Draft Director's Report

For Vectren's 2019 / 2020 Integrated Resource Plan

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on behalf of the Indiana Utility Regulatory Commission

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Draft Director's Report Applicable to Vectren's 2019 / 2020 Integrated Resource Plan and Planning Process

I. PURPOSE OF IRPS

Southern Indiana Gas & Electric Company submitted its 2019-2020 integrated resource plan (IRP) in June 2020 under its d/b/a of "Vectren, a CenterPoint Energy Company." Since that time, the utility's d/b/a name has been changed to "CenterPoint Energy Indiana South." In order to be consistent with the submitted IRP, this report will use the "Vectren" name.

By statute[1] and rule, integrated resource planning requires each utility that owns generating facilities to prepare an IRP and make continuing improvements to its planning as part of its obligation to ensure reliable and economical power supply to the citizens of Indiana. A primary goal is a well-reasoned, transparent, and comprehensive IRP that will ultimately benefit customers, the utility, and the utility's investors. At the outset, it is important to emphasize that these are the utilities' plans. In the report, the Research, Policy, and Planning Director does not endorse the IRP or comment on the desirability of the utility's "preferred resource portfolio" or any proposed resource action.[2]

The essential overarching purpose of the IRP is to develop a long-term power system resource plan that will guide investments to provide safe and reliable electric power at the lowest delivered cost reasonably possible. Because of uncertainties and accompanying risks, these plans need to be flexible as well as support the unprecedented pace of change currently occurring in the production, delivery, and use of electricity. IRPs may also be used to inform public policies and are updated regularly. As Vectren correctly said in its IRP, "The IRP can be thought of as a compass setting the direction for future generation and energy efficiency options." (*Vectren's IRP page 38)*

IRPs are intended to be a systematic approach to better understand the complexities of an uncertain future, so utilities can maintain maximum flexibility to address resource requirements. Inherently, IRPs are technical and complex in their use of mathematical modeling that integrates statistics, engineering, and economics to formulate a wide range of possible narratives about plausible futures. The utilities should utilize IRPs to explore the possible implications of a variety of alternative resource decisions. Because of the complexities of integrated resource planning, it is unreasonable to expect absolutely accurate resource planning 20 or more years into the future. Rather, the objective of an IRP is to bolster credibility in a utility's efforts to understand the broad range of possible risks that utilities are confronting.[3] By identifying uncertainties and their associated risks, utilities will be better able to make timely adjustments to their long-term resource portfolio to maintain reliable service at the lowest reasonable cost to customers.

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[1] Indiana Code § 8-1-8.5-3.

[2] 170 IAC 4-7-2.2(g)(3).

[3] In addition to forecasting changes in customer use of electricity (load forecasting), IRPs must address uncertainties pertaining to the fuel markets, the future cost of resources and technological improvements in resources, changes in public policy, and the increasing ability to transmit energy over vast distances to access economical and reliable resources due to the operations of the Midcontinent Independent System Operator (MISO) and PJM Interconnection, LLC (PJM).

Every Indiana utility and stakeholder anticipates substantial changes in the state's resource mix due to several factors[4] and, increasingly, Indiana's electric utilities are using IRPs as a foundation for their business plans. Since Indiana is part of a vast interconnected power system, Indiana is affected by the enormity of changes throughout the region and nation.

The resource portfolios emanating from the IRPs should not be regarded as being the definitive plan that a utility commits to undertake. Rather, IRPs should be regarded as illustrative or an ongoing effort that is based on the best information and judgment at the time the analysis is undertaken. The illustrative plan should provide off-ramps to give utilities maximum optionality to adjust to inevitable changing conditions (e.g., fuel prices, environmental regulations, public policy, technological changes that change the cost effectiveness of various resources, customer needs, etc.) and make appropriate and timely course corrections to alter their resource portfolios.

II. INTRODUCTION AND BACKGROUND

Vectren's 2019 –2020 IRP is a significant revision of its 2016 IRP, which contemplated the construction of a 700 MW natural gas-fired generator.

> "Vectren serves more than 146,000 electric customers. The service area includes a large industrial base with industrial customers accounting for approximately 44% of energy sales in 2018. The residential class accounts for 30% of sales with approximately 128,000 customers and the commercial class 26% of sales; there are approximately 18,000 nonresidential customers. System 2018 energy requirements were 5,308 GWh with non-weather normalized system peak reaching 1,039 MW." *(Vectren IRP page 113)*

From the Director's perspective, Vectren, like most utilities, is addressing unprecedented resource changes. Vectren developed their Preferred Resource Portfolio, with significant stakeholder input. Vectren undertook a comprehensive evaluation and concluded much of the existing capacity could be replaced by a diverse portfolio of resources that is cleaner and less expensive, including wind, solar, storage and energy efficiency (EE). Vectren also concluded that it will maintain a high degree of optionality to secure resources at the lowest delivered cost by conducting requests for proposals (RFPs) for competitive all-source bidding.

Vectren, like other utilities, have continually improved the modeling of EE and other DERs but credible long-term planning remains a daunting task. The Director appreciates Vectren's deployment of advanced metering infrastructure (AMI) that will provide more in-depth and discrete information about their customers appliances/end-uses and demographic data that will help Vectren better understand its customers.

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[4] A primary driver of the change in resource mix is due to relatively low-cost natural gas and long-term projections for the cost of natural gas to be lower than coal due to fracking and improved technologies. As a result, coal-fired generating units are not as fully dispatched (or run as often) by the Midcontinent Independent System Operator (MISO) or the PJM Interconnection, LLC (PJM). The aging of Indiana's coal fleet, the dramatic decline in the cost of renewable resources, the increasing cost-effectiveness of energy efficiency as a resource, and environmental policies over the last several decades that reduced emissions from coal-fired plants are also drivers of change.

III. FIVE PRIMARY AREAS OF FOCUS

Consistent with the introductory comment, the primary areas of focus, include: (1) load forecasting that should emphasize the development of more discrete load shapes; (2) demand side management (DSM) (includes EE, demand response (DR) and distributed energy resources (DERs which may include hybrid energy systems – HES); (3) risk/scenario analysis; (4) the stakeholder process; and (5) the need for continual improvement such as modeling all forms of DERs and electric vehicles (EVs), which includes the development of full avoided costs that are dynamic and vary by time and location. This will necessitate greater integration of distribution system planning with IRPs and Midcontinent Independent System Operator's (MISO's) long-term planning.

A. Load Forecast

Vectren contracted with Itron, Inc. (Itron), to develop a long-term load forecast to support the 2019/20 Integrated Resource Plan. The energy and demand forecasts extend through 2039. It is based on a bottom-up approach that starts with residential, commercial, and industrial load forecasts that then drive system energy and peak demand. In addition, the forecast includes developing long-term behind-the-meter solar and electric vehicle load forecasts. *(Vectren's IRP Appendix 2, page 1)*

Vectren and its consultants utilized models to project its customers' future electric usage. The significant drivers include projections for the:

> …major drivers of energy consumption, including but not limited to, the economy, appliance efficiency trends, population growth, price of electricity, weather, specific changes in existing large customer demand and customer adoption of solar and EVs. Overall, customer energy and summer demand are expected to grow by 0.6% per year. Winter demand grows at a slightly slower pace of 0.5%. *(IRP pages 39 and 40)*

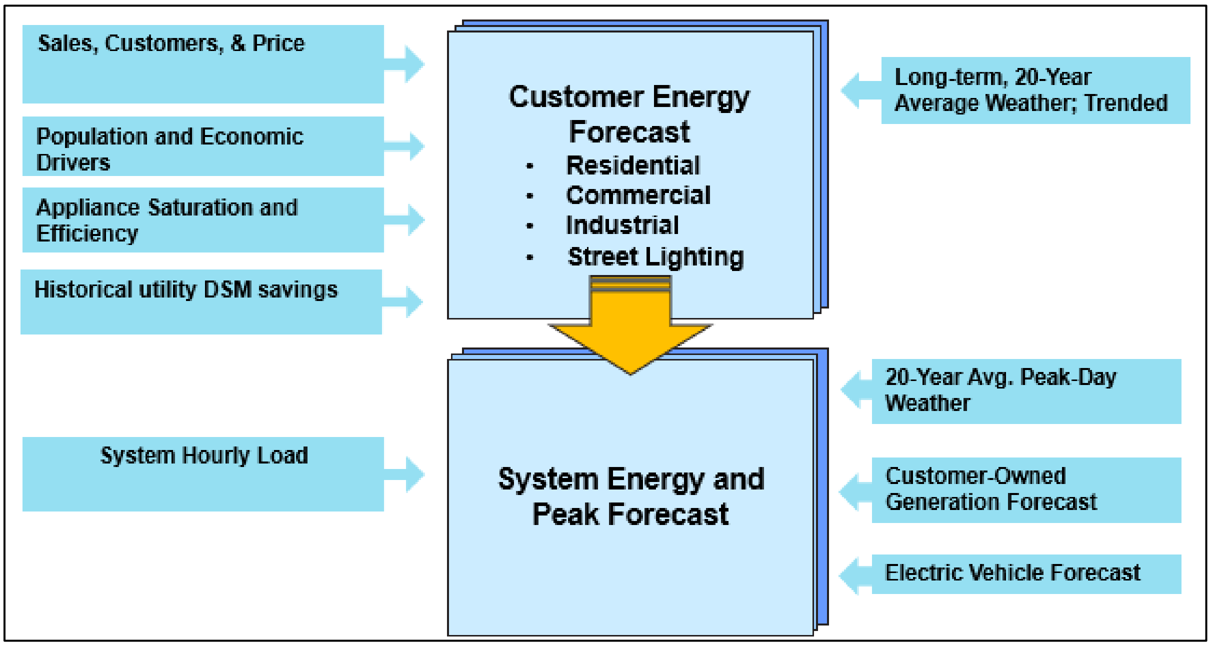
Itron used over 10 years of historical energy and demand data to prepare the energy and demand forecasts. Energy data is aggregated by rate class for the purposes of forecasting. There are two major rate classes for residential customers: the standard residential rate and the transitional electric heating rate (rate closed to new premises). Information for these rates is combined for the purposes of forecasting residential average use per customer. Similarly, small commercial (general service) rates are combined to produce the commercial forecast and large customer rates are combined to produce the industrial forecast. The demand forecast utilizes total system demand. (*Vectren's IRP page 114)*

Economic and demographic information was provided by Moody's Economy.com, which contains both historical results and projected data throughout the IRP forecast period. Examples of economic variables used include, but are not limited to: population, income, output and employment. Vectren's peak demand is typically in summer when temperatures are hottest. Air conditioning drives summer usage. Normal weather data is obtained from DTN, a provider of National Oceanic and Atmospheric Administration (NOAA) data. Vectren utilized data over a 20-year period for the sales forecast and a 20-year period for the demand forecast in order to capture recent weather activity. *(Vectren's IRP page 114)*

> "Itron, Inc. provides regional Energy Information Administration (EIA) historic and projected data for equipment efficiencies and market shares. This data captures projected

changes in equipment efficiencies based on known codes and standards and market share projections over the forecast period, including but not limited to the following: electric furnaces, heat pumps, geothermal, central air conditioning, room air conditioning, electric water heaters, refrigeration, dish washers, dryers, etc. Residential market share data was adjusted to Vectren's service territory based on the latest appliance saturation survey data." *(Vectren's IRP page 114-115)*

"The long-term energy and demand forecasts are based on a build-up approach. End-use sales derived from the customer class sales models (residential, commercial, industrial and street lighting) drive system energy and peak demand. Energy requirements are calculated by adjusting sales forecast upwards for line losses. Peak demand is forecasted through a monthly peak-demand linear regression model that relates peak demand to peak-day weather conditions and end-use energy requirements (heating, cooling and other use). System energy and peak are adjusted for residential and commercial PV adoption and EV charging impacts." *(Vectren's IRP page 115)*



Vectren's forecast structure page 115

"Structural changes include the impact of changing appliance ownership trends, end-use efficiency changes, increasing housing square footage and thermal shell efficiency improvements. Changing structural components are captured in the residential and commercial sales forecast models through a specification that combines economic drivers with end-use energy intensity trends. This type of model is known as a Statistically Adjusted End-Use (SAE) model. The SAE model variables explicitly incorporate end-use saturation and efficiency projections, as well as changes in population, economic conditions, price and weather. Both residential and commercial sales are forecasted using an SAE specification. Industrial sales are forecasted using a two-step approach, which includes a generalized econometric model that relates industrial sales to seasonal patterns and industrial economic activity. Streetlight sales are forecasted using a simple trend and seasonal model." *(Vectren IRP page 116)*

Distributed Energy Resources

Vectren has experience with DERs that are interconnected to Vectren's transmission and/or distribution system. The following examples of current DERs are discussed below.

