EXHIBIT

Exhibit No.:
Issue(s): IRP Rule Compliance
Witness/Type of Exhibit: Vitolo/Rebuttal
Sponsoring Party: Public Counsel
Case No.: EO-2011-0271

REBUTTAL TESTIMONY

OF

DR. THOMAS VITOLO

Submitted on Behalf of
the Office of the Public Counsel

UNION ELECTRIC COMPANY D/B/A AMEREN MISSOURI

Case No. EO-2011-0271

October 28, 2011

** **

Denotes Highly Confidential Information that has been redacted

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BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company's 2011 Utility Resource Filing Pursuant to 4 CSR 240 – Chapter 22	)))	**Case No. EO-2011-0271**

AFFIDAVIT OF DR. THOMAS VITOLO

STATE OF MASSACHUSETTS)
) ss
COUNTY OF MIDDLESEX)

Dr. Thomas Vitolo, of lawful age and being first duly sworn, deposes and states:

1. My name is Dr. Thomas Vitolo. I am an associate for Synapse Energy Economics, Inc.

2. Attached hereto and made a part hereof for all purposes is my rebuttal testimony.

3. I hereby swear and affirm that my statements contained in the attached affidavit are true and correct to the best of my knowledge and belief.

Thomas J. Vitolo
Dr. Thomas Vitolo

Subscribed and sworn to me this 28th day of October 2011.

Melissa Schultz
Notary Public

My commission expires July 27, 2018.

MELISSA SCHULTZ
Notary Public
Commonwealth of Massachusetts
My Commission Expires
July 27, 2018

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1. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, title, and employer.

A. My name is Thomas Vitolo. I am an associate at Synapse Energy Economics, located at 485 Massachusetts Avenue, Cambridge, MA 02139.

Q. Please describe Synapse Energy Economics.

A. Synapse Energy Economics is a research and consulting firm specializing in electricity and gas industry regulation, planning, and analysis. Our work covers a range of issues, including integrated resource planning, economic and technical assessments of energy resources, electricity market modeling and assessment, energy efficiency policies and programs, renewable resource technologies and policies, and climate change strategies. Synapse works for a variety of clients, with an emphasis on consumer advocates, regulatory commissions, and environmental advocates.

Q. Please summarize your professional and educational experience.

A. Before joining Synapse Energy Economics, I was a Ph.D. candidate at Boston University's Division of Systems Engineering. My general area of research was nonlinear optimization and combinatorial optimization, with a focus on searching for optimal solutions within a particular resource allocation problem, as well as on devising metrics to determine the best suited algorithm for solving the problem as a function of the parameters of the problem. My thesis title was *Efficient algorithms to discover degree constrained spanning trees in sparsely connected graphs.*

Concurrent with my graduate studies, I was an intern for Jointown Pharmaceuticals in Wuhan, China. Prior to that, I was employed as a research assistant at Lincoln Laboratory.

I hold a Doctor of Philosophy in Systems Engineering from Boston University, a Master of Science in Financial and Industrial Mathematics from Dublin City University, and a BS in Applied Mathematics, a BS in Computer Science, and a BS in Economics from North Carolina State University.

Q. Please describe your academic and professional experience as it relates to resource planning, as well as to operations research & management science.

A. At Synapse, I have reviewed and critiqued the analysis of the integrated resource plans and certificates of public convenience and necessity submitted by utilities located in Kansas, Missouri, New Mexico, Georgia, and Kentucky. In each case, my role has been to analyze and critique the utility's numerical analysis, modeling, and decision strategies.

My doctoral studies and my research at Lincoln Laboratory were focused on the optimal allocation of network resources. These efforts don't relate solely to transmission and distribution problems; they also directly relate to dispatch, compliance, and the allocation of demand- and supply-side resources, as well as the process by which the asset allocation decisions are made.

I also have experience solving inventory management problems at Jointown Pharmaceuticals. I designed a customized inventory restocking algorithm to determine appropriate order quantities for more than 20,000 distinct products, subject to numerous hard and soft constraints.

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

A. I am testifying on behalf of the Office of Public Counsel (OPC).

Q. Is the Office of the Public Counsel sponsoring other witnesses in this docket?

A. Yes, one of my colleagues at Synapse Energy Economics, Mr. Woolf, is sponsoring testimony on behalf of the OPC. In addition, Ryan Kind is sponsoring testimony on behalf of the OPC. Mr. Kind, Mr. Woolf, and I have collaborated closely in preparing our testimonies.

