Time to Retool the Priorities at the Nexus of Environmental and Energy Policy in the U.S.

Comments submitted to the Environmental Protection Agency regarding the draft rules for the Clean Power Plan, the Clean Air Act Section 111 (d)

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ABSTRACT

The United States needs a much more strategic approach to manage its domestic energy assets including energy generation sources utilizing shale oil and natural gas. As written today, the Environmental Protection Agency (EPA), Clean Power Plan, will drive too much of the electrical utility generation market to natural gas power plants resulting in a short-term failure to meet greenhouse gas reduction goals and undermining more effective immediate steps with energy efficiency, demand management, energy storage, and development of existing as well as future renewable energy generation alternatives. Further, growing transportation markets for electric vehicles (EV) depend on a clean energy grid to be truly effective in reducing greenhouse gases. That clean energy generation grid does not exist today in the U.S. This paper considers the benefits of distributed energy generation with eye

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Prior to attending UW-Madison, Kaldunski covered federal and state-level environmental policy as a reporter and market analyst for Argus Media in Washington, D.C. His primary duties were covering federal emissions markets, the RGGI and California carbon trading markets, and various state-level renewable energy certificate (REC) trading markets. Kaldunski published more than 500 articles during his time at Argus. He has also written several articles as a freelance reporter for the Smart Grid Observer.

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Executive Summary

The Environmental Protection Agency (EPA), Clean Power Plan, represents a critical turning point in the energy and environmental policy nexus. The proposed Clean Power Plan rules must be implemented as quickly as possible, but as written will not achieve enough reductions in greenhouse gas emissions to be an effective policy design. A prime opportunity exists to rethink and retool the rule in order to provide steady progress in greenhouse gas reduction and to allow for the necessary transformation of our electric utility energy sector to provide sustainable solutions for the future. The first draft of the rules written for governing the Clean Power Plan are available for comments and this paper provides detailed comments. Listed below are some of the problems with the current proposed EPA, Clean Power Plan, (aka. Section III (d), of the Clean Air Act), rule and some thoughts on a pathway to a better solution:

Problems:

1) The Clean Power Plan as written drives much of the electrical utility generation market to natural gas power over clean energy solutions.
2) More specifically, the rule as written today will result in the rapid deployment of gas combined cycle power plants and a utility base-load facility over-build throughout the U.S. These are energy assets with 30 or more years of life that investment away from clean energy solutions. This creates a new – although slightly reduced compared to coal plants – greenhouse gas carbon lock-in cycle with natural gas generation plants for the U.S. energy market place.
3) Potential methane emissions from natural gas drilling, transportation, production conversion and energy generation may be much more dangerous than previously thought, according to numerous independently done research and studies cited here.
4) The EPA has likely underestimated U.S. methane emissions in previous analysis.
5) Short-term alternatives with existing renewable energy generation options including wind, solar PV, biomass and biogas, are not being developed today in the U.S. to their full potential driven largely barriers with existing rules, statutes, policy and utility business models and the proposed EPA rule does little to nothing to change these factors. The rule could reverse this trend by placing a priority on renewable generation to meet the targets long-term versus a priority on short-term compliance goals.
6) Another potential GHG reduction strategy in the transportation sector of moving more motor vehicles to electric vehicles (EV) only works if the U.S. electrical generation grid is generating clean energy versus high carbon energy. The U.S. electric generation grid today is not a clean energy solution.
7) The issues with too much water usage going to energy generation can no longer be separated from energy policy, air quality policy and greenhouse gas reduction policy. We need sustainable policy solutions.

Potential Solutions:

1) **Raise the GHG Reduction Benchmark**: A report from the Union of Concerned Scientists says the EPA could nearly double the amount of cost-effective

renewable energy – from 12 percent of total 2030 U.S. electric sales to 23 percent. Most significant is the fact that shifting the emphasis to existing renewable technologies would result in greenhouse reductions from the current proposed rule benchmark of 30 percent below the 2005 levels by 2030 to a 40 percent below the 2005 level. Raising the benchmark should also allow for a more phased-in GHG reduction over time versus large reduction in the first year.

2) **Energy Efficiency and Clean Energy Generation First**: Use a tiered-set of higher-to-lower priorities for approving state implementation plans in an expanded set of building blocks for best system emission reduction measures. Place a higher priority on energy efficiency and substitution of coal and natural gas with clean energy generation sources of wind, solar PV, biomass and biogas.
3) **Use Performance-Based Electric Utility Rates**: Encourage states to adopt performance-based rates that allow electric utilities to make money during the energy transition for high carbon sources to clean energy sources. The federal agencies can assist states in setting good solid measures and metric for set performance goals of reducing greenhouse gases and using energy efficiency.
4) **Improve Regional Energy Planning**: Develop a memorandum of understanding (MOU) between EPA and FERC that cross references the EPA rule with the FERC 1000 rule. Under the MOU the agencies can collaborate with states and regional transmission authorities to make sure both greenhouse gas reduction and energy reliability needs are addressed nationally and locally. The agencies can also work with state and local entities on development of funding and cost allocation methods for non-transmission solutions (NTAs) that including recognition of avoided energy costs, reduced wholesale electricity costs, reduced air pollution and water usage, and avoided land use and siting costs. The NTA options for regional transmission planning and the EPA greenhouse gas reduction goals steps complement each other very well including steps in energy efficiency, demand response, and increasing distributed generation including the advancing to technologies with microgrids and energy storage.
5) **The Dynamic Distribution System**: Encouraging competitive markets forces to complement compliance goals will move the U.S. toward steady and sustained greenhouse gas reduction goals. Redesigning the energy distribution market throughout the U.S. to allow for new energy generation market entrants and even individual businesses and home-owners to sell excess self-generation energy in a fair, open, and transparent dynamic distribution system marketplace is the recommended path.
6) **Wisconsin Options for EPA Rule Compliance**: This analysis compares a business-as-usual (BAU) scenario against a natural gas fuel switching, scenario, and a 30% Renewable Portfolio Standard (RPS) to determine which strategy achieves the greatest emission reductions at the lowest cost. The scenarios were compared using a spreadsheet model and the MyPower modeling software developed by researchers at the Wisconsin Energy Institute (WEI).[1] Both models show that the 30% RPS can reduce Wisconsin's CO_2 emissions below EPA's targets, at a lower cost than the fuel switching scenario. These results were shown under conditions where fossil fuel prices rise steadily at 2% annually, and a scenario where natural gas prices reflect historical volatility observed from 1998-2013. The 30% RPS produced lower costs than the fuel switching scenario under each simulation, illustrating the value of renewables as a hedge against price volatility.

[1] Meier, Paul. "MyPower Methodology and Documentation." Wisconsin Energy Institute (link).

Time to Retool the Priorities of Environmental and Energy Policy Nexus

Abstract: The United States needs a much more strategic approach to manage its domestic energy assets including energy generation sources utilizing shale oil and natural gas. As written today, the Environmental Protection Agency (EPA), Clean Power Plan, will drive too much of the electrical utility generation market to natural gas power plants resulting in a short-term failure to meet greenhouse gas reduction goals and undermining more effective immediate steps with energy efficiency, demand management, energy storage, and development of existing as well as future renewable energy generation alternatives. Further, growing transportation markets for electric vehicles (EV) depend on a clean energy grid to be truly effective in reducing greenhouse gases. That clean energy generation grid does not exist today in the U.S.

While it is critically important that the rules to regulate CO2 emissions from energy power plants advance, the details of compliance under Section III (d) of the Clean Air Act, should be rethought and retooled. The first draft of the rules written for governing the Clean Power Plan are available for comments and this paper provides detailed comments. The core concept of flexibility for the state implementation plans (SIPS) and portfolio of solutions for the building blocks to create a Best System of Emission Reduction (BSER) can be retained as a tiered set of higher-to-lower priorities and goals that help drive both state regulation and market pull in a energy demand reduction and clean power direction. Further, the EPA rule could provide guidance to state policymakers and regulators to consider policies to assist electric utilities to remain financial stable during the inevitable energy source generation transition by utilizing policies including performance-based rates (PBR) or incentives that actually could achieve measureable greenhouse gas reduction goals per year or by a base-year set for 2020 and 2030 dates. The organization for this paper first outlines the problems and vulnerabilities in the energy sector if too much of the energy generation market goes to natural gas. Next the paper reviews some general trends in the energy sector making it ripe for change. The benefits of distributed energy generation are considered with eye toward declining prices in wind and solar along with the constant value in greater energy efficiency steps. Specifically, some recommendations are included for the State of Wisconsin compliance to the Clean Power Plan. Finally, the paper presents some proposed fixes to the current draft rules for the Clean Power Plan and other considerations for improved greenhouse gas reduction.

