Integrated Resource Plan – Draft Results

PSAT Meeting | May 29, 2020
Agenda

• Overview / Meeting Objectives – J.T. Young  10:00 am
• Agenda and Executive Summary - Siemens  10:10 am
• MISO Overview and Membership Assessment - MISO  10:40 am
• Questions of PSAT to MISO  11:30 am
• Break  11:40 am
• IRP Overview - Siemens  11:50 am
  • Introduction
  • Strategies / Scenarios / Portfolio Analyzed
  • Metrics
  • Load Forecast / Fuel Forecast / Technology Assessment
  • Transmission / Resource Adequacy Issues
  • Other Costs for Direct Comparison
  • Portfolio Analyses (deterministic, stochastic and Waterfall)
  • Summary of Conclusions and Recommendations
  • Next Steps
• Break  1:20 pm
• Questions and Comments from PSAT  1:30 pm
Introduction
IRP Process Recap

The IRP process is designed to evaluate options for MLGW to supply of its current and forecasted load while meeting key objectives including:

- **Affordability / Least Cost / Rate Impact**
- **Reliability / Resource Adequacy**
- **Sustainability / CO2 / Water Use / RPS**
- **Stability / Price Risk Mitigation / Reliance on Market**
- **Economic Impact / Local Capital Investment**

Today we will present the results of the final set of Portfolios and our findings and recommendations.
Why do an IRP?

The Integrated Resource Plan is:

- Independent and unbiased
- Comprehensive regarding strategies and options
- Addresses the risk associated with market, regulatory and technology uncertainty
- Compares the TVA Full Requirements Contract to alternatives on an equivalent basis (generation, plus transmission, PILOT, Gap analysis, MISO charges, TVA Benefits, becoming LBA)
- Determines No Regret Strategies

What is an IRP?

The purpose of an IRP is to provide a plan for energy resource (primarily generation, transmission and demand side programs) development to meet future load and compare the status quo (TVA FRC) to MISO market and self generation options):

This is not a traditional IRP which focuses primarily on generation. Exiting TVA requires a combination of generation and transmission investments to replace TVA supply.

Least cost plans are developed for a given transmission infrastructure – hence alignment between Siemens and MISO’s assumptions regarding transmission are critical inputs to the analysis.
Integrated Resource Planning... a Recap

What we will do today

• Siemens will present analyses and results that MLGW can use to determine the best path forward for Memphis

• Siemens will present its findings regarding the tradeoffs among cost, risk, reliability, sustainability, resilience, and economic development

• Siemens will
  • review previous materials,
  • fill in gaps in information that not covered in previous presentations (PILOT, benefits, gap analyses, TVA cost),
  • present the results of the Risk Analysis,
  • Present the balanced Scorecard,
  • Explain No Regret Positions for each Strategy,
  • Describe the Waterfall showing the components of Savings among Strategies
  • Recommend next steps (RFP to confirm savings)

What we will not do today

• Siemens will not make a final recommendation regarding whether MLGW should exit the TVA agreement – that is an MLGW decision

• Siemens has no view regarding which of the metrics is the most important to MLGW

• Siemens believes that MLGW should conduct an RFP to verify savings before making a final decision regarding both TVA and the best Portfolio options. However its timing is an MLGW decision.
Summary of Findings
11 Resource Portfolios under Self-Supply plus MISO (Strategy 3) and All MISO (Strategy 4) were Evaluated

- **Portfolio 1, 2 and 7**: derived from the Reference case.
- **Portfolio 3**: derived from High Load / Base Gas case.
- **Portfolio 4**: derived from Low Load / Base Gas case.
- **Portfolio 5 and 9**: derived from High Transmission case, with battery storage (9 moved CTs to 2025).
- **Portfolio 6 and 8**: derived from Low Load / High Gas case (different numbers of CTs and timing).
- **Portfolio All MISO**: derived without local supply options.
- **Portfolio 10**: Shifted the CCGT and 1000 MW MISO renewables to local.

<table>
<thead>
<tr>
<th>Portfolio ID</th>
<th>Final Portfolio</th>
<th>Total Thermal 2039</th>
<th>Local Renew 2039</th>
<th>Battery 2039</th>
<th>Total Local Nameplate 2039</th>
<th>MISO Renew 2039</th>
<th>MISO Cap 2039</th>
<th>950 MW CC</th>
<th>450 MW CC</th>
<th>237 MW CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3S1_P</td>
<td>Portfolio 1</td>
<td>1137</td>
<td>1000</td>
<td>0</td>
<td>2137</td>
<td>2200</td>
<td>1761</td>
<td>0</td>
<td>2</td>
<td>1</td>
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<tr>
<td>S3S1_F</td>
<td>Portfolio 2</td>
<td>1587</td>
<td>1000</td>
<td>0</td>
<td>2587</td>
<td>1550</td>
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<td>S3S2_BB</td>
<td>Portfolio 3</td>
<td>1824</td>
<td>1000</td>
<td>0</td>
<td>2824</td>
<td>1350</td>
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<td>1000</td>
<td>100</td>
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<td>0</td>
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<td>2200</td>
<td>1761</td>
<td>0</td>
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<td>1</td>
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<tr>
<td>S3S1_2CT</td>
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<td>1000</td>
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<td>2200</td>
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<td>2</td>
<td>2</td>
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<td>S3S7_2CT</td>
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<td>1000</td>
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<td>2200</td>
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<td>0</td>
<td>2</td>
<td>2</td>
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<td>S3S5_YD</td>
<td>Portfolio 9</td>
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<td>1000</td>
<td>100</td>
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<td>3450</td>
<td>1186</td>
<td>0</td>
<td>1</td>
<td>4</td>
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<td>S3S10</td>
<td>Portfolio 10</td>
<td>950</td>
<td>1000</td>
<td>0</td>
<td>1950</td>
<td>2250</td>
<td>1901</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>S4S1</td>
<td>Portfolio All MISO</td>
<td>950</td>
<td>0</td>
<td>0</td>
<td>3200</td>
<td>1909</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Summary of Findings

