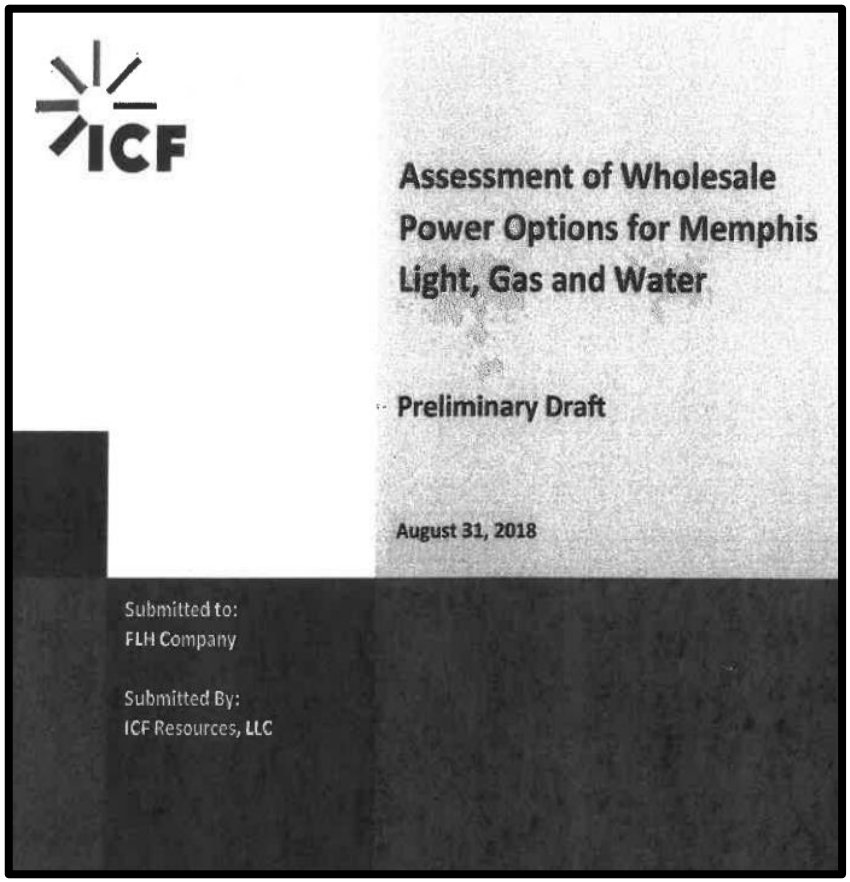
Review of Power Supply Studies

Definitions

- MISO – Mid-Continent Independent System Operator
- Capacity Cost – Fixed cost associated with ownership of a generating asset. (Like a car payment.)
- Energy Cost – Fuel and variable operation and maintenance associated with the generation plant. (Like gasoline, oil, etc.)
- Heat rate – fuel efficiency metric measured in BTU/kWh (British Thermal Units per kilo-Watthour…Like miles/gallon).
- Balancing Authority (BA) – the entity responsible for matching the electrical demand with generation in real-time.
- Pseudo Transmission Tie – a transmission connection point that is not physically tied to the generating area source (Like an indirect MLGW connection to MISO through TVA's transmission system).

ICF – Nuclear Development Study

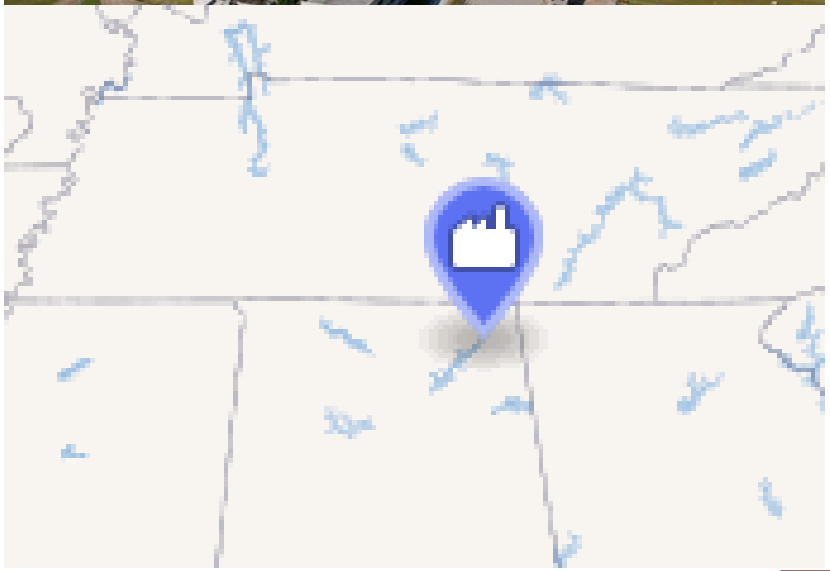
- Looks at Power Purchase Agreement for output of Bellefonte Nuclear Plant with MISO Integration
- Partial transmission analysis included
- Best scenario: MLGW joins MISO and purchases Bellefonte 1 power using Physical Hedging to cover incremental power needs
- Net Savings: $7.9 Billion over 20 years (2024-2043)



