April 17, 2017

Dr. Bradley Borum, Director of Research, Policy, and Planning
Mr. M. Bob Pauley, Chief Technical Advisor of Research, Policy, and Planning
Jeremy Comeau, Assistant General Counsel
Indiana Utility Regulatory Commission
101 West Washington Street, Suite 1500 E
Indianapolis, Indiana 46204
bborum@urc.in.gov
mpauley@urc.in.gov
jcomeau@urc.in.gov
Electronically delivered

Re: Public Version of the Comments on Vectren's 2016 Integrated Resource Plan

Dear Director Borum, Chief Technical Advisor Pauley, and Assistant General Counsel Comeau,

Pursuant to the Indiana Utility Regulatory Commission's ("IURC" or "Commission") draft Integrated Resource Planning Rule, 170 IAC 4-7,[1] Citizens Action Coalition of Indiana ("CAC"), Earthjustice, Indiana Distributed Energy Alliance ("IndianaDG"), Sierra Club, and Valley Watch (collectively, "Commenters") hereby submit the attached public version of the comments by Anna Sommer with Sommer Energy, LLC, and Elizabeth A. Stanton, PhD, with Applied Economics Clinic on the 2016 IRP submitted by Southern Indiana Gas & Electric Company d/b/a Vectren Energy Delivery ("Vectren"). Please note that Commenters filed their unredacted version under seal in IURC Cause No. 44890, because the filing contained information deemed confidential by Vectren and protected as confidential per the Order issued in that Cause. Commenters respectfully reserve the right to challenge Vectren's confidential designation of the information and would note that Vectren has agreed to review the confidential version to see what information can be made public. We appreciate the opportunity to comment, as well as Commission Staff's willingness to provide us with extensions of time that allowed us to seek information from Vectren through an informal discovery process.

As last year's Electricity Director's Final Report on the 2015 IRPs affirmed, "[w]ith the passage of P.L. 246-2015 (SEA 412-2015) on May 6, 2015, Indiana law now explicitly requires long-term resource planning for the State of Indiana."[2] Anna Sommer with Sommer Consulting,

[1] All references to the Commission's IRP Rule, 170 IAC 4-7, refer to the revised draft of the Proposed IRP Rule, which the Commission circulated on October 4, 2012 in the IRP rulemaking, RM# 11-07. As explained in the Electricity Director's Final Report on the 2015 IRPs, since 2012 the Commission, utilities, and other stakeholders have followed the requirements of the draft rule (which was negotiated collaboratively, and includes improvements on the prior IRP rule) as if it were in effect. *See* Electricity Director's Final Report: 2015-16 Integrated Resource Plans, at p. 1 (Aug. 30, 2016) (hereinafter "2015 Final Report"), *available at* http://www.in.gov/iurc/files/Consolidated%20IRP%20Report%20for%20DEI%20IM%20IMPA%20and%20WVPA%20-%20Final%208-30-16.pdf.

[2] 2015 Final Report, at p. 1.

LLC, and Elizabeth A. Stanton, PhD, with Applied Economics Clinic, have organized these comments to address Vectren's compliance with the specific informational, procedural, and methodological requirements of the Commission's IRP rule. Although these comments are not meant to be comprehensive reviews of Vectren's IRP process, resource planning practices, or preferred resource plans, the report offers comments in a number of places that have a broader applicability to the IRP process in Indiana. We urge the Commission to consider these comments as it continues its rulemaking process to improve upon the IRP rules for future planning years. Commenters respectfully request that Commission Staff call on Vectren and all Indiana utilities to address the informational, procedural, and methodical deficiencies identified in the attached comments both in response to the Director's Report on this year's IRPs and in all future resource planning and decision making.

Thank you very much for this opportunity. We look forward to the issuance of and opportunity to comment on the Director's Draft Report. Please feel free to contact Jennifer Washburn, Counsel at Citizens Action Coalition, with any questions or concerns.

Respectfully,

Kerwin Olson, Executive Director
Jennifer Washburn, Counsel
Citizens Action Coalition of Indiana
603 E. Washington Street Suite 502
Indianapolis, Indiana 46204
317-735-7727
kolson@citact.org
jwashburn@citact.org

Steve Francis, Chairperson
Sierra Club, Hoosier Chapter
Jodi Perras, Senior Campaign Representative
Sierra Club, Indiana Beyond Coal
1100 W. 42nd Street, Suite 218
Indianapolis, Indiana 46208
317-296-8395
sierrasteve@comcast.net
jodi.perras@sierraclub.org

Laura Ann Arnold, President
Indiana Distributed Energy Alliance
545 E. Eleventh Street
Indianapolis, Indiana 46202
317-635-1701
Laura.Arnold@IndiananDG.net

Thomas Cmar, Staff Attorney
Earthjustice
1101 Lake Street, Suite 405B
Oak Park, IL 60301
(312) 257-9338
tcmar@earthjustice.org

Shannon Fisk, Managing Attorney
Earthjustice
1617 John F. Kennedy Blvd., Suite 1130
Philadelphia, PA 19103
(215) 717-4522
sfisk@earthjustice.org

John Blair
Valley Watch
800 Adams Avenue
Evansville, Indiana 47713
(812) 464-5663
ecoserve@valleywatch.net

Report on Vectren 2016 IRP

Submitted to the IURC on April 17, 2017

Authors:

Anna Sommer, Sommer Energy, LLC

Elizabeth A. Stanton, PhD, Applied Economics Clinic

on behalf of CAC, Earthjustice, Indiana Distributed Energy Alliance, Sierra Club, and Valley Watch

Table of Contents

Overview

The following comments on the 2016 Integrated Resource Plan submitted by Vectren Energy Delivery of Indiana ("Vectren" or the "Company") were prepared by Anna Sommer with Sommer Energy, LLC, and Elizabeth A. Stanton, PhD, with Applied Economics Clinic. These comments were prepared for Citizens Action Coalition of Indiana ("CAC"), Earthjustice, Indiana Distributed Energy Alliance ("IndianaDG"), Sierra Club, and Valley Watch (collectively, "Commenters") pursuant to the Indiana Utility Regulatory Commission's ("IURC" or "Commission") draft Integrated Resource Planning Rule, 170 Ind. Admin. Code 4-7.[1]

Our review of Vectren's 2016 Integrated Resource Plan (IRP) is organized in response to IURC guidance on IRP preparation in the IURC's IRP Rule (170 IAC 4-7-4, 4-7-8). Table 1, on the following page, summarizes our findings for each of the eighteen (18) Indiana IRP requirements. More generally, our review raised the following main categories of concerns with the Vectren 2016 IRP and how it aligns with the IRP Rule:

- **Failure to communicate core concepts to nontechnical audiences (170 IAC 4-7-4(a)):** Despite the non-technical executive summary submitted with the IRP and overall careful explanations of much of its methodology, Vectren's 2016 IRP obscures critical basic information, includes critical errors and inconsistencies. In addition, some materials necessary for a thorough review were not made available to stakeholders. See Section I of our report below.
- **Incomplete documentation of inputs, methods, and definitions (170 IAC 4-7-4(b)(1)):** Key sections of Vectren's IRP are not transparent to stakeholders, including the scorecard methodology on which the utility bases its selection of its preferred portfolio. See Section II below.
- **Numerous modeling errors (170 IAC 4-7-4(b)(9)):** Vectren's modeling errors include its failure to actually optimize its resource portfolios, overemphasis of long-term costs over near-term costs, and excess capacity acquisition. See Section IV below.
- **Biases against coal retirement (170 IAC 4-7-8(b)(3),(b)(4)):** Vectren's retirement analysis is biases towards later retirement of uneconomic units. See Section IX below.
- **Biases against renewable resources (170 IAC 4-7-8(b)(3),(b)(4)):** Vectren's modeling includes several assumptions that bias resource selection against renewable generation. See Section IX below.
- **Demand-side resources not evaluated on consistent and comparable terms with supply-side resources (170 IAC 4-7-8(b)(3),(b)(4)):** Vectren's modeling includes a faulty projection of energy efficiency costs that bias resource selection against energy efficiency. Demand-side resources are not evaluated on a consistent and comparable basis with supply-side resources. See Section IX below.

[1] All references to the Commission's IRP Rule, 170 IAC 4-7, refer to the revised draft of the Proposed IRP Rule, which the Commission circulated on October 4, 2012 in the IRP rulemaking, RM# 11-07. As explained in the Electricity Director's Final Report on the 2015 IRPs, since 2012 the Commission, utilities, and other stakeholders have followed the requirements of the draft rule (which was negotiated collaboratively, and includes improvements on the prior IRP rule) as if it were in effect. See Electricity Director's Final Report: 2015-16 Integrated Resource Plans, at p. 1 (Aug. 30, 2016) (hereinafter "2015 Final Report"), available at: http://www.in.gov/iurc/files/Consolidated%20IRP%20Report%20for%20DEI%20IM%20IMPA%20and%20WVPA%20-%20Final%208-30-16.pdf.

- **The impacts of this faulty projection of demand-side resources are compounded by the fact that projected costs are not even entered correctly into Strategist (170 IAC 4-7-8(b)(3)):** Strategist, Vectren's capacity expansion model, did not select any energy efficiency in Vectren's base case in large part because the costs of energy efficiency are modeled with large, substantive errors. See Section IX-B below.
- **Flawed scorecard methodology for choosing the preferred portfolio (170 IAC 4-7-8(b)(7)(B),(C)):** Vectren's scorecard assessment methodology includes errors in its execution and modeling choices that bias its results. See Section XIV below.
- **Inflated energy forecast (170 IAC 4-**7-5)): Vectren's energy forecast is predicated on a significant and subjective assumption about growth in industrial sales as well as overly aggressive near-term growth in key drivers of the commercial sales forecast. See Section XIX below.

Vectren did not make all of its background materials and modeling files available together with its 2016 IRP submission, and despite several rounds of discovery requests made over the course of 4.5 months for these documents, we still do not have a complete set at the time of our writing of this report. For these reasons, we respectfully reserve the right to continue reviewing materials as we receive them and to add new information to our response to the Director's Draft Report.

Table 1. Summary of evaluation of selected Indiana IRP requirements

	Requirement	Findings	Citation
I	The IRP must communicate core IRP concepts and results to non-technical audiences	Not Met	170 IAC 4-7-4(a)
II	IRP documentation must include inputs, methods, and definitions	Not Met	170 IAC 4-7-4(b)(1)
III	The IRP must include a discussion of distributed generation within the service territory and the potential effects on generation, transmission, and distribution planning and load forecasting	Not Reviewed	170 IAC 4-7-4(b)(5)
IV	The IRP must include a description of the generation expansion criteria, including a full explanation of the basis for the criteria selected	Not Met	170 IAC 4-7-4(b)(9)
V	The IRP must include an explanation of the contemporary methods utilized in its development, including model structure and reasoning, and the utility's efforts to develop and improve its methodology	Not Met	170 IAC 4-7-4(b)(11)
VI	The IRP must include an explanation, with supporting documentation, of an avoided cost calculation for each year in the forecasted period	Not Met	170 IAC 4-7-4(b)(12)
VII	Preferred resource portfolio must be selected from among the candidate resource portfolios developed	Met	170 IAC 4-7-8(a),(b)
VIII	Preferred resource portfolio must be described, including key variables, standards of reliability, and other assumptions	Met	170 IAC 4-7-8(b)(1),(2)
IX	Supply-side and demand-side resource alternatives must be evaluated on a consistent and comparable basis in the selection of the preferred resource portfolio	Not Met	170 IAC 4-7-8(b)(3)
X	Preferred resource portfolio must utilize, to the extent practical, all economical load management, demand side management, technology relaying on renewable resources, cogeneration, distributed generation, energy storage, transmission, and energy efficiency improvements as sources of new supply	Not Met	170 IAC 4-7-8(b)(4)
XI	Targeted DSM programs must be evaluated, including impacts on the utility's transmission and distribution system	Not Met	170 IAC 4-7-8(b)(5)
XII	Financial impact to the utility of acquiring the future resources identified in the preferred resource portfolio must be assessed	Not Met	170 IAC 4-7-8(b)(6)
XIII	Preferred resource portfolio must balance cost minimization with cost-effective risk and uncertainty reduction	Not Met	170 IAC 4-7-8(b)(7)
XIV	Where possible, assumed risks and uncertainties must be quantified	Not Met	170 IAC 4-7-8(b)(7)(B)
XV	Candidate resource portfolios performance across a wide range of potential futures must be analyzed	Not Met	170 IAC 4-7-8(b)(7)(C)
XVI	Candidate resource portfolios must be ranked by present value of revenue requirement and by risk metric	Not Met	170 IAC 4-7-8(b)(7)(D)
XVII	An assessment of robustness must factor in to the selection of the preferred resource portfolio	Not Met	170 IAC 4-7-8(b)(7)(E)
XVIII	The preferred resource portfolio must incorporate a workable strategy for reacting to unexpected changes in circumstances quickly and appropriately	Met	170 IAC 4-7-8(b)(8)
XIX	The IRP must include an analysis of historical and forecasted levels of peak demand and energy usage.	Not Met	170 IAC 4-7-5

Source: 170 IAC 4-7-8 amended 10-4-12

Analysis

I. Does the IRP communicate core IRP concepts and results to nontechnical audiences?

No. However, Vectren's communication of core IRP concepts and results to nontechnical audiences is far more successful than that found in other recent Indiana utility IRP submissions. We appreciate Vectren's clear prose, non-technical executive summary, and efforts to explain complex concepts to a technical audience.

While Vectren's style of presentation deserves praise, we found that the absence of tables and figures comparing resource retirements, additions, and other inputs across portfolios greatly hindered our ability to understand and analyze Vectren's 2016 IRP findings.

To best communicate core IRP concepts and results to nontechnical audiences, we recommend a clear presentation comparing both inputs and outputs across candidate portfolios. Vectren's 2016 IRP provides a helpful Executive Summary, and many charts comparing portfolio outputs, but its presentation would be improved by the addition of tables or figures comparing portfolio inputs.

II. Does IRP documentation include inputs, methods, and definitions?

No. Vectren's 2016 IRP documentation does not clearly present inputs, methods, and definitions.

II-A. Complete documentation of inputs and outputs

The term "inputs" should not mistakenly be interpreted to be limited to cost and electric consumption projections such as coal and natural gas price forecasts, the load forecast, combined cycle, solar, and wind costs. The full set of inputs to an IRP is significantly more complex than this and includes a very large number and variety of input assumptions made by the modeler, for example:

- The first year a resource can be added to a portfolio
- The last year a resource can be added to a portfolio
- Limitations on the size of the resource that can be added
- The minimum and maximum number of units of a particular resource that can be added
- The reserve margin requirement
- The order in which resources must be dispatched
- Forced outage rates
- Heat rate profile
- Fuel delivery charges by unit
- Emissions rates
- Schedule of maintenance outages

Because there are so many inputs to an IRP, the only plausible way to completely document them is to provide the modeling input files in a format that is easily machine readable (for example, in an Excel spreadsheet) without requiring public interest groups and other intervenors to pay tens of thousands of dollars to license the model.

For future resource plans, it would be extremely helpful to a meaningful and cooperative public process to set the expectation that all modeling files be delivered concurrently with the final IRP report. We would be happy to work with each individual utility to help its staff understand how to best comply with this request given its particular modeling protocols.

These comments extend not just to the Strategist files that we did receive on a timely basis in response to informal discovery, but also to the Aurora stochastic modeling files that supported many of Vectren's scorecard metrics.

We first made the request for the spreadsheet underlying the scorecard in CAC Data Request 1.20 on February 9, 2017. On February 20, 2017, Vectren responded referring CAC to the Risk Analysis secton of the November 29, 2016 stakeholder slide deck. On March 6, CAC again asked for the spreadsheets and underlying data for the scorecard. On March 13, Vectren responded that "[T]he premise of this question is flawed in that you assume a spreadsheet was used to develop the figure, but that assumption is not true. Furthermore, we have previously provided to the CAC all of the underlying data that went into creating the figure." On March 24, CAC again followed up asking Vectren to identify where exactly the scorecard data was in the information already provided to CAC because we could not find it. On March 27, Vectren followed saying, among other things, that Pace Global used the Aurora model to generate most risk analysis metrics, including NPVs. On March 28, CAC again requested Vectren to specify exactly where in the Aurora files the data was contained because we did not see key information like the NPVs. It was not until April 13, the day our comments were due (until a four-day extension was granted later that day) that Vectren responded saying, "Pace provided all Aurora model outputs (which Vectren sent to CAC), which were used as an input for most risk measures. Pace's post process files are work products, not formatted for audiences beyond Pace modelers. For Pace to reproduce the information in a way that is easily understandable is time consuming, as it requires Pace to perform extra work. The files will be available tomorrow and will be provided to you, then, but will not be available until then."

On April 14, 2017, Vectren supplied a spreadsheet with nothing more than hard coded data, most, if not all of which, was not given to us in the original transmittal of the Aurora modeling files. This lack of an adequate response makes a complete review of the stochastic modeling impossible.

It is also worth noting that while this section of the Indiana IRP requirements is specific to "inputs, methods, and definitions", input files must be accompanied by output files for useful third-party review.

II-B. Lack of comparisons across portfolios

Vectren does not provide a complete comparison of its portfolios' resource retirements, additions, and other inputs in a way that facilitates comparison across portfolios. A series of tables or figures presenting these comparisons would make review of Vectren's IRP modeling more effective. Vectren 2016 IRP Attachment 7.1 does not include all retirements and additions, and is only referred to once, on page 203 of the IRP. For our own use, we assembled Table 2 (below), which is best viewed electronically where it is possible to zoom in on the image. Making these comparisons more accessible to stakeholders would likely require multiple tables or figures along with a discussion of why choices to retire or add resources were made, and some indication of which resource changes are fixed (set by the modeler) as compared to optimized (chosen by the model based on the constraints set by the modeler).

Table 2. Vectren 2016 IRP comparison of portfolio retirements and additions

	(A) BAU	(B) Base Scenario (aka Gas Heavy)	(C) Base + Large Scenario	(D) High Regulatory Scenario	(E) Low Regulatory Scenario	(F) High Economy Scenario	(G) Low Economy Scenario	(H) High Technology Scenario	(I) Stakeholder	(J) Stakeholder (Cease Coal 2024)	(K) FB Culley 3, Fired Gas, Renewables	(L) FB Culley 3, Fired Gas, Early Solar, EE	(M) FB Culley 3, Unfired Gas .05, Early Solar, EE and RE	(N) Unfired Gas Heavy with 50 MW Solar in 2019	(O) Gas with Renewables
Joint Operations Warrick 4 Coal: Retire	2016-2022														
Northeast 1 & 2 Gas: Retire	2016-2022														
AB Brown 1 & 2	2016-2022 CCR Compliance 2023-2029	2023-2029 Retire													
Culley 2	2016-2022 CCR Compliance 2023-2029 ELG Compliance	2023-2029 Retire							2030-2036 Retire	2023-2029 Retire					
Culley 3										2023-2029 Retire	2016-2022 CCR Compliance 2023-2029 ELG Compliance			2023-2029 Retire	
Broadway Avenue Gas:	2023-2029														
EE Plan 2016-2017	2016-2022														
Energy Efficiency			2018-2022 1.0% 2023-2029 1.0% 2030-2036 1.0%			2018-2022 2.0% 2023-2029 2.0% 2030-2036 2.0%			2018-2022 2.0% 2023-2029 2.0% 2030-2036 2.0%		2018-2020 1.0% 2021-2022 0.75% 2023-2026 0.75% 2027-2029 0.50% 2030-2036 0.50%			2018-2022 1.0% 2023-2029 1.0% 2030-2036 1.0%	
Demand Response	2016-2022 12 MW 2023-2029 8 MW		2016-2022 12 MW 2023-2029 8 MW		2016-2022 12 MW 2023-2029 8 MW	2016-2022 8 MW 2023-2029 12 MW	2023-2029 20 MW		2016-2022 12 MW 2023-2029 8 MW		2023-2029 4 MW		2016-2022 12 MW 2023-2029 8 MW	2016-2022 12 MW 2023-2029 8 MW	
Solar	2016-2022 4 MW	2016-2022 4 MW 2030-2036 36 MW	2016-2022 4 MW 2030-2036 68 MW	2016-2022 4 MW		2016-2022 4 MW 2023-2039 9 MW	2016-2022 4 MW 2030-2036 59 MW	2016-2022 4 MW 2030-2036 9 MW	2016-2022 4 MW 2023-2029 500 MW 2030-2036 400 MW	2016-2022 4 MW 2023-2029 800 MW	2016-2022 4 MW 2023-2029 9 MW	2016-2022 54 MW	2016-2022 54 MW 2030-2036 118 MW	2016-2022 54 MW 2023-2029 118 MW 2030-2036 100 MW	2016-2022 54 MW 2023-2029 168 MW 2030-2036 109 MW
Wind		2030-2036 400 MW				2030-2036 400 MW			2023-2029 800 MW 2030-2036 200 MW	2023-2029 1,200 MW	2023-2029 50 MW				
Battery								2030-2036 10 MW	2030-2036 100 MW	2023-2029 100 MW 2030-2036 100 MW					
SCGT (220 MW Additions)	2023-2029				2016-2022 2023-2029	2016-2022		2023-2029						2023-2029	
CCGT (Additions)		2023-2029 889 MW							2023-2029 220 MW 2030-2036 110 MW	2023-2029 330 MW	2023-2029 889 MW		2023-2029 700 MW		2023-2029 889 MW
Combined Heat and Power (30 MW)									2023-2029						
Market Capacity Purchases	2020-2022 60-63 MW 2023 60 MW 2035-2036 4-9 MW	2020-2022 68-73 MW 2023 77 MW 2032-2036 1-9 MW	2020-2022 26-43 MW 2023 19 MW 2032-2036 1-9 MW	2020-2022 39-47 MW 2023-2029 28-106 MW 2032-2036	2020 43 MW	2020-2021 10-27 MW	2020-2022 68-73 MW 2023-2029 67-155 MW 2030-2036 161-188	2020-2022 82-87 MW 2023 91 MW 2032-2036 1-10 MW	2020-2021 6-23 MW	2020-2021 6-23 MW 2036 3 MW	2020-2022 42-47 MW 2023 37 MW	2020-2022 23-28 MW 2023-2029 22 MW	2020-2022 11-24 MW 2023 5 MW 2030-2036 2-10 MW	2020-2022 7-24 MW 2025-2029 3-10 MW 2030-2036 3-9 MW	2020-2022 3-24 MW 2025-2029 2-9 MW 2-30-2034 4-10 MW

II-C. Lack of transparency regarding modeling assumptions

Complete documentation of an IRP requires that all inputs, outputs, methods, assumptions, and definitions be made available to stakeholders clearly, transparently, and, for data files, in machine readable form. It also requires that key assumptions that influence modeling outcomes are documented in the IRP and that modeling inputs are consistent with how they are described in the IRP.

In addition, we find that Vectren's scorecard methodology is not at all transparent. Its methodology is not fully explained and not all data used in its preparation were made available for stakeholder review. Our critique of Vectren's scorecard methodology is presented in Section XIV-B.

II-D. Errors and inconsistencies in Vectren's 2016 IRP

The Vectren 2016 IRP contained errors and inconsistencies in five main areas:

1. Opaque and inaccurate scorecard assessment (discussed in Section XIV)
2. Flawed projection of energy efficiency costs (discussed in Section IX-B)
3. Inaccurate energy forecast (discussed in Section XIX)
4. Improper restrictions on resource selection (discussed in Section IV)
5. Incorrect use of a pre-tax discount rate (discussed in Section V)

II-E. Recommendations for complete documentation of inputs, methods, and definitions

To assure complete documentation of an IRP, we endorse the recommendations[2] made by CAC, Indiana Distributed Generation Alliance, the Indiana State Conference of the National Association for the Advancement of Colored People (NAACP), Sierra Club, and Valley Watch in IURC Rulemaking #15-06 to include a "technical appendix" as part of the IRP submission. The following is a partial list of key items for inclusion in an IRP technical appendix:

- **The input and output files from all models in a readable electronic format**
    - System Optimizer, Planning and Risk, Capacity Expansion: Input and output files should be presented in spreadsheet format.
    - Strategist: Input and output files should be in text format at a minimum. Strategist has the capability to export data into a spreadsheet, which is extremely helpful for review purposes.
    - With any of these models, if stakeholders or Commission staff wish to create their own modeling runs, the executable files also should be made available, but this type of exercise would require licensing fees for the model and is therefore usually beyond the resources available to an intervenor/stakeholder group.

