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# The Equilibrium Point Hypothesis: An Analysis of Firm Performance and Renewable Energy Deployment in the Publicly-Held, US Electrical Utility Industry

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**ABSTRACT**

We examine the relationship between renewable energy deployment and financial performance for the 32 largest publicly held US electrical utility companies. A significant positive correlation is found between return on assets and renewable energy deployment and insignificant results for return on equity and renewable energy deployment. Special consideration is given to the relatively small extent of renewable energy deployment, as it could help explain the aforementioned positive correlation and support the discussion of the point (the equilibrium point) in renewable energy deployment, considering factors like firm size and dedication to non-renewables, it stops paying to be green.

KEYWORDS: Social issues, Clean technology, Renewable energy, Electric utilities, Financial performance

## INTRODUCTION

A majority of physical and social scientists believe that current economic growth is not sustainable because of over use and pollution of precious resources such as fresh water and air. Furthermore, greenhouse gasses and global climate change has been a front and center concern, globally, for many years. This concern is evidenced by adoption of the Kyoto Protocol in 1997 (United Nations, 1998), and more recently the Paris Agreement (United Nations, 2015), which was ratified by enough countries to enter into effect on November 4, 2016 (United Nations Treaty Agreement, 2017). This brings into question the business-natural environment interface as it relates to competitive advantage or disadvantage. Does it pay, financially, to be green? Environmental sustainability and stewardship are imminent factors which businesses across the globe must contend with more than ever before. Of critical concern for businesses is the effect of sustainability on their bottom line, a concern which has pervaded the discussion of environmental sustainability for decades.

The concern of sustainability and environmental degradation is especially poignant within the electric power generation sector. The Environmental Protection Agency reports that 25 percent 2010 global greenhouse gas emissions were produced by electricity and heat production (United States Environmental Protection Agency, 2017). In the United States, approximately 40 percent of global warming pollution is produced by the electric power sector (Kwasnik et al, 2014, 13). Given the commanding impact of the electric utility industry on greenhouse emissions, it is of paramount importance for research to take place in this area.

This study examines the relationship between renewable energy deployment and firm performance in the United States electric utility industry. Might it pay to be green? The foundation for this study's hypothesis draws upon prior research, most directly on the study by Ruggiero and Lehkonen (2016). Ruggiero and Lehkonen (2016, 9) who provided evidence that the level of a firm's carbon intensity may be a moderating variable that effects the point at which firm financial performance and renewable energy is at an equilibrated state: renewable energy deployment before the point is positively associated with financial performance and vice versa. As such, the hypothesis of this study is that (for the electric utility industry) in the early stages of renewable energy deployment, i.e. prior to the equilibrium point, firm performance is more likely to be positively associated with such deployment. Using information from the 32 largest U.S. investor-owned electric utilities, which at the time data was collected appear to be early in the stages of renewable energy deployment, and using a nonparametric test (Spearman's rho) to compare rankings as well as a parametric test (Pearson's *r*) to compare indices, it was found that return on assets was positively associated with the level of renewable energy deployment, whereas return on equity was not. Also discussed is why this inconsistency across the two performance measures might exist.

The next section provides an overview of the legislative history and prior research in sustainability and pollution prevention. Following this is development of the hypothesis used in this study. This study's methodology is then described, followed by empirical results, then last is conclusions and limitations.

## HISTORY AND REVIEW OF THE LITERATURE

From the global policy front, the importance of sustainable development and the environment was the focus three initiatives. First, to rally countries to address sustainable development, the United Nations established The Brundtland Commission in 1984. The Commission officially dissolved in December 1987 after releasing "Our Common Future," also known as the "Brundtland Report," in October 1987. The Commission saw the unequal distribution of technology and income as the crux of environmental and development problems.

> Poverty is seen as a major cause and effect of environmental degradation. The resource gap between industrial and developing nations is widening, rule-making on the global scale is dominated by industrial nations, and much of the earth's ecological capital has already been used in industrial development. The Commission views these inequalities as the crux of both the planet's environmental and development problems. The solution lies in economic growth that is equitable, and environmentally sustainable. This change will rely upon informed public participation and the political will to change (United Nations, 1987, 8).

