range of carbon prices reported in section 8 indicates that many utilities believe that by 2020 there will likely be significant economic pressure towards low-carbon electric generation.

10. Synapse 2013 CO_2 Price Forecast

Based on analyses of the sources described in sections 3 through 8 (above), and relying on our own expert judgment, Synapse has developed Low, Mid, and High case forecasts for CO_2 prices from 2013 to 2040. Figure 3 and Table 1 show the Synapse forecasts over this period.

Figure 3: Synapse 2013 CO_2 Price Trajectories

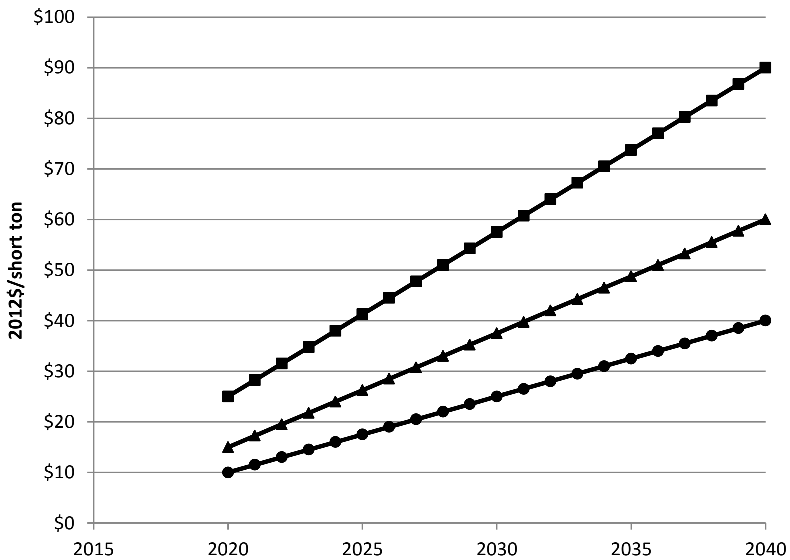


Table 1: Synapse 2013 CO_2 Allowance Price Projections (2012 dollars per ton CO_2)

Year	Low Case	Mid Case	High Case
2020	$10.00	$15.00	$25.00
2021	$11.50	$17.25	$28.25
2022	$13.00	$19.50	$31.50
2023	$14.50	$21.75	$34.75
2024	$16.00	$24.00	$38.00
2025	$17.50	$26.25	$41.25
2026	$19.00	$28.50	$44.50
2027	$20.50	$30.75	$47.75
2028	$22.00	$33.00	$51.00
2029	$23.50	$35.25	$54.25
2030	$25.00	$37.50	$57.50
2031	$26.50	$39.75	$60.75
2032	$28.00	$42.00	$64.00
2033	$29.50	$44.25	$67.25
2034	$31.00	$46.50	$70.50
2035	$32.50	$48.75	$73.75
2036	$34.00	$51.00	$77.00
2037	$35.50	$53.25	$80.25
2038	$37.00	$55.50	$83.50
2039	$38.50	$57.75	$86.75
2040	$40.00	$60.00	$90.00
Levelized 2020-2040	$22.36	$33.54	$51.79

In these forecasts, state and regional policies, together with federal regulatory measures, place economic pressure on CO_2 emitting resources in the next several years, such that it is relatively more expensive to operate a high-carbon-emitting power plant. These pressures are followed later by a broader federal policy, such as cap and trade. In any state other than the RGGI region and California, we assume a zero carbon price through 2019; beginning in 2020, we expect that federal regulatory measures will put economic pressure on carbon-emitting power plants throughout the United States. All annual allowance prices and levelized values are reported in 2012 dollars per short ton of carbon dioxide.