Q. What is the purpose of your testimony?

A. On June 23, 2011 the OPC filed a *Review of Union Electric Company's Electric Resource Planning Compliance Filing*, Case No. E-2011-0271 (OPC Review). That review identified several significant deficiencies with the Union Electric Company d/b/a Ameren Missouri (UE or the Company) Integrated Resource Plan (IRP), and recommended that the Company correct for these deficiencies and conduct its analysis again to select a more appropriate Preferred Resource Plan

and Resource Acquisition Strategy. That OPC review was accompanied by a technical report entitled *Review of the Union Electric Company Integrated Resource Plan* (OPC Technical Report), authored by Mr. Kind, Mr. Woolf, and myself. On August 22, 2011 UE filed a *Response to Comments of Parties* (Response), including responses to the issues raised by the OPC.

The purpose of my testimony is to rebut the Ameren Response with regard to the issues raised by the OPC. In my testimony I focus on those topics that I was primarily responsible for addressing in the OPC Technical Report, including the initial screening of alternate resource plans and the final scorecard for these plans.

Q. How is your testimony organized?

A. My testimony is organized as follows:

1. Introduction and Qualifications
2. Summary of Conclusions and Recommendations
3. Analysis of the Screening Metrics
4. Analysis of the Final Scorecard Methodology

2. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Q. Please summarize your primary conclusions.

A. In sum, I find that the Ameren Response does not sufficiently address the deficiencies identified in the OPC Review and the OPC Technical Report. I confirm the OPC's original finding that the Ameren IRP is fundamentally flawed, does not meet the requirements of 4 CSR 240-22, and does not provide the Company or the Commission with sufficient analysis and information to identify an appropriate Preferred Resource Plan or a reasonable Resource Acquisition Strategy.

In particular:

- Ameren's metrics used in the initial screening and final screening of alternate resource plans contain numerous flaws, resulting in an inappropriate scoring in each of the two screening iterations.

- Ameren's scorecard representation of the results introduces a number of avoidable errors. Their detailed analysis with precisely quantified information is replaced with far coarser numbers, thereby introducing illogical results by masking clear differences between the alternate resource plans with layers of obfuscation.

Q. Please summarize your primary recommendations.

A. I recommend that the Commission require the Company to conduct its IRP analysis again with the following significant modifications:

- The Company should revise its screening metrics for Economic Development and Customer Satisfaction to appropriately measure each candidate plan with respect to those categories, should revise the weights it assigns to each category so that they are consistent at each phase of the screening, and should revise the unitized score scaling method so that the effective weights of each category after scaling match the nominal weights the Company purports to assign to each category.

- The Company should revise its scorecard to retain the precision of the information calculated in previous steps of the screening process, thereby allowing a more careful comparison between candidate resource plans and perhaps reducing the likelihood of erroneously applying illogical scoring to certain plans based on the Company's own criteria[1]. While complex and perhaps subjective policy objectives with multiple measures may require some sub-measures to be ranked with a simple 1 to 5 scoring, each of the six policy objectives in the initial screening process (inexplicably reduced to five in the Preferred Plan Selection Scorecard) contain metrics that aren't subjective. In those cases, the actual values, including their levels of precision, should be used.

[1] For example, the Company erroneously does not score R3 a maximum score of 5 in the Environmental/Diversity category, claiming that "coal reduction" results in "no additions to fuel diversity," despite coal being the largest source of energy for the Company.

3. ANALYSIS OF SCREENING METRICS

Q. Please summarize the OPC's concerns about the Company's screening process.

A. In the OPC Review and the OPC Technical Report, we find that UE failed to develop a screening process that appropriately evaluates the merits of each candidate resource plan. (OPC Review, pages 5-7, 9 and OPC Technical Report, pages 17-21 and page 34.) In particular, we demonstrate significant flaws with both the Economic Development metric and the Customer Satisfaction metric. Additionally, we state that re-weighing the different metrics in the second phase of the screening process is inappropriate. Finally, we show that the Company's flawed implementation of the unitized score methodology substantially distorts the results, so much so that the Present Value of Revenue Requirement (PVRR) has an effective influence of less than 10 percent of a candidate resource plan's final score under the metrics used by the Company.

Q. Please summarize the Company's response to OPC's concerns.

A. The Company did not respond to specific concerns raised by OPC about the scoring method used in UE's screening process. Instead, it claimed that the OPC concerns were the results of "subjectivity [that] cannot be escaped." (UE Response, page 100.)

Q. Do you agree with the Company's response on these issues?

A. No, I do not. The Company did not acknowledge its calculation errors, and did not address the specific critiques of the metrics. The critiques are not matters of opinion or subjectivity; the metrics are deeply flawed, the re-weighing is inappropriate, and the Company's unitized score methodology so significantly distorts the metrics that it renders them uninformative. These are not issues of subjectivity.

Q. Please elaborate on the Company's Economic Development metric.

A. The Economic Development metric includes 100 percent of the job years created in the construction of a nuclear power plant, despite the fact that the Company is only funding a fraction of the plant.