- Future supply Portfolios 5 and 9 were identified that could provide savings of over $1.9 billion in 2018 dollars for the 2020 to 2039 period with respect of the TVA’s Existing Contract and $1.5 billion (shown lower left) with respect of the Long Term Partnership contract. The sum of the $1.9 billion savings becomes about $3 billion in nominal dollars (including inflation).

- These two portfolios could achieve in annual savings of about $150 million per year (2025-2039) with TVA’s Existing Contract (lower middle) and about $120 million per year (2025-2039) with TVA’s LTP (in 2018$). In nominal dollars the $150 million averages about $200 million/year (assuming 2% inflation).
Summary of Findings

- All of the best performing Self Supply plus MISO Portfolios have high levels of generation from zero carbon sources reaching levels from 52% to 75% when fully developed.
- CO₂ emissions are reduced by almost 50% of TVA levels with Portfolios 5 and 9.
- There will be an increase of local water consumption for generation of about 27% relative to TVA.
- All Portfolios meet or surpass NERC reliability requirements, but Portfolio 5 has potential risk of load shed during double 500 kV line outages. This was addressed in Portfolio 9.
MISO Overview and Membership Assessment
Memphis Light, Gas and Water (MLGW)
Power Supply Advisory Team Meeting

May 29, 2020
Part I: MISO Overview
MISO drives value creation through efficient and reliable markets, operations, planning, and innovation

Our Vision: To be the most reliable, value-creating RTO

MISO by-the-numbers

<table>
<thead>
<tr>
<th>Category</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Transmission</td>
<td>65,800 miles</td>
</tr>
<tr>
<td>Generation Capacity</td>
<td>174,000 MW</td>
</tr>
<tr>
<td>Peak Summer System Demand (07-20-11)</td>
<td>127,125 MW</td>
</tr>
<tr>
<td>Customers Served</td>
<td>42 million</td>
</tr>
</tbody>
</table>
MISO’s Key Functions

1. **Keeping the Lights On**: Safe and reliable operation of the electric grid

2. **Operating Open Energy Markets**: Scheduling and economic dispatch of generation to support reliability and efficiencies across the system

3. **Performing Transmission Planning**: Comprehensive expansion planning that meets reliability needs, policy needs, and economic needs
MISO doesn’t own any physical assets, we manage flows on the transmission system by directing generator usage.
MISO members participate across the electricity value chain

**MISO’s focus**

- **Generation**
- **Transmission**
- **Marketers**
- **Distribution**
- **Customers**

**MISO ‘Sectors’**:

- Independent Power Producers: 29
- Competitive Transmission Developers: 30
- Transmission Owners: 51
- Power Marketers/Brokers: 36
- Muni/Coop/Transmission Dependent Utilities: 31
- Eligible End-User Customers: 9
Since 2009, MISO has estimated over $26 billion in membership benefits

Cumulative Benefits ($ millions)

2019 Benefit by Value Driver ($ millions)

MISO provides approximately $3.6 billion in annual benefits to members

MISO Value Proposition
MISO will continue to support the evolution of resources on the bulk electric grid

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>2005 Generation Mix (% MWH)</th>
<th>2019 Generation Mix (% MWH)</th>
<th>2030 Generation Mix (% MWH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewables</td>
<td>76%</td>
<td>39%</td>
<td>27%</td>
</tr>
<tr>
<td>Other</td>
<td>13%</td>
<td>17%</td>
<td>32%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>7%</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>Gas</td>
<td>4%</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>Coal</td>
<td>4%</td>
<td>13%</td>
<td>28%</td>
</tr>
</tbody>
</table>

1The 2030 projection compiled from Integrated Resource Plans, investor reports and other sources. Figures represent energy generated by fuel type, distinguished from capacity.
Part II: MLGW Membership Assessment
Siemens provided a list of study objectives and requested MISO’s independent review

- **Resource Adequacy:**
  - Is the capacity expansion plan sufficient to join MISO Local Resource Zone (LRZ) 8 or to be a standalone Local Resource Zone?
  - What is the impact to the MISO Planning Reserve Margin (PRM)?
  - Is there adequate capacity for MLGW to purchase starting in 2025?

- **Transmission Interconnection:**
  - Is the transmission expansion proposal a reliable solution?
  - What is the MLGW import capability?
  - What is MISO’s estimate of the costs for transmission expansion, reliability upgrades, and generator interconnections?

- **Market Impact:**
  - How will membership affect its Adjusted Production Costs (APC)?
  - What are the impacts to MISO’s regional congestion patterns?