In 1997, The Kyoto Protocol was adopted: an extension of the United Nations Framework Convention on Climate Change (United Nations, 1998). The treaty established obligations on industrialized countries to reduce emissions of greenhouse gases. It recognized that developed countries are principally responsible for the current high levels of greenhouse gas emissions in the atmosphere. As part of the Kyoto Protocol, many developed countries agreed to legally binding limitations/reductions in their emissions of greenhouse gases in two commitment periods: 2008-2012 and 2013-2020.

On December 12, 2015, the United Nations Framework Convention on Climate Change drafted the Paris Agreement (United Nations, 2015), which addresses measures to be taken after the second Kyoto Protocol commitment period ends in 2020. The Agreement will enter into force when "fifty-five Parties representing at least fifty-five percent (estimated) of total global greenhouse gas emissions have deposited their approval" (United Nations, 2015, Article 21, p. 31), which did take place in 2016. A goal is to hold the increase in average global temperature to well below 2 $^0$C above pre-industry levels and to pursue efforts to limit the temperature increase to 1.5 $^0$C above pre-industrial levels (United Nations, 2015, Article 2, p22).

Seminal work in the field was performed by Hart (1995), who posited that "strategy and competitive advantage in the coming years will be rooted in capabilities that facilitate environmentally sustainable economic activity," and developed the Natural-Resource-Based View (NRBV) of the firm, as shown in Figure 1 (Hart, 1995, p. 991; Hart & Dowell, 2011).

Figure 1
Natural-Resource-Based-View

| Strategic Capability | Environmental Driving Force | Key Resource | Competitive Advantage |
|---|---|---|---|
| Pollution Prevention | Minimize emissions, effluents, & waste | Continuous improvement | Lower costs |
| Product Stewardship | Minimize life-cycle cost of products | Stakeholder integration | Preempt competitors |
| Sustainable Development | Minimize environmental burden of firm growth and development | Shared vision | Future position |

The NRBV focused on three strategic capabilities for firms: pollution prevention, which came from the idea that pollution "is a sign of inefficiency" and that "waste is a nonrecoverable cost" detrimental to the profitability of a company (Hart and Ahuja, 1996, p. 31); product stewardship, which entailed designing products with the environment in mind in order to reduce their environmental liability and dedicate more company focus towards innovation rather than retroactively managing long life-cycle costs like pollution (Hart, 1995, pp. 993-996); and sustainable development, which was in reference to ensuring that developing countries would not advance economically at the expense of the environment (Hart, 1995, pp. 996-998). The key point that connects each of the strategic capabilities within the NRBV is proactivity, an echo of foreboding warnings about the unknown impacts of environmental degradation from past researchers, for which research of the years following would come to increasingly support.

In this research, proactive environmental strategies showed associations with enhanced financial performance (Aragon-Correa & Sharma, 2003; Judge & Douglas, 1998; Klassen & McLaughlin, 1996).

Working forward from the applications of proactivity, other researchers began to investigate exactly what businesses served to gain financially in the pursuit of environmental sustainability. Ambec and Lanoie (2008) summarized each of these potentially profitable deliverables into the two broad categories: increasing revenues and reducing cost (p. 46). Increased revenues, they argued, could come from improved market access (e.g. positive product perception and favorable sale terms provided to green suppliers by buyers), product differentiation (e.g. higher-priced recycled, organic, or renewable products), and the sale of pollution-control technology (e.g. first-mover advantage and licensing) (Ambec and Lanoie, 2008, pp. 47-50). Alternatively, reduced overall costs, they posited, result from reduced liability costs (e.g. lower impact of regulations and favorable relationship with concerned shareholders), reduced input costs (e.g. raw materials and energy), reduced capital costs (e.g. easy access to green/ethical mutual funds), and reduced labor costs (e.g. attracts better-quality employees less susceptible to illness and turnover) (Ambec and Lanoie, 2008, pp. 50-57). While the theoretical explanations for positive financial effect are numerous in this research, the effects felt in other studies did not always follow Ambec and Lanoie's expectations.

