Training on Integrated Resource Planning for South Carolina Office of Regulatory Staff

Conducting a Technical Review of an IRP

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Conducting a Technical Review of an IRP

- Introduction and Basics for Reviewing IRP
- Overview of Best Practices for Reviewing IRP
  - Compliance with South Carolina IRP Requirements/Parameters
  - Common Issues Across Jurisdictions for Reviewing IRPs
- Reviewing Utility IRP Results for Internal Consistency
  - Action plan recommendations
  - Action plan rationale
- Reviewing Input Assumptions
  - Load Forecast
  - Resource Characteristics
  - Future Conditions (e.g., fuel & market prices, environmental regulations)
- Review Analytical Methodology
  - Resources Optimization
  - Treatment of Uncertainty/Risk

Reviewing “Philosophically”

- The ***goal*** of a review is to assess whether the proposed actions (i.e. “the plan”) is:
  - ✓ Consistent with statutory and regulatory requirements
  - ✓ Supported by objective analysis and methodology
  - ✓ Based on the best information available
  - ✓ Acknowledges and reflects uncertainty
- Critiques are based on challenges to data, methodology and “rationalizations” -- not on differing views of the future

> “Strong minds discuss ideas, average minds discuss events, weak minds discuss people.”
>
> Socrates

Overview of Best Practices for Reviewing an IRP: IRP Must Satisfy South Carolina and Other Regulatory Requirements

- Contains the *demand and energy forecast* for at least a fifteen-year period
- Contains the *program for meeting the requirements* shown in its forecast in an *economic* and *reliable* manner, including *both* demand-side and supply-side options
- Contains a brief *description and summary cost-benefit analysis*, if available, of each option which was considered, including those not selected
- Sets forth the assumptions and conclusions with respect to the effect of the plan on the *cost and reli*ability of energy service
- Describes the *external environmental and economic consequences* of the plan to the extent practicable
- For electrical utilities subject to the PSC's jurisdiction, consistent with the integrated resource planning process adopted by the commission
- Meets state and/or regional reliability standards (e.g., NERC planning and operating reserve margins)

Overview of Best Practices for Reviewing an IRP: Issues Common Across Jurisdictions Reviewing IRPs

- Data requests and data confidentiality
- Commission action in response to IRP (e.g., approve, approve with modifications, deny)
- Remedies for an IRP that is deficient or non-compliant
- Constant cycle of improvement
- Outcomes or actions that trigger an IRP filing requirement (outside of normal filing requirements)

Reviewing Utility IRPs: Overarching Questions

- Action Plan Recommendations
  - What is the resource plan?
  - What is the implementation plan?
  - What is the plan to improve the planning process and future IRPs?
- Action Plan Rationale
  - Does the analysis support the resource plan?
  - Does the analysis support the implementation plan?
  - Does the analysis support the plan to improve the IRP process?

Action Plan Recommendations – What's the Resource Plan?

- Is there a clear statement of the principles on which the IRP is built?
- Is there a clear statement of a resource development plan or strategy?
  - Near Term Resource Development – What are the actions that will be taken and the timing of decisions that must be made ***prior*** to the completion of the next IRP?
  - Mid- and Long-Term Resource Development – What are the actions that can be taken and the timing of decisions that can be made ***after*** to the completion of the next IRP?

Example of Utility Planning Principles

RELIABILITY — Each plan analyzed was required to meet the reliability planning requirements established by MISO

AFFORDABILITY — Affordability was measured by the yearly impacts to the revenue requirement

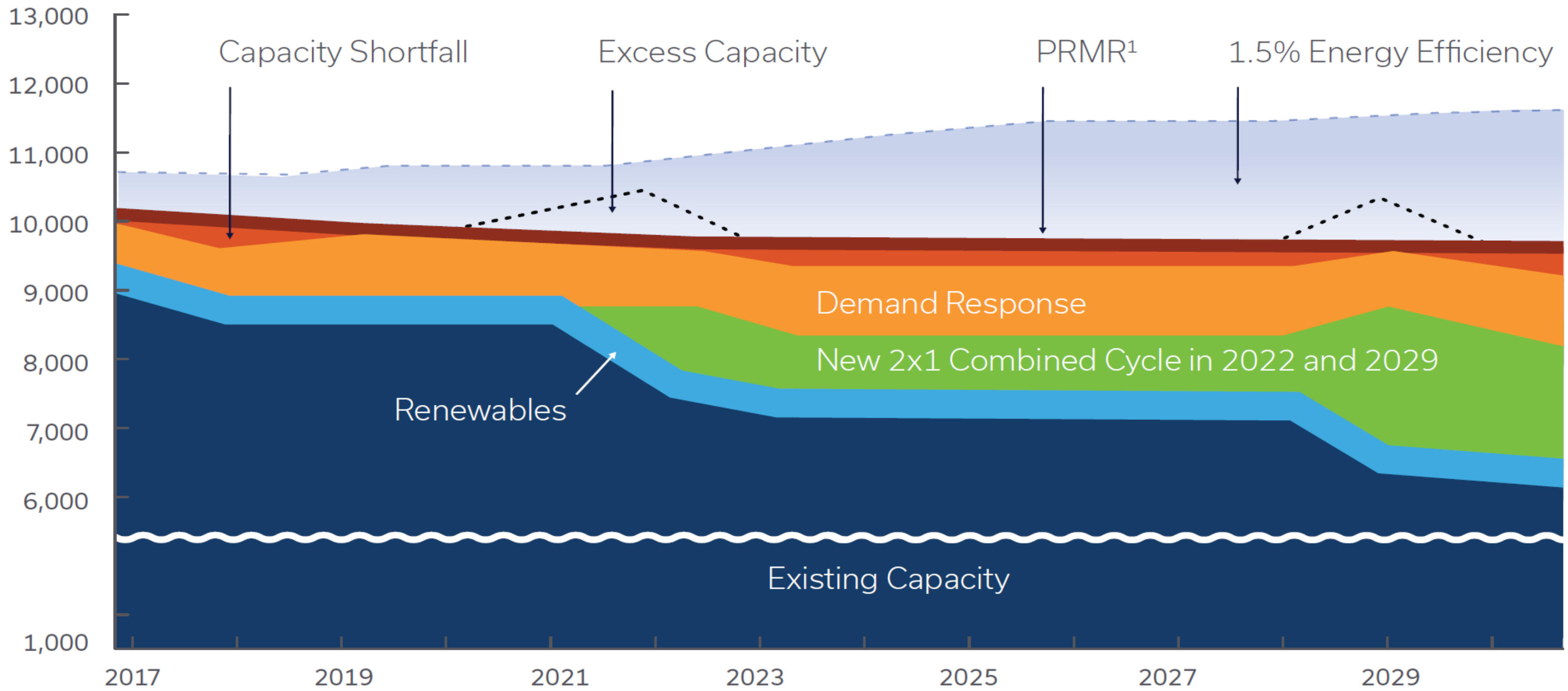
CLEAN — Environmental sustainability and low carbon aspirations were considered as major factors in the determination of the recommended resource portfolio

FLEXIBLE AND BALANCED — The resource plan needs to be flexible, having the ability to adapt to unforeseen changes in the market. Additionally, it must have a well balanced mix of resources so that it is not heavily reliant on the market or one source of generation

COMPLIANT — All resource plans were modeled to be compliant with the 6(s) requirements as well as environmental regulations

REASONABLE RISK — The Company desires a portfolio that minimizes risks related to commodity and market pricing, fuel availability, grid reliability, capacity constraints, operations and evolving regulations

Example of Utility Preferred Resource Plan



Example of Utility Preferred Resource Plan Type, Amount and Timing

DTEE 2017 IRP				
Category	**Project**	**Description**	**MW[1] Impact**	**Years of implementation**
Energy Efficiency Resources		Expand Program in harmony with PA 342	1.5% Sales annually	2018-2030
Demand Response Resources	Interruptible Air Conditioning	Incremental increase from 2017	125 MW[2]	2018 to 2023
Renewables	Solar Wind	Expand Renewable Portfolio to meet PA 342	30 MW[3] 107 MW[3]	2017-2025
Generic CHP	New Project	Possible CHP installation	35MW	2020
Fossil Unit Retirements	River Rouge 3 St. Clair 1-4, 6 & 7 Trenton 9 Peakers Belle River 1 & 2		-234 MW -1215 MW -430 MW -17 MW -998 MW	2020 2022, 2023 2023 2020-2023 2029-2030
Replacement CCGT	Proposed project	Addition of 2x1 Combined Cycle	1067 MW 1067 MW	2022 2029
Pumped Storage Upgrades	Ludington 1-6	Efficiency increase and capacity improvement of pumped storage	227 MW	2017-2020
Market Purchases		Used to balance short term capacity position	up to 300 MW	2022-2040

1. Impact is UCAP (i.e. MISO capacity credit)
2. 135 MW adjusted for PRMR and Transmission Losses
3. Nameplate for solar is 60 MW and wind is 686 MW

Action Plan Recommendations – What's the implementation plan?

- Is there a clear statement of the actions that the ***utility*** will to take facilitate the implementation of the IRPs resource development plan or strategy?
  - Secure Certificate of Necessity
  - Issue RFP
  - Initiate siting and licensing process
  - Initiate or expand new EE or DR programs
- Is there a clear statement of the recommended actions that ***external parties*** could take to facilitate the implementation of the IRPs resource development plan or strategy?
  - Are there recommendations for revisions to existing or new legislation needed to facilitate implementation of the preferred resource strategy/plan?
  - Are there recommendations for changes to commission rules or orders (IRP, distribution planning, tariffs) needed to facilitate implementation of the preferred resource strategy/plan?

Example: Short-Term Implementation Plan Items

Utility will also continue to:

- Expand renewable generation portfolio to meet the requirements of Act No. 342 Public Acts of 2016
- Continue the EO program in harmony with the requirements of Act No. 342 Public Acts of 2016
- Offer service options for customers, including EO and voluntary renewable energy programs
- Maintain its industry-leading position in the utilization of demand response resources
- Keep generation plants running safely, reliably, and cost effectively until scheduled retirements
- Complete Ludington expansion
- Seek approvals as appropriate to implement its plan, including the CON filing to add a combined cycle

Action Plan Recommendations – What is the plan to improve the planning process and future IRPs?