- **MISO Cost:**
  - What are the annual costs to MLGW of MISO membership?
MISO performed its assessment for MLGW based on the following capacity and transmission expansion plan

### Base Capacity Expansion Plan

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas CT</th>
<th>Gas CC</th>
<th>MLGW Solar</th>
<th>Arkansas Solar</th>
<th>Arkansas Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>237</td>
<td>1,350</td>
<td>600</td>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>2026</td>
<td>0</td>
<td>0</td>
<td>400</td>
<td>0</td>
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<td>2027</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>2028</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
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<tr>
<td>2029</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
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<td>2030</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>0</td>
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<tr>
<td>2031</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
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<tr>
<td>2032</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>2033</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>2034</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>300</td>
<td>0</td>
</tr>
<tr>
<td>2035</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2036</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

### Transmission Expansion Plan

- 500 kV line from San Souci – Shelby
- 500 kV line from West Memphis – New Allen
- 230 kV line from Twinkletown – New Allen

![Map showing new infrastructure](image-url)
The MLGW membership analysis resulted in the following takeaways

<table>
<thead>
<tr>
<th>RESOURCE ADEQUACY ASSESSMENT</th>
<th>TRANSMISSION INTERCONNECTION ASSESSMENT / COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>❖ Siemens’ proposal provides MLGW with adequate resources to join MISO Local Resource Zone (LRZ) 8 or to be its own standalone zone</td>
<td>❖ MISO validated the physical transmission import capability up to 2,400 MW during 2024 summer peak conditions</td>
</tr>
<tr>
<td>❖ If MLGW were to join MISO it would lower the Installed Capacity (ICAP) Planning Reserve Margin (PRM) from 18.2% to 17.9%</td>
<td>❖ MISO’s estimated the transmission expansion, reliability upgrades, and interconnection costs to be $736.2M vs. $728.2M by Siemens²</td>
</tr>
<tr>
<td>❖ MISO is unable to provide direction on how much excess capacity would be available for purchase</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARKET IMPACT ASSESSMENT</th>
<th>MISO ADMINISTRATIVE COST RECOVERY FEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>❖ MLGW could realize annual production cost savings of $92.6 million in 2024 to as much as $268.6 million in 2034 (note: these totals do not account for fixed costs)</td>
<td>❖ Based on a projection of MISO’s annual operating expenses MLGW’s share of MISO’s costs would be approximately $6 million annually</td>
</tr>
<tr>
<td>❖ Projections show MLGW self supplying 50% of its energy needs in 2024 and increasing over time</td>
<td>❖ As a MISO member MLGW would be charged a portion of FERC’s annual budget. This cost is estimated at an additional $730,000 per year.</td>
</tr>
<tr>
<td>❖ No significant changes to congestion patterns were observed</td>
<td></td>
</tr>
</tbody>
</table>

²The Siemens cost estimate is adjusted to match MISO’s assumptions regarding contingencies and inflation.
MLGW has requested that MISO evaluate an additional option which includes no local generating resources

- MISO will be analyzing the same variables that were reviewed under the previous capacity/transmission expansion plan
  - Resource Adequacy
  - Transmission Interconnection Reliability
  - Transmission Interconnection Cost
  - Market Impacts

- MISO has committed to delivering the results of its analysis prior to MLGW’s Integrated Resource Plan (IRP) being finalized in early July
MISO Local Resource Zone (LRZ) Map

- MISO’s footprint is divided into ten Local Resource Zones (LRZs)
- MISO developed LRZs to reflect the need for an adequate amount of planning resources to be located in the right physical locations within the MISO Region
- The geographic boundaries of the LRZs are based on multiple criteria
Strategies / Scenarios / Portfolio Analyzed
Key Issue: Portfolio Expansion Strategies

- The Strategies, representing the available options to MLGW to supply its load, are combined with Scenarios (i.e. future states of the world) and using a structured approach to identify Portfolios.

- Multiple Strategies were assessed:
  - Strategy 1: Full Requirements Contract with TVA
  - Strategy 2: Self-Supply (found to be impractical)
  - Strategy 3: MLGW-MISO combination with restricted transmission access (“No Deal” Case)
  - Strategy 4: All MISO

- Multiple Scenarios were developed for Strategy 3

- A least cost generation and transmission plan was developed for each Strategy/Scenario combination
Recognizing that cost was not the sole basis for selecting Portfolios, the determination of the final Portfolios is a two-step process:

- **First**: a base capacity expansion is produced using the Long Term Capacity Expansion (LTCE) module of the optimization software (AURORA).

- **Next**: Expert judgement is used to adjust the initial expansion plan and the AURORA LTCE was re-run with these adjustments in place, resulting in a unique Portfolio that is better suited to manage risks, such as reduced dependence on remote resources.
Metrics
## Objectives and Metrics Used in The Evaluation Of Alternative Portfolios

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>METRICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>Meets or exceeds NERC reliability requirements and manages intermittency. All Portfolios meet the minimum levels of NERC thus the metric is designed to measure the ratio of Capacity Import Limit (CIL) + Generation Unforced Capacity (UCAP) to Peak Load. <strong>Higher the better.</strong></td>
</tr>
<tr>
<td>Least cost (Affordability)</td>
<td>NPV of revenue requirements: this includes all costs in addition to the generation capital and operating costs, i.e. transmission, MISO Membership, TVA benefits, PILOT, etc. <strong>Lower the better.</strong></td>
</tr>
<tr>
<td>Price Risk (Minimization/Stability)</td>
<td>Measured as: a) 95% (worst) outcome and b) Regret: i.e. the level by which MLGW would regret having chosen a Portfolio in case of an adverse future. <strong>Lower worst outcome and Minimum or No Regret is the goal.</strong></td>
</tr>
<tr>
<td>Sustainability</td>
<td>Measured as a) Carbon (proxy for total emissions), b) water consumption and c) percentage of the energy coming from renewable resources (nuclear and large hydro excluded). <strong>On a &amp; b lower the better , c higher the better.</strong></td>
</tr>
<tr>
<td>Market Risk</td>
<td>Energy Market Purchases or Sales as a percentage of load; Amount of Capacity Purchases. <strong>Lower the better.</strong></td>
</tr>
<tr>
<td>Economic Growth</td>
<td>Capital Expenditures in Shelby County and number of plants as a proxy. <strong>Higher the better.</strong></td>
</tr>
<tr>
<td>Resiliency</td>
<td>Amount of load shed during extreme events. <strong>Lower the better.</strong></td>
</tr>
</tbody>
</table>
Input Assumptions
Memphis Stochastic Load

