Integrated Resource Plan – Draft Results

PSAT Meeting | May 29, 2020

Agenda

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- 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

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Introduction

IRP Process Recap

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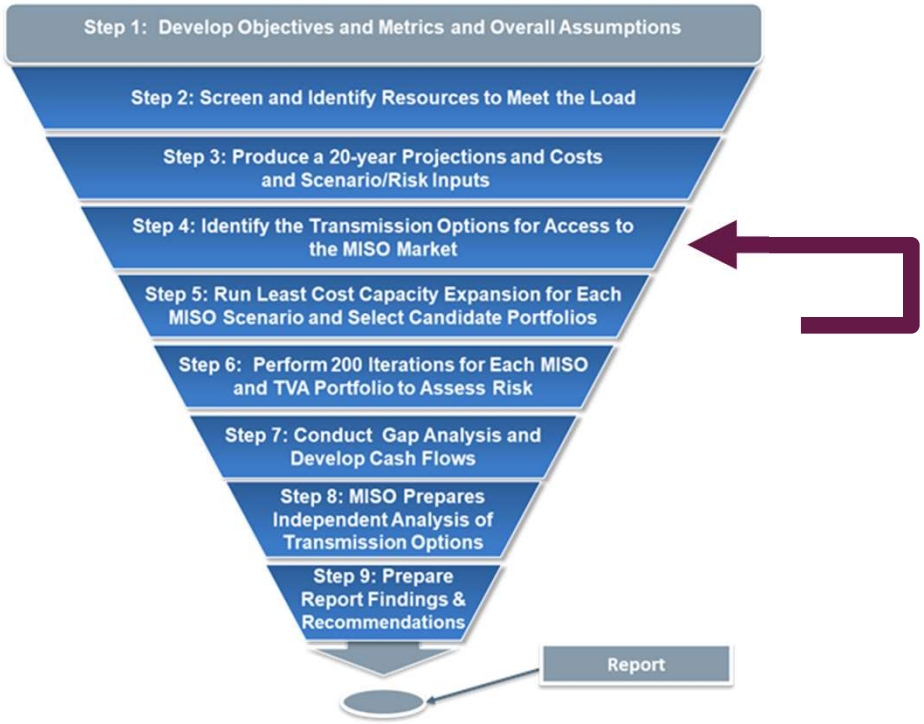
- The IRP process is designed to evaluate options for MLGW to supply of its current and forecasted load while meeting key objectives including:
  - *Affordability / Least Cost / Rate Impact*
  - *Reliability / Resource Adequacy*
  - *Sustainability / CO2 / Water Use / RPS*
  - *Stability / Price Risk 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.



Integrated Resource Planning… a Recap

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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

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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.

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Summary of Findings

11 Resource Portfolios under Self-Supply plus MISO (Strategy 3) and All MISO (Strategy 4) were Evaluated

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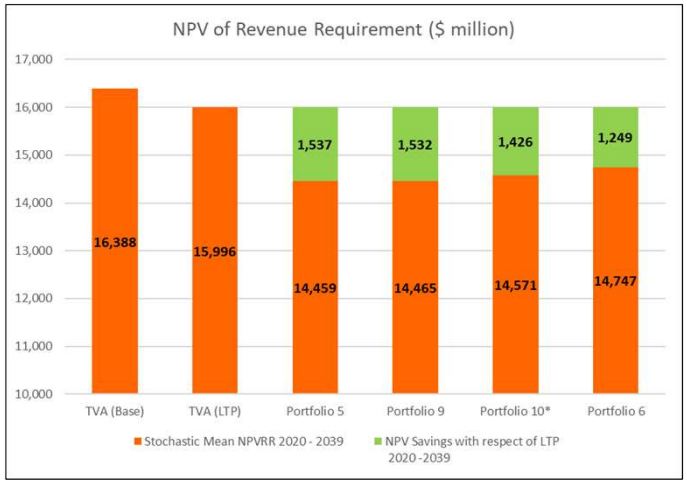
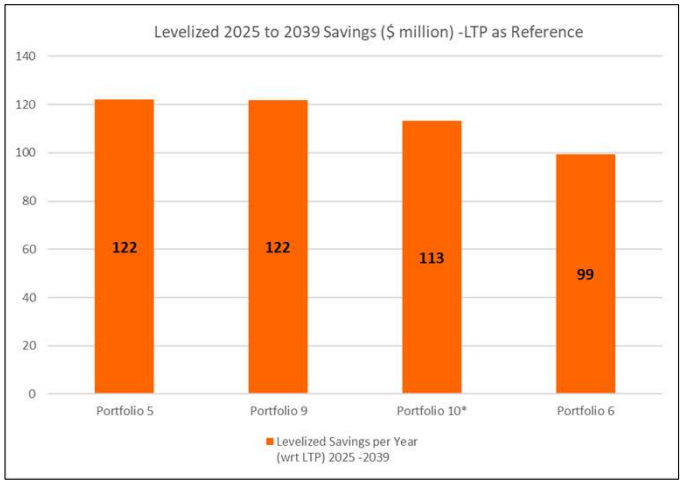
Portfolio ID	Final Portfolio	Total Thermal 2039	Local Renew 2039	Battery 2039	Total Local Nameplate 2039	MISO Renew 2039	MISO Cap 2039	950 MW CC	450 MW CC	237 MW CT
S3S1_P	Portfolio 1	1137	1000	0	2137	2200	1761	0	2	1
S3S1_F	Portfolio 2	1587	1000	0	2587	1550	1487	0	3	1
S3S2_BB	Portfolio 3	1824	1000	0	2824	1350	1308	0	3	2
S3S3_BB	Portfolio 4	1350	1000	0	2350	1550	1697	0	3	0
S3S5	Portfolio 5	1398	1000	100	2498	3450	1183	0	1	4
S3S7_BB	Portfolio 6	1137	1000	0	2137	2200	1761	0	2	1
S3S1_2CT	Portfolio 7	1374	1000	0	2374	2200	1550	0	2	2
S3S7_2CT	Portfolio 8	1374	1000	0	2374	2200	1550	0	2	2
S3S5_YD	Portfolio 9	1398	1000	100	2498	3450	1186	0	1	4
S3S10	Portfolio 10	950	1000	0	1950	2250	1901	1	0	0
S4S1	Portfolio All MISO	950	0	0	0	3200	1909	1	0	0

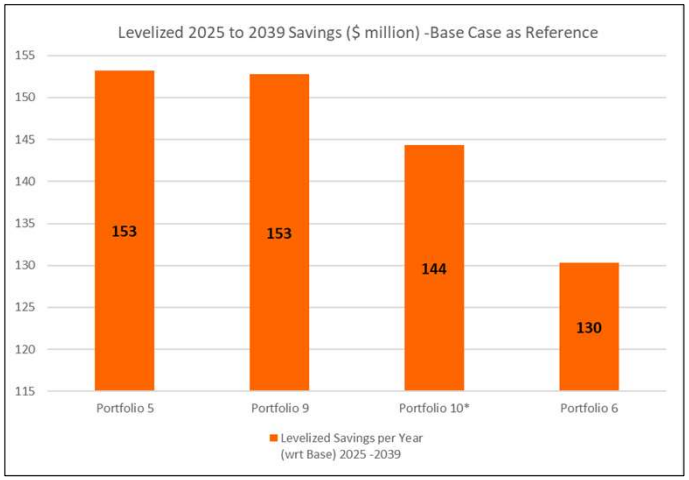
- Portfolio 1, 2 and 7: derived from the Reference case.
- Portfolio 3: derived from High Load / Base Gas case.
- Portfolio 4: derived from Low Load / Base Gas case.
- Portfolio 5 and 9: derived from High Transmission case, with battery storage (9 moved CTs to 2025).
- Portfolio 6 and 8: derived from 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.

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).

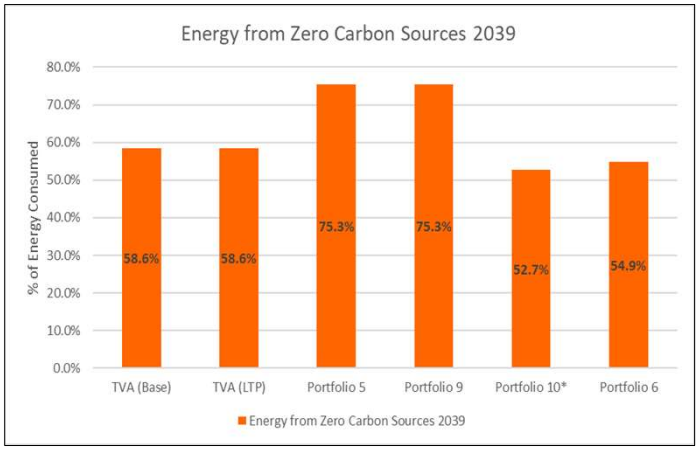


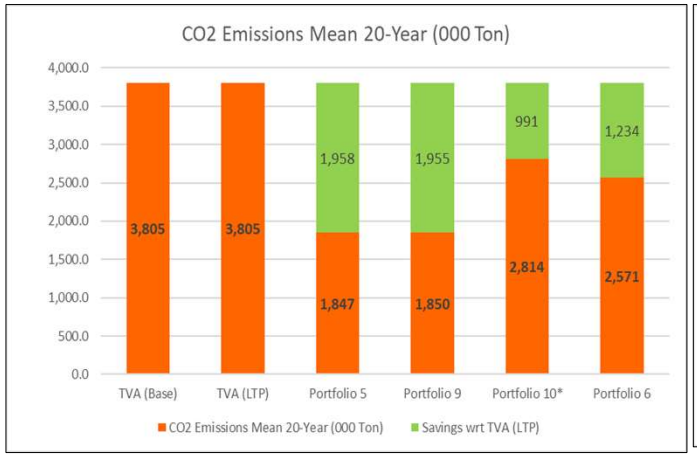


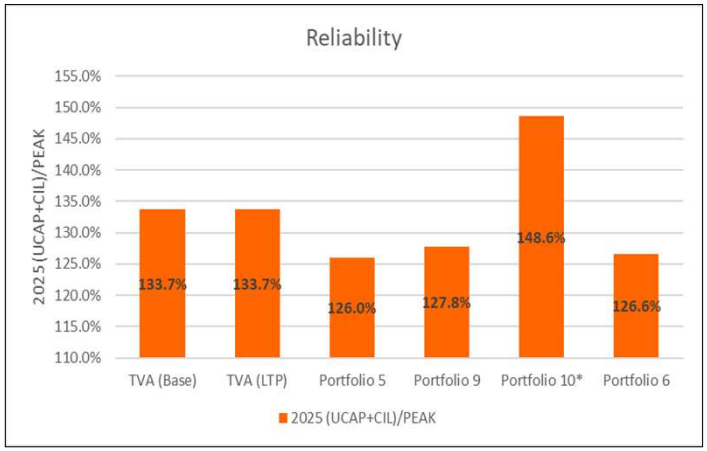


Summary of Findings

- 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.
- CO_2 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.







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MISO Overview and Membership Assessment

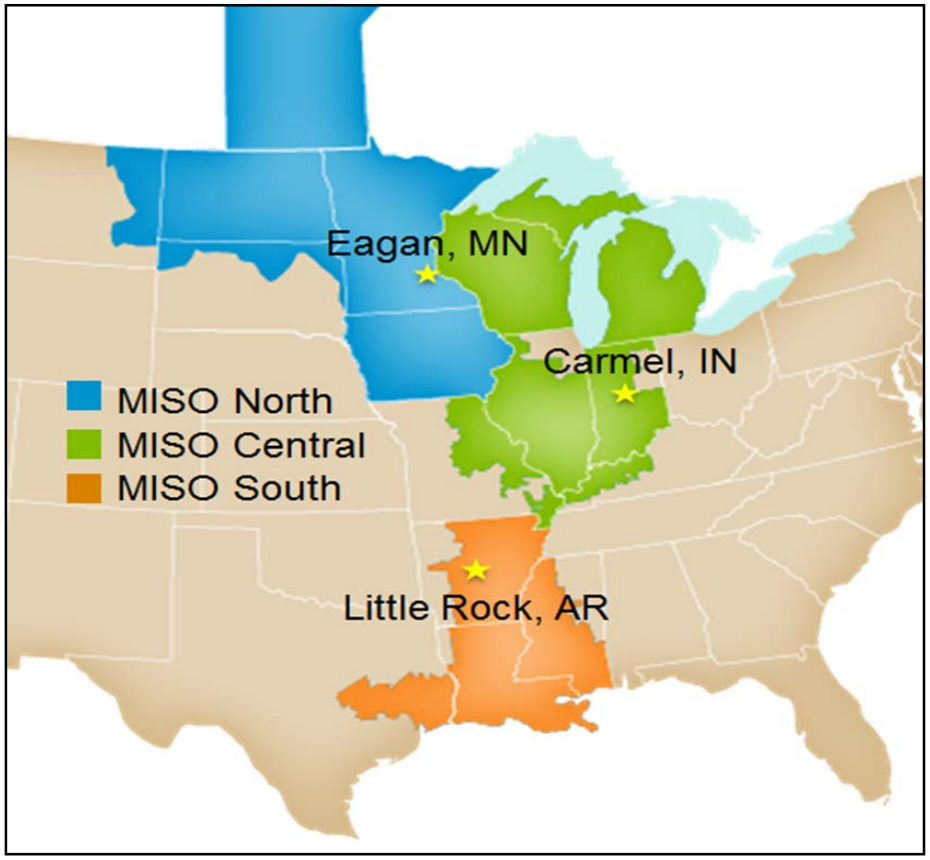
Memphis Light, Gas and Water (MLGW)
Power Supply Advisory Team Meeting

May 29, 2020

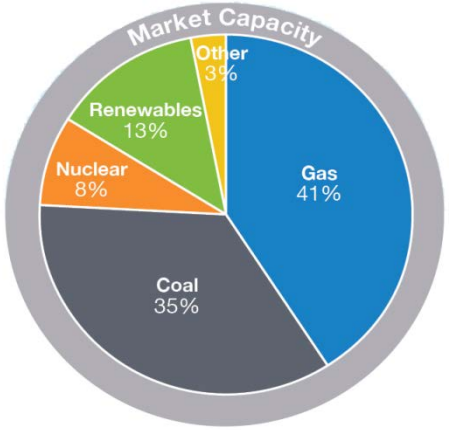
Part I: MISO Overview

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	
High Voltage Transmission	65,800 miles
Generation Capacity	174,000 MW
Peak Summer System Demand (07-20-11)	127,125 MW
Customers Served	42 million