ICF – Nuclear Development Study (cont.)

- Why? The study was written for the FLH Company as noted on cover of the study.
- Study primarily centered around a “mothballed” nuclear site.
- The Bellefonte nuclear units site is located in Hollywood, Alabama.

Bellefonte Site



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ICF – Nuclear Development Study (cont.)

- Background information on Bellefonte
  - TVA began construction on two units began around 1975 with initial plans for up to four units.
  - Units 1 and 2 were designed to be approximately 1350 MW (MLGW's peak load is around 3200 MW) and were partially constructed.
  - Meaningful construction was halted around 1988 after more than $6 billion of investment.

"The agency's decision was noteworthy mostly for coming so late; in the mid-1980's, investor-owned utilities and government power agencies abandoned about 100 nuclear reactors in various stages of construction after spending about $30 billion on their construction. Most acted in response to pressure from shareholders or state regulators, but the T.V.A., as a Federal agency, is answerable to neither."
Snippet from a NY Times Article December 13, 1994

Nuclear Resurrection???

- Nuclear power plants have very high initial capital costs
  - Most recent Lazard capital cost estimate range is $6,500 to $12,250 per kW.
  - So in today's dollars, 1 Bellefonte unit would cost $16.5 billion on the high end
- Nuclear power plants have very low fuel costs
  - Uranium 235 cost is around $0.85 per MMBTU which at a heat rate of 10,250 BTU/kWh is $0.0089/kWh
- Currently the Levelized Cost of Energy (LCOE) of nuclear is much higher than alternatives.
- The price used for the study is $39/MWh (or 3.9 cents/kwh).
- Lazard LCOE 12.0, nuclear all-in range is $112 to $189/MWh (or 11.2 to 18.9 cents/kwh) if built overnight today.

Nuclear Resurrection??? (cont.)

Federal court rejects TVA move to cancel sale of Bellefonte Nuclear Power Plant to developer Franklin Haney

May 17th, 2019 | by Dave Flessner | in Business Around the Region | Copyright 2019 |

- In November 2016, FLH Company won a TVA bid auction for the Bellefonte nuclear plant and had two years to consummate the sale.
- The actual sales transaction is currently in court proceedings.
- If the sale is finalized FLH Company would finish out Unit 1 within 5 to 6 years and Unit 2 sometime in the future.
- The plant has been sitting idle for about 45 years.

Scenarios Presented

- Option 1 - TVA BA, Bellefonte + PartReq
- Option 2A - MISO BA, Hedge
- Option 2B - MISO BA, Spot (or Market Price)
- Option 3A MLGW BA, Hedge
- Option 3B - MLGW BA, Spot
- Each option was priced out 20 years and then compared to a “Business As Usual” case.
- The “Business As Usual” case represented TVA’s wholesale rate level increased at about 2% per year for the 20 year period beginning in 2024.