The overall distribution shows considerable uncertainty for future average load growth exceeding the reference case, and less uncertainty for future average load growth trending below the reference case.
Natural Gas Price Outlook Cost Components: Henry Hub + Market Gas Hub Index + Transport Tariff

Annual Henry Hub Natural Gas Forecast (2018$/MMBtu)

Monthly Forecast Gas Basis to Henry Hub (2018$/MMBtu)

- The average of Trunkline Zone 1A and Texas Gas Z1 was used as the gas basis for gas plants built in MLGW territory.
- Trunkline firm transportation rate of $0.3811/MMBtu was used for combined cycles and interruptible transportation rate of $0.3212/MMBtu was used for gas peaker.
Stochastic Inputs – Gas Prices

- Siemens has developed stochastics around the price at the Henry Hub based on historical volatility, current market forwards, and a long-term term fundamental view that considers the expected supply-demand balance.
- The 95th percentile probability bands are driven by increased gas demand (most likely due to coal retirements) and fracking regulations that raise the cost of producing gas.
- Prices in the 5th percentile are driven by significant renewable development that keeps gas plant utilization down as well as little to no environmental legislation around power plant emissions.
These stochastic distributions are based on a reference case view of coal prices with probability bands developed based on a combination of historical volatility and mean reversion parameters.
### Technology Options – Capital Costs

<table>
<thead>
<tr>
<th>Technology</th>
<th>Advanced 2x1 CCGT</th>
<th>Conventional 1x1 CCGT, Duct Fired</th>
<th>Simple Cycle Advanced Frame CT</th>
<th>Simple Cycle Conventional Frame 7FA CT</th>
<th>Simple Cycle Aero CT</th>
<th>Coal With 30% CCS</th>
<th>Utility Solar PV - Tracking</th>
<th>Onshore Wind</th>
<th>Lithium Ion Batteries (4 hrs.)</th>
<th>Nuclear SMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Time (Yrs.)</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>&lt;1</td>
<td>50-1,200</td>
<td></td>
</tr>
<tr>
<td>Size (MW)</td>
<td>950</td>
<td>361 (Base)</td>
<td>343</td>
<td>237</td>
<td>50</td>
<td>600</td>
<td>50</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td>Average Heat Rate (Btu/kWh), HHV</td>
<td>6,536</td>
<td>8,704</td>
<td>9,292</td>
<td>9,013</td>
<td>9,750</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>VOM (2018$/MWh)</td>
<td>1.81</td>
<td>2.49</td>
<td>7.13</td>
<td>5.05</td>
<td>6.50</td>
<td>7.14</td>
<td>0.00</td>
<td>0.92</td>
<td>1.39</td>
<td>14.79</td>
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<tr>
<td>FOM (2018$/kW-yr)</td>
<td>15.90</td>
<td>17.41</td>
<td>9.53</td>
<td>4.39</td>
<td>15.70</td>
<td>73.45</td>
<td>20.70</td>
<td>36.56</td>
<td>32.21</td>
<td>165.42</td>
</tr>
</tbody>
</table>

- The technologies in red boxes were selected for Self-Supply + MISO Portfolios.
- Local solar has important advantages as it is closer to the load, behind the transmission constraints, and has lower transmission costs. Due to land availability, only 1000 MW was allowed to be built in Shelby County.
- Advanced 2x1 CCGT was removed from being built locally as an option due to reliability considerations; but remains a candidate for All-MISO Strategy.
Stochastic Inputs – Technology Costs

Advanced CCGT 2018$/kW

Advanced SCGT 2018$/kW

Solar 2018$/kW

Wind 2018$/kW
Sustainability / Environmental Considerations

- Renewable standard was imposed at a minimal level. However, because renewable technologies were found to be an economic option, most portfolios included 50% or more renewable generation.
- A moderate federal price on carbon emissions was included in the Reference Case starting in 2025.
- Emission allowance price costs were included for existing market for SO$_2$ and NO$_x$.
- Permitting for new generation facilities was not conducted as a part of the IRP.
- High level assessment suggests that water access and air permits would be feasible for any large new gas generation facility in Shelby County.

![CO$_2$ Price (2018 $/ton)](chart)
Siemens developed uncertainty distributions around carbon compliance costs based on “expert-opinion” based projections, when the historical data is not available. The top end reflects estimates of the social cost of carbon.

The distribution of carbon prices were used in the power dispatch modeling to capture the inherent risk associated with regulatory compliance requirements.
Siemens also produces a range of views on how energy prices will change over the planning horizon.

These are based on our forecast of future expansions.

AURORA is used with all the input distributions to calculate energy prices.