- Is there a clear statement of actions the utility will take to continuously improve the planning process and future IRPs?
  - What are the utility's plans for development and maintenance of data and analytical capabilities (e.g., updating resource potential assessments, tracking or demonstrations of emerging technology, model enhancements)?
  - What load research projects will be undertaken to facilitate DER planning?
  - What utility-sponsored research and demonstration projects on emerging technologies are planned to address data gaps or reduce uncertainties?
  - What actions are planned to improve the ability of IRP modeling tools (forecasting, distribution planning and capacity expansion) to treat DERs as resource options?
  - What actions are planned to improve the ability of IRP modeling tools (e.g., capacity expansion model) to treat uncertainty and risk?

Action Plan Rationale –
Does the analysis support the resource plan?

- Does the analysis support the type, amount and timing of resources proposed for development?
  - Which scenarios/sensitivity studies serve as justification for the preferred resource strategy?
  - What input assumptions are most critical to the success of the preferred resource strategy (e.g., low gas prices, high load growth, new technology)?
  - What assumptions make the preferred resource portfolio vulnerable to increased risk (e.g., low gas prices, high load growth, new technology, GHG regulations)?
    - Are any of these input assumptions beyond the control of utility decision makers?
    - If so, does the IRP explore the sensitivity of the preferred portfolio to the risks presented by these input assumptions?
  - What actions are proposed to hedge against risk in the preferred portfolio (e.g., fuel price hedging, resource development in lieu of market reliance, market reliance in lieu of resource development, less reliance on GHG-emitting resources)?
    - What is the justification for the proposed risk mitigation actions?

Action Plan Rationale – Does the analysis support the implementation plan?

- Does the analysis support proposed policy recommendations to facilitate implementation?
- Does the utility require approval of new tariffs or pilot programs for resources included in its plan?
- Does the utility require a certificate of need for resources included in its plan?

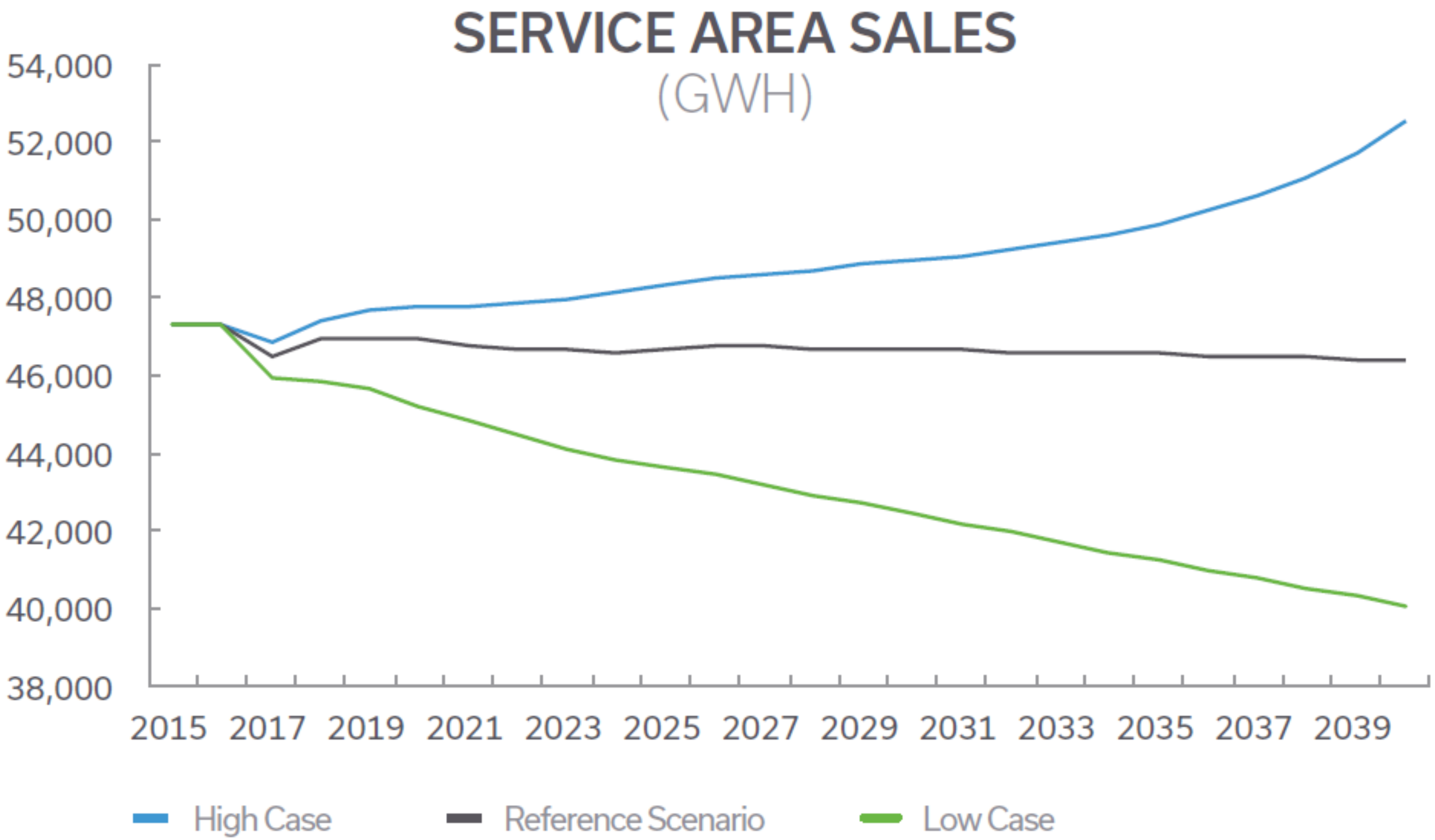
Action Plan Rationale –
Does the analysis support the plan to improve the planning process and future IRPs?

- Does the analysis support the action plan recommendations on ways to continuously improve the planning process and future IRP?
  - Are the limitations or uncertainty surrounding data inputs described?
  - Are the constraints of models and modeling approach discussed?
  - Are specific model or modeling system enhancements described that could address identified constraints?
  - Are potential improvements in stakeholder engagement described or discussed?

Reviewing Utility IRP Inputs

- Load Forecast
  - Role and Range
  - Consistency with EE and DR Potential Assessments
  - Treatment of *Known* (codes and standards) and *Unknowns* (customer behavior, economic cycles and technology change)
- Resource Characteristics
  - Energy Efficiency
  - Demand Response
  - Distributed Generation & Storage
  - Utility Scale Generation & Storage

Utility Load Forecast Range Example



Reviewing Input Assumptions
Load Forecast – General Issues

- Does the Load Forecast Assume a "Frozen" Baseline or "Dynamic Baseline"?
  - *Frozen* - only stock turnover and known codes and standards produce efficiency gains
  - *Dynamic* - embeds ongoing EE programs and *may or may not* include impact of known codes and standards
- Are the load forecast scenarios reasonable, including the range from low to high?
  - Is there a range forecast as well as a "reference" or "baseline" forecast?
  - How was the range forecast developed (i.e., what is rationale underlying the low and high forecast)?
  - Was the range forecast used in the analysis of resource plans (i.e., was the preferred portfolio based on the "reference" forecast only, or was the entire range of load growth considered in its selection)?
- Is the utility's load forecast(s) for IRP consistent with other utility filings?
  - If not, is there an explanation of why different forecasts were used?

Reviewing Input Assumptions
Load Forecast – General Issues

- Is the load forecast(s) consistent with the DER potential assessment?
  - Is there a discussion of the "calibration" between the energy efficiency potential assessment and load forecast(s)?
  - Does the energy efficiency potential vary with the load forecast (i.e., is there greater potential in the high forecast than in the low forecast)?
- Are known DSM programs and policies, including but not limited to codes and standards, reflected in the load forecast?
  - Is there an explanation (with quantification) of the impact of recently adopted federal efficiency standards on future loads?
- Does the forecast reflect customer adoption of distributed energy resources in the baseline and/or as sensitivity studies?
- Does the forecast reflect adoption of electric vehicles in the baseline and/or as sensitivity studies?

Example Load Forecast – Specific Issues

From the IRP - Electricity sales in the Residential class were forecast by an end-use method including 39 different appliances or appliance groups. For each forecast year, three separate items were forecast: number of residential customers; saturations of major appliances; and average electricity use per appliance. For each appliance, the product of these three forecast values yields the annual electricity sales.

Questions *– 1) Do the assumed number of appliances and use per appliance match those assumed in the assessment of energy efficiency potential? 2) Where is this documented or discussed? 3) Since the number of new homes, water heaters and appliances vary with the pace of load growth, does the efficiency potential also vary with load growth?*

From the IRP - The federal government has enacted energy efficiency standards for many appliances. The end-use approach incorporates projected increases in energy efficiency of the various appliances into the Residential class electricity sales. The Company uses federal efficiency standards to determine the decrease in use per appliance. As most customers do not buy a new appliance just because a more energy efficient one becomes available, the Company phases in the decrease in energy usage, which over time drives down residential customer electricity usage.

Question *– 1) Which standards are reflected in the load forecast? 2) How did the Company "phase in the decrease in energy use" to reflect the impact of standards?*

Example Load Forecast – Specific Issues

From the IRP - Sales for most sectors of the Commercial class were forecast using regression models. Explanatory variables included county level employment, local automotive production and population. Other markets, such as agricultural supply, farming and apartments, were forecast with time trend models and were combined with the previous regression models to obtain total Commercial class electricity sales.

***Questions**: The Commercial sector forecast is based on econometric trends based on historical relationships between the dependent (sales) and independent variables (employment, automotive production and population). 1) Please describe how this sectors load forecast was calibrated to the assessment of energy efficiency potential? 2) "Efficiency Standards" do not appear to be one of the independent variables used in the load forecast. Please describe how this sectors load forecast reflects the impact of recently enacted federal efficiency standards?*

From the IRP - The Hourly Electric Load Model (HELM) was used to forecast annual (*utility*) Service Area and Bundled peak demand. HELM was developed by the Electric Power Research Institute (EPRI) and aggregates hourly demand profiles from various sales categories or end-uses into a system annual load shape.