> "As of December 2019, Vectren had approximately 486 residential solar customers and 71 commercial solar customers, with an approximate installed capacity of 10.7 MW. Based on recent solar installation data, the residential average size is 10.5 KW, while the commercial average system size is 78.7 KW. Vectren has incorporated a forecast of customer owned photovoltaic systems into the sales and demand forecast. Vectren monitors Combined Heat and Power (CHP) developments in its service area and adjusts the load forecast for any known, future customer owned CHP installations. A large CHP system went into service on Vectren's system in 2017." *(Vectren's IRP page 117)*
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> "The energy and peak forecasts incorporate the impact of customer-owned photovoltaic systems. System adoption is expected to increase as solar system costs decline. The primary factor driving system adoption is a customer's return-on-investment. Itron created a simple payback model, which was used as proxy. Simple payback reflects the length of time needed to recover the cost of installing a solar system - the shorter the payback, the higher the system adoption rate. From the customer's perspective, this is the number of years until electricity generated from the system is considered "free." Solar investment payback is calculated as a function of system costs, tax credits, and incentive payments, retail electric rates and treatment of excess generation (solar generation returned to the grid). Currently, excess generation is credited at the customer's retail rate. While current net metering customers will be credited the retail rate, DG installed beyond 2021 will be credited at the wholesale cost plus 25%." *(Vectren's IRP pages 117-118)*
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> "One of the most significant factors driving adoption is declining system costs, which have been declining rapidly over the last several years. In 2010, residential solar system cost was approximately $7.00 per watt. By 2017 costs had dropped to $3.70 per watt. For the forecast period, Itron assumed system costs will continue to decline 10% annually through 2024 and an additional 3% annually after 2024. Customer owned solar cost projections are consistent with the U.S. Dept. of Energy's Sun Shot Solar goals and national trends." (*Vectren's IRP page 118)*
>
> "In the commercial sector, there have been too few adoptions to estimate a robust model…Some challenges to commercial adoption are higher investment hurdle rates, building ownership issues (i.e., the entity that owns the building often does not pay the electric bill) and physical constraints as to the placement of the system. For this forecast, Itron assumed there continues to be some commercial rooftop adoption by allowing commercial adoption to increase over time, based on the current relationship between commercial and residential adoptions rates." *(Vectren IRP page 119)*

Vectren raised an important incipient reliability issue that will affect Vectren's operations (including all forms of DERs) and planning. Vectren said they will need to modify its distribution system protection to accommodate bi-directional flows so that Vectren customers can participate in either the MISO wholesale market or Vectren's market, or both.

> "Distributed Generation customers currently affect a small amount of load … has not caused significant operational issues for Vectren. At higher levels of DG penetration, Vectren would

> encounter more operational issues and would need to allocate more resources to mitigate these issues." *(Vectren IRP page 120)*

Higher penetration levels of DGs may create issues including high voltage on distribution feeders. Power quality and harmonics may also pose operational issues associated with high photovoltaics penetration levels on distribution networks. Power inverters used to interface PV arrays to power grids increase the total harmonic distortion of both voltage and current, which can introduce heating issues in equipment like transformers, conductors, motors, etc. Consideration must also recognize short-term forecast uncertainties due to higher levels of DG penetration. Short-term load forecasting becomes more difficult and requires more granular load and weather data. Vectren may have to evaluate changes in the configuration and location of capacitor banks on distribution feeders to improve power factor and maintain voltage. Vectren's generating reserves may also be affected by increased deployment of DG that may need to be capable of quickly reacting to the fast and potentially large generation changes on the system, as well as providing generation support during times when DG will not be available (such as during the night to replace solar DG). *(Vectren IRP pages 120-122)*

<u>EV Forecast</u>
The adoption of EVs could also lead to increased load demand in the nighttime hours as they are charging. These issues will need to be evaluated and potentially require mitigations such as storage facilities, quick start generators, etc. *(Vectren IRP pages 122).* In 2019, Vectren estimated 238 registered EVs were in the counties that Vectren serves: this included full electric (i.e., Battery EVs - BEV) as well as plug-in hybrid electric (PHEV) vehicles. The 238 vehicles were comprised of 105 BEVs and 133 PHEVs, with a total of 23 different make/model vehicles represented. This estimate was based on Indiana Bureau of Motor Vehicles (BMV) registration data for the counties that Vectren serves. Vectren purchases quarterly from the BMV a list of vehicle registrations for the counties that Vectren serves. *(Vectren IRP page 123*)

> "…Vectren decided to include an electric vehicle forecast in the 2019/2020 IRP (see 2019 Long-Term Electric Energy and Demand Forecast Report in the Technical Appendix of this IRP), Itron created an electric vehicle forecast utilizing the Energy Information Administration (EIA) Annual Energy Outlook (AEO) transportation forecast to estimate the number of cars per household over time. This number is multiplied by the forecast of residential customers to create a projected number of vehicles per Vectren household. Itron then applied the EIA AEO projected saturation of battery electric vehicles and plug-in hybrid electric vehicles... The average annual kWh for the current mix of EVs registered in Vectren's service territory is 3,752kWh for BEV and 2,180 kWh for PHEV based on annual mileage of 12,000 miles." *(Vectren IRP page 123)*

<u>Residential Load Forecast</u>
The residential sales forecast is the result of a residential customer forecast multiplied by a residential use per customer forecast from a monthly statistically adjusted end-use model. The customer model is linear regression model driven by household projections for Evansville Metropolitan Statistical Area (MSA). The 2016 IRP used the word "population" instead of "households." The residential use per customer model is a monthly statistically adjusted end-use model in which sales are a function of heating, cooling, other, and DSM activity variables. The end-use variables capture the interaction of end-use intensity projections, household characteristics such as size and income, electricity price, and heating and cooling degree days. The inclusion of the DSM variable in the residential average use model is new since the previous IRP.

Commercial Load Forecast

The commercial forecast is the result of a monthly statistically adjusted end-use model in which sales are a function of heating, cooling, other, and DSM activity variables. The end-use variables capture the interaction of annual end-use intensity projections, a commercial economic variable, real electricity price, heating degree days (HDD) and cooling degree days (CDD), and DSM activity. The commercial economic variable is an equally weighted combination of commercial employment and output.

Industrial Load Forecast

Industrial customers constitute about 50% of total customer use and is expected to grow. *(Vectren IRP page 275)* The industrial forecast is done in two steps. The first five years are based on Vectren's internal forecast. Vectren determines a baseline predicated on history and then adjust it based on expected closures and expansions or new customer additions. The industrial forecast, after the first five years, is based on a generalized linear regression model relating monthly historical industrial billed sales to manufacturing employment, manufacturing output, CDD, and monthly binaries capturing seasonal load variation and shifts in data. Manufacturing employment and output are equally weighted in the model. *(Vectren IRP page 116)* Large Commercial and Industrial customers (C&I) are expected to increase both in numbers and consumption, also with a partial offset of this growth by increasing efficiency. As a result, average energy sales grow at 2.2% for 2019-2021. *(Vectren IRP page 200)*. Vectren stated that they use its internal database, which contains detailed customer information including rate, service, and North American Industrial Classification System (NAICS) codes *(Vectren IRP page 288)*

Street Lighting Load Forecast

The street lighting forecast is the result of a simple seasonal exponential smoothing model with a trend and seasonal component.

Director's Comments – Load Forecasting

Beginning with its 2016 IRP, Vectren's load forecasting documentation was provided by Itron and Itron provided services for the current for its 2019 / 2020 IRP. Itron and Vectren provided a well-written and fairly comprehensive discussion of their load forecast and discussed on-going enhancements to Vectren's load forecast processes. In this regard, the Director appreciates Vectren's recognition of the need for more discrete data to improve load forecasting, understanding the operational attributes of DG and EVs (and all forms of DERs), and rate design. Much of this discrete data includes the utilization of AMI data to develop sub-hourly load shapes that more accurately reflect Vectren customers' use of electricity that also informs the future use of electricity. Obtaining more customer specific data for all types of customers will improve the confidence in load forecasts. In general terms, Vectren's long-term energy and demand forecasts are generated using a bottom-up methodology in which customer class models for residential, commercial, industrial, and street lighting determine system energy (after accounting for line loses) requirements and then drive the peak demand model. The system energy and peak are now adjusted for residential and commercial solar adoption as well as electric vehicle charging impacts which is a change from the previous IRP.

More specifically, the residential and commercial sales models are Statistically Adjusted End-Use (SAE) models, which capture structural changes over time such as appliance ownership trends, efficiency improvements, housing square footage changes, and thermal shell improvements as well as changes in population, economic conditions, prices, and weather. The industrial sales model is an econometric model relating sales to industrial economic activity and seasonal patterns. Vectren recognizes that industrial customers constitute almost half of the total use which results in significant risks. Long-term forecasts are inherently more uncertain than short-term forecasts for all types of customers but the risks of serving industrial customers warrants increased scrutiny. Unfortunately, there was little information about the long-term forecast analysis or efforts to improve the credibility of industrial customers. The street lighting model is a simple trend and seasonal model.

The peak demand forecast is a monthly linear regression model based on heating, cooling, and base use energy requirements from the class sales models as well as peak day weather conditions. The peak demand forecast is also adjusted for rooftop solar and EVs, the latter being new to the 2019 / 2020 IRP.

The Director commends Vectren for forecasting the potential ramifications of solar resources and EVs. *(Vectren IRP page 120)* Vectren's discussion of solar and EV forecasts are well done. The Director appreciates that this analysis is in its infancy and will improve over time.

However, the Director notes that current correlations of EV usage to the number of cars and milage may not imply cause and effect. The EV forecast uses U.S. Energy Information Administration's (EIA's) projections of cars per household as a starting point but seems to assume that miles traveled per car will not change as cars/household changes. Technology improvements should also be considered. Water utilities discovered years ago that people do not flush the toilets more often just because they increase the number of bathrooms in their home. In future IRPs, Vectren might consider other estimation methods such as vehicle miles traveled or population of driving age. This adds emphasis to the Director's comments throughout this report that Vectren needs to develop more Vectren customer-specific information in addition to AMI such as Vectren customer-specific demographic, detailed end-use, and building characteristics.

As Vectren states: "[e]lectric vehicles' impact on peak demand depends on when and where EVs are charged. Since Vectren does not have incentivized BEV/PHEV off-peak charging rates, it is assumed that most of the charging will occur at home in the evening hours. Table 4.5 shows the electric vehicle forecast." *(Vectren IRP page 124)*

It is not at all clear how the EV forecasts affect Vectren's summer and winter peak demand. For future IRPs, it will be increasingly important to know how and when EVs will affect Vectren's summer and winter peak demand as well as Vectren's contribution to the MISO system peak demand. The contribution of EVs to Vectren's system winter and summer peak demand as well as Vectren's coincident peak demand with MISO will change with increased solar and other DERs. The load shape for EV charging is key to understand how growing EV saturation interacts with other DERs over time.

Notwithstanding the significant improvements in Vectren's load forecast processes, the forecast for this IRP still does not include significant discussion of the future effect of DSM (and other DERs) on Vectren's load forecast. The inclusion of the DSM variable in the residential average use model is new since the last IRP. It seems incremental future DSM is added back to the model results to arrive at an average use forecast that does not include the modeled impact of future DSM. It is not clear whether this represents a real change from the 2016 IRP in the way things were done or if Vectren just clarified that the original model accounted for DSM and that it is then added back after the fact for the final forecast. *(Vectren IRP pages 193-194)*

Vectren's discussion of the potential changes to the distribution and transmission systems *(Vectren IRP pages 120-122)* that are caused by DERs was a good discourse. Vectren's recognition of the potential changes necessitated by increased DERs and EVs, highlights the importance of coordinating distribution system planning and operations with the MISO markets' planning and operations.

The commercial forecast is the result of a monthly statistically adjusted end-use model in which sales are a function of heating, cooling, other, and DSM activity variables. The end-use variables capture the interaction of annual end-use intensity projections, a commercial economic variable, real electricity price, HDD and CDD, and DSM activity. The commercial economic variable is an equally weighted combination of commercial employment and output. The measure of output is unclear here because the text still refers to it as "non-manufacturing output" as it did in the 2016 IRP but the actual equation now shows it as "GDP" (the "Economic Data" section also says "non-manufacturing output"). As with the residential model, the DSM variable in the commercial model is new since the previous IRP but incremental future DSM is added back to the final forecast so, again, it's not clear if this is an actual change in methodology or just how the models are presented.