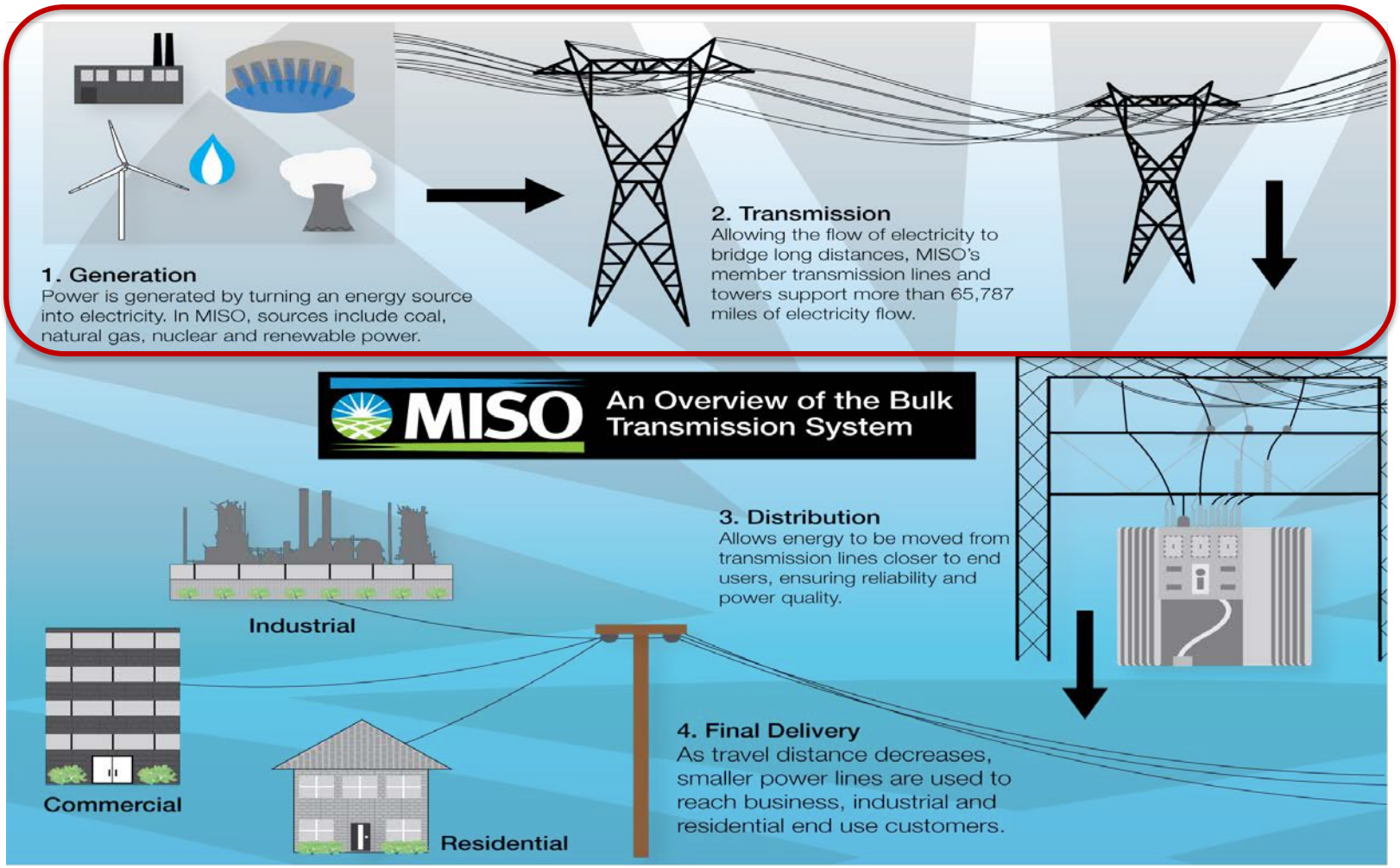


MISO Corporate Fact Sheet

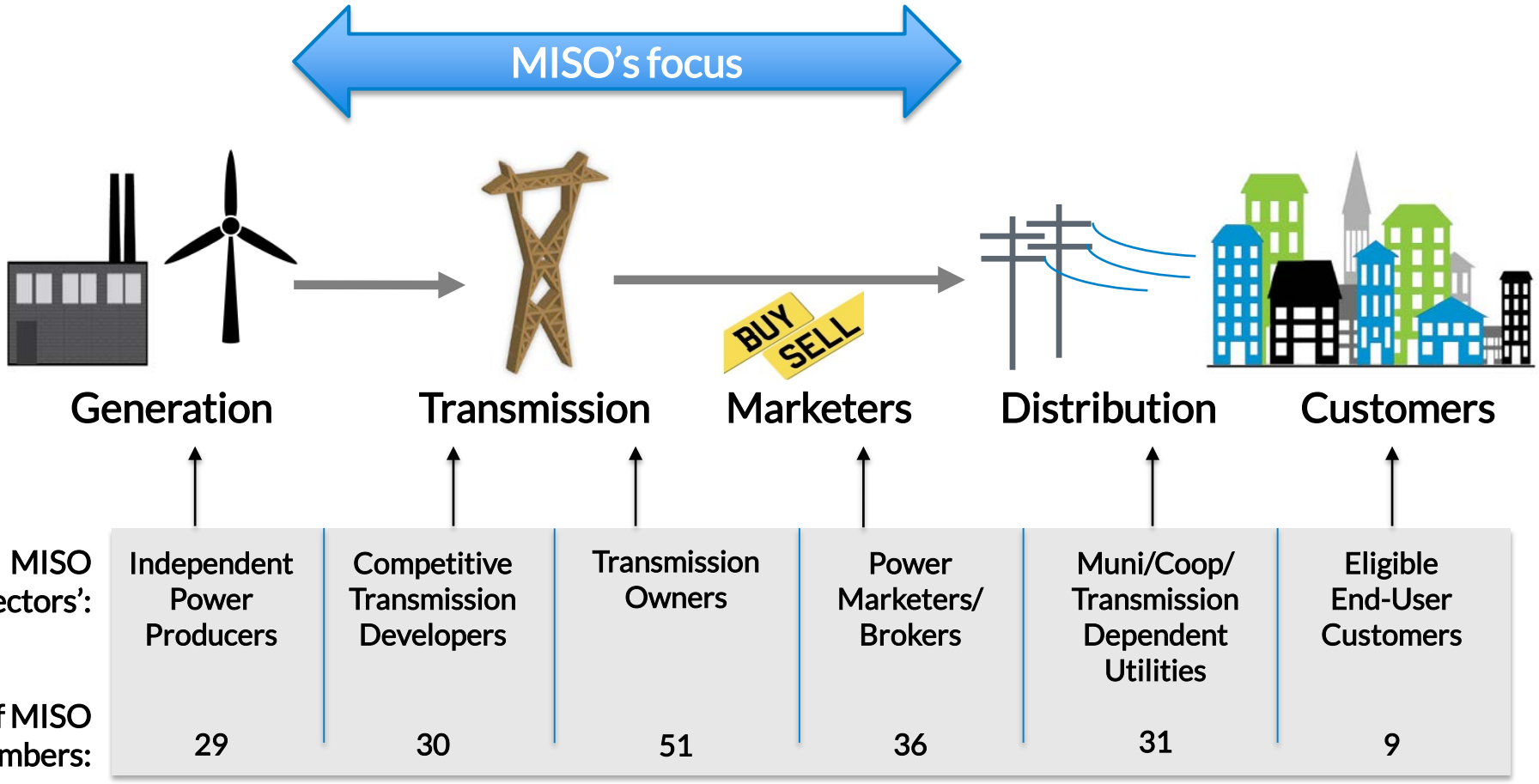
MISO's Key Functions

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

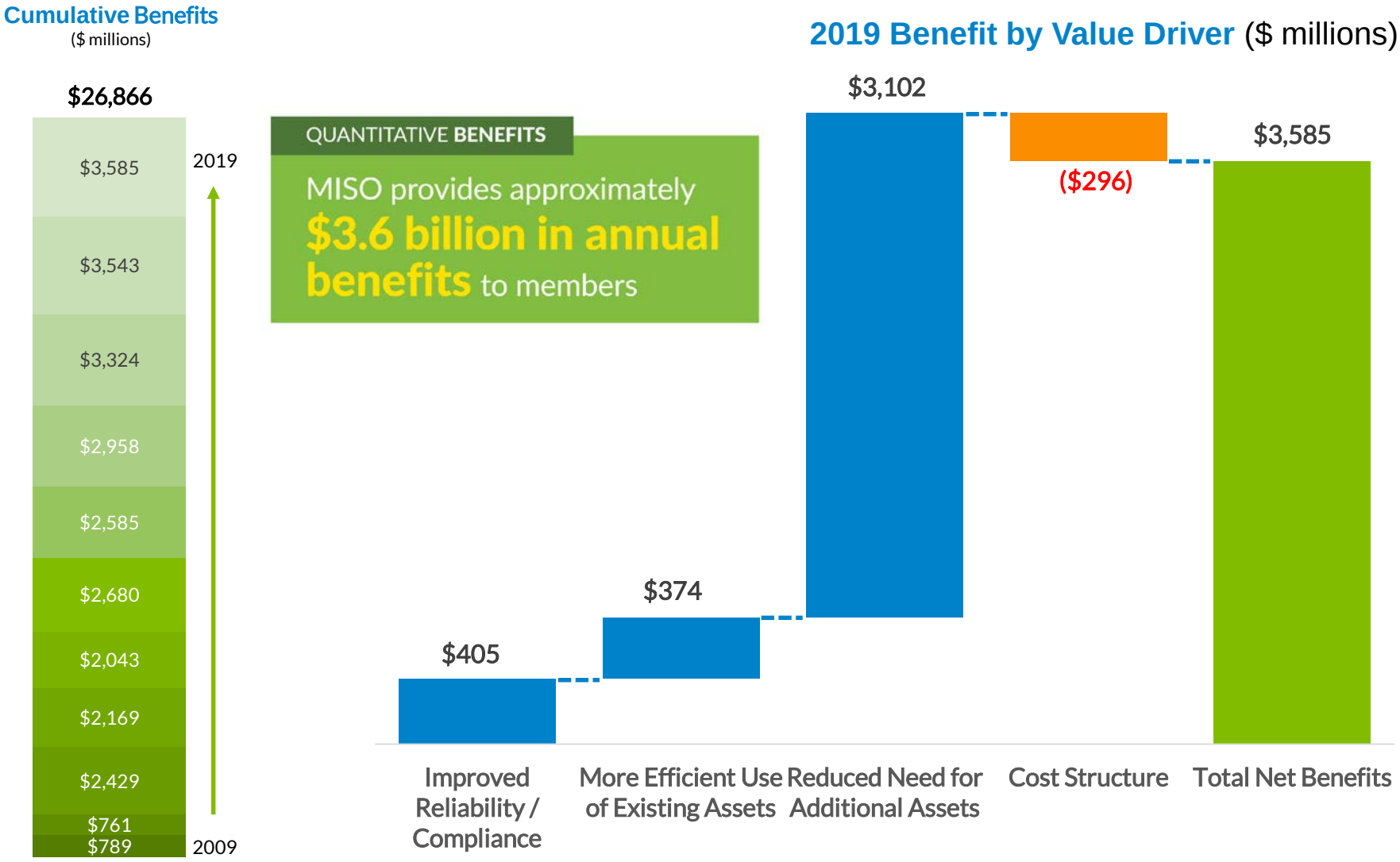
MISO doesn't own any physical assets, we manage flows on the transmission system by directing generator usage



MISO members participate across the electricity value chain

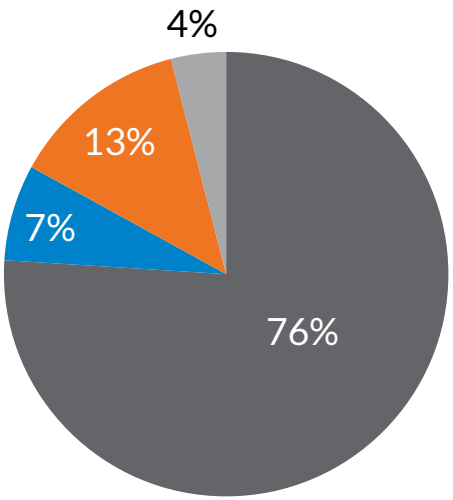


Since 2009, MISO has estimated over $26 billion in membership benefits

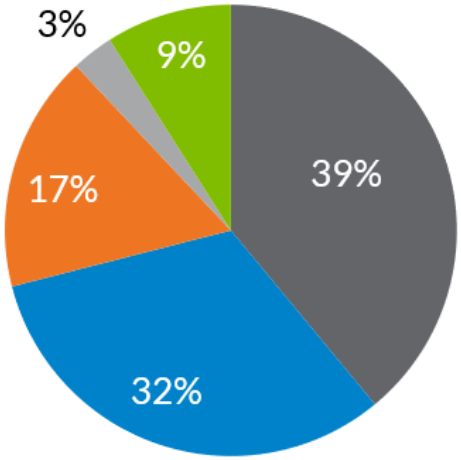


MISO will continue to support the evolution of resources on the bulk electric grid

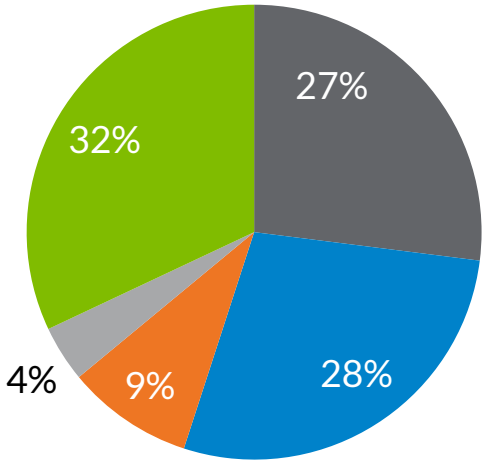
2005 Generation Mix (% MWH)



2019 Generation Mix (% MWH)



2030 Generation Mix (% MWH)[1]



Renewables | Other | Nuclear | Gas | Coal

[1]The 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?

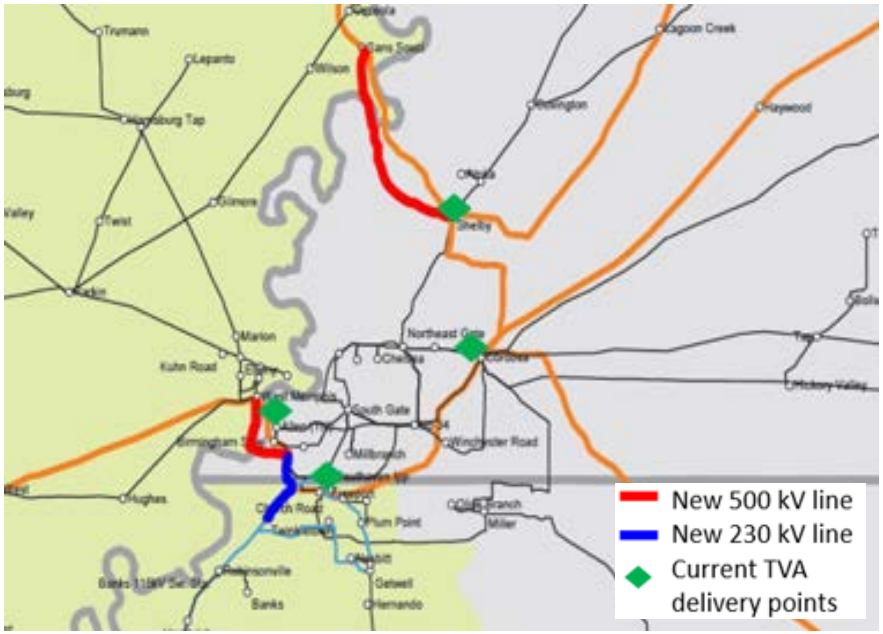
MISO performed its assessment for MLGW based on the following capacity and transmission expansion plan

Base Capacity Expansion Plan

MW	Gas CT	Gas CC	MLGW Solar	Arkansas Solar	Arkansas Wind
2025	237	1,350	600	500	200
2026	0	0	400	0	0
2027	0	0	0	0	0
2028	0	0	0	0	50
2029	0	0	0	0	50
2030	0	0	0	150	0
2031	0	0	0	50	0
2032	0	0	0	0	50
2033	0	0	0	50	0
2034	0	0	0	300	0
2035	0	0	0	0	0
2036	0	0	0	50	0

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



The MLGW membership analysis resulted in the following takeaways

RESOURCE ADEQUACY ASSESSMENT

- Siemens' proposal provides MLGW with adequate resources to join MISO Local Resource Zone (LRZ) 8 or to be its own standalone zone
- If MLGW were to join MISO it would lower the Installed Capacity (ICAP) Planning Reserve Margin (PRM) from 18.2% to 17.9%
- MISO is unable to provide direction on how much excess capacity would be available for purchase

TRANSMISSION INTERCONNECTION ASSESSMENT / COST

- MISO validated the physical transmission import capability up to 2,400 MW during 2024 summer peak conditions
- MISO's estimated the transmission expansion, reliability upgrades, and interconnection costs to be $736.2M vs. $728.2M by Siemens[2]

MARKET IMPACT ASSESSMENT

- 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)
- Projections show MLGW self supplying 50% of its energy needs in 2024 and increasing over time
- No significant changes to congestion patterns were observed

MISO ADMINISTRATIVE COST RECOVERY FEES

- Based on a projection of MISO's annual operating expenses MLGW's share of MISO's costs would be approximately $6 million annually
- 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.