[2] Public Comments received by the IURC in IURC RM #15-06 are available here: http://www.in.gov/iurc/2844.htm.

  - Other models: For most other models, spreadsheet-based input and output files will be the most useful. We would be happy to consult with any Indiana utility on the appropriate format to use for a given model.
- **A user guide for each model used:** Indiana utilities use many different models including Strategist, System Optimizer, Planning and Risk, MIDAS, Capacity Expansion model, and Plexos, so having a user guide on hand is essential to a public process so that stakeholders and Commission staff can have an understanding as to how a model works and how to interpret its input and output files.
- **Any files used to "post-process" IRP results in readable electronic format with formulae intact:** For example, at least two Indiana utilities, NIPSCO and Duke, take the results of their modeling and modify the present value of revenue requirements (PVRR) in a spreadsheet.

In addition, we recommend:

- **Earlier submission of key information even prior to the IRP's release:** Early release of detailed descriptions and modeling files during the stakeholder process would make possible public review and comment that could aid the utility in identifying errors before the IRP is submitted to the Commission.

III. Does the IRP include a discussion of distributed generation within the service territory and the potential effects on generation, transmission, and distribution planning and load forecasting?

We did not review this aspect of Vectren's 2016 IRP.

IV. Does the IRP include a description of the generation expansion criteria, including a full explanation of the basis for the criteria selected?

No. The description of generation expansion criteria in Vectren's 2016 IRP is incomplete and/or incorrect. Vectren's portfolios are not optimized. Instead, they are constrained by multiple resource limitations set by scenario. Vectren also fails to mention that differences in the 20-year net present value costs among the three portfolios to which Vectren assigned the best overall scores (Portfolios L, K, and M) and the two stakeholder inspired (Portfolios I and J) is largely due to differences in the portfolios in the post 2023 time period. In addition, Vectren is modeling those late capacity additions such that reserves greatly exceed reserve margin requirements—which in turn tends to inflate longer-run costs in Stakeholder Portfolios I and J, as described in Section IV-C.

The bottom line is that there is nothing more than very shaky ground underlying Vectren's premise that its Preferred Portfolio L is less costly than either of the Stakeholder Portfolios I and J and, notably, Vectren itself finds that Portfolios I and J are less risky than its preferred portfolio (see Section XIV). Vectren's selection of Portfolio L as the preferred portfolio is also undermined by errors in Vectren's load forecast (see Section XIX) as well as errors in calculating renewable costs (see Section IX-A) and energy efficiency costs (see Section XIV.B).

IV-A. Optimized portfolios are not really optimized nor even logical.

Vectren's 2016 IRP modeling constructs a Base Case plus six scenarios for Strategist modeling:

- High Regulatory
- Low Regulatory
- High Technology
- High Economy
- Low Economy, and
- Base Case plus a Large Load Addition.

Vectren claims that the purpose of these scenarios is "to test a relevant range for each of the key market drivers on how various technologies are selected under boundary conditions." (Vectren 2016 IRP, p. 182)

Vectren devotes several pages to describing what it claims are the key characteristics of the first five scenarios in the short, medium, and long terms. Strangely, Vectren entirely fails to mention that a different set of technologies is available for selection in each of the scenarios. That is, Strategist is either prevented from selecting certain technologies entirely, or the first year those technologies are available to select is considerably delayed, depending on the scenario in question. This non-standard use of "scenarios" to restrict available resources is both troubling methodologically and not at all transparent to stakeholders. Scenarios classically—and in accordance with Vectren's own definition above—provide a range of potential values for uncertain future conditions. Scenarios set up the circumstances under which resource portfolios are tested; they do not themselves call the shots as to what resources will or will not be available.

Vectren states that because of the limitations on Strategist, an "iterative" process was followed where the "model was run with several alternatives. Viable options were kept for the next model run, uneconomic options were screened out, and new options were added in for evaluation." (Vectren 2016 IRP, p. 80) The criteria by which Vectren determined the "viable options" is completely opaque and many of the choices do not make sense not only because of the scenario characteristics but because Vectren is manipulating not just the resource available to the model but the first year in which those resources are available as described below.

IV-A-1. Resource availability

Table 3 provides a report of Vectren's assumptions limiting the selection of energy efficiency and renewable energy resources by scenario. Designating a resource as having a "First Year Available" in 2099 means that resource is unavailable for the entire planning period, which spans from 2017-2036.

Table 3. Selected renewable and energy efficiency "First Year Available" by scenario[3]—CONFIDENTIAL

	Scenario						
Resource	Base	High Regu-latory	Low Regu-latory	High Tech-nology	High Econom y	Low Econom y	Base + Large Load
200 MW Wind	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
50 MW Solar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
50 MW Wind	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
9 MW Solar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4 MW DR added every 5 years	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
EE Block 1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Data source: *Strategist file PRV Input Summary report for each scenario*
Note: *"2099" indicates that this resource is never available for selection during the 20-year modeling period.*

- Base Case: It is not clear to us how Vectren's "Base Case" represents a "Base" set of conditions since the model cannot choose resources that are clearly available today including [redacted]

- High Regulatory: Vectren states that its High Regulatory scenario is characterized in part by:

    - *More renewable adoption pushed through via mandates;*

[3] The energy efficiency options are chained in Strategist such that EE Block 1 must be selected before EE Block 2, etc. As such it is reasonable to assume that any first year available restriction on EE Block 1 has the effect of also limiting the remaining blocks.

- *Additional regulations on carbon on the horizon after 2030 [apart from the Clean Power Plan] that are higher than in the base case;*
- *Greater adoption of distributed generation in the form of solar and combined heat and power; [and]*
- *Restrictions on fracking and fugitive methane emissions that limit gas supply growth, drive up gas prices, and result in an additional push and economic case for renewable energy. (Vectren 2016 IRP, p.183)*

And yet no renewable energy mandate appears to be modeled in this High Regulatory scenario in Strategist. Moreover, all of these factors "pushing" the adoption of renewable energy can have no effect because the 200 MW wind resource is the only renewable resource [redacted]. It makes absolutely no sense to severely limit the model to only [redacted] in a "High Regulatory" scenario, which has high fossil fuel prices and stringent regulations favoring renewables.

- <u>High Technology</u>: Likewise, Vectren's High Technology scenario, which supposedly reflects, in part, "significant developments in technologies that improve energy efficiency, which helps to mitigate the load growth that might otherwise be expected in a high technology scenario with robust economic growth" uses exactly the same load forecast as the Base Case scenario (see the discussion of this below) while preventing the model from [redacted].

- <u>Base Case plus a Large Load Addition</u>: Vectren claims that its Base plus Large Load Addition scenario "add[s] 100 MWs of load beginning in 2024 to the base forecast. All else is equal to the base scenario" (Vectren 2016 IRP, p. 193). This is clearly not the case. As shown in Table 3, only the resource choices of 4 MW of demand response added each year for 5 years, and energy efficiency block 1 are first available in the same years as in the Base Case; yet all other resources in Table 3 have different first years available.

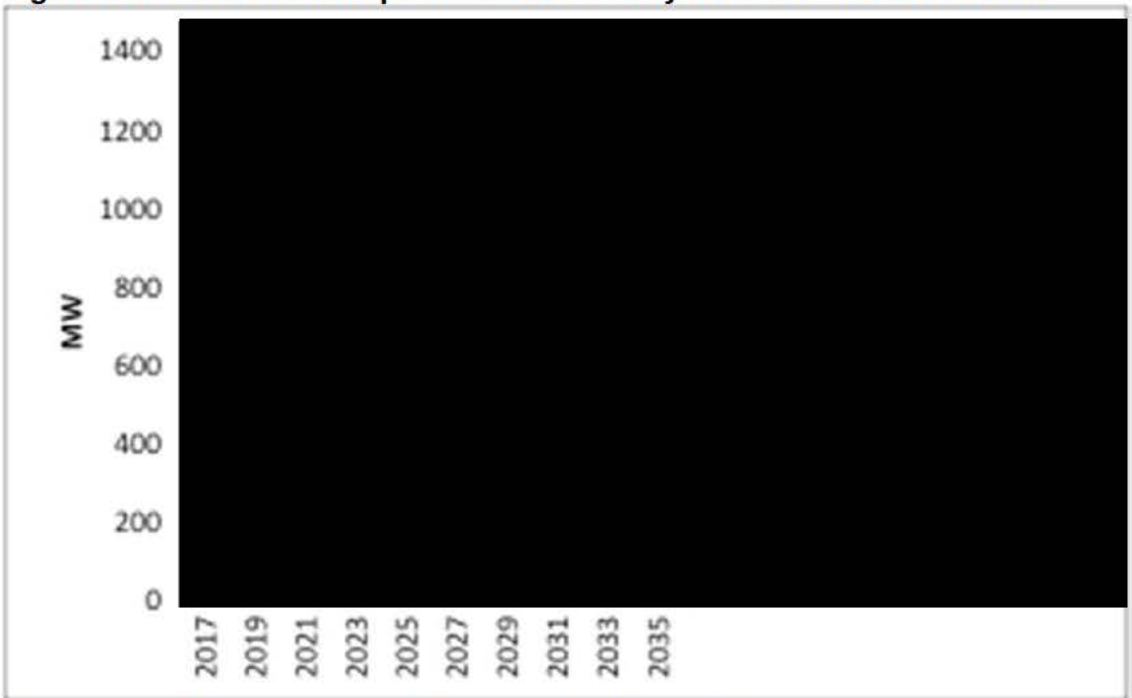
<u>IV-A-2. Peak load and energy requirement assumptions</u>

Despite differing limits on the adoption of energy efficiency and demand response, all of Vectren's scenarios use <u>exactly</u> the same peak load forecast, with the exception of the Base plus Large Load Addition scenario, as shown in Figure 1.

Vectren's scenarios do differ in their reconstituted energy forecasts (before energy efficiency), as shown in Figure 2.

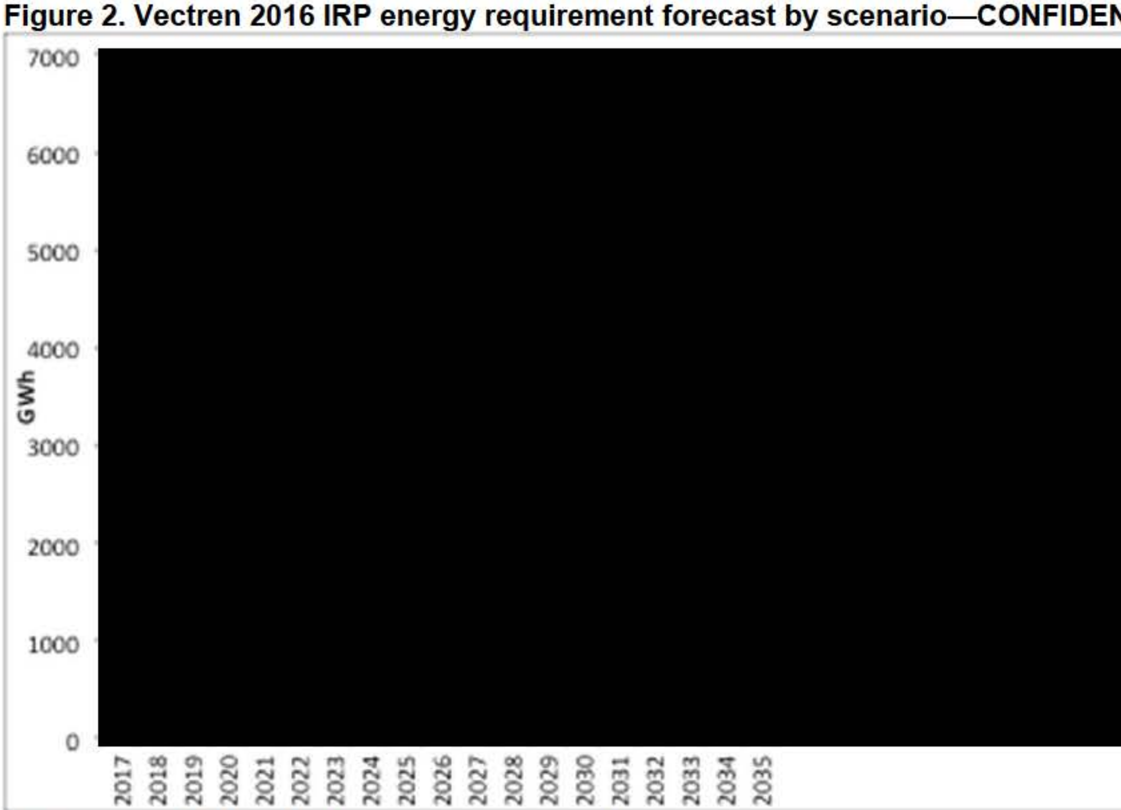
Unfortunately, these differences raise additional questions regarding Vectren's peak load forecasts. Why is there no correlation between Vectren's peak load and energy requirements forecasts? It simply does not make sense that the two would not be related.

Figure 1. Vectren 2016 IRP peak load forecast by scenario—CONFIDENTIAL



Data source: *Strategist Loads and Resources Detail Report for each scenario.*

Figure 2. Vectren 2016 IRP energy requirement forecast by scenario—CONFIDENTIAL



Data source: *Strategist LFA Input Summary report for each scenario.*

As an example of this lack of relationship, note in Figure 1 and Figure 2 that the energy requirements of the Low Regulatory scenario dramatically increase above those of the Base Case scenario, yet the peak load remains the same. Conversely, the energy requirements of the Low Economy scenario fall for the first six years of the planning period before growing again, but peak load remains unchanged from the Base Case scenario. Indeed, not only are the rates of growth in peak load and energy requirements seemingly unrelated to each other, but in some instances such as the Low Economy scenario, these rates of growth have opposite *signs* (i.e., positive or negative). Again, this result is nonsensical and totally undermines Vectren's portfolio results.

While Vectren might claim that "each of these scenarios has an internally consistent narrative" (Vectren 2016 IRP, p. 194), that narrative does not seem to translate into logical inputs in its scenarios. These scenarios cannot even be claimed to be "plausible" as Vectren asserts on page 194 of its IRP, because the peak load forecast is a key input into any resource plan scenario, and the fact that it does not change when the energy forecast changes renders these scenarios unusable. In addition, we have concerns about the validity of the base case energy forecast as described in Section XIX.

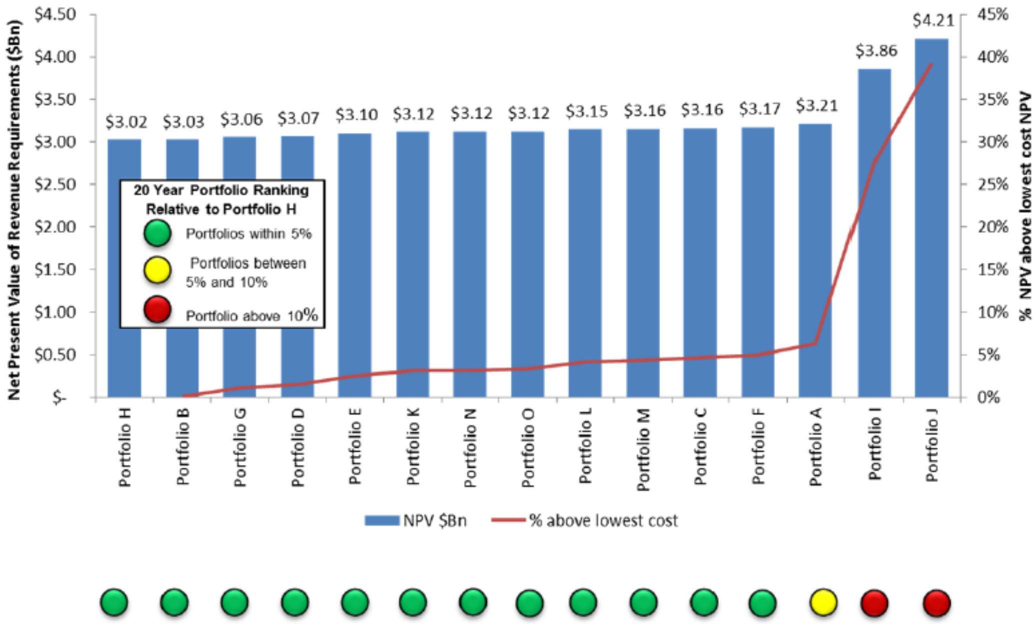
Our discussion in this section includes just a sample of the ways in which Vectren's descriptions of scenarios are not consistent with its scenario assumptions. A full comparison of scenarios, along with extraction of this information from the Strategist files, would be very time consuming and was beyond the scope of this analysis at this time.

One way that Vectren could make its scenarios more transparent in the future is by linking its scenario descriptions to specific inputs. For example, if the High Regulatory scenario is characterized by "more renewable energy adoption pushed through via mandates", then Vectren should specify what modification from the Base Case was made to represent this characteristic. Doing this would increase the transparency of Vectren's IRP process since most of its scenario narratives do not lend themselves to clear, unambiguous interpretation. If no input was modified, then there would be no need to describe that aspect of a scenario in the IRP report.

IV-B. Stakeholder portfolios and Vectren's preferred portfolio have very similar near-term costs.

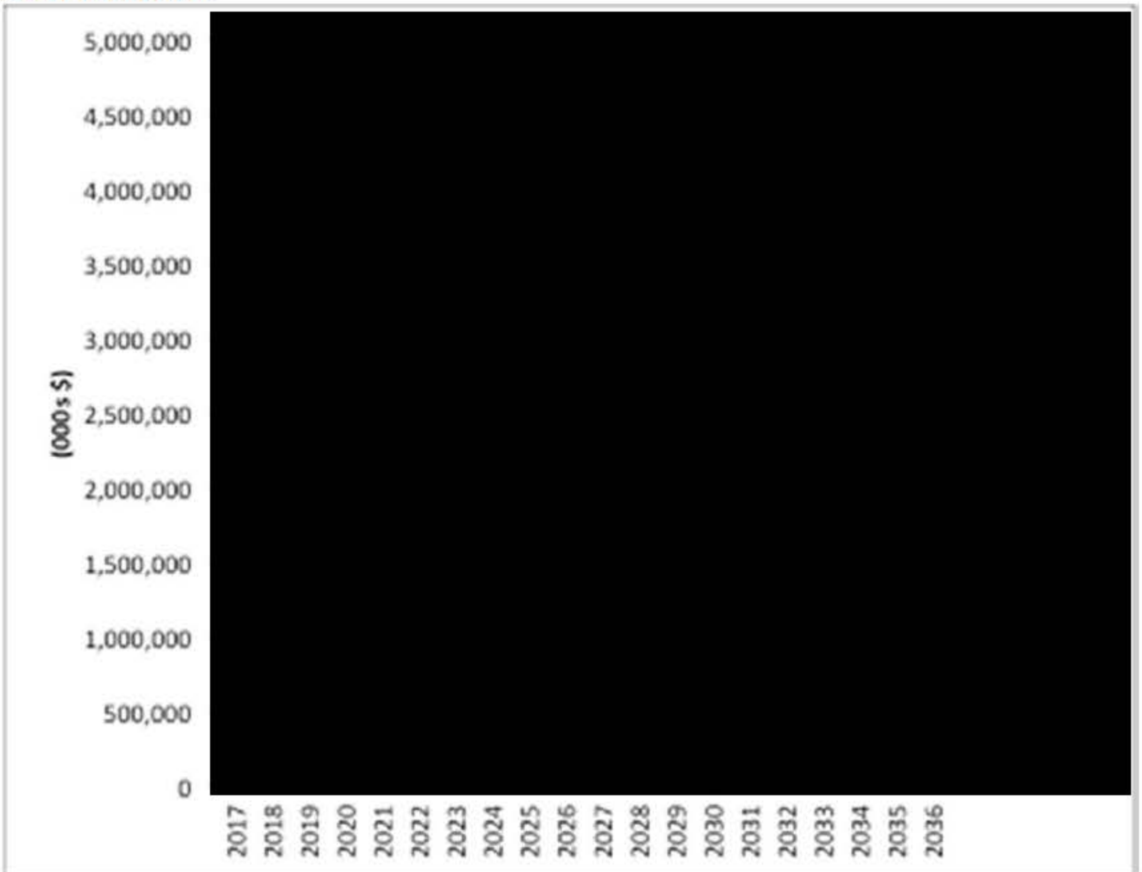
Vectren selects its preferred portfolio using the scorecard assessment methodology critiqued in Section XIV below. Portfolios I and J--the Stakeholder portfolios—receive by far the worst scores for net present value (NPV) according to Vectren's analysis, as shown by Vectren's Figure 7.17, reproduced below as Figure 3. Indeed, these portfolios are the only ones that appear to have costs that differ significantly from the remaining 13 portfolios.

Figure 3. Vectren 2016 IRP Figure 7.17—20-Year NPV Ranking of Portfolios



The data shown in Vectren's Figure 7.17 are taken from Vectren's Aurora stochastic modeling. As described in Section II-A, CAC has asked Vectren, on multiple occasions, to identify where the data underlying Figure 7.17 are located, but Vectren has not done so. Without this information, it is impossible for us to verify the accuracy of Figure 3. Because the equivalent cost data from Strategist is transparent and readily available, we constructed a similar graph with a subset of portfolios of particular interest, Portfolios I, J, K, L, and M (see Figure 4). We chose to present Portfolios I and J (the so-called Stakeholder Portfolios) and Portfolios K, L, and M which receive the highest overall scores in Vectren's scorecard analysis in Figure 4. As a reminder, Vectren selects Portfolio L as its preferred portfolio.

Figure 4. Strategist annual cumulative present value of selected portfolios—CONFIDENTIAL



Data source: *Strategist PRV System Cost report for each scenario.*

While Figure 3 presents the portfolios' 20-year NPV, Figure 4 shows the total cumulative present value of each selected portfolio in each year over a 20-year period. The 2036 value for each of these portfolios shows a similar trend to Figure 3 (above) – Portfolios I and J are substantially more expensive than Portfolios K, L and M.

What Figure 4 makes obvious, though, is that the 20-year NPV values obscure the fact that cost differences between the portfolios only arise starting in 2024; prior to that, the portfolios are very similar in cost. This is significant because one of the biggest differences between Portfolios I and J and Portfolios K, L and M in the initial seven years of each plan is the level of energy efficiency being implemented.

Even under Vectren's flawed projection of energy efficiency costs and the subsequent incorrect modeling of those flawed costs[4], there appears to be very little difference in cost between adopting a 2 percent energy savings goal (as in Portfolios I and J) and adopting a 1 percent energy savings goal (Portfolios K, L and M) for the period 2018 – 2022.

[4] See Section IX-B-2, Attachment A, and Section IX-B-3 for a discussion of the problems underlying the analysis supporting Vectren's cost projections.