Just as the Company is only responsible for its fractional share of the costs and risks of owning an asset, it is only entitled to its fractional share of the benefits. If four companies were to co-own the plant and they each used the Company's metric, commissioners would expect four times the number of full time equivalent (FTE) job years that the project would actually generate. If the Company proposed owning 30 percent of a coal fired power plant, would it claim 100 percent of the emissions in their cost analyses? It ought not.

This is a significant flaw; if UE were to correctly measure its Economic Development impact by multiplying the FTE job years created by its fractional share of ownership in the project, it would have scored three RAP candidate resource plans significantly higher than the nuclear plans when evaluated under this metric. Schedule TJV-1 contains the unitized Economic Development scores for all 14 plans on the Preferred Plan Selection Scorecard. The bar charts demonstrate that correcting the Economic Development metric reduces the nuclear proposals by about 30 percent and increases the non-nuclear scores by over 230 percent.

Q. Please explain the ramifications of the Company's Customer Satisfaction metric.

The Customer Satisfaction metric consists of two components of equal weight: the average rate increase and the maximum single year rate increase. While both quantities are described in 4 CSR 240-22.060(2), the regulation does not require them to be weighed equally. By doing so, the Company has created a metric that scores plans that are substantially more expensive to rate payers as providing more Customer Satisfaction than plans that are significantly less costly, a rather unlikely reality. Consider two scenarios, Scenario A and Scenario B, as shown in Schedule TJV-2. Scenario A has no rate increase for 9 years, and then a 10 percent increase in the tenth year. Scenario B has a 5 percent rate increase each and every year. The Company's metric scores Scenario B as preferable to Scenario A in terms of Customer Satisfaction, even though the customer with an initial $100/month electric bill will find that every single bill is higher in Scenario

B than in Scenario A, totaling a difference of over three thousand dollars over the decade.

Furthermore, the regulation does not require that the Company weigh a maximum single year rate increase in a near future year equally with that of a distant future year. Consider Scenario C (also found in Schedule TJV-2): a 10 percent rate increase the first year, and no rate increases for the rest of the decade. The Company's Customer Satisfaction metric scores Scenario C as equal to A and worse than B. In fact, when compared to Scenario A, the customer in Scenario C pays higher bills every single year except the final year, for a difference totaling over $1,000 in real dollars. Again, the Company's Customer Satisfaction metric scores Scenario B as more attractive than Scenario C, despite the fact that the customer in Scenario C pays lower bills in every year but the first one, and over the span of the decade pays more than two thousand dollars less than in Scenario B.

Both of these comparisons produce absurd results. Scenario A is clearly preferable to Scenario B with respect to Customer Satisfaction, yet the Company's metric scores Scenario B higher. Likewise, Scenario C is clearly more satisfying to customers than Scenario B, yet the Company's metric claims Scenario B is preferable. Finally, despite Scenario A's obvious superiority to Scenario C, the Company's metric scores them an exact tie. A Customer Service metric that produces such nonsensical results must be revised.

Q. Why is using different scoring weights for the first and second phases of the screening process inappropriate?

The Company used one set of weights when totaling the scores of each candidate resource plan in the first round of screening, and then used a different set of weights when totaling the scores of each finalist candidate resource plan in the second round of screening to create the Scorecard. There are at least two problems with this process.

Firstly, by re-weighing the categories without making the changes explicit in the IRP, the Company creates a false impression of the relative import it is placing on the Policy Objectives. For example, the Company created a false impression that Energy Efficiency (EE) was a Policy Objective under full consideration. In the initial screening process, EE scores were worth 10% of the candidate resource plan's final score, as shown in Table 9.2 of the IRP. In the second phase of the screening, however, the Company re-weighed the EE metric to 0 percent without explicitly mentioning that significant change in its consideration of that policy objective. One must rely on a confidential worksheet to discover the new weights[2]. Other metrics were changed as well – the Cost metric was changed from 25 percent to ** ** percent and the Customer Satisfaction metric was altered as well, from 15 percent to ** ** percent. Furthermore, UE never provided a reasonable justification for its use of different scoring metrics and weights for the first and second phases.

The second critique is technical in nature. In real world applications such as this one, applying a different objective function in the second phase of the selection process than the one used in the first phase results in the selection of a suboptimal resource plan. Consider this admittedly silly example: if your first phase chooses the 14 tallest runners and your second phase selects the fastest of those 14, have you selected the fastest runner overall? You probably didn't, because the fastest runner isn't likely among the tallest. You probably didn't end up with the tallest, either. By reweighing the six categories (including reweighing EE with a weight of 0 percent), the Company almost certainly didn't choose the candidate resource plan that performed best under *either* set of criteria.

[2] \MRM - HC\Preferred Plan Selection Scorecard FINAL.xlsx

Using a two-phase screening process is sensible because compiling detailed analyses for 216 plans is burdensome; detailed analyses for between 10 and 20 plans is appropriate. However, by changing the criteria between the first and second phases of the screening process, UE fostered a false understanding of the Policy Objectives used, and furthermore almost certainly selected a candidate resource plan that wasn't optimal under either of their scoring criteria.