Since the early research surrounding the financial effects of environmental sustainability, studies have gone back and forth on the correlations found between the variables. Albertini (2013) summarized 52 of these studies into a meta-analysis, discovering only a slight majority of the 52 studies between 1972-2008 showing a positive correlation between financial performance and environmental sustainability (Albertini, 2013, p. 432). Despite the differences in the measurement of environmental sustainability across industries, the lack of a clear correlation across the board for various industries, including electrical utilities, suggests that other unknown confounding variables could be involved.

## HYPOTHESIS

Researchers have begun to suggest more recently that, rather than asking if it pays to be green, the question should be when it pays to be green. In other words, under what circumstances might it pay to pollute less (Ruggiero and Lehkonen, 2016, p. 2)?

Hart and Ahuja (1996, p. 31) examined emission reduction and firm performance for a sample of S&P 500 firms. They found that "efforts to reduce emissions through pollution prevention drop to the bottom line within one to two years after initiation" (Hart and Ahua, 1996, p. 34). In their study, the sample of firms was divided into high polluting and low polluting subsamples, and they found that emissions reductions had a significant effect on financial performance of the high polluting subsample, but not for the low polluting subsample (Hart and Ahua, 1996, p. 34). Their results also indicated that early in the adoption process, the positive effect on financial performance was more pronounced, stating that "in the early stages of pollution prevention there is a great deal of 'low-hanging fruit' – easy and inexpensive behavioral and material changes that result in large emission reductions relative to costs." This is supported by Frosch and Gallopoulos (1989), who advocate that as the firm's environmental performance improves, additional reductions in emissions become progressively more difficult, often requiring more significant changes in process or even entirely new production technology. Furthermore, the ability/inability of assets dedicated to old production technology surrounding non-renewable energy sources (e.g. coal plants, oil refineries) to adapt to the needs of the new production technology required for renewable energy sources make these reductions even more difficult (Verburggen and Lauber, 2012). In the interest of investigating this difficulty, Ruggiero and Lehkonen (2016) carried out a panel study from sixty-six large electric utility companies world-wide. Their findings "indicated that the relationship between an increase in renewable power production and profitability is contingent upon the level of carbon intensity of the firm" (Ruggiero and Lehkonen, 2016, p. 9). In explaining their findings, Ruggiero and Lehkonen (2016, p. 9) posit that, while at early stages renewable energy deployment positively effects firm performance, there may be an equilibrium point beyond which any increase in renewable energy capacity "may be economically detrimental." This leads to this study's hypothesis.

> Hypothesis: Renewable energy deployment for high-polluting companies is positively associated with firm performance early in the renewable energy deployment process.

METHODOLOGY

The United States investor-owned electric utility industry was chosen for analysis for two primary reasons: (1) a study by Kwasnik et al. (2014) provided a ranking of the 32 largest US investor-owned electric utilities (see Table 1) with respect to renewable energy deployment, and (2) due to this industry's relatively large carbon footprint.

Table 1: Utility Holding Companies in the Kwasnik et al. (2014) Study

| | |
|---|---|
| PG&E | National Grid |
| PSEG | OGE Energy |
| Southern Co | Edison International |
| PPL Corp | Puget Sound Energy |
| Alliant Energy | Pinnacle West |
| Xcel Energy | SCANA |
| Berkshire Hathaway Energy | We Energies |
| ConEdison | NV Energy |
| Sempra Energy | Portland General Electric |
| Northeast Utilities | American Electric Power |
| DTE Energy | CMS Energy |
| Entergy | Duke Energy |
| Pepco Holdings | Exelon |
| FirstEnergy | Dominion Resources |
| AES | Ameren |
| FPL | Iberdrola |