The presence of a significant cost difference only later in the planning period is also important because:

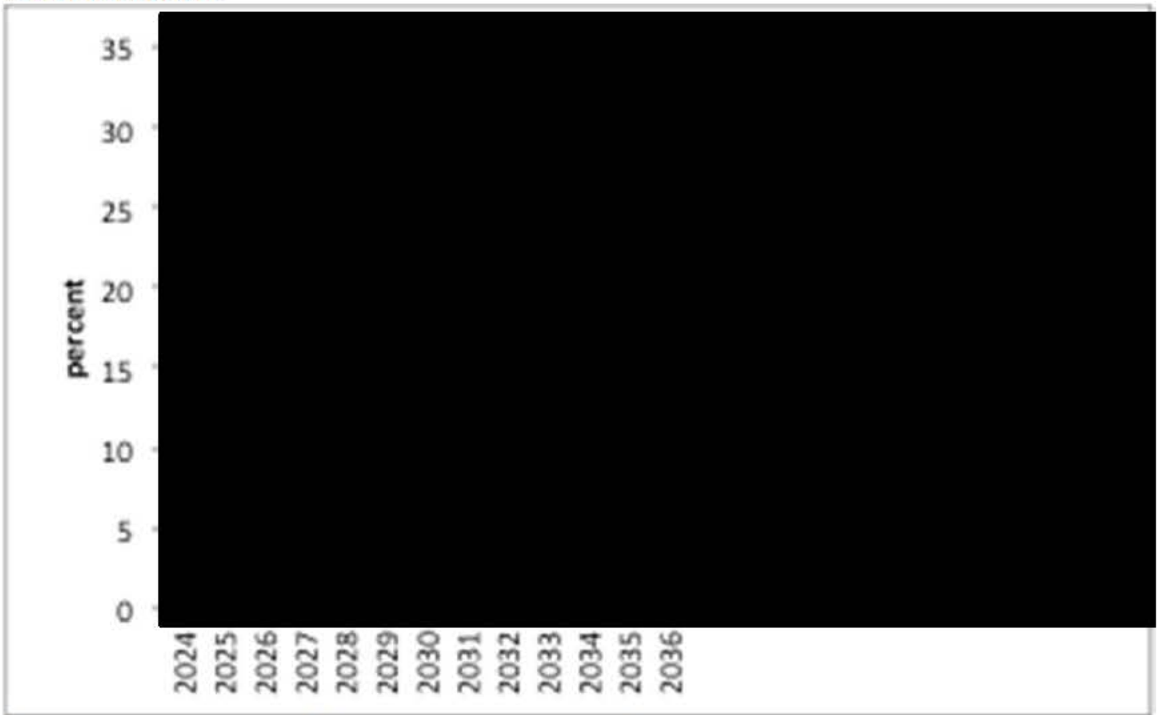
(1) It emphasizes how similar these portfolios are in the first seven years of the planning period. This means that Vectren's modeling provides the utility and the stakeholders with very little information about different and plausible near term resource choices are because those resource choices are simply not analyzed; and

(2) It undermines Vectren's choice to rely on the 20-year NPV as a good indicator of which portfolio is lower cost. That is not to say that a shorter planning period ought to have been used, rather it's important to give much less weight to near-term decisions driven by the 20-year NPV results when the differences in cost between portfolios is largely due to resource choices made later in the planning period. This is partly because those later resource choices have little effect on the choice to implement higher amounts of energy efficiency or not, but also because the later into the planning period, the more costs become speculative and less certain. The post-2023 resource choices embodied in these portfolios are likely to change with changing load forecasts, changing capital costs, and changing decisions about unit retirements.

IV-C. Too much capacity is added in key Vectren portfolios

Vectren's assessment of comparative portfolio costs is based on 20-year NPV, which appears (as is discussed in Section IV-B) to be driven by costs in the 2024 to 2036 period. Even if it were reasonable to allow the post-2023 years to drive the NPV results, Vectren's portfolios suffer from an additional serious flaw: high levels of excess capacity. As presented in Figure 5, post-2023 reserves often greatly exceed MISO reserve margin requirements.

Figure 5. Reserves and reserve margin requirement for selected portfolios—CONFIDENTIAL



Data source: *Strategist GAF Loads and Resources Detail reports for each scenario*

Vectren's reserve margin requirement, accounting for its coincidence with the MISO peak, is [redacted] percent. Portfolios I, J, K, and L inexplicably include much higher levels of capacity than what is necessary to meet reserve requirements. This almost certainly drives costs higher than is necessary in each of these portfolios. One cannot, however, necessarily conclude that this impact is greater for Portfolios L and K simply because they have higher reserve margin levels. This is because to the extent there is a difference in cost per MW of accredited capacity added (the nameplate of all resources is adjusted for forced outages and/or ability to serve load at peak), the costs may be, for example, more for Portfolio I than Portfolio L. It is important to note that at least in the case of Portfolios I and J, this excess capacity is entirely the result of Vectren's modeling specifications because every resource choice was determined by the modelers in those runs.

IV-D. Recommendations for describing generation expansion criteria

For a complete and accurate description of generation expansion criteria in an IRP, we recommend that detailed data be provided at the time of IRP submission that is sufficient for a public process and third-party review. This information should include: the type, quantity, and size of capacity available to the model in each year, as well as any limitations on resource choices.

In addition, utilities should carefully review all narrative descriptions of scenario assumptions and modeling methodologies to ensure that this text is accurate, clear enough to be easily interpreted by a nontechnical audience, and internally consistent across all sections of the IRP and related materials. In particular, utilities should verify internal consistency between peak load and energy, and between descriptions of scenarios and actual scenario specifications.

V. Does the IRP include an explanation of the methods utilized in its development?

No. While Vectren's thorough explanation of most of the methods used in the development of its 2016 IRP is a helpful tool for stakeholders and third-party reviewers, Vectren does not explain certain key elements of its IRP. Specifically, it does not explain how it chose the retirement dates for its coal units, all of which seem to uneconomical to operate under Vectren's own assumptions as described in Section IX. Vectren does not explain how, if at all, the so-called "optimized" portfolios relate to the Balanced Energy and Stakeholder portfolios in which some or all resources were specified by Vectren. And it does not justify its use of a pre-tax rather than post-tax discount rate, which leads to errors in its NPV values and a likely bias against the portfolios with the most renewable additions.

V-A. Does the IRP include an explanation of the model structure and reasoning?

No. As described above, key elements of Vectren's 2016 IRP model structure and reasoning are missing.

V-B. Does the IRP include an adequate explanation of its use of a weighted average cost of capital?

No. Vectren's 2016 IRP uses a pre-tax 10.09 percent discount rate to do two important functions in its modeling: (1) create a levelized annual fixed cost for each new resource available in Strategist (see response to CAC 1.29-Confidential (Exhibit 1-C)) and (2) discount the cost streams in Strategist to arrive at a net present value (NPV). It is likely that Vectren also uses a pre-tax discount rate to calculate NPV in Aurora, its stochastic risk model. The NPVs from Aurora are included in two of Vectren's scorecard metrics: Portfolio NPV (where 20-year NPV is the only component measure) and Portfolio Cost/Risk Trade-Off (where the metric is scored based on an underspecified relationship between NPV and the standard deviation of costs, see Section XIV).

Given the importance of cost in Vectren's selection of a preferred portfolio, it is worth considering whether the utility's unusual selection of a pre-tax discount rate is proper or not. A 2009 article in the Journal of Applied Research in Accounting and Finance (Lonergan, "Pre and Post Tax Discount Rates and Cash Flows – A Technical Note", Volume 4, Issue 1)[5] asserts that,

> *When discounting pre tax cash flows it is often assumed that discounting pre tax cash flows at pre tax discount rates will give the same answer as if after tax cash flows and*

[5] See http://hdl.handle.net/1959.14/98570.

> *after tax discount rates were used. However, this is not the case and material errors can arise, unless both the cash flows and the discount rate are after-tax.*

Lonergan concludes that, "There are only a few special cases where [using pre-tax cash flows and discount rates] may give the same answer as discounting after tax cash flows at after tax discount rate[s], for instance the case of cash flows in perpetuity with no growth…Consequently, it is important that after tax cash flows and after tax discount rates are applied in DCF [discount cash flow] valuations."

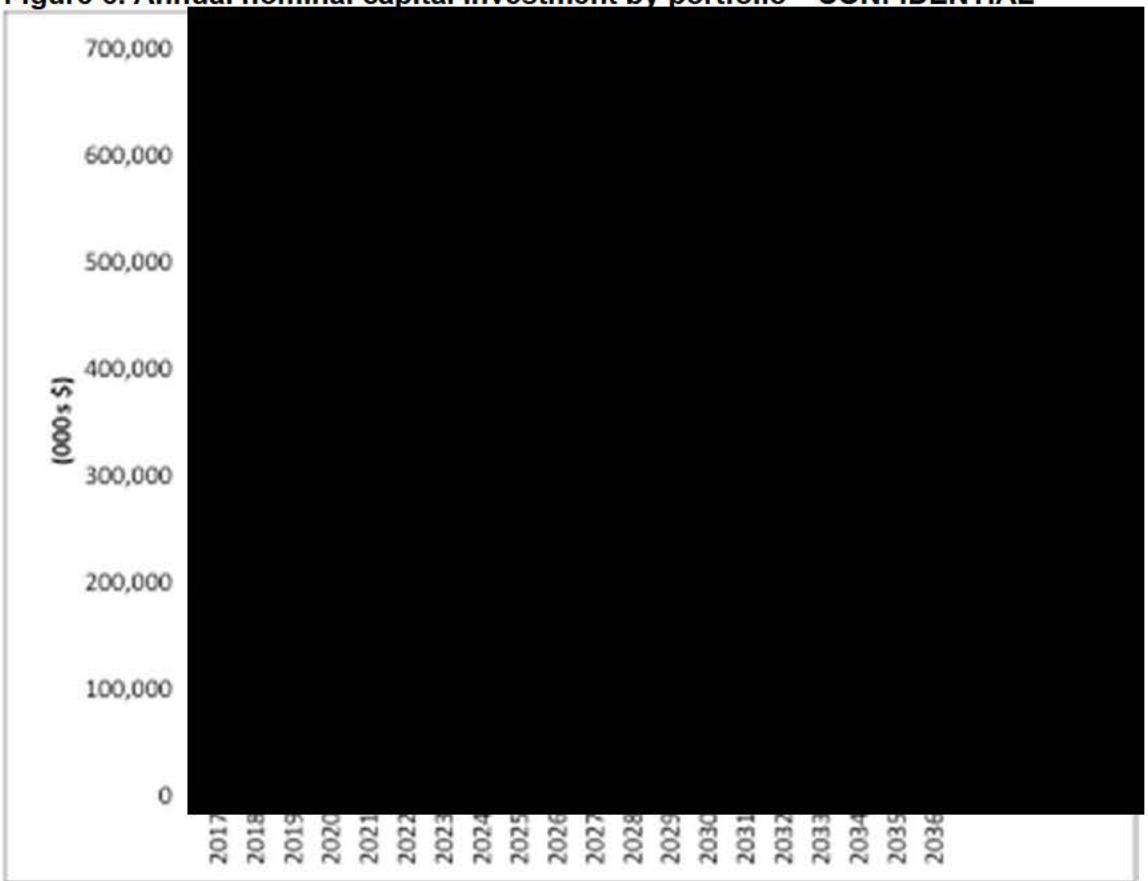
It is highly unlikely that one would encounter a case where there is no growth in spending and therefore no growth in "cash flow" in an IRP. As such, using a pre-tax discount rate would seem to give the incorrect NPV answer here.

To further illustrate this point, we reworked one example from Vectren's IRP, which applies the 10.09 percent pre-tax discount rate to a pre-tax "cash flow" to demonstrate that one does not get the same answer as when discounting post-tax cash flows using a post-tax rate.

Our point of comparison was Vectren's 50 MW wind resource modeled. According to Vectren, the levelized annual cost of that resource over a 25 year period without consideration of the production tax credit is $[redacted] each year (CAC 1.29-Confidential (Exhibit 1-C)). Based on an April 11, 2017 email from Vectren staff (Exhibit 2), the utility's calculations do not assume accelerated depreciation and the discount rate is grossed up for federal income tax at an assumed rate of 35 percent and the state income tax is assumed to be 4.9 percent. We applied these tax rates to the common equity portion of the return on the investment rather than grossing up the discount rate and arrived at a 25-year levelized value of $[redacted], which is approximately 4 percent less than what Vectren calculated.

Even if you assume this problem equally affects all resources, overestimating capital costs due to this incorrect pre-tax treatment seems likely to have the biggest impact on Stakeholder Portfolios I and J because they have significantly more capital spending than Portfolios K, L, and M as shown in Figure 6.

Figure 6. Annual nominal capital investment by portfolio—CONFIDENTIAL



[redacted]

Data source: *Strategist PRV System Cost reports for each scenario*

Portfolio I contains more than twice as much capital spending in the period 2024 – 2036 while Portfolio J has about three times the capital investment compared to Portfolios K, L, and M. Put another way, even if one assumes that the annual costs of each resource embedded in these cost streams is overestimated by 4 percent, the absolute impact of that 4 percent is more than twice as significant for Portfolio I as it is for Portfolios K, L, and M, and more than three times as large for Portfolio J. And in turn, the capital costs are about 60 - 80 percent of the total cost post-2023 for Portfolios I and J.

V-C. Recommendations for explaining methods used in IRP development

For a complete and accurate explanation of the methods used in the development of an IRP, we recommend that Vectren address the issues regarding methodology, data quality, and clarity of presentation identified in this report. We also recommend that Vectren reexamine and replace its discounting methodology and/or demonstrate that it provides the same results as a post-tax methodology.

VI. Does the IRP include an explanation, with supporting documentation, of an avoided cost calculation for each year in the forecasted period?

No. While the Vectren IRP provides a very brief description of its avoided cost methodology on page 260, its methodology is not appropriate for use in an IRP. Vectren bases its avoided costs on marginal costs:

> *The marginal operating energy costs were based off the modeled Vectren system marginal energy cost from the base optimized scenario under base assumptions. This included emission cost for CO_2 starting in 2024, estimated capital, variable operation and maintenance, and fuel costs. The marginal system cost reflects the modeled spinning reserve requirement and adjusted sales forecasts accounting for transmission and distribution losses. (Vectren 2016 IRP, p.260)*

Avoided costs based on marginal costs are not appropriate for DSM screening because the impact of energy efficiency is not “marginal”, particularly when programs are implemented over many years. In addition, marginal cost is not used to justify a utility’s investment of capital in a supply-side resource in, for example, a Certificate of Public Convenience and Necessity proceeding; that is, utilities do not typically invest capital only up to the “marginal cost”. So to apply this convention to energy efficiency creates unequal treatment of supply and demand side resources.

By limiting its avoided cost calculations to the marginal cost, Vectren may unnecessarily limit the energy efficiency chosen in its DSM plans.

VII. Was the preferred resource portfolio selected from among the candidate resource portfolios developed?

Yes. The preferred resource portfolio was selected from among the candidate resource portfolios developed.

VIII. Is the preferred resource portfolio described?

Yes. Vectren provides a description of the inputs and outcomes associated with its preferred resource portfolio.

IX. Are supply-side and demand-side resource alternatives evaluated on a consistent and comparable basis?

No. Supply-side and demand-side resource alternatives are not evaluated on a consistent and comparable basis in Vectren's 2016 IRP. Vectren's IRP modeling assumptions and methodology distort the costs of supply-side resources (Section I-C) and also create a bias against renewables. In addition, demand-side resources are subjected to inaccurate and biased projections of future costs (Section IX-B-2).

IX-A. Is each supply-side resource alternative evaluated on a consistent and comparable basis with other supply-side resources?

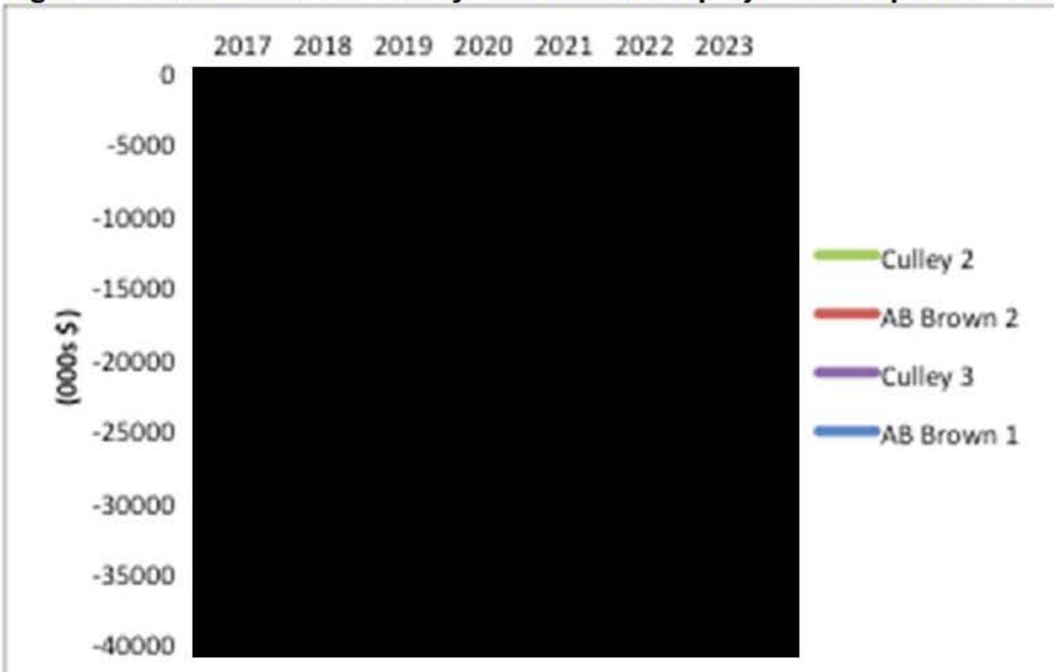
No. There are multiple biases against renewables, energy efficiency, and coal plant retirements as detailed below.

IX-A-1. Retirement analysis is biased towards later retirement of uneconomic units

Vectren assumes that Warrick Unit 4 retires in 2020 in all cases. As Vectren states in a footnote to its IRP at page 163, "There is still uncertainty with respect to the ALCOA-Warrick generation facility following the retirement of ALCOA's aluminum smelter. A conservative planning approach was taken in this analysis and all four Warrick generating units were modeled as retired with Vectren serving the remaining ALCOA load." Given that this is an "uncertainty" it would have made far more sense to model scenarios with and without Warrick rather than simply assuming that it is retired. In addition, there may be concerns about what it means to assume that Vectren continues to serve the "remaining ALCOA load", the implication of which is never specified.

The retirement of Warrick Unit 4 takes Vectren's system down from a position of significant excess capacity to one with a slight deficit in capacity. The continued operation of Warrick Unit 4 is likely to be preferable if only because Warrick Unit 4 is more efficient than Culley Unit 2 and the ABB Brown units. However, it is also worth noting that the operation of all the Culley and ABB Brown units is anticipated to be uneconomic even under Vectren's optimistic assumptions. Specifically, according to Vectren's modeling under Base Case scenario conditions, the Culley and ABB Brown units would lose [redacted] millions of dollars each year starting in 2017, as shown in Figure 7.

Figure 7. Vectren 2016 IRP Culley and Brown unit projected net profits—CONFIDENTIAL

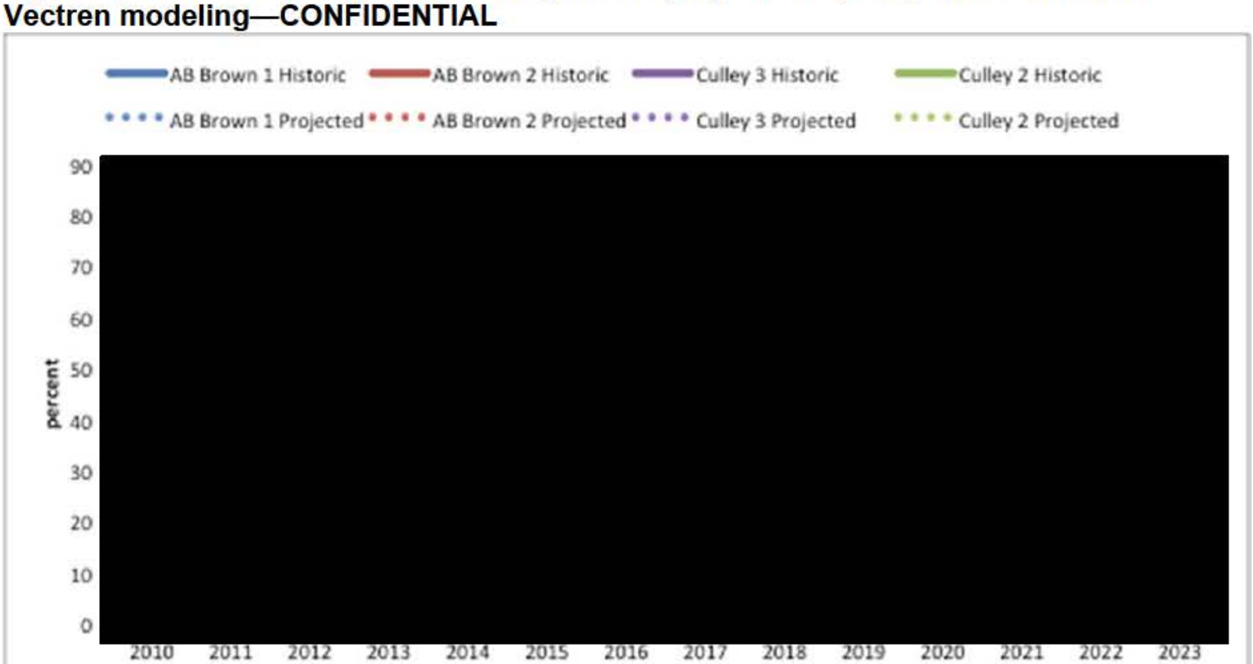


Data source: *Strategist modeling file labeled "Base-Business as Usual (Continue Coal)-A GAF Unit Report"*

In 2017 alone, the total amount of losses from these four units is projected to be $[redacted] million.

It is also important to note that Vectren is predicting these losses based on projected capacity factors that far exceed the historic performance of these units as shown in Figure 8.

Figure 8. Historic capacity factors compared to projected capacity factors used in Vectren modeling—CONFIDENTIAL



Data source: *Strategist modeling file Base-Business as Usual (Continue Coal)-A GAF Unit Report and SNL Financial*

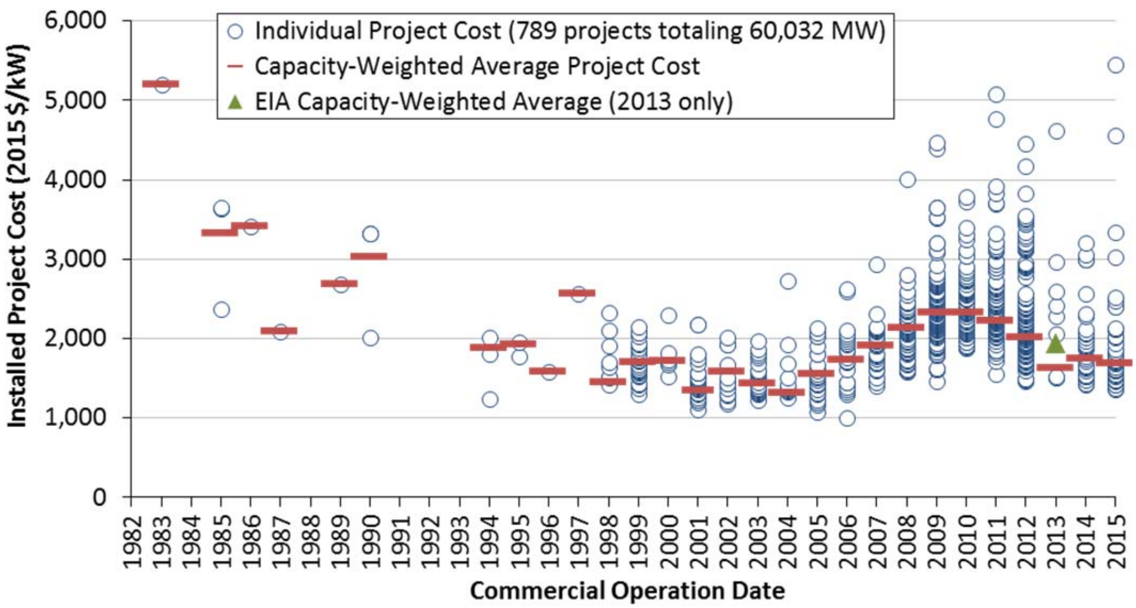
While Vectren also projects that Warrick Unit 4 will lose money, it anticipates Warrick's losses will be smaller than those of the Brown units or Culley Unit 3.