The industrial forecast, after the first five years, is based on a generalized linear regression model relating monthly historical Industrial billed sales to manufacturing employment, manufacturing output, CDD, and monthly binaries capturing seasonal load variation and shifts in data. Manufacturing employment and output are equally weighted in the model. The model still excludes one large customer that is meeting its load through onsite cogeneration.

The solar forecast used to adjust the energy and peak forecasts comes from a payback model that relates solar installations to the length of time required to recover the investment in solar. The payback is a function of system costs, federal and state tax credits, incentive payments, retail electric rates, and how excess generation is treated. Commercial installations are based on the current relationship between commercial and residential rates because there have been too few commercial installations to estimate a model like with the residential sector. The solar capacity forecast is then calculated as the product of the solar customer forecast and average system size. Monthly solar load factors are used to translate capacity into generation. The factors come from typical solar profile for Evansville from the National Renewable Energy Laboratory (NREL).

The EV forecast makes use of EIA data and information on registered electric vehicles in Vectren's service area but, increasingly, it is important to have utility specific data to supplement EIA data. Total vehicles are modeled as function of Vectren's customers multiplied by EIA's vehicles per household. The number of EVs are, then, calculated using EIA's projections of the saturation of BEV and PHEV in the service area. EV weighted annual kWh use is calculated based on its current mix of EVs. In future IRPs, noting that BEVs consume more energy than PHEVs will be one important factor to distinguish.

EV usage information derives from manufacturer's reported fuel efficiency. EV's wide ranging effects on customer use and peak depends on the timing of charging. Vectren assumes most charging will occur during the evening hours since they have not incentivized customers to charge their vehicles at other times. In the future, as Vectren's rate structures change to influence the timing and magnitude of EV demand, it is imperative that Vectren take actions to anticipate changes.

The 2014 IRP contained low and high load forecasts, but the 2016 and 2019 IRPs do not. Were alternative forecast bands calculated? Did Vectren rely solely on stochastic analysis to capture the variability of electricity demand? Pace Global developed stochastics around load growth expectations for the Vectren control area and the neighboring ISO zones, including MISO, PJM, and the South East Reliability Council (SERC). *(Vectren IRP page 218)* Unfortunately there is virtually no discussion of whether high and low load forecasts were developed and there is minimal discussion of the stochastic load forecasting methodology.

Vectren's external data sources such as weather data, demographic information, historical electric sales, appliance / end-use data detailed below, are reasonable for now. Future IRPs will benefit from more detailed Vectren specific information to supplement existing sources.

Weather data for Evansville airport is from NOAA. There have been three changes to the weather data since the 2016 IRP. First, Vectren used normal weather calculated over 20 years instead of 30 years. Second, instead of holding normal weather constant over the forecast period as is typically done, Vectren is allowing projected normal weather to change, specifically for CDD to increase and HDD to decrease reflecting general warming trends. Third, peak-day weather variables are calculated based on 20 years of historical data instead of only 10 years.

B. Energy Efficiency, Demand Response, and Distributed Energy Resources

The following section is divided into two major interrelated components. The first is EE and the second is DR with some discussion of other DERs. Rate design was also addressed in Vectren's IRP. Vectren has approximately 21,000 residential customers with 27,000 direct load control (DLC) switches participating in the program. However, the existing switches will be replaced with smart thermostats.

> "Vectren retained the Cadmus Group to evaluate the DLC program and provide unbiased demand and energy savings estimates. In 2020, Cadmus predicted that the DLC Program was capable of generating approximately 8.3 MWs of peak demand savings from residential air-conditioning load control and residential water heating load control. This is roughly half of prior predictions, which were used for IRP modeling." *(Vectren's IRP page 168)*

<u>Development and Use of a Market Potential Study</u>
Vectren developed a Market Potential Study (MPS) in 2019 to provide "a roadmap" to predict the best opportunities for EE savings opportunities.

> "Energy efficiency potential studies are an effective tool for building the policy case for energy efficiency, evaluating efficiency as an alternative to supply-side resources and formulating detailed program design plans. They are typically the first step taken by entities interested in initiating or expanding a portfolio of efficiency programs and serve as the analytic basis for efforts to treat energy efficiency as a high-priority resource equivalent with supply-side options."[5]

Vectren's MPS developed technical, economic and achievable potential that informed the IRP and supported the DSM Action Plan. The MPS also collected primary market research on the saturation

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[5] "Guide for Conducting Energy Efficiency Potential Studies"; Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc; https://www.epa.gov/sites/production/files/2015-08/documents/potential_guide_0.pdf; November 2017; page ES-1

of C&I energy-using equipment, building characteristics and the percent of energy using equipment that is already high efficiency. *(Vectren IRP pages 184-185)*

Vectren's MPS evaluated: 1) Maximum Achievable Potential estimates achievable potential on paying incentives equal to 100% of measure incremental costs and aggressive adoption rates: and 2) Realistic Achievable Potential estimates achievable potential with Vectren paying incentive levels (as a percent of incremental measure costs) closely calibrated to historical levels but is not constrained by any previously determined spending levels. It is important to note the MPS (and the IRP) excludes potential savings from approximately 75% of large C&I customers that opted-out of Vectren's energy efficiency programs.[6] For the DSM reference case of the IRP analysis, Vectren used the realistic achievable potential identified in the 2019 Market Potential Study as the starting point for developing bundles of energy efficiency to be modeled in .25% increments of eligible sales. However, two additional adjustments to the MPS' realistic achievable EE potential were necessary prior to inclusion in the IRP. *(Vectren IRP page 186)*

> "[T]he first adjustment converted the energy efficiency potential from gross savings to net savings. It is appropriate to model net energy efficiency impacts in order to remove MWh and MW impacts that would have occurred even in the absence of Vectren's programs. Net savings were calculated by applying Vectren's most recent (2017) program evaluation results and NTG ratios to the MPS estimates of gross realistic achievable savings." *(Vectren IRP page 187)*
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> "The second adjustment aligned the level of low-income potential identified in the realistic achievable potential with levels achieved historically by Vectren. The MPS assumes Vectren pays the full cost for all possible low-income potential savings, regardless of cost-effectiveness. However, this produces a low-income budget that significantly outpaces historical spending for the low-income sector and would create cross-subsidization concerns across customer segments. As a result of aligning the low-income sector spending in the IRP with recent historical levels, low-income achievable savings were also scaled accordingly. "*(Vectren IRP page 187)*

A total of 10 bundles were modeled for DSM, including one fixed low-income bundle, one fixed DR bundle (AC DLC as well as Smart Thermostat), one selectable DR BYOT (Bring Your Own Thermostat) and seven selectable energy efficiency bundles each representing 0.25% of annual load excluding opt-out sales. *(Vectren IRP page 187)*

Once the total energy efficiency savings to be included in the IRP Reference Case were calculated, a cost was assigned to each bundle of energy efficiency so that it can compete and be selected against supply-side resources. The cost estimates from the MPS include incentive costs, program delivery costs and other cross-cutting program costs based on reported historical levels. Two modifications to the MPS cost estimates were created to further align the IRP Reference Case with empirical Vectren data. For the Vectren IRP process, energy efficiency is a selectable resource. Once the total energy efficiency savings to be included in the IRP Reference Case were calculated, a cost was assigned to each bundle of energy efficiency so that it can compete and be selected against supply-side resources. Again, the 2019 MPS and the annual supply curves were used to develop costs for each energy efficiency bundle. The costs from the MPS include incentive costs, program delivery costs and other cross-cutting program costs based on reported historical levels. Two modifications

[6] These percentages are calculated based on 2019 Vectren large C&I customer data and 2018-2019 billing history.

to the MPS cost estimates were created to further align the IRP Reference Case with empirical Vectren data. The first adjustment was to reduce incentive costs in the C&I sector from 2020 through 2027. This adjustment served to align modeled costs with Vectren recent historical and 2019 planned costs in the C&I sector. The second adjustment was to change the escalation rate for non-incentive program costs to 2.2% (in lieu of the 1.6% modeled in the MPS) to be consistent with other IRP planning assumptions.[7] *(Vectren IRP page 188)*

> "Following these savings and costs adjustments, a supply curve of the remaining electric energy efficiency potential was developed for each year of the MPS. A supply curve of energy efficiency potential is a device for demonstrating the total amount of energy efficiency savings available at specific price points…Energy efficiency measures along the supply curve were then bundled into blocks of approximately 0.25%." *(Vectren IRP page 188)*

DSM in the IRP Modeling

For the IRP analysis, each of the seven EE bundles serves as inputs into the resource optimization model which may select up to 1.75% of eligible sales per year. Each bundle is a mix of residential and non-residential electric EE measures and have an associated load shape and cost ($/MWh). A supply curve of EE potential is developed for each year of the MPS to rank the measures from low cost to high cost. Then residential and non-residential EE measures along the supply curve are bundled into groups of about 0.25% net energy savings. The total number of bundles each year is dependent on the RAP identified in that year in the MPS. A single low-income bundle is created so that low-income spending over the 2020 – 2039 planning period is consistent with historical levels. Each bundle reflects the increasing cost seen in the EE supply curve. As a result, increasing amounts of EE selected in a given year means increasing costs to achieve the reductions.

Two bundles of DR resources are included in the IRP model. One includes a fixed bundle (air conditioning direct load control as well as a smart thermostat) and the other includes a Bring Your Own Thermostat program bundle. The first bundle is modeled as a fixed adjustment to the total system load and is included as a "must-run" resource option. The second bundle consisted of additional DR potential above and beyond the current penetration of DR devices. This bundle is modeled as a selectable resource.

The model was allowed to make multiple selections over two three-year periods (2021 – 2023 and 2024 – 2026) and then evaluate the period 2027 – 2039 as a single period.
Given the uncertainty of the DSM resource costs, high and low-cost trajectories were developed by leveraging Vectren's 2011 – 2018 historical DSM spend and calculating one standard deviation from the mean. That is, Vectren uses the actual variation in resource acquisition costs to define upper and lower bounds of future annual DSM costs. The EE high and low sensitivity costs (with a range of approximately +/- 12% compared to the reference case were included in the scenario modeling optimization process.

Director's Comments – Energy Efficiency, Demand Response and Distributed Energy Resources

[7] Incentive costs were not escalated in the MPS or IRP DSM inputs. Incentives (as a % of measure costs) were held constant in nominal dollars. Any fluctuation in incentives is a result of changes in annual participation.

The Director appreciates the DSM modeling improvements implemented by Vectren in the IRP. First, the IRP optimization model selects DSM for two three-year periods beginning in 2021 and 2024. The optimization model then evaluates DSM for a third time period covering 2027 to 2039. The effect of allowing choices over multiple time periods is to allow the model to select the level of DSM based on cost-effectiveness differences between short, mid, and the long term. Another improvement is the use of bundle specific load shapes instead of the same average load shape for each bundle as was done in the previous IRP. The inclusion in the resource optimization model of DR bundles is another significant improvement compared to what was done previously.

Despite the significant improvements, the Director's primary concern is each bundle combines residential and C&I measures. Combining unrelated measures across residential and C&I measures, except that they have similar costs, makes a questionable load shape obscuring the time aspects of different measures. This is an important consideration in a world increasingly characterized by low marginal costs across most hours, it is important that the hourly impact of DSM measures be given particular attention.

EE, arguably, has been the most controversial aspect of the integrated resource plans. There is no consensus on constructing EE that is treated as comparably as possible to other resources. Among other factors, EE has different attributes to other DERs and traditional resources. There does, however, seem to be growing recognition that the value of EE and other DERs are affected by location and timing.

Vectren placed much less attention on DR and even less on other DERs that are less contentious. Consistent with the IRP rule requiring continual improvement, the Director has encouraged Vectren and other Indiana utilities to develop analysis of EE, DR, and other DERs that more closely reflect the real-time and locational value of these resources for the wholesale and retail markets. Vectren, in its work with MISO, recognizes that reliability and the attendant costs will continually vary over time, which warrants corresponding valuation of EE and other DERs.