Q. Please explain the unitized scoring system used by UE, its flaw, and how it can be corrected.

A. The Company utilized a unitized scoring system so that the candidate resource plans that perform better or worse when scored using different metrics could be compared holistically. The metrics used to compare each candidate resource plan in each of the six Policy Objective categories produce numbers that can't be compared directly because the metrics result in numbers of vastly different sizes, and that are measured in dollars, percent, number of FTE job years, and even unit-less numbers. Unitized scoring maps each score, regardless of unit, to a real number between 0.000 and 1.000 inclusive, thereby allowing a holistic direct comparison of plans that perform better or worse in each of the categories.

However, the Company's implementation of unitized scoring distorts the results to the point of uselessness. The flaw is this: while the best unitized score in each metric is always 1.000, the worst score varies across the criteria. The worst score is as small as 0.000 (in the Economic Development and Energy Efficiency categories) and as large as 0.858 (in the PVRR category). This means that the candidate resource plan with the *worst* PVRR gets 86 percent of the score of the candidate resource plan with the *best* PVRR, whereas the candidate resource plan with the worst Economic Development score gets 0 percent of the score of the candidate resource plan with the best Economic Development score.

The ramification of the Company's unitized scoring flaw is that the **effective** weights of the six Policy Objectives are radically different than the nominal weights the Company purports to use. Calculating the effective weight is a two-step process. In step 1, for each of the six Policy Objectives, subtract the minimum unitized score from 1.000, and multiply the result by the weight of that Policy Objective. Secondly, add the six products together. To calculate the effective weight of a Policy Objective, divide the result of the first step by the sum calculated in the second step. The results are shown in Schedule TJV-3.

One result of the Company's inappropriate method of unitized scoring is that the Cost metric has the smallest range between worst and best scores, and therefore a much smaller effective weight than its nominal weight. In fact, in the first phase of the screening process the effective weighing of PVRR is 7.5 percent. Because the Company didn't report the complete scoring data of the 14 candidate resource plans in the second screening phase I cannot calculate the exact effective weighing of PVRR in the second stage. However, using the Cost and Economic Development scores from the second phase, and the first-phase scoring ranges for the other three Policy Objectives, one can calculate an estimate of the effective weighing of PVRR: 7.1 percent. This result can be found in Schedule TJV-3.

Q. You have identified a number of flaws with the models, metrics, and calculations. Can they be easily fixed?

A. Yes, they can. The Economic Development metric can be fixed by simply multiplying the number of FTE job years created by the Company's proposed share of ownership. The Customer Satisfaction metric should be changed to discount maximum rate increase values that occur further into the future, and should weigh average rate increase more heavily than the maximum increase; both are straightforward changes. When applying a two-stage screening process, the weights of the categories should not be changed, also a simple change to the model. Finally, the unitized scores should be scaled by the lowest raw score in the category, so that the worst score always gets a value of 0.000 and the highest

score always gets a value of 1.000. Like the other flaws, the unitized score flaw is easily corrected.

These are not matters of inescapable "subjectivity"; these are matters of correct and accurate measurements, which are necessary both if "the decision makers charged with managing the company on behalf of both customers and investors" are to do so effectively, and if the Company is to follow the requirements detailed in 4 CSR 240-22.

4. ANALYSIS OF FINAL SCORECARD METHODOLOGY

Q. Please summarize the OPC's concerns about the Company's Final Scorecard methodology.

A. The concerns about the Company's final scorecard methodology and implementation detailed in the OPC Review and the OPC Technical Report are numerous. (OPC Review, pages 7-9 and OPC Technical Report, pages 27-40.). Firstly, a number of scores on the scorecard defy explanation. Secondly, the scorecard uses whole numbers ranging from 1 to 5, thereby eliminating the precision provided by the unitized scores. Finally, the Company eliminates even more precision by grouping ranges of scores together, simply representing the range as a green circle, a yellow triangle, and a red diamond. The Final Scorecard methodology is a step backward in the planning process because it replaces careful numerical analysis and study with guesswork and subjectivity.

Q. Please summarize the Company's response to the OPC's concerns.

A. The Company did not address the OPC's concerns directly, instead stating that "there is subjectivity in the use of scorecards," and that "scorecards, while helpful tools in informing decision-making, cannot themselves be the primary determinant for decisions." (UR Response, page 100.)