[2]The Siemens cost estimate is adjusted to match MISO's assumptions regarding contingencies and inflation.

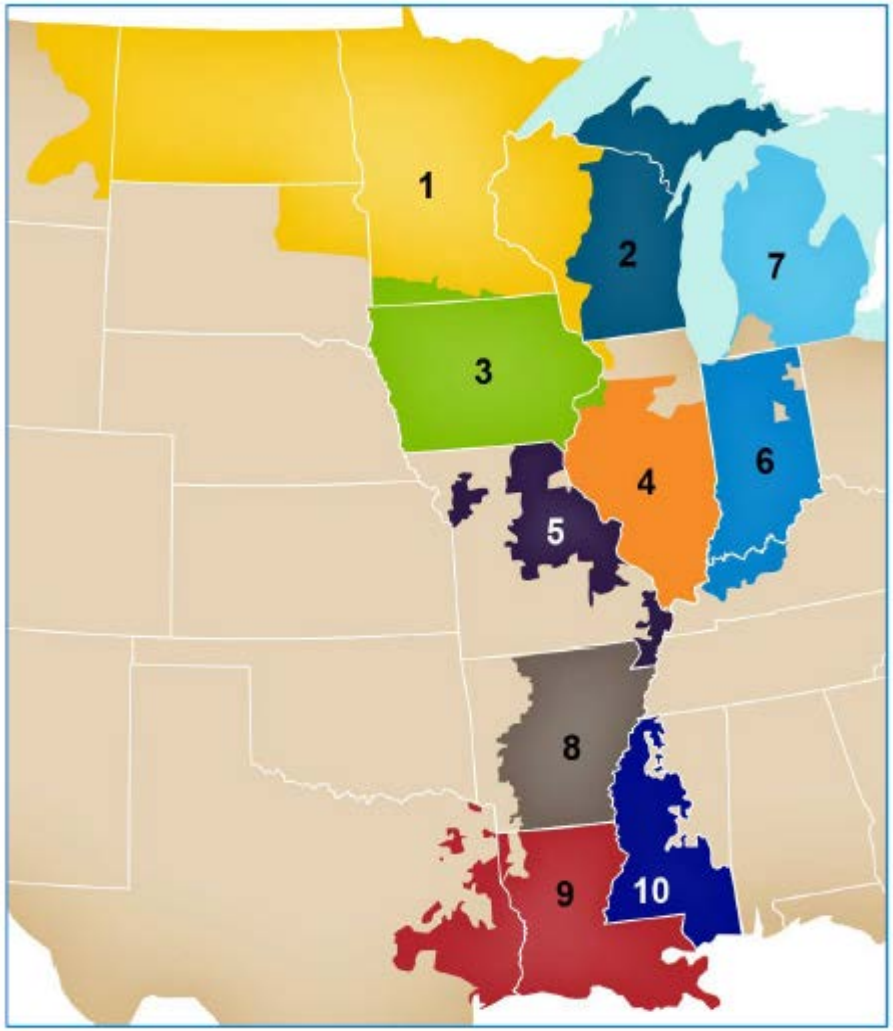
MLGW has requested that MISO evaluate an additional option which includes no local generating resources

- 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

Appendix

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



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Strategies / Scenarios / Portfolio Analyzed

Key Issue: Portfolio Expansion Strategies

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- 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

Scenarios / Portfolios		Strategy		
		Strategy 1 (TVA)	Strategy 3 Self + MISO	Strategy 4 All MISO
State of the World	Scenario 1 Reference	S1S1	S3S1	S4S1
	Scenario 2 (High Load)		S3S2	
	Scenario 3 (Low Load)		S3S3	
	Scenario 4 (High Load/Low Gas)		S3S4	
	Scenario 5 (High Transmission)		S3S5	
	Scenario 6 (Promote BESS)		S3S6	
	Scenario 7 (Low Load/High Gas)		S3S7	

Summary of the Selection of 11 Portfolios

Portfolio ID	Final Portfolio	Load	Gas Price	Total Thermal 2039	Local Renew 2039	Battery 2039	Total Local Nameplate 2039	MISO Renew 2039	MISO Cap 2039	950 MW CC	450 MW CC	237 MW CT	343 MW CT
S3S1	No	Base	Base	1137	1000	0	2137	2200	1761	0	2	1	0
S3S1_P	Portfolio 1	Base	Base	1137	1000	0	2137	2200	1761	0	2	1	0
S3S7_BB	Portfolio 6	Base	Base	1137	1000	0	2137	2200	1761	0	2	1	0
S3S1_2CT	Portfolio 7	Base	Base	1374	1000	0	2374	2200	1550	0	2	2	0
S3S7_2CT	Portfolio 8	Base	Base	1374	1000	0	2374	2200	1550	0	2	2	0
S3S1_M	No	Base	Base	1930	650	0	2580	1050	1342	0	3	1	1
S3S1_MP	No	Base	Base	1587	750	0	2337	1800	1487	0	3	1	0
S3S1_F	Portfolio 2	Base	Base	1587	1000	0	2587	1550	1487	0	3	1	0
S3S1_A	No	Base	Base	1587	1000	0	2587	1150	1554	0	3	1	0
S3S2	No	High	Base	1824	1000	0	2824	1350	1746	0	3	2	0
S3S2_BB	Portfolio 3	Base	Base	1824	1000	0	2824	1350	1308	0	3	2	0
S3S3	No	Low	Base	1350	1000	0	2350	1550	1655	0	3	0	0
S3S3_BB	Portfolio 4	Base	Base	1350	1000	0	2350	1550	1697	0	3	0	0
S3S4	No	High	Low	1824	1000	25	2849	700	1849	0	3	2	0
S3S5	Portfolio 5	Base	Base	1398	1000	100	2498	3450	1183	0	1	4	0
S3S5_YD	Portfolio 9	Base	Base	1398	1000	100	2498	3450	1186	0	1	4	0
S3S6_N	No	Base	Base	900	1000	475	2375	2200	1505	0	2	0	0
S3S6	No	Base	Base	900	1000	475	2375	2200	1505	0	2	0	0
S3S7	No	Low	High	1137	1000	0	2137	2200	1718	0	2	1	0
S3S8	No	Base	Base	0	1000	0	1000	4850	2248	0	0	0	0
S3S10	Portfolio 10	Base	Base	950	1000	0	1950	2250	1909	1	0	0	0
S4S1	Portfolio All MISO	Base	Base	950	0	0	0	3200	1909	1	0	0	0

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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.

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Metrics

Objectives and Metrics Used in The Evaluation Of Alternative Portfolios

OBJECTIVES	METRICS
Reliability	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. ***Higher the better.***
Least cost (Affordability)	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. ***Lower the better.***
Price Risk (Minimization/Stability)	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. ***Lower worst outcome and Minimum or No Regret is the goal.***
Sustainability	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). ***On a & b lower the better , c higher the better.***
Market Risk	Energy Market Purchases or Sales as a percentage of load; Amount of Capacity Purchases. ***Lower the better.***
Economic Growth	Capital Expenditures in Shelby County and number of plants as a proxy. ***Higher the better.***
Resiliency	Amount of load shed during extreme events. ***Lower the better.***

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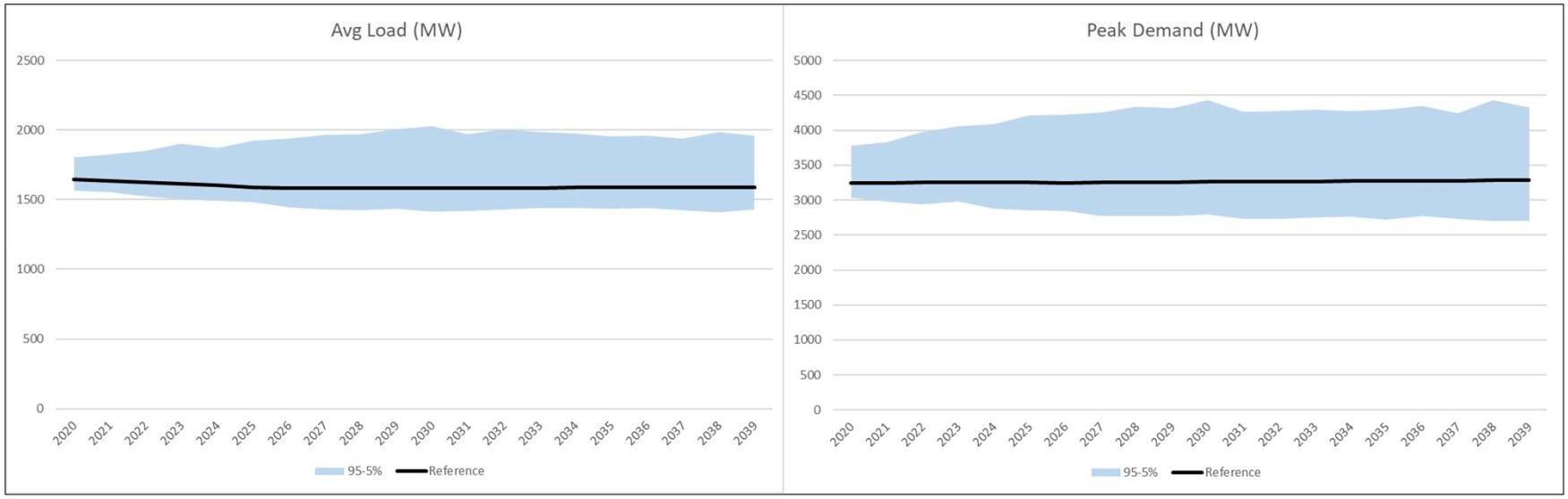
Input Assumptions

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

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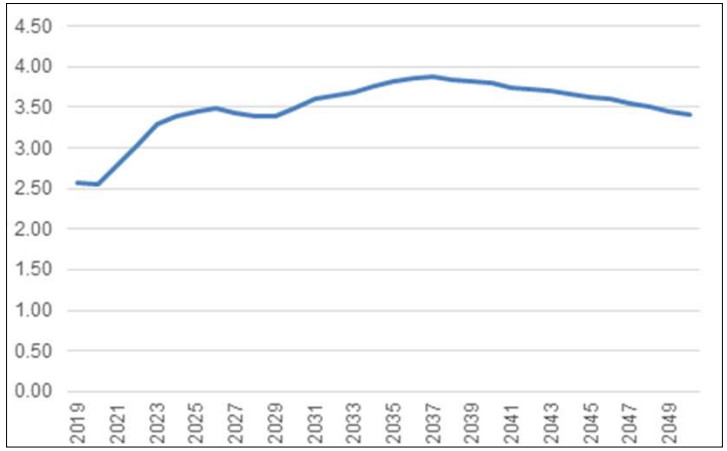
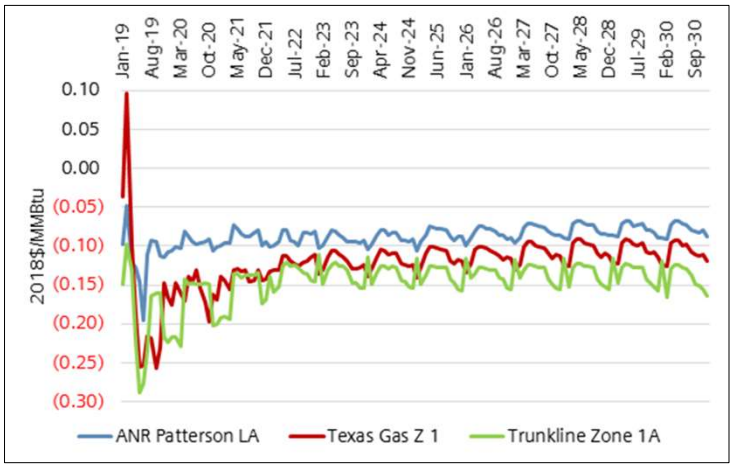
Annual Henry Hub Natural Gas Forecast (2018$/MMBtu)

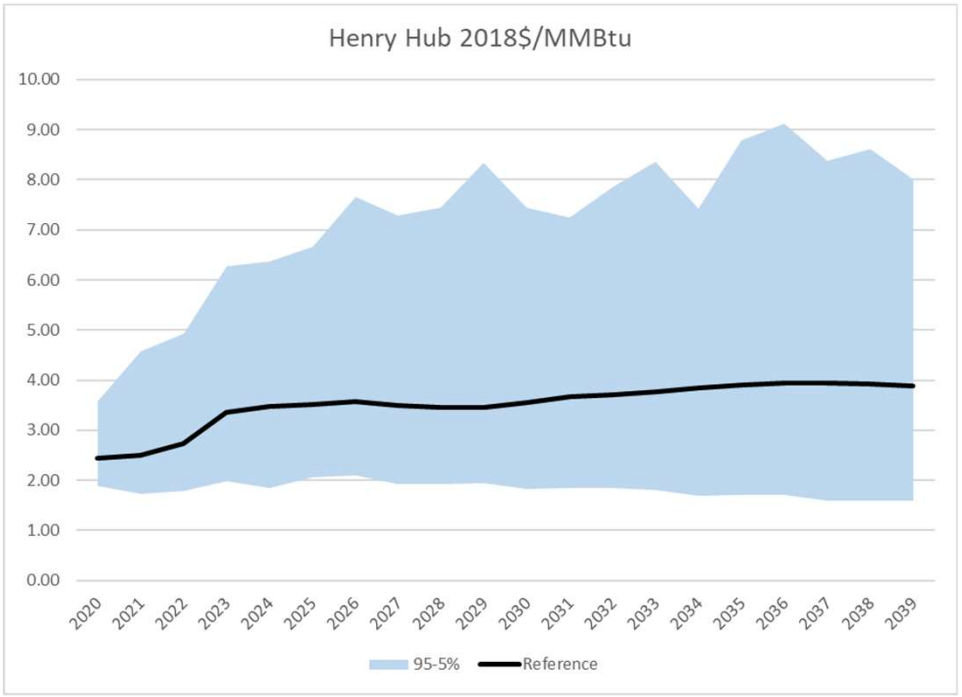


Monthly Forecast Gas Basis to Henry Hub (2018$/MMBtu)



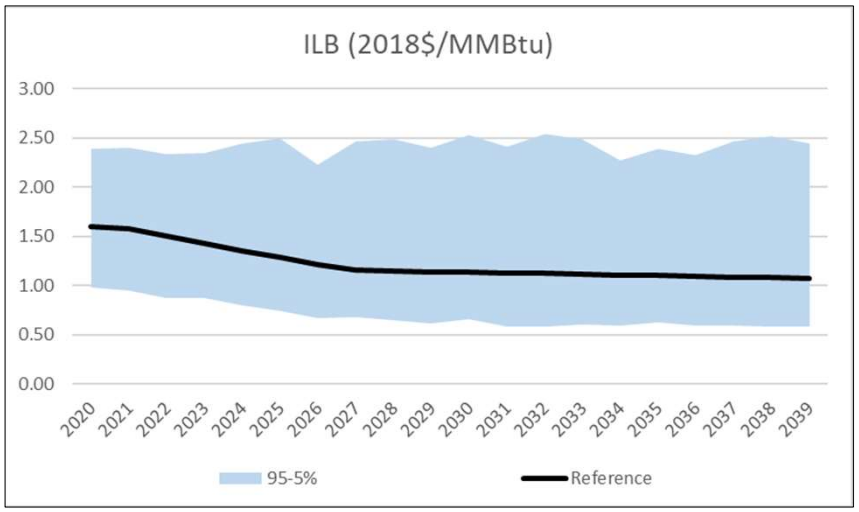
- The average of Trunkline Zone 1A and Texas Gas Z1 was used as the gas basis for gas plants built in MLGW territory.
- Trunkline firm transportation rate of $0.3811/MMBtu was used for combined cycles and interruptible transportation rate of $0.3212/MMBtu was used for gas peaker.

