BEFORE THE
CORPORATION COMMISSION OF OKLAHOMA

IN THE MATTER OF THE APPLICATION OF OKLAHOMA GAS AND ELECTRIC COMPANY FOR COMMISSION AUTHORIZATIONOF A PLAN TO COMPLY WITH THE FEDERAL CLEAN AIR ACT AND COST RECOVERY; AND FOR APPROVAL OF THE MUSTANG MODERNIZATION AND COST RECOVERY	**)**	**CAUSE NO. PUD 201400229**

Direct Testimony of
Rachel S. Wilson

On Behalf of
Sierra Club

December 16, 2014

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1. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, business address, and position.

A. My name is Rachel Wilson and I am a Senior Associate with Synapse Energy Economics, Incorporated ("Synapse"). My business address is 485 Massachusetts Avenue, Suite 2, Cambridge, Massachusetts 02139.

Q. Please describe Synapse Energy Economics.

A. Synapse is a research and consulting firm specializing in energy and environmental issues, including electric generation, transmission and distribution system reliability, ratemaking and rate design, electric industry restructuring and market power, electricity market prices, stranded costs, efficiency, renewable energy, environmental quality, and nuclear power.

Synapse's clients include state consumer advocates, public utilities commission staff, attorneys general, environmental organizations, federal government, and utilities.

Q. Please summarize your work experience and educational background.

A. At Synapse, I conduct research and write testimony and publications that focus on a variety of issues relating to electric utilities, including: integrated resource planning; federal and state clean air policies; emissions from electricity generation; environmental compliance technologies, strategies, and costs; electrical system dispatch; and valuation of environmental externalities from power plants.

I also perform modeling analyses of electric power systems. I am proficient in the use of spreadsheet analysis tools, as well as optimization and electricity dispatch models to conduct analyses of utility service territories and regional energy markets. I have direct experience running the Strategist, PROMOD, PROSYM/Market Analytics, and PLEXOS models, and have reviewed input and

output data for a number of other industry models. I was trained on and used the PCI Gentrader model for this particular docket.

Prior to joining Synapse in 2008, I worked for the Analysis Group, Inc., an economic and business consulting firm, where I provided litigation support in the form of research and quantitative analyses on a variety of issues relating to the electric industry.

I hold a Master of Environmental Management from Yale University and a Bachelor of Arts in Environment, Economics, and Politics from Claremont McKenna College in Claremont, California.

A copy of my current resume is attached as Exhibit RSW-1.

Q. On whose behalf are you testifying in this case?

A. I am testifying on behalf of the Sierra Club.

Q. Have you testified previously before the Corporation Commission of Oklahoma?

A. No.

Q. What is the purpose of your testimony in this proceeding?

A. My testimony details and evaluates specific components of Oklahoma Gas & Electric's ("the Company" or "OG&E") analysis supporting this application. I evaluate the PROMOD and PCI Gentrader ("Gentrader") modeling performed by the Company, as well as certain inputs to the models. I also describe my own Gentrader modeling analysis and present the results of that evaluation.

Q. Please identify the documents and filings on which you base your opinions regarding the Company's proposed environmental compliance plan.

A. In addition to the Company witnesses' testimonies and discovery responses in this case, I have reviewed the Company's Gentrader modeling input and output files.

2. OVERVIEW OF TESTIMONY AND CONCLUSIONS

Q. In your opinion, do the input assumptions and the modeling performed by OG&E support the decision to install the proposed pollution control retrofits on its coal fleet?

A. No. First, the Company's modeling is faulty in that it assumes that its generating units operate independently from the market, taking energy prices as given rather than operating within the market and contributing to the magnitude of these prices. OG&E simulated the entire Southwest Power Pool Independent Marketplace ("SPP IM") using the PROMOD IV model to determine hourly prices for energy. In PROMOD, hourly energy prices are determined by regional loads and by the operating characteristics of the units that are available to meet that load in a given hour. The Company took those prices and input them into the PCI Gentrader model, dispatching its generating units against this set of market prices. OG&E's assumption that the market energy prices are exogenous to the Gentrader model results in erroneous output.

Second, OG&E has not modeled installation of pollution control retrofits that are likely necessary to control nitrogen oxide emissions at the Sooner 1 and 2 units. OG&E has also failed to model compliance with the EPA's proposed 111(d) rule, which would place limits on carbon dioxide ("CO_2") emissions from the power sector. My modeling results show that inclusion of costs to install selective catalytic reduction ("SCR") technologies at the Sooner units would place an additional operating penalty on these units and negatively affect their profitability in the SPP IM. Inclusion of EPA's shadow price on CO_2 as a means to model 111(d) compliance further disadvantages OG&E's preferred resource portfolio relative to other compliance options.