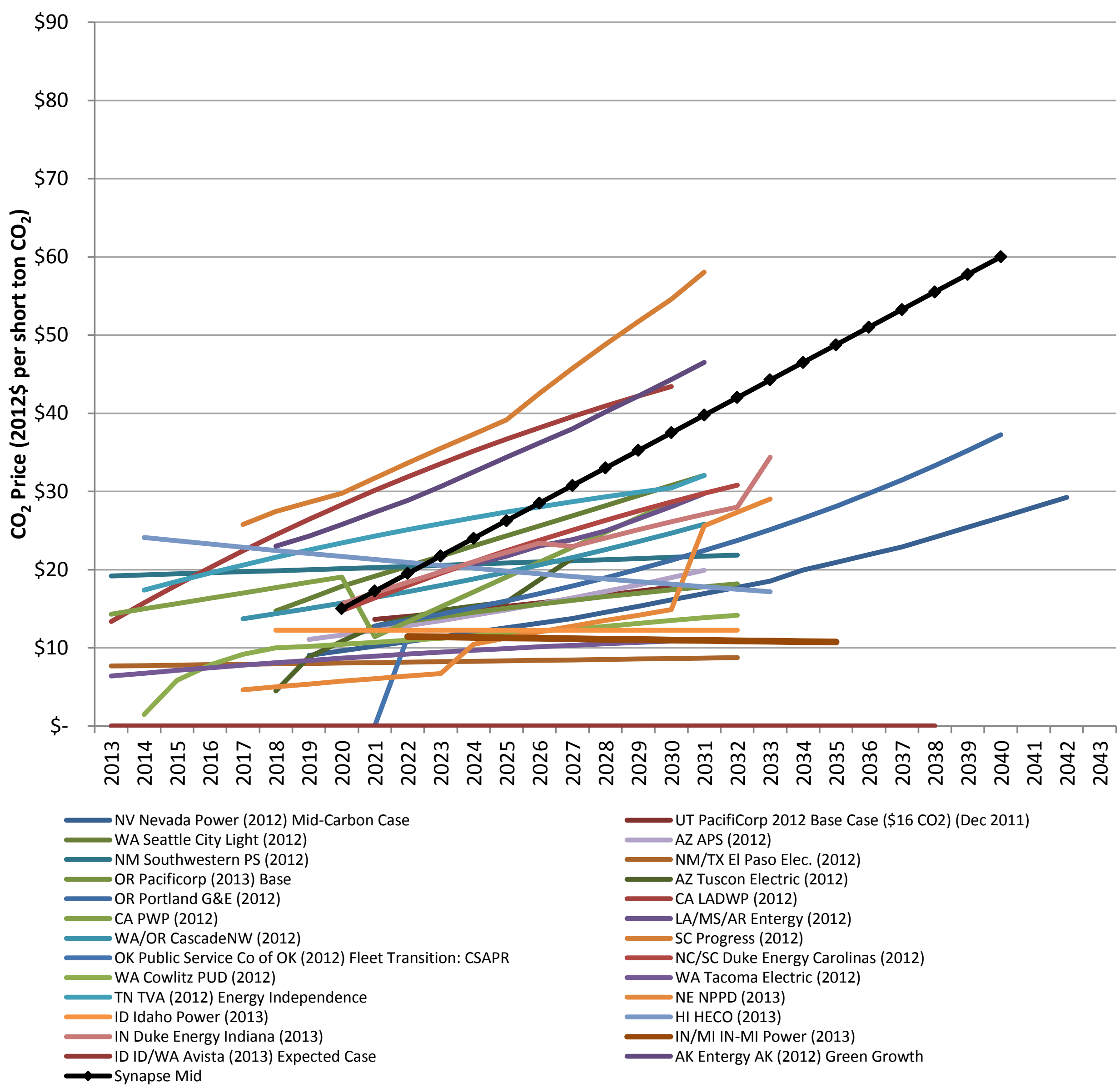
- The **Low case** forecasts a carbon price that begins in 2020 at $10 per ton, and increases to $40 per ton in 2040, representing a $22 per ton levelized price over the period 2020-2040. This forecast represents a scenario in which federal policies—either regulatory or legislative—exist but are not very stringent.
- The **Mid case** forecasts a carbon price that begins in 2020 at $15 per ton, and increases to $60 per ton in 2040, representing a $34 per ton levelized price over the period 2020-2040. This forecast represents a scenario in which federal policies are implemented with significant but reasonably achievable goals.
- The **High case** forecasts a carbon price that begins in 2020 at $25 per ton, and increases to approximately $90 per ton in 2040, representing a $52 per ton levelized price over the period 2020-2040. This forecast is consistent with the occurrence of one or more factors that have the effect of raising carbon prices. These factors include somewhat more aggressive emissions reduction targets; greater restrictions on the use of offsets; restricted availability or high cost of technology alternatives such as nuclear, biomass and carbon capture and sequestration; more

aggressive international actions (thereby resulting in fewer inexpensive international offsets available for purchase by U.S. emitters); or higher baseline emissions.