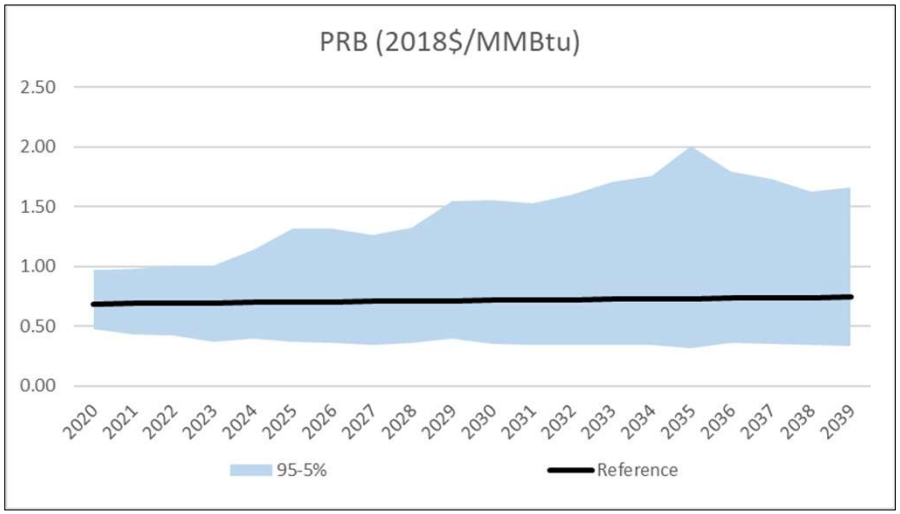
Stochastic Inputs – Gas Prices



- 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.

Stochastic Inputs – Coal Prices





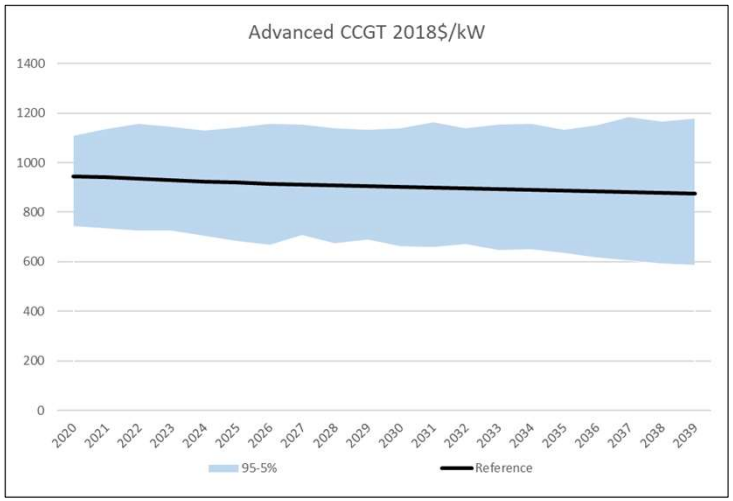
These stochastic distributions are based on a reference case view of coal prices with probability bands developed based on a combination of historical volatility and mean reversion parameters.

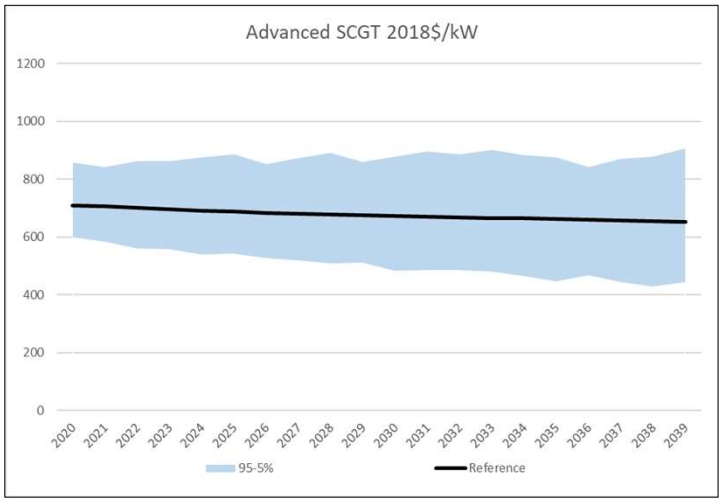
Technology Options – Capital Costs

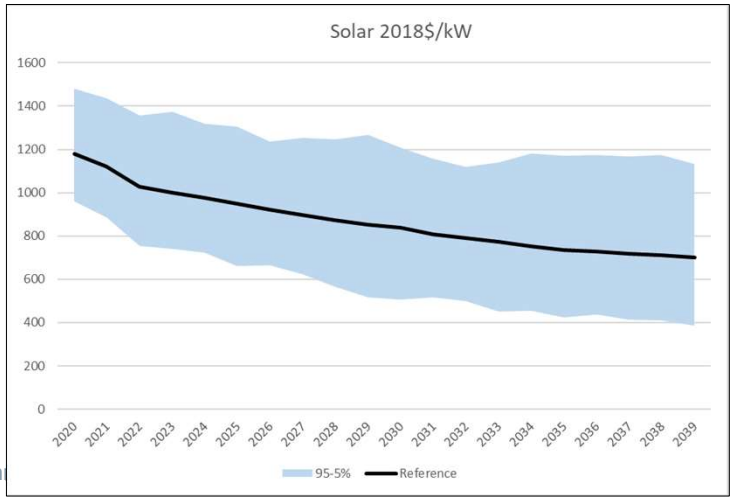
Technology	Advanced 2x1 CCGT	Conventional 1x1 CCGT, Duct Fired	Simple Cycle Advanced Frame CT	Simple Cycle Conventional Frame 7FA CT	Simple Cycle Aero CT	Coal With 30% CCS	Utility Solar PV - Tracking	Onshore Wind	Lithium Ion Batteries (4 hrs.)	Nuclear SMR
Fuel	Nat. Gas.	Nat. Gas.	Nat. Gas.	Nat. Gas.	Nat. Gas.	Coal	Sun	Wind	Elec. Grid	Uranium
Construction Time (Yrs.)	3	3	2	2	2	5	1	2	<1	7
Size (MW)	950	361 (Base) 89 (DF)	343	237	50	600	50	100	5 MW / 20 MWh	50-1,200
Average Heat Rate (Btu/kWh), HHV	6,536	7,011 (Base) 8,380 (Incr. DF)	8,704	9,928	9,013	9,750	N/A	N/A	N/A	N/A
VOM (2018$/MWh)	1.81	2.49	7.13	5.05	6.50	7.14	0.00	0.92	1.39	14.79
FOM (2018$/kW-yr)	15.90	17.41	9.53	4.39	15.70	73.45	20.70	36.56	32.21	165.42
Range of Capital Cost (2018$/kW)	947-874	1084-1003	711-652	626-578	1136-1041	6135-5027	1245-702	1636-1399	1534-693	9539-5365
Range of LCOE (2018$/MWh)	35-51	42-58	95-112	88-110	140-155	98-101	38-29	37-28	151-84	124-86

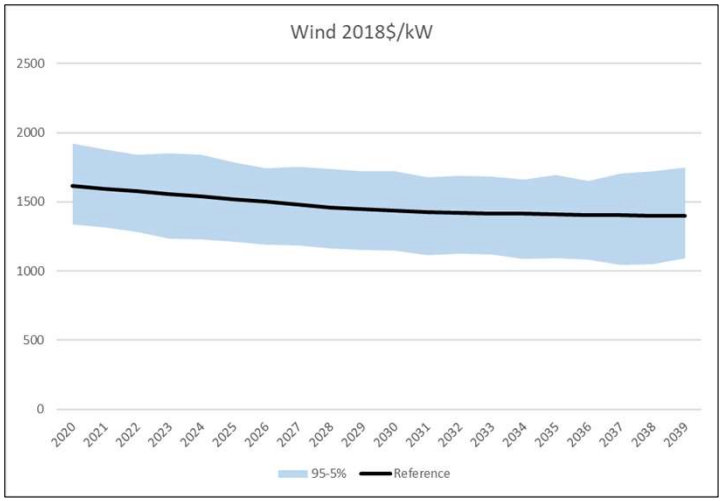
- The technologies in red boxes were selected for Self-Supply + MISO Portfolios.
- Local solar has important advantages as it is closer to the load, behind the transmission constraints, and has lower transmission costs. Due to land availability, only 1000 MW was allowed to be built in Shelby County.
- 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



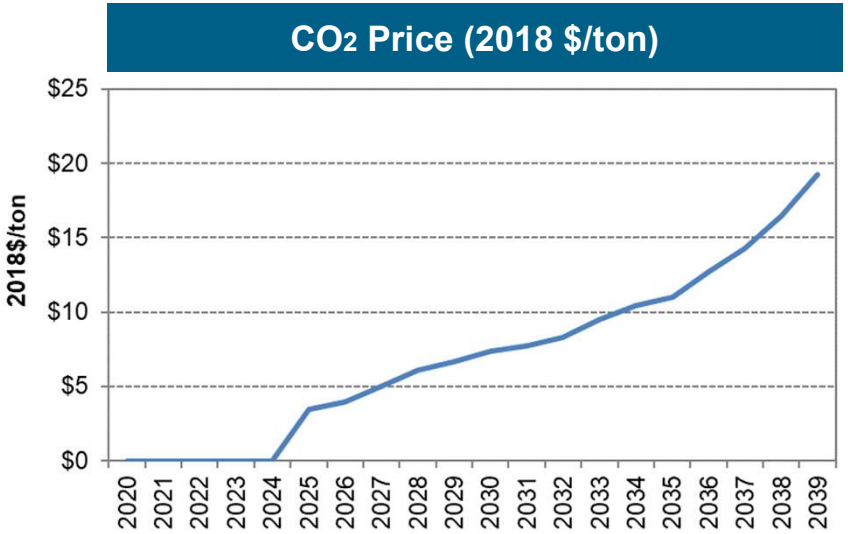




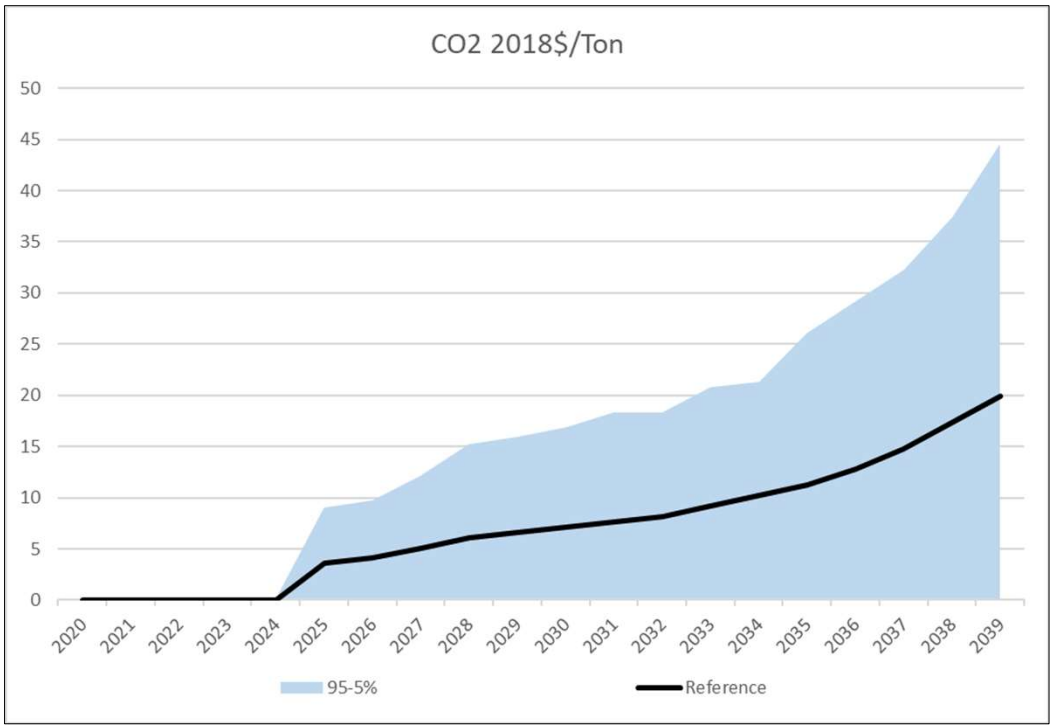


Sustainability / Environmental Considerations

- 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.