EPA Can Shift Emphasis to Renewable Energy Generation Over More Large Natural Gas Generation Plants in Many States

Evidence is mounting that a much stronger focus on renewable energy generation is needed to make the EPA's Clean Power Plan effective. A report from the Union of Concerned Scientists says the EPA could nearly double the amount of cost-effective renewable energy – from 12 percent of total 2030 U.S. electric sales to 23 percent. Most significant is the fact that shifting the emphasis to existing renewable technologies would result in greenhouse reductions from the current proposed rule benchmark of 30 percent below the 2005 levels by 2030 to a 40 percent below the 2005 level. The costs of renewable energy generation continues to go down and this increase state emphasis under the rule should not in any way dramatically increase costs to energy ratepayers, under the models used for the study the maximum increase is 18 cents on the monthly electrical bill and lower in some states. Further, the report supports research by others that increasing the renewable energy mix reduces the economic risk from volatile natural gas prices and overreliance on deploying large-scale natural gas plants under the existing rule language. The recommended change to greater emphasis of renewable energy generation found in the Union of Concerned Scientists policy paper states the modification can fit into the "building block" approach in the original rule draft, but does suggest targets determining the best system of emission reductions, aka BSER.

- "Setting a national renewable energy growth rate benchmark based on demonstrated growth in the states from 2009 to 2013.
- Assuming full compliance with current state RES policies, as set by law, that require certain percentages of electricity to come from renewable sources.
- Accounting for actual and expected renewable energy growth between 2013 and 2017."[2]

The study looked at existing Energy Information Agency (EIA) data on state's deployment of renewable energy and found that on average states increased their renewable share of electricity sales by 1 percent annually during the period of 2009 to 2013. Using this growth rate as a national benchmark provides as helpful measure for public policy to helps states comply with the EPA Clean Power Plan. Again, the suggestion for increased renewable energy is part of several building block measures to comply with the Clean Air Act. Second, states could as recommended in this paper use a policy such as performance-based rates to comply with the achievable increases of 1% annually in renewable energy generation.

Natural Gas is Critical to Baseload Power Needs and Must Be Redeployed to Complement Greater Targeting of Renewable Energy Solutions First

There are many critical issues and questions with a large-scale fuel switch to natural gas for power electrical generation purposes including:

- **Supply:** What is the real long-term U.S. natural gas supply? How does that projected natural gas supply balance with the new much larger increase in fuel source demand?
- **Price:** Natural gas is a globally traded commodity and the price will eventually more closely reflect the global prices. To put it another, cheap domestic natural gas prices are likely a short-term phenomena and will move closer to either the historic domestic price volatility or possibly even soar to a level much higher based on global demand. Has the EPA and Department of Energy (DOE) along with the Federal Energy Regulatory Commission (FERC) adequately modeled natural gas price scenarios given this likely market change?
- **Water**: The entire energy market is increasingly vulnerable to the current and future drought conditions found in the U.S. and the larger issue of high water usage from the energy sector is not being factored into strategic planning. What are the best adaptive management strategies in the energy sector for controlling water use and generating more power from low water use generation sources?

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[2] Union of Concerned Scientists (UCS) (2014) Strengthening the EPA's Clean Power Plan. http://www.ucsusa.org/our-work/global-warming/reduce-emissions/role-of-renewable-energy-in-epa-clean-power-plan#.VD6GZnBZHao

Should these water resource management strategies be included in the EPA rules or development further in other regulatory schemes?

- **Market Push and Pull Policy for Increasing Energy Technology Innovation**: It will take dramatic increases in energy technology innovation to meet long-term greenhouse gas reduction goals and the EPA rule as written does not adequately take into account how the rule drives private market investment. What are some complementary steps the EPA, DOE and FERC might take in a coordinated fashion to advance the Energy Technology Innovation System in the U.S.?

Background: The US Environmental Protection Agency (EPA) is in the process of crafting the nation's first regulations to curb CO_2 emissions from existing fossil fuel-fired power plants. Under the Clean Power Plan, the EPA has set individual goals for each state. To achieve their individual goals, EPA expects the state implementation plans ("SIPs") to include a portfolio of one or more of four "building blocks" to create a Best System of Emission Reduction ("BSER"). The building blocks consist of:

- **Building Block 1**: Heat rate improvements at fossil fuel plants (e.g., increasing heat rates at coal plants by 6 percent)
- **Building Block 2**: Displacing coal-fired steam and oil/gas-fired steam generation by increasing generation from existing natural gas combined cycle ("NGCC") plants to raise NGCC plant capacity factors to as much as 70 percent) (the "Re-Dispatch Option")
- **Building Block 3**: Substitution of renewable resources and new nuclear facilities, and extension of life of existing nuclear plants that may be shuttered
- **Building Block 4**: Demand reduction aimed at 1.5 percent annual electricity sales from 2020-2029

Natural Gas: Is the booming drilling of shale oil and the U.S. domestic natural gas energy fix too good to be true?

Nothing about the transition from the legacy high carbon energy economy to the new energy economy powered by clean energy technology is easy. Framing this energy transition as a challenge is the best way to contextualize the relationship between natural gas and renewable energy generation. Public policy is best viewed as a series of trade offs and political compromise often drives what opposing sides can accept. The question in the U.S. energy future debate is whether those advocating for dramatic reductions in greenhouse gases from our energy systems and those advocating for greater energy security from increasing domestic production of natural gas can find that happy medium. To put it more simply it is not a debate about natural gas or renewable energy, it is whether the energy system can move ahead with natural gas and renewable energy. The key to policy is striking that balance and the proposed EPA Clean Power Act actually throws the energy market out of whack and will likely shift too much of the power plant generation to natural gas. Current, research is mounting that the move to greater natural gas energy generation in the U.S. causes an abundance of other policy problems.

Methane Emissions Higher Than EPA Estimates

A series of research papers continue to document vulnerability with a U.S. policy that looks to substitute coal-burning plants with natural gas generation plants. A report published in the Proceedings of the National Academy of Sciences found much higher levels of methane leakage from oil and gas operations and agriculture than estimates from the Environmental Protection Agency (EPA) and international monitoring agencies.

Specifically, the study found total methane emissions in the United States appear to be 1.5 times to 1.7 times higher than previous estimates by the international Emissions Database for Global Atmospheric Research. The research work was done by a large, multi-institutional team of researchers taking what is termed a top down approach of atmospheric measurements. This study published in December 2013 used both observations and modeling to determine methane emissions.[3]

The EPA bottom up approach of monitoring emissions (or methane leaks) at the source site was also criticized by the Office of the U.S. Inspector General in a report issued in July of 2014. Methane, which is a potent greenhouse gas with global warming potential of 25 times that of carbon, leaks from the natural gas pipeline infrastructure used to transport from production site to use source. Currently, the EPA uses a voluntary program, Natural Gas Star, to address methane leaks from pipeline infrastructure. In 2012, there were more than 1.2 million miles of gas distribution mains with an estimated 32,000 miles of mains that are cast iron or wrought iron and more than 61,000 miles of unprotected steel mains. Leaks are most likely from older pipelines. A lot of this pipeline infrastructure is older with some mains on the East Coast being more than 100 years old. Methane leaks actually can occur at all points across the supply chain from hydraulic fracturing drilling sites to liquid natural gas conversion and shipping facilities.[4]

Shale Oil Drilling Sites Methane Leakages Higher Than Once Thought
A more focused research study looked at leaks of methane from oil shale drilling boom areas of the Bakken Shale site and Eagle Ford in East Texas site. Researchers used satellite remote sensing instruments to measure methane leaks into the atmosphere. The findings published in the Scientific Journal, Earth's Future, found there two shale oil drilling basins leaked around 10 percent of the natural gas they produce, during the study period of 2006-2011. This is a significant issue considering that the North Dakota Bakken Shale site produced 485 million cubic feet per day of gas average during the month of September 2011 and the Eagle Ford East Texas site produced 1,232 million cubic feet of gas per day in 2011. Methane as a greenhouse gas in 86 times as potent as carbon dioxide for the climate when emitted over a 20-year period. The methane gas leaks likely come from wellheads, valves, tanks, pipes, processing plants and other areas in the energy production supply chain. Scientists say that a methane leakage about 3.2 percent may negate the natural gas fuel's benefit to reducing a electricity power plan greenhouse gas emissions. These findings that leakage could be at these very high levels means that natural gas as a fuel sources for electricity power plants is just as bad as coal. The authors of the study say they were conservative in providing a range of leakage readings over time, but even the low range readings far exceed the leakage rates used by the Environmental Protection Agency (EPA) of 1.2 percent for these sources.[5]

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[3] Miller, Scott. et. al. (2013) Anthropogenic Emissions of Methane in the United States. Proceedings of the National Academy of Sciences (PNAS) Vol. 110. No. 50 20018-20022.
[4] Office of the Inspector General. Environmental Protection Agency. (2014). Improvements Needed in EPA Efforts to Address Methane Emissions from Natural Gas Distribution Pipelines. Report No. 14-P-0324. July 25, 2014.
[5] Schneising, O., Burrows, J.P., Dickerson, R., Buchwitz, M., Reuter, M., and Bovensmann, H. (2014). Remote Sensing of Fugitive Methane Emissions from Oil and Gas Production in North American Tight Geologic formations. Earth's Future. AGU Publications 10.1002/2014EFOOO265. Online September, 2014.