Based on my review, I conclude that OG&E has not shown that its choice to install scrubbers at the Sooner units and convert the Muskogee units to burn natural gas – the "Scrub/Convert portfolio" – represents the portfolio that is the

lowest cost to ratepayers under conditions that can be reasonably expected to occur.

3. DESCRIPTION OF COMPANY MODELING

Q. Please describe the modeling methods used by OG&E in this docket.

A. It is my understanding that OG&E used two different electric system dispatch models in its analysis of environmental compliance options. The Company first used the PROMOD IV production cost model to simulate hourly energy prices in the SPP IM. These hourly prices are then input to the PCI Gentrader production cost model, and each of OG&E's units is run against these market prices in order to determine total unit generation, operating expenses, and revenues.

Q. What do you mean when you say that the OG&E units are "run against the market?"

A. Historically, generating units owned by a utility had to operate in order to serve load in that utility's service territory, producing enough energy to keep the customers' lights on in each hour of the day. A utility might find the optimal mix of energy resources that minimize costs, but would need to run more expensive units to serve load when necessary. With the creation and evolution of energy markets like the SPP IM, utilities are no longer responsible for serving the electric load in their service territories. Instead, they bid their energy into the market, and the market is responsible for ensuring that enough generation is online to meet customer demand in a given hour. Generating units are organized from lowest operating cost to highest, and the market price in that hour is the cost to run the marginal generating unit – the most expensive unit that needs to be online in order to meet load. When an OG&E unit is run against the market, the PCI Gentrader model looks at the market price in a given hour, and – subject to constraints on outages, ramping, start times, etc. – if the cost to operate that unit is less than the

market price, that unit will generate electricity. If the costs to operate are greater than the market price, the unit will not generate.

Q. Is OG&E's modeling approach a reasonable way to evaluate its environmental compliance options?

A. The Company's modeling approach is duplicative. The PROMOD IV production cost model takes data on load, fuel price, and unit operating costs to simulate electricity markets and produce a forecast of market prices. When creating market price outputs, the model also determines the operating times, costs, and revenues for each individual unit in the market. OG&E thus already had information on the operations and profitability of its generating units from the PROMOD IV model, but the Company chose to also perform a dispatch simulation in Gentrader using the prices derived from PROMOD.

In terms of time spent modeling, this is certainly an efficient approachas the Company can run every possible compliance pathway at one time; but it provides limited value. When the OG&E units are run solely against the market prices, the operation of one unit has no affect on the operation of another unit. OG&E can, therefore, run the Sooner 1 and 2 Scrub option at the same time as the Sooner 1 and 2 Convert option or the Sooner 1 and 2 Replace option, and simply pick and choose a resource portfolio from the output results. However, this approach implies that the operation of the OG&E units has no affect on market prices, which is not true. OG&E makes up 13 percent of the SPP IM,[1] and the choices made by the utility, such as the type and quantity of generating resources in its portfolio, do influence the operations of the SPP IM. OG&E's modeling in Gentrader does not reflect this.

[1] SPP Market Monitoring Unit. 2013 State of the Market Report. May 19, 2014. Page 21, attached hereto. Also Available at: http://www.spp.org/publications/2013%20SPP%20State%20of%20the%20Market%20Report.pdf

Q. How should OG&E have modeled their units differently?

A. The Company should have produced hourly energy price forecasts for each of its environmental compliance plans using the PROMOD IV model. It should have then taken the output results (generation and operating costs) straight from the PROMOD IV modeling runs that produced the different sets of market prices.

Q. Do you have any other concerns with the Company's modeling analysis?

A. Yes. As I mentioned above, OG&E used production cost models to analyze its environmental compliance options. For this type of analysis, however, utilities will often use a capacity expansion model. Under OG&E's approach, the Company must execute a simulation of the electricity market with each of its environmental compliance options, as well as any capacity build-out, and compare output results to determine the least-cost plan. A capacity expansion model would screen these different resource options and determine the resource plan that would meet environmental and capacity constraints at the lowest cost over a specified period of time. By handpicking the generating resources, OG&E is likely missing a portfolio that is lower cost than the one the Company selected.