***Questions** – 1) Are hourly end use load shapes used in HELM the same as those used to determine the capacity savings from energy efficiency measures? 2) Are the hourly load shapes used in HELM used as inputs to the resource adequacy and capacity expansion models?*

A Caution About the Relevance of Load Forecast *Accuracy* for Planning

5.4 Forecast Accuracy

Utility tracks its forecast accuracy on a year-ahead basis. Based on data from 2010 [illegible] mean absolute percentage error (MAPE) for temperature-normalized Service A[illegible] emperature-normalized peak is 0.9 percent. At the custom[illegible] for Residential, 1.4 percent for Commercial, and [illegible] and 5.4-2 compare the forecasts to actual temperature-norm[illegible] Service Area sales and peak, respectively.

There are no "facts about the future."

- ❑ Electricity load forecast rely on other *forecast* "drivers" – all of which have their own uncertainties
  - ➢ Population growth
  - ➢ Economic growth and income growth
  - ➢ Employment growth
- ❑ "Accuracy" measures how closely a forecast of sales was to actual sales when *historical* values for these drivers are used
  - ➢ Historical values used are often the same ones used to establish the statistical relationship between electricity sales and theses drivers
  - ➢ Historical relationships may not reflect future relationships due to structural changes in the economy such as the introduction of new technology (Evs) or adoption of new codes and standards (particularly a problem for long range forecast)

Reviewing Resource Input Assumptions
Energy Efficiency – General Issues

- Is the magnitude of technical and achievable potential relative to the utility's total load comparable to other recent EE potential studies?
  - Are there tables or graphs showing the annual and cumulative technical and achievable potentials by levelized cost "bins or blocks"?
  - Are the technical and achievable potentials (e.g., % of sector load, % of end use load) comparable to other utilities' EE assessments?
  - Are the annual and cumulative technical and achievable potentials' shares of technical potential comparable to other utilities' EE assessments?
- Are there separate estimates of the technical and achievable potential for lost-opportunity and non-lost opportunity resources?
- Are the baselines internally consistent with forecast units and energy use intensity applied in the load forecast?
  - Is there an explanation of how the assessment of energy efficiency potential was adjusted to reflect the impact of recently adopted federal efficiency standards?

Reviewing Resource Input Assumptions
Energy Efficiency – General Issues

- Are the maximum cumulative achievable penetrations based in total resource cost and/or consistent with the state's cost-effectiveness criteria?*
  - Are the ramp rates and/or cumulative potential savings constrained by assumed customer cost-sharing?
- Is the load shape of energy efficiency used in the capacity expansion/resource optimization model?
- Is the economic potential of energy efficiency determined independently of the capacity expansion model or through the resource optimization modeling process?

*Note: Modeling energy efficiency *as a resource option* in capacity expansion models requires that the total cost of its acquisition, including the full incremental cost of measures, program administration, marketing and evaluation, be used as an input. This allows the model to identify the maximum utility payment for measures that is cost-effective so that the total economic potential can be established.

Reviewing Resource Input Assumptions
Demand Response – General Issues

- Is the magnitude of technical and achievable potential relative to total load comparable with the most recent DR potential studies?
- Do deployment costs reflect experience in wholesale markets (e.g., PJM and ISO New England where DR can bid into forward capacity market)?
- Do maximum achievable ramp rates and cumulative savings reflect experience in wholesale markets (e.g., PJM and ISO New England where DR can bid into forward capacity market)?

Note: In addition to demand response, experience with the pace and cost of *energy efficiency* procurement in ISO/RTO wholesale markets may also be a relevant source of comparisons.

Reviewing Resource Input Assumptions
Demand Response – General Issues

- Are non-generation and self-generation options included?
- Is the range of services (e.g., capacity, wind integration) that demand response resource can provide fully characterized and considered?
- Is there a table or graph showing the annual and cumulative achievable potential of DR by levelized cost bin (MW-yr)?
- Is the economic potential of DR determined independently of the capacity expansion model or through the resource optimization modeling process?

Examples of EE and DR Resource Potential Assessment – Specific Issue Estimating EE and DR Development Cost

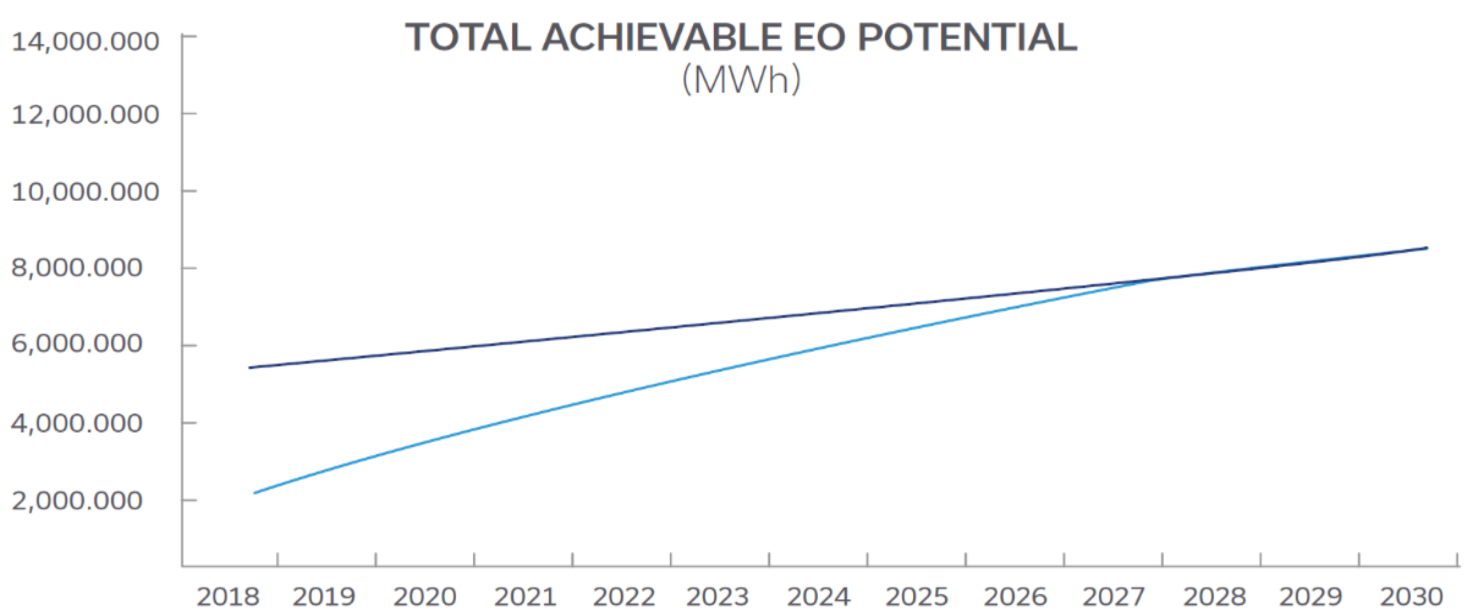
From the IRP - The demand response and energy efficiency potential studies provides a roadmap for determining the opportunities for cost-effective demand response and energy efficiency programs within the utility's service area. For these studies, our consultant produced the following estimates of potential: technical potential, economic potential, and achievable potential.(*When determining economic potential*) the consultant considered only the costs of the measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.

Observation - The utility's demand response and energy efficiency programs in the IRP include an assumption of program costs, load reductions, and customer acceptance.

Questions – *1) Since the utility will incur programmatic cost to secure DR and EE resources, were these costs considered in the cost-effectiveness analysis? 2) It appears that the cost-effectiveness of DR and EE were determined both independent of the resource portfolio optimization process and through that analysis. Please clarify which determination was used to select the preferred resource portfolio. 3) Since avoided costs are not dynamically derived based on the mix of resources in portfolios that have alternative levels of EE savings and DR, how is this reflected in the economic analysis of these resources?*

Example of Energy Efficiency – Specific Issue: Modeling Efficiency

Figure 10.7.10-1: Total Achievable Electric Energy Efficiency Potential (MWh)



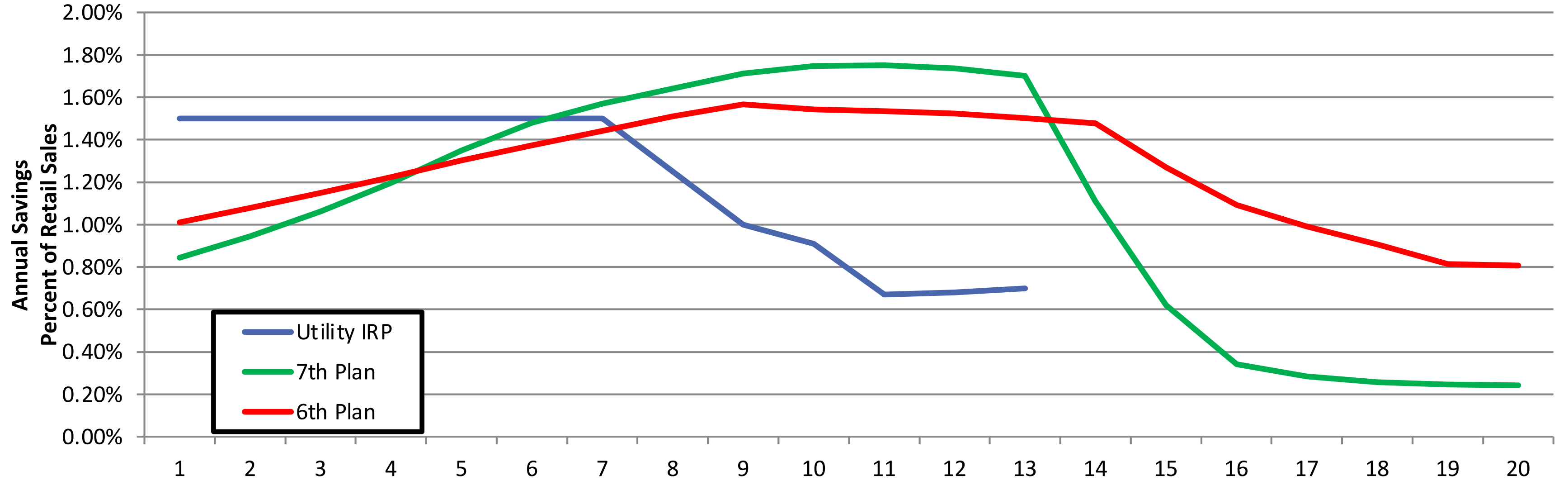
2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.25%	1.00%	0.91%	0.67%	0.68%	0.70%

Question *- How are lost opportunities that are missed in the early years accounted for in this analysis? For example, if the market penetration of an EStar program is only 50% in years 1-5, then every year 50% of the potential savings isn't captured. Do these savings become available again when those EStar appliances turn over?*

Example Energy Efficiency - Specific Issue: Resource Development Limit

From the IRP - Since (*the utility*) may only maintain 2.00 percent energy savings through 2022, customer rates would be inconsistent due to program spending ramping up and down, resulting in unnecessary fluctuations. In addition, the 2.00 percent sensitivity creates the most inconsistency at an administrative level. It would be administratively burdensome to ramp programs up for a short time period and then ramp back down. This fluctuation in programs may result in poor trade ally, vendor, and customer satisfaction.