Natural Gas Electricity Plants Not a Greenhouse Gas Solution
Putting even more damage on the argument that natural gas is the bridge fuel to reduce greenhouse gases is a study done by economist Chris Busch and physicist Eric Gimon that found very little benefits to the fuel switch from coal to natural gas. The study analysis including looking at both short and long-term effects of natural gas versus coal energy generation fuels, finds that short-term natural gas may be worse than burning coal. While in some cases, over longer periods of time, such as 100 years, could result in GHG emissions reductions with natural gas, the study authors could not endorse the fuel switch strategy. "These results contribute to the argument that building new baseload gas plants is unadvisable," according to summary of findings from the report.[6]

An even stronger statement against natural gas energy generation comes from a University of California-Irving study that makes the case that additional natural gas plant building crowds out cleaner renewable energy generation options. This study was comprised of two parts, the first step involved consulting with 23 energy experts analyzing plausible natural gas supply curves, and then modeling to look at future technology compositions of the power sector and the greenhouse gas emissions of the generation technology. The model looks at energy generation from a 2005 to 2055 period. With higher natural gas supplies in various scenarios the renewable energy generation demand decreases. With further natural gas use the potential for greenhouse gas reduction diminishes. The authors of the report argue that only greenhouse gas reduction policy, such as a carbon tax or carbon emission caps will result in significant reductions.[7]

Several more challenges lie before the drive to natural gas energy as it moves to a more dominant role in the U.S. overall energy picture. First, the cost to extract the fuel remains a long-term issue. Second is how much water is needed in the process to extract the energy source. Finally, the long-term environmental sustainability of natural gas especially in a carbon-constrained world remains paramount. A report done by the Stanford University, Energy Modeling Forum, which convened 50 experts, 14 different modeling teams, and a hybrid team of industry, academia, and government, paints a mixed bag of findings about the benefits of horizontal drilling and hydraulic fracturing natural gas discoveries. The Stanford study titled, "Changing the Game?: Emissions and Market Implications of New Natural Gas Supplies," says the economic boom to the U.S. economic growth, raises the U.S. gross domestic product (GDP) by about $70 billion each year over the next several decades (in current dollars) is only a modest benefit longer term. "Although this amount appears large," the report notes, "it represents a relatively modest 0.46 percent of the U.S. economy."[8] The economic benefit in the domestic natural gas discoveries goes to drilling businesses, the oil and gas industry, and some petrochemical firms using natural gas as a raw material, but these economic sectors account for only less than 1 percent of the employment in the broader U.S. economy. Cheaper energy costs do benefit consumers, but the commodity distribution of natural gas is subject to a highly volatile marketplace, especially as LNG

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[6] Busch, C. and Gimon, E. (2014) Natural Gas Versus Coal: Is Natural Gas better for the Climate? The Electricity Journal. Aug/Sept. 2014. Vol. 27, Issue 7.
[7] Shearer, C. Bistline, J., Inman, M. and Davis. S. (2014). The Effect of Natural Gas Supply on U.S. Renewable Energy and CO2 Emissions. Environmental Research Letters. Environ. Res. Lett. 9 (2014) 09408 (8 pp).
[8] Huntington, Hillard. (2013). Changing the Game? Emissions and Market Implications of New Natural Gas Supplies. Energy Modeling Forum. Stanford University. EMF 26: September, 2013.

exports go onto the global energy marketplace, and all told still represent a small portion of the GDP. This winter saw skyrocketing natural gas prices in some U.S. markets because of limitations in the gas distribution systems and supply/demand dynamics. An issue that often does not receive full discussion is that the gas pipeline infrastructure in the U.S. today is not adequate to meet a full domestic demand without a significant build out and upgrade.

The Stanford study models also show that the shale gas boom produced only modest benefits long-term for greenhouse reduction. A part of the reason is the economic models show that the increase in natural gas use might discourage efforts to conserve energy and boost efficiency. While that part of the study will stimulate some debate, the shorter-term benefits of fuel switching from coal to natural gas at large base-load energy utility power plants did help with recent domestic greenhouse gas reductions along with energy efficiency and decrease energy demand. The Stanford study did not address some of the debate about methane leaks from hydraulic fracturing drillings and other production supply chains steps.

Water Issues: Water usage could also be an Achilles heal in the long-term sustainability of hydraulic fracturing and natural gas production. Of the nearly 40,000 oil and gas wells drilled since 2011, three-quarters were located in areas where water is scarce, and 55% were in areas experiencing drought, according to a report by Ceres.[9] This report found that the fracking at the wells used 97 billion gallons of water. Similar evidence was reported in two reports looking more specifically at water usage in the Marcellus Shale region, the waters of Pennsylvania and West Virginia, found that the drilling for shale oil at some 6,000 wells used an average of 4.1 million to 5.6 million gallons of fresh water.

Methane and Air Quality Issues: The Environmental Protection Agency will be working on series of studies in 2014 to identify potentially significant sources of methane within the oil and gas sector. This action was a part of a package of steps announced on March 28, 2014 by the Obama Administration to reduce methane emissions. Methane – the primary component of natural gas – is more than 80 times more powerful as a greenhouse gas than carbon dioxide over a 20-year time frame. Oil and gas sites are the biggest industrial source of methane. The gas accounted for about 14% of US climate pollution in 2013, according to the EPA's greenhouse gas inventory, and that share is expected to grow. Colorado is currently the only state that has adopted rules limiting methane emissions from oil and gas operations. Seven Northeastern states (New York, Connecticut, Delaware, Maryland, Rhode Island, Vermont, and Massachusetts) wrote a letter to EPA in December 2012 stating their intent to sue EPA for failure to regulate methane emissions from oil and gas operations under Section 111 of the Clean Air Act. It is not clear to date whether the Obama Administration’s new actions to combat methane emissions will stop the Northeast states legal threats.

Natural gas prices in the U.S. went from a high in 2008 of $13 per million British Thermal Units (mmBTU) and went to record lows around $2 per (mmBTU) in 2012. While prices are expected to go higher long-term, they could stay low for the short-term with new hydraulic fracturing technology and discoveries. Some debate is now emerging on the long-term availability of the newly discovered shale gas, and there is little question that it has changed energy pricing dramatically, with more utilities switching out fuels of coal for

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[9] Freyman, Monika. (2014). Hydraulic Fracking and Water Stress: Water Demand by the Numbers. Ceres Water Program

natural gas. As more U.S. supplies shift to a global market the natural gas price will likely rise. In addition, new drilling seems focused more on finding shale gas, frequently resulting flaring off the natural gas. The price and available volumes of natural gas going forward is still a very dynamic energy trend without a clear definitive conclusion.

How Much Natural Gas Can the U.S. Produce?
A team of around 100 geologists and engineers was formed to research the question of how much natural gas is buried in the U.S. shale rock formations. The Potential Gas Committee, a nonprofit founded in the early 1960s, has been assisting in the training of geologists and engineers for many years. Their work is in collaboration with the Colorado School of Mines and receives some support from the American Gas Association, the American Petroleum Institute and Independent Natural Gas Association of America.

The Potential Gas Committee reports its assessment of potential gas sources in three categories of decreasing geological certainty:

1. Probable resources (discovered but unconfirmed resources associated with known fields and field extensions; also undiscovered resources in new pools in both productive and nonproductive areas of known fields).
2. Possible resources (undiscovered resources associated with field/pool discoveries in known productive areas); and
3. Speculative resources (undiscovered resources associated with new field/pool discoveries).[10]

In 2010, the committee found that the most likely amount of U.S. natural gas that could be produced from all sources with today's technology was 1,898 trillion cubic feet (tcf). With the addition of the 273 trillion cubic feet of reserves reported by the energy industry, the committee estimate for the U.S. was 2,100 tcf at the end of 2010. Given that the U.S. annual consumption of natural gas was at the time around 24 tcf some people speculated that the U.S. had a resource supply that might last a century. But it was not this committee that speculated about any 100-year supplies. John Curtis, who chairs the Potential Gas Committee, has publicly stated that there remains a lot of uncertainty around the specifics of how much natural gas is recoverable and at what costs. Curtis said of the U.S. natural gas discoveries, "It isn't a bridge to the hydrogen future. It is part of the future as we transition off of fossil fuels." In 2012, the committee increased its estimate of the most likely amount of U.S. natural gas that could be produced from all sources to a technically recoverable amount of resource base of 2,384 trillion cubic feet or an increase of 486 (tcf) over the 2010 calculation. This represented the largest natural gas resource evaluation in the committee's 48-year history of work.