OG&E identified a need for capacity in 2020.[2] Under its assumptions, OG&E must put in place generating alternatives to the Sooner 1 and 2 and Muskogee 4 and 5 units by 2018 or 2019, depending on the unit. OG&E is considering these capacity need and compliance issues in isolation from each other. Had OG&E considered these issues together there is likely a resource option that would provide replacement capacity for the Sooner and/or Muskogee units that also helps defer some of the capacity need that exists in 2020. A capacity expansion model could evaluate capacity needs and compliance issues together to develop a least-cost resource portfolio.

[2] Direct Testimony of Leon Howell, August 6, 2014, page 4.

4. DESCRIPTION OF SYNAPSE MODELING

Q. Did you utilize any of the models used by OG&E when conducting your review of the Company's analysis?

A. Yes. I used the Gentrader model to run two additional scenarios.

Q. Please describe the scenarios that you evaluated.

A. First, I assumed that the Company's sensitivity case that contains a price per ton of CO_2 beginning in 2020 represents a realistic base case. I then examined two different scenarios, using the OG&E CO_2 scenario as my starting point. The first scenario that I evaluated incorporates costs associated with the installation of SCR technology at Sooner 1 and 2. The basis for this is described in the testimony of Tyler Comings in this docket.

The second scenario that I evaluated increases the price per ton of CO_2 to reflect the shadow price for CO_2 that the EPA estimates would be necessary for compliance with the proposed 111(d) rule. The basis for this is described in the testimony of both Mr. Tyler Comings and Dr. Jeremy Fisher. Note that this second scenario does not include installation of selective catalytic reduction technology at the Sooner units.

Q. What were the results of your modeling?

A. When selective catalytic reduction technology is installed at each Sooner unit, the production cost associated with the Scrub/Convert portfolio (Sooner units are scrubbed and the Muskogee units are converted) rises from $19.590 billion to $19.612 billion.

In OG&E's Base Case Scenario, the Scrub/Convert portfolio performs best on a net present value basis, followed by the Scrub portfolio, and the Convert portfolio. In the Company's CO_2 Scenario, the Convert portfolio has the lowest NPV, with a $525 million advantage over the Scrub/Convert portfolio. Under the scenario that modifies the CO_2 price to reflect EPA's modeling of 111(d) compliance, the Convert portfolio outperforms the Scrub/Convert portfolio by

$784 million. Those results are shown in Table 1, below. The difference in NPV between the portfolios would increase with the addition of selective catalytic reduction technologies, making the Scrub/Convert portfolio even less economic under the Synapse scenario.

Table 1. NPV and Rank of OGE Portfolios Under OGE Base, OGE CO_2, and Synapse 111(d) CO_2 Scenarios.

Portfolio	OGE Base	Rank	OGE CO2	Rank	Synapse 111(d) CO2	Rank
Scrub/Convert	$22,352	1	$26,404	2	$27,163	2
Scrub	$22,423	2	$27,049	5	$27,911	3
Convert	$22,484	3	$25,879	1	$26,379	1
Scrub/Replace	$23,226	4	$26,867	4	$28,009	4
Replace	$24,230	5	$26,800	3	$28,215	5

5. CONCLUSIONS

Q. Please summarize your conclusions.

A. Based on my review, I conclude that OG&E has not shown that its choice to install scrubbers at the Sooner units and convert the Muskogee units to burn natural gas – the "Scrub/Convert portfolio" – represents the portfolio that is the lowest cost to ratepayers under conditions reasonably expected to occur. The Company's modeling is faulty in that it assumes that its generating units operate outside of the market, taking energy prices as given rather than operating within the market and contributing to the magnitude of these prices. In addition, OG&E has not modeled installation of pollution control retrofits that are likely necessary to control nitrogen oxides at the Sooner 1 and 2 units. OG&E has also failed to model compliance with the EPA's proposed 111(d) rule, which would place limits on the emissions of CO_2 from the power sector. My modeling results show that inclusion of selective catalytic reduction technologies at the Sooner units would place an additional operating penalty on these units and negatively affect their profitability in the SPP IM. Inclusion of EPA's shadow price on CO_2 as a means to model 111(d) compliance disadvantages the Scrub/Convert portfolio relatively to other compliance options.

Q. Does this conclude your direct testimony?

A. Yes.

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Cambridge, MA. *Senior Associate*, 2013 – present, *Associate*, 2010 – June 2013, *Research Associate*, 2008 – 2010.

- Conducts research and writes testimony and reports on a wide range of issues relating to electric utilities, including: integrated resource planning; federal and state clean air policies; emissions from electricity generation; electric system dispatch; and environmental compliance technologies, strategies, and costs.
- Uses optimization and electricity dispatch models, including Strategist, PROMOD, PROSYM/Market Analytics, and PLEXOS to conduct analyses of utility service territories and regional energy markets.