Despite the Culley and Brown units' expected losses, Vectren appears to have not considered the retirement of these more expensive units in place of Warrick Unit 4, in advance of the year 2021. Nor has Vectren included a discussion of the reasonableness of the factors that led to its very high projections of coal unit generation. While Vectren did explore the retirement of the Culley and Brown units in 2021, it is not clear if earlier retirement of those units was rejected on its own merits or because of the modelers' restrictions on the resources that could be added to replace those units and Vectren's projected high costs of the alternatives (see our critiques in Sections, IV, V and IX-A-2). Vectren fails to discuss these choices or the retirement of its more inefficient, more expensive units in its IRP.

IX-A-2. Biases against renewables

The earliest that wind appears to be available for commercial operation in Vectren's Strategist modeling is [redacted] in the scenarios we reviewed. The assumed capital cost in that year is $[redacted] per kW (nominal) or about $[redacted] per kW (in real 2015$). While Vectren's trajectory of wind costs includes a slight decline in real pricing, we do not think it is in line with current expectations regarding future wind costs. There have been significant declines in wind pricing since 2010, as shown in Figure 9.

Figure 9. Historical wind installed project cost (2015 $/kW)



Data source: *LBL 2015 Wind Technologies Report, August 2016, available at:* *https://emp.lbl.gov/publications/2015-wind-technologies-market-report*

There have likely been further price declines since the 2015 data for LBL's report was collected. For example, UBS Securities reports that current equipment pricing for wind is in the $900 per kW range with an all-in cost of $1,300 per kW, with some companies expecting that the continued decline in pricing will at least make up for the roll-off of the production tax credit (PTC).[6] [7]

Deflationary trends in solar also make it difficult to predict what solar will cost in the future. One estimate from UBS Securities predicts that solar is poised to cost in the range of $800 to $900 per kW with total levelized costs in the $30 per MWh range across much of the U.S.[8] Conversely, Vectren's 2017 estimated cost for a utility scale 50 MW solar plant is $[redacted] per kW (CAC 1.29-Confidential (Exhibit 1-C)) or $[redacted] per MWh. Vectren's estimate is much higher than the UBS forecast in part because of assumptions like the need for significant owner and contractor contingency as well as a large amount of AFUDC (CAC 2.3-A Confidential (Exhibit 3-C)). While there is certainly evidence to assume that solar costs will continue to decline significantly, there is also reason to assume a lower solar cost than $[redacted] per MWh today. The National Renewable Energy Laboratory (NREL) benchmarks the cost of solar around the country. According to its analysis, New Jersey, which has a roughly comparable solar resource to Indiana, was estimated to have a nominal levelized cost of solar energy of $99 per MWh in the first quarter of 2016, far lower than Vectren's current estimate.[9]

These overestimates of renewable costs not only bias the IRP against the stakeholder portfolios, they also bias the selection of renewables in other portfolios, to the extent that their selection is permitted by Vectren's modelers. Either way, Vectren's assumptions likely led to a suboptimal amount of renewable energy being selected.

IX-A-3. Inconsistent screening of resources

Vectren's decisions regarding what resources to screen for inclusion in modelling and what resources to model appear to be largely ad hoc. Table 4 presents resources listed, screened for inclusion in modeling, and modeled in Vectren 2016 IRP. The utility's rationale for these choices is not explained in the IRP: Why are resources screened that are not described in Section 5.2? Given the busbar analysis performed by Vectren, how then were resources chosen for inclusion in modeling? Additional information on these decisions would facilitate stakeholders' ability to review the IRP.

---

6 "The Renewable Cost Deflation Trends Continue." UBS Securities, February 16, 2017.
7 See also page 10 of https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf for an additional estimate of how much wind (and solar) costs have declined in recent years.
8 Ibid.
9 See http://www.nrel.gov/docs/fy16osti/66532.pdf

Table 4. Resources listed, screened, and approved for modeling for Vectren 2016 IRP

	Section 5.2	Section 5.5	
	Listed	Screened	Approved
TOTAL	**31**	**34**	**12**
Coal	**3**	**3**	**0**
500 MW Supercritical Pulverized	yes	yes	no
750 MW Supercritical Pulverized	yes	yes	no
525 MW IGCC 2x1	yes	yes	no
SCGT	**4**	**4**	**2**
40 MW 1xLM6000	yes	yes	no
100 MW 1xLMS100	**yes**	**yes**	**yes**
90 MW 1xE-Class	yes	yes	no
220 MW 1xF-Class	**yes**	**yes**	**yes**
CCGT	**4**	**9**	**3**
170 MW	no	yes	no
240 MW (ABB)	no	yes	no
343 MW 2x1 7FA.05 (ABB)	yes	no	no
440 MW 1x1 7FA.05	**no**	**yes**	**yes**
580 MW 2x1 7FA.04 (ABB)	yes	yes	no
750 MW 2x1 7FA.04	**no**	**yes**	**yes**
690 2x1 7FA.05 (ABB)	yes	no	no
890 2x1 7FA.05 (ABB)	**no**	**yes**	**yes**
1,340 MW 3x1 7FA.05 (ABB)	yes	yes	no
CHP	**5**	**5**	**1**
1 MW Microturbine	yes	yes	no
3 MW Combustion Turbine Generator	yes	yes	no
5 MW Combustion Turbine Generator	yes	yes	no
10 MW Combustion Turbine Generator	yes	yes	no
14-15 MW Combustion Turbine Generator	**yes**	**yes**	**yes**
Wind	**2**	**2**	**2**
50 MW Wind (Indiana)	**yes**	**yes**	**yes**
200 MW Wind (Indiana)	**yes**	**yes**	**yes**
Solar	**5**	**5**	**3**
3 MW Solar PV	yes	yes	no
4 MW Solar PV	**no**	**no**	**yes**
6 MW Solar PV	yes	yes	no
9 MW Solar PV	**yes**	**yes**	**yes**
50 MW Solar PV	**yes**	**yes**	**yes**
100 MW Solar PV	yes	yes	no
Hydro	**1**	**0**	**0**
50 MW Lowhead Hydroelectric	yes	no	no
WTE	**2**	**1**	**0**
50 MW Wood Stoker Fired	yes	no	no
5 MW Landfill Gas IC Engine	yes	yes	no
Storage	**5**	**5**	**1**
10 MW / 40 MWh Lithium Ion	**yes**	**yes**	**yes**
1 MW / 1 MWh Lithium Ion	yes	yes	no
100 kW / 250 kWh Commercial	yes	yes	no
2 kW / 7 kWh Residential	yes	yes	no
Compressed Air Energy Storage	yes	yes	no

Data source: *Vectren 2016 IRP, Section 5.2 and 5.7*

IX-B. Are supply-side resource alternatives evaluated on a consistent and comparable basis with demand-side resources?

No. Demand-side resources are not treated on a consistent and comparable basis with supply-side resources. Specifically, energy efficiency costs are inflated based on a flawed statistical model supposedly linking energy efficiency costs and market penetration. These flaws are described in the subsection IX-B-2 and Attachment A.

IX-B-1. Vectren avoided certain critical mistakes in its analysis of DSM

We commend Vectren for certain aspects of its treatment of DSM that are superior to IPL and NIPSCO's approaches. Specifically, we appreciate that Vectren's energy efficiency cost analysis, while flawed, does not rely on such black box elements as "achievable potential" rates. In addition, it does not appear that Vectren performed any cost-effectiveness pre-screening of measures, which generally serves only to result in more screens for energy efficiency than supply-side measures. We say this with the caveat that the IRP's Section 5.2.3.7 Cost Benefit Analysis appears to apply to the DSM planning process rather than the IRP itself.

IX-B-2. Improper inflation of efficiency costs due to market saturation

Vectren's 2016 IRP uses a projection of future energy efficiency program costs based on Richard Stevie's 2015 working paper.[10] In a separate paper, attached to this report as Attachment A, we critique Stevie's econometric results and their application to efficiency cost projections. To demonstrate the errors and inconsistencies in Stevie's methodology and conclusions, we replicated his results using the same data.

Stevie's study asserts that no other study has illuminated the relationship between energy efficiency program costs and market penetration, and purports to itself demonstrate that market saturation causes higher efficiency program costs. We find that Stevie's study provides no usable evidence of a market saturation-program cost relationship and *ipso facto* no such relationship has as yet been demonstrated. Stevie's analysis suggests, erroneously, that there exists evidence of efficiency market saturation significantly driving up programs costs. We find, in contrast, that the evidence presented is insufficient and inaccurate. We are aware of no reliable evidence for higher energy efficiency market penetration leading to higher efficiency costs. Inclusion of a baseless inflation of efficiency program costs in the name of market saturation results in higher energy efficiency costs than would otherwise be expected. When applied to Vectren's energy efficiency program cost projections, it can be expected that less efficiency than is optimal will be selected.

IX-B-3. Improper modeling of energy efficiency blocks

The Vectren 2016 IRP models energy efficiency blocks incorrectly and includes large, substantive errors in efficient costs. The errors in methods and data are so serious as to render

---

10 http://www.integralanalytics.com/files/documents/Projecting%20Energy%20Efficiency%20Program%20Costs%202015.pdf

the results of Vectren's DSM analysis unusable for the purpose of IRP assessment and the determination of a preferred portfolio.

Vectren represents energy efficiency as eight separate "blocks" of what it contends is 0.25 percent of retail sales in each block (Vectren 2016 IRP, p. 129). During an October 14, 2016 meeting with Vectren on the topic of how energy efficiency was being modeled in this IRP, we mentioned that it was likely that connecting the initial years' savings to later years would serve to bias the model against selection of energy efficiency that is not realistic. For example, the level of savings selected as economic in 2018 should not be tied to the question of whether savings in 2025 are also economic.

Vectren staff followed up on this concern in an October 25, 2016 email (Exhibit 4) saying

> *I just wanted to follow up with you on the discussion we had on October 14th regarding EE modeling. During the meeting, Anna Sommers [sic] expressed some concern about the 25 year horizon over which EE is modeled. She said that modeling EE over 25 years overly constrains EE and makes it difficult for the model to select any EE. But, when Matt asked whether modeling EE in 3 year increments is preferable, she seemed to me to say that she could not answer that question because she did not know what other inputs are included in the model. So, I write to ask you what inputs do you all need to know? We are trying to be responsive to your inquiries, but we need to understand what information about our inputs are relevant to EE modeling.*

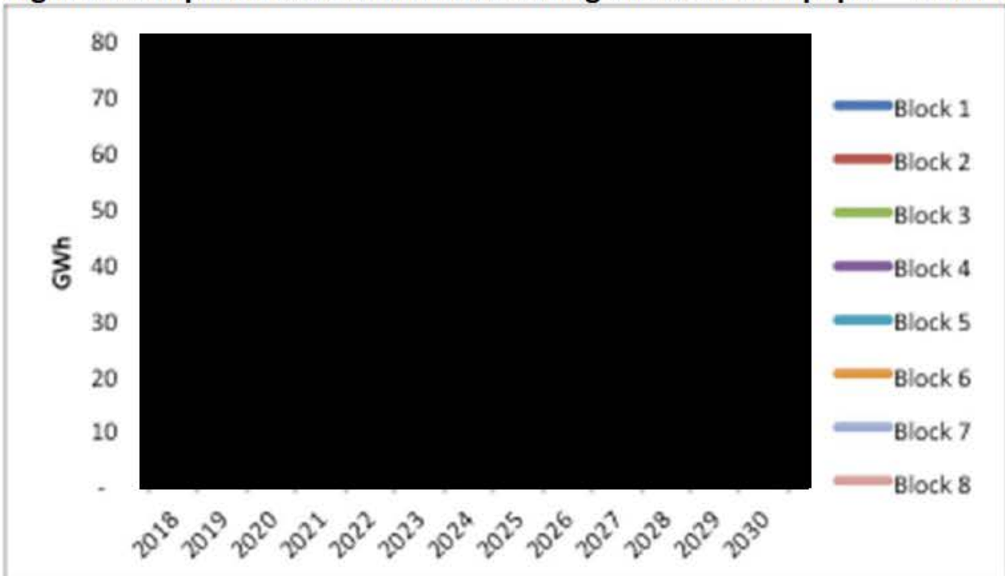
Rather than "no specific feedback [being] provided at the time" as Vectren contends at page 91 of its IRP, CAC staff responded the same day asking, on our behalf, for key Strategist files for three different submodules: Proview, Generation and Fuel, and Load Forecast Adjustment. (Exhibit 4). Vectren never responded to this request. Instead, it moved forward with a "Stakeholder" sensitivity that was intended to look at whether Strategist would select savings only in the years 2018 – 2020 if given the option (Vectren 2016 IRP, p. 91).

Oftentimes, there are aspects of resource selection which are opaque without reviewing the modeling files and yet have a material impact on resource selection. Such is the case here. A primary reason Strategist is not selecting energy efficiency in the Base Case (Scenario B) is because energy efficiency is modeled incorrectly. Indeed, it is very possible that it was modeled incorrectly in all scenarios (we did not have the time to check each one before these comments were submitted).

Figure 10, Figure 11, and Figure 12 compare:

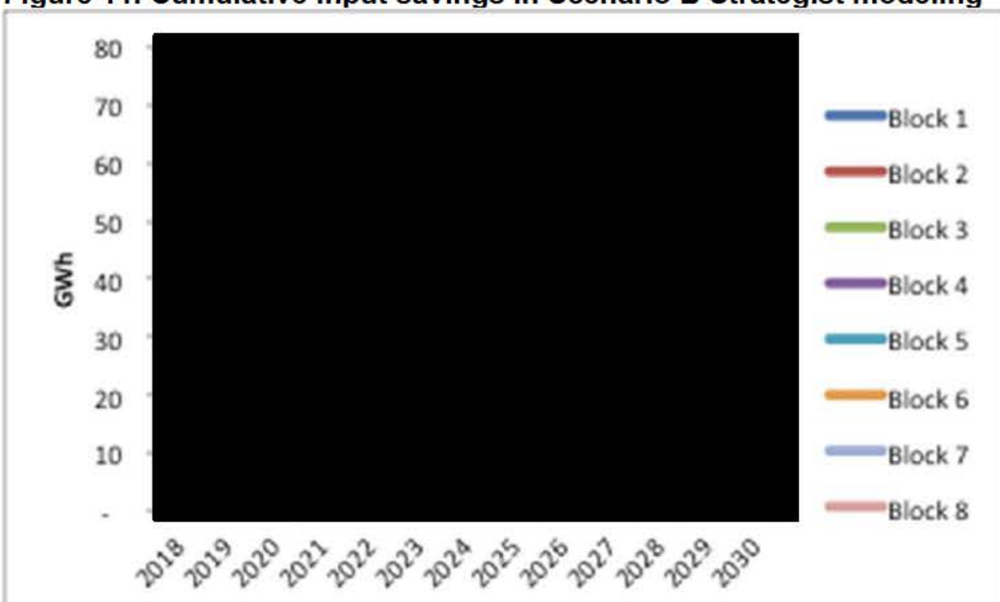
- Savings assumptions (not the savings selected but rather the inputs) as they should have been represented according to Vectren's DSM workpaper;
- Savings assumptions as they were modeled in Scenario B, and
- Savings assumptions as they were modeled in the Stakeholder 3-year sensitivity.

Figure 10. Imputed base cumulative savings in DSM workpaper—CONFIDENTIAL



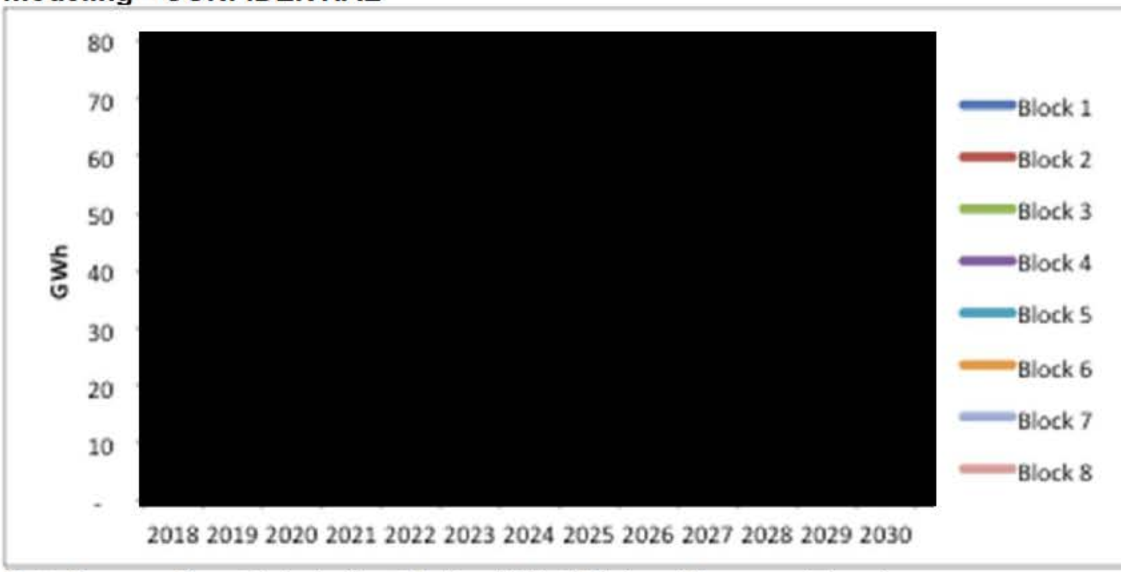
Data Source*: "Copy of Base DSM Modeling File—Confidential.xlsx"*

Figure 11. Cumulative input savings in Scenario B Strategist modeling—CONFIDENTIAL



Data Source*: Scenario B LFA Input Summary Report*

Figure 12. Cumulative input savings in 3-year Stakeholder sensitivity Strategist modeling—CONFIDENTIAL

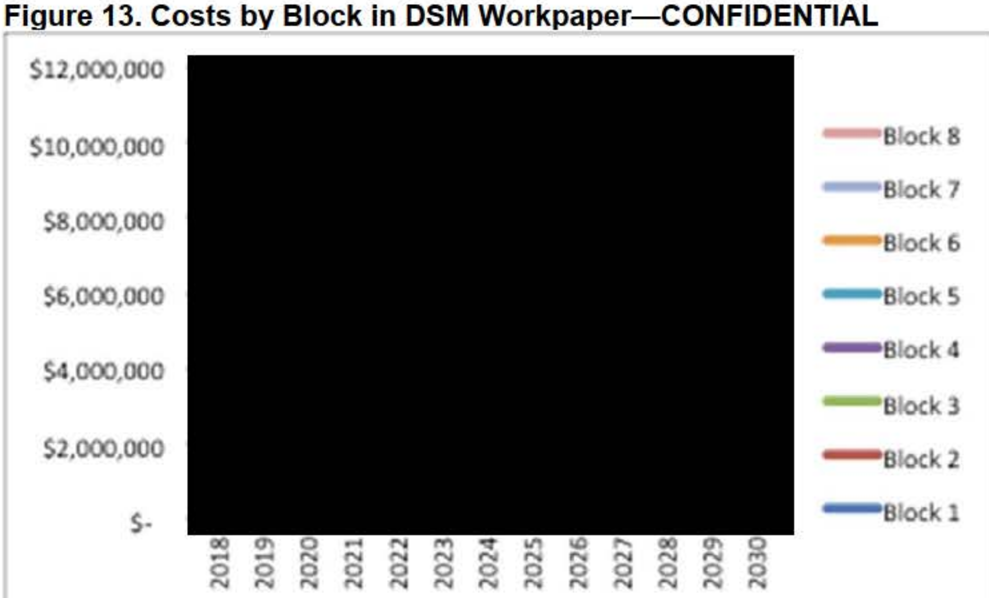


***Data Source**: Base-Stakeholder EE Sensitivity LFA Input Summary Report*

The lines in Figures 10, 11, and 12 are indistinguishable because each block models the same level of savings. As would be expected, the savings from the DSM workpaper (Figure 10) match the savings from the Scenario B input file (Figure 11). And since the Stakeholder EE sensitivity includes just three years of savings, the total plateaus after 2020 (Figure 12).

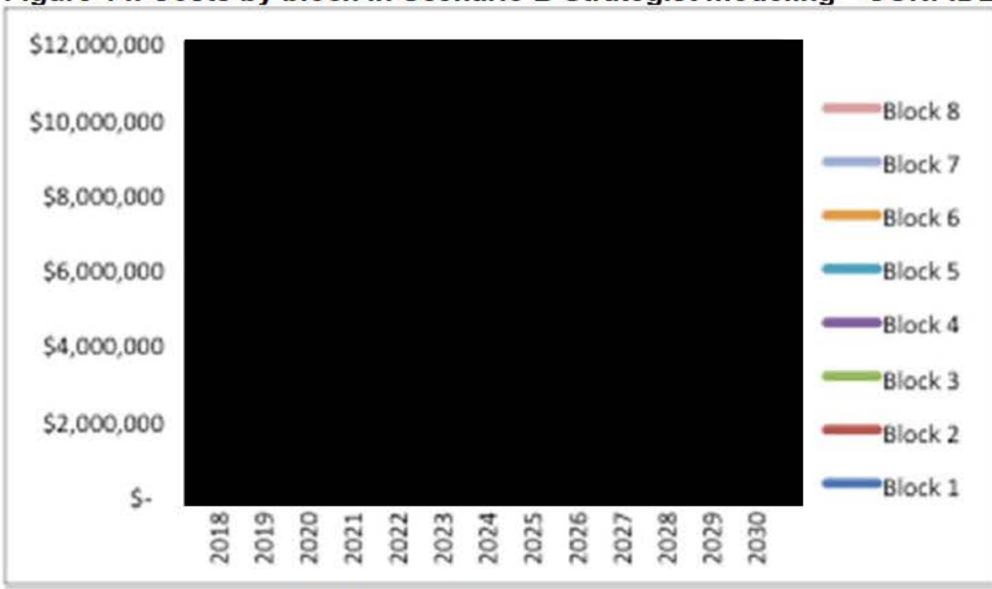
The costs, however, are not consistent (see Figure 13, Figure 14, and Figure 15).

Figure 13. Costs by Block in DSM Workpaper—CONFIDENTIAL



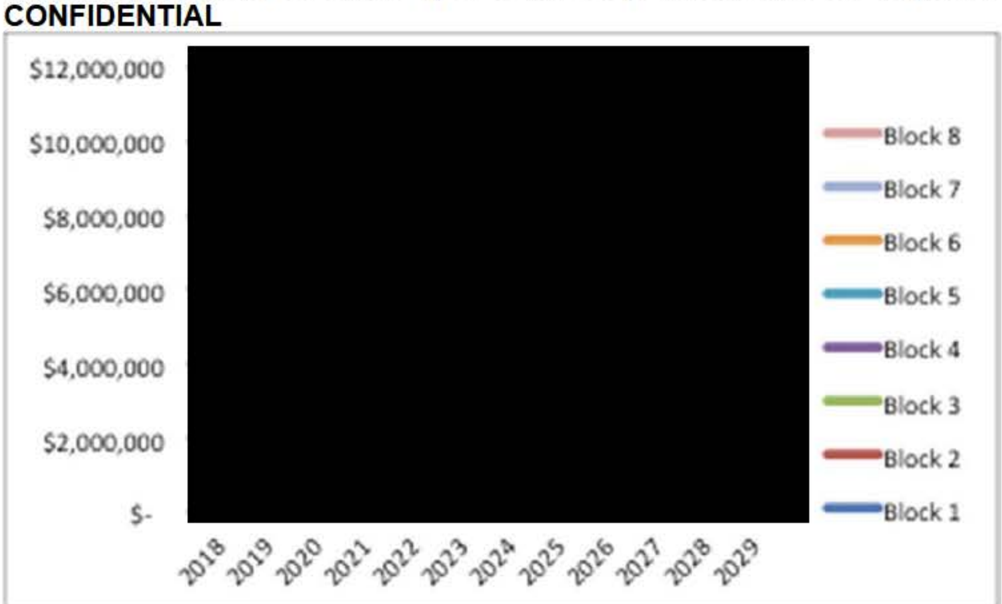
***Data Source**: "Copy of Base DSM Modeling File—Confidential.xlsx"*

Figure 14. Costs by block in Scenario B Strategist modeling—CONFIDENTIAL



***Data Source**: Scenario B LFA Input Summary Report*

Figure 15. Costs by block in 3-year sensitivity stakeholder Strategist modeling—CONFIDENTIAL



***Data Source**: Base-Stakeholder EE Sensitivity LFA Input Summary Report*

Scenario B and the 3-year Stakeholder Sensitivity costs match in years 2018-2020 (Figure 14 and Figure 15). Both, however, are over [redacted] percent higher than the costs in Vectren's DSM workpaper[11] in 2019 alone (Figure 13). That difference is even higher in subsequent years. In

[11] See Vectren's Copy of Base DSM Modeling File—Confidential.xlsx

addition, the 3-year Stakeholder sensitivity includes costs after 2020. The model inputs for that sensitivity properly include energy savings impacts from pre-2020 programs but no additional money should be necessary to sustain those impacts after 2020.[12]

Note that these issues have nothing to do with the application of Stevie's flawed cost projections nor any potential issues around the conversion of net to gross kWh for modeling purposes (the latter was beyond the scope of our analysis at this time).