These price trajectories are designed for planning purposes, so that a reasonable range of emissions costs can be used to investigate the likely costs of alternative resource plans. We expect an actual CO_2 price to fall somewhere between the low and high estimates throughout the forecast period.

In Figure 4, the Synapse Mid forecast is shown in comparison to the reference case utility forecasts presented earlier. See Appendix A for comparisons to utilities' Low and High case forecasts.

Figure 4: Synapse Mid Forecast Compared to Recent Utility Mid Case Forecasts



In Figure 5, the Synapse forecasts are compared to the carbon price used in federal rulemaking. While the federal price starts out higher in 2020, the Synapse Mid forecast approaches this value at the end of the projected period. In Figure 6, the Synapse forecasts for 2020 are compared to several of the sources identified in this report: the carbon price used in federal rulemakings, EMF 24 study results, and recent utility forecasts. The high and low ends of these sources span a wide range, but the central values show less variation.

Figure 5: Synapse Forecast Compared to Carbon Price Used in Federal Rulemakings

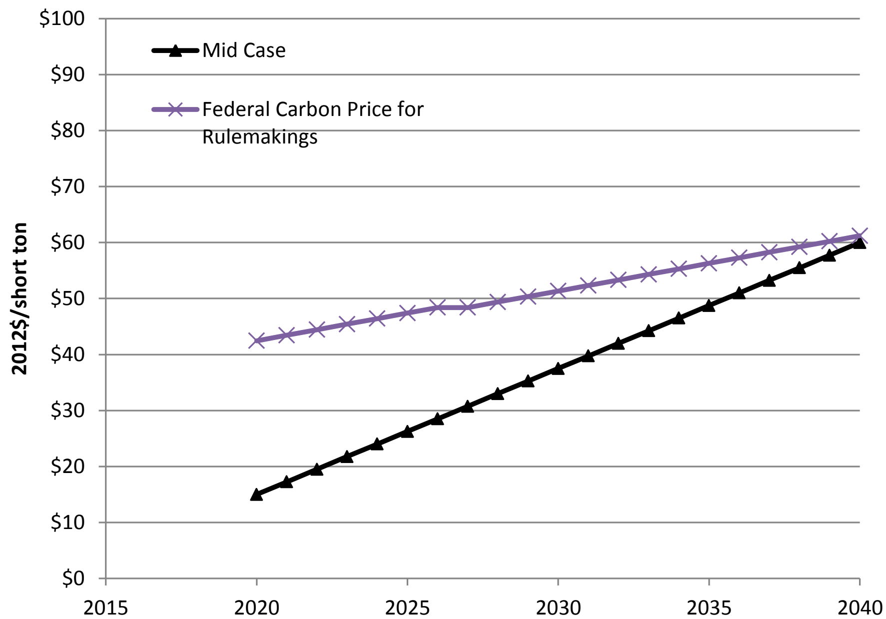
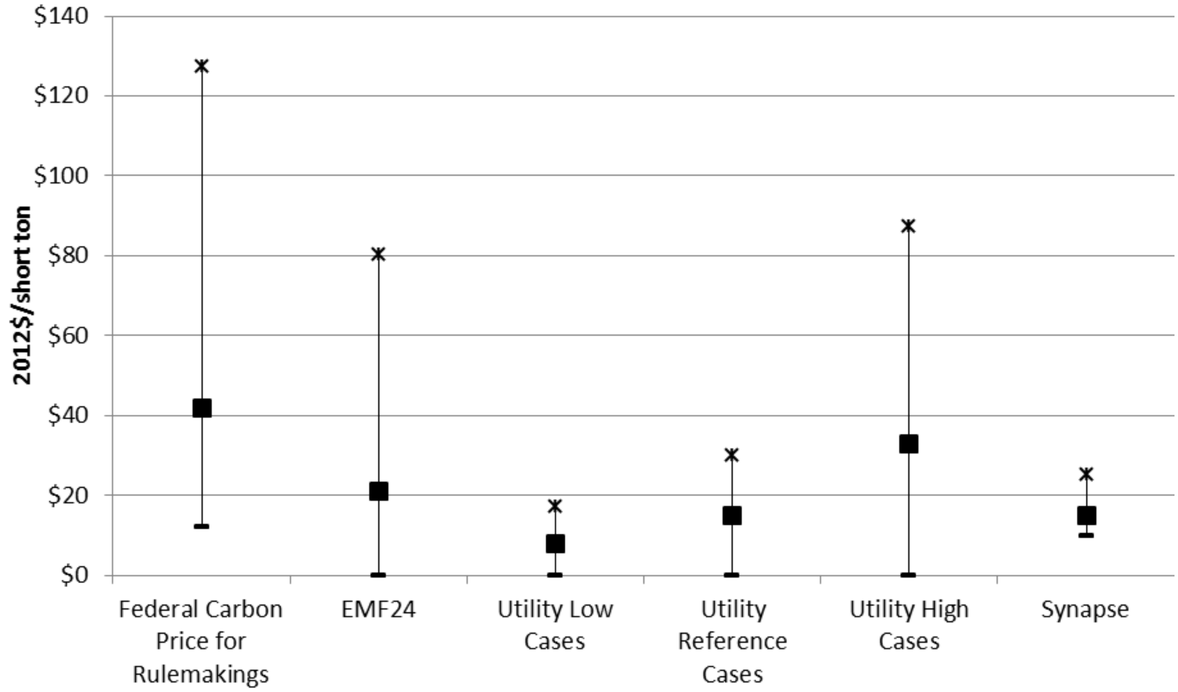