Natural Gas Pipeline Infrastructure Barrier

Given the likely demand for natural gas to provide more and more base-load electric utility generation, the potential demand from industries such as chemical manufacturing sector, and the unknown growth long-term to convert it to liquid natural gas (LNG) for shipping to the international global energy market, the next challenge comes from expanding and updating the large-scale needs for pipeline, storage, and other midstream infrastructure. The natural gas industry itself has raised this infrastructure

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[10] Potential Gas Committee. http://potentialgas.org//what-we-do-2.

need concern. A study done by the Interstate Natural Gas Association of America (INGAA) Foundation modeled three scenarios, a high and a low along with a base case for gas growth from 2009 to 2030 for the U.S. and Canada. In total, the study found that the U.S. and Canada will need 28,900 to 61,600 miles of additional natural gas pipelines through 2030. The report made an estimate that in a midstream of expenditures that between $130 to $210 billion would be needed for expenditures between 2009 to 2030 for natural gas infrastructure to meet project market requirements. Pipeline construction and installation is not only a cost issue, but faces land use challenges from potential not-in-my-backyard (NIMBY) opponents to locating pipelines near residential, commercial or farm lands. In the energy world, these natural gas infrastructure investments must also be measured against potential investments in electrical grid lines and other needs.

Dynamics in today's U.S. electrical energy sector

There is abundant evidence that the U.S. energy world is changing, the question remains whether the transition from the legacy high carbon energy economy to the new energy economy based more on renewable energy technology is happening quick enough to achieve national goals to reduce greenhouse gases emissions (GHG). President Barack Obama has set the United States goal for an 83% reduction in GHG emissions by 2050. Distributed energy generation from solar, wind, biomass and biogas, geothermal, can be integrated into the existing electrical power system, but also can be seen as a threat to the electric utility status quo model. More than half the new electric energy power plant capacity additions in 2013 came from natural gas (6,861 MW compared to 9,210 MW in 2012), according to the U.S. Energy Information Administration.[11] Solar energy provided nearly 22% of the new generation (2,959 MW), but it is worth mention those figure do not include distributed capacity under 1 MW. The solar generation increase was less than 6% in 2012 by comparison. Wind energy generation provided nearly 8% of electric capacity additions in 2013 (1,032 MW), which was a dramatic drop from 2012 when 12,885 MW were added motivated primarily to qualify for the federal production tax credit (note that a one-year extension for 2013 allowed developers to claim the credit for projects that began construction in 2013 even if the project will be completed in a later year). Nearly 75% of added solar capacity was in California and about 10% was in Arizona. More than 90% of the added wind generation capacity in 2013 was located in the states of California, Kansas, Michigan, Texas, and New York. About 60% of added natural gas capacity was in California.[12]

Renewable energy generation can play a much more significant role in the U.S. electrical system than previous projections would indicate. This U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy has formed a collaborative with more than 110 researchers from 35 organizations including national laboratories such as NREL, industry, universities and non-governmental organizations under the umbrella called, RE Futures. This group issues a study, titled RE Futures, which analyzed the possibility and feasibility of using several variable energy technologies at various degrees of market penetration (30%, 50%, and 80%) finding that renewable electricity generation from technologies that are commercially available today are more than adequate to supply 80% of total U.S. electricity generation in 2050 in every region of the country.

[11] Energy Information Administration (EIA) (2014) Today in Energy. April 2014.
[12] Ibid. (EIA) (2014) Today in Energy. April 2014.

Demand-side Changes

While overall renewal energy market penetration remains small in the U.S., it continues to grow as a new generation source along with increases in natural gas energy generation. U.S. electricity demand grew over the last decade at an average annual rate of 0.7%, according to the Energy Information Administration (EIA). While this energy agency sees a slight increase in the near future to 0.9% a year tied to a projected overall U.S. economic growth at around 2.4%, these decade long trends are well below the past energy demand which typically exceeded the annual rate of economic growth. (AEO 2014) But a combination of energy efficiency measures, declining costs of renewable energy rooftop solar photovoltaic (PV), and steady technology innovation with energy storage systems and distributed energy (DE) management systems through microgrids, could mean traditional base-load electricity generation will likely see steady declines in future years.

The Synergy Between Energy Technology Innovation System and Renewable Energy Deployment in the United States

Three significant factors have come into play pointing to renewable solar and wind becoming mainstream energy generation sources in the United States. First, the energy technology innovation system has worked successfully with major advances in wind turbine blade design and solar panel production. Second, these technology improvements then resulted in better overall energy production and operations efficiency that produced decreased energy pricing. Third, as the cost of energy generation from wind and solar comes down the nationwide deployment of these systems has rapidly increased. Just check out the progress made in the last few years:

Solar Power Grows 400 Percent in Only 4 Years

- Since 2010, EIA said, U.S. solar capacity increased 418 percent from 2,326 megawatts, accounting for 0.2 percent of total U.S. electric generation, to today's 12,057 MW, or 1.13 percent of U.S. generation.

- Driven by an explosion in photovoltaics, the U.S. solar sector has emerged "from a relatively small contributor to the nation's total electric capacity into a one of comparative significance," the Energy Information Administration reported this week in its latest Electricity Monthly Update.[13] (Released April 22, 2014 with data from February 2014).

- More than half of that additional capacity — 5,251 MW -- has been installed by home and business owners participating in utility net metering programs that allow owners of solar systems to sell excess capacity back to their local utility at retail rates, according to EIA.

Wind Power Growth Leads New Generation Capacity in the United States

- American wind power topped 4 percent of the U.S. power grid for the first time

[13] Ibid. (EIA) (2014) Today in Energy. April 2014.

last year and has delivered 30 percent of all new generating capacity for the last five years. In Iowa and South Dakota, wind power now exceeds 25 percent of total electricity production. In nine states it provided more than 12 percent and in 17 states, more than five percent.

- Wind power generated 4.13 percent of all the electricity in America in 2013 as the fifth largest electricity source in the U.S., according to the latest data from the Department of Energy's Energy Information Administration (EIA). That is enough to power the equivalent of 15.5 million American homes, which is equivalent of all the residential households in Arkansas, Colorado, Georgia, Kansas, Nebraska, Nevada, and Ohio combined.

The Decline in Electricity Annual Demand Growth and Other Pressures on Electric Utilities Traditional Business Model

Energy Demand Decline

Pressures on the traditional electric utility business model are now coming from all directions and it is not solely due to the rise of distributed generation sources. For years, large base-load coal plants were the key to the utility business model along with projections for steady energy demand growth. What frequently is not discussed is electricity energy demand growth has been declining since the 1950s. The average U.S. electricity demand growth was 9.3% in the 1950s, 7.4% in the 1960s. 4.4% in the 1970s, 2.8% in the 1980s, 2.4% in the 1990s, and only 1.0% from 2000 to 2010, and now the Energy Information Agency projects 0.7% electricity demand growth for the future. While regulated utilities could adjust budgets for these changes, but the movement to no load growth is more acute today. The decline in the U.S. industrial sector has been a major factor in energy demand, along with other societal and demographic changes. In more recent years, electric utilities have seen declining sales volumes tied to a variety of factors including a weak U.S. industrial economy, increased energy efficiency and conservation, especially in industry, slow, but steady growth in combined heat and power (CHP), along with any of the significant new impacts from customer owned (DG) behind the energy meter. Next the U.S. energy economy is dealing with a potential knockout one-two combination of any aging fleet of energy generation facilities and with new environmental compliance for reducing air emissions. These factors are then further coupled with more recent cheap natural gas has which has put price pressure on some generation facilities with high coal use or equally pressure on nuclear plants functioning in deregulated markets. Depending on the market, such as the Midwest, rail shipping of coal has steadily been climbing for years, adding further to costs of coal as fuel for energy generation.

Coal Plant Closure

Nearly a quarter of the nation's coal power generation capacity could shut down by 2035, according to the U.S. Government Accountability Office (GAO). [14] The GAO, which is the auditing and evaluation arm of the U.S. Congress, issued a report in October 2012, stating that the power industry could retire between 15 percent and 24

[14] Government Accounting Office (GAO). (2014) Updates on Agencies' Monitoring Efforts and Coal-Fueled Generating Unit Retirement. GAO-14-672. August, 2014.

percent of its coal-fueled power generation capacity over the next 22 years. The report notes that the two big trends affecting power company decision-making are the changing environmental regulations and shifts in the market conditions such as the decrease in the price of natural gas. It also points out the EPA has documented that coal used to generate electricity is associated with health and environmental concerns such as emissions of sulfur dioxide, a pollutant linked to respiratory illnesses, and carbon dioxide, a greenhouse gas. Overall, coal's share to electrical generation nationwide has dropped from 50 percent in 2002 to 42 percent in 2011.[15] This combination of 50 years of energy demand decline and coal plant closures is a very significant pressure point on the traditional electric utility model.