If Vectren had supplied the files requested by CAC in October, it is likely that we would have identified this issue and brought it to Vectren's attention before the IRP was even finalized – some five months prior to the date these comments are submitted.

IX-C. Recommendations for a consistent and comparable resource evaluation

Vectren's approach to evaluating energy efficiency in its IRP, setting aside its cost assumptions which have serious implications, is superior to IPL and NIPSCO's approaches. However, the usefulness of its modeling for purposes of DSM plan formation can be enhanced. As we did in our recommendation on this topic in our comments on the NIPSCO and IPL IRPs, we also recommend that Vectren move to an avoided cost proxy for DSM. Under this approach, the appropriate level of savings is calculated in the DSM plan proceeding, but relies on avoided costs developed from the IRP, not on cost assumptions in the IRP modeling that may or may not be correct. Vectren is closer to this methodology than the other utilities, in that it modeled energy efficiency as 0.25 percent blocks of savings. However, to determine an avoided cost proxy, it is necessary to have portfolios with distinct levels of energy savings, but similar resource choices and other input assumptions so that the cost differences between the portfolios is driven by the level of energy savings rather than some unrelated characteristic.

This analysis must also be predicated on appropriate (and even-handed) selection of supply-side resources. The types of restrictions on renewable resources in the "optimized" portfolios are certainly not appropriate or even-handed and will not give a useful answer about the value of each load decrement.

[12] There are likely similar errors in the modeling of the demand response and current energy efficiency costs.

X. Does the preferred resource portfolio utilize all economical resource alternatives as sources of new supply?

No. The preferred resource portfolio does not utilize all economical resource alternatives as sources of new supply.

X-A. Overall issues with Vectren's method of selection of economical resources

Vectren fails to provide the reasonable modeling of future conditions that would be necessary to utilize all economical resource alternatives including biases against the addition of renewables resources and demand-side measures.

X-B. Does the preferred resource portfolio utilize all economical load management, demand-side management, and energy efficiency improvements?

No. Vectren's 2016 IRP does not appear to utilize all economical demand-side management and load management as discussed in Section IX-B.

X-C. Does the preferred resource portfolio utilize all economical technology relying on renewable resources?

No. Vectren's 2016 IRP does not appear to utilize all economical technology relying on renewable resources as discussed in Section IX-A.

X-D. Does the preferred resource portfolio utilize all economical cogeneration?

We did not assess Vectren's use of cogeneration.

X-E. Does the preferred resource portfolio utilize all economical distributed generation?

We did not review this aspect of Vectren's modeling.

X-F. Does the preferred resource portfolio utilize all economical energy storage?

We did not assess Vectren's use of energy storage.

X-G. Does the preferred resource portfolio utilize all economical transmission?

We did not review this aspect of Vectren's IRP modeling.

X-H. Recommendations for utilizing all economical resource alternatives

For a complete, and even handed, utilization of all economical resource alternatives, we recommend that Vectren use a technology neutral approach to resource inclusion in modeling and take care to evaluate all resources on a consistent and comparable basis (see Section IX for a discussion of consistent and comparable resource evaluation).

XI. Are targeted DSM programs evaluated, including their impacts on the utility's transmission and distribution system?

No. Vectren does not evaluate DSM targeted at transmission and distribution system issues.

XII. Are the financial impacts to the utility of acquiring the future resources identified in the preferred resource portfolio assessed?

No. Vectren does not discuss any analysis of the financial impacts of acquiring the future resources identified in the preferred resource portfolio.

XIII. Does the preferred resource portfolio balance cost minimization with cost-effective risk and uncertainty reduction?

No. Vectren includes both cost minimization and risk and uncertainty reduction in its scorecard assessment. However, the insurmountable flaws in Vectren's scorecard method render its results meaningless, as discussed in detail in Section XIV-B.

XIV. Are risks and uncertainties quantified, including, but not limited to: regulatory compliance, public policy, fuel prices, construction costs, resource performance, load requirements, wholesale electricity and transmission prices, RTO requirements, and technological progress?

No. Vectren's 2016 IRP analysis of risks and uncertainties, while quantitative, does not include many of the risk categories listed in IURC guidance and contains other errors and limitations.

Overall, we question the usefulness of black box, qualitative "scorecard" approaches to IRP portfolio selection. These methods are largely opaque to the IRP audience and cannot be subjected to the kind of rigorous third-party analysis that protects the public interest in an IRP process. Furthermore, because of their black box and qualitative characteristics, such analyses can be made to produce a very wide range of policy results (here, IRP preferred resource portfolios) based on small modeling choices that are not always expressed to stakeholders as explicit IRP goals.

Vectren's 2016 IRP uses just such a black box scorecard methodology, which appears to contain multiple errors in its execution, including insufficient iterations of its model to appropriately represent uncertain future conditions, and choices of scorecard ranking rules that have the effect of biasing results against particular portfolios.

XIV-A. Not enough iterations

Each of Vectren's 15 portfolios was tested "under 200 iterations representing different, but cohesive and plausible market condition scenarios" (Vectren 2016 IRP, p.84). Vectren's portfolio results are the average of these 200 iterations or model runs. The variables that were chosen by Vectren to model stochastically include:

1. Load
2. Natural gas price
3. Coal price
4. Carbon compliance costs
5. Capital costs
6. Cross-commodity correlation for gas, coal and carbon prices[13]

As explained below, with six independent variables it is not at all clear how a full range of possible combinations of variables could be represented in just 200 iterations.

Vectren has chosen to use a style of sensitivity analysis referred to as Monte Carlo analysis. In brief, Monte Carlo analysis tests out the potential range of NPVRR, emissions and other modeling results using (1) the range of values deemed possible for each uncertain variable, and (2) multiple intersecting uncertainties (this means that more than one variable's value is changing in each modeling run). The more uncertain variables being examined, the more modeling runs (each with a new set of values for the uncertain variables) are needed to get a

[13] Vectren 2016 IRP pp. 221-223

good sample of the entire range of potential modeling results. Monte Carlo analyses of two or three uncertain variables often involve tens of thousands of modeling runs.

Monte Carlo analysis is a well-accepted methodology used in sensitivity analysis—although, perhaps not one that it is particularly transparent to a nontechnical audience. The problems with Vectren's choice of this methodology result from the number of uncertain variables that they are simultaneously sampling. Vectren appears to be testing the sensitivity of modeling results to six uncertain variables simultaneously. Vectren reports that it uses just 200 modeling runs to provide a complete sensitivity analysis. In our opinion, this number of runs cannot be sufficient to provide a good sample of potential modeling results.

Here's how the math works under a typical Monte Carlo analysis, assuming that each uncertain variable's range of possible values is divided into 10 parts (in principle, such a grid could be divided into many more parts, compounding the problem presented here):

- Two uncertain variables: Two dimensions, each with 10 segments, results in 10x10 or 100 samples (sets of variable value combinations)
- Three uncertain variables: Three dimensions, each with 10 segments, results in 10x10x10 or 1,000 samples
- Four uncertain variables: Four dimensions, each with 10 segments, results in 10x10x10x10 or 10,000 samples
- Five uncertain variables: Five dimensions, each with 10 segments, results in 10x10x10x10x10 or 100,000 samples
- Six uncertain variables: Six dimensions, each with 10 segments, results in 10x10x10x10x10x10 or 1,000,000 samples

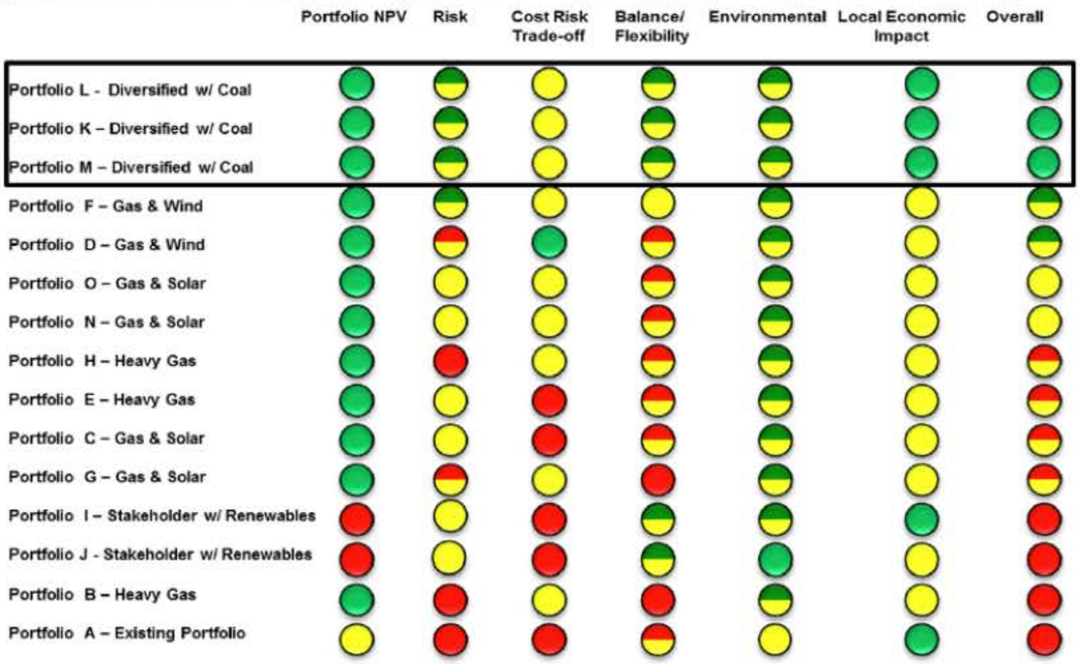
In contrast, Vectren conducts just 200 modeling runs for six uncertain variables. For this number of independent variables, a grid divided into 10 parts would require 1 million modeling runs for good sampling. (For context, a grid divided into 3 parts, requires 729 runs, while a grid divided into 100 parts requires 1 trillion runs.) As a result, Monte Carlo analysis typically includes far fewer than six uncertain variables and/or far more than 200 runs.

XIV-B. Scorecard weighting is inconsistent and/or inaccurate

Vectren's 2016 IRP scorecard methodology for selection of the preferred portfolio ranks each of its 15 resource portfolios by a score on six categories of metrics and then purports to average these metrics to result in a final ranking (see Figure 16). Vectren explains that its consultant, Pace Global:

> *[C]onducted a risk analysis of 15 portfolios. The analysis subjects each portfolio to 200 iterations (future market and regulatory outcomes). Then portfolios were ranked by each group of key criteria and associated metrics. The best performers in each metric were given a green color and the worst were given a red color; yellow was also shown as caution within a given metric. (Vectren 2016 IRP, p.224)*

Figure 16. Vectren 2016 IRP Figure 7.16—IRP Portfolio Balanced Scorecard



To better understand this methodology, we replicated Vectren's scorecard metric and weighting system (see Figure 17 for a direct reproduction of Vectren's six main metrics and overall metric using our formatting, here presented in a neutral order). Figure 17 shows Vectren's red, yellow, and red scores with black text and its red-yellow and green-yellow scores with yellow text. The numbers shown are ranks, 1-5, for these colors: red (worst) = 1; red-yellow = 2; yellow (caution) = 3; green-yellow = 4; and green (best) = 5.

Figure 17. Reproduction of Vectren 2016 IRP Portfolio Balanced Scorecard (ranked from 1=worst to 5=best)

Portfolios	Portfolio NPV	Risk	Cost Risk Trade-Off	Balance/ Flexibility	Environment	Local Econ Impact	Overall: As Reported
A - Existing Portfolio	3	1	1	2	3	5	1
B - Heavy Gas	5	1	3	1	4	3	1
C - Gas & Solar	5	3	1	2	4	3	2
D - Gas & Wind	5	2	5	2	4	3	4
E - Heavy Gas	5	3	1	2	4	3	2
F - Gas & Wind	5	4	3	3	4	3	4
G - Gas & Solar	5	2	3	1	4	3	2
H - Heavy Gas	5	1	3	2	4	3	2
I - Stakeholder w/ Renewables	1	3	1	4	4	5	1
J - Stakeholder w/ Renewables	1	3	1	4	5	3	1
K - Diversified w/ Coal	5	4	3	4	4	5	5
L - Diversified w/ Coal	5	4	3	4	4	5	5
M - Diversified w/ Coal	5	4	3	4	4	5	5
N - Gas & Solar	5	3	3	2	4	3	3
O - Gas & Solar	5	3	3	2	4	3	3

While Figure 17 directly reproduces Vectren's metric results, Figure 18 instead replicates these results using the exact numeric ranks by color for the 13 sub-metrics presented in Vectren's 2016 IRP. It is assumed, because Vectren did not specify otherwise, that all metrics are given equal weight, both among the sub-metrics (not shown in Figures 2 or 3) that combine to these six main metrics and also among the six main metrics in order to determine an overall metric.

Figure 18. Replication of Vectren 2016 IRP Portfolio Balanced Scorecard (ranked from 1=worst to 5=best)

Portfolios	Portfolio NPV	Risk	Cost Risk Trade-Off	Balance/ Flexibility	Environment	Local Econ Impact	Overall: Calculated
A - Existing Portfolio	3	2	1	3	3	5	3
B - Heavy Gas	5	2	3	2	4	3	3
C - Gas & Solar	5	3	1	2	4	3	3
D - Gas & Wind	5	3	5	3	4	3	4
E - Heavy Gas	5	3	1	3	4	3	3
F - Gas & Wind	5	4	3	3	4	3	4
G - Gas & Solar	5	3	3	1	4	3	3
H - Heavy Gas	5	2	3	2	4	3	3
I - Stakeholder w/ Renewables	1	3	1	5	4	5	3
J - Stakeholder w/ Renewables	1	3	1	4	5	3	3
K - Diversified w/ Coal	5	4	3	4	4	5	4
L - Diversified w/ Coal	5	4	3	4	4	5	4
M - Diversified w/ Coal	5	4	3	4	4	5	4
N - Gas & Solar	5	3	3	2	4	3	3
O - Gas & Solar	5	3	3	2	4	3	3

A comparison of Figure 18 to Figure 17 raises several questions:

- If these metrics were not equally weighted (as appears to be the case judging from the discrepancies between Figure 17 and Figure 18), on what basis were they weighted and why?
- Why has Vectren chosen to rerank the overall metric results in a manner which certainly accentuates and perhaps overemphasizes the differences between them?

When weighted equally, Vectren's top ranked Portfolios K, L and M share their "best"/"caution" score with Portfolios D and F, while the remaining 8 Portfolios share the "caution" score.

In addition to these concerns, our detailed review of Vectren's specific sub-metrics drew our attention to the possibility of other equally reasonable interpretations of these measures and their rankings. Figure 19 presents a revised version of Vectren's scorecard using these changes (which are described in detail in the sections that follow).

Figure 19. Revisions to Vectren 2016 IRP Portfolio Balanced Scorecard (ranked from 1=worst to 5=best)

Portfolios	Portfolio NPV	Risk	Cost Risk Trade-Off	Balance/ Flexibility	Environment	Local Econ Impact	Overall: Calculated
A - Existing Portfolio	3	1	1	2	1	5	2
B - Heavy Gas	5	2	5	2	4	3	4
C - Gas & Solar	5	3	1	2	4	3	3
D - Gas & Wind	5	3	5	3	4	3	4
E - Heavy Gas	5	3	1	3	4	3	3
F - Gas & Wind	5	5	3	4	4	3	4
G - Gas & Solar	5	2	3	1	4	3	3
H - Heavy Gas	5	2	1	2	4	3	3
I - Stakeholder w/ Renewables	1	4	5	5	4	5	4
J - Stakeholder w/ Renewables	1	4	1	5	5	3	3
K - Diversified w/ Coal	5	4	5	4	2	5	4
L - Diversified w/ Coal	5	4	3	4	2	5	4
M - Diversified w/ Coal	5	4	5	4	2	5	4
N - Gas & Solar	5	3	5	2	4	3	4
O - Gas & Solar	5	3	5	2	4	3	4

The changes presented in the next subsections are at least as reasonable—and, we would argue, more reasonable—than the assumptions chosen by Vectren. The result of these small adjustments to the scorecard ranking system is the very different ranking of portfolios as presented in Figure 19. To be clear, we did not adjust the underlying data or measures. Instead, we made changes to Vectren's methods of ranking and combining these measures.

Figure 20 compares Vectren's overall portfolio scores with our revisions (based solely on changes to the method of ranking). In our revised scorecard, no portfolio receives the top green score (5) and the "best"/"caution" (4) score is shared by nine portfolios, including those scored "best" by Vectren (Portfolios K, L, and M) and one of the stakeholder portfolios (I).

Figure 20. Revisions to Original Vectren 2016 IRP Scorecard Comparison (ranked from 1=worst to 5=best)

Portfolios	Overall: As Reported	Overall: Calculated
A - Existing Portfolio	1	2
B - Heavy Gas	1	4
C - Gas & Solar	2	3
D - Gas & Wind	4	4
E - Heavy Gas	2	3
F - Gas & Wind	4	4
G - Gas & Solar	2	3
H - Heavy Gas	2	3
I - Stakeholder w/ Renewables	1	4
J - Stakeholder w/ Renewables	1	3
K - Diversified w/ Coal	5	4
L - Diversified w/ Coal	5	4
M - Diversified w/ Coal	5	4
N - Gas & Solar	3	4
O - Gas & Solar	3	4

***Note:** The "Overall: As Reported" values are Vectren's overall portfolio scores shown in Figure 16 and Figure 17. The "Overall: Calculated" values are recalculated with our changes to ranking methods only, shown in Figure 19.*

We present this revised treatment of Vectren's scorecard system not to argue for the choice of any particular scenario as "preferred" but instead to draw attention to the problems inherent in any black box scorecard assessment. Small, reasonable changes in ranking assumptions result in big changes in assigned scores. Vectren's method of choosing its preferred portfolio is not robust to small changes in metric assumptions nor is it the only possible interpretation of the data upon which Vectren relies.

XIV-B-1. "Customer Rates"

We question Vectren's characterization of differences across its Portfolios' net present value of revenue requirements (NPVRR) as differences in "customer rates". On page 225 of the IRP, Vectren clarifies that NPVRR "facilitate[s] lower customer rates". We feel that it would be more transparent to consistently refer to this metric as "Portfolio NPV".

We made no adjustments to Vectren's Portfolio NPV metric in our revised scorecard shown in Figure 19. We do, however, question the modeling assumptions that led to these NPVRR results as we discuss in Sections IV, V, and IX.

XIV-B-2. Risks

Vectren's Risk metric is composed of four component metrics: (1) standard deviation above the portfolio with the lowest cost; (2) 20-year average capacity purchases; (3) 20-year average market purchases; and (4) remote generation risk.

20-year average capacity purchases

This component takes the 20-year average of capacity purchases and assigns a green score if a portfolio purchases an average of 20 MW or less. However, a portfolio with significant capacity purchases is not inherently risky as much as poorly planned. If the resource plan that results from a modeling run includes significant capacity purchases for several years, that is an indication that more self-build, contracted, or demand-side resources need to be added to the portfolio even if that might be more expensive over the long-term. This approach is rational because the resources in any given scenario should be indicative of action a reasonable utility would actually take. Nor is the 20-year average of capacity purchases indicative of any real long-term risk that a utility cannot mitigate since even if load grew suddenly and unexpectedly in the real world, a utility can react by building or purchasing through contract the additional capacity it needs, rather than relying on the MISO capacity auction (called the Planning Resource Auction (PRA)).

Indeed, Vectren's focus on what it considers to be the volatility (see for example, Vectren 2016 IRP, p. 71) of MISO PRA prices as a justification for including this risk sub-metric is confusing because even MISO describes the PRA as

> *a voluntary annual capacity auction [that] allows Market Participants to achieve resource adequacy more economically and its enhanced market-based design allows for greater transparency. The location-specific approach used in the PRA provides efficient price signals to encourage the appropriate resources to participate in the locations where they provide the most benefit. This methodology creates a variety of options for Load Serving Entities ("LSEs") to obtain the resources required to meet*

> *their Planning Reserve Margin Requirement, including Fixed Resource Adequacy Plans, bilateral transactions, self-scheduling, capacity deficiency payments, and auction purchases.*[14]

MISO itself notes the many ways in which a utility can meet its resource adequacy requirements without exposure to the "volatility" of the PRA: by submitting a Fixed Resource Adequacy Plan, by entering into a bilateral transaction, by self-scheduling, or by making capacity deficiency payments. And of course, in the 20 years contemplated by Vectren, by constructing a new unit or acquiring more demand-side resources.

In fact, having an excess of capacity is much more concerning since it is likely to be difficult to extract the utility from that risk without prematurely retiring assets. Simply changing this sub-metric to the 20-year average of *excess* capacity would make it more indicative of risk to the utility. A better solution is to eliminate it entirely since planning to have 20-year long excesses of significant capacity is also likely an indication of a poorly planned modeling run.

20-year average market purchases

Market purchases of less than 800 GWh per year are awarded a green (best) score, and we believe this component is a good one. Relying on the MISO market for large quantities of energy is a risky long-term strategy. And 800 GWh, which equates to about 15 percent of Vectren's needs, is a reasonable rule of thumb cap on purchases.

Vectren contradicts itself, however, when it rewards portfolios for *selling* as much energy as possible in its Balance and Flexibility metric (see below).

Remote generation risk

Vectren does not adequately justify its assumption that "remote" generators are more risky than other generators. The locational marginal prices calculated at any given generator node are likely to include a congestion component, so it is not clear why generators that are "remote" to Vectren would necessarily experience higher congestion costs than any other generator. Nor is it even clear which generators Vectren considers "remote". It simply provides the following explanations for its remote generation metric:

> *Portfolios that have stations far removed from its load centers are more subject to transmission congestion, transmission failures, or price spikes than local generation. (p.72)*

> *Portfolios with generation assets located away from Vectren's service territory are exposed to greater risk of transmission congestion and outages. (p.227)*

> *The fourth metric is the risk of remote sources, which subjects capacity to greater levels of transmission and site related risks, simply by being remote to its service territory. (p.241)*

In addition, on Vectren 2016 IRP p.69 in its explanation of the objectives of its metrics, Vectren lists only three component metrics to its risk metric, and instead includes "new remote resources in generation mix" under its Balance and Flexibility metric.