Figure 6: Synapse CO_2 Forecasts for 2020 Compared to Other Sources



APPENDIX A: SYNAPSE FORECAST COMPARED TO UTILITY FORECASTS

Figure 7: Synapse CO_2 Price Forecast Compared to Recent Utility Low-case Forecasts

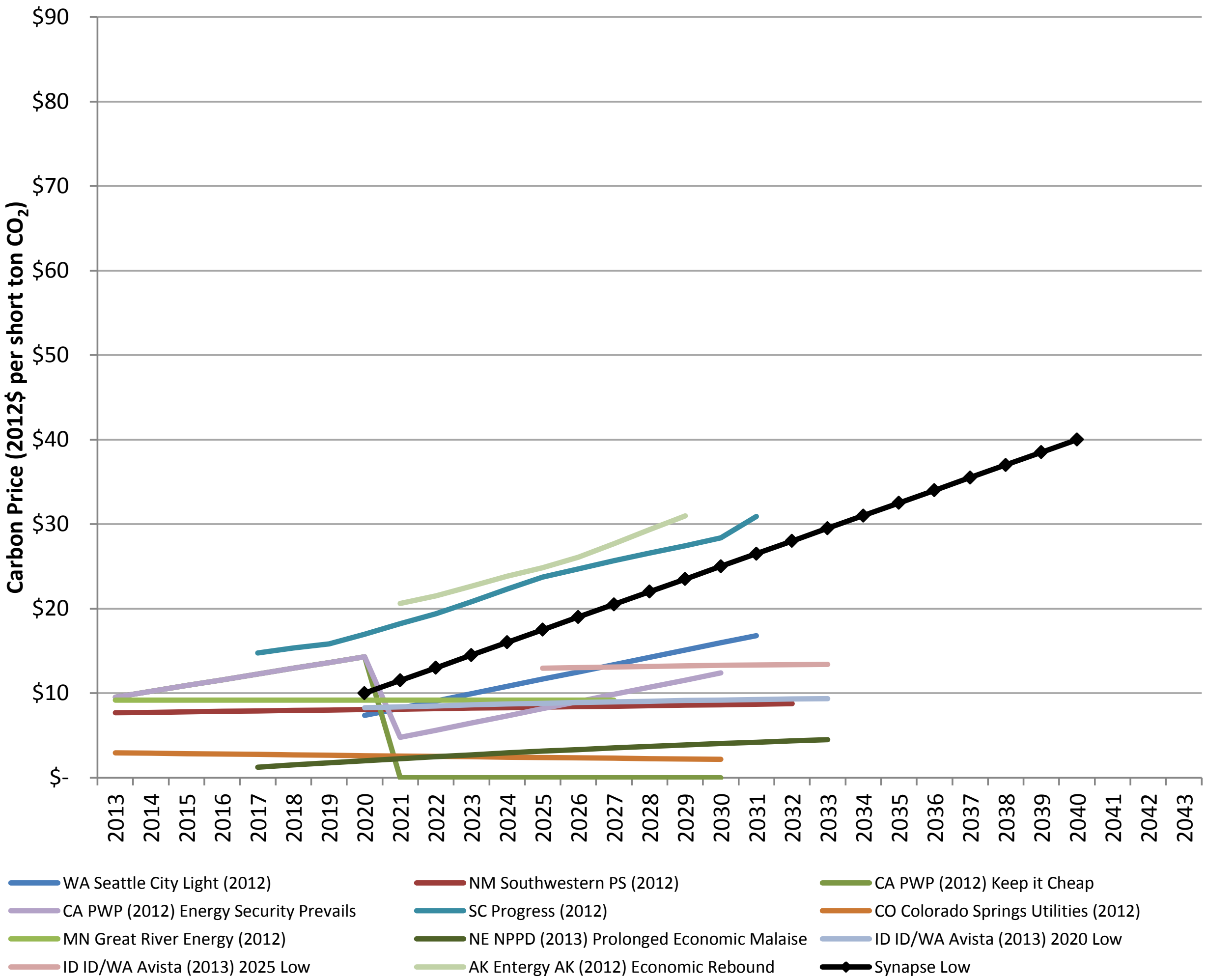
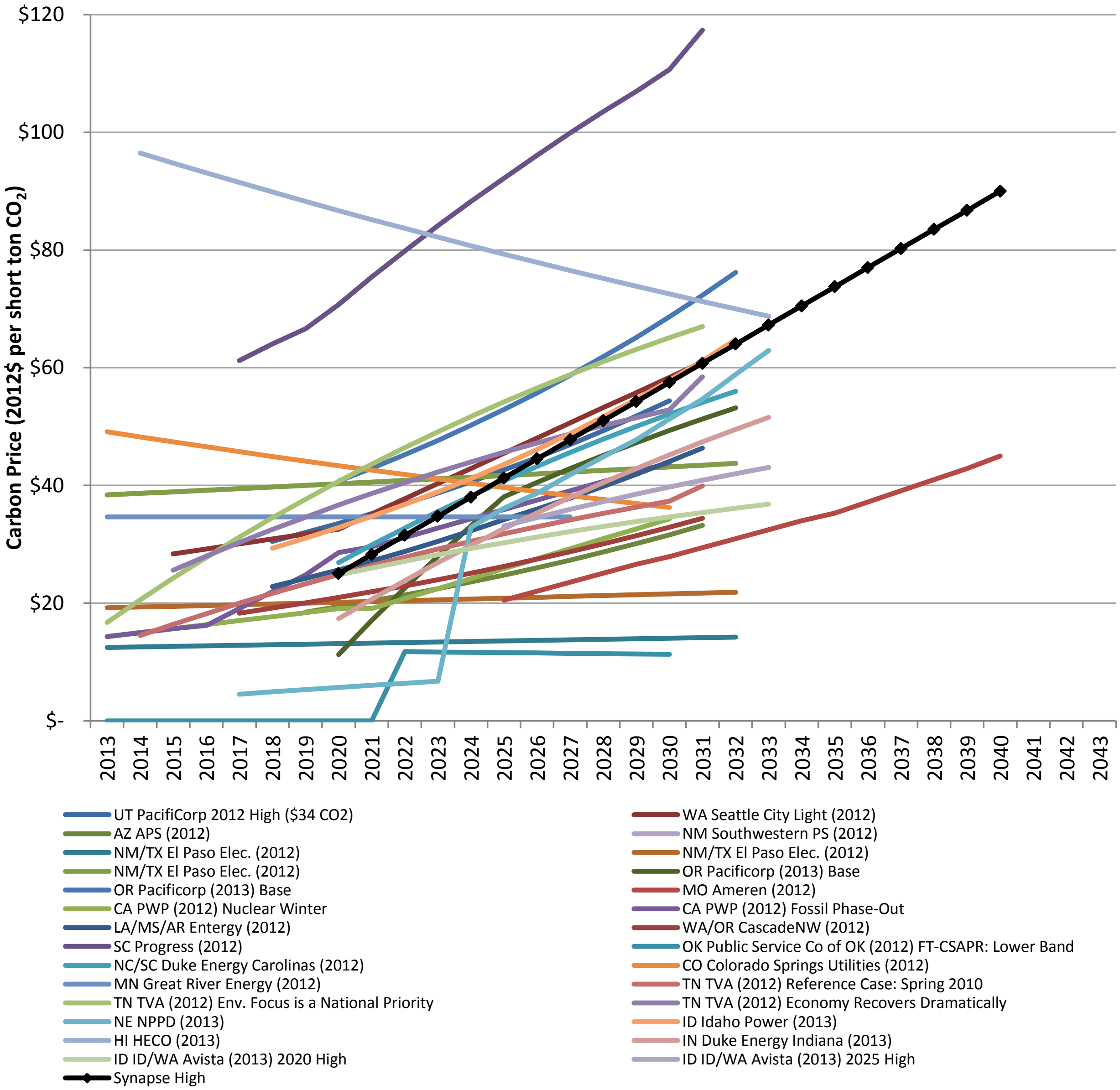