ICF and MISO forecasts are well within the bands of uncertainty evaluated. MISO is lower in the near term and higher in the long term.
Resource Adequacy
All Portfolios Must Meet MISO Resource Adequacy

- MISO is planned so that there are enough reserves to ensure that the loss of load expectation (LOLE) is less than one day in 10 years
- Current requirement is 8.9% of Unforced Capacity (UCAP) or 18.2% considering the Installed Capacity (ICAP)
- To plan for this MISO is divided into 10 Local Resource Zones (LRZ)
- Each LRZ must have enough Local Resources so that with the ability to import resources from the rest of MISO (Capacity Import Limit – CIL) it meets the zone’s criteria of 1 in 10. This is called the Local Reliability Requirement (LRR)
  - If MLGW were a new LRZ it would have a LRR of about 126%
  - If MLGW is part of LRZ-8 Arkansas this drops to about 120.6%

Each LRZ must have internal resources so that it meets the larger of:

a. MISO Planning Reserve Margin (PRM) of 8.9% (108.9% of peak load)

b. The Local Clearing Requirement; which is the amount of internal generation (UCAP) that when added to the ability to import from MISO to meet the LRR

- All Portfolios that have internal generation were designed to meet:

  **UCAP + CIL >= 126% of Peak Load**
Transmission – The Proposed Plan and Analysis Performed

- Transmission was planned under the assumption that TVA will not provide wheeling to MLGW for use of its transmission system, aka “No Deal”
- Strong interconnections must be established between MLGW and MISO if MLGW were to join MISO. This applies to Strategies 3 & 4.
- Baseline transmission interconnections consist of:
  1. New San Souci-MISO to Shelby-MLGW 500 kV line, 26 miles
  2. West Memphis-MISO to New Allen-MLGW 500 kV line, 8.5 miles
  3. Twinkletown-MISO to New Allen-MLGW 230 kV line, 8 miles
- Based on the LTCE plans and proposed transmission configurations, Siemens performed:
  - Steady state contingency analysis, using NERC TPL reliability standards confirming all system reliable, and identified local upgrades
  - Transfer analysis, determined import capabilities from 2579 MW to 3690 MW depending on the requirement by the Portfolio
  - Stability analysis, demonstrated system stable against critical faults
  - Economic nodal production cost analysis, showed no expected system congestion
- Maximum transmission option adds 4th interconnection line: Dell-MISO to Shelby-MLGW 500 kV, 44 miles, required for All MISO Strategy.
Transmission – The Numbers

- Total capital costs for baseline configurations ~$700 M (with contingency) in 2018 $ or $2.1/MWh NPV 2025-2039:
  - Transmission expansions, $376 M
  - Local 161 kV reinforcements, $184 M
  - Generator Interconnections, $88 M
  - Reimbursements to TVA for Allen CCGT reconnection and reliability upgrades, $47 M
  - Maximum transmission option (for All MISO Strategy), adds ~$407 M for a total of $1,014 M, or $3.1/MWh NPV 2025-2039.
- Cost of transmission O&M for new facilities, 2.5% of capital cost, ~$9.4M/year, or $0.7/MWh for base plan and increased to $0.9/MWh for max transmission plan.
- Capital cost varies based on the import requirement of each Portfolio

*The transmission configurations, reliability performance, transfer capability, and cost estimation were all independently reviewed by MISO*
Other Costs – Integral part of the total revenue requirement

- Payment in Lieu of Taxes (PILOT)
  - MLGW assumes full responsibility of state and local PILOT
    - State PILOT assumes 5% of the wholesale power cost, ranging $2.3/MWh to $2.6/MWh, or avg. $33 M /year, depending on the NPVRR of the Portfolio
    - Local PILOT ranges $1.4/MWh to $2.3/MWh depending on the total transmission investments
- TVA Service and Benefits Replacements
  - TVA has been providing social and economic benefits to Memphis area
  - MLGW is expected to continue those benefits and spend $13 to $15 million per year, or $1/MWh on the NPV basis.
- MISO Membership Cost
  - MLGW would be responsible for MISO membership fee and annual cost shares at about $6.7 million per year or $0.45/MWh on the NPV basis.
- Energy Efficiency Programs
  - MLGW is assumed to implement system wide energy efficiency programs to achieve 0.5% penetration at a cost of ~$ 7 million per year or $0.64/MWh on the NPV basis.
Gap Analysis

Siemens reviewed MLGW’s existing capabilities and assessed the gaps for enabling MLGW to perform required planning and operating functions as a MISO LBA.

The Gap Analysis referenced NERC reliability standards assigned to Balancing Authorities (BAs), and examined NERC’s operations readiness (BA Certification) document. Additionally, the review included an analysis of the MISO Operating Agreement, last amended in January 2019.

The total cost is about $0.5/MWh on NPV 2025-2039.

<table>
<thead>
<tr>
<th>Local Balancing Area Costs</th>
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<tr>
<td>Fixed Capital Cost (2020 $M) - LBA</td>
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<td>AGC to MLGW controlled units</td>
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<td>Data communications to generators and LBA service provider</td>
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<td>Control center facility upgrade</td>
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<td>Real-time contingency and reliability analysis</td>
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<td>CIP compliance upgrade</td>
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<td><strong>TOTAL</strong></td>
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<th>Annual O&amp;M Cost (2020 $M, with annual escalator) - LBA</th>
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<td>Annual LBA service vendor</td>
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<td>Expanded CIP Scope</td>
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<td>Staff (+3) and training</td>
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<td>Additional communications maintenance and fees</td>
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<td>Additional control center systems maintenance</td>
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<td><strong>TOTAL</strong></td>
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**Gap Cost - Other**