Q. Do you agree with the Company's response to these issues?

A. There certainly can be subjectivity in the use of scorecards. However, because the scorecard includes measures for Environmental Impact, Energy Efficiency,

Financial and Regulatory considerations, Customer Satisfaction, Economic Development, and Cost, I disagree with the claim that the scorecard cannot be the primary determinant for decisions. I don't know what other considerations, individually or in total, the Company would weigh more heavily than the six Policy Objective categories used to create the scorecard. Additionally, 4 CSR 240-22.060 (2) explicitly requires that when assessing the performance of alternative resource plans, the utility must use "quantitative measures." Assigning somewhat arbitrary scores with only some regard to the actual data would seem to stretch the definition of "quantitative." Furthermore, given that UE is altering the PVRR data in a somewhat arbitrary manner, obscuring it by using a 1-5 scoring system,

effectively weighing PVRR to be less than 10 percent of the final scoring, and then not using the scorecards to comply with the requirement in the IRP rules to use minimization of PVRR as the primary plan selection criteria (4 CSR 240-22.010 (B)), UE does not demonstrate compliance with the rules requiring the minimization of PVRR.

Q. Please elaborate on the Scorecard scores that are unreasonable.

A. Consider the Economic Development metric. The Company justified its assigned Scorecard scores using statements like "score lower due to loss of jobs at Meramec with minimal offsetting job creation," and "Meramec retirement plans with supply side replacement score low due to loss of jobs at Meramec offset by near-term construction jobs for combined cycle." To illustrate the problem with assigning precise data an integer between 1 and 5 using qualitative methods when actual quantities exist, I've created Schedule TJV-4. For each of the 14 finalist candidate resource plans, Schedule TJV-4 compares the actual number of FTE job years as reported by the Company with the score the Company assigned that resource plan. Notice that if the actual number of FTE job years as reported had been used to assign Scorecard scores, the scores for plans R0, R3, B4, and H2 would have to differ by a full point, and depending on the rounding scheme employed, plans R1, R2, C1, C3, and H3 would have different scores as well. More succinctly, how can it be that plans R0 and R2 both purport to generate

11,991 FTE job years, but R0 is scored a 4 and R2 only a 3? How is it that candidate resource plans C2, B1, and B3 are all scored a 1, yet each of those plans creates more jobs than plans C3, H3, and H2, which were each awarded a score of 2? These are all examples of unreasonable Scorecard scores.

The Economic Development metric isn't the only Policy Objective that suffers from the Company's assigning qualitative subjective scoring to a quantitative issue. The Company makes the same error with Cost (PVRR), using qualitative and subjective explanations like "RAP DSM plans with Meramec controlled, converted or retired score "moderate advantage" due to higher cost compared with Meramec retiring." Schedule TJV-5 contains the actual PVRR reported by the Company and the Scorecard scoring for each finalist candidate resource plan. Using either the Company's flawed unitized scoring system or the corrected unitized scoring system, the errors are clear. On the Scorecard, R1, R2, and R3 are assigned a 4, but their actual values align below a score of 3. H1 is the worst performing plan with respect to PVRR, but it gets a score of 2 instead of 1, alongside the poorly performing H2, C3, and H3.

In both cases, the problem isn't just that the Company chose the wrong integer – the problem is that they shouldn't be using integers in the first place. The correct way to score Policy Objectives with straightforward metrics like jobs or PVRR is to simply use the actual result of the analysis, scaled to a value between 1.000 and 5.000. In this way, a plan with a slight advantage preserves that advantage on the Scorecard, and it removes subjectivity and unreasonableness from the process of assigning a Scorecard score to an actual number of FTE jobs or an actual PVRR.

The Scorecard isn't, as the Company describes it, "just one such piece of information." The Scorecard the Company created is better described as misinformation. By removing precision to the point of grouping the candidate resource plans into three groups differentiated by colored shapes, the Scorecard implies that a number of candidate resource plans are equivalent in total impact, if not identically at least approximately so. This is because the Company took high precision scores and eliminated the fidelity, thereby rendering somewhat similar

results (or even not-similar results) identical. Doing so alters and obfuscates the information, providing the false impression of similarity or equivalence when it simply isn't so.

Q. If the Scorecard is so flawed, aren't you pleased that the Company doesn't use it as the primary determinant for decisions?

A. Of course not. The Scorecard should correctly encapsulate the different candidate resource plans' policy objective impacts in a meaningful and useful way for the benefit of the Company, the Commission, and other stakeholders such as the OPC. A scorecard can be used as a primary determinant when making decisions when the scorecard calculations are implemented correctly. The Company's implementation of its screening process and Scorecard is extremely flawed, as I have laid out in Sections 3 and 4. However, should the Company revisit its screening method and scoring metrics to correct the errors contained therein, preserve the high fidelity gained in the screening process at the scorecard stage, and present the senior management of UE a scorecard based on correct measurements and sound methodologies, then the scorecard would become the *ideal* determinant for deciding which candidate resource plan (or plans) to pursue.

Q. Does this conclude your pre-filed testimony?

A. Yes, it does.

Thomas Vitolo

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Cambridge, MA. Associate, April 2011 to present. Performs consulting, conducts research, and assists in writing testimony and reports on a wide range of issues relating to electric utilities, energy efficiency, electricity transmission and generation, consumer advocacy, environmental policy and compliance, and air emissions.