Question *– Is the utility's forecast for the time frame over which it will exhaust its estimated achievable potential at a 2.00 percent annual energy acquisition level consistent with other utilities or entities?*



Example Energy Efficiency
Specific Issue: Achievable Potential Assumption

Cumulative savings over first 13 years:
Utility – 15.7% (Average 1.2%/yr.)
PNW Historical (most recent 13 years) – 18.5% (1.4%/yr.)
PNW Historical (most recent 15 years) – 20.8% (1.4%/yr.)

Example Energy Efficiency
Specific Issue: Determining Achievable Economic Potential

From the IRP - An aggressive scenario, for example, could provide program participants with payments for the entire incremental cost of more energy efficient equipment. This is often referred to as "maximum achievable potential."

Questions *– 1) Was the forecast of achievable potential for all resources consider in this analysis based on the above definition of "maximum achievable potential"? 2) If not, were the cost-sharing assumptions used for utility scale generating resources developers/vendors consistent with those assumed for energy efficiency, demand response and distributed generation resources?*

From the IRP - Cost effectiveness for energy efficiency was determined using (*utility*) - specific cost-effectiveness criteria, including the most recent utility specific avoided cost projections for electricity.

Question *– What were the avoided cost input assumptions used for determining the cost-effectiveness of energy efficiency measures, including the values (hourly cost/$MWh and $MW-yr or $MW-mth) used for the following: energy, capacity, ancillary services, reserves, distribution and transmission infrastructure deferral, risk, GHG emissions, DRIPE?*

Example Energy Efficiency
Specific Issue: Achievable vs. Economic Potential

From the IRP - For the utility's service area overall, the achievable potential for electricity savings based on the UCT cost-effectiveness test screening is 18.8 percent of forecast kWh sales from 2016 through 2035, while overall economic potential was estimated at 35.6% of load.

Questions: *1) Is the amount of achievable potential (18.8 percent of forecast load), which is just over 50 percent of economic potential, the "maximum achievable potential" (i.e., does it assume that utility would pay the full incremental measure cost)? 2) What actions does the utility propose that would increase the share of the economic potential captured by its programs over the planning period?*

From the IRP - The estimated average useful life included in the long-term modeling was 15 years.

Questions *– 1) Does the utility assume that EE savings expire at the end of their EUL? 2) If so, for measures that are currently deemed cost-effective to acquire now, would these same measures be cost-effective to acquire in a future year when they expire to retain those benefits? Does the capacity expansion model "re-acquire" these cost-effective savings at the end of their EUL?*

Reviewing Resource Characteristics Input Assumptions
Distributed Generation – General Issues

- What DG resources were considered and characterized for technical and achievable potential?
  - PV
  - PV w/storage
  - CHP
  - EVs
- Is the magnitude of technical and achievable potential relative to total load comparable with other DG potential studies?
- Do deployment costs reflect experience in other markets?

Reviewing Resource Characteristics Input Assumptions
Distributed Generation – General Issues

- Do maximum achievable ramp rates and cumulative savings reflect experience in other markets?
- Is there a table or graph showing the annual and cumulative achievable potential of DG by levelized cost bin ($/MWh)?
- Is the economic potential of DG determined independently of the capacity expansion model or through the resource optimization modeling process?

Reviewing Resource Characteristics Input Assumptions - Utility-Scale Resources - General Issues

- What types of potential utility-scale resources are included as options in the capacity expansion model?
  - Natural gas (SCT, CCCT, RICE)
  - Renewable (wind, solar, biomass)
  - Emerging technology (battery storage, modular nuclear)
- Do cost and performance assumptions reflect current technology and experience (heat rates, forced-outage rates, siting and construction lead times, emissions profiles)?
- Do cost and performance assumptions for each generating resource option reflect known future environmental regulations?

Reviewing Resource Characteristics Input Assumptions - Utility Scale Resources - General Issues

- Do the cost and/or performance assumptions for any resources change over time?
  - If so, what is the basis for such forecast?
- Is the type of renewable resource required (if any) to satisfy a Renewable Portfolio Standard (RPS) determined independently of the capacity expansion model or through the resource optimization modeling process?
- Is there a table or graph showing the potential of each utility-scale resource by levelized cost bin ($/MWh)?

Reviewing Scenario Input Assumptions and Analysis - General Issues

- Scenario Inputs and Assumptions
  - Market Prices
  - Fuel Prices
  - Resource Retirements
  - Environmental and other Regulations
- Analysis of Resource Options - In Search of the Preferred Resource Portfolio
  - Resource Optimization
    - Since I know the future, “What I should do?”
  - Uncertainty and Risk
    - What could happen when I am wrong?
    - How should I “hedge” my bets?

Reviewing Scenario Input Assumptions and Analysis - General Issues

- How was the forecast of future wholesale market prices for energy and capacity determined?
  - Market fundamentals modeling
    - Is this documented?
    - How does it compare to forecast by other parties?
    - Does the utility present a range of future market prices?
    - How does their range forecast of market prices compare to the forecast of other utilities/entities?
  - Reference to other sources (commercial forecasting services, EIA)
    - Same questions as above
- Is the range of future market prices for energy and capacity consistent with other utility filings covering the same period?
  - If not, is the reasoning for assuming different forecast(s) provided?
- Is the range of future fuel (natural gas, fuel oil, coal, uranium) prices consistent with other utility filings covering the same period?
  - If not, is the reasoning for assuming different forecast(s) provided?
  - How does the forecast of future fuel prices compare to the forecast of other utilities/entities?

Reviewing Scenario Input Assumptions and Analysis - General Issues

- Are known resource retirements reflected in future load resource balances?
- Are known local, state, and federal environmental requirements reflected in the cost and performance of resources and the type of resource options considered?
- Is a range forecast used for all major input assumptions (market prices, fuel prices, resource costs, loads, etc.)?
- Do the scenarios and sensitivity studies selected explore the full range of forecast values for all major inputs that are not under utility control (market prices, fuel prices, resource costs, loads, etc.)?

Reviewing of Analytical Methodology for Resource Portfolio Optimization - General Issues

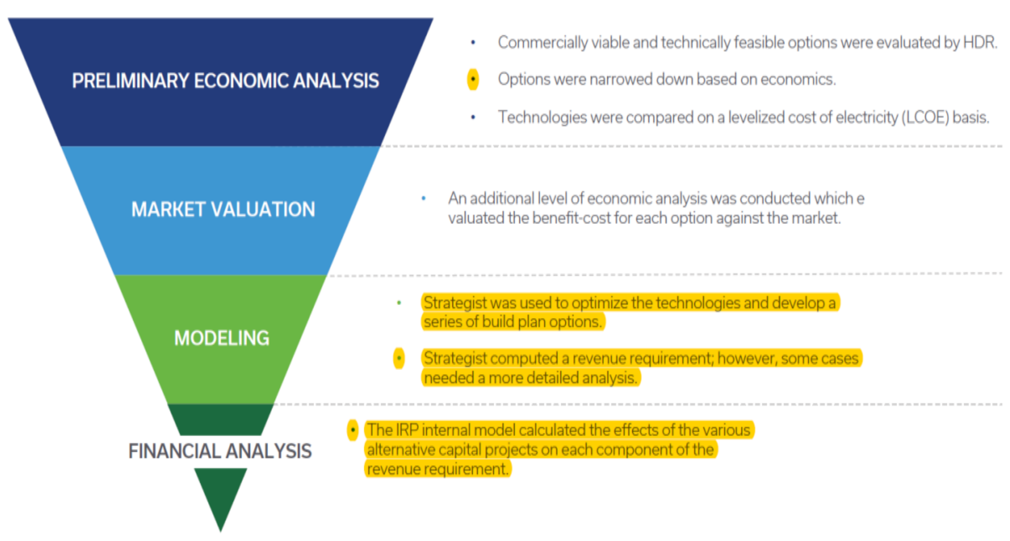
- What was the objective function of the optimization (e.g., minimize NPV of revenue requirements, meet CO_2 emissions caps at lowest NPV, minimize average rates)?
  - Where any constraints placed on the optimization (e.g., meet reliability standards, satisfy RPS, meet CO2 emissions goals, minimize rate increases)?
  - Were other factors (apart from the optimization objective) used to determine the preferred resource portfolio?
- Were all resources allowed to compete directly with one another in the optimization process to determine the amount, timing and cost-effectiveness of their development?
- Were limits (min/max pace, lead times, max development, max cost) placed on any resource's deployment?
  - Are any such limits explicitly documented and justification provided?

Reviewing of Analytical Methodology for Resource Portfolio Optimization - General Issues

- Were variations in the type, amount, and timing of the development of energy efficiency, demand response and DG resources tested in the optimization process?
  - Does the modeling of EE development and achievable potential recognize the intrinsic difference between the availability of “lost opportunity” and “retrofit” energy efficiency resources?
- What input assumptions for the optimization process were varied across scenarios?
  - Did varying these assumptions significantly alter the optimization results (i.e., the type, amount and timing of resources developed in the portfolio?)