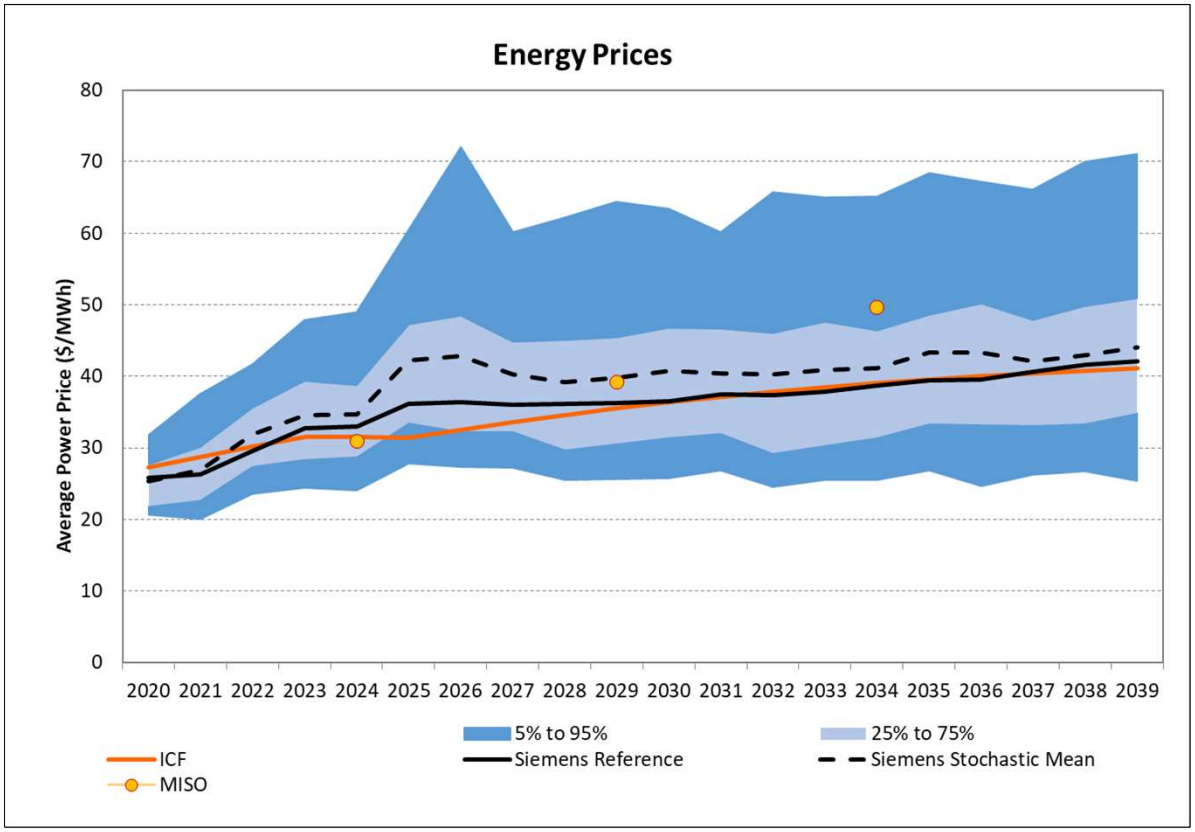


Stochastic Inputs – CO_2 Prices



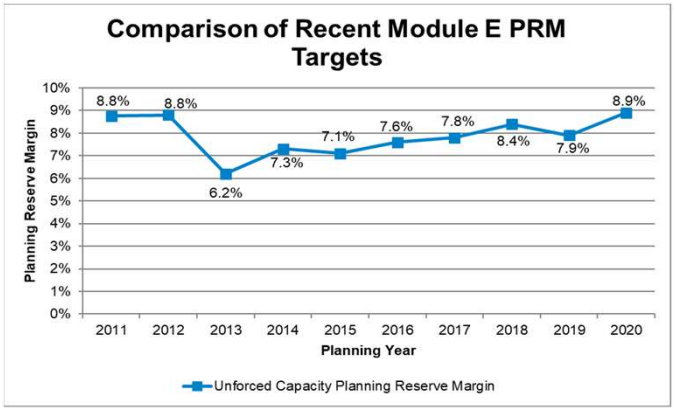
- Siemens developed uncertainty distributions around carbon compliance costs based on “expert-opinion” based projections, when the historical data is not available. The top end reflects estimates of the social cost of carbon.
- The distribution of carbon prices were used in the power dispatch modeling to capture the inherent risk associated with regulatory compliance requirements.

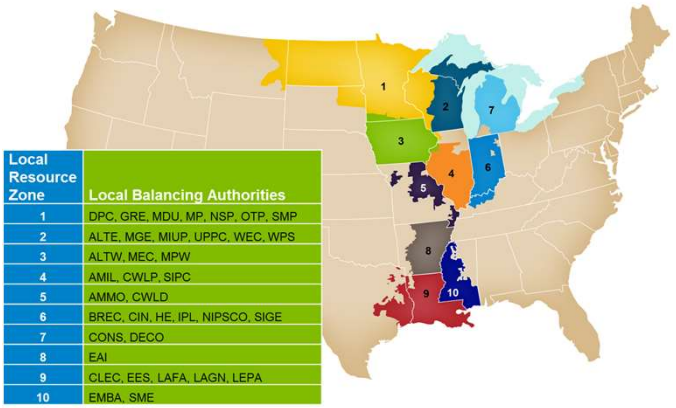
Stochastic Inputs – Market Forecast



- 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





Local Resource Zone	Local Balancing Authorities
1	DPC, GRE, MDU, MP, NSP, OTP, SMP
2	ALTE, MGE, MIUP, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, SIPC
5	AMMO, CWLD
6	BREC, CIN, HE, IPL, NIPSCO, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA
10	EMBA, SME

- 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

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- 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

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- 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

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Local Balancing Area Costs	
Fixed Capital Cost (2020 $M)-LBA	
AGC to MLGW controlled units	$0.8
Data communications to generators and LBA service provider	$1.2
Control center facility upgrade	$1.0
Real-time contingency and reliability analysis	$0.8
CIP compliance upgrade	$0.8
TOTAL	$4.6
Annual O&M Cost (2020 $M, with annual escalator)-LBA	
Annual LBA service vendor	$0.8
LBA service technical support at MLGW	$0.4
Expanded CIP Scope	$0.2
Staff (+3) and training	$0.8
Additional communications maintenance and fees	$0.4
Additional control center systems maintenance	$0.4
TOTAL	$3.0

- 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.

Gap Cost - Other	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10	Steady State--->
Resource and Transmission Planning, Studies and Procurement	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Resource Planning Staff	1	2	2	2	2	2	2	2	2	2	2
Transmission Planning and Interconnection Study Staff	1	2	2	2	2	2	2	2	2	2	2
Procurement Staff	1	2	2	2	2	2	2	2	1	1	1
Total Staff	3	6	6	6	6	6	6	6	5	5	5
Staffing Costs $266,000/FTE including salary, benefits, rent, facilities	$0.8	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.3	$1.3	$1.3
Contractor & Consulting Costs, G&T MLGW	$0.5	$0.8	$1.0	$1.0	$1.0	$1.0	$1.0	$0.5	$0.5	$0.3	$0.3
Total Cost	**$1.3**	**$2.4**	**$2.6**	**$2.6**	**$2.6**	**$2.6**	**$2.6**	**$2.1**	**$1.8**	**$1.6**	**$1.6**

*All staff are in addition to existing staff
*costs start 2021

*All Costs in Million

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Analyses of Portfolios

Balanced Scorecard: Portfolios 9 and 10 of Strategy 3 Perform Best Across All Metrics

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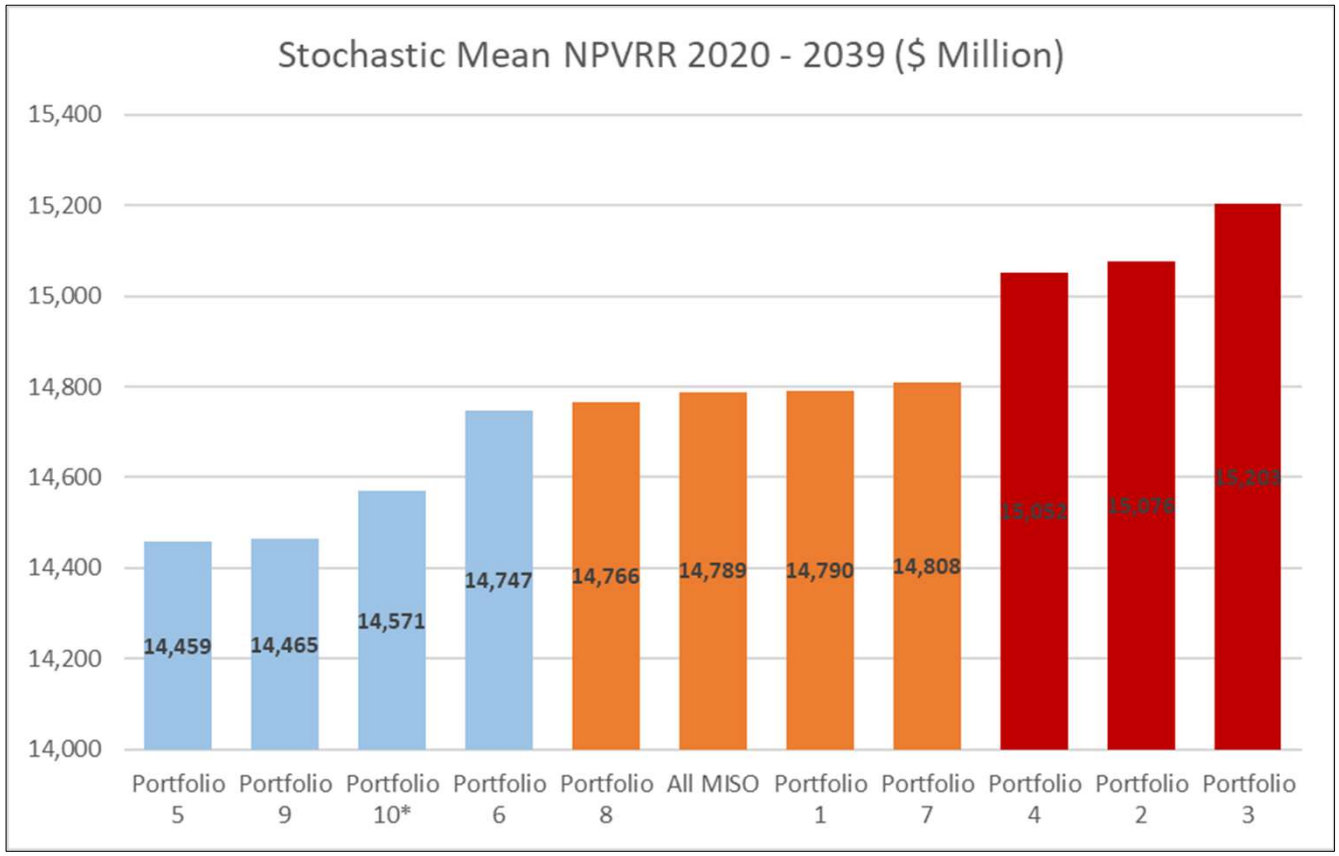
Objective	Measure	Unit	TVA (Base)	TVA (LTP)	Portfolio 5	Portfolio 9	Portfolio 10	Portfolio 6	Portfolio 8	All MISO	Portfolio 1	Portfolio 7	Portfolio 4	Portfolio 2	Portfolio 3
					1 CC + 4 CT	1 CC + 4 CT	1 CC + 0 CT	2 CC + 1 CT	2 CC + 2 CT	1 CC + 0 CT	2 CC + 1 CT	2 CC + 2 CT	3 CC + 1 CT	3 CC + 2 CT	3 CC + 0 CT
Least Cost	NPVRR 2020 - 2039	$ Millions	16,411	16,020	14,504	14,453	14,304	14,614	14,627	14,522	14,490	14,503	14,511	14,668	14,709
	Stochastic Mean NPVRR 2020 - 2039	$ millions	16,388	15,996	14,459	14,465	14,571	14,747	14,766	14,789	14,790	14,808	15,052	15,076	15,203
	Levelized Cost of Energy	$ / MWh	67.47	65.86	59.32	59.34	59.48	60.51	60.59	60.68	60.69	60.76	61.77	61.87	62.39
	NPV Savings with respect of LTP (wrt LTP) 2020 -2039	$ Millions			**1,537.4**	**1,531.7**	**1,425.9**	**1,249.3**	**1,230.5**	**1,207.8**	**1,206.8**	**1,188.0**	**944.7**	**920.2**	**793.0**
	Levelized Savings per Year (wrt LTP) 2025 -2039	$ Millions			**122.1**	**121.7**	**113.3**	**99.2**	**97.8**	**96.0**	**95.9**	**94.4**	**75.0**	**73.1**	**63.0**
	Levelized Savings per Year (wrt Base) 2025 -2039	$ Millions			**153.2**	**152.8**	**144.4**	**130.3**	**128.8**	**127.0**	**127.0**	**125.5**	**106.1**	**104.2**	**94.1**
Min Risk	95th Percentile Value of NPVRR	$ millions	17,221	16,830	16,576	16,517	16,993	16,946	16,944	17,211	17,051	17,074	17,648	17,535	17,844
Min Envr. Risk	CO_2 Emissions Mean 20-Year	Million Tons CO_2	3.8	3.8	1.85	1.85	2.81	2.57	2.57	2.81	2.57	2.57	3.29	3.29	3.30
	Energy from Renewable Sources 2039 (RPS)	% of Energy Consumed	6.5%	6.5%	75.3%	75.3%	52.7%	54.9%	54.9%	52.7%	56.8%	56.8%	47.3%	46.1%	40.7%
	Energy from Zero Carbon Sources 2039	% of Energy Consumed	58.6%	58.6%	75.3%	75.3%	52.7%	54.9%	54.9%	52.7%	56.8%	56.8%	47.3%	46.1%	40.7%
	2025 Local Water Consumption	Million Gallon	3,103	3,103	3,961	3,782	4,899	4,782	4,789	3,103	4,788	4,795	5,645	5,551	5,607
Reliability	2025 (UCAP+CIL)/PEAK	%	133.7%	133.7%	126.0%	127.8%	148.6%	126.6%	127.2%	115.4%	126.6%	127.2%	126.7%	130.8%	137.3%
Resiliency	Max Load Shed in 2025 under Extreme Event	MW	0	0	622.4	0.0	0.0	8.4	0.0	0.0	8.4	0.0	0.0	0.0	0.0
Min Market Risk	% Energy Purchased in Market	%	10.9%	10.9%	31.2%	31.2%	23.0%	17.4%	16.2%	16.7%	16.7%	15.6%	7.4%	7.0%	7.7%
	% Energy Sold in Market	%	8.7%	8.7%	22.6%	22.6%	17.9%	9.7%	9.7%	10.5%	10.5%	10.6%	7.6%	6.7%	5.6%
Econ. Grwth	Local T&G CapEx	$ Millions			2,989	2,864	2,984	2,845	2,965	1,014	2,811	2,932	3,138	3,299	3,404

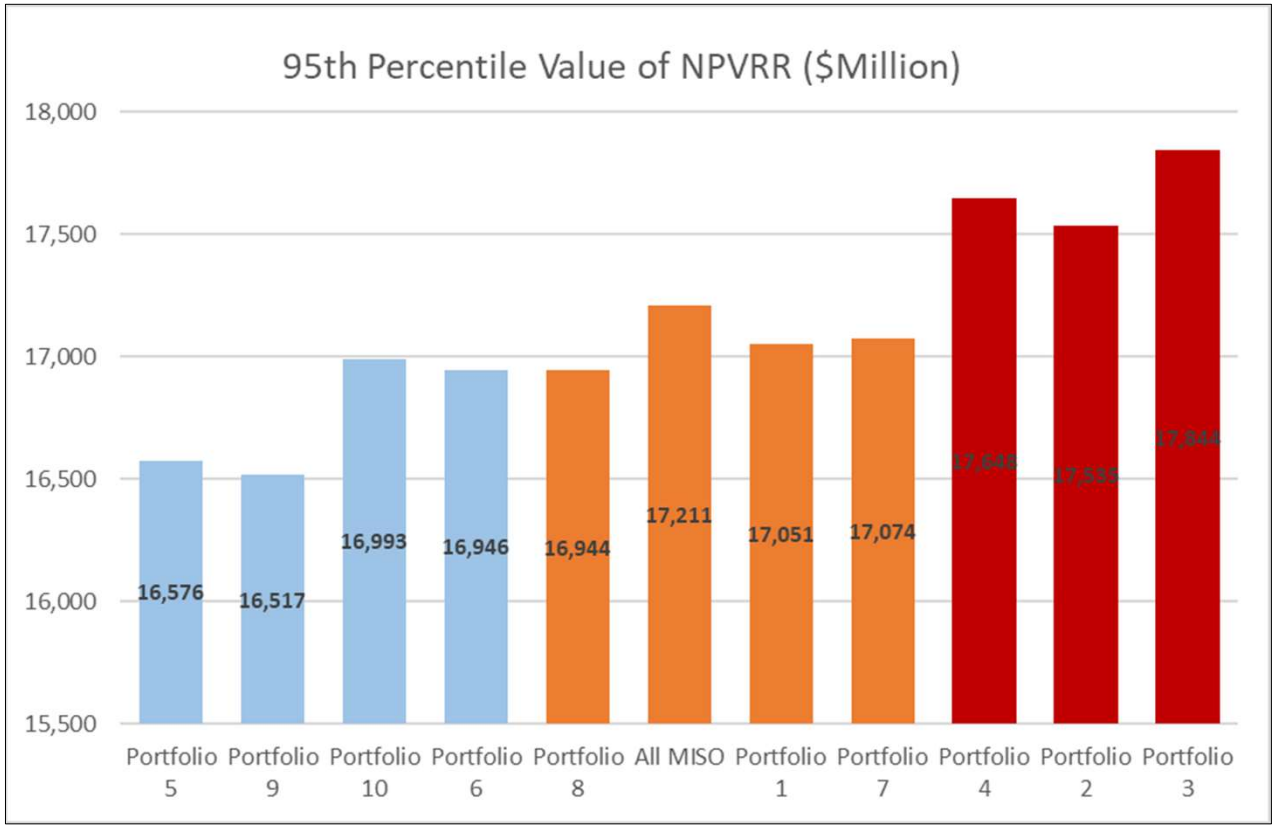
*All $ is in 2018$ unless otherwise noted.