---

[14] See https://www.misoenergy.org/Planning/ResourceAdequacy/Pages/RAContruct.aspx

Risk metric revisions

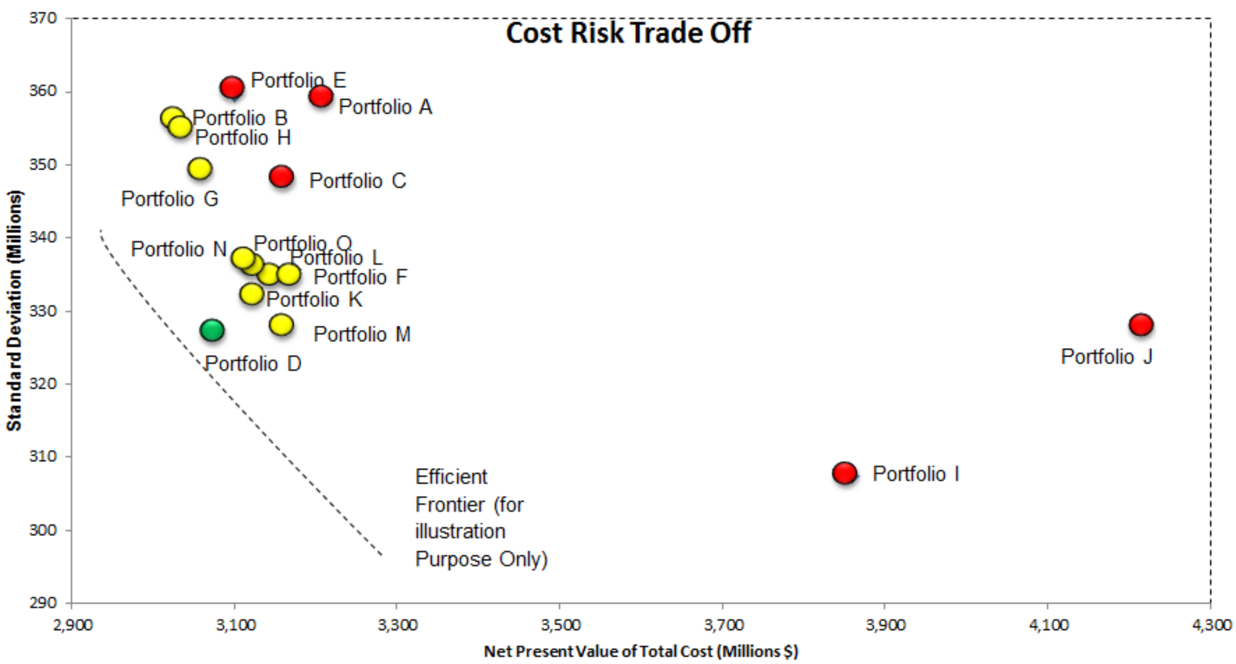
In our revised scorecard shown in Figure 19, we adjusted Vectren's Risk metric by removing the underexplained remote generation metric. The result is better Risk metric scores for the portfolios with the most wind energy.

IV-B-3. Cost-Risk Trade-Off

Vectren's Cost-Risk Trade-Off metric combines data points that have already been incorporated in the scorecard: the NPVRR of the portfolio and the standard deviation of the NPV (a component measure under the Risk metric). By including both of these metrics a second time in the Cost-Risk Tradeoff, their impact is double counted, increasing the weight given to the standard deviation and NPV outcomes.

Furthermore, Vectren's method of assigning scores to its Cost-Risk Trade-Off metric is entirely arbitrary. On page 229 of the IRP, a scatterplot of portfolio standard deviations versus portfolio NPVRR is presented. Vectren's qualitative assignment of scores in this metric appears to be made on the basis of visual inspection of this graph and a sketched "Efficient Frontier (for illustration Purpose Only)" curve (see Figure 21).

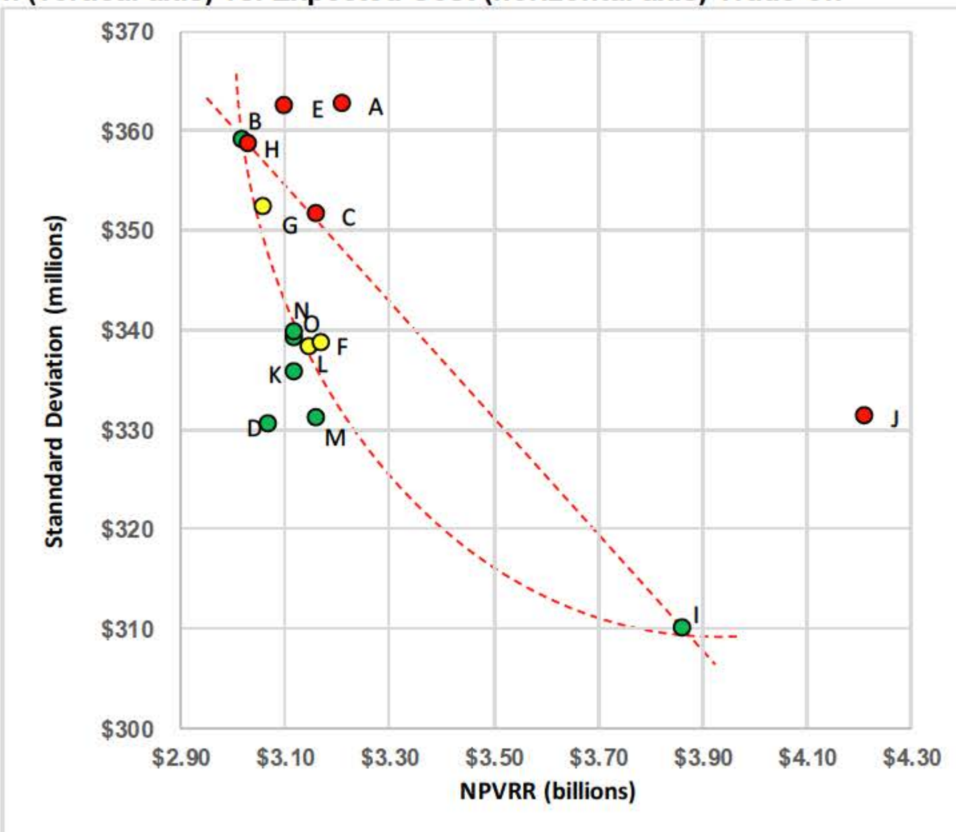
Figure 21. Vectren 2016 IRP, Figure 7.19—Portfolio Standard Deviation Risk (vertical axis) vs. Expected Cost (horizontal axis) Tradeoff



Cost-Risk Trade-Off metric revisions

Vectren's illustrative, so-called "Efficient Frontier" (shown in Figure 6 above) is given without explanation or justification and appears to lead to a scoring system that is to the disadvantage of the two stakeholder portfolios, I and J. In order to illustrate the problems with Vectren's method of assigning scores to a metric, Figure 7, below, reproduces Vectren's data in Figure 6, but with a different rule of thumb for determining which portfolios receive which scores. Our equally illustrative "efficient frontiers", drawn in Figure 22, both pass through the portfolio with the lowest cost (Portfolio B) and the portfolio with the lowest standard deviation (Portfolio I). We have adjusted Vectren's Cost-Risk Trade-Off scores based on each portfolio's position with respect to these two frontiers.

Figure 22. Replication of Vectren 2016 IRP, Figure 7.19—Portfolio Standard Deviation Risk (vertical axis) vs. Expected Cost (horizontal axis) Trade-off



XIV-B-4. Balance and Flexibility

Vectren's Balance and Flexibility metric is composed of four component metrics: (1) number of baseload units in 2036; (2) reliance on the technology with the greatest share of generation; (3) number of technologies; and (4) net sales.

Number of baseload units in 2036

Vectren characterizes the largest number of baseload units in 2036 as a benefit because it is a "hedge against outages" (Vectren November 29, 2016 Stakeholder Presentation, slide 60). We would instead say that having multiple units of any kind is a meaningful hedge against outages. Further, to view power plants as neatly falling into baseload, intermediate, or peaking is outdated thinking that does not square with current-day realities. What matters is that generation and consumption largely align and that alignment can be tweaked on both the supply and demand side.

More specifically, the problem with this sub-metric is that the term "baseload" is losing its meaning as applied to coal-fired power plants. Does F.B. Culley Unit 2's 20 percent capacity factor in 2016 indicate that it should be viewed as an intermediate or perhaps even a peaking resource instead of baseload? Does this suggest that F.B. Culley Unit 3, which had a 41 percent capacity factor in 2016, is an "intermediate" unit? This portion of the Balance and Flexibility metric would more meaningfully capture outage risk if what was being measured was the number of individual units being relied upon for, say, 10 percent or more of total customer consumption with the green color going to those portfolios that relied on the highest number of unique generators.

Reliance on the technology with the greatest share of generation

This sub-metric is a poor approximation for resource diversity and seems to be partially justified by risk that is already accounted for in other metrics. In addition, the metric looks only at a single year, far in the future in 2036, which is akin to saying that 2036 is really the only year in which this sub-metric matters.

The single largest concern about relying on any one technology is likely to be fuel related. Indeed, Vectren partially justifies this sub-metric by says "If Vectren relies heavily on the economic performance of any one technology, such as natural gas or coal, higher than anticipated fuel costs for one technology could expose customers to higher prices than a more balanced portfolio" (Vectren 2016 IRP, p.72). Fuel related costs do not apply to wind and solar, of course, even so portfolios with just these supply-side resources would be ranked worse than those with wind, solar, gas, and coal. In addition, fuel risk is captured in the standard deviation results that are already part of the scorecard. All of these factors suggest that this sub-metric should be eliminated from Vectren's scorecard.

Number of technologies

Vectren's inclusion of the number of technologies is somewhat duplicative of its reliance on the sub-metric based on the technology with the greatest share of generation and indeed the justification for the two are lumped together in Section 2.2.4.1 of Vectren's IRP. Furthermore, the number of technologies is also largely meaningless as a measure of risk since there are many more direct and accurate ways to capture risk by technology category, such as by weighing fuel risk. Simply focusing on the absolute "number of technologies" is, objectively, an inadequate measure of fuel risk if only because some of the technologies counted consume no fuel whatsoever.

Net sales

Vectren awards worse scores for high energy purchases in its Risk metric but better scores for high energy sales in its Balance and Flexibility metric. The net sales component metric rewards portfolios for *selling* as much energy as possible, assigning the green (best) color to those portfolios with total net sales of more than 10 percent over the 20-year period, while purchases over roughly 15 percent are penalized. This contradiction is inexplicable. To the extent that Vectren deems it "risky" to rely on the market to purchase power, it must be equally risky to plan on selling power to the market. There is no mechanism that will always make a kWh sold riskless or even beneficial for the seller but risky for the buyer.

Vectren claims that high net sales allow "the flexibility to adapt to unexpected breakthroughs in technology" (Vectren 2016 IRP, p. 230). Many technology breakthroughs, however, make it *more* risky to sell power. For example, the dramatic declines in the cost of wind and solar coupled with the low cost of gas due to the growth of fracking technology have depressed wholesale market prices, making excess power a liability more than a benefit to customers.

Balance and Flexibility metric revisions

We adjusted Vectren's Balance and Flexibility metric in our revised scorecard shown in Figure 19 by removing the "largest number of baseload units" metric. The result is better Balance and Flexibility metric scores for the portfolios with the highest net sales including the stakeholder portfolios I and J.

XIV-B-5. Environmental

Vectren's Environmental Metric is composed of two component metrics: (1) reduction in CO_2 emissions; and (2) reduction in NO_x and SO_2 emissions. The Environmental metric assigns equal weight to a reduction in CO_2 emissions consistent with what it describes as the goals of the Clean Power Plan and an 80 percent reduction in NO_x and SO_2 from 2012-2015. The IRP provides no explanation for why Vectren weighted these two submetrics equally.[15] Do both cost the same to achieve? Do both arise from finalized or near finalized rules? Do both reduce health or other societal impacts equally? Nor does the IRP explain why Vectren disregarded other environmental risks, such as water and solid waste pollution. One might, for example, also consider the risk associated with effluents and coal combustion residuals if their costs are to some degree avoidable by making different resource choices. These costs are very real since the EPA has promulgated rules addressing those waste streams.

Instead, Vectren states that, "Since EPA clean air standards, both national ambient air quality standards and public health-based risk standards for hazardous air pollutants already take public health into account, there is no basis for trying to further account for health impacts from the preferred portfolio."(p.93) This amounts to an assertion by Vectren that EPA rules are immediate, comprehensive, inviolable, and well enforced and that public health impacts arise only from air pollutants. We strongly disagree with the concept that any health or environmental impact for which EPA regulation exists need not be considered in the choice of a preferred portfolio.

CO_2 emission reductions

Vectren awards the same "caution" or yellow score to all portfolios with emission CO_2 reductions from 2012 levels ranging from 67 percent to 35 percent. We think that a more reasonable designation of scores would be green (best) to reductions above 75 percent, yellow to reductions between 50 and 75 percent, and red to reductions below 50 percent.

NO_x/SO_2 emission reductions

Vectren appears to average each portfolio's NO_x and SO_2 reductions to arrive at a single score. It then assigns a green score to all but the existing portfolio, which receives a red score. We think that a more reasonable designation of scores would be green (best) to reductions above

[15] See November 29th stakeholder meeting presentation at slide 65.

90 percent, yellow to reductions between 50 and 90 percent, and red to reductions below 50 percent.

Environmental metric revisions

We adjusted Vectren's Environmental metric in our revised scorecard shown in Figure 19 using the alternative scoring criteria presented above. As a result of our revisions, the portfolios with the highest air emissions receive the worst "environmental metric" scores.

XIV-B-6. Local Economic Impact

Vectren's Local Economic Impact metric is based on the results of a 2016 study by Alhenawi and Bayar. The actual application of Alhenawi and Bayar's findings to the Local Economic Impact metric was not made available to stakeholders. In its response to informal discovery request CAC 2.2, Vectren states that, "Vectren did not do an analysis of jobs and tax base impacts for wind generation and demand side measures." Both wind additions and demand-side measure can have substantial positive job impacts. As one example, a 2015 study of demand-side management programs in Indiana found:

> *The estimate covers the portfolio as implemented by GoodCents over the three-year program cycle, consisting of program years 2012–2014. …The results of this analysis indicates that Energizing Indiana initiatives produced approximately 18,679 jobs as a result of implementing the three-year program cycle. This estimate removes 438 jobs that are associated with the direct hires as reported by GoodCents to avoid double counting. (p.161)*[16]

We disagree with Vectren's partial and biased methodology of selectively valuing jobs and other economic impacts from some resources but not others. Nonetheless, we have made no adjustments to this measure in our replication of Vectren's scorecard.

XIV-C. Recommendations for quantifying risks and uncertainties

For complete quantification of risks and uncertainties, we recommend against the use of black box, qualitative scorecards for IRP portfolio section and instead recommend clearly presented quantitative results (and not the subjective rankings) for various key findings presented side-by-side for all portfolios and scenario combinations. This grid of results could be color coded to indicate obvious gradations in value without disguising the underlying information. Utilities should reference this grid in their presentation of a clear, detailed justification for their choice of a preferred portfolio from among the candidates. This, too, is a qualitative and subjective approach, but it is far more transparent to stakeholders and requires utilities to carefully justify their subjective choices.

---

[16] IURC Cause No. 42963-S1, Demand Side Management Coordination Committee's Response to June 4, 2015 Docket Entry, June 9, 2015.

XV. Is the performance of candidate resource portfolios analyzed across a wide range of potential futures?

No. The Vectren 2016 IRP introduces a wide range of candidate resource portfolios but its method for testing its portfolios against this range is not sufficient as discussed in Section XIV-A.

XVI. Are candidate resource portfolios ranked by present value of revenue requirement and by risk metric?

No. Vectren's 2016 IRP candidate resource portfolios are only partially ranked by the PVRR values that the IURC requires, and the utility's approach to ranking by risk metric uses a methodology that is deeply flawed and almost entirely opaque to stakeholders.

XVI-A. Are candidate resource portfolios ranked by their present value of revenue requirement in total dollars and dollars per kilowatt-hour delivered with discount rate specified?

No. Vectren's candidate resource portfolios are ranked only by their present value of revenue requirement in total dollars and not by dollars per kilowatt-hour.

XVI-B. Are candidate resource portfolios ranked by risk metric?

Vectren includes both a Risk and a Cost-Risk Trade-Off metric in its scorecard assessment. Our concerns with Vectren's scorecard method are discussed in detail in Section XIV.

XVI-C. Recommendations for appropriate ranking PVRR and risk metric

For a complete and appropriate ranking by PVRR and risk metric, we recommend a transparent IRP process in which all modeling files and descriptions, as well as all background analyses, are made available to stakeholders. We recommend against the use of black box, qualitative scorecards for IRP preferred portfolio selection as used in Vectren's 2016 IRP.

XVII. Does an assessment of robustness factor into the selection of the preferred portfolio?

No. Vectren mentions the robustness of future economic conditions, DSM resource selections, load growth, the MISO's regional Transmission Expansion Plan for development of transmission infrastructure, and its own approach to risk modeling. Vectren's 2016 IRP does not, however, factor an assessment of robustness into the selection of its preferred portfolio.

We recommend that IRPs include an explicit, detailed account of how robustness was factored into the selection of the preferred resource portfolio from among the candidate portfolios.

XVIII. Does the preferred resource portfolio incorporate a workable strategy for reacting to unexpected changes in circumstances quickly and appropriately?

Yes. Vectren includes an assessment of flexibility among its metrics used to determine the preferred portfolio. The component measures of reliance on the technology with the greatest share of generation and (although perhaps duplicative) number of technologies are at least a partial indicator of the preferred resource portfolios ability to react to unexpected changes in circumstances.

XIX. Did the utility prepare an analysis of historical and forecasted levels of peak demand and energy usage?

No. Vectren's analysis of historical and forecasted levels of peak demand and energy usage is inaccurate. Vectren hired Itron to prepare a peak and energy load forecast on its behalf, but provided key pieces of the energy forecast itself. In addition, some of the data Itron relied upon for its forecast appears to be unrealistic and biases the commercial and industrial growth rates.

XIX-A. Flaws and/or concerns with the load and energy forecasting methodologies

Economic data on household income, number of new households, nonmanufacturing output, nonmanufacturing employment, and population are among the key economic drivers of Vectren's load forecast (Attachment 4.1, p. 30). In addition, the residential and commercial sales models are specified by heating, cooling and "other" requirements.

The source for the economic data is cited as Moody's Economy.com December 2016 economic forecast for the Evansville Metropolitan Statistical Area (MSA) (Attachment 4.1, p. 30). We cannot see how this is possible, however, since Itron's report, Attachment 4.1, is dated August 4, 2016.

Setting aside that issue and assuming that the economic forecast described in Itron's report is indeed the data with which the sales forecast was developed, there are still concerns regarding the Moody's dataset. Concerns have been raised in other jurisdictions regarding Moody's practice of forecasting strong near term growth in key variables, indeed growth that is much stronger than recent historic performance. ERCOT, Texas's wholesale market operator, found that Moody's overestimation of a key driver in its forecast, non-farm employment, led to overly optimistic load growth.[17] It seems likely the same problem is occurring here.

Itron describes the Moody's dataset (Attachment 4.1, pp. 30-31) as follows:

> *The primary economic drivers in the residential model are household income and the number of new households. Household formation is stable and increasing consistently though [sic] the forecast period with a CAGR of 0.4%, this is slightly stronger than population growth of 0.2%. Household income growth is forecasted to be stronger in the first 3 years of the forecast period, with a CAGR of over 2.5%, after which point growth declines to a long-term rate of 1.6%.*
>
> *Commercial sales are driven by nonmanufacturing output, nonmanufacturing employment, and population. Moody's is forecasting strong near-term growth in non-manufacturing output, with a CAGR of 3.6% for the first three years of the forecast period, after which point growth declines to a long-term rate of 2.0%. Non-*

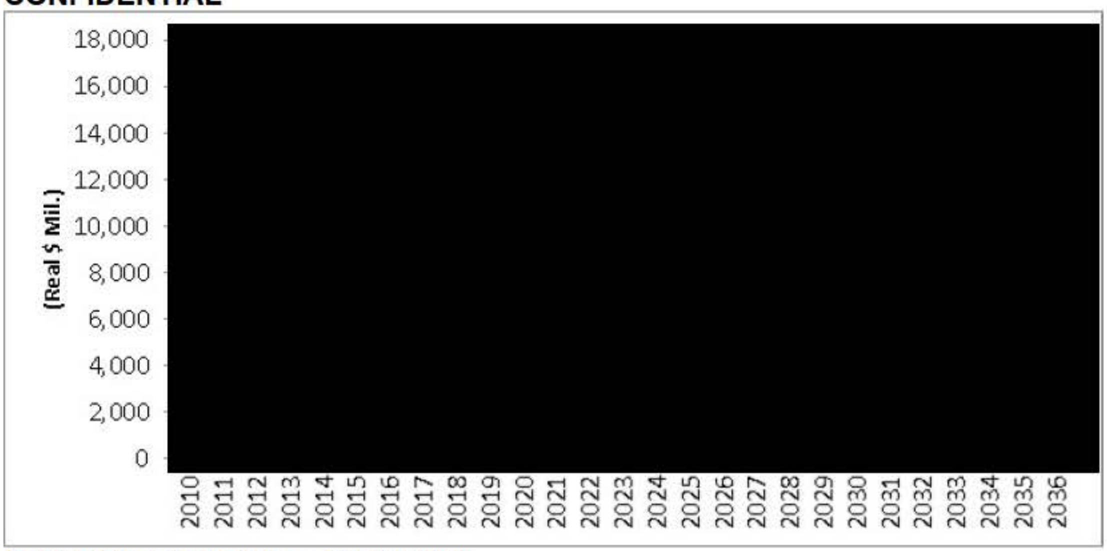
---

[17] 2013 ERCOT Planning Long-Term Hourly Peak Demand and Energy Forecast available at http://www.ercot.com/gridinfo/load/2013 Long-Term Hourly Peak Demand and Energy Forecast.pdf.

> *manufacturing employment fallows [sic] a similar path with strong near-term growth of 2.6% and long-term growth of 0.8%. Population is forecasted to increase at 0.2% annually through the forecast period.*
>
> *Industrial sales are driven by manufacturing output, and manufacturing employment. Manufacturing output is not projected to grow as rapidly as non-manufacturing outpuy [sic], with a long-term CAGR of 1.8%. Manufacturing employment is the only economic indicator which is declining, with a long-term CAGR of -0.4%.*

In response to CAC 1.1a, Vectren provided both the annual projected values for these drivers as well as historic values going back to 2010. It appears to us that the projections begin with the year 2015. Some drivers, like population, with a CAGR of 0.2 percent, and perhaps even household income, are consistent with the 5-year historic data provided to us. However, others, specifically non-manufacturing output and manufacturing output, clearly have predicted growth rates that are radically different than recent historic values as shown in Figure 23 and Figure 24.

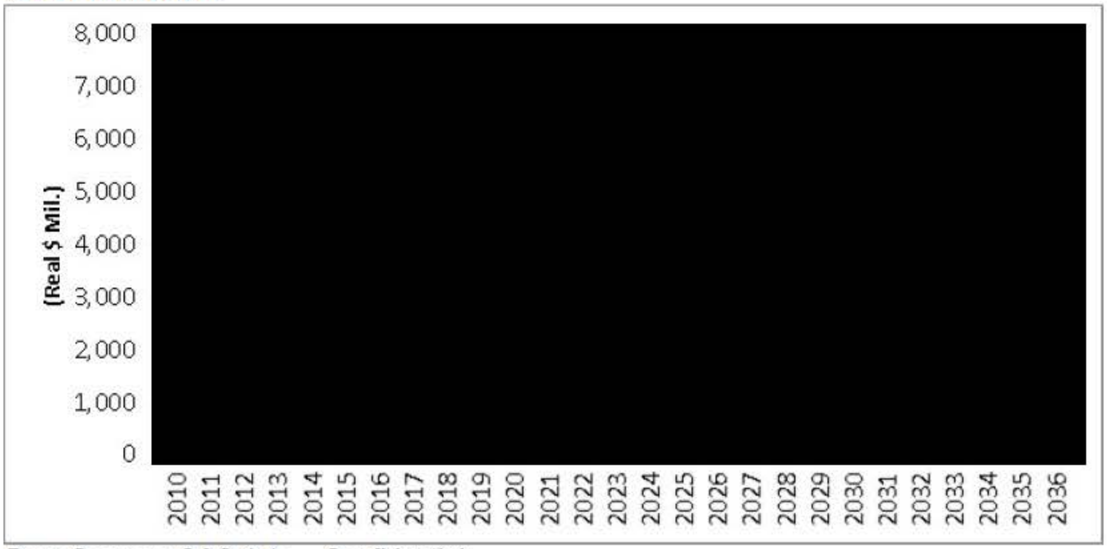
Figure 23. Non-manufacturing output historic and projected values by Moody's—CONFIDENTIAL



Data Source: *CAC 1.1a – Confidential*

While non-manufacturing output was [redacted] between 2010 and 2014, Moody's is projecting [redacted] in 2015 and beyond (the solid black line is the historic values and the dotted black line is the projected values).