Example of Utility IRP Analysis Framework

Figure 4.5-1: IRP Modeling Process

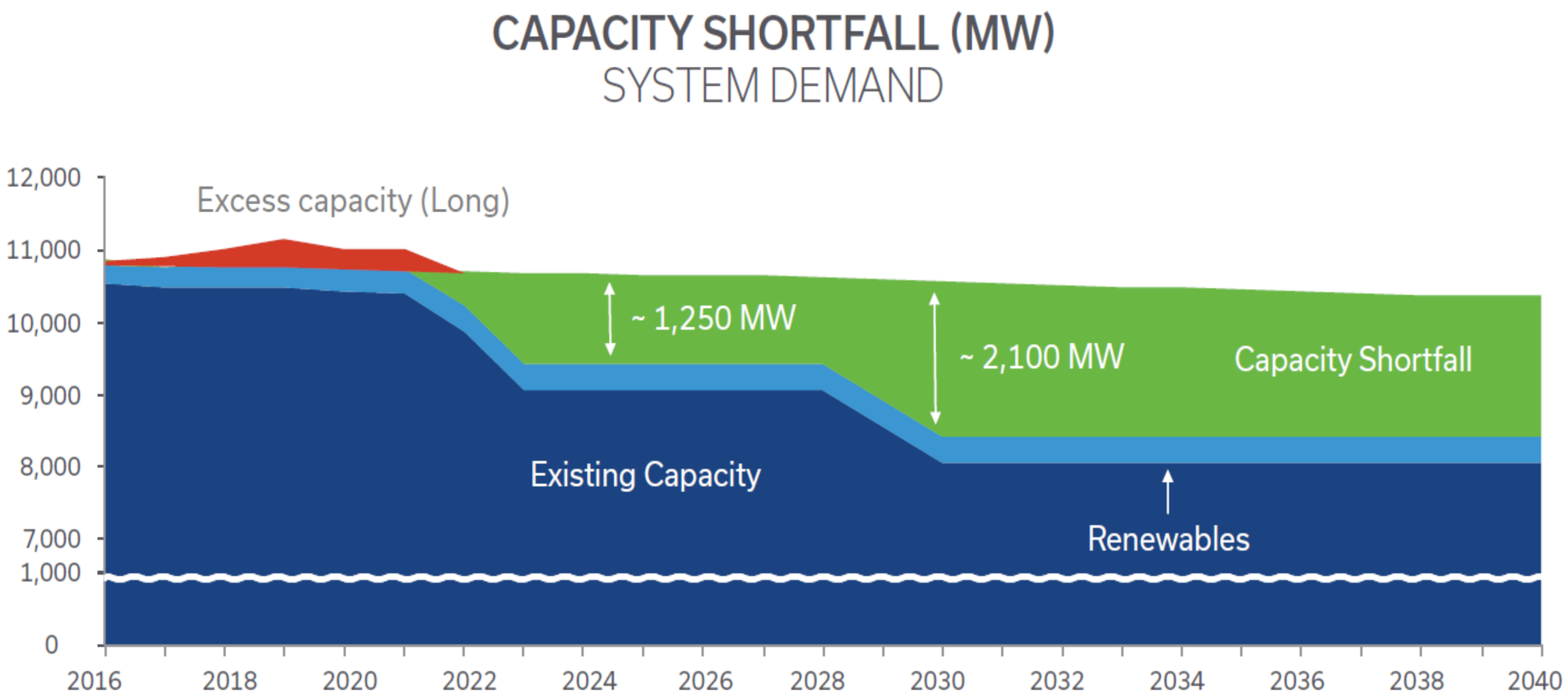


The first level of modeling was a preliminary economic analysis consisting of a levelized cost of electricity comparison (LCOE) between similar technologies. The $/MWh value was computed for each technology option for capital, fuel, and operation and maintenance costs. The initial screening was concluded with the LCOE, and the options that were the least economical in terms of the highest $/MWhs were eliminated. At the next level of screening, the remaining technology options were modeled with Strategist, and a market valuation or benefit-cost analysis was performed.

From the IRP - Following the market valuation, for the modeling step, the Strategist PROVIEW™ module was used with the associated costs of the alternative options and existing resource operational data. PROVIEW generated the least cost resource plan options under the various scenarios and sensitivities to fill the need resulting from future coal retirements

From the IRP - PROVIEW provided a multitude of resource plans and ranked the options in order of least cost determined by present value utility cost. The results of PROVIEW were thoroughly analyzed to identify a base resource plan based on not only economics but also what was the best option for customers based on the Planning Principles.

Example of Resource Adequacy Assessment Using Forecast Load Resource Balance



Example of Resource Options Considered

Table 10.10-1 Resource Options evaluated in the IRP process

Category	Alternatives Evaluated	Technical Screening	LCOE	Strategist
Simple Cycle	1X0 NGSC (7E.03)	X	X	X
Simple Cycle	1X0 NGSC (LMS100)	X		X

Technical Evaluation	Levelized Cost of Energy	Option Evaluated in Strategist
62	17	22

Resource Type	Number of Options Evaluated in Strategist
SCCT	6 Technology/Sizes
CCCT	5 Technology/Sizes
Nuclear	1
EE	4 % of sales options
DR	3 programs
Wind	1 generic
Solar	1 generic

Review of Analytical Methodology
Treatment of Uncertainty and Risk – General Issues

- Did the optimization assume "perfect foresight?"
  - Was the *optimized* resource portfolio for each scenario tested in alternative scenarios (i.e., future conditions for which it was not optimized)?
  - Is there a table or graphic showing the NPV system cost (and risk) for the *optimized* resource portfolio for each scenario tested under future conditions for which it was not optimized?
- Did the optimization process involve stochastic modeling?
  - Which, if any, input assumptions were assigned stochastic distributions?
  - Is the form of these distributions (e.g., log-normal, uniform, triangular) and the reasoning for their selection for each stochastic input documented?
- What were the correlations (if any) assumed between input variables (e.g., natural gas prices and market prices?
  - Is the derivation of these correlations documented?
- Was the risk associated with each resource portfolio quantified?
  - Are the sources of risk for the preferred resource portfolio delineated?
  - Are potential risk mitigation actions for sources of risk described in the action plan?

Example Resource Strategy Selection – Specific Issue Risk Assessment and Management

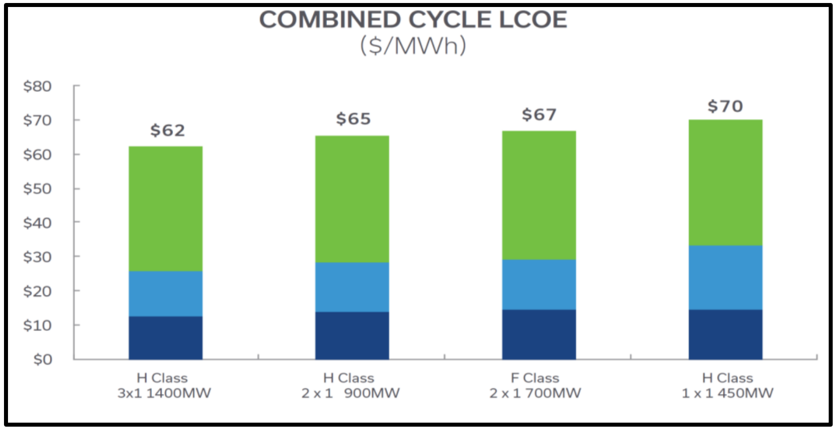
From the IRP - After the utility's 2017 IRP was selected, a risk analysis was conducted to ensure that the plan was prudent considering these factors. The utility intends to ensure risk is minimized for both customers and other stakeholders across a broad range of changing assumptions; therefore, risk assessment is an essential part of the IRP process. Over time, commodity markets and environmental and regulatory conditions may change from what was initially forecast. The *utility's* 2017 IRP is flexible enough to accommodate these changes as they occur.

Question – What are the attributes of the resource plan that make it flexible?

From the IRP - Due to the fluctuation and/or uncertainty of market conditions over the longer term (post 2022), the plan will continue to be re-evaluated as changes occur. The *utility's* 2017 IRP represents a balance between demand-side and supply-side options while providing favorable economic outcomes for customers. By replacing the retiring coal generation with the most prudent technologies or resources, the projected load requirements and clean energy goals can be met in an optimal manner.

Question – The utility discusses its current hedging strategy for coal purchases ("ladder contracting") as a risk management strategy. Since the Company's Preferred Resource Portfolio increases its reliance on natural gas, does it intend to implement this or other fuel-price risk management strategies for natural gas?

Example Natural Gas Price Risk – Specific Issue

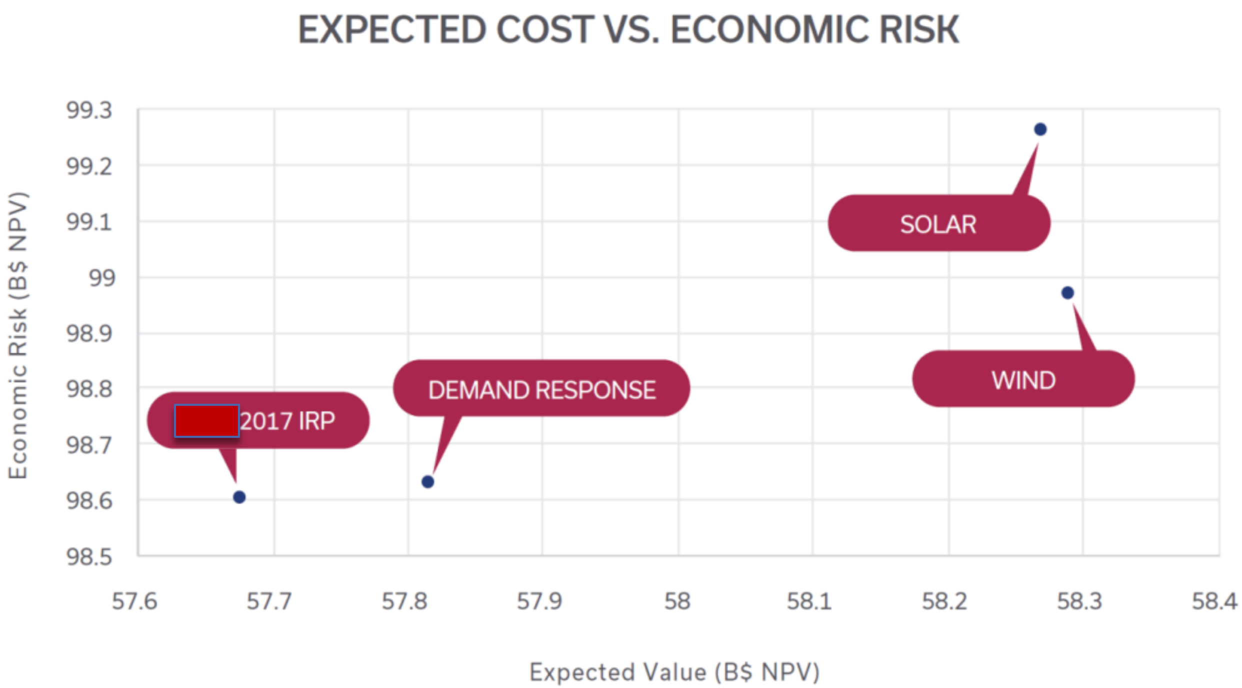


Question – This chart assumes the Reference scenario natural gas prices. 1) What were the LCOE under those scenarios where gas prices varied? 2) How was the commodity cycle of gas prices incorporated in the risk analysis, especially given the increased reliance on natural gas generation in the preferred plan?