Evaluation of Strategies 3 and 4: Portfolios 5, 6, 9 and 10 are Lowest Cost



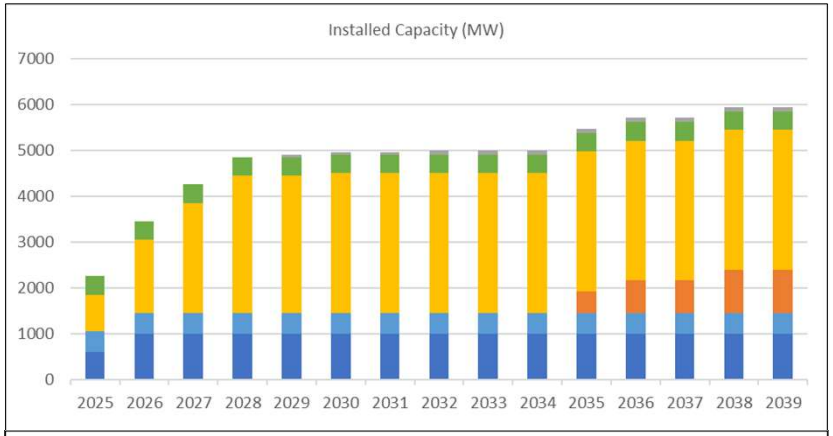
- Portfolios 5 and 9 have one 450 MW CCGT and Portfolio 10 has one 950 MW CCGT.
- Portfolio 6 has two 450 MW CCGTs.
- Other Portfolios with two CCGTs are close and Portfolio 6 is representative.
- Portfolios in blue are preferred.

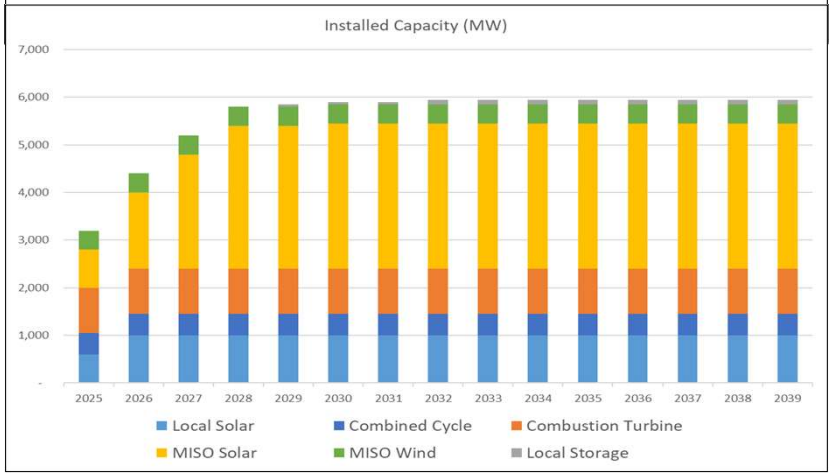
Evaluation of Strategies 3 and 4: Portfolios 5, 6, 9 and 10 are among the Lowest Risk



- 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.

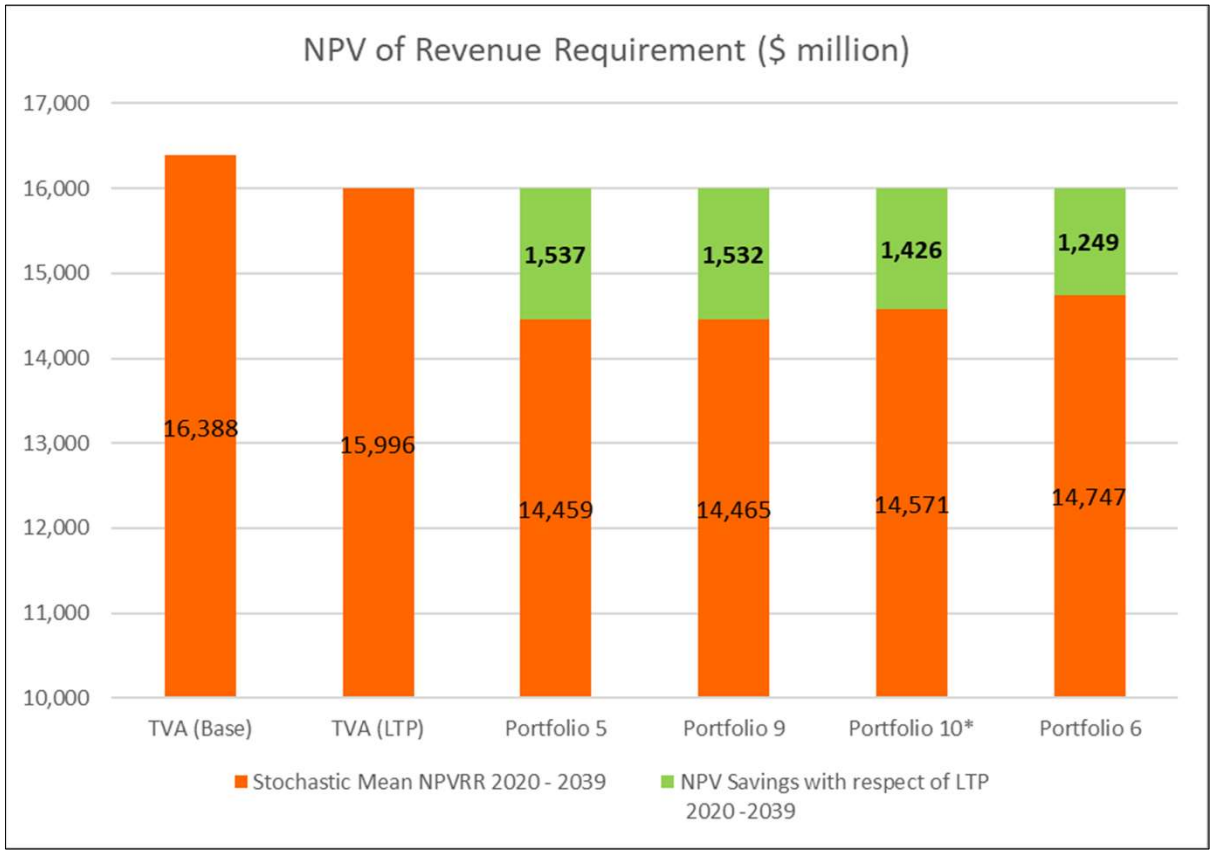
Portfolio 6

- 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

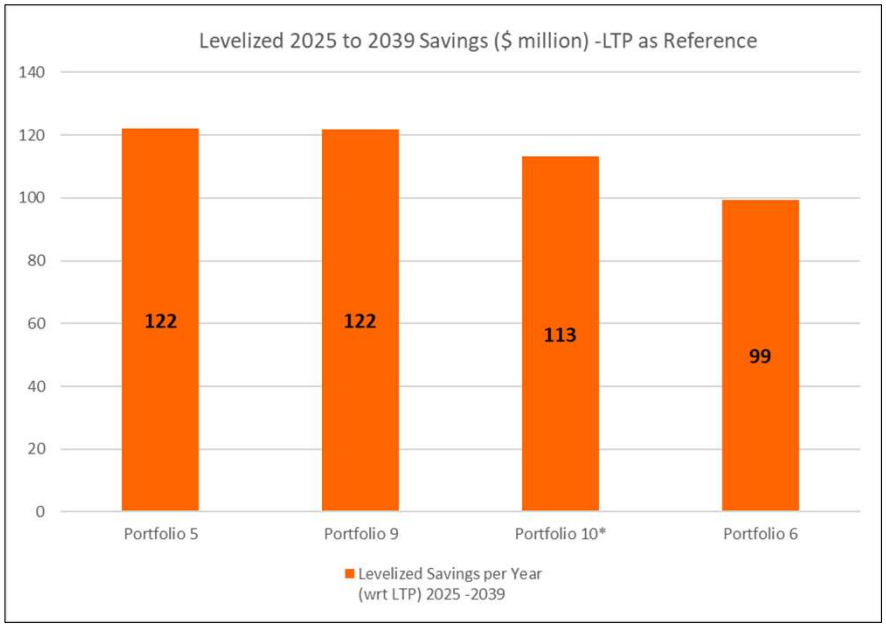
Exiting TVA Could Save MLGW $1.5 Billion over 20 Years Considering the LTP and $ 1.9 Billion with Current Contract

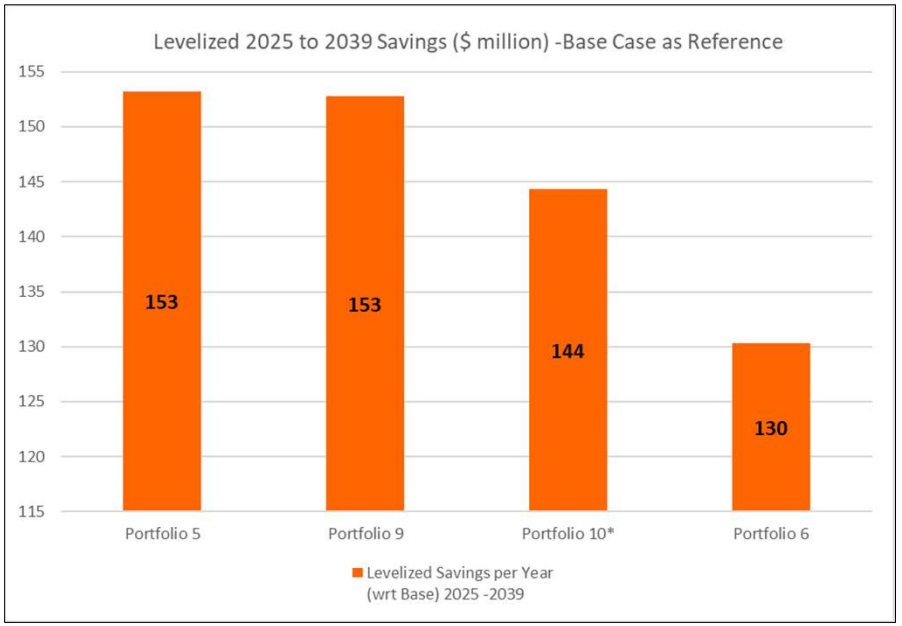


The savings are in real 2018$

- 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.

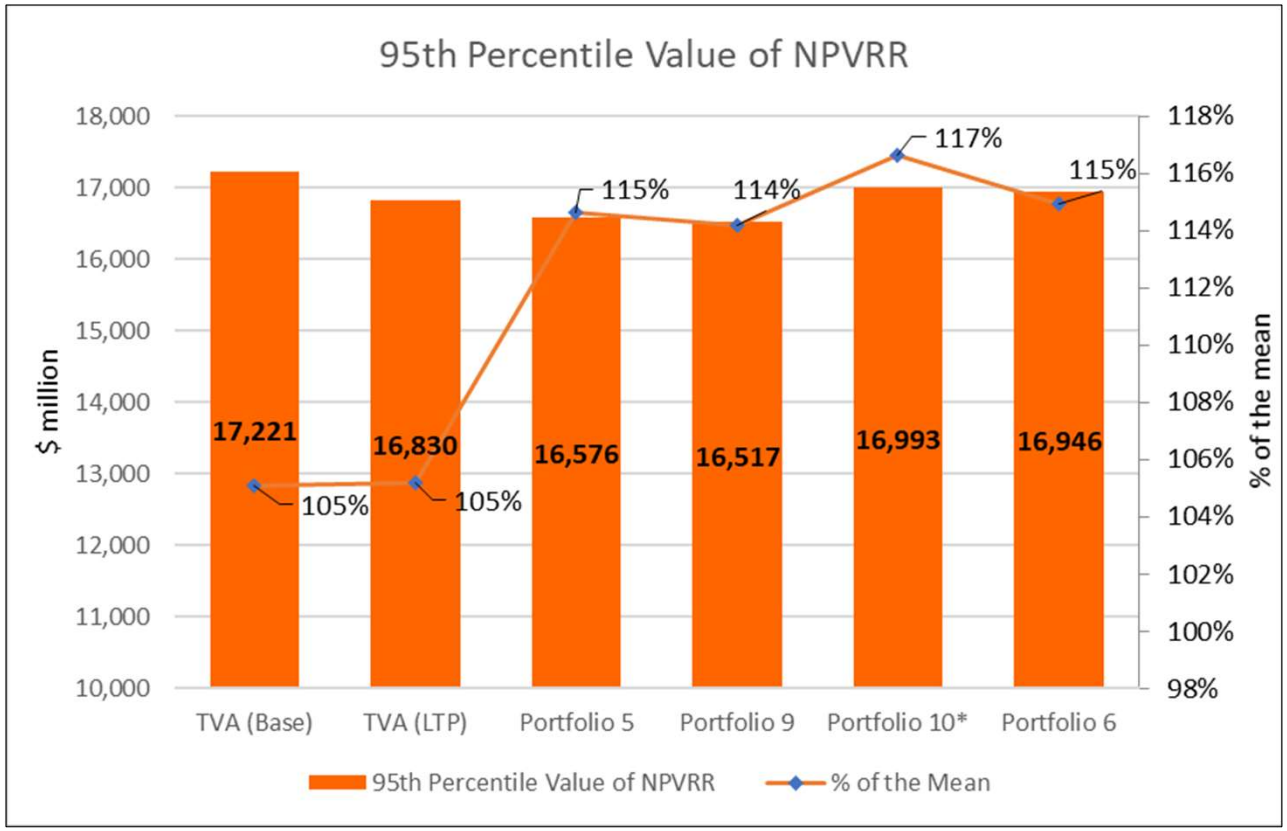
Exiting TVA could result in annual savings of about $120 million per year (2025-2039) with LTP to about $150 million per year (2025-2039) with current contract