Figure 24. Manufacturing output historic and projected values by Moody's—CONFIDENTIAL



Data Source: *CAC 1.1a – Confidential*

Similarly, historic manufacturing output has been [redacted], while Moody's projects a [redacted] in this driver, a CAGR of 1.8 percent.

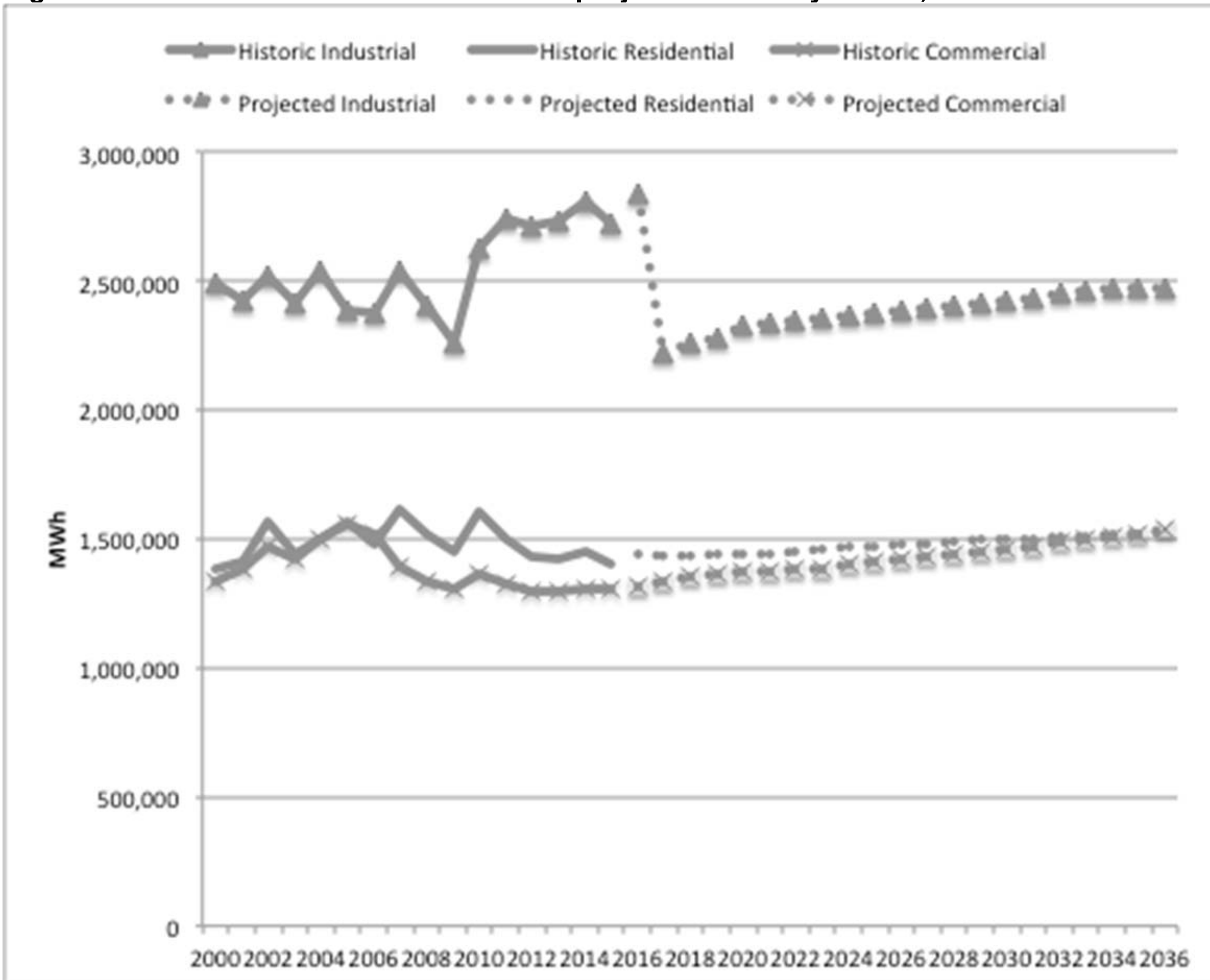
The industrial forecast is not only biased by this aggressive rate of projected manufacturing output, but also by the fact that the first five years of the forecast are estimated entirely by Vectren, not Itron (Attachment 4.1, p.12), using a process that is completely distinct from Itron's statistically adjusted end-use modeling. Itron describes the process as follows:

> *The first five years of the forecast is based on [Vectren]'s internal forecast. Industrial sales are forecasted using a historical baseline of 12 months ended December 2015. Vectren reviews baseline volumes at the customer level and is adjusted based on known customer activity such as closures and expansions. New customers are specifically identified and forecasted based on expected load. An overall growth rate of approximately 1% is then applied to the baseline period to capture growth that has not been specifically identified by customer. The forecast after that is based on a model-based forecasted growth rate; the forecasted growth rate is applied to the fifth year industrial sales forecast. (Attachment 4.1, p.12)*

Not only are sales in the first five years based on just one year's worth of historical sales data, but an additional one percent of growth is added under the assumption that there will be significant growth in industrial sales no matter what. With industrial sales making up 50 percent of total sales, this assumption is significant.

Given these very optimistic assumptions from Moody's and by Vectren, it should not be surprising that the commercial and industrial sales projections are driving the overall projected growth in sales (Figure 25).

Figure 25. SNL historic sales and Vectren projected sales by sector, 2000 - 2036



Data source: *SNL Financial and Vectren 2016 IRP Attachment 4.1*

While residential use grows very slowly, the majority of growth in sales is in the industrial and commercial sectors after accounting for the expected loss of an industrial customer in 2017.

The historic sales do include energy efficiency impacts to the extent those programs existed at the time, but it is our understanding that Vectren achieved very few energy savings prior to implementation of the IURC's Phase II Order in 2009, so utility-sponsored energy efficiency cannot explain the mostly stagnant load growth prior to that time.

All of this leads to the conclusion that Vectren is likely overestimating projected growth in energy sales.

XIX-B. Recommendations on preparing an analysis of historical and forecasted levels of peak demand and energy usage

To prepare a complete and accurate analysis of historical and forecasted levels of peak demand and energy usage, we recommend the use of an economic dataset that does not include unrealistic near-term rates of growth in key drivers. We also recommend that if a statistically adjusted end-use model does not explain industrial load growth well, then industrial load growth projections should be linked to known factors that can be documented for stakeholder review rather than black box and entirely subjective assumptions about growth in energy consumption.

ATTACHMENT A

No Evidence for Energy Efficiency Market Saturation Leading to Higher Costs

Public Version

Elizabeth A. Stanton, PhD, Applied Economics Clinic
Anna Sommer, Sommer Energy, LLC
April 17, 2017

Public Version

No Evidence for Energy Efficiency Market Saturation Leading to Higher Costs

Elizabeth A. Stanton, PhD, Applied Economics Clinic

Anna Sommer, Sommer Energy, LLC

April 17, 2017

Abstract

A 2015 working paper by Richard Stevie asserts that no other study has illuminated the relationship between energy efficiency program costs and market penetration, and purports to itself demonstrate that market saturation causes higher efficiency program costs. We find that Stevie's study provides no usable evidence of a market saturation-program cost relationship and *ipso facto* no such relationship has as yet been demonstrated. The results of Stevie's working paper have impacted resource decisions proposed by electric utilities in at least three states (Indiana, North Carolina, and South Carolina). Stevie's analysis erroneously suggests that there exists evidence of efficiency market saturation significantly driving up programs costs. We find, in contrast, that the evidence presented is insufficient and inaccurate. We are aware of no reliable evidence for higher energy efficiency market penetration leading to higher efficiency costs. Inclusion of a baseless inflation of efficiency program costs in the name of market saturation results in higher energy efficiency costs than would otherwise be expected. Implementing Stevie's suggestions would lead utilities to the selection of less energy efficiency than is optimal.

1. Background

Projected energy efficiency cost and savings levels are an important input to electric utilities' modeling of future resource additions and retirements. These projections are used in Integrated Resource Plans and other, similar filings submitted to state utility commissions for their approval. Some contend that the future cost of saved energy is influenced both by historical costs and by patterns in the relationship between the cost of saved energy and other factors, including: The amount of new efficiency savings in a given year, and the cumulative amount of savings that has built up over time (after adjusting for efficiency measures that have "sunset" at the end of their measure life).

In many jurisdictions around the United States, projected energy efficiency costs are used to determine utilities' efficient or otherwise optimal investment in energy efficiency and other resources in the next few years. An expectation of high costs, rising costs, or both can reduce investments in energy efficiency. Studies that overestimate the future cost of efficiency programs—and thereby result in lower levels of planned efficiency—deprive electric customers of low (and often least) cost efficiency measures while simultaneously pushing states towards an electric resource mix with higher costs and higher emissions of greenhouse gases and other pollutants.

Richard Stevie's 2015 analysis of these relationships has been used by utilities in Indiana, North Carolina, and South Carolina to justify a future cost of saved energy that rises with higher energy efficiency market penetration (that is, the higher the cumulative efficiency savings, the higher the efficiency cost).[1] The rationale for this purported relationship—as discussed in Stevie's paper—is market saturation and diminishing returns:

> *[A]s market penetration increases, energy efficiency implementation costs are expected to rise at higher levels of penetration of the market. The degree of impacts on program costs, from these factors, is a question to be empirically analyzed. (p.9)*

Stevie provides a review of some of the existing literature exploring the relationship between efficiency costs and savings levels and finds it wanting:

> *In summary, this review of past studies on the costs of energy efficiency reveals that a significant void exists in our understanding of how the implementation costs of energy efficiency are affected by the level of market penetration. (p.7)*

Having noted this gap, Stevie performs regression analysis using data voluntarily reported by utilities to the U.S. Energy Information Administration (EIA) and concludes somewhat heroically that:

> *From the review of other studies, it is apparent that little to no evidence exists on the relationship between program costs, program size, and market penetration. But now, the research conducted in this study provides an initial insight into this relationship…It should be obvious that further research in this area is warranted. As mentioned, this study is the first to investigate how costs can rise with increases in program size and market penetration. The findings point to the existence of cost efficiencies with respect to program size, but rising costs as market penetration increases. (p.21)*

Stevie's regression analysis—and the conclusions drawn from it that have been used to inflate the cost of saved energy—are the subject of this review. We found that Stevie's analysis:

- Is based on highly questionable data sources (Section 2),
- Relies on regression analysis that is sensitive to the inclusion or exclusion of problematic data entries, and seems to depend on unusual choices in variable and model specification (Section 3), and
- Is applied incorrectly and incompletely in the utility filing for which we were able to review confidential workpapers (Section 4).

[1] Stevie, Richard (2015) "Energy Efficiency Program Costs, Program Size, and Market Penetration." Draft Working Paper. Integral Analytics. http://www.integralanalytics.com/files/documents/Projecting%20Energy%20Efficiency%20Program%20Costs%202015.pdf.

The result of these errors and omissions is higher energy efficiency costs than would otherwise be expected in utility planning and, consequently, less efficiency chosen in optimal resource planning.

2. Data Sources

In regression analysis, variations in the value of one data point or "variable" (here, program costs) are explained through patterns in the values of other related variables. Stevie bases his analysis on the presumption that energy efficiency program costs can be explained using the values of several other variables, which he aggregates to the state level.

The dependent or explained variable in Stevie's regressions is:

- Program Cost: "the level of direct program spending (dollars) on energy efficiency programs only. Indirect costs are not included."(p.10); "For the purposes of this study, only the direct program costs including incentive payments to participants will be considered in the analysis."(p.15); Stevie's data for direct spending on energy efficiency program are taken from EIA Form 861 (p.13).

Stevie's explanatory variables are:

- Program Size: "the current year achievement of energy impacts as a percent of current year retail kWh sales"(Stevie (2015), p.11); Stevie's data for incremental energy efficiency (or current year annualized impacts) are taken from EIA Form 861 (p.13).
- Market Penetration: "the cumulative achievement of energy efficiency sales as a percent of retail kWh sales"(p.11); Stevie's data for cumulative energy efficiency (called "annual" in the EIA data set) are taken from EIA Form 861 (p.13).
- Electric Rate: "the cost of power ($/kWh) to customers in an area"(p.11); Stevie's data source for total revenue and total retail sales appear to be taken from EIA From 861.
- "Unemployment Rate"(p.12): Stevie gives no data source for his unemployment rate measure, instead noting that, "Data on national inflation and unemployment may be found from numerous sources"(p.14), and mentions but does not directly cite a secondary data source for these measures, "See the website Freelunch.com sponsored by Moody's Analytics for general macroeconomic data including inflation and unemployment."(p.14, fn.21)

While Stevie relies exclusively on EIA Form 861 for his data on energy efficiency spending, Stevie himself notes that EIA Form 861 data has limitations that impede its ability to correctly characterize the relationship between energy efficiency savings and the cost of saved energy. While Stevie's list of concerns is not comprehensive, it provides an overview of this data set's flaws, including: (1) a lack of data on the life of efficiency measures; (2) various known reporting errors (incorrect or mislabeled responses, inconsistent treatment of free riders, inconsistent classification of costs); and (3) changes in reporting requirements and instructions over time (p.14).

With respect to using these data to understand the effect of efficiency market penetration on costs, the most important issue is EIA Form 861's lack of information on the life of efficiency measures. Without this data point there is no way to measure the cost of saved energy, because this year's efficiency savings are not the only savings that will arise from this year's efficiency costs. The best measure for any energy resource cost is a "levelized" cost, which divides a resource's total fixed and variable costs by the total amount of energy that it will provide (or save) over its lifetime. EIA Form 861's cost and savings data are simply not sufficient to provide a measure of the levelized cost of saved energy.

Stevie acknowledges these data limitations. His stated solution is to limit his data set to the most recent three years of data available at the time of his study—a remedy that in no way addresses the problem of the mismatch between the cost and savings data available in EIA Form 861:

> *For this reason, the analysis conducted here looks at total annual spending relative to the first year impacts. Trying to compute a levelized cost requires knowledge that is just not available. While one might intuit an expected measure life for a portfolio, it is only a guess and could lead to misleading conclusions. In reviewing the EIA data, it is apparent that the reporting is not consistent. For example, kWh could be reported instead of MWh or dollars instead of thousands of dollars as specified in the instructions to the form. For this reason, the study will focus on the last three years of data for the years 2010 through 2012. Use of the most recent data should provide the best quality of data from the data base. (p.14)*

In addition, while EIA's Form 861 data are voluntarily reported by utilities—and are, therefore, available disaggregated by utility—Stevie makes the choice to aggregate these data:

> *Finally, to facilitate the research, costs and impact data is [sic] aggregated to a state level. This provides a useful data set for the 50 states plus the District of Columbia. (p.15)*

Stevie's choices to limit his data to three years and aggregate the data to the state level results in a very small dataset for his regression. While Stevie does not follow the convention of reporting the size of his data sets, it would appear that his "Model 1" has 153 data points and his "Model 2"—which he further limits to just data for the year 2012—has 49 data points.[2] If this analysis were performed at the utility level, using these same data, its data points would number in the thousands. Such small data sets limit the reliability of regression findings and call into question the confidence that can be placed in patterns observed in Stevie's study.

Our replication of Stevie's analysis uses his data and methodology to the greatest extent possible given his omission of some key details regarding variable specification and data sources:

- Program Cost: (dollars) EIA Form 861[3] 2010-2012 aggregated to 51 states:

---

[2] Stevie notes in Fn.23 that, "Data for Delaware and Louisiana were deleted since the EIA data indicates [sic] essentially zero cumulative impacts for the year 2012."(p.16)

[3] EIA Form 861 data consists of multiple spreadsheets. For the years 2010 and 2011, "program cost", "program size", and "market penetration" data are taken from Form 3 and from the "dsm_2012" spreadsheet for 2012. While "electric rate" data are calculated from Form 2 for the years 2010 and 2011 and from the "retail_sales_2012" spreadsheet for 2012.

DIRECTCOSTEEF + INCENTIVEEF

- Program Size: (%) EIA Form 861 2010-2012 aggregated to 51 states divided by EIA Form 861 2010-2012 aggregated to 51 states:

  ENERGYEFFINCTOT / Total Sales

- Market Penetration: (%) EIA Form 861 2010-2012 aggregated to 51 states divided by EIA Form 861 2010-2012 aggregated to 51 states:

  ENERGYEFFANNTOT / Total Sales

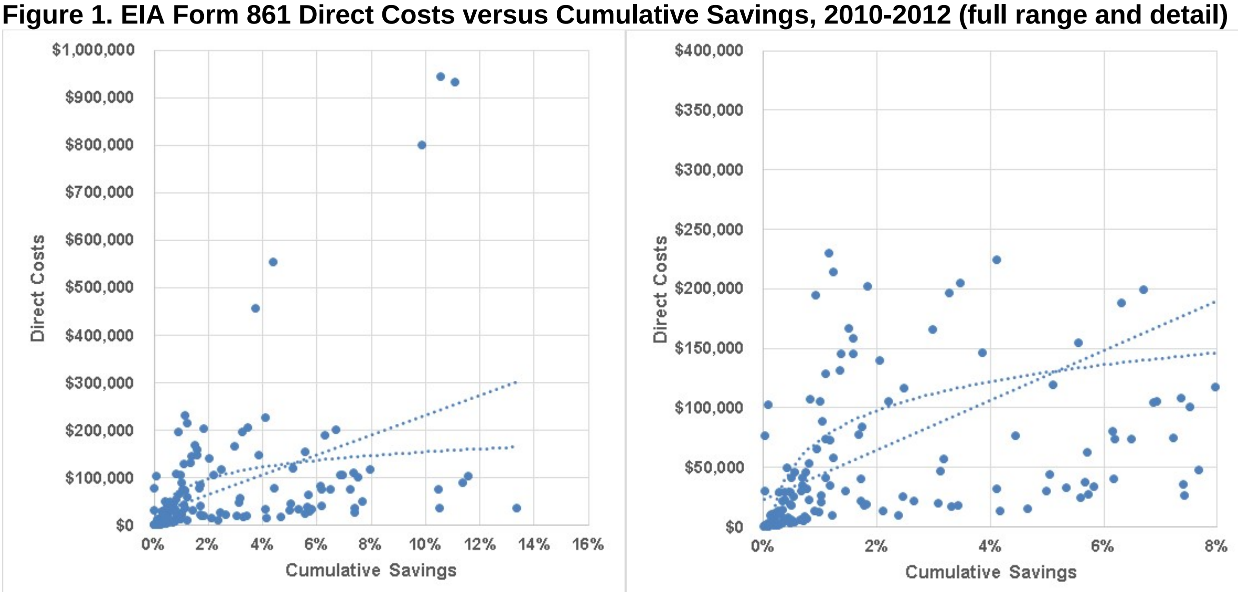
- Electric Rate: ($/kWh) EIA Form 861 aggregated to 51 states divided by EIA Form 861 2010-2012 aggregated to 51 states:

  Total Revenue / Total Sales

- Unemployment Rate: (%) U.S. Bureau of Labor Statistics (LNS14000000) Unemployment Rate, U.S. annual average

Using the data gathered to replicate Stevie's analysis, Figure 1 depicts the relationship between energy efficiency program costs and market penetration that Stevie recommends be used in forecasting future utility efficiency costs, claiming that: "It provides guidance on the expectation that as the market penetration of energy efficiency increases, the unit cost increases."(p.21) The left-side panel in Figure 1 includes the full range of data, while the right-side panel zooms in for a close up view of the most densely populated portion of the data ranges.

Figure 1. EIA Form 861 Direct Costs versus Cumulative Savings, 2010-2012 (full range and detail)



***Note:** The lines shown are trendlines, describing the relationship between the two variables. The straight line is the linear relationship; the curved line is the log-log relationship.*

Figure 1 also provides a snapshot of several critical weaknesses in both Stevie's analysis and the data on which it was based:

- **EIA Form 861 data are deeply flawed.** In Figure 1, we have applied Stevie's removal (in his 2012-only dataset) of states with zero savings to all years. But other data remain that upon closer examination appear to be based on exactly the type of data entry errors highlighted by Stevie (misapplication of units, inconsistency across years in reporting practices, etc.).

- **The positive correlation between direct costs and market penetration (cumulative savings) is weak and appears to be driven by a few outliers.** Figure 1 above shows a dense cloud of data points with a few outliers, and not an obvious trend in which higher costs are associated with greater levels of market saturation. (Note that the data points do not congregate around the trendlines but rather are found well above and below these lines.) Later in this paper, we support this finding by removing the most obviously flawed states and years from the data set.

- **Larger programs have larger costs, and smaller programs have smaller costs.** Stevie's analysis offers little insight into the relationship between market penetration and the cost of saved energy. Stevie's puzzling choice of program costs in dollars as the dependent variable and percentage savings as the explanatory variable results in a regression analysis that points only to the obvious relationship between program size and program costs while failing to ask pertinent questions about how any one utility's repeated investments in efficiency over many years may impact its program costs.

- **A few years of state-level data cannot reveal an actionable expectation regarding efficiency program costs.** Stevie purports to identify a pattern among states over three years that can be applied to long-term projections of efficiency costs for individual utilities. Not only does Stevie's methodology suffer from well-known reliability issues arising from very small datasets, it also fails to track individual utilities—or even individual states—over time, because his data are aggregated to the state level, and three years of data do not provide a pattern that can be applied to decades of projections. One year of data (as used in Stevie's Model 2) has no information whatsoever about the pattern of changes over time.

3. Regression Analysis

We attempted to replicate Stevie's regression analysis results using the data described in the previous section and the two regression equations reported in his working paper:

Model 1: $ProgCost\$_{it} = Intercept + \beta1 * ProgSize_{it} + \beta2 * MarketPen_{it} + \beta3 * ElecRate_{it} + \beta4 * Unemploy_{it} + \varepsilon_{it}$

Model 2: $ProgCost\$_{i} = Intercept + \beta1 * ProgSize_{i} + \beta2 * MarketPen_{i} + \beta3 * ElecRate_{i} + \varepsilon_{i}$

Our attempt at replication, however, was not successful: We were not able to calculate the same results presented by Stevie using the same EIA 816 data.

After careful review, we believe that three factors make it impossible to replicate Stevie's results: unexplained changes by Stevie to EIA Form 861 data; data quality issues in EIA 861 data not properly addressed by Stevie; and Stevie's specification of the dependent variable.

3-a. Unexplained changes by Stevie to EIA Form 861 data

Our review of Stevie's regression analysis workpapers revealed widespread, large-scale inconsistencies between EIA Form 861 source data and the data on which Stevie based his regressions. These inconsistencies take two forms:

1. Stevie's working paper mentions only one adjustment made to EIA data (the removal of two states in the 2012-only regression). We can offer no possible explanation for over [redacted] percent of Stevie's data entries being different from those calculated directed from EIA data as state weighted averages (see Table 1). Still more puzzling is the finding that many of Stevie's data are exactly identical to EIA data—meaning that whatever factor is causing this inconsistency is only present in some of Stevie's data extraction. It should also be noted that these data errors were not small in scale: the average error for program costs was [redacted] percent; current year savings, [redacted] percent; cumulative savings, [redacted] percent; and total revenues, [redacted] percent.

Table 1. Share of erroneous data entries – CONFIDENTIAL

	2010	2011	2012
Program costs ($)	[redacted]		
Current year savings (kWh)			
Cumulative savigns (kWh)			
Total revenue ($)			
Total revenues (kWh)			

2. Stevie has, without explanation, replaced zero current-year and cumulative savings, and zero program costs with the value 0.00001. This change makes it possible to use these data in regression analysis, and can be a necessary tactic in logarithmic regressions (the logarithm of zero is undefined). In this instance, however, data entries with zero savings do not offer information to an analysis of energy efficiency programs and should be removed, as Stevie himself does with such entries in his 2012-only analysis.