Analysis Group, Inc., Boston, MA.

Associate, Energy Practice, 2007 – 2008.

- Supported an expert witness asked to opine on various topics in the electric industry as they applied to merchant generators and provided incentives for their behavior in the late 1990s and early 2000s.
- Analyzed data related to coal production on Indian land and contractual royalties paid to the tribe over a 25 year period to determine if discrepancies exist between these values for the purposes of potential litigation.
- Examined Canadian policies relating to carbon dioxide, and assisted with research on linkage of international tradable permit systems.
- Managed analysts' work processes and evaluated work products.

Senior Analyst Intern, Energy Practice, 2006 – 2007.

- Supported an expert witness in litigation involving whether a defendant power company could financially absorb a greater investment in pollution control under its debt structure while still offering competitive rates. Analyzed impacts of federal and state clean air laws on energy generators and providers. Built a quantitative model showing the costs of these clean air policies to the defendant over a 30 year period. Built a financial model calculating impacts of various pollution control investment requirements.
- Researched the economics of art; assisted in damage calculations in arbitration between an artist and his publisher.

Yale Center for Environmental Law and Policy, New Haven, CT. *Research Assistant*, 2005 – 2007.

- Gathered and managed data for the Environmental Performance Index, presented at the 2006 World Economic Forum. Interpreted statistical output, wrote critical analyses of results, and edited report drafts.
- Part of the team that produced *Green to Gold*, an award-winning book on corporate environmental management and strategy. Managed data, conducted research, and implemented marketing strategy.

Marsh Risk and Insurance Services, Inc., Los Angeles, CA. *Risk Analyst*, Casualty Department, 2003 – 2005.

- Evaluated Fortune 500 clients' risk management programs/requirements and formulated strategic plans and recommendations for customized risk solutions.
- Supported the placement of $2 million in insurance premiums in the first year and $3 million in the second year.
- Utilized quantitative models to create loss forecasts, cash flow analyses and benchmarking reports.
- Completed a year-long Graduate Training Program in risk management; ranked #1 in the western region of the US and shared #1 national ranking in a class of 200 young professionals.

EDUCATION

Yale School of Forestry & Environmental Studies, New Haven, CT
Masters of Environmental Management, concentration in Law, Economics, and Policy with a focus on energy issues and markets, 2007

Claremont McKenna College, Claremont, California
Bachelor of Arts in Environment, Economics, Politics (EEP), 2003. *Cum laude* and EEP departmental honors.

School for International Training, Quito, Ecuador
Semester abroad studying Comparative Ecology. Microfinance Intern – Viviendas del Hogar de Cristo in Guayaquil, Ecuador, Spring 2002.

ADDITIONAL SKILLS AND ACCOMPLISHMENTS

- Microsoft Office Suite, Lexis-Nexis, Platts Energy Database, Strategist, PROMOD, PROSYM/Market Analytics, and PLEXOS, some SAS and STATA.
- Competent in oral and written Spanish.

- Hold the Associate in Risk Management (ARM) professional designation.

PUBLICATIONS

Wilson, R., B. Biewald. 2013. *Best Practices in Electric Utility Integrated Resource Planning: Examples of State Regulations and Recent Utility Plans.* Synapse Energy Economics for Regulatory Assistance Project.

Fagan, R., P. Luckow, D. White, R. Wilson. 2013. *The Net Benefits of Increased Wind Power in PJM.* Synapse Energy Economics for Energy Future Coalition.

Hornby, R., R. Wilson. 2013. *Evaluation of Merger Application filed by APCo and WPCo.* Synapse Energy Economics for West Virginia Consumer Advocate Division.

Johnston, L., R. Wilson. 2012. *Strategies for Decarbonizing Electric Power Supply.* Synapse Energy Economics for Regulatory Assistance Project, Global Power Best Practice Series, Paper #6.

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

Hornby, R., R. Fagan, D. White, J. Rosenkranz, P. Knight, R. Wilson. 2012. *Potential Impacts of Replacing Retiring Coal Capacity in the Midwest Independent System Operator (MISO) Region with Natural Gas or Wind Capacity.* Synapse Energy Economics for Iowa Utilities Board.

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

Fisher, J., C. James, N. Hughes, D. White, R. Wilson, and B. Biewald. 2011. *Emissions Reductions from Renewable Energy and Energy Efficiency in California Air Quality Management Districts.* Synapse Energy Economics for California Energy Commission.