The Director acknowledges that improved planning for EE, DR, and other DERs will be evolutionary due to the endemic difficulties of accurately quantifying the dynamics of these resources. The utilization of AMI and continually improving residential and commercial customer information (e.g., load shapes and customer data), including from empirical experience, should enable Vectren to continually improve the credibility of the value of EE, DR. and other DERs. The Director understands that industrial customers require different treatment, but it is imperative that Vectren include improved industrial detail in the DER information. In sum, Vectren needs to develop its customer specific data and reduce, but not eliminate, their reliance on outside data resources that are not as likely to be indicative of Vectren's customers.
Presently, most Indiana utilities bundle their EE and DERs. The Director is very appreciative of Vectren's excellent discussion of the value of EE programs and the creation of resource bundles. However, it would be helpful if Vectren would provide a more detailed example of how the bundles were constructed to better reflect the changing value of EE. Vectren should also demonstrate how other DERs are treated as comparability as possible to other resources. Ultimately, it is the integration of these different load shapes that should provide a more accurate assessment of the value of EE and other DERs in comparison to other resources.

The credible integration of load shapes that better reflect the time and locational value on the distribution system is critical to distribution system planning. This same degree of integration would benefit MISO's operation and planning, which is consistent with Federal Energy Regulatory

Commission (FERC) Order 2222. In selecting new resources, future requests for proposals, should consider all the DER opportunities.

The discussion of direct load control is not clear.[8] The narrative discusses savings numbers that do not seem plausible for DLC. Would Vectren agree that 69,000 kW and 360,000,000 kWh would mean that DLC was operating 5,000 hours a year and the load was eliminated, not just moved to other periods? Is it correct to assume the savings numbers are for all DSM, not just DLC? *(Vectren IRP pages 165-166)*

According to MISO's planning studies (e.g., Renewable Integration Impact Assessment or RIIA and Resource Availability and Need or RAN), there is a need for an expanded ability to reduce demand and energy usage throughout the year. It is important that Vectren increases its understanding of its customers' willingness to participate in all forms of DSM / DERs including those that require the customer to be interrupted under mutually beneficial conditions.

Vectren notes, however, that prior to Jan. 31, 2019, MISO never requested Vectren to utilize load modifying resources (LMRs), Vectren anticipates MISO may consider tariff changes to encourage cost-effective LMR as reliability concerns become more pervasive. However, Vectren expects some, if not all, of its currently enrolled customers will drop out, as frequent interruptions in service can be very costly to industrial customers' operations. Vectren believes it is unlikely that new customers will sign up for this program. *(Vectren IRP page 169)* Because of the anticipated reaction of customers to MISO's programs, Vectren limited the ability of the IRP optimization model to select additional DR.

After Vectren issued this IRP, FERC published Order 2222. It is not clear how the DER market will change over time as a result of this order, but it is clear that the possibilities have changed significantly. The Director urges Vectren to work with MISO to assess the potential for cost-effective and mutually beneficial programs to better ensure reliability at reasonable costs. The Brattle Group estimated the size of this cost-effective load flexibility in the U.S. is about 200 gigawatts which is, approximately, 20% of the system peak in the United States.[9] This number is focused on

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[8] The DLC program provides remote dispatch control for residential and small commercial air conditioning, electric water heating and pool pumps through radio-controlled load management receivers. Under the program, Vectren compensates customers in exchange for the right to initiate events to reduce air-conditioning and water-heating electric loads during summer peak hours. Vectren can initiate a load control event for several reasons, including: to balance utility system supply and demand, to alleviate transmission or distribution constraints, or to respond to load curtailment requests from MISO.*(Vectren IRP pages 154-6, second paragraph)*

[9] The National Potential for Load Flexibility: Value and Market Potential Through 2030, Brattle Group, June 27, 2019. This Report suggests the national benefit could be $15 billion a year through 2030 based on the likely performance of DERs. The report stresses the importance of determining location-specific value of DER and the full avoided costs. Brattle suggests the avoided generation cost could be in excess of $9.4 billion per year which constitutes 57% of avoided costs. Avoided transmission and distribution costs could total $1.9 billion per year or about 12% of the full avoided costs. Increasingly, the added benefit of geographically targeted T&D investment deferral opportunities is likely to grow as utility T&D data collection and planning processes improve. Ancillary Services may result in a $0.3 billion per year savings which is about 2% just from frequency regulation. Avoided energy costs may result in $4.8 billion per year or about 29% of the total value of reduced resource costs associated with shifting load to hours with lower cost to serve.

the system peak demand which means there are opportunities to shift load from peak to off-peak and build load during off-peak periods. The challenge for Vectren and other utilities in future IRPs will be to provide increasingly credible assessments of the flexible demand which should foster more interest in innovative rate design, fostering cost-effective DERs (and HES), accommodating EVs, and new technologies.

C. Resource Optimization and Risk Analysis

> "Uncertainty creates a risk that a generation portfolio that is reasonable under an anticipated future fails to perform as expected if the future turns out differently. Vectren's IRP analysis was developed to identify the best resource mix of generation and energy efficiency to serve customer energy needs over a wide range of possible future states. Vectren performed two sets of risk analyses, one exposing a defined set of portfolios to a limited number of scenarios and another that exposed the same portfolios to 200 scenarios (stochastic or probabilistic risk assessment). To help better understand the wide range of possibilities for wholesale market dynamics, regulations, technological breakthroughs and shifts in the economy, complex models were utilized with varying assumptions for major inputs (commodity price forecasts, energy/demand forecasts, market power prices, etc.) to develop and test portfolios with diverse resource mixes." *(Vectren's IRP pages 45 and 46)*

Vectren identified the preferred portfolio using the following:

1. Conduct an All-Source RFP to better understand resource cost and availability.
2. Develop a scorecard as a tool in the full risk analysis to help highlight several tradeoffs among various portfolios of resources.
3. Work with stakeholders to develop a wide range of future states (scenarios), to test portfolios.
4. Work with stakeholders to develop a wide range of portfolios for testing and evaluation within scenarios, sensitivity analysis and probabilistic analysis.
5. Utilize the quantitative scorecard measures and judgement to select the preferred portfolio (the best mix of resources to reliably and affordably serve customer energy needs while minimizing known risks and maintaining flexibility). *(Vectren's IRP page 46)*

<u>All Source Request for Proposals (RFP)</u>
Vectren issued an all-source RFP seeking power and demand-side proposals for capacity and unit-contingent energy to meet the needs of its customers. There was a potential capacity need of approximately 700 MW of accredited capacity beginning in the 2023/2024 planning year. Vectren used aggregated data from the RFP responses as inputs into the IRP modeling. Vectren sought to satisfy the capacity need either through a single resource or multiple resources including dispatchable generation, load modifying resources, demand response, renewables, stand-alone and paired storage and contractual arrangements. Vectren sought additional capacity that qualifies as a MISO internal resource with physical deliverability utilizing Network Resource Integration Service (NRIS) to MISO load resource zone 6. *(Vectren IRP page 79)*

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As the number and variety of DERs increase, Vectren should be open to allowing customer owned DERs to participate in all-source requests for proposals on as comparable a basis as reasonably possible to other resources. To determine the viability of DERs, Vectren should begin the process of calculating the all the costs involved (generation, transmission, and distribution) to provide all resources with the requisite price signals to determine the efficacy of different DERs under a variety of applications."

IRP Objectives and Metrics to Evaluate Resource Portfolio Performance

Vectren tried to develop a systematic and comprehensive planning process to determine a "preferred portfolio" that best meets all the objectives over a wide range of market futures. While cost is an important objective, it is by no means the only objective. Vectren had several important objectives, each of which needs to be considered when evaluating the best portfolio over time. Vectren recognized that tradeoffs must be considered when evaluating how alternative portfolios meet the desired objectives. The following table shows the metrics used to select the preferred portfolio.

	Objective	Metric
Quantitative and Qualitative (considered outside of scorecard)	Reliability	• Reliability Assessment
Quantitative Scorecard Measure	Affordability	• Mean value for the 20-Year Net Present Value of Revenue Requirements (NPVRR) (million$) across 200 dispatch iterations under varying market conditions
	Cost Uncertainty Risk Minimization	• 95^{th} percentile [illegible] of NPVRR (million$) across 200 dispatch iterations under varying market conditions
	Environmental Emissions	• Reduction in tons of life-cycle greenhouse gas emissions (CO_2e) 2019-2039
	Avoiding Overreliance on Market Risk	• Annual Energy Sales and Purchases, divided by Annual Generation, average (%) • Annual Capacity Sales and Purchases, divided by Total Resources, average (%)
Qualitative (considered outside of scorecard)	Resource Diversity	• Risk of overreliance on one type of resource
	System Flexibility	• Ability operationally to support the system to maintain stability and reliability
	Future Flexibility	• Risk that assets in a portfolio may become uneconomic

(*Table Vectren IRP page 83*).

Models

Vectren used AURORAxmp to perform long-term capacity expansion modeling. Least cost optimal resources were developed given sets of market driver assumptions under various scenarios. Supply-side, demand-side, and market supply options are all available to be selected by the model.

Method for Scenario and Risk Analysis

Vectren selected a Reference case and four alternative scenarios as boundary conditions for two purposes. The first was to select a least cost portfolio for each of the five scenarios and the second was to test final portfolios against each of the market scenarios to determine how well they perform against alternative futures.

The Reference Scenario represents the most likely future scenario. For natural gas, coal, and capacity prices, Vectren used a "consensus" Reference case view of expected prices by averaging forecasts from several sources. The Reference Case included a CO_2 price. All-source RFP bids were used for resource cost information between 2022 and 2024. Beyond 2024 long-term cost curve information was developed using a consensus approach using Burns and McDonnell, NREL ATB, and Pace Global.

Vectren selected four alternative scenarios (a Low Regulatory, a High Regulatory, an 80% Carbon Reduction, and a High Technology). The alternate scenarios were created with increasing order of regulatory restriction. The Low Regulatory scenario was meant to be a lower boundary scenario in which there is a general laissez-faire attitude toward regulations. For example, only the Area Control Error (ACE) rule is included for carbon dioxide (CO_2) regulation and remains in place throughout the planning period with Indiana implementing a lenient interpretation of the rule. ELG is partially repealed with bottom ash conversions not required for some smaller units and is delayed two years (this does not apply to Culley 3). EE costs are expected to net to the Reference Case level. (*Vectren IRP pages 214-215)* The High Technology scenario was constructed to be indicative of significant advances in energy storage technology, renewable energy deployment, emissions reduction, and CO_2 removal technology, high efficiency gas-fired generation and natural gas extraction productivity. A relatively low CO_2 tax is implemented. Utility sponsored EE costs rise early in the forecast but fall back below Reference Case levels due to technology improvements. (*Vectren IRP page 215)*

The 80% Carbon Reduction by 2050 assumes That a carbon cap regulation is implemented, which mandates an 80% reduction of CO_2 by 2050 from 2005 levels. A glide path was set based on a gradual ratcheting down of CO_2 emissions and increasing CO_2 allowance cost. (*Vectren IRP page 216)*

The High Regulatory scenario is characterized by a more heavily regulated path relative to the Reference Case:

a. A much higher cost for compliance with emissions controls, which begins in 2022 at \$50/short ton of CO_2;
b. More renewables adoption through mandates;
c. Additional regulations on carbon after 2030 that are higher than the Reference Case;
d. Greater adoption of DG in the form of solar and combined heat and power; and
e. Restrictions on fracking and fugitive methane emissions that limit gas supply growth.
f. The social cost of carbon is implemented via a high CO_2 tax early in the scenario.

(Vectren IRP page 217)

Vectren developed 11 other "least cost" portfolios for evaluation that included the continuing use of coal plants (status quo) for comparative cost and performance benchmarking purposes, bridge portfolios designed to take advantage of existing resources during the transition to a generation fleet with many new resources, diversified portfolios with a balanced mix of generation technology types, and renewables-focused portfolios designed with direct input from stakeholders. Each alternative portfolio had some resource options hardwired consistent with its theme and was optimized with the ability to include near-term solar, wind, and battery storage options from the

All-Source RFP solicitation, while medium-term and long-term resource options were available for selection. These alternative resource portfolios were then selected on a least-cost basis using the LTCE module of the Aurora model. DSM resource options were also available for selection. *(Vectren IRP page 227)*

Vectren selected 10 of the 15 least cost portfolios for evaluation in the risk analysis. The remaining ten candidate portfolios selected for further analysis were each modeled under each of the four scenarios with their respective market inputs. *(Vectren IRP page 244)* Several sensitivities were also conducted on the candidate portfolios to test and refine the design of the portfolios and whether and how results might change if isolated variables might change.