From the IRP - The resource plan that develops EE at 2.0 % of retail sales defers a CCCT one year, from 2022 to 2023, while the 1.5% annual level of EE development does not. The NPV for the 2% level of development is roughly $60 million less than the 1.5% level of development in the Reference case. The 2% level of EE development was not evaluated in any of the other scenarios.

Question: 1) Since gas price risk will be increased under the preferred portfolio, why wasn't 2% level of EE development sensitivity tested under at least the High Gas Price and Aggressive CO2 scenarios?

Example of Stochastic Risk Analysis of Deterministically Optimized Resource Portfolios – Specific Issue Missing Portfolio



From the IRP - In the risk analysis the Aurora model made 200 runs using different draws of the key drivers. Both the average PV of the portfolio cost was determined, as well as the economic risk. The economic risk shows the risk of having a high cost portfolio. It is calculated by taking the average of the highest 10 percent of the draws for each resource plan.

Question: *The utility indicated (in a prior section of the IRP) that the lowest cost resource plan included more energy efficiency than the "2017 IRP"* portfolio. *Why wasn't the lowest-cost resource plan from the Strategist analysis included in the Aurora risk analysis?*

Example Adaptive Management Plan – Specific Issue

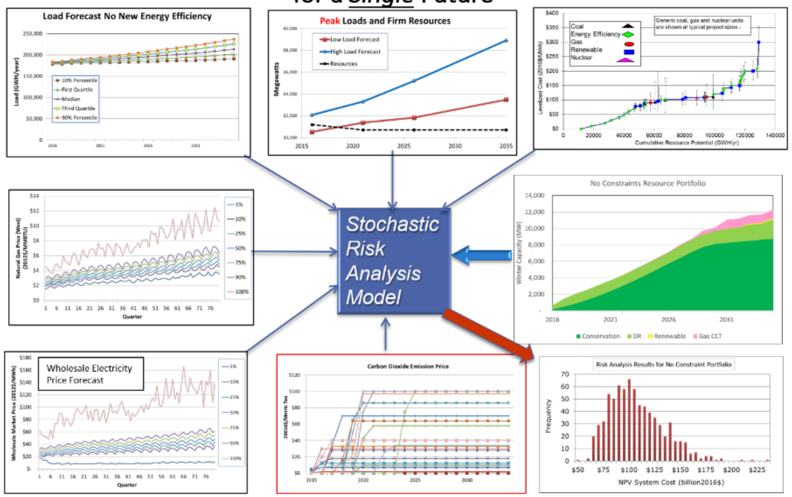
From the IRP –

- In the high load and both choice return cases, additional resources will be needed, and CCGT technology was still selected.
- In the low load and the 2.0 percent EE sensitivities, the CCGT technology was still selected; however, it is delayed one year.
- If future signposts indicate than the load is higher than forecasted or choice load is known to be returning, issuing a RFP for added capacity to bridge until the next IRP is completed would mitigate this situation.
- If sales are lower than forecasted, economic analysis could be done to determine the value of delaying the proposed project by one year. The value of the delay would be offset by the risk of some of the remaining coal units needing to retire earlier than 2023.

Question – Given that there are two cases where the CCGT could be delayed one year and both of those have lower NPV (and likely lower risk), why were these cases not evaluated in the risk assessment?

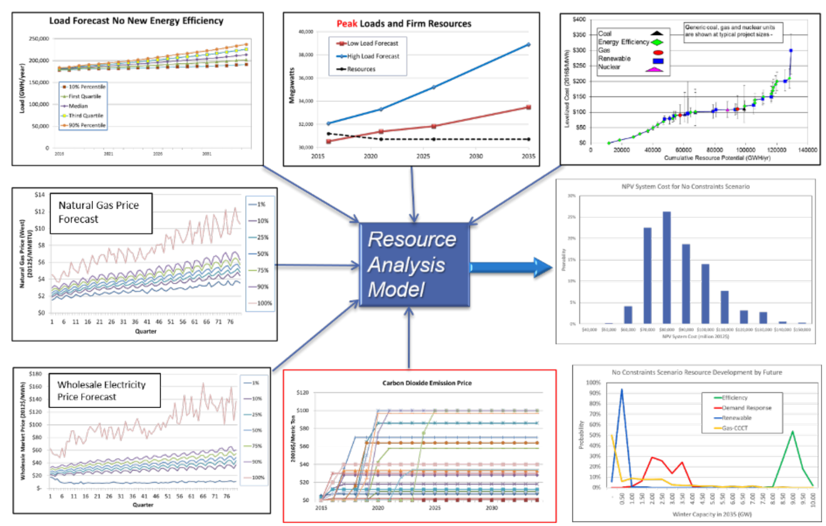
Average of the Inverse ≠ Inverse of the Average

Stochastic Risk Analysis of Resource Strategies Optimized
for a *Single* Future



Deterministically optimized Resource Portfolios likely *underline* risk relative to stochastically optimized Resource Portfolios

Stochastic Risk Analysis for Resource Strategies Optimized
Across A Range of Future Conditions



Stochastic risk assessments of deterministically optimized Resource Portfolios likely *overstate* risk relative to stochastically optimized Resource Portfolios

Resource Portfolio Selection – Selection Criteria

From the IRP - Once the comparisons were completed and analyzed, the lowest cost resource plan for each scenario or sensitivity was selected for further analysis (i.e., selected resource plans). Ultimately, the utility selected one resource plan that was the most reasonable and prudent as the 2017 IRP

Question – What criteria were used to determine which resource plan was "the most reasonable and prudent as the 2017 IRP"?

Questions Regulators and Staff Can Ask Utilities

Portfolio Analysis and Selection

- Was a range forecast used for all major input assumptions (market prices, fuel prices, resource costs, loads, etc.)?
- Do the scenarios and sensitivity studies selected for evaluation explore the full range of forecast values for all major inputs that are not under utility control (market prices, fuel prices, resource costs, loads, GHG emissions regulations, etc.)?
  - Follow-up example - Specifically, how was the load forecast range used in the analysis of resource plans (i.e., was the preferred portfolio based on the "reference" forecast only, or was the entire range of load growth considered in its selection)?
- What was the rationale for selecting (or excluding) specific resource portfolios/scenarios from evaluation?
- What criteria were used to determine which resource portfolio was "the most reasonable and prudent in the IRP"?

Portfolio Analysis and Selection (2)

- Were variations in the type, amount, and timing of the development of energy efficiency, demand response and distributed generation resources tested in the optimization process?
  - What input assumptions for the optimization process were varied across scenarios?
  - Did varying these assumptions significantly alter the optimization results (i.e., the type, amount and timing of resources developed in the portfolio)?
- Did the optimization assume "perfect foresight"?
  - Was the "optimized" resource portfolio for each deterministic future tested in alternative futures (i.e., the future conditions for which it was not optimized)?
- Did the optimization process involve stochastic modeling?
  - Which, if any, input assumptions were assigned stochastic distributions?

Analysis of Energy Efficiency and Demand Response

- Are the economic potential of energy efficiency and demand response resources determined independently of the capacity expansion model or through the resource optimization modeling process?
- How does the magnitude of technical and achievable potential relative to the utility's total load compare to other energy efficiency and demand response potential studies conducted by utilities with similar service area characteristics?
- How do the estimated costs and deployment pace of energy efficiency and demand response resources assumed in the IRP compare with the historical experience by other utilities and other EE program administrators?
- How do the estimated costs and deployment pace of energy efficiency and demand response resources assumed in the IRP compare with the experience in markets (e.g., PJM and ISO New England where these resources can bid into forward capacity market), if relevant?
- How were the load forecast and the assessment of energy efficiency potential calibrated to ensure consistency?

Action Plan

- Near-Term Resource Development – What actions will be taken, and what is the timing of decisions that must be made, ***prior*** to the completion of the next IRP?
  - What actions will the *utility* take to facilitate the implementation of the current IRP's resource development plan or strategy?
  - What are the potential consequences of delaying those actions?
  - What recommended actions should *parties external to the utility* (e.g., commission, legislature, state energy office, and siting agency, if different) take to facilitate the implementation of the IRP's resource development plan or strategy?
- Mid- and Long-Term Resource Development – What are the actions that can be delayed until ***after*** the completion of the next IRP, and what is the timing of those decisions?
  - What are the potential consequences of taking those actions before the completion of the next IRP?
- What actions will the *utility* take to continuously improve the IRP process and future IRPs?

IRP Resources

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- Rachel Wilson, Bruce Biewald. *Best Practices in Electric Utility Integrated Resource Planning*. (2013). http://www.raponline.org/document/download/id/6608
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- SEE Action, *Using Integrated Resource Planning to Encourage Investment in Cost-Effective Energy Efficiency* (2011). https://www4.eere.energy.gov/seeaction/publication/using-integrated-resource-planning-encourage-investment-cost-effective-energy-efficiency
- National Action Plan for Energy Efficiency. *Guide to Resource Planning with Energy Efficiency* (2007). https://www.epa.gov/sites/production/files/2015-08/documents/resource_planning.pdf
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- Jim Lazar, *Electricity Regulation in the US: A Guide* (2016). http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf

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TECHNICAL REVIEW OF IRP – BACKUP SLIDES

Energy Efficiency Resource Potential Assessment – Specific Issues

From the IRP - The data used for this report was the best available at the time this analysis was completed on April 20, 2016. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated.