Utility Business Model Out of Date

In the utility industry, the money comes from sales of commodity electricity and measured by how much the utility has in capital assets. The interest rate of borrowed money for utilities has been historically low and because assets are paid over long periods of time this becomes a critical factor in utility success. In the transformed utility world, success should come from the provision of services and measured by the delivery of real value versus low interest sunken assets. In many cases, utilities have also over-built capacity. In many cases, highest peak demand lasts for about 100 hours per year. But utilities built facilities for reliability to meet and exceed peak demand along with a degree of speculation that electricity demand could grow. This alone makes some facilities uneconomical. Then, add to mix new air emissions regulations which utilities must meet through expensive redesign or rebuild of plants and finally cheap natural gas putting further pressure on uncompetitive coal plants. This leads to the plant closure scenario described in the previous paragraph by the GAO study. Finally, as the world looks to reduce or eliminate high carbon fossil fuels such coal, oil, and potentially natural gas, these coal plants in particular shift from assets to potential liabilities (some call these stranded assets).

New Competition in the Energy World

Too often the debate about the out-of-date utility model places all the blame on the rise of customer owned solar PV on their rooftop. That is far too simplistic view, but it does expose that many utilities (especially regulated monopolies) have little to no experience with competitive markets and look to the rate setting public utility commissions (PUC) for solutions (or more generally to policymakers). This issue of utilities constrained by rules and regulators setting their prices are what public policy must address going forward. The last decade has seen the rise of small-distributed generation companies, especially in the PV space, including bringing in new third-party vendors that can lease DG equipment to a homeowner and business. This is where the rub begins in the new energy world, some states basically prohibit third party energy vendors and in other states the utilities feel constrained from competing directly with companies taking away their customers. Third party distribution and net-metering laws are now subject to political power debates in several states. Net metering has been used as a policy instrument to encourage development of locally-produced renewable electricity connected to the electric grid. Currently, 35 U.S. states have some form of a net metering policy. Under a net metering program, renewable electricity generated by a utility customer enables the customer to run the electric meter backward to offset electric

[15] Ibid. GAO. (2014).

use. Projects that produce excess generation and still remain under the designated capacity limit receive retail rates for the excess electricity fed to the grid.

An emerging societal trend is that businesses, large and small, and homeowers are increasingly interested in roof top solar generation on-site of the building or home. In states such as Hawaii, California, and Arizona, as more distributed generation, primarily rooftop PV is developed, this cutting into utility energy market share is now acute. This now has become a trend worth paying attention to as, for example, large retail business like Wal-Mart, IKEA, and Kohl's department stores -- as a part of their corporate sustainability policy -- are installing large roof top solar arrays to power their building.

If utilities were not concerned enough about third-party market share threats from PV companies, then comes the news that large corporations such as Google, General Electric, and Comcast want to get into the energy market place. So far these companies are interested in areas such as demand response, advanced metering and the future of smart grids and related technologies. But the kind of market power wielded by these companies show how the energy world can be changing quicker than some might project.

The Potential of Distributed Generation (DG) and Energy Efficiency (EE) to Supply U.S. Energy Needs

Wind Power in the United States

The evidence continues to mount that long-term contracts for wind power generation are cost competitive with all other potential energy generation sources and in many states can lower electrical bills for utility customers. Recent years have seen wind power costs fall as a new generation of larger, more efficient turbines is deployed over a wider range of the U.S. Studies done for the Midwest Independent Systems Operator (MISO) found that increasing wind power generation would reduce power costs by $3B to $9.4B, or between $63 and $200 per customer per year.[16] The New England Independent Systems Operator did an wind integration study modeling a 14% increase in its footprint and found electricity prices dropped around 10%, and further a 24% increase in wind generation would send prices down by about 15%.[17] A study done by Syracuse University and the University of California modeled cost comparisons for wind energy generation and natural gas power for electricity finding that wind energy comes within .35 cents per kWh when levelized over the 20-year life of a typical wind contract.[18] What makes this research more telling is that historically natural gas prices are very volatile and despite recent low natural gas prices the long-term hedge dimensions of wind power purchase agreements show the value of states having diverse energy generation portfolios.

[16] Fagan, B., Chang, M., Knight, P., Schulz, M., Comings, T., Hausman, E., & Wilson, R. Synapse Energy Electronics (2012). The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region. May 22, 2012.
[17] General Electric Energy Applications and Systems Engineering, EnerNex Corporation, AWS Truepower (2010). New England Wind Integration Study. Prepared for ISO New England. http://www.uwig.org/newis_es.pdf
[18] Decrick, J., Kraemer, K., and Linden, G. (2014). Visualizing the Production Tax Credit for Wind Energy. White Paper found at: http://ischool.syr.edu/media/documents/2014/3/PTC32514.pdf

The American Wind Energy Association – an advocacy organization, reviewed some 15 independently done studies on wind power generation impacts on the energy market and their analysis found a strong correlation between the amount of wind deployment and electricity cost reductions to users. This analysis presents a strong case for energy generation portfolio diversity noting that the 11 states that get more than 7% of their electricity from wind energy have seen electric prices decrease by 0.37% over the past five years, in contrast all other states have seen electricity prices increase by 7.79% during that time. The 11 states with a five-year decrease in electricity prices and largest wind energy generation are Iowa, South Dakota, Texas, South Dakota, Wyoming, Oklahoma, Idaho, Colorado, Kansas, Minnesota, and North Dakota. Both Iowa and South Dakota around are getting around 25% of their electricity from wind generation followed by Texas at 10% wind generation for electricity.[19]

Solar Power in the United States

Plug-in solar photovoltaic (PV) prices in recent years has sent growth in this energy generation sector soaring in the U.S. After more 30 years of energy technology innovation in the PV components sector the price has gone down 99 percent. More recently solar PV systems went down by almost 15% just from 2012 to 2013. Cheaper prices of solar components have lead to a dramatic growth in this sector. PV installations increased 41 percent from 2013 compared to 2012 with 4,751 MW added in the United States. Solar was the second-largest source of new electricity generation in the U.S., exceeded only by natural gas. By the end of 2013 there was 12.1 GW of PV and 918 MW of CSP operating in the U.S., according to the year in review report from GTM Research and the Solar Energy Industries Association.[20]

The Department of Energy's Lawrence Berkeley National Laboratory report on the installed price of photovoltaics states that price fell by a range of roughly $0.30 per Watt (W) to $0.90/W or 6 to 14 percent from 2011 to 2012, depending on the type of system. The Berkeley Lab study is based on data from more than 200,000 residential, commercial, and utility-scale PV systems installed between 1998 and 2012 across 29 states. The data analyzed in the Berkeley Lab study represents approximately 72 percent of all grid connected PV capacity installed during 1998-2012 period. Two key points in the Berkeley Lab study include that most of the cost reduction was due to savings in the modules and that future savings will come more from "soft costs" including system design, installation and permitting fees.[21]

There is quite a bit of state-by-state variation in PV installation growth. California alone installed more than half the solar in the U.S. during 2013 and is the national leader in both residential and utility solar installations, according the GTM/SEIA report. Arizona and New Jersey have historically been leaders in solar installations, but 2013 saw new emerging growth with North Carolina growing 171% over 2012 to install 335 MW, Massachusetts grew 76% or 335 MW, and Georgia grew by a whopping 762% to install 91 MW in 2013. A big factor in solar growth has been state policy on net metering and

[19] American Wind Energy Association (AWEA). 2014. Wind Power's Consumer Benefits. www.awea.org
[20] GTM Research and Solar Energy Industries Association (SEIA). U.S. Solar Market Insight Report. 2013 Year in Review.
[21] Barbose, G., Darghouth, N., Weaver, S., and Wiser, R. Lawrence Berkeley National Laboratory. (2013). Tracking the Sun VI. July, 2013.

allowing third-party companies to develop and install panels. Net metering allows for the times that a distributed generation customer, for example residential roof top solar, are generating more electricity than they are consuming to put that electricity back into the grid.[22]

Energy Efficiency Remains the Cheap Energy Source

Avoiding new energy generation costs through energy efficiency measures remains the cheapest option for a diverse portfolio in the electricity sector. Many states, but not all, have long-time energy efficiency programs. Two recently published studies, one by the American Council for an Energy-Efficient Economy (ACEEE) and the other by Lawrence Berkeley National Laboratory (LBL) found savings even in states with long-term energy efficiency programs where many of the easy to achieve savings have already occurred. Both of the studies utilize a levelized cost of saved energy measure – this means the calculation of the cost per kilowatt hour of an efficiency measure when the upfront costs are spread over the lifetime of the investment. For the ACEEE study, analysis was done on 20 states electricity costs and natural gas data from 10 states, while the LBL study collected data from 31 states.[23]

Over the 31 states in the LBL study the average cost of saved energy was about 2 cents per kilowatt hour and in comparison the ACEEE study estimated savings of 2.8 cents. There can be variation in states savings, but California with long-term energy efficiency program and planning saved 4.5 cents per kilowatt hour in the ACEEE study. The states that set aggressive goals for its electric utilities to achieve energy efficiency savings may longer term find it harder to achieve savings goals, but the study analysis shows that new energy generation is still two and three times more expensive than efficiency measures.[24]

Potential Benefits of Distributed Generation

The Department of Energy lists the following as benefits of distributed generation:

- Energy cost savings
- Savings in transmission and distribution losses and congestion costs
- Deferred Generation Capacity
- Deferred transmission and distribution capacity
- System reliability
- Power Quality Benefits
- Reliability/Resilience (FERC/DOE, 2007)[25]

Numerous studies document the benefits of distributed generation. The summary below highlights the benefits of distributed generation:

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[22] GTM Research and Solar Energy Industries Association (SEIA). U.S. Solar Market Insight Report. 2013 Year in Review.