Figure 8: Synapse CO_2 Price Forecast Compared to Recent Utility High-case Forecasts



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STATE OF MISSOURI

Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director

DEPARTMENT OF NATURAL RESOURCES

www.dnr.mo.gov

AUG - 2 2012

Mr. Michael L. Menne
Vice President of Environmental Services
Ameren Services
1901 Chouteau Avenue
P.O. Box 66149, MC 602
St. Louis, MO 63166-6149

RE: Compliance Extension Request for Ameren Missouri Labadie Energy Center Units 1, 2, 3 and 4

Dear Mr. Menne:

The Missouri Department of Natural Resources' Air Pollution Control Program (APCP) has received your request, dated June 21, 2012, for a one-year extension of the compliance date for the federal Mercury and Air Toxics Standards (the MATS rule), also known as the *National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units* found in 40 CFR Part 63 Subpart UUUUU. This request was made in accord with Section 63.9(c) and/or Section 63.6(i); 40 CFR Part 63, Subpart A, *National Emission Standards for Hazardous Air Pollutants for Source Categories*, Subpart A-General Provisions and in accord with the Clean Air Act under 42 USC §7412(i)(3)(B).

After reviewing your letter and documentation, the APCP hereby approves your request for a one-year extension of the compliance date with the MATS rule for the above facility. Therefore, the approved compliance date for the above facility will be April 16, 2016.

Thank you for your cooperation in this matter. If you have any questions regarding this letter or the MATS rule, please contact Ms. Darcy Bybee at the Air Pollution Control Program, P.O. Box 176, Jefferson City, MO 65102 or by telephone at (573) 751-6415. You can also find out more about the department on the Internet at www.dnr.mo.gov.