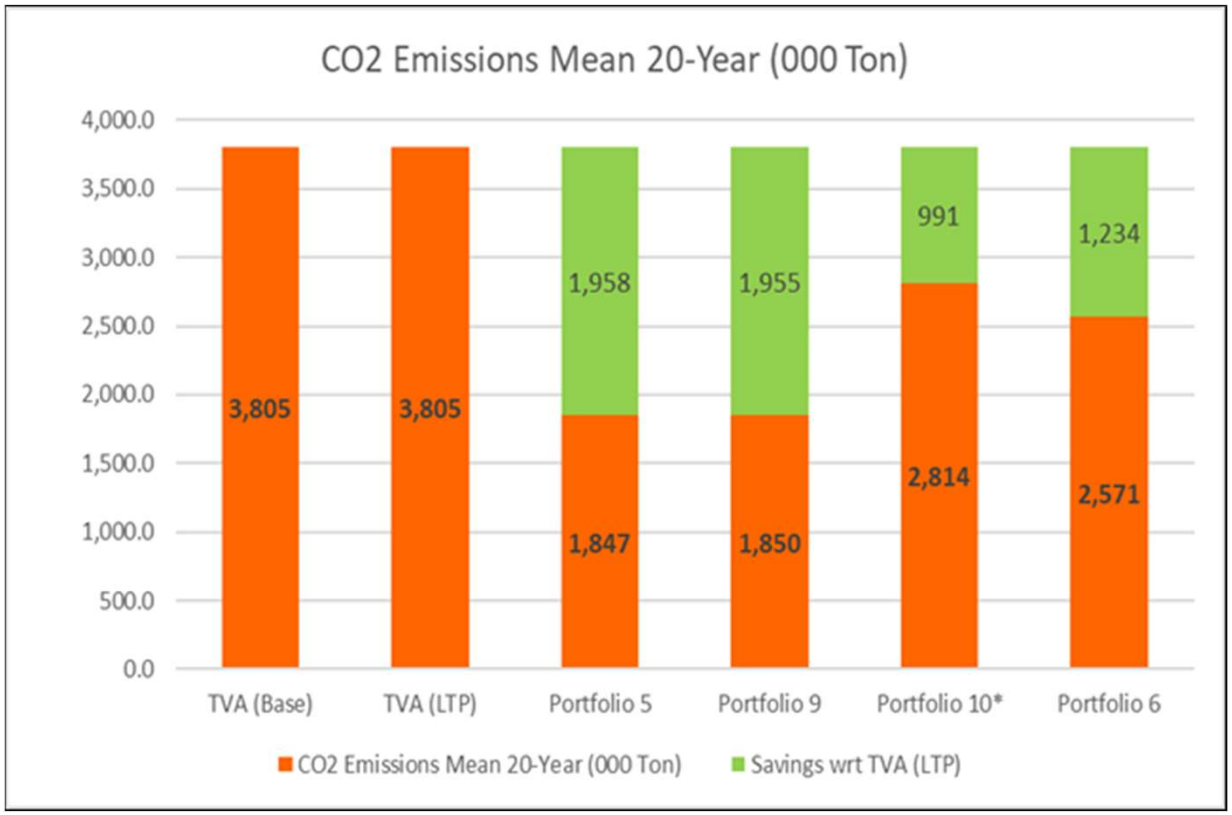
- There are potential savings of over $ 3.0 billion for the 2025 to 2039 period in nominal terms and with respect of the current contract. This averages to $ 200 million per year.

95th % NPVRR Risk Higher with TVA than Self Supply + MISO Options

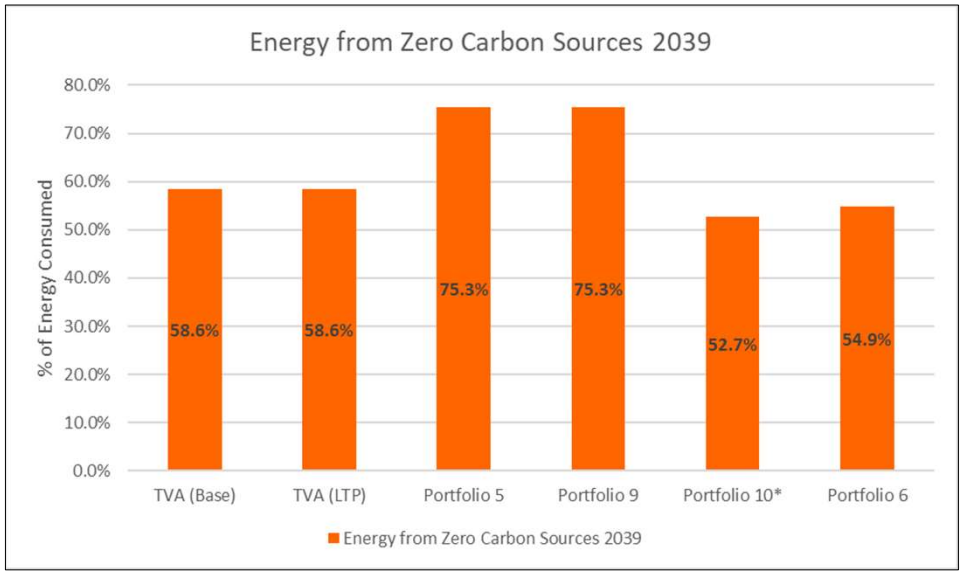


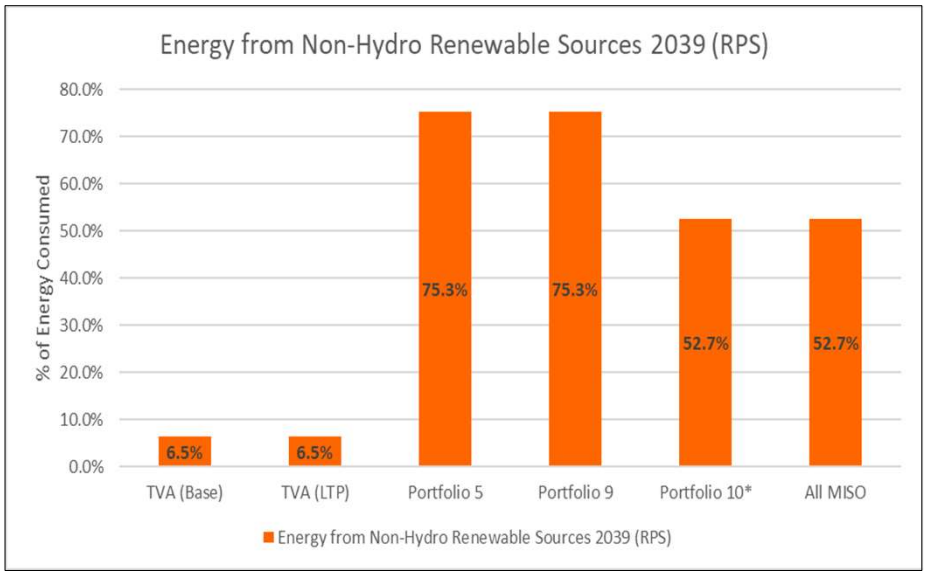
- The TVA option, given the size of the company and strong presence of nuclear and hydro that experience little or no volatility in costs, has more stable cost
- The 95th percentile of TVA portfolios is only 105% times the mean, while in other portfolios this reaches 114% to 117% times.
- Portfolios 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.

CO_2 Emissions from Self-Supply + MISO options are well below TVA options



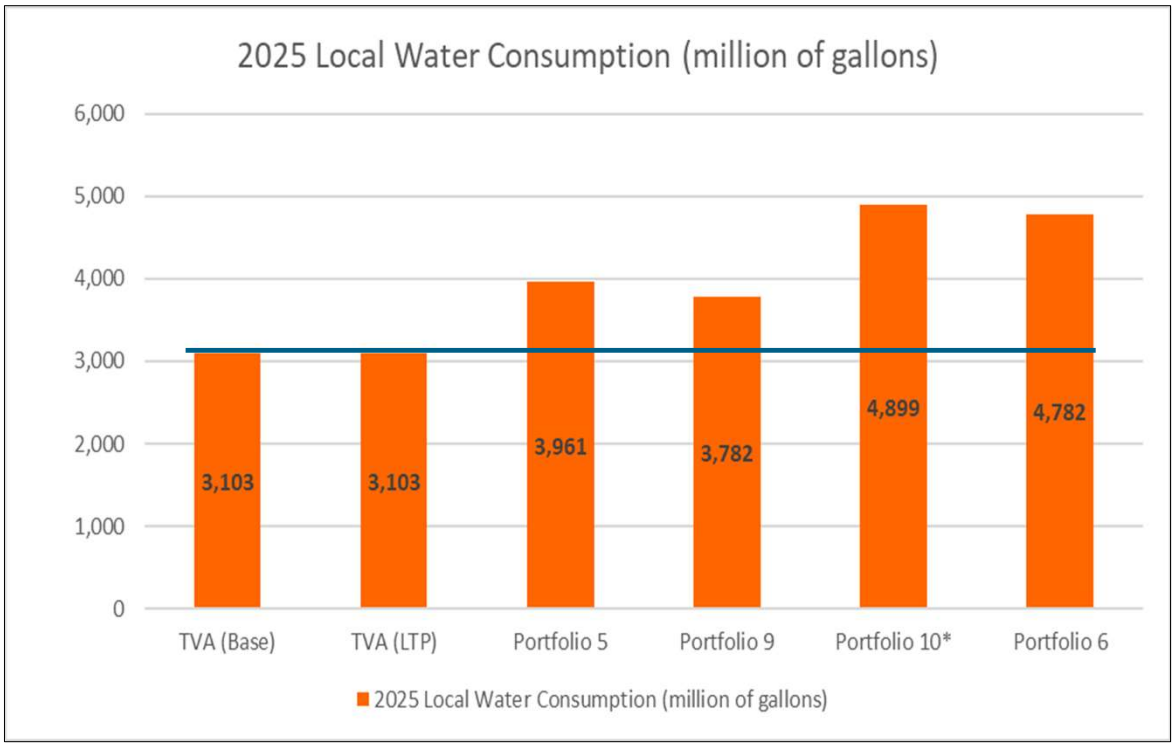
Self-Supply + MISO Options Can Produce more Energy (Portfolios 5 and 9) from Zero Carbon Sources than TVA





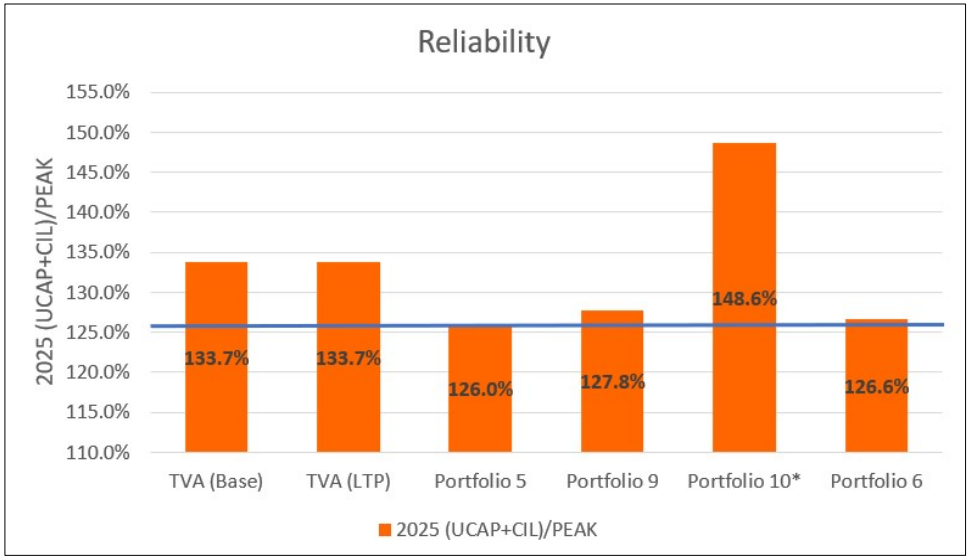
- TVA portfolio has lower renewable generation due to large hydro and nuclear being excluded.

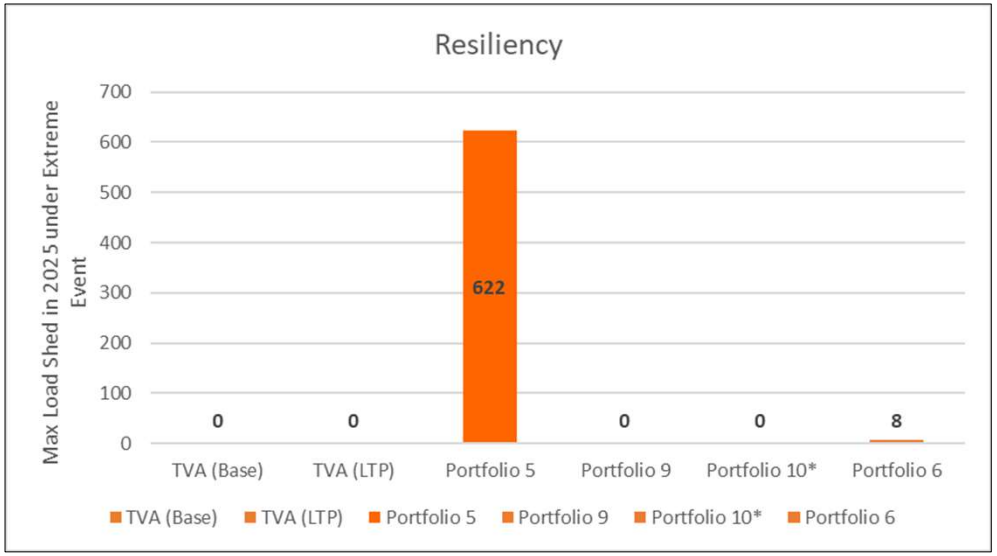
Shelby County Water Consumption is Lowest with TVA Options



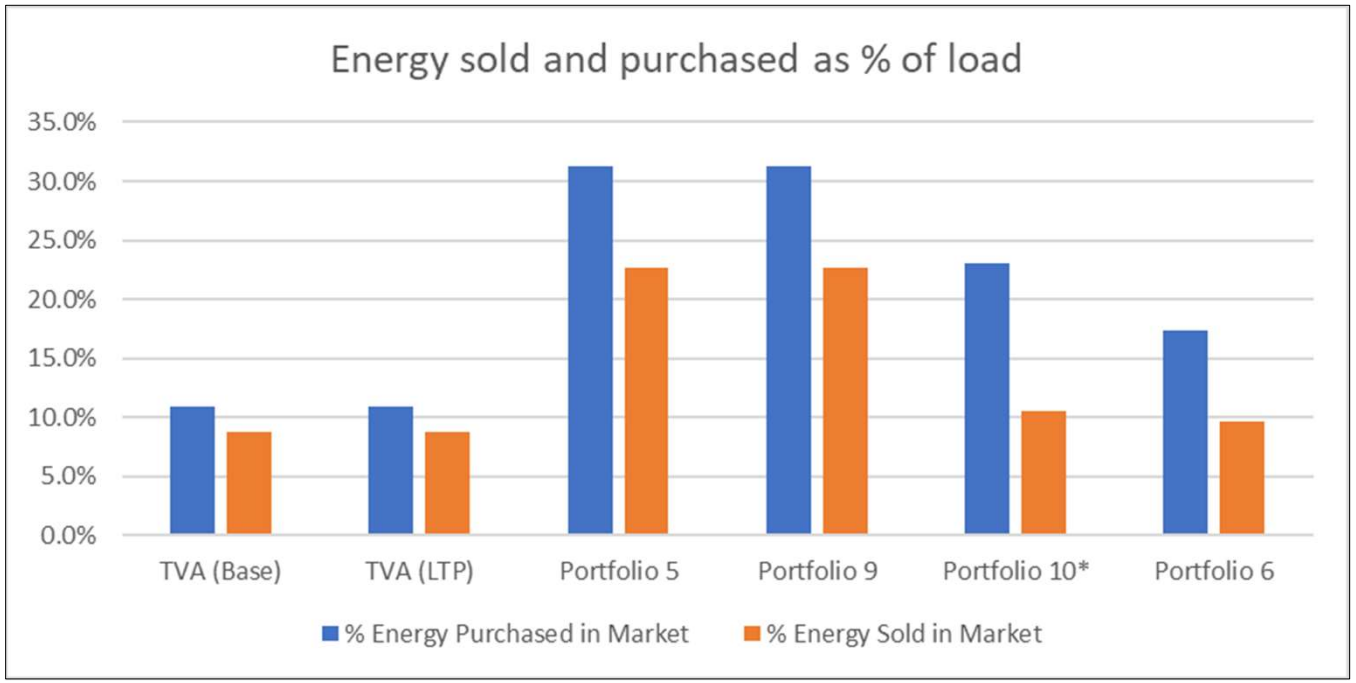
- These are the water usage for cooling thermal generation
- In case of TVA, the consumption is only by the Allen Combined Cycle
- Any other thermal generation adds to it.