[23] Molina, Maggie. ACEEE (2014). The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs. March, 2014. www.aceee.org

[24] Ibid. Molina, M. ACEEE 2014.

[25] U.S. Department of Energy. (2007). The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion.

Energy Cost Savings: One study done for the Arizona public utility commission look at the benefits of solar PV identified the fuel savings alone at up to 8 cents per kWh.[26] These fuels savings take on added significance with the rising costs of shipping coal and the potential volatile prices of natural gas. Further, a PV system that is net metered or feeding back into the grid beyond what the customer needs, might be providing a higher value of electricity, called a differential time-value of energy. California is funding these differential time-values, with one study pointing to PV electricity as increasing its value by 30% to 50% when taking into the time and costs of energy.[27]

Savings in Transmission and Distribution Losses: When electricity is generated close to the point of use, line loses in transmission are reduced or eliminated. The U.S. Department of Energy identifies line loses in the big electric grids representing 5% to 8% of the total electricity produced.[28] These line loss inefficiencies in the big grid will increasingly be targeted for potential savings as the growth of distributed generation, microgrids, and energy storage options proliferate. Line loss from the grid can increase during peak loads reaching as high as 20 percent of the load.[29] A different study done by DOE and FERC estimated a reduction of line losses of 19% for each 10% that a distributed generation source such as PV reduces the current load.[30]

Deferred Generation Capacity: A longer-term benefit of DG, again increasing even more with microgrids, demand response, other efficiency measures, and energy storage options, will be the savings from deferred transmission investments. One utility example is Con Edison of New York which reduced capital expenditures designated for transmission and distribution by 1 billion with additional savings of over $300 million in specifically targeted demand resources differing distribution systems investments.[31]

Value of Solar Documents Savings and Externalities: This issue was poignant in the recent Minnesota and Colorado debates on the value of solar. As of April 2014 the Colorado Public Utilities Commission was wrestling with different calculations submitted by Xcel Energy. In Minnesota, a voluntary value of solar program was implemented in March, 2014, after extensive study and debate. Under the current methodology in Minnesota the value of solar is calculated at 14.5 per kWh and includes avoided cost of purchasing energy from other sources, including environmental costs; avoided cost from the need to build additional power plant capacity to meet peak energy needs; and reducing impacts on the electric grid, including power lines, substations and power plants; and finally for the benefit of providing energy for long-periods of time.[32]

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[26] Beck, R.W., Inc. (2009). Distributed Renewable Energy Operating Impacts and Valuation Study. Done for the Arizona Public Service.

[27] Borenstein, Severin. (2008). The Market Value and Cost of Solar Photovoltaic Energy Production. Center for Study of Energy Markets – University of California Energy Institute.

[28] U.S. Department of Energy. (2007). The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion..

[29] Lazar, Jim and Baldwin, Xavier. (2011). Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements. Regulatory Assistance Project.

[30] U.S. Department of Energy. (2007). The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion..

[31] Watson, E. and Colburn, K. (2013). Looking Beyond Transmission. FERC Order 1000 and the Case for Alternative Solutions. Fortnightly Magazine.

[32] Farrell, John. (2014). Minnesota's Value of Solar. Institute for Self-Reliance. http://www.ilsr.org/minnesotas-value-of-solar/

Energy-Water Nexus and Sustainability Strategies

Managing water resources is paramount to any sustainable energy strategy for many reasons. First, energy is necessary to keep the pumping, moving, treatment and distribution of water throughout the U.S. Second, it takes a lot of water to maintain the status quo energy system. Droughts in states such as Texas and California are already making the energy-water nexus a critical public policy matter. The energy sector, specifically thermoelectric, biofuels, and fuel production, are second largest water consumer at 14% nationally behind agricultural irrigation at 71% of the usage total.[33] Further, the energy sector is a rapidly growing consumer of water with the expanding production of hydraulic fracking and the drilling of unconventional oil and gas. Hydraulic fracking is currently used in more than 90% of new oil and gas wells and involves injecting large volumes of water, sand, and specialized chemicals under pressure into a well to fracture the formations holding or trapping the oil and gas. A study that modeled various energy scenarios and the water implications through 2050 found that high renewable energy penetration scenarios lead to the most substantial reductions in water withdrawals and consumption. The scenario with energy efficiency measures reducing electricity demand by 20% by 2035 and 35% by 2050 versus the reference case, and renewable energy generation technologies (wind, solar, geothermal, biomass and hydropower) increases of 10% by 2010, 50% in 2035, and 80% by 2050 were the most successful in reducing water withdrawals and consumption.[34] The U.S. energy policy must soon take a more accurate accounting of reducing water usage in a sustainable strategy.

Solution: EPA Needs to Sync Up its Rules with Requirements for State Energy Plans and Improved Regional Coordination with FERC

A strong tie to long-term energy planning is necessary for the EPA Clean Power Plan to be successful. Changes in the electric utility energy sector are moving ahead faster than the EPA rule process can follow and could create confusion and difficulty in implementation. One starting point to keeping environmental and energy policy more consistent would be for EPA to develop memorandum of understanding (MOU) with the Department of Energy and the Federal Regulatory Energy Commission. Likewise, it will be critical to work closely with state Public Utility Commissions and regional entities such as the Regional Transmission Organizations (RTO) and Independent System Operator (ISO). The RTO and ISO are similar in that both are responsible for coordination of regional transmission systems and reliability of the electric system. A specific example of the need for interagency coordination is managing the necessary infrastructure build out for an aging electric energy grid and gas pipeline system across the U.S. These are high cost investments and containing utilities desire to over build infrastructure to support their legacy electrical system needs to be tempered by federal, state, and regional authorities aware of the growth of distributed energy resources (DERs) in a changing system. The FERC landmark Order 1000 rule requires the utilities and others responsible for our high voltage transmission grid to participate in a regional planning

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[33] Carter, Nicole (2013) Congressional Research Service. Energy-Water Nexus: The Energy Sector's Water Use. 7-5700. www.crs.gov R43199. August 30, 2013.

[34] Macknick, J., Sattler, S. Averyt, K., Clemmer, S. and Rogers, J. (2012) The Water Implications of Generating electricity: Water Use Acorss the United States Based on Different Electricity Pathways Through 2050. Environmental Research Letters. Environ. Res. Lett. 7 (2012) 045803.

process, eliminate certain provisions that give incumbent utilities a competitive edge in transmission planning, establish methods to clarify who will pay for the costs of transmission projects, and include procedures to consider how public policies like federal carbon pollution standards and state clean energy policies impact the grid. The FERC authority was unanimously upheld in the D.C. Circuit Court of Appeals in August 2014. The order forces utilities to consider renewable energy in their transmission planning.

A number of trends in the U.S. energy market could cause regulatory conflict going forward. First, the most recent trend is the current low natural gas prices causing existing aging coal plant closures, and to a smaller degree some nuclear plant closures such as Wisconsin's Kewaunee plant, and the ability to replace this generation capacity. Where the rub may occur in the future with the EPA Clean Power Plan and FERC is over whose regulating authority trumps the other over the issue of reliability or carbon reduction? There is a subtle, but significant shift in regulatory relationships where in the past EPA regulated a single specific power plant, now may allow states to meet compliance under the Clean Power Act by a collective emission action of all power plants in the state. There could be problems with the state-by-state nature of EPA carbon emission regulations and the regional energy planning. While these issues are not insurmountable, it will require much closer planning between FERC and EPA then is currently spelled out.

Maybe less of an issue, but still creating some confusion could come from some states that are already reinventing their utility sector. At the forefront is the New York state effort called Reforming the Energy Vision (REV) creating regulatory changes that promote more efficient use of energy, increase renewable energy generation from wind and solar, wider deployment of DERs such as microgrids, on-site power sources and storage. Following close behind New York are other Northeastern states redoing their regulatory framework for electric utilities. These state reforms may require greater flexibility and ability to quickly modify utility operations while the EPA rules might be less nimble and ready for change. The federal government could learn a lesson from these eastern states that have been clear that the new energy system must unlock markets, spur innovation, modernize the grid, empower customers, and have forward looking and outcome based regulation and rate structures. The critical bottom line is that the federal rules not be an impediment to electrical utility energy sector reform.