Wilson, R. 2011. *Comments Regarding MidAmerican Energy Company Filing on Coal-Fired Generation in Iowa*. Synapse Energy Economics for the Iowa Office of the Consumer Advocate.

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

Hornby, R., P. Chernick, C. Swanson, D. White, J. Gifford, M. Chang, N. Hughes, M. Wittenstein, R. Wilson, B. Biewald. 2011. *Avoided Energy Supply Costs in New England: 2011 Report*. Synapse Energy Economics for Avoided-Energy-Supply-Component (AESC) Study Group.

Wilson, R., P. Peterson. 2011. *A Brief Survey of State Integrated Resource Planning Rules and Requirements*. Synapse Energy Economics for American Clean Skies Foundation.

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

Fisher, J., R. Wilson, N. Hughes, M. Wittenstein, B. Biewald. 2011. *Benefits of Beyond BAU: Human, Social, and Environmental Damages Avoided Through the Retirement of the US Coal Fleet*. Synapse Energy Economics for Civil Society Institute.

Peterson, P., V. Sabodash, R. Wilson, D. Hurley. 2010. *Public Policy Impacts on Transmission Planning*. Synapse Energy Economics for Earthjustice.

Fisher, J., J. Levy, Y. Nishioka, P. Kirshen, R. Wilson, M. Chang, J. Kallay, C. James. 2010. *Co-Benefits of Energy Efficiency and Renewable Energy in Utah: Air Quality, Health and Water Benefits.* Synapse Energy Economics, Harvard School of Public Health, Tufts University for State of Utah Energy Office.

Wilson, R. 2009. "The Energy-Water Nexus: Interactions, Challenges, and Policy Solutions." Presentation at the National Drinking Water Symposium 2009, October 2009.

Fisher, J., C. James, L. Johnston, D. Schlissel, R. Wilson. 2009. *Energy Future: A Green Alternative for Michigan*. Synapse Energy Economics for Natural Resources Defense Council (NRDC) and Energy Foundation.

Schlissel, D., R. Wilson, L. Johnston, D. White. 2009. *An Assessment of Santee Cooper's 2008 Resource Planning*. Synapse Energy Economics for Rockefeller Family Fund.

Schlissel, D., A. Smith, R. Wilson. 2008. *Coal-Fired Power Plant Construction Costs*. Synapse Energy Economics.

TESTIMONY

Michigan Public Service Commission (Case No. U-17087): Direct testimony before the Commission discussing Strategist modeling relating to the application of Consumers Energy Company for the authority to increase its rates for the generation and distribution of electricity. On behalf of the Michigan Environmental Council and Natural Resources Defense Council. February 21, 2013.

Indiana Utility Regulatory Commission (Cause No. 44217): Direct testimony before the Commission discussing PROSYM/Market Analytics modeling relating to the application of Duke Energy Indiana for Certificates of Public Convenience and Necessity. On behalf of Citizens Action Coalition, Sierra Club, Save the Valley, and Valley Watch. November 29, 2012.

Kentucky Public Service Commission (Case No. 2012-00063): Direct testimony before the Commission discussing upcoming environmental regulations and electric system modeling relating to the application of Big Rivers Electric Corporation for a Certificate of Public Convenience and Necessity and for approval of its 2012 environmental compliance plan. On behalf of Sierra Club. July 23, 2012.

Kentucky Public Service Commission (Case No. 2011-00401): Direct testimony before the Commission discussing STRATEGIST modeling relating to the application of Kentucky Power Company for a Certificate of Public Convenience and Necessity, and for approval of its 2011 environmental compliance plan and amended environmental cost recovery surcharge. On behalf of Sierra Club. March 12, 2012.

Kentucky Public Service Commission (Case No. 2011-00161 and Case No. 2011-00162): Direct testimony before the Commission discussing STRATEGIST modeling relating to the applications of Kentucky Utilities Company, and Louisville Gas and Electric Company for Certificates of Public Convenience and Necessity, and approval of its 2011 compliance plan for recovery by environmental surcharge. On behalf of Sierra Club and Natural Resources Defense Council (NRDC). September 16, 2011.

Minnesota Public Utilities Commission (OAH Docket No. 8-2500-22094-2 and MPUC Docket No. E-017/M-10-1082): Rebuttal testimony before the Commission describing STRATEGIST modeling performed in the docket considering Otter Tail Power's application for an Advanced Determination of Prudence for BART retrofits at its Big Stone plant**.** On behalf of Izaak Walton League of America, Fresh Energy, Sierra Club, and Minnesota Center for Environmental Advocacy. September 7, 2011.

Resume dated August 2013