Questions: 1) Are all of the there federal standards with known effective dates, adopted prior to April 20, 2016 reflected in the consultant's potential assessment? 2) Are these same standards also reflected in the load forecast? 3) Does the utility have a forecast of the magnitude of impact of federal standards adopted since April 20, 2016 could have on both its assessment of energy efficiency potential and load forecast?

From the IRP - All results were developed using customized Residential, Commercial and Industrial sector-level potential assessment analytic models and utility-specific cost-effectiveness criteria, including the most recent utility specific avoided cost projections for electricity

Questions: 1) What are the "utility-specific cost-effectiveness criteria" and 2) How were the most recent "Utility specific avoided cost projections for electricity" derived?

Energy Efficiency Cost-Effectiveness Determination Specific Issue

From the IRP - To optimize the portfolio, the utility uses an Excel-based linear programming model, in which real-world constraints such as energy savings potential and costs are input along with historical and forecasted operational data. The model then optimizes the energy savings while satisfying the constraints. Finally, the output derived from the previous three steps is analyzed through the Demand- Side Management Option Risk Evaluator (DSMore) cost analysis tool to calculate cost-effectiveness. DSMore is a financial analysis tool designed to evaluate the cost-effectiveness, benefits, and risks of demand-side management programs, including energy efficiency.

Question - It appears that the cost-effectiveness level of EE is not evaluated within the optimization" process, but through the use of DSMore and a fixed set of avoided costs. Is this correct?

Modeling Energy Efficiency Deployment - Statements

From the IRP - Assumptions on changes to load shapes and reductions in demand and energy can be derived from the results of existing programs and projected for blocks, which serve as proxies of yet-to-be-defined future programs, as well as continuation of existing efforts. This approach provides greater flexibility, reduces the time needed to develop modeling inputs, and affords the opportunity for the model to select an optimum level of energy efficiency on an annual incremental basis to match the given strategy and sensitivity.

Blocks were grouped by sector based on the available energy savings potential and program cost. The block sizes provide flexibility for model selection by being a proxy for energy efficiency programs. Each block also has an associated set of modeled data, including the peak demand reduction, operational characteristics, and an 8,760-hour load shape consistent with the sector end-use load shape.

The steps in which the available potential is diminished is similar to a supply stack and includes blocks with low cost–high potential, mid cost–mid potential, and high cost–low potential.

From the IRP – The utility evaluated numerous sensitivities to determine the optimal level of energy efficiency savings to provide its ratepayers. Sensitivities were modeled so that drivers such program cost, useful life, cost-effectiveness, coincident peak reduction, energy savings potential, and administration efforts were evaluated to provide robustness in the 2017 IRP. The utility’s long-term energy efficiency modeling accounts for future uncertainties through its block approach, which will be updated over time as programs are developed.

Modeling Energy Efficiency Deployment – Specific Issues

Questions: 1) How many blocks were modeled? 2) What was the average COSE of each block? 3) What were the maximum annual savings limits assumed for each block? 4) Were these limits varied across sensitivity tests? 5) Were there separate blocks for lost-opportunity and non-lost opportunity measures? 6) If not, how was the assumed maximum annual deployment limit reflect the window of opportunity constraints of lost-opportunity measures. 7) How does the "block approach account for uncertainty? 8) Does this approach simply aggregate savings into large blocks with similar costs and load shapes, or are their multiple blocks with varying cost, but comparable load shapes?

From the IRP - The utility's 2017 IRP was developed using the 1.50 percent sensitivity since it is the sensitivity with the greatest demand reduction while being administratively achievable within a budget that is consistent, and this sensitivity achieves the highest UCT score.

85

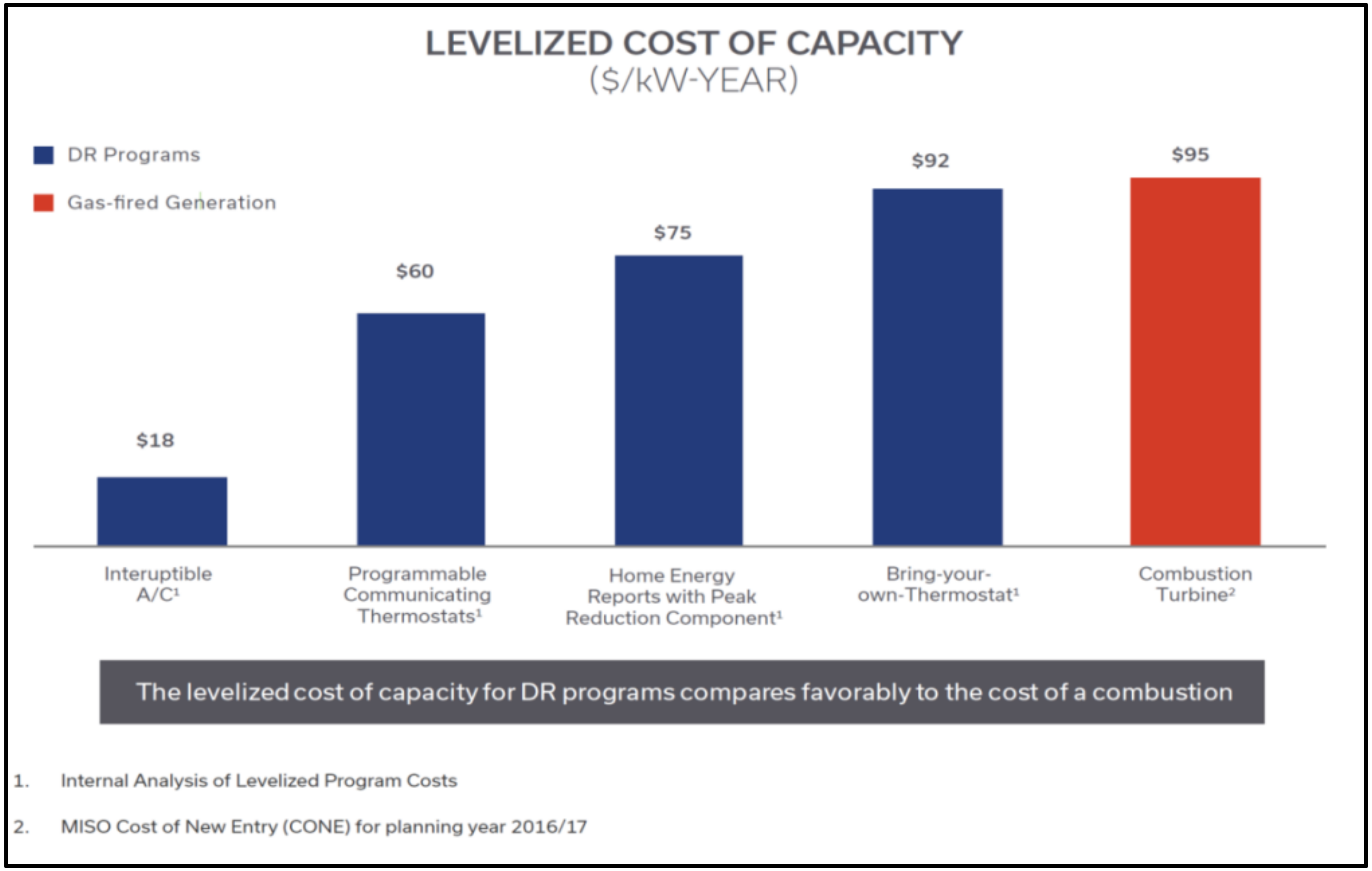
Question - What is the impact on the utility's need for additional generation if it maintained a 2.00 percent energy savings level for energy efficiency potential assessments for the longest period achievable given the limits of cost-effective potential?

Does Levelized Cost of Energy (LCOE) for EE Matter?

From the IRP - While LCOE is a representation of costs, it does not show how much market value the technology is creating—either in the energy market, the capacity market, or the ancillary services market. The value that the different technologies create in these markets goes right to the bottom line in a revenue requirement view, which is ultimately the cost representation the utility uses using to compare the different resource plans.

From the IRP - LCOE was an important step in the IRP screening process because it reduced the number of alternatives to the best of each category (base load, cycling, peaking). The utility is careful to only compare like technology types when screening and eliminating technologies (e.g., CCGT units were compared to each other, peakers were compared to each other).

Value of Capacity Savings – Specific Issue



Question – The utility evaluated the cost-effectiveness of DR against the cost of new capacity using MISO Cost of New Entry (CONE) as avoided cost. Was CONE used at the avoided cost for the capacity savings in the Strategist/PROVIEW modeling?

Analysis Process

Screen Against Levelized Cost and Market Prices - Due to the complexity of the dynamic programming model, the resulting resource plans could be exponential or even unsolvable. To prevent this from occurring, DTEE implemented a screening process to limit the number of resource options that go into the more complex modeling phase, to the most technically, commercially, and economically viable resources. The levelized cost of electricity analysis and market evaluation are two of the screening processes that DTEE utilized.

Optimize Resource Plan for Each Scenario - The Strategist module PROVIEW was used to evaluate the various combinations of available demand side and supply-side alternatives to meet DTEE's future resource requirements. Data from the supply-side and demand-side alternatives was input directly into PROVIEW to evaluate each of the alternatives head-to-head.

Conduct Sensitivity Tests - Resource plans were exposed to scenario and sensitivity analyses to test the robustness of those plans. PROMOD and an internal revenue requirement model were utilized to further analyze resource plans.

Resource Strategy Selection – Selection Criteria

From the IRP - Once the comparisons were completed and analyzed, the lowest cost resource plan for
each scenario or sensitivity was selected for further analysis (i.e., selected resource plans). Ultimately, the utility selected one resource plan that was the most reasonable and prudent as the 2017 IRP

Question – What criteria were used to determine which resource plan was "the most reasonable and prudent as the 2017 IRP"?