Solutions for the Environmental and Energy Nexus

An opportunity may exist for EPA and FERC coordination with the states through the requirement to develop state implementation plans to comply with the Clean Power Plan. In fact, there may be some crosswalk opportunities with requirements for regional transmission planning under the FERC 1000 rule. The FERC rule requires consideration of non-transmission alternatives ("NTAs" or Non-Transmission Solutions") during regional transmission planning. NTAs are resources that can replace the need for additional transmission through energy efficiency, demand response, distributed generation, or centralized generation sited near load. The additional benefits of NTAs are avoided energy costs, reduced wholesale electricity costs, reduced air pollution and water usage, and avoided land use and siting issues. No ready source of funding or cost allocation methodology exists for non-transmission issues. The economic and environmental benefits of NTAs could be calculated under research and formulas developed during a collaborative step by EPA, FERC and the states. A memorandum of understanding between EPA and FERC with a linkage to language in the final rules for the Clean Power Plan could simultaneously address gaps in grid reliability issues, regional energy planning (specifically transmission planning under FERC 1000), add a requirement to develop a calculation of costs and environmental benefits of reduced air pollution (including greenhouse gas reductions) and reduced water usage from the greater use of NTAs, and some requirement for participation of public utility commissions and state air and water quality regulators to participate in mutual planning processes. Maybe a portion of this work encouraging NTAs falls under the EPA creating in the final rule a tier-system to prioritize a Best System of Emission Reduction (BSER).

The proposed building blocks to create a best system of emission reduction for the state implementation plans could recommend a tier-set of priority steps from first to last.

1) System-wide energy efficiency measures
2) Increased use of combined heat and power systems
3) Greater utilization of waste-to-energy generation options
4) Deeper utility market integration of distributed energy resources (DERs) particularly with increased use of microgrids, energy storage, and distributed generation of renewable energy sources such as wind, solar, and biomass and biogas.
5) Demand reduction
6) Re-dispatch from coal-fired steam and oil/gas fired steam generation by increasing generation from existing natural gas combined cycle plants.

Solution: Cooperative Federalism Opportunity

Some states are taking an antagonistic view toward the EPA and the Clean Power Plan, with ten states filing a lawsuit challenging the EPA authority under the electric power plant regulatory proposal. While some litigation was inevitable, maybe this instead could be a rare moment of Cooperative Federalism where states and the federal government could find common ground around issues of energy security, climate change, and environmental protection. The issues ahead in the environmental and energy policy nexus require coordination among the federal, state and regional authorities. To put it another way, electrons from the energy sectors and carbon molecules from the environmental side do not recognize state borders. So the EPA, Clean Power Act, by first regulating at the state level must do its best to recognize creative and adaptive policy steps. Yet, where regional authority exists with the RTO and ISO structure it might be best to continue to have solutions occur in the region. Further, to address the issue of states moving ahead on electric utility market reforms, the EPA and FERC memorandum could find ways to encourage other states to consider modernization planning for the electric grid, create forward looking, outcomes-base regulatory and rate structures, such as performance-based rates that reward utilities to reduce greenhouse gas emissions, encourage greater energy efficiency and advance distributed energy resources, and use regional planning processes for transmission planning.

One key to actually achieving a Cooperative Federalism concept would be federal, regional and state collaboration on data and measures of performance and creating value measures for externalities. The issue of helping utilities to cover some of the costs from now paying for the externalities association with carbon reduction and the erosion of traditional utility revenues through stranded investments and loss traditional generation revenues could be supplemented in part through performance based rate setting.

Solution: Performance-Based Regulation and State Target Linkage

The EPA Clean Power Plan and performance based rating setting may be the perfect match for utilities and state regulators. The primary reason this policy makes sense is states could set reasonable annual goals for greenhouse gas reductions, improves in energy efficiency, integration of distributed energy resources, and allow utilities to make money on this energy transition. The design of these performance-based rates is discussed in the sidebar (Figure 1.0). Basically, the utility could earn a higher rate of return if they perform well under the targets set by the state. Most programs also include penalties for not making the targets, but flexibility can be provided for annual goals by setting an 8-10 year target and allowing for benchmarks to be achieved in a cluster of 2-3 year increments. These programs can be decoupled from more general utility profits and expenses if the state wishes to structure the program in that manner. Overall, these models can address the major utility concern with revenue erosion from traditional energy generation sources and flattening electricity demand. The benefits to state policymakers, regulators, and the utility customers is that it creates an market-based solution to policy goals and risk is shifted to the utility in exchange for greater revenue opportunities.

(Figure 1.0): **Principles for Designing Performance-Based Regulation**

1. “Define goals and outcomes. Then, set a quantitative standard for performance; include incentives for exceptional performance and penalties for missing the standard. If appropriate, use a neutral performance band within which the utility is neither rewarded nor penalized.

2. Define a clear methodology for measuring performance (including a counterfactual) at the outset of the program.

3. Shift an appropriate amount of performance risk to the utility, in exchange for longer term regulatory certainty and perhaps incentive compensation. Reward entrepreneurialism.

4. Establish a long enough time horizon for the utility and third-parties to make investment decisions with certainty and innovate to meet performance targets.

5. Revenue sharing can align utility performance with customer benefits. Structure programs so there is enough upside potential for the utility to drive innovation.

6. Build on an existing framework, but aim to find holistic solutions that go far enough to align incentives and simplify the regulatory process. Adding piecemeal performance-based regulation to existing regulation—without carefully adjusting the terms and conditions of each—can add complexity and undermine both.

7. Simply beginning to measure performance can reveal substantial opportunities for savings.

8. Mid-course correction can be built in, but the need for any changes must be announced well in advance of implementation, in order to minimize uncertainty.

9. Engage with customers and power sector participants early to find out which outcomes they care about. Both the Commission and the utility can be proactive on this.

10. Learn from experience with energy efficiency standards and incentive programs. Apply these approaches to achieve other system goals that produce customer value."[35]

Solution: Create a Dynamic Distribution System:

More electrical power is being generated in homes, businesses, and commercial buildings and used locally. This jump in power production at the distribution level presents a challenge to the traditional electrical transmission and distribution system based on centralized power generation and control. The centralized system operated by utilities was not designed for the flexible load tracking required by renewables or the control of large numbers of distributed electrical energy resources. An alternative approach that holds promise is a dynamic distribution system that includes a Distribution System Operator as the local balancing authority. As conceived, the dynamic distribution system uses local sources to track loads, stabilize voltage and frequency, and smooth intermittent renewable energy generation providing a predictable, constant load profile to the utility. This new dynamic distribution system connects central and local electricity generation, storage, microgrids, and loads with a marketplace that enables energy transactions, such as payments passing between buyers and sellers of energy at the local distribution level. This new system provides a promising framework for distributed energy resources to deliver the same services at a better price, with decreased power losses, decreased emissions, and better reliability.[36]

A dynamic distribution system, based on a new balance in structure and function between centralized and decentralized architecture, requires a new market model. This involves a balance between highly regulated exclusive franchise and free-for-all bid and trade schemes. Alone these two energy market schemes are sub-optimal when taken as isolated solutions to our ever more dynamic social and economic needs. These factors suggest a dynamic market built from building blocks some of which are taken from the two ends of the central to ultra-distributed spectrum of possibilities. This portfolio of sub-markets approach is logically centered on the distribution layer of the electrical network based on two major driving factors: (1) distribution is the natural interface between distributed energy, centralized power, and point of use generation; (2) the scale of distances in the distribution network allows waste heat to be distributed as a utility thereby greatly increasing efficiency; (3) the market can effectively and safely be tailored to the local and regional needs of the economic ecosystem at the distribution layer of the electrical network. The dynamic distribution system combines a regional and locally tailored market model built from this new set of building blocks. As an example, the market in California and a market in New York would contain a different combination of tailored cooperative building blocks (e.g. Adaptive spot trade exchanges, supply-demand

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[35] Aggarwal, S. and Burgess, E. (2014). Electricity Journal. Performance Based Models to Address Utility Change.