Kwasnik et al. (2014) reported that the U.S. electric power sector is responsible for approximately 40 percent of the country's global warming pollution (p. 13). The study focused on investor-owned utilities because data quality was generally found to be superior to publicly owned utilities and more investment in renewable energy and energy efficiency has occurred in the investor-owned segment of the utility industry (Kwasnik et al, 2014, p. 14). Three indices of clean energy deployment were used in the study to rank the companies:

1. The total amount of renewable electricity sold to retail customers, measured as the total renewable electricity sales as a percentage of total retail electric sales (see Table 2) (Kwasnik et al, 2014, p. 17).
2. Cumulative annual energy efficiency savings, measured as the energy savings from all energy efficiency programs as a percentage of total retail electric sales (see Table 3) (Kwasnik et al, 2014, p. 19).
3. Incremental annual energy efficiency savings, measured as all energy savings from (a) new participants in existing programs and (b) all participants in new programs in a given year, as a percentage of retail electric sales (Kwasni, et al, 2014, p. 21).

Measures #1 and #2 were used in this study as independent variables, as they are measures of total renewable energy deployment. These measures and this study was used for the analysis because the renewable energy deployment appears to be relatively small, perhaps not yet reaching the equilibrium point beyond which additional renewable deployment negatively effects firm performance. For measure 1, the highest level of renewable electricity sales as a percentage of total retail electric sales was 21.08%, with the mean being 6.24%. For measure 2, the highest energy savings from all energy efficiency programs as a percentage of total retail electric sales was 17.18%, with the average being 5.9%. Measure #3 was not used, as it is a measure of incremental, as opposed to total, renewable energy deployment. These clean energy deployment measures were stated as a percentage of total retail electric sales to normalize the data and enable benchmarking of the utility holding companies (Kwasnik et al, 2014, p. 14).

The rankings of the utility holding companies for the two clean energy deployment indices are shown on Table 2 (total renewable electricity sales as a percentage of total retail electric sales) and Table 3 (energy savings from all energy efficiency programs as a percentage of total retail electric sales).

Table 2: Renewable Electricity Sales as a % of Retail Electric Sales: indices and ranking

| *Utility Holding Company* | *Indices* | *Rank* |
|---|---|---|
| NV Energy | 21.08 | 1 |
| Xcel Energy | 18.11 | 2 |
| PG&E | 16.87 | 3 |
| Sempra Energy | 16.86 | 4 |
| Edison International | 16.67 | 5 |
| Berkshire Hathaway Energy | 12.71 | 6 |
| Portland General Electric | 7.52 | 7 |
| Northeast Utilities | 6.60 | 8 |
| OGE Energy | 6.59 | 9 |
| National Grid | 5.70 | 10 |
| We Energies | 5.67 | 11 |
| Alliant Energy | 5.41 | 12 |
| Pinnacle West | 5.35 | 13 |
| CMS Energy | 5.21 | 14 |
| PSEG | 4.93 | 15 |
| DTE Energy | 4.15 | 16 |
| Ameren | 4.03 | 17 |
| Pepco Holdings | 3.40 | 18 |
| Duke Energy | 3.29 | 19 |
| ConEdison | 3.19 | 20 |
| Exelon | 2.97 | 21 |
| Puget Sound Energy | 2.75 | 22 |
| American Electric Power | 2.65 | 23 |
| FirstEnergy | 2.26 | 24 |
| PPL Corp | 1.69 | 25 |
| Entergy | 0.64 | 26 |
| AES | 0.53 | 27 |
| Dominion Resources | 0.52 | 28 |
| Southern Co | 0.05 | 29 |
| SCANA | 0.00 | 30 |

Adapted from "Kwasnik, J. M., Mullen, D., Pernick, R., & Wilder, C. (2014). Benchmarking Utility Clean Energy Deployment: 2014. Retrieved from Ceres: https://www.ceres.org/resources/reports/benchmarking-utility-clean-energy-deployment-2014"