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<tr>
<th>Resource and Transmission Planning, Studies and Procurement</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
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<tr>
<td>Total Staff</td>
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<td>Staffing Costs $266,000/FTE including salary, benefits, rent, facilities</td>
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<td>1.6</td>
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<td>1.3</td>
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<td>Contractor &amp; Consulting Costs, G&amp;T MLGW</td>
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<td>0.8</td>
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<td>1.0</td>
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<td>1.0</td>
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<td>0.5</td>
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<tr>
<td><strong>Total Cost</strong></td>
<td><strong>1.3</strong></td>
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<td><strong>1.8</strong></td>
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*All staff are in addition to existing staff
*costs start 2021

*All Costs in Million
Analyses of Portfolios
Balanced Scorecard: Portfolios 9 and 10 of Strategy 3

Perform Best Across All Metrics

<table>
<thead>
<tr>
<th>Objective</th>
<th>Measure</th>
<th>Unit</th>
<th>TVA (Base)</th>
<th>TVA (LTP)</th>
<th>Portfolio 5</th>
<th>Portfolio 9</th>
<th>Portfolio 10</th>
<th>Portfolio 8</th>
<th>All MISO</th>
<th>Portfolio 1</th>
<th>Portfolio 7</th>
<th>Portfolio 4</th>
<th>Portfolio 2</th>
<th>Portfolio 3</th>
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<tr>
<td>$ Millions</td>
<td>NPVRR 2020 - 2039</td>
<td></td>
<td>16,411</td>
<td>14,020</td>
<td>14,504</td>
<td>14,453</td>
<td>14,304</td>
<td>14,614</td>
<td>14,627</td>
<td>14,522</td>
<td>14,490</td>
<td>14,503</td>
<td>14,511</td>
<td>14,688</td>
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<tr>
<td>$ millions</td>
<td>Stochastic Mean NPVRR 2020 - 2039</td>
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<td>16,388</td>
<td>15,996</td>
<td>14,459</td>
<td>14,465</td>
<td>14,571</td>
<td>14,747</td>
<td>14,766</td>
<td>14,789</td>
<td>14,790</td>
<td>14,808</td>
<td>15,052</td>
<td>15,076</td>
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<tr>
<td>$/MWh</td>
<td>Levelized Cost of Energy</td>
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<td>87.47</td>
<td>66.86</td>
<td>59.32</td>
<td>59.34</td>
<td>59.48</td>
<td>60.51</td>
<td>60.59</td>
<td>60.68</td>
<td>60.69</td>
<td>60.76</td>
<td>61.77</td>
<td>61.87</td>
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<tr>
<td>$ Millions</td>
<td>NPV Savings with respect of LTP</td>
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<td>1,537.4</td>
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<td>1,230.5</td>
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<td>$ Millions</td>
<td>Levelized Savings per Year</td>
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<td>122.1</td>
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<td>95.9</td>
<td>94.4</td>
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<td>73.1</td>
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<td>$ Millions</td>
<td>Levelized Savings per Year (wrt Base) 2025-39</td>
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<td>144.4</td>
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<td>125.5</td>
<td>106.1</td>
<td>104.2</td>
<td>94.1</td>
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<td>$ millions</td>
<td>95th Percentile Value of NPVRR</td>
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<td>16,830</td>
<td>16,576</td>
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<td>16,644</td>
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<td>17,074</td>
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<td>17,648</td>
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<td>$ Millions</td>
<td>CO₂ Emissions Mean 20-Year</td>
<td>Million Tons CO₂</td>
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<td>3.8</td>
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<td>1.85</td>
<td>2.81</td>
<td>2.57</td>
<td>2.67</td>
<td>2.68</td>
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<tr>
<td>$ Millions</td>
<td>Energy from Renewable Sources 2039 (RPS)</td>
<td>% of Energy Consumed</td>
<td>6.5%</td>
<td>6.5%</td>
<td>75.3%</td>
<td>75.3%</td>
<td>52.7%</td>
<td>54.9%</td>
<td>54.9%</td>
<td>52.7%</td>
<td>56.8%</td>
<td>56.8%</td>
<td>47.3%</td>
<td>46.1%</td>
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<tr>
<td>$ Millions</td>
<td>Energy from Zero Carbon Sources 2039</td>
<td>% of Energy Consumed</td>
<td>58.6%</td>
<td>58.6%</td>
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<td>52.7%</td>
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<td>56.8%</td>
<td>56.8%</td>
<td>47.3%</td>
<td>46.1%</td>
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<tr>
<td>Million Gallon</td>
<td>2025 Local Water Consumption</td>
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<td>3,103</td>
<td>3,103</td>
<td>3,961</td>
<td>3,782</td>
<td>4,899</td>
<td>4,782</td>
<td>4,789</td>
<td>3,103</td>
<td>4,788</td>
<td>4,795</td>
<td>5,640</td>
<td>5,551</td>
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<tr>
<td>%</td>
<td>2025 (UCAP+CIL)/PEAK</td>
<td>%</td>
<td>133.7%</td>
<td>133.7%</td>
<td>126.0%</td>
<td>127.8%</td>
<td>148.6%</td>
<td>126.6%</td>
<td>127.2%</td>
<td>115.4%</td>
<td>126.8%</td>
<td>127.2%</td>
<td>126.7%</td>
<td>130.8%</td>
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<td>MV</td>
<td>Max Load Shed in 2025 under Extreme Event</td>
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<td>0</td>
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<td>622.4</td>
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<tr>
<td>%</td>
<td>% Energy Purchased in Market</td>
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<td>31.2%</td>
<td>31.2%</td>
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<td>16.7%</td>
<td>7.4%</td>
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<tr>
<td>%</td>
<td>% Energy Sold in Market</td>
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<td>8.7%</td>
<td>8.7%</td>
<td>22.6%</td>
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<td>$ Millions</td>
<td>Local T&amp;G CapEx</td>
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<td>2,965</td>
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<td>3,299</td>
<td>3,404</td>
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</tr>
</tbody>
</table>