[36] Beihoff, Bruce, Jahns, Tom, Lasseter, Robert, and Radloff, Gary. (2014). Transforming the Grid from the Distribution System Out. The potential for a dynamic distribution systems to create a new energy marketplace. July, 2014. Wisconsin Energy Institute. Report available at: http://energy.wisc.edu/sites/default/files/Transforming-the-Grid-from-the-Distribution-System-Out.pdf

equilibrium exchanges, bid-trade pools, performance rate exchanges, dynamic pricing plans, and energy services bundling (as an example). This building block approach for the first time creates flexible and robust, self-tuning markets with number of cooperating self-markets. It is further envisioned that this new dynamic electrical and thermal distribution market would also serve as an evolutionary, cost-effective architecture to adapt and integrate centralized generation, transmission, fuel supplies and individualized markets into a more balance and integrated energy ecosystem.[37]

(Figure 2.0) Market Place Model Definitions:

(a) **Adaptive spot trades**: market mechanism that changes the energy spot price and allowance of next price increment based on adaptation to overall market volatility and present value metrics;

(b) **Supply-demand equilibrium**: market mechanism that 'set's next price bid based on computing distance of present bid price from the supply demand equilibrium point as inferred from availability and demand dispatch algorithms;

(c) **Bid-trade pools**: market mechanism that creates pools to which power users and producers subscribe that bid and dispatch as coordinated entities in larger markets;

(d) **Performance rates**: energy purchase rates that are calculated on a specific update schedule that are based on balanced combination of spot cost, overall efficiency, and other externality measures;

(e) **Dynamic pricing**: market mechanism that dynamically changes the cost of energy based on real-time calculation of direct and indirect costs;

(f) **Energy service bundling**: market mechanism that permits the utilities and third party energy providers to offer additional services to consumers beyond metered power and apportion these the charges in various rate and billing structures (e.g. premium power system resilience. premium power quality, pulse power, power system maintenance, distributed energy system leasing, project financing, technology upgrades, system retrofits, etc.)[38]

Solution: Require DOE working with FERC and EPA to Develop a New National Energy Plan for the Transition to from the legacy Carbon Economy to the New Clean Energy Economy

It will take dramatic increases in energy technology innovation to meet long-term greenhouse gas reduction goals and the EPA rule as written does not adequately take into account how the rule has great influence in driving private sector energy market investment. Therefore, the Department of Energy (DOE), possibly in conjunction with the

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[37] Beihoff, Bruce, Jahns, Tom, Lasseter, Robert, and Radloff, Gary. (2014). Transforming the Grid from the Distribution System Out. The potential for a dynamic distribution systems to create a new energy marketplace. July, 2014. Wisconsin Energy Institute. Report available at: http://energy.wisc.edu/sites/default/files/Transforming-the-Grid-from-the-Distribution-System-Out.pdf

[38] Definitions provided by Bruce Beihoff at the Wisconsin Energy Institute (WEI) and Midwest Energy Rearch Consortium (MWERC)

proposed memorandum of understanding (MOU) between EPA and FERC, could develop a National Energy Plan for the Electric Utility Sector Transition. The plan should be a combination of national vision, goals and metrics to assist in this longer-term change in the electric utility sector. The DOE invests in energy research, programs like APRA-E, and could shape the necessary energy technology innovation system advances to continue providing critical GHG reduction. So one dimension of the plan could include an energy technology roadmap. Likewise, input is needed from DOE and FERC on critical infrastructure investments such as the electric expansion or natural gas pipeline upgrade and expansion. The increased integration of renewable energy will dramatically re-shape energy infrastructure needs as well as require changes in the electric energy utility business model. Planning documents can help make this a smooth transition versus disruptive change. The energy vision, goals and metrics document should be produced by January of 2016. Finally, states using integrated resource planning (IRP) and regional transmission plans through FERC 1000 could be used to continually feed into and update the federal plan document.

Modeling Clean Power Plan Scenarios for the State of Wisconsin

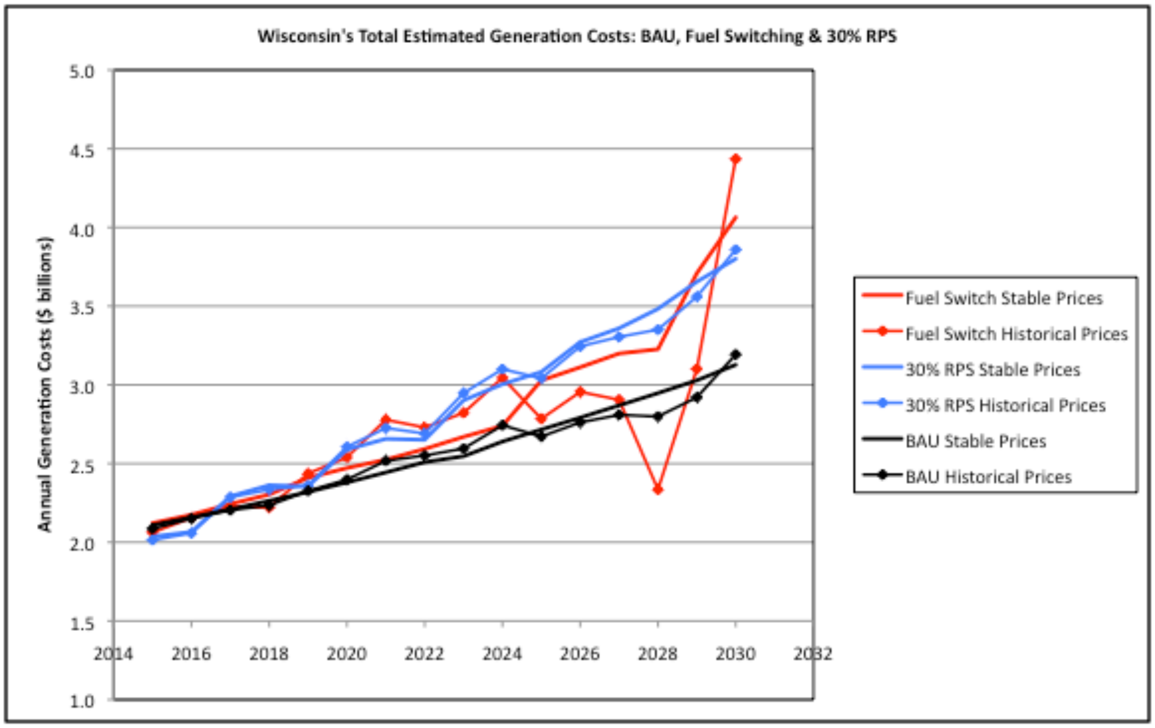
Analysis of Wisconsin's electric power sector compares a business-as-usual (BAU) scenario against a natural gas fuel switching, scenario, and a 30% Renewable Portfolio Standard (RPS) to determine which strategy achieves the greatest emission reductions at the lowest cost.[39] The scenarios were compared using a spreadsheet model and the MyPower modeling software developed by researchers at the Wisconsin Energy Institute (WEI).[40] Both models show that the 30% RPS can reduce Wisconsin's CO_2 emissions below EPA's targets, at a lower cost than the fuel switching scenario. These results were shown under conditions where fossil fuel prices rise steadily at 2% annually, and a scenario where natural gas prices reflect historical volatility observed from 19998-2013. The 30% RPS produced lower costs than the fuel switching scenario under each simulation, illustrating the value of renewables as a hedge against price volatility.

Marginal Generation Costs ($/MWh) from MyPower Simulation				
Year	**2015**	**2020**	**2025**	**2030**
BAU (Stable Prices)	$32.83	$36.60	$41.25	$46.91
BAU (Historical NG Prices)	$32.48	$36.88	$40.58	$47.89
30% RPS (Stable Prices)	$33.06	$39.90	$46.90	$57.12
30% RPS (Historical NG Prices)	$32.70	$40.16	$46.28	$58.00
Fuel Switch (Stable Prices)	$33.03	$38.01	$45.99	$60.95
Fuel Switch (Historical Prices)	$32.11	$39.05	$42.29	$66.52

Both the fuel switching and 30% RPS were shown to carry higher generation costs than the BAU scenario, but the 30% RPS outperformed the fuel switching scenario over the long-term. The 30% RPS results in lower marginal generation costs ($/MWh) by 2030 (the date of final compliance with EPA's Clean Power Program), compared to the fuel switching scenario. By 2030, the 30% RPS carries total coststhat are $260 million lower than the fuel switching scenario given stable natural gas prices, and $575 million lower when historical volatility is modeled (illustrated in figure 3 on the following page).

[39] Kaldunski, Ben. (2014) "Wisconsin CO2 Reduction Strategies" October, 2014. Report available online at the Wisconsin Energy Institute.
[40] Meier, Paul. "MyPower Methodology and Documentation." Wisconsin Energy Institute (link).

Figure 3 Wisconsin's Simulated Generation Costs Using MyPower



The results of both Wisconsin modeling exercises mirror the results of recent analysis performed at the national level by the Union of Concerned Scientists (UCS).[41] The UCS analysis found that EPA's proposed rule "significantly underestimates" the role of renewables in establishing state-level emissions targets, and fails to reflect the falling cost of renewables. The UCS analysis found that ramping up renewable energy deployment to 23% by 2030, compared to 12% of total retail sales under the proposed rule, would increase average electricity prices by just 0.3% per year above a business-as-usual (BAU) scenario. The UCS results are even more favorable than the results of modeling for the state of Wisconsin. The evidence for supporting an aggressive shift to renewable electricity generation in Wisconsin, and across the nation, is clear. Wisconsin has an opportunity to stimulate local economic growth and energy independence, or the state could take the easier path and risk locking in decades of higher energy prices without cutting harmful greenhouse gas emissions.

[41] Union of Concerned Scientists. "Strengthening EPA's Clean Power Plan." October 2014 (link).

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Additional Related Reports and Information:

The full report on natural gas pipeline infrastructure is available at:
http://www.ingaa.org/cms/31/7306/7828.aspx

A good analysis of the Net Metering and Third Party energy business challenge is in a new report, Third-Party Distributed Generation, Issues and Challenges for Policymakers, published by the Energy Center of Wisconsin. Available at:
http://ecw.org/sites/default/files/273-1_1.pdf