Savings Summary

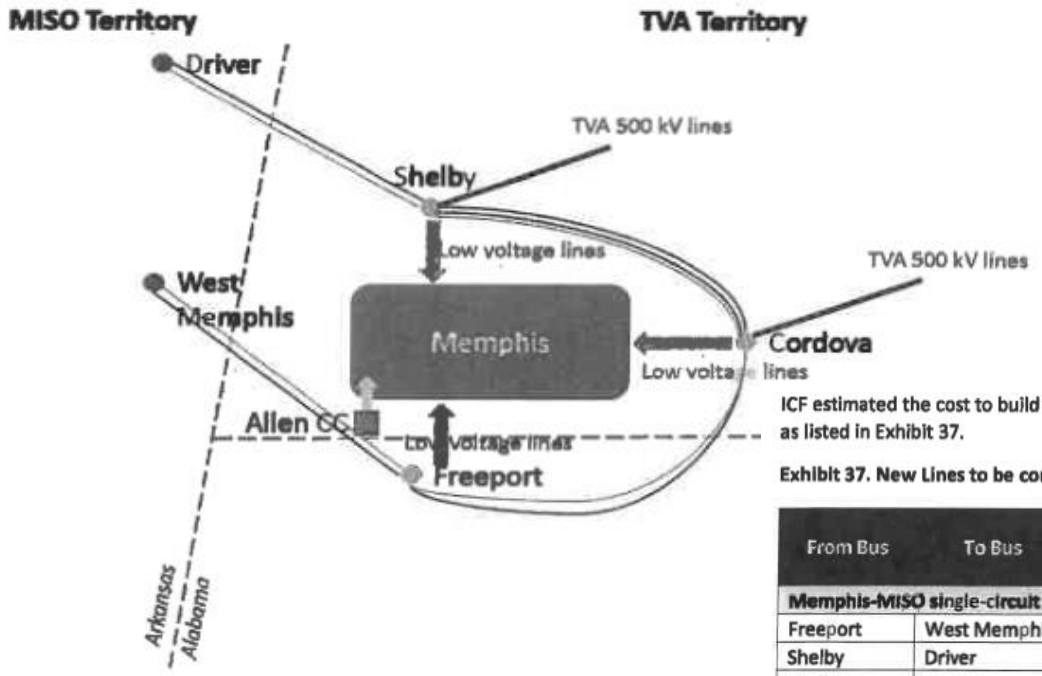
Option	Levelized Annual Savings in Millions
Option 1: TVA BA, Bellefonte + PartReq	$374
Option 2A: MISO BA, Hedge	$384
Option 2B: MISO BA, Spot	$235
Option 3A: MLGW BA, Hedge	$254
Option 3B: MLGW BA, Spot	$104

- Option 2A includes:
  - a PPA with Bellefonte for 20 years,
  - Transmission service with TVA for Bellefonte,
  - MLGW builds transmission lines to interconnect with MISO and secures transmission rights through MISO,
  - Buys or Contracts with existing power plants in MISO for the incremental power needs (physical hedge against buying in spot market)

Transmission line construction

Nevertheless, MLGW may still want to build its own physical connections with MISO for various reasons. For example, as will be discussed further in Chapter 10, it is more economic than paying the transmission charges that TVA and MISO can impose on MLGW for using their transmission lines. Moreover, the capacity of the existing TVA-MISO may be less sufficient for meeting MLGW's load growth from a long-run perspective. In this case, MLGW can consider building a single-circuit loop in parallel to the existing one as shown in Exhibit 36 below

Exhibit 36. Representation of 500kV Network with Additional Single Circuit



Source: ICF

ICF DID THINK ABOUT THE TRANSMISSION ISSUE RELATED TO AN INTERCONNECTION WITH MISO

ICF estimated the cost to build and operate such single-circuit loop using NREL's JEDI Transmission Line Model as listed in Exhibit 37.

Exhibit 37. New Lines to be constructed for Single-Circuit Direct MLGW Connectivity with MISO

From Bus	To Bus	Voltage (kV)	length (mile)	# of circuits	Capital Cost (million 2018$)	Annual O&M Costs (million 2018$)
Memphis-MISO single-circuit loop case						
Freeport	West Memphis	500	15	1	94.6	0.28
Shelby	Driver	500	18	1	96.6	0.30
Shelby	Cordova	500	20.5	1	99.6	0.32
Freeport	Cordova	500	25.3	1	109.2	0.38
Total			**78.8**		**400.0**	**1.28**