*All $ is in 2018$ unless otherwise noted.
Evaluation of Strategies 3 and 4: Portfolios 5, 6, 9 and 10 are Lowest Cost

- Portfolios 5 and 9 have one 450 MW CCGT and Portfolio 10 has one 950 MW CCGT.
- Portfolio 6 has two 450 MW CCGTs.
- Other Portfolios with two CCGTs are close and Portfolio 6 is representative.
- Portfolios in blue are preferred.
Evaluation of Strategies 3 and 4:
Portfolios 5, 6, 9 and 10 are among the Lowest Risk

- Portfolios 10 and 6 show the higher risk among the preferred portfolios in blue.
- Risk is measured as the value that only 5% of the outcomes in the stochastic assessment was worse.
Four Portfolios Selected for Comparison with TVA Portfolios 5, 6, 9 and 10.

Portfolio 5
- Has the largest amount of renewable generation with 4,450 MW, most of which (4,400 MW) by 2028.
- Has one 450 MW CCGT in 2025.
- Four CTs (4x237 MW) are selected optimally as the price in MISO capacity increases.
- Requires heavy investments in transmission.

Portfolio 9
- Has the same level of renewable generation as Portfolio 5 and the CCGT.
- The four CTs are advanced to 2025 to address reliability concerns with Portfolio 5.
- Requires less investments in transmission.
Four Portfolios Selected for Comparison with TVA Portfolios 5, 6, 9 and 10.

Portfolio 6
- Has 3,200 MW of renewable generation, all of which by 2027.
- Has two 450 MW CCGTs in service by 2025.
- Has one CT (237 MW) by 2025.
- Moderate investments in transmission.

Portfolio 10
- Has 3,200 MW of renewable generation, most of which (3,000 MW) by 2030.
- Has one large 950 MW CCGT in 2025.
- No CT.
- Max investments in transmission to address reliability concerns due to one large CCGT.
Exiting TVA Could Save MLGW $1.5 Billion over 20 Years Considering the LTP and $ 1.9 Billion with Current Contract

The savings are in real 2018$

- If expressed in 2020$ this would increase to $1.6 billion with respect of the LTP and $ 2.0 with respect of current contract.
- These savings are after all other costs are included.
- In nominal terms the savings add to over $ 3 billion with respect to the current contract.
Exiting TVA could result in annual savings of about $120 million per year (2025-2039) with LTP to about $150 million per year (2025-2039) with current contract.

- There are potential savings of over $3.0 billion for the 2025 to 2039 period in nominal terms and with respect of the current contract. This averages to $200 million per year.
95th % NPVRR Risk Higher with TVA than Self Supply + MISO Options

- The TVA option, given the size of the company and strong presence of nuclear and hydro that experience little or no volatility in costs, has more stable cost.
- The 95th percentile of TVA portfolios is only 105% times the mean, while in other portfolios this reaches 114% to 117% times.
- Portfolios 5 & 9 are still least cost.
- It is important for MLGW to manage this volatility in costs by entering into, for example, long term fuel supply contracts.
CO2 Emissions from Self-Supply + MISO options are well below TVA options
Self-Supply + MISO Options Can Produce more Energy (Portfolios 5 and 9) from Zero Carbon Sources than TVA

- TVA portfolio has lower renewable generation due to large hydro and nuclear being excluded.
Shelby County Water Consumption is Lowest with TVA Options

- These are the water usage for cooling thermal generation
- In case of TVA, the consumption is only by the Allen Combined Cycle
- Any other thermal generation adds to it.
All the Portfolios Meet Minimum Reliability Requirements
Portfolio 5 is Less Desirable Because of Potential Load Shedding

![Reliability Chart]

![Resiliency Chart]
TVA Has Less Exposure to Energy Market Risk
Portfolios 5 and 9 Have the Greatest Exposure

- Portfolios 5 and 9 with high levels of renewable have the greatest amounts of energy exchanged with MISO.
- Sales during the day and purchases at night.
Economic Development (as expressed by local investment) Impacts are Similar Among Portfolios

![Bar Chart: Local Investments ($ Million)]

- Portfolio 5: 2,989
- Portfolio 9: 2,864
- Portfolio 10*: 2,984
- Portfolio 6: 2,845
Summary of Comparisons with TVA
Focusing on the period after notice is given, the waterfall shows savings (2025-2039) with respect of the TVA LTP contract compared with Portfolio 9

- The waterfall (buildout) shows the importance of the relative components of cost for Portfolio 9.
- The transmission and other costs are important. They contribute over $122 million/year to the comparable cost for TVA.
- This highlights the importance of assumptions.
- The savings are determined looking only at the difference in NPVs for the 2025 to 2039 period.
Focusing on the period after notice is given, annual savings for exiting TVA’s current (5 year exit) contract (2025-2039) compared with Portfolio 9

- Siemens forecast assumptions drives a future rate for TVA of about $71/MWh. If TVA rate were to be maintained at the current $75/MWh, the savings would increase by about $66 million in 2018 $.