Table 3: Cumulative annual energy efficiency savings as a % of retail electric sales: indices and rank

| *Utility Holding Company* | *Indices* | *Rank* |
|---|---|---|
| PG&E | 17.18 | 1 |
| Edison International | 16.87 | 2 |
| Northeast Utilities | 16.46 | 3 |
| Sempra Energy | 12.54 | 4 |
| Xcel Energy | 10.62 | 5 |
| National Grid | 10.44 | 6 |
| Portland General Electric | 10.25 | 7 |
| We Energies | 10.14 | 8 |
| Puget Sound Energy | 9.93 | 9 |
| Alliant Energy | 8.39 | 10 |
| Pinnacle West | 7.98 | 11 |
| NV energy | 7.01 | 12 |
| Berkshire Hathaway Energy | 6.74 | 13 |
| ConEdison | 5.10 | 14 |
| DTE Energy | 3.62 | 15 |
| AES | 2.83 | 16 |
| CMS Energy | 2.79 | 17 |
| PPL Corp | 2.77 | 18 |
| Exelon | 2.69 | 19 |
| Duke Energy | 2.68 | 20 |
| American Electric Power | 2.13 | 21 |
| FirstEnergy | 2.05 | 22 |
| Ameren | 1.10 | 23 |
| Southern Co | 1.01 | 24 |
| OGE Energy | 0.96 | 25 |
| PSEG | 0.90 | 26 |
| SCANA | 0.84 | 27 |
| Pepco Holdings | 0.73 | 28 |
| Dominion Resources | 0.41 | 29 |
| Entergy | 0.13 | 30 |

Adapted from “Kwasnik, J. M., Mullen, D., Pernick, R., & Wilder, C. (2014). Benchmarking Utility Clean Energy Deployment: 2014. Retrieved from Ceres: https://www.ceres.org/resources/reports/benchmarking-utility-clean-energy-deployment-2014”

Consistent with research in this area, accounting financial ratios were used as dependent variables to measure firm performance (Earnhart & Lizal, 2007). The performance measures used here are return on assets (ROA) which serves as a measure of operating performance, and return on equity (ROE) which serves as a measure of financial performance. A strength of these measures is that both computations (ROA=net income/total assets, ROE=net income/equity) normalize the data, enabling ranking of the companies and controlling for size.

Two utility holding companies were not part of the analysis because one (Iberdrola) was an LLC and the other (FPL) was subsidiary of NextEra Energy, Inc. and financial information was unavailable for these. Tables 4 and 5 show the ROA and ROE computations, respectively for the companies.

Table 4: Return on assets (ROA): measure and rank

| *Utility Holding Company* | *Measure* | *Rank* |
|---|---|---|
| PG&E | 0.0609 | 1 |
| National Grid | 0.0435 | 2 |
| PSEG | 0.0414 | 3 |
| OGE Energy | 0.0409 | 4 |
| Southern Co | 0.0395 | 5 |
| Edison International | 0.0369 | 6 |
| PPL Corp | 0.0356 | 7 |
| Puget Sound Energy | 0.0344 | 8 |
| Alliant Energy | 0.0328 | 9 |
| Pinnacle West | 0.0316 | 10 |
| Xcel Energy | 0.0299 | 11 |
| SCANA | 0.0298 | 12 |
| Berkshire Hathaway Energy | 0.0294 | 13 |
| We Energies | 0.0292 | 14 |
| ConEdison | 0.0282 | 15 |
| NV Energy | 0.0272 | 16 |
| Sempra Energy | 0.0264 | 17 |
| Portland General Electric | 0.0247 | 18 |
| Northeast Utilities | 0.0243 | 19 |
| DTE Energy | 0.0236 | 20 |
| American Electric Power | 0.0235 | 21 |
| CMS Energy | 0.0227 | 22 |
| Entergy | 0.0207 | 23 |
| Duke Energy | 0.0198 | 24 |
| Pepco Holdings | 0.0186 | 25 |
| Exelon | 0.0175 | 26 |
| FirstEnergy | 0.0158 | 27 |
| Dominion Resources | 0.0071 | 28 |
| AES | -0.0209 | 29 |
| Ameren | -0.0428 | 30 |

10-k's were not available for Iberdrola and FPL. As such, they are not included in the analysis and rankings are adjusted accordingly.