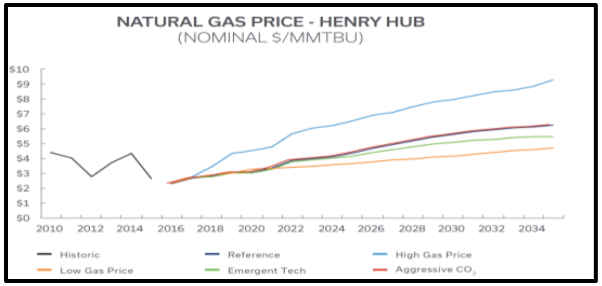
Review of Alternative Resource Plans

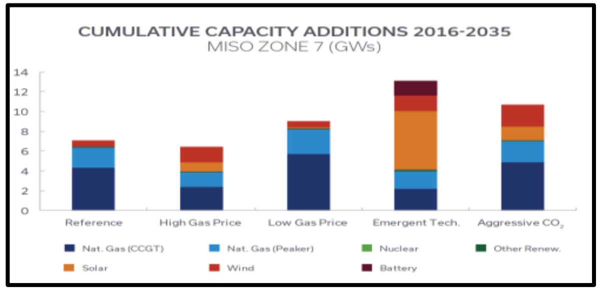
Table 12.1.1-6: Alternative Resource Plans for AHP

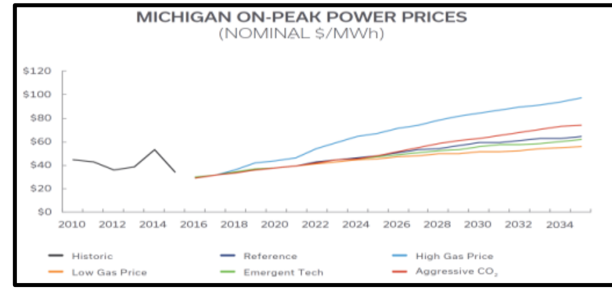
Portfolio	Build
Base resource plan	1,100 MW combined cycle in 2022
Wind	950 MW CT in 2022, 1000 MW wind (2017-2023)
Solar	950 MW CT in 2022, 500 MW solar (2017-2023)
Demand Response	950 MW CT in 2022, 150 MW Demand Response (2017-2023)

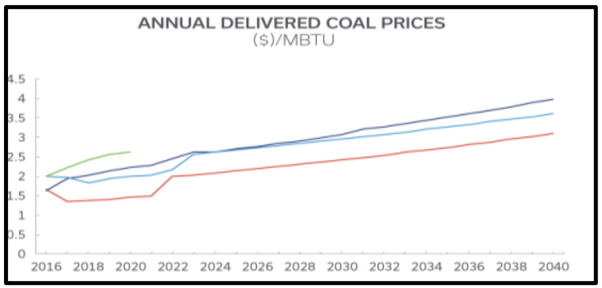
Question: It appears from the Strategist optimization analysis that developing energy efficiency at a pace of 2% of retail sales annually would defer the 1,100 MW combined cycle by at least one year, resulting in a lower NPV system cost. Why wasn't this resource plan considered?

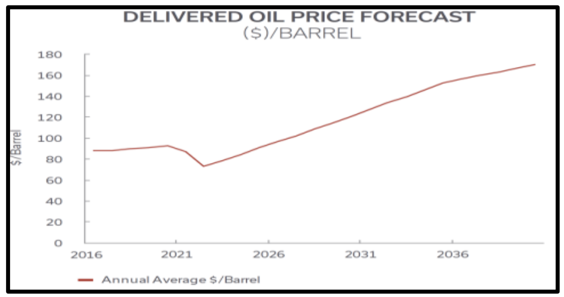
Scenario Input Assumptions – How Were These Used to Select A Preferred Plan?

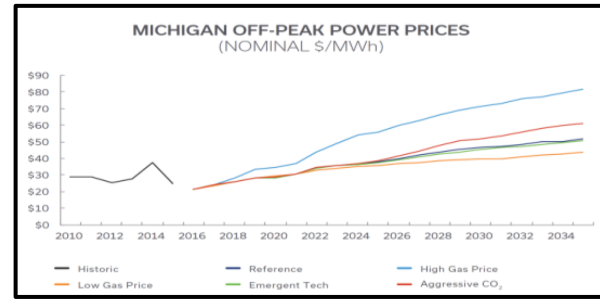


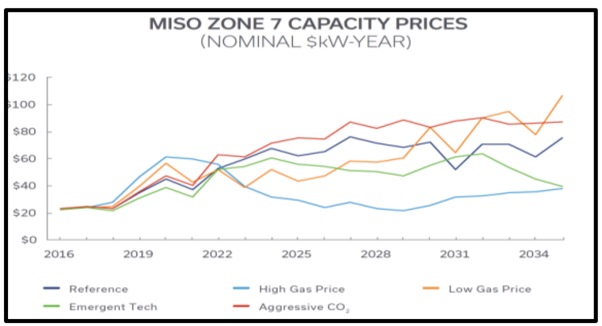


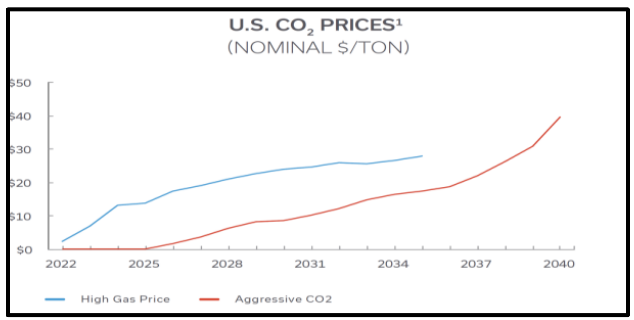


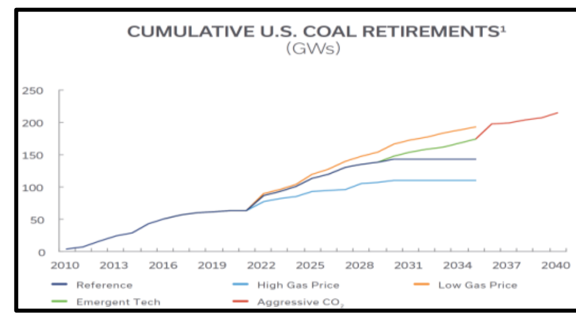












Do the Scenarios Selected for Comparison Evaluate All Logical Alternatives?

From the IRP - Strategist uses the after-tax weighted cost of capital as the discount rate while the revenue requirements model uses the pre-tax weighted cost of capital as the discount. This appears to reduce the difference between the 2% level of EE development and the 1.5% level of EE development from $60 million to around $8 million.

Question: Why was the discount rate used for "optimization" modeling different than the discount used for revenue requirements modeling, since the revenue requirements modeling was used to justify the preferred resource portfolio?

What's the Missing Resource? Why Not Test "Rely on the Market"?

Table 11.3.2-1: Market Valuation Results

		Reference	High Gas	Low Gas	Emerging Tech	AggressiveCO_2
NATURAL GAS	1 x 1 H Class CCGT	0.85	0.91	0.80	0.84	0.86
	2x 1 H Class CCGT	0.92	0.93	0.87	0.91	0.93
	3x 1 H Class CCGT	0.95	0.94	0.90	0.94	0.96
	2 x 1 F Class CCGT	0.87	0.90	0.82	0.86	0.88
	Frame 7 CT	0.74	0.75	0.66	0.72	0.70
RENEWABLE	Solar	0.59	0.69	0.51	0.55	0.62
	Wind	0.75	0.88-1.05[1]	0.67	0.73	0.83
	Lithium Ion Battery	0.26	0.19	0.21	0.23	0.24
DEMAND RESPONSE	Behavioral	0.69	0.42	0.43	0.63	0.63
	Thermostat	0.79	0.40	0.56	0.66	0.71
	BYO Thermostat	0.73	0.37	0.48	0.62	0.66

[1]Based on capacity factors ranging from 35%-41%.

Questions: 1) Since a market evaluation is a fundamental step in assessing B/C for other resource options, why wasn't it done for EE and DG? Based on the results shown in this table, the least cost option for the utility appears to be to fully rely on the market, (i.e., none of these resources have a B/C ratio over 1.0). 2) Why does the utility's preferred resource plan limit market reliance? 3) How was the limit determined?

Are There Missing Sensitivities?

Table 11.4-1: Summary of all Sensitivities Modeled

		Reference	High Gas	Emerging Technologies	Low Gas	Aggressive CO_2
Sensitivities	Load	High Growth				
		Low Growth				
	Renewable Energy	High Renewables	High Renewables	High Renewables		
	Energy Efficiency	5 levels of EE	3 levels of EE	3 levels of EE	3 levels of EE	3 levels of EE
	Capital Cost		+20% increase	+20% increase	+20% increase	
	CC Size (vs. 2x1)	H Class 1x1	H Class 3x1	H Class 3x1	H Class 3 x 1	H Class 3x1
		H Class 3 x1				
	Choice	All comes back				
		50% comes back				
	New Nuclear		Nuclear in 2030			
	CO_2		New Sources count			Aggressive CO2 Reduction

Qualitative Risk Assessment -

Table 12.1.1-1: Energy Risk – 5 Criteria

AHP criteria	Metric	Corresponding IRP Planning Principle
Cost	PVRR	Affordability
Environmental	CO_2 tons	Clean
Portfolio Balance	Function of the amount of Base load to Peaking units added	Flexible and Balanced
Commodity Prices	Weighted average of the Fuel volatility index for gas, coal, nuclear, oil, and renewable	Reasonable risk Flexible and Balanced
Market risk	Net purchases and sales	Reasonable risk

Questions: 1) Portfolio balance is measured by the ratio of base load resources added compared to peaking resources added. Was the ratio of capital vs fuel considered as a risk (e.g., renewable vs. gas turbines)? 2) Given that load uncertainty was one of the sensitivities considered, why was load uncertainty not evaluated as a risk? 3) In order to maintain a minimum market risk, does this mean that net purchases in dollars should equal net sales in dollars? 4) Zero net purchases reduces market risk, but it also increase costs, since MISO market prices will always be lower "on average" than the CONE, are market risk symmetrical?

Distribution System Planning

From the IRP - Based on the results of the 2018 pilot the utility will evaluate the benefit/cost of a system-wide capacity and regulator upgrade to enable Volt/VAR Optimization and include the findings in future IRPs.

Question: Given the experience of other utilities with respect to implementation of CVR, what research questions does the utility feel it needs to address with additional CVR pilots?

Note - There are multiple approaches to CVR that can achieve significant savings. See NEEA pilot study results. Available at: http://neea.org/docs/default-source/reports/long-term-monitoring-and-tracking-distribution-efficiency.pdf?sfvrsn=5