Sincerely,

AIR POLLUTION CONTROL PROGRAM

Kyra L Moore

Kyra L. Moore
Director

KLM:dbv

c: Mr. Kendall Hale, Air Pollution Control Program
Mr. Gary Bertram, EPA Region VII
Mr. Ward Burns, EPA Region VII
Mr. Tom Sims, St. Louis Regional Office
Source File: 071-0003

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Ameren

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June 21, 2012

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Kyra Moore
Director, Air Pollution Control Program
Missouri Department of Natural Resources
P. O. Box 176
Jefferson City, MO 65102

Subject: Compliance Extension Request for Ameren Missouri Labadie Energy Center Units 1, 2, 3 and 4

Dear Ms. Moore,

Ameren Services as authorized agent for Ameren Missouri submits this request for a one-year extension of the compliance date for the federal Mercury and Air Toxics Standards (the MATS rule); National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam
Generating Units 40 CFR Part 63 Subpart UUUUU; from April 16, 2015 to April 16, 2016. This request is being made in accordance with section 63.9(c) and/or section 63.6(i); 40 CFR Part 63, Subpart A — National Emission Standards for Hazardous Air Pollutants for Source Categories, Subpart A — General Provisions and in accordance with the Clean Air Act under 42 USC § 7412(i)(3)(B) (CAA Section 112 (i)(3)(B)).

Ameren Missouri has been and continues to evaluate compliance strategies for the Labadie Energy Center to meet the stringent requirements of the MATS rule. Labadie units 1-4 currently use SO_3 as a flue gas conditioning agent to enhance electrostatic precipitator performance to ensure compliance with the current particulate and opacity emission standards. Based on industry research and specific tests conducted at Labadie it is known that the use of SO_3 as a flue gas conditioning agent interferes with the capture of mercury (Hg). Because of this interference, continued use of SO_3 will have an adverse impact on mercury capture and will not allow the Labadie units to continuously comply with the mercury emission limitation under the MATS rule. Ameren Missouri is evaluating several options to determine the best strategy to comply with all of the MATS emission limitations. As part of that evaluation, Ameren Missouri is/has:

1. Evaluating various mercury sorbents including activated carbon;
2. Evaluating alternative flue gas conditioning agents to replace SO_3 such as ATI-2001;
3. Evaluating electrostatic precipitator (ESP) optimization strategies;
4. Conducted induced draft fans testing to evaluate their suitability with enhanced ESPs;
5. Purchased and installed particulate matter continuous emission monitors (PM CEMs) to evaluate variability in PM emissions and to aide in the design of pollution control upgrades.

The evaluations indicate that the best strategy to meet the MATS emissions limitations for both mercury and particulate matter is to discontinue or minimize the use of SO_3 as a flue gas conditioning agent. In order to comply with the more stringent PM emission limit under the MATS rule and eliminate or minimize the use of SO_3 will require the replacement and/or significant upgrades to the existing electrostatic precipitators. Currently Ameren Missouri believes the most cost effective approach for achieving PM limits will be to utilize the site averaging provisions in the MATS rule and blend a combination of new and upgraded electrostatic precipitators on the Labadie units to achieve compliance with the required emission limits. The time needed to complete the replacement and/or significant upgrades, testing, and development of an approved averaging plan will extend beyond the April 16, 2015 compliance date. Ameren has begun engineering and design work and we do not believe that the retrofit projects for all 4 units can be completed by the compliance deadline. As a result, Ameren Missouri is requesting this one year extension of the compliance date. The following list includes information to support this conclusion:

1. Based on the information provided in this request, Labadie Energy Center units 1, 2, 3 and 4 will not be able to meet the new emission limitations of the MATS rule with currently installed pollution control equipment.
2. The use of SO_3 as a flue gas conditioning agent significantly hinders the ability to comply with the mercury emission limits of the MATS rule with the existing electrostatic precipitators. The existing electrostatic precipitators must be replaced or significantly upgraded to ensure compliance with the MATS emission limits without the use of SO_3 gas conditioning.
3. Time must be allowed after completion of the upgrades and/or replacements to test and tune the equipment, verify design performance, develop an averaging plan and ensure that the emission limits can be met.
4. Ameren has started engineering and design for retrofit and upgrade of the existing electrostatic precipitators for units 1 and 2 and has a contract in place with a material supplier. The retrofit will replace the existing "A" and "B" precipitators and will upgrade the existing "C" precipitator. This retrofit and upgrade is expected to take two years to complete with construction beginning in late 2012.
5. It is not feasible to replace/upgrade all of the electrostatic precipitators for Labadie units 1, 2, 3 and 4 simultaneously due to engineering, safety, schedule, testing and space constraints in time to meet the April 16, 2015 compliance date.
6. Ameren Labadie Energy center plans to install activated carbon injection (ACI) systems to control mercury. ACI systems will be ineffective in mercury capture until precipitator replacements and upgrades are in place allowing SO_3 systems to operate minimally or be retired.
7. Due to site configuration, proper placement of the activated carbon storage silos associated with the ACI systems requires that the engineering and design be completed for the electrostatic precipitator retrofits before construction of the activated carbon silos can commence.