Table 5: Return on equity (ROE): measure and rank

| *Utility Holding Company* | *Measure* | *Rank* |
|---|---|---|
| National Grid | 0.2227 | 1 |
| Edison International | 0.1543 | 2 |
| OGE Energy | 0.1445 | 3 |
| PPL Corp. | 0.1443 | 4 |
| Southern Co. | 0.1260 | 5 |
| CMS Energy | 0.1228 | 6 |
| PSEG | 0.1211 | 7 |
| Pinnacle West | 0.1075 | 8 |
| Xcel Energy | 0.1043 | 9 |
| Alliant Energy | 0.1040 | 10 |
| Berkshire Hathaway Energy | 0.0987 | 11 |
| ConEdison | 0.0976 | 12 |
| Entergy | 0.0933 | 13 |
| NV Energy | 0.0925 | 14 |
| Sempra Energy | 0.0911 | 15 |
| SCANA | 0.0878 | 16 |
| DTE Energy | 0.0859 | 17 |
| American Electric Power | 0.0842 | 18 |
| Portland General Electric | 0.0832 | 19 |
| Northeast Utilities | 0.0794 | 20 |
| Pepco Holdings | 0.0649 | 21 |
| PG&E | 0.0648 | 22 |
| Exelon | 0.0648 | 23 |
| FirstEnergy | 0.0585 | 24 |
| Duke Energy | 0.0549 | 25 |
| Dominion Resources | 0.0299 | 26 |
| AES | -0.1058 | 27 |
| Ameren | -0.1340 | 28 |

Information to compute ROE was not available for We Energies and Puget Sound Energy, and 10-k's were not available for Iberdrola and FPL. As such, they are not included in the analysis and rankings are adjusted accordingly.

Two statistical tests were used to correlate company performance with the two clean energy indices; the Spearman rank correlation coefficient (Spearman's rho) and the Pearson correlation coefficient (Pearson's *r*). Spearman's rho is used to compare the company ranking for the renewable energy deployment indices with the company ranking for the two performance measures (ROA and ROE), is a nonparametric statistic (its validity does not rely on assumptions that the data is drawn from a given probability distribution), and is considered appropriate when "the original data are ordinal, as with ranks" (Shavelson, 1988, p. 155). Pearson's *r* was used to measure the correlation between the two renewable energy deployment indices and the two performance measures. Empirical results are shown in Tables 6 (correlation of rankings) and 7 (correlation of measures/statistics).

EMPIRICAL RESULTS

Results were similar using both comparisons: rankings and actual measures. When rankings were compared (Table 6), operating performance, as measured by return on assets, was significantly associated with both renewable energy deployment measures. Spearman's rho was 0.366 ($p = 0.047$) when comparing ROA with renewable electricity sales as a percentage of retail electric sales, and it was 0.384 ($p = 0.036$) when comparing ROA with cumulative annual energy efficiency savings as a percentage of retail electric sales. When measures were compared (Table 7), Pearson's $r$ was 0.319 ($p = 0.085$) when comparing ROA with renewable electricity sales as a percentage of retail electric sales, and it was 0.405 ($p = 0.026$) when comparing ROA with cumulative annual energy efficiency savings as a percentage of retail electric sales.

When return on equity, the proxy for financial performance, was compared with the renewable deployment measures, statistical results were not significant. Spearman's rho was 0.269 ($p = 0.165$) when comparing ROE with renewable electricity sales as a percentage of retail electric sales, and it was 0.194 ($p = 0.322$) when comparing ROE with cumulative annual energy efficiency savings as a percentage of retail electric sales. Similarly, when measures were compared (Table 7), Pearson's $r$ was 0.212 ($p = 0.278$) when comparing ROE with renewable electricity sales as a percentage of retail electric sales, and it was 0.261 ($p = 0.180$) when comparing ROE with cumulative annual energy efficiency savings as a percentage of retail electric sales. One possible explanation is that ROE can be influenced by non-performance-related factors. For instance, holding all other factors equal, businesses that are not highly leveraged will have more equity relative to debt, resulting in a lower ROE. Put another way, ROE not only reflects operating efficiency, but also the capital structure of the firm.