Jointown Group Co., Ltd., Wuhan, China. Systems Engineer Intern, Summer 2007. Developed and implemented a modified (*s, S*) inventory management scheme for over 20,000 warehoused pharmaceutical products, resulting in more orders filled, lower carrying costs, nad a reduction in the frequency of product expiration.

MIT Lincoln Laboratory, Group 65, Lexington, MA. Research Assistant, 2003–2006. Designed algorithm and implemented software to create autonomous wireless point-to-point topologies for aerial, land-based, and nautical vehicles as part of an Optical & RF Combined Link Experiment (ORCLE) funded by the Defense AdvanceD Research Projects Agency (DARPA).

EDUCATION

Ph.D., Systems Engineering. Boston University, Boston, MA, 2011.
M.Sc., Financial and Industrial Mathematics. Dublin City University, Dublin, Ireland, 2001.
B.S., Applied Mathematics. North Carolina State University, Raleigh, NC, 2000.
B.S., Computer Science. North Carolina State University, Raleigh, NC, 1999.
B.S., Economics. North Carolina State University, Raleigh, NC, 1998.

REPORTS

Topology Formulation Algorithms for Wireless Networks with Reconfigurable Directional Links, prepared for the Proceedings of the IEEE Military Communications Conference, 2005.

PRESENTATIONS

RPS in the USA: The Present Impact and Future Possibilities of Renewable Portfolio Standards in America, speaker at the Boston University Energy Club Seminar Series, 2009.

An ILP Approach to Spanning Tree Problems on Incomplete Graphs with Heterogeneous Degree Constraints, speaker at the INFORMS Annual Meeting, 2007.

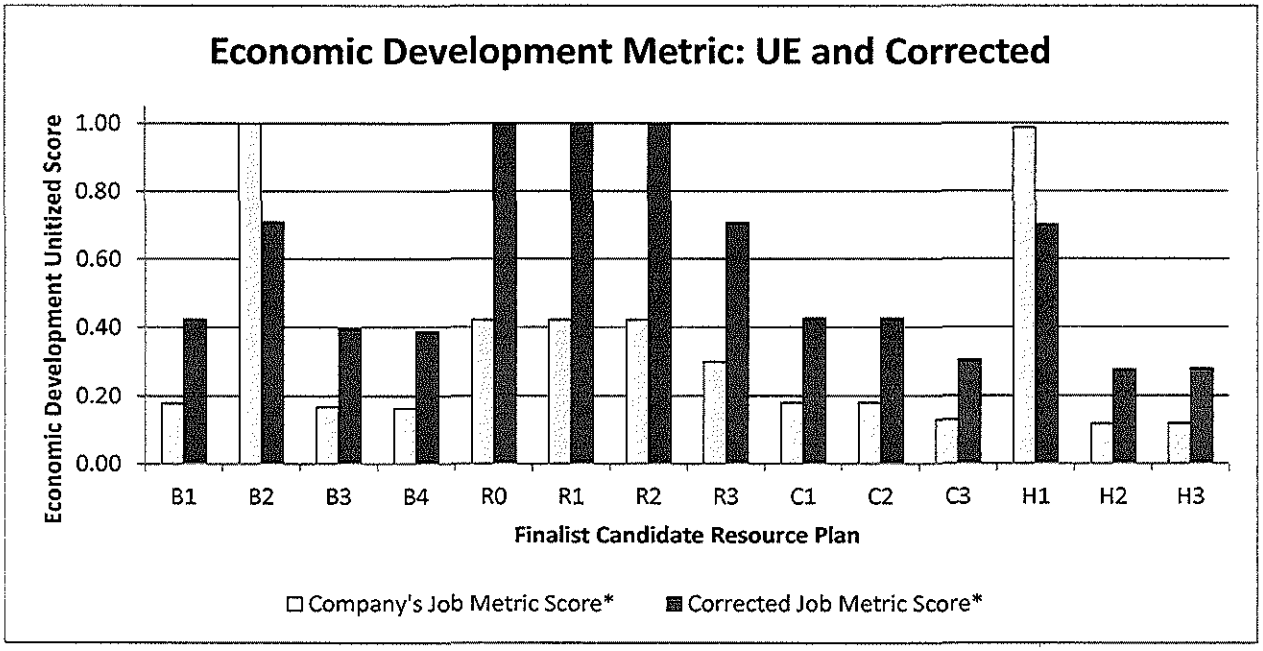
Topology Design and Traffic Routing for Wireless Networks with Node-Based Topological Constraints, speaker at the Boston University CISE Seminar Series, 2004.