All the Portfolios Meet Minimum Reliability Requirements Portfolio 5 is Less Desirable Because of Potential Load Shedding



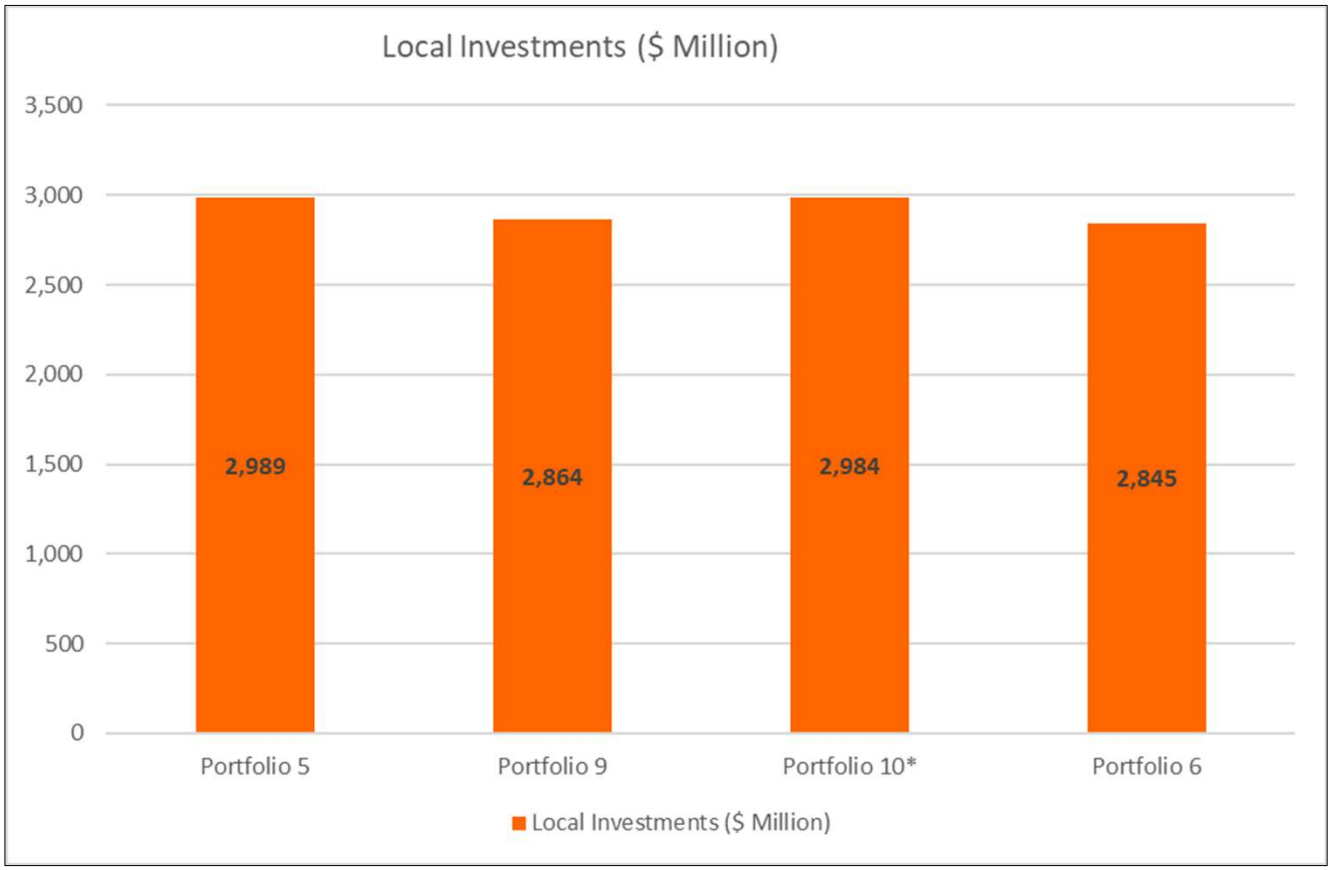


TVA Has Less Exposure to Energy Market Risk
Portfolios 5 and 9 Have the Greatest Exposure



- 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



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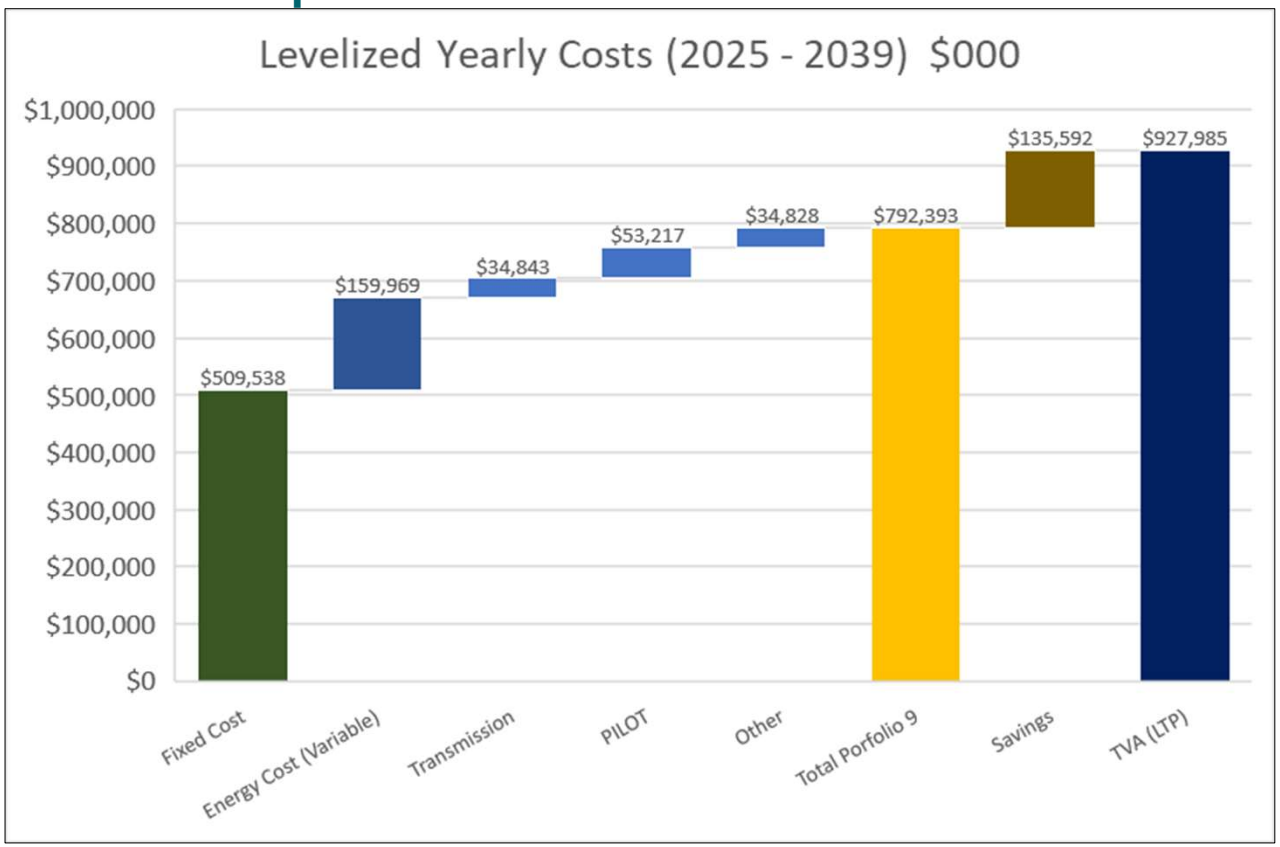
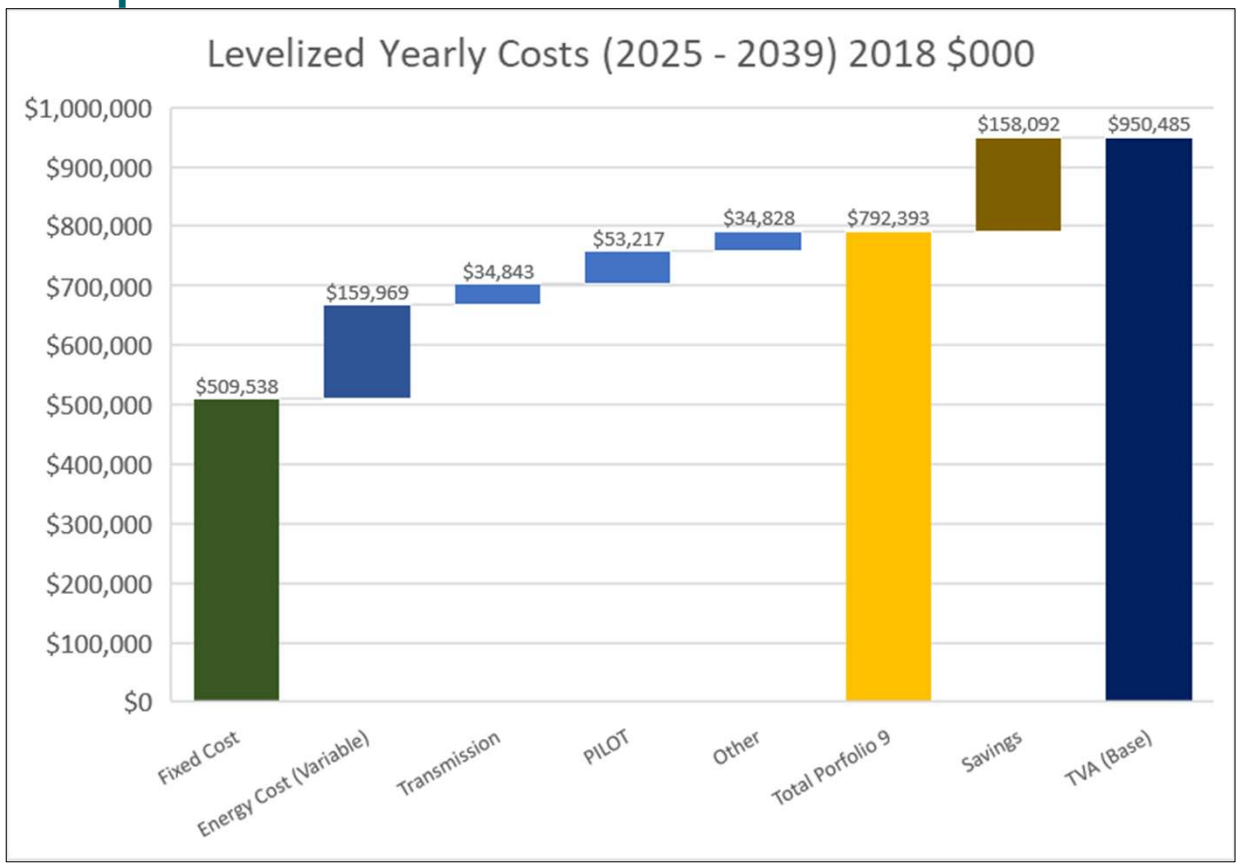
Summary of Comparisons with TVA

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



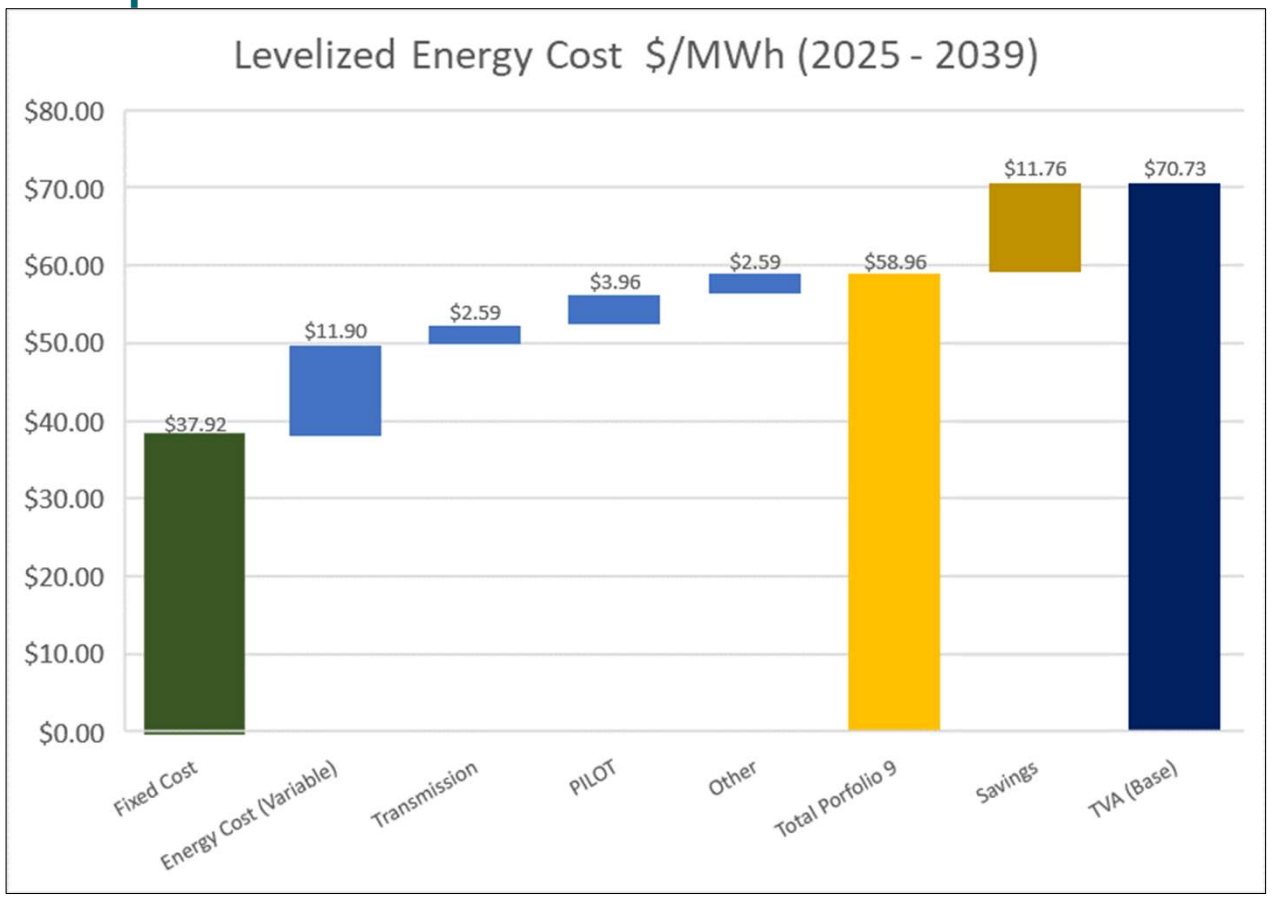
- The waterfall (buildout) shows the importance of the relative components of cost for Portfolio 9.
- The transmission and other costs are important. They contribute over $122 million/year to the comparable cost for TVA.
- This highlights the importance of assumptions.
- The savings are determined looking 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)

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Recommendations

No Regret Actions if MLGW Joins MISO

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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

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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

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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 an 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).