Table 6: Ranks: Performance measures, energy efficiency indices

| *Utility Holding Company* | *Return on Assets* | *Return on Equity* | *Renewable electricity sales as a % of retail electric sales* | *Cumulative annual energy efficiency savings as a % of retail electric sales* |
|---|---|---|---|---|
| PG&E | 1 | 22 | 3 | 1 |
| National Grid | 2 | 1 | 10 | 6 |
| PSEG | 3 | 7 | 15 | 26 |
| OGE Energy | 4 | 3 | 9 | 25 |
| Southern Co | 5 | 5 | 29 | 24 |
| Edison International | 6 | 2 | 5 | 2 |
| PPL Corp | 7 | 4 | 25 | 18 |
| Puget Sound Energy | 8 | - | 22 | 9 |
| Alliant Energy | 9 | 10 | 12 | 10 |
| Pinnacle West | 10 | 8 | 13 | 11 |
| Xcel Energy | 11 | 9 | 2 | 5 |
| SCANA | 12 | 16 | 30 | 27 |
| Berkshire Hathaway Energy | 13 | 11 | 6 | 13 |
| We Energies | 14 | - | 11 | 8 |
| ConEdison | 15 | 12 | 20 | 14 |
| NV Energy | 16 | 14 | 1 | 12 |
| Sempra Energy | 17 | 15 | 4 | 4 |
| Portland General Electric | 18 | 19 | 7 | 7 |
| Northeast Utilities | 19 | 20 | 8 | 3 |
| DTE Energy | 20 | 17 | 16 | 15 |
| American Electric Power | 21 | 18 | 23 | 21 |
| CMS Energy | 22 | 6 | 14 | 17 |
| Entergy | 23 | 13 | 26 | 30 |
| Duke Energy | 24 | 25 | 19 | 20 |
| Pepco Holdings | 25 | 21 | 18 | 28 |
| Exelon | 26 | 23 | 21 | 19 |
| FirstEnergy | 27 | 24 | 24 | 22 |
| Dominion Resources | 28 | 26 | 28 | 29 |
| AES | 29 | 27 | 27 | 16 |
| Ameren | 30 | 28 | 17 | 23 |

Spearman's rho correlation coefficient = 0.366 ($p$ = 0.047). Return on assets and renewable electricity sales as a % of retail electric sales.

Spearman's rho correlation coefficient = 0.384 ($p$ = 0.036). Return on assets and cumulative annual energy efficiency savings as a % of retail electric sales.

Spearman's rho correlation coefficient = 0.269 ($p$ = 0.165). Return on equity and renewable electricity sales as a % of retail electric sales.

Spearman's rho correlation coefficient = 0.194 ($p$ = 0.322). Return on equity and cumulative annual energy efficiency savings as a % of retail electric sales.