A sensitivity was performed in which solar costs were increased by 30% to determine if this would impact their selection in 2022-2024. The sensitivity showed that even with an increase of 30% in cost, that solar resources continued to be selected by the model as beneficial low-cost resources. *(Vectren IRP page 247)*

A sensitivity was conducted on the near-term (2021-2023) selectable EE blocks. The optimization module in the Aurora model selected between 0.50% and 1.50% EE, based on the modeling inputs and the scenario being optimized. A sensitivity was performed to compare 1.25% of EE to the 0.75% EE selected in the Reference Case. The sensitivity showed that increasing the near-term EE to 1.25% from 0.75% only increased the 20-year NPVRR by 0.15%. *(Vectren IRP page 248)*

A sensitivity was conducted to determine the implications to the Reference Case portfolio of building to a summer peak vs. a winter peak and the resulting impact this would have on seasonal planning reserve margin requirements. The sensitivity demonstrated that Vectren should continue to plan for meeting its summer peak as the greater of the two seasonal constraints. When planning for and building to a winter peak, the Vectren system is built to meet the winter peak in all hours but is overbuilt to meet the summer peak in all hours. Based on this sensitivity, each portfolio was designed and built to meet summer peak load and resulting planning reserve margin requirements. *(Vectren IRP pages 248-250)*

The last step in the evaluation of risk and uncertainty was to conduct a 200 iteration or scenario risk assessment and complete the scorecard, consider "other" relevant factors, and select the preferred portfolio given all of the information. Probabilistic modeling begins with the development of 200 sets of future pathways for coal prices, natural gas prices, carbon prices, peak and average load, and capital costs for a range of technologies. These 200 iterations of each stochastic variable are then loaded as inputs into the dispatch model. These inputs allow the testing of each portfolio's performance across a wide range of market conditions. Each Vectren portfolio is fixed but other MISO members can make decisions under each market scenario when using the Aurora model in dispatch mode. *(Vectren IRP pages 100-101)*

Director's Comments – Resource Optimization and Risk Analysis

Among the 15 candidate portfolios developed by Vectren, only five are least-cost optimal portfolios selected by Aurora based on assumptions about market drivers for each specific scenario. Although the five portfolios were classified as scenario-based optimal solutions, each already included quite a few pre-determined decisions, including 1) F.B. Culley 3 being modeled with continued operations through the planning period; 2) certain amount of EE bundles, one low-income and one DR bundle; 3) a 180 MW limit for annual capacity market purchases (except in a transitional year); and 4) limits on the amount of annual additions of wind, wind plus storage, solar, solar plus storage, and battery storage.

For the other candidate portfolios, on top of the previously mentioned hard-wired options and limits, certain design considerations for specific generation stations, including bridge options for converting existing coal units into gas peakng units or extendng the life of A.B. Brown coal units were evaluated with the model selecting the least cost portfolio of the remaining assets. Vectren also constructed diverse portfolios with two sizes of gas combined cycle technologies and portfolios focused primarily on renewable and battery storage technologies. In sum, Vectren's portfolio design does not leave much space for model selection.

The Director appreciates the wide range of alternative candidate portfolios that were partially optimized. Each was clearly designed to evaluate specific alternative resource strategies. Emphasis was placed on the conversion of one or both Brown units to natural gas and the acquisition of 400-500 MW of natural gas combined cycle capacity. The information from this analysis is helpful, but the Director would have appreciated one optimization run with a minimum of constraints or exogenous choices pre-selected. The Director recognizes the resulting portfolio might be unrealistic because it fails to adequately account for real world limitations but thinks such an exercise is still informative.

General Observation on Optimization Models

Optimization models like Aurora have perfect foresight. This means that the model knows ahead of time that a variable resource will be unavailable so the model will take action (e.g., have all the batteries fully charged) to prepare for it. This has the potential to overstate the value of any limited energy/use resource (storage, DR, a CT with an air permit limit on hours of operation). In the real world, the utility will not have perfect foresight and will use these resources in a way that looks sub-optimal in hindsight, either by saving the resource for later when it would be best used now or using it now and not having it later when it would be more valuable. This is not a criticism of Vectren's IRP or the preferred plan, but it is something that should be kept in mind as utilities incorporate more resources like storage in their IRP modeling.

Performance Metrics Questions

a. Vectren uses the 95th percentile as the metric for cost uncertainty. This is reasonable but it ignores the uncertainty around the potential for lower-than-expected cost. It is possible that a portfolio has more downside cost benefit than other portfolios but this was not considered by Vectren. *(Vectren IRP page 85)* Would Vectren agree that other portfolios that expand the risk analysis might provide valuable insights?
b. Is it appropriate to use full life cycle emissions for existing units? The numbers cited include facility construction, which are "sunk" emissions at this point for existing generation facilities. *(Vectren IRP pages 85-86)*
c. Would adapting the Herfindahl-Hirschman index (HHI) used to measure market concentration be useful here? The portfolio HHI could be calculated by unit or by source. HHI = the sum of the squares of the percentage market share. *(Vectren IRP pages 88-89)*

Despite the limitations discussed above, the risk and uncertainty analysis and discussion in the IRP are well done. Each step of the evaluation process is discussed with sufficient detail to reasonably understand what was done and how. The Director especially appreciates the discussion of the quantitative scorecard metrics and the "other" metrics that are more qualitative in nature. Vectren clearly discusses how the metrics were applied to the portfolios and how Vectren used the results to inform its decisions to derive the preferred portfolio. One can disagree with how Vectren applied the metrics, but one cannot say Vectren's thoughts are not made clear.

D. The Stakeholder Process

Despite the limitations imposed by COVID-19 during the development of 2019/2020 IRP, Vectren provided forums for stakeholders to provide their input. This input included verbal feedback through question/answer sessions during public stakeholder meetings, and through participation in Vectren stakeholder workshops. Vectren also engaged in several phone conversations with subject matter experts. Some stakeholders provided written comments to Vectren. *(Vectren IRP page 109)*

During the stakeholder meeting on Oct. 10, 2020, Vectren emphasized the importance of the load forecast as the foundation for the IRP. This provided an educational opportunity to provide input and raise questions. (*Vectren IRP page 129*) Vectren provided a good discussion of the 15 candidate portfolios that included three portfolios that emphasized renewables, Other portfolios, including the Business as Usual and Bridge portfolios, were designed to consider the interests of a separate set of stakeholders. (*Vectren's IRP page 227*)

Figure 3.1 – Summary of Key Stakeholder Input (Vectren IRP pages 109-110)

Request	**Response**
Update the High Regulatory scenario to include a carbon fee and dividend	Included a fee and dividend construct which assumed less impact on the economy/load
Lower renewables costs in the High Regulatory and 80% CO_2 Reduction scenarios	Updated scenario to include lower costs for renewables and storage than the Reference scenario
Consider life cycle emissions using CO_2 equivalent	Included a quantitative measure on the risk scorecard based on National Renewables Energy Laboratory (NREL) Life Cycle Greenhouse Gas Emissions (CO_2e) from Electricity Generation by Resource
Include a measure within the risk score card that considers sunk costs	Vectren worked with Pace Global to create an uneconomic asset risk measure. Ultimately, this measure was considered but not included within the scorecard, it did not fulfil the initial intention, to evaluate risk of resources with large initial capital investments

Request	Response
Include a scenario with a carbon dividend modeled after HB 763 with a CO_2 price curve that was approximately $200 by the end of the forecast	Ran a sensitivity to create a portfolio. Ultimately, this was not selected for the risk analysis, as the amount of generation built within modeling vastly exceeded Vectren's need
Reconsider the use of a seasonal construct for MISO resource accreditation	Reviewed calculation for solar accreditation in winter and utilized an alternate methodology, increasing accreditation in the winter
Include a CO_2 price in the reference case	Included a mid-range CO_2 price curve 8 years into the forecast. The low regulatory scenario did not include a CO_2 price, and remains a boundary condition

Director's Comments – The Stakeholder Process

The Director commends Vectren for facilitating a robust stakeholder process even though the meetings had to be virtual or by phone. Even with the restrictions necessitated by the pandemic, Vectren has improved its stakeholder processes by conducting transparent and meaningful conversations with Vectren's subject matter experts and consultants. Vectren, as evidenced by the significant changes in this IRP's preferred plan, demonstrates a willingness to consider the ideas and perspectives of others. Vectren provided detailed modeling assumptions early in the process, enabling meaningful discussion about inputs and methodology.

One of the continuing controversies has been stakeholder access to confidential information. To a large extent, Vectren made good use of public data which limited Vectren's need to rely heavily on confidential data.

E. Future Enhancements to the IRP Process

From the Director's perspective, Vectren has made significant progress and commitments for ongoing enhancements. The primary effort for improving Vectren's load forecast processes has been, and continues to be, the development of customer databases, maintaining state-of-the art planning models, and improvements to analysis. The Director urges Vectren to include a "value proposition" discussion of how Vectren intends to use AMI and other customer information [10] to

[10] Supplemental information would include, but not be limited to, customer surveys to obtain detailed appliance / end use data using surveyors that have expertise, demographic information, house / building data, use of the North American Industrial Classification System – primarily for the very diverse commercial

increase the credibility of its load forecast (including projections of all forms of DERs and EVs). AMI and other customer information should also improve rate design including full avoided costs (generation, transmission, and distribution) for DERs. To be clear, the Director recognizes the difficulties of utilizing vast amounts of data necessary to develop full avoided cost that reflects the timing and location of resources. Sharing information with other Indiana utilities, their RTOs, and other regional utilities may result in efficiency gains that could not be realized for an individual utility.

The granular customer data is a mutual benefit for Vectren and MISO. Especially with MISO's planning studies showing reliability concerns throughout the year and FERC's Order 2222,[11] it is increasingly imperative that Vectren's distribution system planning and operational needs largely coincide with the needs of the MISO. As a result, there is a need for increased integration of distribution system planning with Vectren's IRP and the MISO's resource planning. Vectren's future IRPs should demonstrate increasing development of this coordination. The Director's understands that Vectren's distribution system protection scheme may require modifications to allow DERs to participate in the wholesale power markets. As a result, MISO and Vectren share common cause for improved data to improved distribution system modeling and integration with MISO's operations and planning.

With significant avoided cost information, Vectren should give due consideration to allowing DERs to bid in future RFPs for resources. Allowing DERs to participate in RFPs, perhaps aggregations of DERs, is consistent with the IRP rules to treat all resources as comparably as reasonably feasible. Not allowing DERs to participate in Vectren's RFP raises anticompetitive concerns.

<u>Vectren's Load Forecast Commitments</u>
Itron continues to improve and evolve the SAE (Statistically Adjusted End-Use) modeling framework. In addition to annually updating efficiency and saturations projections with the latest estimates from the EIA the framework has evolved to include utility specific DSM program activity data. The inclusion of a utility specific DSM variable in the modeling specification greatly improves model fit and enables the model to produce a baseline forecast excluding the impact of future DSM program activity. Additionally, Itron built a framework for the inclusion and use of trended normal weather where historical weather patterns show this to be appropriate.

The Vectren forecast now also takes into account emerging technologies: customer distributed generation and EVs. Customer owned photo-voltaic (PV) adoption is modeled as a function of simple payback. The model explains historic adoption well and provides a framework that considers projected PV installation costs, electric prices and incentives. The adoption of EVs is

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sector. This would provide opportunities to micro-targeting of specific types of customers for different DERs, HES, and EVs. The National Laboratories and private research consultants might be utilized.

[11] To be clear, FERC's Order 2222 was issued subsequent to this IRP. It is a credit to Vectren that they are proactive. NERC's System Planning Impacts from DERs Work Group (SPIDER WG) December 2020: (1) Lack of observability and availability of real-time data for increasing DER will necessitate accurate measuring of real-time DER data and performance. Guidance is needed for telemetry requirement and communication capability as well as increases in data handling capability and data quality issues with increasing DER. (2) A reliability guideline for providing industry recommended practices on collection and validation of DERs and distribution level characteristics given the measurement equipment at the transmission level should be developed.

based on the EIA's forecast of vehicle adoption. The EIA uses a robust transportation model that includes a vehicle manufacturer component and a consumer choice component to estimate the mix of vehicles by powertrain type; gasoline, diesel, electric, plug-in hybrid electric, etc. The model accounts for projected fuel prices, electric prices, the decline in battery costs and federal incentives for EVs. *(Vectren IRP page 290-291)*

There is a need for integrating distribution systems with IRPs and RTO planning is essential for capturing the dynamic (timing and locational) values of DERs. FERC Order 2222 should hasten the development of truly integrated planning and operations.