Economic Development Metric Comparision: The Company's Job Metric Score and the Corrected Job Metric Score

Candidate Plan Name	Number of FTE Job Years	Corrected Number of FTE Job Years	Company's Job Metric Score*	Corrected Job Metric Score*
B1	5,095	5,095	0.18	0.42
B2	28,403	8,521	1.00	0.71
B3	4,749	4,749	0.17	0.40
B4	4,662	4,662	0.16	0.39
R0	11,991	11,991	0.42	1.00
R1	11,991	11,991	0.42	1.00
R2	11,991	11,991	0.42	1.00
R3	8,496	8,496	0.30	0.71
C1	5,125	5,125	0.18	0.43
C2	5,125	5,125	0.18	0.43
C3	3,652	3,652	0.13	0.30
H1	28,070	8,421	0.99	0.70
H2	3,321	3,321	0.12	0.28
H3	3,345	3,345	0.12	0.28

* Unitized Score calculated using the Company's flawed algorithm

Sources: Ameren Missouri 2001 Integrated Resource Plan Chapter 10, p. 13 and Chapter 10, Appendix B. Scores calculated from sourced data.



Schdule TJV-1

Customer Satisfaction Metric Comparision: Three Hypothetical Scenarios

OPC
Case No. EO-2011-0271
Exhibit TJV-2
Witness: Thomas Vitolo

	--- Scenario A ---			--- Scenario B ---			--- Scenario C ---		
Year	Single Year Rate Increase	Total Rate Increase	Sample Monthly Bill in Real Dollars	Single Year Rate Increase	Total Rate Increase	Sample Monthly Bill in Real Dollars	Single Year Rate Increase	Total Rate Increase	Sample Monthly Bill in Real Dollars
2010	--	--	$100	--	--	$100	--	--	$100
2011	0%	0%	$100	5%	5%	$105	10%	10%	$110
2012	0%	0%	$100	5%	10%	$110	0%	10%	$110
2013	0%	0%	$100	5%	16%	$116	0%	10%	$110
2014	0%	0%	$100	5%	22%	$122	0%	10%	$110
2015	0%	0%	$100	5%	28%	$128	0%	10%	$110
2016	0%	0%	$100	5%	34%	$134	0%	10%	$110
2017	0%	0%	$100	5%	41%	$141	0%	10%	$110
2018	0%	0%	$100	5%	48%	$148	0%	10%	$110
2019	0%	0%	$100	5%	55%	$155	0%	10%	$110
2020	10%	10%	$110	5%	63%	$163	0%	10%	$110

	Scenario A	Scenario B	Scenario C
Levalized Annual Avg Rate	1%	5%	1%
Maximum1 Yr. Increase Rate	10%	5%	10%
Score (low is better)	11%	10%	11%
10 Year Rate Increase	10%	63%	10%
Total 10 Year Expense, Real $	$12,120	$15,848	$13,200

OPC
Case No. EO-2011-0271
Exhibit TJV-3
Witness: Thomas Vitolo
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**Nominal Weight and Effective Weight of Policy Objectives,
Initial and Final Screening**

Blackened Cells are Highly Confidential

--- Initial Screening ---								
Policy Objective	Absolute Min	Absolute Max	Unitized Min	Unitized Max	Unitized Score Range	Nominal Weight	Effective Weight	Note
Environmental/Diversity						20%	7.7%	1
Eneryg Efficiency						10%	21.2%	1
Financial/Regulatory						20%	24.3%	1
Customer Satisfaction						15%	18.1%	1
Economic Development						10%	21.2%	1
Cost						25%	7.5%	1
Total							100%	100%

--- Final Screening ---								
Policy Objective	Absolute Min	Absolute Max	Unitized Min	Unitized Max	Unitized Score Range	Nominal Weight	Effective Weight	Note
Environmental/Diversity						20%	9.6%	1
Eneryg Efficiency	--	--	--	--	--	0%	0%	--
Financial/Regulatory						20%	30.1%	1
Customer Satisfaction						20%	30.0%	1
Economic Development	3,321	28,403	0.117	1.000	[0.117, 1.000]	10%	23.2%	2
Cost	$59,661	$65,596	0.910	1.000	[0.910, 1.000]	30%	7.1%	2
Total							100%	100%