Table 7: Statistics: Performance measures, energy efficiency indices

| *Utility Holding Company* | *Return on Assets* | *Return on Equity* | *Renewable electricity sales as a % of retail electric sales* | *Cumulative annual energy efficiency savings as a % of retail electric sales* |
|---|---|---|---|---|
| PG&E | 0.0609 | 0.0648 | 16.87 | 17.18 |
| National Grid | 0.0435 | 0.2227 | 5.70 | 10.44 |
| PSEG | 0.0414 | 0.1211 | 4.93 | 0.90 |
| OGE Energy | 0.0409 | 0.1445 | 6.59 | 0.96 |
| Southern Co | 0.0395 | 0.1260 | 0.05 | 1.01 |
| Edison International | 0.0369 | 0.1543 | 16.67 | 16.87 |
| PPL Corp | 0.0356 | 0.1443 | 1.69 | 2.77 |
| Puget Sound Energy | 0.0344 | - | 2.75 | 9.93 |
| Alliant Energy | 0.0328 | 0.1040 | 5.41 | 8.39 |
| Pinnacle West | 0.0316 | 0.1075 | 5.35 | 7.98 |
| Xcel Energy | 0.0299 | 0.1043 | 18.11 | 10.62 |
| SCANA | 0.0298 | 0.0878 | 0.00 | 0.84 |
| Berkshire Hathaway Energy | 0.0294 | 0.0987 | 12.71 | 6.74 |
| We Energies | 0.0292 | - | 5.67 | 10.14 |
| ConEdison | 0.0282 | 0.0976 | 3.19 | 5.10 |
| NV Energy | 0.0272 | 0.0925 | 21.08 | 7.01 |
| Sempra Energy | 0.0264 | 0.0911 | 16.86 | 12.54 |
| Portland General Electric | 0.0247 | 0.0832 | 7.52 | 10.25 |
| Northeast Utilities | 0.0243 | 0.0794 | 6.60 | 16.46 |
| DTE Energy | 0.0236 | 0.0859 | 4.15 | 3.62 |
| American Electric Power | 0.0236 | 0.0842 | 2.65 | 2.13 |
| CMS Energy | 0.0227 | 0.1228 | 5.21 | 2.79 |
| Entergy | 0.0207 | 0.0933 | 0.64 | 0.13 |
| Duke Energy | 0.0198 | 0.0549 | 3.29 | 2.68 |
| Pepco Holdings | 0.0186 | 0.0649 | 3.40 | 0.73 |
| Exelon | 0.0175 | 0.0648 | 2.97 | 2.69 |
| FirstEnergy | 0.0158 | 0.0585 | 2.26 | 2.05 |
| Dominion Resources | 0.0071 | 0.0299 | 0.52 | 0.41 |
| AES | -0.0209 | -0.1058 | 0.53 | 2.83 |
| Ameren | -0.0428 | -0.1340 | 4.03 | 1.10 |

Pearson's *r* correlation coefficient = 0.319 ($p$ = 0.085). Return on assets and renewable electricity sales as a % of retail electric sales.

Pearson's *r* correlation coefficient = 0.405 ($p$ = 0.026). Return on assets and cumulative annual energy efficiency savings as a % of retail electric sales.

Pearson's *r* correlation coefficient = 0.212 ($p$ = 0.278). Return on equity and renewable electricity sales as a % of retail electric sales.

Pearson's *r* correlation coefficient = 0.261 ($p$ = 0.180). Return on equity and cumulative annual energy efficiency savings as a % of retail electric sales.

## DISCUSSION AND CONCLUSIONS

The goal of this study was to examine the deployment of renewable energy in US publicly-held utility companies relatively new to renewable energy deployment (such that they have not reached the discussed equilibrium point) to determine if there existed a positive correlation between said deployment and these companies' financial performance.

The study's hypothesis that renewable energy deployment is correlated with firm performance under circumstances prior to the equilibrium point is supported when using ROA as the performance measure, but not when using ROE as the performance measure.

The key limitation inlaid in this research is the lack of defined boundaries of what constitutes a firm being classified as early in the stages of renewable energy deployment versus midway through or late. In this study, it was presumed that the utilities analyzed were at early stages of renewable energy deployment based upon what was considered to be a relatively small proportion of renewable energy sales to total energy sales and cumulative energy savings to total energy sales (Kwasnik et al, 2014). This lack of a reference frame calls for future research to be conducted on the quantification of renewable energy deployment in the electrical utility industry as well as on the same correlation for electrical utility firms classified as late in the stages of renewable energy deployment. A second limitation is that the electrical utility companies in the sample are exclusively from the United States, whereas other in studies, such as Ruggiero and Lehkonen (2016), the electrical utility companies observed as global. The business and regulatory environment in the United States cannot be assumed to be like other business and regulatory environments across the world, which limits the application of this data abroad to a degree.

The conclusion that can be drawn from this research based upon the found correlation is that there exists a potential research basis for this idea of an equilibrium point where, consistent with the electrical utility firms studied by Ruggiero and Lehkonen (2016), the level of renewable energy deployment for firms ceases to yield positive financial impacts and begins to yield the opposite.

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