- All savings are reported in real 2018 $. If future inflation is 2%/year, the actual average savings is about $200 million/year.
Focusing on the period after notice is given, levelized costs (2025-2039) with TVA current contract compared with Portfolio 9

- This shows savings on a levelized cost of energy basis ($/MWh)
Recommendations
No Regret Actions if MLGW Joins MISO

If MLGW chooses to exit the TVA contract and join MISO, MLGW should:

- Maximize the amount of local renewable generation, which provides local support and it is not affected by transmission. This is a no regret decision, i.e. it is present in all Portfolios and should be pursued.

- One combined cycle (450 MW) is present in all preferred solutions, thus this is a no regret decision. However, its size could be subject to further optimization.

- Installing at least two combustion turbines (237 MW) in 2025, also appears to be a no regret solution. Also, if two CCGTs are selected (as in Portfolio 6) and then two CTs would be required to reduce the risk of load shedding under N-1-1 to zero.

- MLGW should seek to become part of MISO Local Resource Zone 8 rather than becoming an independent zone. Both MLGW and the current members in LRZ8 stand to gain from this given the load diversity and the larger size of the new zone.
Recommended Next Steps to Confirm Savings Before Making a Final Determination

An RFP should be undertaken by MLGW to confirm the savings before making a final decision.

The IRP can be utilized to determine the general mix of assets and locations of interest in the RFP and the orders of magnitude of transmission required.

Differences between Portfolios 5, 9, 6 and 10 can be reassessed with bids provided by potential suppliers.

Options to manage fuel price risk should be an element to be included in the RFP.
No Regret Actions if MLGW Stays with TVA

In case MLGW decides to stay with TVA:

- MLGW should explore options to increase the amount of local renewable generation (which is limited to 5% offered by TVA under the 20-year LTP).

- In addition, MLGW should assess further the LTP option. On one hand there will be a reduction on the costs and the 20-year NPVRR with the LTP is approximately $400 million lower than without it. On the other hand, MLGW will be locked for 20 years or more and unable to control or take advantage of development in the power industry as, for example, deeper drops in the cost of renewable generation and storage that could increase the economic savings for reconsidering exiting TVA and joining MISO at a later date. The value of the optionality provided by a shorter term exit can be evaluated.

- This analysis only needs to be performed if MLGW chooses to stay with TVA.
Questions
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Glossary
Glossary

- **All-in Capital Cost** = The capital costs for building a facility within the plant boundary, which includes equipment, installation labor, owners costs, allowance for funds used during construction, and interest during construction.
- **Appalachia Basin** = Marcellus Shale Play and Utica Shale Play.
- **Average Demand** = Average of the monthly demand in megawatts.
- **Average Heat Rate** = The amount of energy used by an electrical generator to generate one kilowatt hour (kWh) of electricity.
- **Baseload Heat Rate** = The amount of energy used by an electrical generator to generate one kilowatt hour (kWh) of electricity at baseload production. Baseload production is the production of a plant at an agreed level of standard environmental conditions.
- **Breakeven Cost** = Average price of gas required to cover capital spending (ideally adjusted to regional prices).
- **BAU** = Business As Usual
- **BTU** = British Thermal Unit = unit of energy used typically for fuels.
- **CF** = Capacity Factor. The output of a power generating asset divided by the maximum capacity of that asset over a period of time.
- **CCGT (or CC)** = Combined Cycle plant, gas turbine combined with steam turbine
- **CCS** = Carbon Capture and Sequestration
- **CT** = Combustion Turbine
- **DER** = Distributed Energy Resources, distributed generation, small scale decentralized power generation or storage technologies
- **DS** = Distributed Solar
- **Dth** = Dekatherm (equal to one million British Thermal Units or 1 MMBtu)
- **EE** = Energy Efficiency
- **ELCC** = Effective Load Carrying Capability
- **EFT** = Enhanced Firm Transportation (varies by pipeline but can include short- or no-notice changes to day-ahead nominations of fuel delivery
- **FID** = Final Investment Decision
- **FOM** = Fixed operations and maintenance costs
- **FT** = Firm Transportation. FT capacity on a natural gas pipeline is available 24/7 and is more expensive than interruptible transportation (IT) capacity but unused FT capacity can be sold on secondary market.
- **Futures** = Highly standardized contract. Natural gas futures here are traded on the New York Mercantile Exchange (NYMEX) or Chicago Mercantile Exchange (CME).
Glossary

- GT = Gas Turbine
- IPP = Independent Power Producer
- IRP = Integrated Resource Plan
- LNG = Liquified natural gas
- LCOE = Levelized cost of energy
- LOLE = Loss of load expectation
- LOLH = Loss of load hours
- LTCE = Long Term Capacity Expansion Plan; optimization process to select generation
- MMBtu = million British Thermal Units, unit of energy usually used for fuels
- MWh = unit of energy usually electric power = 1 million watts x hour
- MW = unit of power = 1 million watts
- Peak Demand = The maximum demand in megawatts (MW) in a year
- PPA = Power Purchase Agreement; contract to purchase the power from a generating asset
- PV = Photovoltaic
- Reserve Margin = The amount of electric generating capacity divided by the peak demand.
- RPS = Renewable Portfolio Standard: a regulation that requires the increased production of energy from renewable energy sources
- RFP = Request for Proposal
- SMR = Small Modular Reactor
- “Sweet Spot” Core Acreage = Areas within a natural gas play that offer the highest production at least cost.
- Utility Scale = large grid-connected power generation, could be solar, gas, diesel, etc.
- VOM = Variable operations and maintenance costs
- Wheeling = a transaction by which a generator injects power onto a third party transmission system for delivery to a client (load).