Despite these serious issues, Stevie's workpapers show that out of 153 possible data entries in this analysis, he used [redacted] in his Model 1 regression and [redacted] in his 2012-only Model 2 regression.

3-b. Data quality issues in EIA 861 data not properly addressed by Stevie

Stevie's working paper reports only two data points removed from Model 2 ("since the EIA data indicates [sic] essentially zero cumulative impacts for the year 2012"(p.16)). From this we can infer that all 153 data entries are included in Stevie's 2010-2012 regression and 49 in his 2012-only regression.

Our review of the 2010-2012 data showed that 11 entries include zero values for current-year savings, incremental savings, or both. State-years without energy efficiency savings cannot offer useful information to the analysis and should be removed. In addition, our review found another 29 data entries with obvious data quality issues: some with $1 entries in program costs or other obvious errors, and other states for all years where there were unambiguous inconsistencies between reported incremental and cumulative savings (for example, 2011-2012 incremental savings that, when added to 2010 cumulative savings, resulted in a value far greater than the reported 2012 cumulative savings[4]).

These apparently erroneous data comprised the majority of data outliers shown in Figure 1 (above); the remaining high program cost outliers are three-years of program data for California. It is difficult to discern an obvious pattern in Figure 1, or to suggest from a visual inspection that higher cumulative savings are associated with higher costs. We performed a simple regression of these 2012 data that bears out this observation: The relationship between program costs in dollars and market penetration is not statistically significant, that is, any pattern observed is no more meaningful than random noise in the data.

3-c. Stevie's specification of the dependent variable

Program costs in dollars are impacted by the scale of savings, not because of market saturation but—more fundamentally—as a result of the size of the state or utility itself. Program costs on a per kWh basis, however, are far more likely to show meaningful impacts of current year program size and cumulative savings. Using the improved (but very small) dataset described above, we examined the sensitivity of Stevie's results to his unusual choice of independent variables by comparing (1) the correlation of program costs in dollars to market penetration to (2) the correlation of program costs per kWh to market penetration (see Table 2, which presents the degree of correlation between variables in percentages).

Table 2. Correlation matrix using EIA Form 861 data with obvious errors removed

	ProgCost$	ProgCost$/kWh	ProgramSize	MarketPen	ElectricRate	UnemployRate
ProgCost$	100%					
ProgCost$/kWh	2%	100%				
ProgramSize	40%	-14%	100%			
MarketPen	46%	-8%	83%	100%		
ElectricRate	7%	2%	-2%	4%	100%	
UnemployRate	-8%	13%	-18%	-16%	-2%	100%

Both program size and market penetration are less correlated with program costs in $ per kWh than they are with program costs in dollars. Changing the dependent variable to program costs in $ per kWh also changes the sign of the correlation to market penetration: greater market penetration is associated with <u>higher</u> program costs in dollars but <u>lower</u> program costs in dollars per kWh.

Any conclusions that might be drawn from that finding should, however, be considered in light of the following caveats: (1) these regression models have too small of a sample size and therefore may not be statistically significant (i.e., discernable from happenstance), and (2)

[4] We recognize that some utilities will have correctly adjusted for sunsetting measures in their cumulative savings, and for this reason we removed only gross differences between these reported and calculated values.

Stevie's choice to limit the regression to model just a few years of data makes it impossible to discern data patterns that can have any application to long-term changes in efficiency costs.

Overall, our review of Stevie's regression analysis calls into question the quality of his data, the significance of his results, and whether or not any results produced using this methodology can be said to add meaningful insight to the projection of future efficiency costs.

4. Application of Stevie's Analysis in Utility Planning

We also had the opportunity to review confidential workpapers in which the results of Stevie's regression analysis were applied to an electric utility's 20-year projection of energy efficiency program costs. The coefficients resulting from a logarithmic regression can be interpreted as elasticities, that is, a 1.0 percentage point change in the value of an explanatory variable can be said to be associated with a β percentage point change in the value of the dependent variable, where β is the coefficient value for the explanatory variable.

The coefficients for Stevie's market penetration variable are applied to program costs for a recent historical year such that each incremental 1.0 percent increase in savings has the effect of adding not the cost equivalent of 1.0 percent savings but rather the cost equivalent of 1.6 percent savings (calculated as the average of Stevie's Model 1 and Model 2 coefficients for market penetration: 0.278 and 0.897, respectively). Over the course of 20 years, this results in a more than doubling of the program costs associated with a 1 percent incremental savings level: a 128 percent increase due exclusively to the claimed impact of market saturation.[5]

In summary, this utility application of regression findings to efficiency cost projections suffers from several errors in substance and logic, any one of which would, by itself, render the study's use in resource decisions inappropriate:

- **Errors, omissions, and misspecifications of data:** Stevie's data are taken—by his own admission—from a deeply flawed dataset, use an illogical combination of dependent and independent variables, are too few in number to provide meaningful results, and do not include the correct variables (or encompass sufficient years) to provide insight into changes to state's or utility's costs over time. In addition, our review of the data used in his regressions found serious unexplained errors and inconsistencies.

- **Weak significance and a lack of robustness in regression findings:** Stevie's overall model significance and significance for his key variable, market penetration, appear to be sensitive to removal of problematic data entries and corrections to his misspecified functional form.

- **Purported impact of electric rates on program costs is excluded from the application of regression findings:** Stevie's regression analysis also finds a significant impact of electric rates on program costs, but this effect is excluded from the utility's projection of future efficiency costs. Our calculations suggested that including this effect

[5] Vectren 2016 Integrated Resource Plan, https://www.vectren.com/assets/cms/pdfs/2016%20Vectren%20IRP%20vol%201.pdf

on a forecasted growth of electric rates ranging from 0.7 percent per year[6] to 3.2 percent per year[7] results in a decrease in the incremental change in program costs of 4 to 20 percentage points in each year averaged across Stevie's two models. Put into context, just this countervailing effect would reduce Stevie's 60 percent annual increase in incremental efficiency costs due to market saturation down to 40 to 56 percent.

- **Averaging a coefficient from a full dataset with the same coefficient from a truncated version of the data set:** Stevie's explanation of the inclusion of Model 2 (which excludes all data entries from 2010 and 2011) is largely rhetorical: He—without substantiation—calls this method "traditional" and notes that it is "extremely useful" because it "provides a view into the long-run since the data contains multiple points along the continuum of experience"(p.16). This approach is neither traditional nor particularly useful, and a regression of data from various states (each unique in program size, market penetration, and electric prices) in the same year in no way provides a view into the long-run and cannot be said to contain multiple points along a continuum of experience. Indeed, the extent to which those multiple data points from various states do predict future performance would be mere coincidence. Averaging the regression result of the 2012 truncation with the full dataset does have one clearly observable result: It increases the annual addition to program costs from 28 percent to 60 percent when the results of his model are applied to a projection of incremental program costs.

5. Findings and Conclusion

Stevie asserts repeatedly in his working paper that no other study has illuminated the relationship between energy efficiency program costs and market penetration. If this is the case, then that status quo remains unchanged: Stevie's study provides no usable evidence of such a relationship and *ipso facto* no such relationship has, as yet, been demonstrated.

This area of research is by no means purely scholarly or theoretical. To our knowledge the results of Stevie's working paper have impacted the resource decisions proposed by electric utilities in no fewer than three states. Stevie's analysis suggests, erroneously, that there exists evidence of energy efficiency market saturation driving up programs costs that is sufficient to justify a more than doubling of direct costs over 20 years.

We find, in contrast, that the evidence presented in his working paper is insufficient and inaccurate. We are aware of no reliable evidence for higher energy efficiency market penetration leading to higher efficiency costs. Inclusion of a baseless inflation of efficiency program costs in the name of market saturation results in higher energy efficiency costs than would otherwise be expected in utility planning and, consequently less efficiency chosen in optimal resource planning.

[6] Vectren 2016 IRP Attachment 4.1
[7] 2016 Residential Bill Survey. Available at: http://www.in.gov/iurc/files/2016_Residential_Bill_Survey_Presentation.pdf

EXHIBIT 1-Confidential

Vectren Attachment to CAC 1.29-Confidential

EXHIBIT 2

4/11/17 Email Exchange with Vectren

Jennifer Washburn <jwashburn@citact.org>

2016 Vectren IRP--follow-up on Vectren responses to CAC et al. Set 1

Quinn, Michelle D. <mquinn@vectren.com> Tue, Apr 11, 2017 at 10:58 AM
To: Jennifer Washburn <jwashburn@citact.org>
Cc: Anna Sommer <anna@sommerenergy.com>, "Borum, Bradley" <bborum@urc.in.gov>, "Comeau, Jeremy" <JComeau@urc.in.gov>, "Krohn, Karol" <kkrohn@oucc.in.gov>, Liz Stanton <liz@lizstantonconsulting.com>, Matthew Gerhart <megerhart@gmail.com>, "Pauley, Morgan" <MPauley@urc.in.gov>, "Rice, Matt" <mrice@vectren.com>, "Stephenson, Jason" <jstephenson@vectren.com>, Thomas Cmar <tcmar@earthjustice.org>, infomgt <infomgt@oucc.in.gov>, "jreed@oucc.in.gov" <jreed@oucc.in.gov>

Jennifer,

The 10.09% represents the pre-tax weighted average cost of capital, using the approved after-tax cost of capital of 7.29% from Cause No. 43839, grossed up for income taxes. The income tax percentages utilized represent the statutory rates, with the Indiana State Tax rate set at 4.99%, which is the rate we are gradually declining towards, effective July 1, 2021. If we used the statutory rates from Cause No. 43839, the only change would be in the Indiana State Income Tax rate, which was 8.50%, making the pre-tax cost of capital 10.37%. By using the future "floor" current in statute, it represented a proper indication of future costs/impacts in line with when the investments would be made (post-2021). The 10.09% is the currently approved rate of return, with projected tax rates used to derive the projected pre-tax WACC at current rates. The source file used shows both the Rate Case Pre-Tax and the 2021 Projected Pre-Tax WACC (see attached). Please let me know if you have any additional questions or concerns regarding this issue. Thanks!

Michelle

From: Jennifer Washburn [mailto:jwashburn@citact.org]
Sent: Tuesday, April 11, 2017 9:37 AM
To: Quinn, Michelle D.
Cc: Anna Sommer; Borum, Bradley; Comeau, Jeremy; Krohn, Karol; Liz Stanton; Matthew Gerhart; Pauley, Morgan; Rice, Matt; Stephenson, Jason; Thomas Cmar; infomgt; jreed@oucc.in.gov
Subject: Re: 2016 Vectren IRP--follow-up on Vectren responses to CAC et al. Set 1

This EXTERNAL email may contain an attachment. Do not open attachments or click on links in emails unless you are certain the source AND content of the email are credible.

Good morning,

Could we please have an update?

Thanks,

Jennifer

On Tue, Apr 4, 2017 at 12:30 PM Jennifer Washburn <jwashburn@citact.org> wrote:

Good afternoon,

We were just checking to see if you by chance had a status update re where exactly the data is in the Aurora files, i.e. we don't see any NPV, standard deviation, emissions, etc., in the files that have been provided to us. Thanks!

Sincerely,

Jennifer

On Tue, Mar 28, 2017 at 11:57 AM, Jennifer Washburn <jwashburn@citact.org> wrote:

Thanks, Michelle. We appreciate it. However, we still don't see our question addressed re: exactly where the data is in the Aurora files, i.e., we don't see any NPV, standard deviation, emissions, etc., in the files that have been provided to us. Could you please tell us where exactly we can find this information? Thanks in advance.

Sincerely,

Jennifer

On Mon, Mar 27, 2017 at 5:23 PM Quinn, Michelle D. <mquinn@vectren.com> wrote:

> Jennifer,
>
> Please be advised that Figure 2.6 was derived from the risk analysis presented at Vectren's final stakeholder meeting, which was held on November 29, 2016. You may access this presentation from Attachment 3.1 Stakeholder Materials or by clicking the following link https://www.vectren.com/assets/cms/pdfs/irp/Third%20IRP%20Stakeholder%20Meeting%20Presentation.pdf . Column 1, labeled Portfolio NPV, can be found on slides 46-47. Criteria for red, green, or yellow lights are generally provided for each metric. For example, as noted on these slides, NPVs within 5% of the lowest cost portfolio were given a green light. Portfolios between 5 and 10% were given a yellow light, and portfolios over 10% were given a red light. Information used to create column 2, labeled Risk, can be found on slides 50-53. When several metrics were included in a risk category we included a summary slide. For example, slide 53 shows the summary slide used to build up the risk column in Figure 2.6. Each category follows this same approach. Cost Risk Trade-off can be found on slides 56-57. Balance/Flexibility can be found on slides 59-60. Environmental can be found on slides 63-65. Local Economic Impact can be found on 68. Overall corresponds with slide 70.
>
> PACE used Aurora to generate most risk analysis metrics, including NPVs. Note that the Economic Impact was not generated by PACE in Aurora.
>
> The breakpoints for the cost risk trade off were not provided because the answer lies on the efficient frontier, which is represented by the dotted line on slide 56. Portfolios closest to the line have a better cost risk trade off. Portfolio D was closest to the efficient frontier and was therefore given a green light. A cluster of portfolios have a slightly worse cost/risk tradeoff and were labeled with a green light. Finally, those furthest from the line were given a red light. For example, portfolios I and J are low risk, but the NPVs of these portfolios is very high, far from the efficient frontier.

If you have additional questions, please let me know. Thanks!

Michelle

From: Jennifer Washburn [mailto:jwashburn@citact.org]
Sent: Friday, March 24, 2017 11:35 AM
To: Quinn, Michelle D.
Cc: Krohn, Karol; infomgt; jreed@oucc.in.gov; Borum, Bradley; Comeau, Jeremy; Pauley, Morgan; Anna Sommer; Liz Stanton; Stephenson, Jason; Rice, Matt; Thomas Cmar
Subject: Re: 2016 Vectren IRP--follow-up on Vectren responses to CAC et al. Set 1

Good afternoon,

Regarding CAC 1.20, if Figure 2.6 was not created with a spreadsheet, that's fine, but could you please at least tell us where the data is? And if you've already provided it, could you please tell us exactly where it is because we're having a difficult time finding it?

The NPV as it relates to Figure 2.6 isn't clear either. Is it from the Strategist or Aurora files? If Strategist, which runs specifically? If Aurora, how did you get an NPV, because there doesn't seem to be an NPV output from Aurora?

We have the same question for all the other metrics related to Figure 2.6 that probably came from the modeling runs: "flexibility measure", "environmental metric", etc.

Also, regarding CAC 1.20, the "break points" are not all on the Stakeholder slides from Nov. 29. The "cost/risk" tradeoff is missing. Could you please provide information about that?

As you know, we have our comments due in less than a week. If you could provide us this information as soon as possible, we would appreciate it.

Thanks,
Jennifer

On Mon, Mar 13, 2017 at 10:18 AM, Quinn, Michelle D. <mquinn@vectren.com> wrote:

Jennifer, please see Vectren's responses in blue below to the questions raised by the CAC in your March 6th email message. Thanks!

Michelle

From: Jennifer Washburn [mailto:jwashburn@citact.org]
Sent: Monday, March 06, 2017 12:43 PM
To: Quinn, Michelle D.; IRP
Cc: Krohn, Karol; infomgt; jreed@oucc.in.gov; Borum, Bradley; Comeau, Jeremy; Pauley, Morgan; Anna Sommer; Liz Stanton
Subject: 2016 Vectren IRP--follow-up on Vectren responses to CAC et al. Set 1

Hi Michelle,

We had a few issues with the objections and responses to CAC et al.'s Set 1 from Vectren in the IRP Stakeholder Process, and are hopeful you can assist us. We've put them in order of priority with the hope that you can send us updates as you receive them.

1.11

CAC et al.'s Data Request 1.11 asked "Please provide an electronic copy of the Burns & McDonnell screening analysis discussed at the bottom of page 79 with all formulas and links intact." Vectren objected stating:

Vectren objects to this Request on the grounds and to the extent that the Request seeks a document not presently in Vectren South's possession, custody or control. In addition, Vectren South objects to this Request on the separate and independent grounds that such Request seeks information which is the proprietary, competitively sensitive and trade secret information of a third party consultant who has not consented to the release of such information. The electronic screening analysis requested was developed by Burns & McDonnell over time and the release of the tool could result in economic harm to Burns & McDonnel, as the company has invested a significant amount of time and talent developing the tool for its internal business use.

Could you please provide some clarification as to what in this analysis is proprietary? Could you please redact the information that is being claimed as proprietary and provide that redacted document? Could we please sign a nondisclosure agreement with B&M to see the screening analysis?

Vectren's Response: The CAC requested an electronic copy of the B&M screening analysis with all formulas and links intact. Our objection is to providing the electronic spreadsheet with formulas and links intact. That electronic document itself is what is proprietary. B&M created that document and the document serves as a key component of its business model that B&M is not willing to provide to Vectren or anyone else. Vectren has provided you all of the inputs into the screening analysis model so that your experts can utilize the tools at their disposal to analyze the data. Vectren does not have the tool in its possession and B&M is not required to provide to you the proprietary tools of its trade.

1.2

CAC et al.'s Data Request 1.2(a) asked:

Refer to Confidential Attachment 1.2.
a. Please provide the documents that serve as the basis for the permitting and construction schedule assumption for each of battery storage, CAES, wind, and solar.
b. Please explain the relationship between these assumptions and the first year in which Strategist was able to pick these resources.

Vectren responded:

a. Please be advised that the schedule assumptions for the resources listed were developed by a third party consultant using expertise gained over time working with various electric utilities. As such, Vectren objects to this Request on the grounds and to the extent that the Request seeks documents not presently in its possession, custody or control. In addition, Vectren objects to this Request on the independent and separate grounds and to the extent that the documents requested are the proprietary, competitively sensitive and trade secret information of a third party vendor that has not consented to the release of such information.
b. The first year in which Strategist was able to pick any new generation resource was based on industry experience and reasonable expectations of the earliest calendar year in which a typical project could come online.

With regard to subpart (a), could you please provide some clarification as to what in these documents is proprietary? Could you please redact the information that is being claimed as proprietary and then provide the redacted documents? Could we please sign a nondisclosure agreement with the third party consultant to see these documents?

Vectren's Response: The premise of this question is flawed in that it assumes there is a single document or set of documents upon which the assumptions for permitting and construction schedules for the various resources (battery, wind and solar) are based. The issue is that there is no single document or set of documents upon which the assumptions are based. Instead, those assumptions were based upon the expertise of consultants with many years of experience assessing such matters through their work with other utilities on similar projects throughout the country. Neither Vectren nor its consultants have either a single written document or set of written documents in their possession that are responsive to this request. As a result of that fact, we objected to this request on the basis provided above.

1.20

CAC et al.'s Data Request 1.20 asked:

Please provide the spreadsheet used to develop Figure 2.6 including the metrics measured for each of the objectives and the ranges used to determine whether a particular portfolio has a green bubble, red bubble, partially green and partially yellow bubble, etc.

Vectren responded:

Response: Please see the Risk Analysis section (page 41-70) of the final stakeholder deck presented on November 29, 2016 (included in attachment 3.1 Stakeholder Materials) for details on how the IRP Portfolio Balanced Scorecard was developed. See the legends in the slides for each of the variables where the specifics were provided. In some instances, we used "break points" as the basis for colors.

We were requesting the spreadsheets and the underlying data in spreadsheet format used to develop that Figure. Could you please provide the spreadsheets and the data used to develop this in spreadsheet format?

Vectren's Response: Again, the premise of this question is flawed in that you assume a spreadsheet was used to develop the figure, but that assumption is not true. Furthermore, we have previously provided to the CAC all of the underlying data that went into creating the figure.

Thank you in advance for your assistance,
Jennifer

--

Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.

This message (including any attachments) is intended only for the use of the individual or entity to which it is addressed and may contain information that is non-public, proprietary, privileged, confidential, and exempt from disclosure under applicable law or may constitute as attorney work product. If you are not the intended recipient, you are hereby notified that any use, dissemination, distribution, or copying of this communication is strictly prohibited. If you have received this communication in error, notify us immediately by telephone and (i) destroy this message if a facsimile or (ii) delete this message immediately if this is an electronic communication. Thank you.

--

Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.

This message (including any attachments) is intended only for the use of the individual or entity to which it is addressed and may contain information that is non-public, proprietary, privileged, confidential, and exempt from disclosure under applicable law or may constitute as attorney work product. If you are not the intended recipient, you are hereby notified that any use, dissemination, distribution, or copying of this communication is strictly prohibited. If you have received this communication in error, notify us immediately by telephone and (i) destroy this message if a facsimile or (ii) delete this message immediately if this is an electronic communication. Thank you.

--

Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.

--

Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.

--

Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.

This message (including any attachments) is intended only for the use of the individual or entity to which it is addressed and may contain information that is non-public, proprietary, privileged, confidential, and exempt from disclosure under applicable law or may constitute as attorney work product. If you are not the intended recipient, you are hereby notified that any use, dissemination, distribution, or copying of this communication is strictly prohibited. If you have received this communication in error, notify us immediately by telephone and (i) destroy this message if a facsimile or (ii) delete this message immediately if this is an electronic communication. Thank you.

Copy of VEDS Capital Structure with Capital Recovery Factor for 2016 IRP Modelin....xlsx
344K

EXHIBIT 3-Confidential

Vectren Attachment to CAC 2.3-A-Confidential

EXHIBIT 4

10/25/16 Email Exchange with Vectren

Jennifer Washburn <jwashburn@citact.org>

EE Modeling

Jennifer Washburn <jwashburn@citact.org> Tue, Oct 25, 2016 at 2:59 PM
To: "Quinn, Michelle D." <mquinn@vectren.com>

Michelle,

Thanks so much for your email. We appreciate you following up with us. We would like to please request for now:

- the PRV input and output summary reports
- the LFA input and output summary reports
- the GAF output summary reports

That should help us provide some clearer comments.

Sincerely,
Jennifer

On Tue, Oct 25, 2016 at 10:56 AM, Quinn, Michelle D. <mquinn@vectren.com> wrote:

> Hi Jennifer,
>
> I hope all is well. I just wanted to follow up with you on the discussion we had on October 14th regarding EE modeling. During the meeting, Anna Sommers expressed some concern about the 25 year horizon over which EE is modeled. She said that modeling EE over 25 years overly constrains EE and makes it difficult for the model to select any EE. But, when Matt asked whether modeling EE in 3 year increments is preferable, she seemed to me to say that she could not answer that question because she did not know what other inputs are included in the model. So, I write to ask you what inputs do you all need to know? We are trying to be responsive to your inquiries, but we need to understand what information about our inputs are relevant to EE modeling. If you could provide some additional details, I would certainly appreciate it. Thanks!
>
> Michelle
>
> This message (including any attachments) is intended only for the use of the individual or entity to which it is addressed and may contain information that is non-public, proprietary, privileged, confidential, and exempt from disclosure under applicable law or may constitute as attorney work product. If you are not the intended recipient, you are hereby notified that any use, dissemination, distribution, or copying of this communication is strictly prohibited. If you have received this communication in error, notify us immediately by telephone and (i) destroy this message if a facsimile or (ii) delete this message immediately if this is an electronic communication. Thank you.

--
Jennifer A. Washburn, Counsel
Citizens Action Coalition of Indiana, Inc.
603 E. Washington Street, Suite 502
Indianapolis, Indiana 46204
E-mail: jwashburn@citact.org
Direct Line: (317) 735-7764
Direct Fax: (317) 290-3700

Mission Statement: To initiate, facilitate and coordinate citizen action directed to improving the quality of life of all inhabitants of the State of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

Privilege and Confidentiality Notice: This message is intended only for the use of the individual(s) or entities named above, and may contain information that is privileged, confidential, and exempt from disclosure under applicable law such as attorney-client and work-product confidential or otherwise confidential information. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this message is strictly prohibited. If you have received this message in error, please notify Jennifer A. Washburn, Counsel at Citizens Action Coalition of Indiana, Inc., at 317-735-7764. Thank you in advance.