Current long-term state-of-the-art resource expansion planning models (AURORA, PLEXOs, and ENCOMPASS) are not currently capable of integrating full avoided cost, including capturing ***all*** grid benefits of DERs. The "time-step" for long-term planning models are primarily designed to capture hourly or daily values. However, these models can achieve more discrete time intervals (such as five to 15 minutes) but, among other things, it requires more computer time to solve.

There may be a consensus that recognizing the time and locational value of different resources is appropriate. However, the difficulty of calculating more accurate avoided costs are very difficult because the values are so dynamic, especially for long-term avoided costs. For example, congestion on the distribution system, like the transmission system, changes over time.

The largest benefits that current models do not capture are the avoided cost of distribution and transmission capacity provided by DERs. For some grid services, such as within-hour flexibility and volt/var support this can be done using these long-term capacity expansion models but run at shorter time steps (run at five-minute intervals).

Distribution system modeling also requires customization that includes can utilize very discrete time intervals. To comply with FERC Order 2222, some of the distribution system protection schemes will have to be reconfigured to allow DERs to sell into the wholesale markets (allowing back-feeding).

Typically, the best current long-term planning models also fail to capture the value of ancillary services such as volt/var [12]support and within-hour flexibility which is needed for integrating variable output renewables that might be provided by distributed generation, battery storage or certain types of demand response.
At least until the computation capabilities of long-term resource planning models increase dramatically, it is probably necessary to rely on other models utilizing separate engineering cost estimates to develop avoided cost of distribution and transmission capacity. The avoided transmission and distribution cost/kW of capacity from these other models can, then, be used as a credit against the capacity deferral value of DERs when they are model in the long-term capacity expansion process.

IV. SUMMARY

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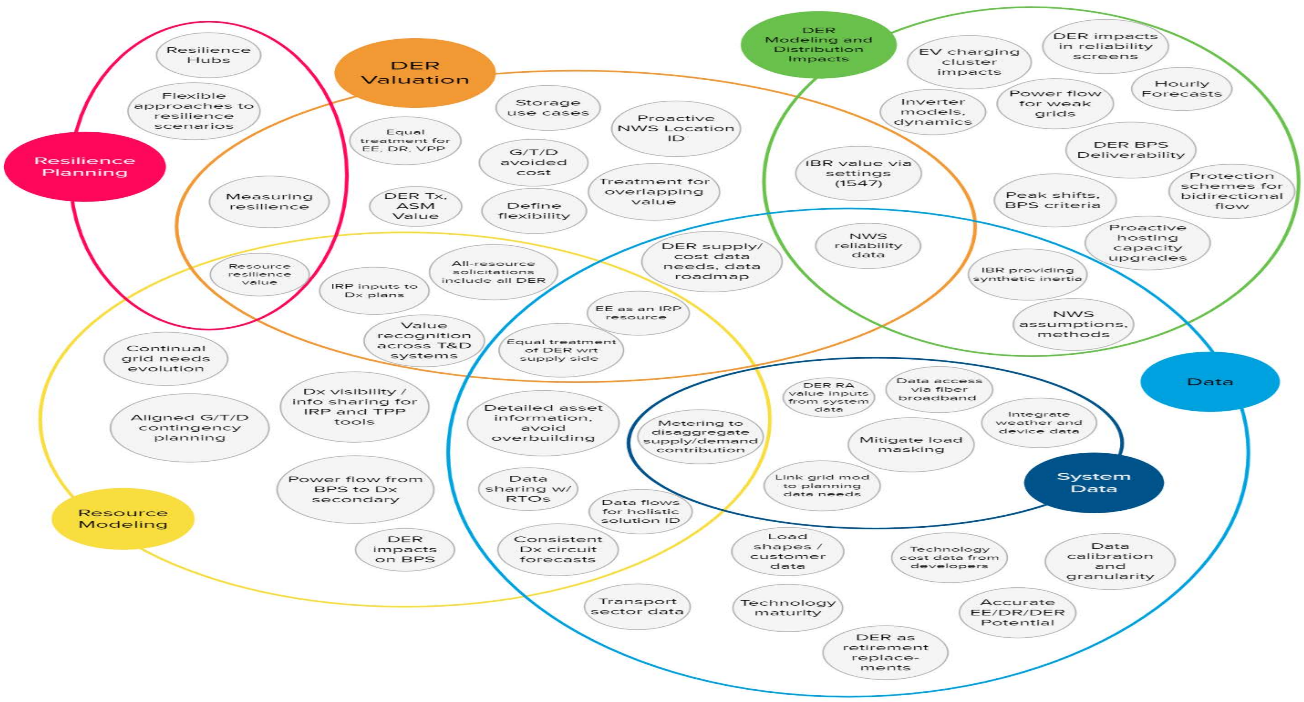
[12] Volt / Var is intended to improve reliability and reduce operational costs. Reactive power flows through transmission lines and can have a positive or negative effect on voltage amplitude. Experience has proven that overall costs and performance of power system operation can be best managed if voltage control and VAR control are well-integrated in utility operations. The availability and deployment of microprocessor-based controls, advanced communications technology, sensors, and advanced metering infrastructure have made it easier to integrate voltage control with VAR control.

Vectren's IRP included significant advances to its processes, analysis, methodology, and software. The Director appreciates the significant changes Vectren has made from its 2016 IRP. For future IRPs, the most significant challenges to Vectren seem likely to include improved modeling of EE, DR, and other forms of DERs as well as EVs, on-going efforts to improve the credibility of avoided costs and incorporate those into IRPs / RFPs, greater integration of distribution system planning with IRPs and the MISO's planning processes, and increasing the opportunities for DERs to participate in all-resource RFPs on as comparable a basis as possible with all other resources.

Vectren has a solid foundation for its continuing efforts to enhance customer information such as: customer surveys, improvements in the calculation full avoided cost that reflect the dynamic changes in the time and location, increasing sharing of information with the MISO, increased information about the ramifications and attributes of different DERs and EV infrastructure, continued improvements in the narratives to explain the scenarios and portfolios, and increasing integration of distribution system planning with Vectren's IRP and sharing information with the MISO. The following graphic illustrates the integration of distribution system planning with utilities' IRP, and their respective regional transmission organizations' long-term transmission planning. ICF Consulting prepared for NARUC and NAESO under DOE auspices.



DERs at specific locations on the distribution system and the bulk power system, is determined by the capability of the resource and the potential costs it can avoid in that location under a variety of conditions. The primary potential location-specific benefit of DERs for the distribution system is their deferral value. That value is tied to specific DER projects, operating at specific times and at specific locations where distribution capacity is insufficient to meet expected future needs. There is growing evidence that DERs can avoid or defer investments in the transmission and distribution system which is required by FERC Order 2222 and increasing reliability concerns throughout the year. To the extent that DERs can avoid upgrades to transformers, conductors, capacitors, and in select cases, substations, it is imperative that Vectren continually improves their ability to calculate avoided generation, transmission, and distribution values.

V. STAKEHOLDER COMMENTS

(Stakeholder comments, utility responses, and Director's responsive comments are labeled below):

The public input to Vectren's IRP has been gratifying. The following comments are intended to be a representative sampling of the public input into Vectren's 2018 Integrated Resource Plan and stakeholder process. Often similar comments raised by more than one commenter. To reduce redundancy, the Director selected some of the more salient and representative commentary.

As a preliminary matter, the Director will take this opportunity to remind all stakeholders of the limitations spelled out in IRP administrative rule on the appropriate content of the Director's report. According to 170 IAC 4-7-2.2(g), the Director's report can only address:

(g) The draft report and the final report shall:
(1) be limited to commenting on the IRP's compliance with the requirements of this rule;
(2) list the areas where the director believes the IRP fails to comply with the requirements of this rule; and
(3) not comment on:
(A) the desirability of the utility's preferred resource portfolio; or
(B) a proposed resource action in the IRP.

Given these guidelines, the Director will limit discussion of stakeholder comments that appear to target the resource portfolio developed by the IRP process or specific resource actions in the IRP. The Director will try to highlight stakeholder comments that address issues or questions about models, methodology, data, assumptions, and criteria used to evaluate the output of the IRP analyses.

Berry Global

After reviewing and speaking with CenterPoint Energy representatives, Berry Global supports CenterPoint's efforts to diversify their generation portfolio. The collective effort to reduce the carbon intensity of our energy resources while continuing to provide reliable and cost-effective power is imperative to our production and success.

Additionally, Berry Global supports the transition to renewable power, which aligns with our Impact 2025 sustainability strategy. Berry Global states: The increase in renewable energy and decrease in carbon intensity of CenterPoint's portfolio will provide tremendous assistance in achieving our goal.

Economic Development Coalition of Southwest Indiana and Evansville Industrial Foundation (Evansville Coalition)

Vectren's 2019 / 2020 IRP reflects positive developments with respect to its resource mix. The directional nature of the IRP is significant and beneficial as well for economic growth in Southwest Indiana. The shift to renewable resources supports future growth among Vectren's large industrial and commercial clients as well as attracts new customers to its overall base.

Evansville believes, the creation of additional renewable jobs in the communities Vectren serves has a ripple effect on the local economy that supports growth, retention, and attraction. We support the direction of Vectren's IRP generation resource mix and encourage its approval.

Indiana Coal Council (ICC)

The ICC argues that Vectren's 2019 / 2020 IRP analysis is biased in several ways but perhaps most glaringly by its different treatment of capital costs. Each of the methodological concerns are summarized below.

a. Vectren determined the capital cost upgrades that would be required to keep the A.B. Brown coal units on-line and burning coal beyond 2023 for two scenarios. In each case Vectren assumed recovery of the capital costs in one year, rather than amortizing recovery over the life of the investment. In contrast, for other new capital investments Vectren assumed amortized recovery over the life of the investment. This differential treatment materially slanted the NPV metric in favor of investing in new resources and against Brown operating on coal beyond 2023.
b. Vectren continued use of the 20-year NPV as the only economic metric for ranking of its scenarios. This metric provides limited information as to the rate impacts over a 20-year planning period and beyond. A proper resource plan should consider both the overall costs of a resource portfolio as reflected in the 20-year NPV and the shape of projected annual rate impacts, recognizing that the farther into the future one attempts to project, the more unreliable one's assumptions become.
c. Vectren failed to give the BAU to 2029 scenario (keeping the Brown units burning coal through 2029) any value related to the benefit to Vectren of a delay in selecting no- or low-carbon generation resources.
d. Vectren's carbon analysis used a carbon price as a proxy for a carbon regime, ignoring increasing indications that Resource Portfolio Standards for achieving net zero emissions has become a more likely future scenario. A net zero plan could preclude the use of natural gas CT's of CCGT's or could require they be retrofit with carbon capture technology.
e. In addition to carbon pricing, Vectren's analytics appear to be based upon a number of problematic assumptions including MISO market capacity costs, fuel prices, and capital costs. For example, Vectren received an extremely attractive offer that would have reduced the delivery costs of coal to Brown by an over $16 million on an NPV basis. This offer was not included in the IRP analysis.
f. Vectren has played down the importance of MISO's findings related to renewables, i.e., that MISO is limited with respect to renewables integration and that costs increase significantly above 30 percent renewables. These findings are for MISO as a whole, not an individual utility and they point to the necessity that an entire state plan be integrated, not on a utility-by-utility basis.

<u>Vectren's Response</u>

Vectren had the following response to the ICC's concern about the differential treatment of capital investment in the IRP optimization:

> "The Indiana Coal Council ("ICC") tried to paint the picture that the treatment of how coal options were modeled made the difference in their competitiveness. This is not the case. In the 2016 IRP, all coal options were levelized, and all coal was retired based on economics. In

the 2019/2020 IRP, Vectren explored more resource options within the IRP, simultaneously. This required the model to be able to break existing coal resources into multiple paths (retire, convert to natural gas, or remain open). The outcome of the decision point was reflected in 2024. In order to facilitate this optionality, Pace Global's model included capital spend required to keep the Brown units operational (conversion, continue with existing scrubber, or replace existing scrubber) beyond 2024. These options required spend prior to 2024 to allow the units to comply with environmental regulations. As described in a data request to the CAC, Pace noted that the model is able to discern competitiveness among resources, regardless of method if the capital spend is included early in the forecast.[13] Coal is not uneconomic because of how Pace Global treated the resource within modeling; the answer would have been the same had Pace Global levelized these costs. The fact that coal is not the most economic resource is well demonstrated in other IRPs within the state and around the nation. That being said, Vectren believes in resource diversity; as such, Culley 3 was included in the preferred portfolio, just as it was in 2016." *(Vectren Response to Stakeholder Comments page 3)*

Director's Response

The Director is not sufficiently familiar with the Aurora model to render judgement about Vectren's frontloading of capital costs and the possible impact on the results.