Ameren has attempted to evaluate compliance with the HCl MATS emission limit by doing spot emission tests to determine the HCl concentration in the flue gas. The MATS rule includes the use of continuous emission monitoring systems for HCl, however no viable CEMS for electric generating units are commercially available at this time. The results of limited emission tests indicate that the Labadie units are in compliance with the HCl MATS emission limit, however longer term monitoring is needed to ensure future compliance. Ameren's goal is to confirm this trend using HCl CEMs when they become available to avoid installation of unnecessary additional control equipment. Ameren does not believe that this can be accomplished by the April 16, 2015 deadline.

Ameren

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CONTROL PGM

June 21, 2012

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Kyra Moore
Director, Air Pollution Control Program
Missouri Department of Natural Resources
P. O. Box 176
Jefferson City, MO 65102

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Ameren Missouri has been and continues to evaluate compliance strategies for the Labadie Energy Center to meet the stringent requirements of the MATS rule. Labadie units 1-4 currently use SO_3 as a flue gas conditioning agent to enhance electrostatic precipitator performance to ensure compliance with the current particulate and opacity emission standards. Based on industry research and specific tests conducted at Labadie it is known that the use of SO_3 as a flue gas conditioning agent interferes with the capture of mercury (Hg). Because of this interference, continued use of SO_3 will have an adverse impact on mercury capture and will not allow the Labadie units to continuously comply with the mercury emission limitation under the MATS rule. Ameren Missouri is evaluating several options to determine the best strategy to comply with all of the MATS emission limitations. As part of that evaluation, Ameren Missouri is/has:

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Ameren Missouri is currently working with EPRI to test prototype HCl CEMS at our Rush Island Energy Center in early 2013. The goals of the testing are to better understand HCl CEMs capabilities as well as to evaluate their operation for meeting monitoring requirements of the MATS rule.

As stated in this request, Ameren Missouri believes that ample justification has been provided to support a decision to grant a one year extension in accordance with the Clean Air Act for Labadie Energy Center units 1, 2, 3 and 4.

Please contact either Steve Whitworth (314-554-4908) or Ken Anderson (314-554-2089) of my staff at your convenience if you have any questions regarding this request.

I certify, based on information and belief formed after reasonable inquiry, the statements and information in this document are true accurate and complete.

Sincerely,

Michael L. Menne

Michael L. Menne
Vice President, Environmental Services

Cc: Darcy Bybee
Compliance and Enforcement Section Chief
Air Pollution Control Program
Missouri Department of Natural Resources
P. O. Box 176
Jefferson City, MO 65102

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a AmerenUE's Tariffs to Increase its Annual Revenues for Electric Service	)))	Case No. ER-2014-0258

County of Marion)
) ss
State of Oregon)

AFFIDAVIT OF EZRA D. HAUSMAN

Ezra D. Hausman, of lawful age, on his oath states: that he has participated in the preparation of this revised direct testimony in question and answer form consisting of 21 pages to be given as Direct Testimony in the above-named case; that the answers were given by him and that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.

E. D. Hausman

Ezra D. Hausman

In witness whereof I have hereunto subscribed by name and affixed my official seal this 8th day of December, 2014.

OFFICIAL STAMP
CHERYL ANN CHURCHEK
NOTARY PUBLIC - OREGON
COMMISSION NO. 928940
MY COMMISSION EXPIRES MAY 28, 2018

Cheryl A. Churchek