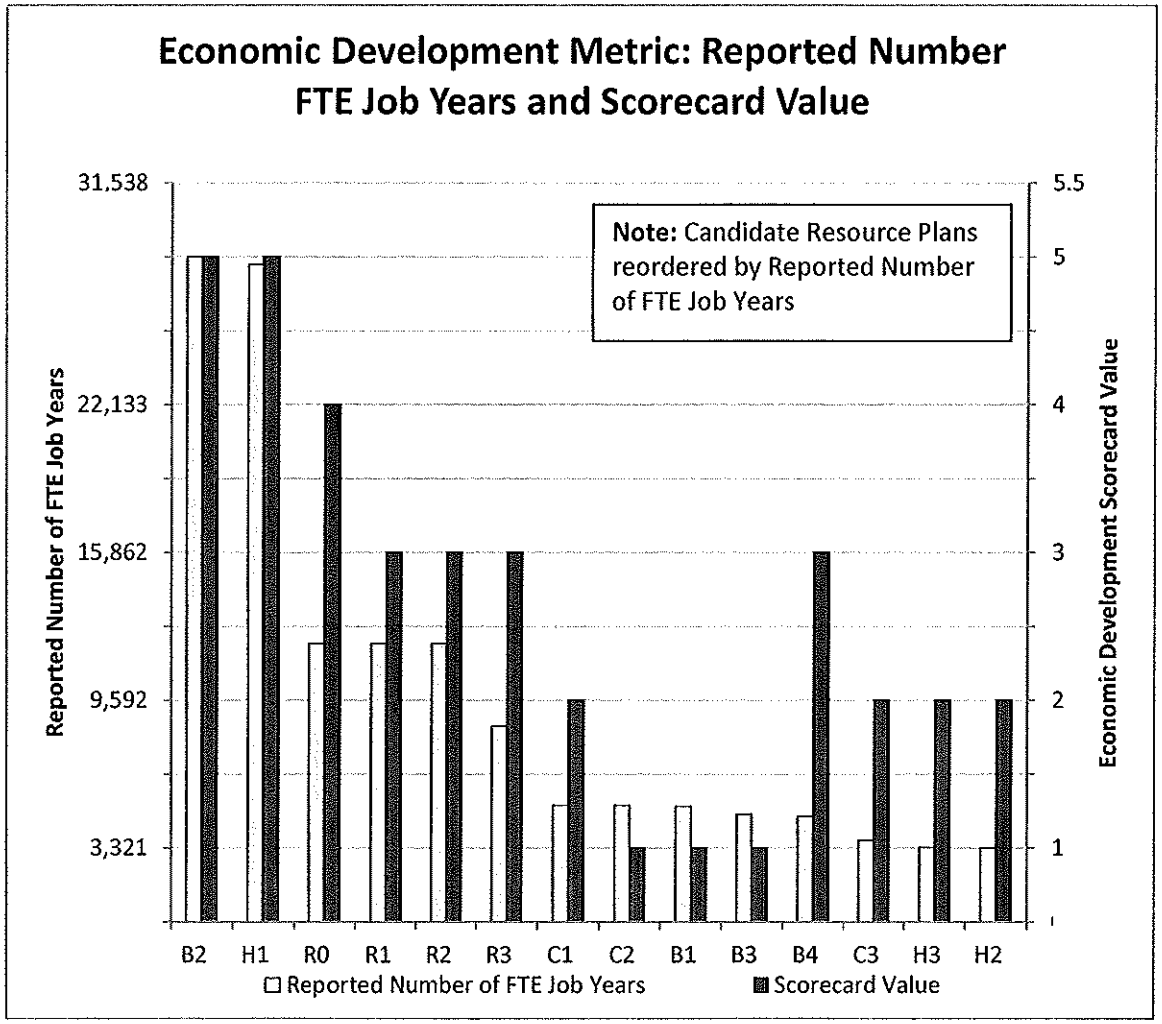
Notes	
1	From HIGHLY CONFIDENTIAL
2	From Ameren Missouri Integrated Resource Plan Chapter 9, Appendix A.

Economic Development Metric Comparision: The Company's Reported Number of FTE Job Years and Scorecard Value

Candidate Plan Name	Reported Number of FTE Job Years	Scorecard Value
B2	28,403	5
H1	28,070	5
R0	11,991	4
R1	11,991	3
R2	11,991	3
R3	8,496	3
C1	5,125	2
C2	5,125	1
B1	5,095	1
B3	4,749	1
B4	4,662	3
C3	3,652	2
H3	3,345	2
H2	3,321	2

Sorted by Number of FTE Job Years

Sources: Ameren Missouri 2001 Integrated Resource Plan Chapter 10, p. 13 and Chapter 10, Appendix B. Scores calculated from sourced data.



Cost Metric Comparision: The Company's Unitized PVRR and Scorecard Value

Candidate Plan Name	PVRR	Unitized PVRR*	Scorecard Value
R0	$59,661	1.000	5
B3	$61,161	0.977	4
B1	$61,259	0.976	4
B4	$61,403	0.973	4
B2	$61,568	0.971	4
R1	$62,867	0.951	4
R3	$63,101	0.948	4
R2	$63,358	0.944	4
C1	$64,403	0.928	2
C2	$64,875	0.921	2
H2	$65,198	0.916	2
C3	$65,356	0.913	2
H3	$65,420	0.912	2
H1	$65,596	0.910	2

* Unitized Score calculated using the Company's flawed algorithm

Sources: Ameren Missouri 2001 Integrated Resource Plan Chapter 10, p. 13 and Chapter 10, Appendix B. Scores calculated from sourced data.

Sorted by Number of FTE Job Years