The Director thinks the inclusion of annual revenue requirements is a helpful addition in Vectren's IRP. It should not be surprising that the early years are very close and that future results will increasingly diverge to better reflect future changes, technologies, public policy, and risk. This reflects that any changes in the resource portfolio are being phased in over a period of years.

The Director believes the ICC unreasonably criticizes Vectren for its modeling of carbon regulation using a carbon price instead of modeling a Renewable Portfolio Standard (RPS) for achieving net zero emissions by a set date. It is impossible to know how and when government will implement a carbon policy so one must make a reasonable attempt to evaluate potential implications given this extensive uncertainty. Vectren developed five scenarios that were fully optimized, and each scenario reflected a different assumption about CO_2 regulation. The range included modeling the ACE Rule, a low CO_2 tax, a high CO_2 tax based on the social cost of carbon, and an aggregate national CO_2 emissions cap.

The Director is not quite sure what the ICC is criticizing Vectren for regarding MISO's evaluation of the potential impact of increasing levels of renewables penetration, especially as penetration of renewables in the MISO region exceeds 30 percent. The ICC seems to believe that Vectren has significantly understated the complications and costs associated with increasing levels of renewables penetration. As the ICC seems to understand, the real issue over time is how individual utilities include MISO-wide considerations of the changing regional resource portfolio in the IRP process to evaluate alternative utility-specific resource choices.

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[13] CAC DR 4.4 "…The resources that were modeled as upfront investments included modifications to existing resources, for example adding an environmental control option or a conversion from coal-firing to natural gas-firing. These costs were modeled as upfront because they occurred early in the forecast (end of 2023) with 16
years remaining in the study period, a sufficient amount of time for the model to adequately compare the economics to alternatives. "

Indiana Office of Utility Consumer Counselor (OUCC)

The OUCC had several concerns and positions about the analysis and results of Vectren's IRP.

a. The OUCC had a concern with Vectren's near-term projection of industrial load. Vectren is projecting industrial sales increases of 8.7% in 2020, 4.4% in 2022, and 8.4% in 2023. These large increases stand in sharp contrast to increases ranging from 0.3% to 0.6% in all other years of the planning horizon. When compounded, those three large increases result in a 23% increase in industrial sales, which would be a highly unusual increase in sales over just a few years. Without better justification, the OUCC is concerned Vectren's forecast of industrial sales and related need for capacity are too high. *(OUCC Comments 2)*
b. The OUCC notes a most basic form of flexibility is provided by minimizing capital expenditures and making use of already-owned facilities – especially the potential for converting the Brown units to burning natural gas instead of investing in CT facilities. However, it appears Vectren used unreasonably high conversion costs. Information provided in discovery indicates Vectren expects the capital cost of the conversion to be over $500 per kW compared to costs for IPL in the range of $150 to $200 per kW a few years ago. Further, Vectren assumes ongoing costs of O&M after a gas conversion are even higher than if the plant continued burning coal. This higher O&M cost stands in contrast to FERC Form 1 data for IPL's Harding Street station, which showed O&M cost going down significantly after conversion.
c. Vectren exaggerated its avoided capacity costs by including the cost of a gas pipeline. Neither the pipeline, nor the turbines, are costs Vectren's DSM savings will avoid. In calculating an avoided T&D capacity cost, Vectren employs a "rule of thumb" of 10% of the avoided generating capacity costs. There is no relationship between reductions in demands on the T&D system and decreased demands caused by DM activity. No Indiana utilities approach this topic in a consistent manner.
d. Vectren uses a carbon tax in its IRP analyses as a proxy for possible carbon legislation. There is little consistency among Indiana utilities in their attempts to estimate carbon taxes. The Commission should determine and implement a reasonable and consistent carbon tax used in IRP analyses in Indiana.
e. The OUCC is concerned that Vectren is forcing Culley Unit 3 to remain online. The Commission has already approved the ELG/CCR compliance costs in Cause No. 45052 ($62 million). However, the Commission's approval of these projects should not be interpreted to automatically assume Culley should continue operation. The whole point of the IRP process is to determine the most cost-effective resource plan that is flexible throughout multiple scenarios. There is only one scenario where Culley 3 is retired early, and this does not occur until 2030.
f. The OUCC is concerned with Vectren's electric vehicle forecasts. Vectren is forecasting accelerated vehicle ownership with 255 vehicles in 2019 increasing to 5,648 in 2023. Vectren's overestimated electric vehicle energy consumption artificially increases sales growth. Specific studies for electric vehicles in Indiana have not been performed. Without a reliable indicator regarding future market penetration, Vectren should be conservative in its forecasting.

<u>Vectren's Response</u>

Vectren provided the following response to the OUCC's concern about the industrial load forecast being too high:

> "OUCC and Joint Commenters both were concerned with the load forecast being too high, particularly expressing concern with Vectren's industrial sales forecast. As described in the IRP, Vectren utilized its internal estimate for large sales in the first 5 years of the forecast and then relied on modest long-term annual growth estimates thereafter. This process ensures that Vectren captures large, expected shifts in load, up or down, based on conversations/negotiations with Vectren's largest active and prospective customers. Estimates from large customers not only feed Vectren's integrated resource planning but also the company budget and are submitted to MISO. Vectren only includes projects with the most certainty within the forecast. Large shifts in load must be accounted for outside of econometric modeling. For example, when a large customer recently installed a co-generation facility, there was drop of about 80 MWs in the year that it was installed. A drop of this magnitude cannot be predicted within econometric modeling, nor is it reflective of potential future drops in large customer load. Additionally, Vectren continues to engage in confidential negotiations with potential customers for large load additions." *(Vectren Response to Stakeholder Comments pages 2 – 3)*

Vectren also addressed the OUCC's concern regarding the conversion capital and O&M cost estimates used by Vectren in the IRP:

> "While the OUCC was appreciative of Vectren's stakeholder process, they had concerns with the evaluation of gas conversion options within the IRP. Based on feedback from the last IRP, Vectren fully evaluated natural gas conversion options within the 2019/2020 IRP. While none of these options were selected economically, several were included within scenario and probabilistic modeling as a part of the full risk analysis. The OUCC's concerns lie in the cost estimates that were utilized within modeling. They noted that Vectren's modeled capital cost for conversion exceeded $500 per KW. This is not the case. Vectren utilized Black and Veatch, a well-respected engineering company, to develop -30%/+ 50% cost estimates for conversion of resources. Three portfolios included site-specific cost estimates for the AB Brown plant. Vectren was unable to determine the OUCC's source for the claim. The real number that was modeled was approximately $280 per KW (not counting AFUDC) to convert AB Brown 1&2 to natural gas. OUCC cited a range of $150-$200 per kW for conversion of IPL's Harding Street plant. From publicly available information, Vectren verified that approved costs at Harding were at the top end of the estimate accounting for inflation at approximately $190 per kW.
>
> While there is a cost difference from the Harding Street plant number, it is not more than double and within the estimated range utilized by Vectren. Vectren in no way "stacked the deck" against conversion options as the OUCC asserts. As mentioned above, an independent third party produced a credible, site-specific estimate.
>
> Additionally, the OUCC had concerns about ongoing O&M costs for gas conversion. Vectren would like to clarify that firm gas supply was included in ongoing O&M estimates within modeling inputs, which caused the O&M to appear higher after conversion. Vectren believes that firm gas supply is a prerequisite to ensure reliability, allowing for the units to run when needed, 365 days per year. Conversion of two Brown units would require more firm gas supply than two CTs; cost estimates were therefore higher for conversion. Following completion of the IRP, Vectren confirmed that the price estimate for gas supply to the Brown site was accurate." *(Vectren Response to Stakeholder Comments page 2)*

<u>Director's Response</u>

The Director agrees with the OUCC that the large increase in projected industrial sales in the next few years looks unusual. Utilities often make an adjustment in the first few years of an industrial load forecast to account for large changes that are thought to be missed by an econometric forecast that emphasizes historical trends and relationships. The issue of how to account for large near-term changes in load is not new. For this reason, the Director thinks a significant part of the IRP analysis needs to thoroughly evaluate the implications of a wide range of load forecasts, including large changes in the first five years of the planning period.

The Director thinks that the area of avoided costs used in developing the MPS and EE plans needs to be more thoroughly addressed in the IRP Stakeholder process. Also, the Director recognizes that the avoided costs used in the MPS and EE plan development necessarily differs from the avoided costs accounted for in the IRP models. Estimating an appropriate avoided cost proxy depends on what is being analyzed and the purpose of the exercise. Because of the inexact nature of a proxy for avoided costs, a range of possible avoided costs estimates is probably reasonable.

As for the OUCC's concern about not evaluating the possible retirement of Culley Unit 3, the Director noted above the desirability of allowing the IRP model to optimize at least one scenario with as few limitations as reasonably possible. The resulting portfolio may be unrealistic for any number of reasons, but the Director believes the information will be helpful by providing a better understanding of the potential impacts of various constraints that are analyzed.

City of Evansville

The City of Evansville supports Vectren's integrated resource plan. The City was pleased that Vectren anticipates approximately two-thirds of the energy included in the new plan will be produced from renewable resources and that Vectren's plan will save customers an estimated $320 million over 20 years.

AstraZeneca

AstraZeneca thoroughly reviewed Vectren's IRP and is fond of the strides Vectren is making to reduce the carbon footprint in the SW Indiana community. They are in strategic support of Vectren's efforts to use natural gas and renewables for generating electricity. Natural gas is proving to be a sustainable fuel from a reliability and cost perspective.

AstraZeneca is striving to be carbon neutral at its North American manufacturing sites by 2025. They are evaluating solar and cogeneration along with Vectren renewable options to reach its environmental impact goals. However, cost goals from federal government pressures toward pharmaceutical pricing are an important variable in its competition against sister plants all across North America including Puerto Rico.

They are concerned as well, with where regulated pricing from renewables accepted by the IURC will land Vectren considering its higher than state average for generation cost for coal plants in particular. They are in a region of the state of Indiana where electricity costs are considerably higher than the state average.

AstraZeneca is in full support of renewables for a cleaner state, but would hope that gas turbines of the highest efficiency are considered, voltage and VAR control aren't forgotten on the technical acumen front, and costs are held in reasonable check.

Advanced Energy Economy Indiana (AEEI)

AEEI makes four main points:

a. AEEI supports Vectren's proposal to significantly increase its use of renewable energy and storage in the short term because it will offer affordable energy to ratepayers and satisfy growing commercial and industrial demand for these resources.
b. Vectren could deploy EE programs, DR, and electric vehicles more aggressively to benefit customers, especially C&I DR.
c. Vectren could delay procurement of new CTs to avoid potential stranded assets. In its place, Vectren should rely more heavily on energy storage, DR, and the MISO energy market to supply capacity and to meet peak demand.
d. Vectren should seek to continuously improve its IRP modeling and implement a transparent, modern distribution system planning process.

(AEEI Comments page 2)

AEEI draws particular attention to Vectren's recent investment in advanced metering infrastructure (AMI) across its territory, providing an opportunity to capitalize on the enhanced functionality of AMI, including the collection and use of granular customer meter data to create innovative programs that help shape load, reduce peak demand, improve integration of DERs, and enhanced opportunities for greater EE achievement. Improved management and integration of demand-side resources can help Vectren make better use of existing generation resources, improve reliability, and avoid the need for investments in new generation resources. *(AEEI Comments page 6)*

AEEI also appreciated Vectren's work to date forecasting EV load growth and analyzing its potential impacts on the system. Vectren recognizes that greater charging station usage will require it to adjust to changing load shapes as well as consider generation reserves, transmission and distribution planning, and incentives for smart charging behavior. In future modeling, Vectren should include realistic assumptions about EV growth and charging impacts on the system. This work can then inform the creation of managed charging programs and EV rates that maximize EV benefits to the grid, which will feedback into Vectren's IRP modeling. *(AEEI Comments page 8)*

Vectren should seek to improve its resource planning methodologies by using enhanced analytical tools that capture the full diversity of supply-side and demand-side resources with sufficient granularity. To the extent possible, assumptions and timelines should be synced between generation, distribution, and transmission planning. This will allow Vectren to find the most cost-effective solutions, whether that be a generation facility, distribution network upgrade, transmission asset, or a non-wires alternative. Implementing a modern distribution system planning process that allows for stakeholder input and enhanced coordination and consistency with the IRP planning process is also an important step towards planning optimization. *(AEEI Comments page 10)*

<u>Director's Response</u>

The Director agrees with AEEI that the implementation of AMI across the Vectren service territory makes possible an array of new types of analysis that can improve, among other things, load forecasting, distribution system planning, the evaluation of alternative rate designs, and the understanding of how different choices by customers interact with the planning and operational decisions a utility must make. How best to use this data will evolve as will the capability of the models used in the different types of planning and studies.

It is very likely that net load shapes will change as different DERs are added to the system. Better models and data will be necessary if utilities and customers are to make informed decisions about various energy resources given how these choices interact with each other. For example, one possible area of interest is how increasing amounts of DERs and utility-scale intermittent renewables with virtually zero marginal cost interact with and affect the evaluation of EE and different rate designs.

Sierra Club

Sierra Club has two core concerns about Vectren's IRP. First, Vectren should reevaluate its decision to sink customers' money into Culley Unit 3 now that the Effluent Limitations Guidelines (ELG Rule) has been revised to allow that unit to operate through 2028 with no additional ELG Rule capital spending. In 2019, the Commission granted a Certificate of Public Convenience and Necessity (CPCN) to allow Vectren to charge the costs of a Culley Unit 3 retrofit – $62 million – to ratepayers based on the ELG Rule that existed at that time. Since that CPCN was issued, however, the ELG Rule was changed, allowing operators to avoid such extensive retrofit costs if the facility retires by 2028. Vectren should reevaluate the economics of Culley Unit 3's continued operation after this date and assess whether the retrofit costs are worth its continued operation. *(Sierra Club comments page 1)* As Vectren began the IRP development process, the U.S. EPA proposed a revision to the ELG Rule that allowed a utility to avoid converting to dry ash handling by the then-existing December 2023 deadline if the unit was committed to cease coal-burning by December 2028. Vectren's 2019/2020 IRP neglects to study the economics of Culley Unit 3 under the revised ELG Rule. *(Sierra Club comments pages 2 – 3)*

Second, Sierra Club asked that the Commission staff caution Vectren against proceeding with procuring two large combustion turbines (CTs) because Vectren failed to weigh the risk that these units would become stranded assets during the otherwise expected useful life.

<u>Director's Response</u>

As stated above, the Director thinks Vectren should have allowed the IRP optimization model to evaluate the early retirement of Culley Unit 3. The decision to continue operation of a unit or to retire the facility by a specific date is complicated and requires the weighing of numerous objectives, many of which will involve conflicts. Circumstances are changing continuously, and the potential implications of these changes needs to be fully developed for proper consideration when making resource commitment decisions.

The Director will not provide a substantive response to Sierra Club's second core concern except to note that Vectren was clear about their decisions and why they made the choices they did. Developing a resource plan is extremely complicated in a world with an unknowable future and long-lived resource commitments, so it is critical for the utility to be clear how they used the information developed.

Citizens Action Coalition, Carmel Green Initiative, Earthjustice, Solarize Indiana, Solar United Neighbors of Indiana Solarize Indiana Valley Watch, and Vote Solar (Joint Commentors)

"Vectren deserves significant credit for the marked improvement it exhibited throughout this IRP in contrast to its prior IRP. In our comments on Vectren's 2016 IRP, we concluded that the 2016 IRP suffered from major…flaws." (JC page 4) Vectren has diminished many, but not all, of these concerns. For example, in the 2016 IRP, Vectren assumed wind and solar costs that were well above the prices seen at the time. For this IRP, Vectren issued an all-source request for proposal ("RFP") to collect real-world data to characterize its near-term resource choices. However, in the post 2024-timeframe, Vectren used an averaging approach that puts storage costs well above current, publicly available projections. Vectren then inappropriately shifts these costs for all renewables and storage two years forward in time, effectively double counting the construction period." (JC Comments page 5)

Joint Commenters raised the main categories of concern about Vectren's IRP:

a. Joint Commenters expressed concerns that the lack of avoided cost that include distribution related costs will underestimate the value EE. The Joint Commenters also contends that Vectren grouped EE into bundles in manner that is inconsistent with how those measures would be offered.

b. The Joint Commenters said there is a substantial improvement in Vectren's commercial load forecasting methodology but continued to be concerned about Vectren's industrial sales being exaggerated. According to JC, Vectren continues to rely on an internally developed near term industrial sales forecast that cannot be validated.

c. Joint Commenters expressed concern that Vectren applied its reserve margin requirement to all months of the year rather than just the MISO system coincident peak demand. Vectren assumed a seasonal capacity value for wind and solar resources that is lower than that based on MISO's guidance. If Vectren would use MISO's seasonal capacity value methodology, it would eliminate the need for the proposed combustion turbines.

d. Joint Commenters said Vectren improperly modified one of the solar RFP bids to limit the number of projects that could be selected. Similarly, non-RFP solar, wind, and battery storage resources were not allowed to be selected until 2025. Vectren, according to Joint Commenters inappropriately shifted the capital cost projections for new solar, wind, and battery storage resources.

e. From Joint Commenters' perspective, Vectren assumed unreasonable cost savings for building the second combustion turbine in 2025.

f. Joint Commenters expressed concern that Vectren use of the Aurora model limited access to the model's input and output files along with the model manual.

(Joint Commenters' Comments page 5)

Joint Commenters expanded on all the areas of concern shown above but only some of these more detailed expressions not addressed in other stakeholder comments of concern are summarized here.

Joint Commenters had a couple of interrelated concerns regarding how Vectren modeled a potential move by MISO to a seasonal planning construct. Joint Commenters understood Vectren as applying a reserve margin requirement to the peak month and then applied the resulting planning reserve margin requirement to all months of the year while modeling a monthly capacity credit for wind and solar resources. *(Joint Commenters' Comments page 14)*

Joint Commenters had no issue with capturing the uncertainty of MISO's PRM going forward, but was concerned that Vectren modeled this uncertainty in one specific way. More specifically, that Vectren applied the reserve margin requirement to its annual peak load to determine the total requirement and then enforced that PRMR across all months of the year. Joint Commenters'' was concerned that the difference in Vectren's summer and winter peaks over the planning period will likely lead to an overbuild of the system and result in unnecessary costs to ratepayers. *(Joint Commenters' Comments page 15)*

In addition to modeling a monthly reserve margin requirement, Vectren also modeled a summer and winter capacity credit for wind and solar resources. For solar, Vectren modeled a seasonal ELCC that starts out in 2022 at 29% for the summer months and 7% for the winter months. For wind, Vectren modeled a seasonal ELCC of 7% for the summer months and 16% for the winter. That these figures were based on MISO's RIIA Phase 1 study. But that more cent MISO studies show solar would not reach an ELCC of 29% until solar in the MISO region reaches about 46%. Thus, Vectren's solar ELCC assumption of 29% is extremely pessimistic. *(Joint Commenters' Comments page 18)*

In addition to applying annual constraints for the renewable resources modeled between 2025 and 2039, Vectren also modified one of the solar RFP bids in order to limit the amount of solar that could be selected by the model. Model files indicated there were modifications for all projects related to a specific solar RFP bidder. Vectren changed the number of projects and the timeframe during which those projects could be selected. Modeling results showed the constraint Vectren imposed was binding and that the model most likely would have selected two more projects, it they had been offered to the model. *(Joint Commenters' Comments page 21)*

New supply-side resources were offered into the model with different assumptions depending on whether the resource represented an RFP bid or was modeled as a generic resource outside of the RFP. Vectren allowed the model to select the RFP bids between 2022 and 2024. Vectren then modeled generic resources for selection in different, subsequent years, depending on whether the resource was thermal or renewables and storage. New thermal resources could be selected by the model starting in 2024, while new generic solar, wind, and battery storage, and hybrid resources could not be selected by the model until 2025. The model took all 2024 RFP projects available to it, which is a strong indication that the model would have selected additional solar, hybrid, or energy storage in 2024, if they had been offered to the model. *(Joint Commenters' Comments pages 22 – 23)*

Joint Commenters' has concerns about the approach Vectren used to model EE bundles (or bins). Grouping EE bundles based on cost does not reflect how Vectren implements its DSM programs. The least cost bundles modeled in the IRP includes savings only from the least expensive measures. Those measures together would not provide a coherent EE program. Ultimately, Vectren will implement some measures included in bundles selected by the model, but other measures implemented will be from bins not selected by the IRP model. Unavoidably, cost-effective measures will be eliminated from implementation because, under this modeling approach, the connection between the IRP and DSM plan is based merely on the level of savings in the preferred plan. Joint

Commenters think this method could be masking a result that even more EE would be cost-effective. *(Joint Commenters' Comments page 40)*

Vectren's Response

Vectren providing the following response regarding Joint Commenters' concerns on resource accreditation and reserve margin modeling:

> "Joint Commenters suggest that Vectren's preferred portfolio is overbuilt and that Vectren does not need to build a second CT. They suggest that MISO's projected changes to accreditation of renewable resources should be a scenario, not a reference case assumption. Since filing the IRP, changes to MISO resource accreditation has become more certain, not less. In the December 2020 MISO Resource Adequacy Sub Committee meeting, MISO indicated that sub-annual planning and Planning Resource Auction reform are imminent. Concept design is expected in the first quarter of 2021, with a FERC filing following in Q2-Q3 of 2021. While the final design is yet to be shared, all presented options indicate the need to consider resource accreditation sub-annually. Vectren is not speculating about this reality, it is responsibly planning for it by considering how much resources could be accredited in the winter and the summer. "
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> "The Joint Commenters appeared to misunderstand how Vectren ultimately implemented a summer/winter construct. While Vectren tried to model winter and summer accreditation during portfolio development, this proved to be too difficult. Vectren ultimately built portfolios based on summer peaking requirements, as done in the past; however, Vectren ensured portfolios would meet both summer and winter requirements. This is particularly important with solar resources, which are expected to receive little to no accreditation in the winter. As such, portfolios that have too much solar pose a big risk to Vectren and its customers (more discussed below). "
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> "Additionally, Joint Commenters don't deny that MISO's Effective Load Carrying Capability ("ELCC") treatment of wind and solar resources will mean lower future accreditation of these resources; they simply say that Vectren is overstating the potential buildout of solar will happen as fast as predicted in Vectren's IRP. Even if the steep drop in accreditation of solar resources occurs a few years later, this does not point to the need for more solar resources. Vectren's preferred portfolio calls for 700-1,000 MWs of solar. The range was provided to help ensure that Vectren adds solar resources responsibly as to not overbuild." *(Vectren Comments pages 5 and 6)*

Vectren provided a response as to the limits on solar selection by the IRP optimization model:

> "As described on page 248 of the IRP, Vectren chose to limit solar resources within optimization modeling to 1,150 MWs, about the amount of its peak load, in years 2023 and 2024. As mentioned in the IRP, there is risk in heavily weighting a portfolio with too much of any one resource. This is particularly true with solar, as MISO moves towards seasonal accreditation for resources. As discussed in the IRP, portfolios that may be able to meet the current MISO construct, may receive zero accreditation in the winter…Beyond Vectren's stated goal for resource diversity, Vectren believes that a staged approach to incorporating large amounts of solar resources protects customers and ensures reliability… It should be noted that Vectren did include portfolios for the risk analysis with greater levels of solar

resources, one of which was included in the final four portfolios." *(Vectren Comments page 6)*

Director's Comments

The Director is not sure he understands the Joint Commenters' concerns about organizing EE bundles based on measure cost. The Director thinks organizing the measures into bundles based on costs provides a reasonable means of understanding at what level of costs EE is competitive with other resource options as represented in the IRP optimization model. Resource optimization is always based on relative costs and this approach provides helpful information on the cost-effectiveness of EE compared to other potential resources. The Director, of course, recognizes that IRP models normally don't include all components of avoided costs and that there remain substantial questions as to how to measure various types of avoided costs. Nevertheless, the Director believes the type of bundling methodology used by Vectren provides some insights into the cost-effectiveness of EE.

As stated above, the Director would like to see some model optimizations with a minimum of constraints on resource choices, both on an annual basis and aggregated over the planning period. The Director believes there are real reasons to limit or constrain model choices, but that the minimally constrained analysis can provide critical information to better understand the impacts of various constraints that are added in subsequent analysis.

The Director also understands the intent of Vectren when it tried modeling a seasonal planning reserve margin and resource accreditation. Vectren's experience demonstrates the complexities that may have to be addressed as MISO implements different resource planning requirements. Vectren explored the implications of a seasonal reserve margin and modified its modeling when the results were unreasonable.