Source: ICF using data from PowerWorld and Ventyx

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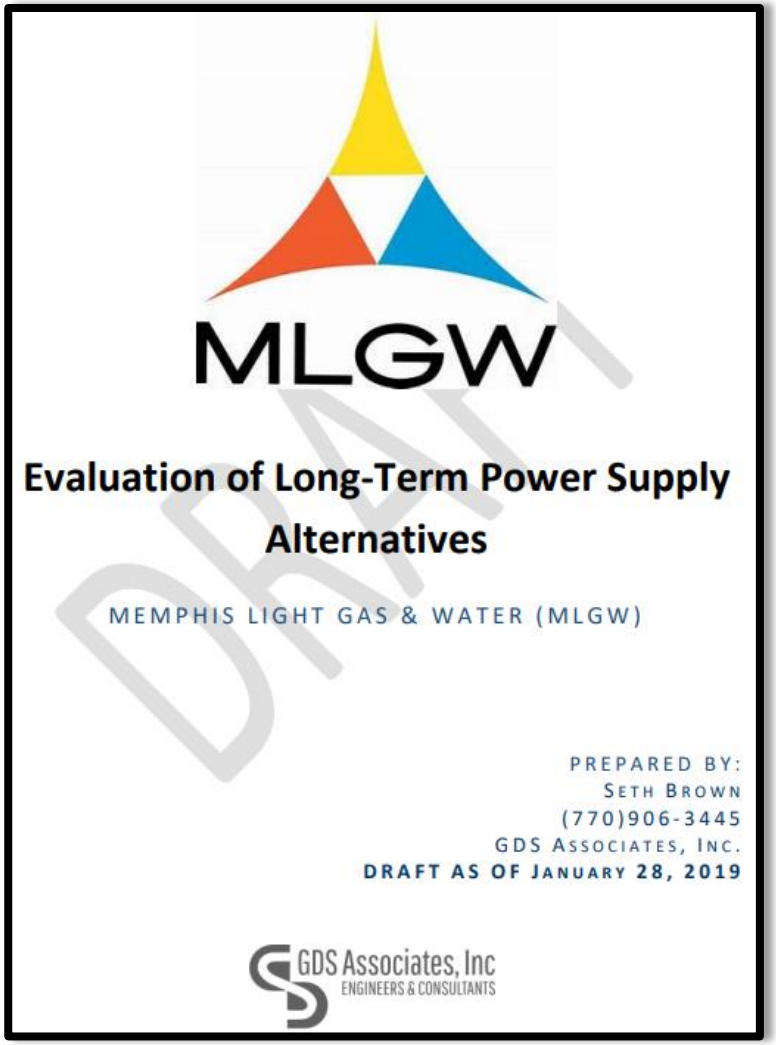
Issues for Consideration

- Significant risk of having a significant portion of supply tied up in 1 unit.
- Economics of $39/MWh seem too good to be valid for 20 years.
- Timing of giving notice to TVA and having a plant ready and transmission lines constructed.
- Securing transmission rights with TVA.
- No risk and sensitivity analysis performed around PPA prices, financial parameters, unit availability, load forecast.
- The entire focus of study assumes Bellefonte is resurrected, always works and the price is $39/MWh (and it assumes TVA's price increases 2%/year every year).

GDS Associates Inc. (MLGW Study)

- Analysis of Power Purchase Agreement for output of Bellefonte Nuclear Plant with and without MLGW – MISO integration
- Assumption of Bellefonte Unit at $39/MWh for 20 years.
- 4 scenarios analyzed
- No detailed transmission deliverability analysis
- Most economic scenario: MLGW is its own Balancing Authority pseudo-tied to MISO with MISO Purchases Only
- Identified Savings: $417.8 MM for 1 year (2022)
- Recommendations: MLGW develops a complete Integrated Resource Plan (IRP)



Evaluation of Power Supply Alternatives

- Study Objective: Evaluate long-term power supply alternatives including Nuclear Development – Bellefonte Project Power Purchase Agreement
- Cost of Energy-only modeled
- Evaluate MLGW as both stand-alone and integrated into MISO
- 2022 Study Year
- Include 15% renewable (wind) portfolio
- Compare to current TVA wholesale power agreement – **NOTE THAT STUDY DID NOT INCLUDE VALUE/COST OF CAPACITY OR COSTS ASSOCIATED WITH ANY NEW DEBT SERVICE**

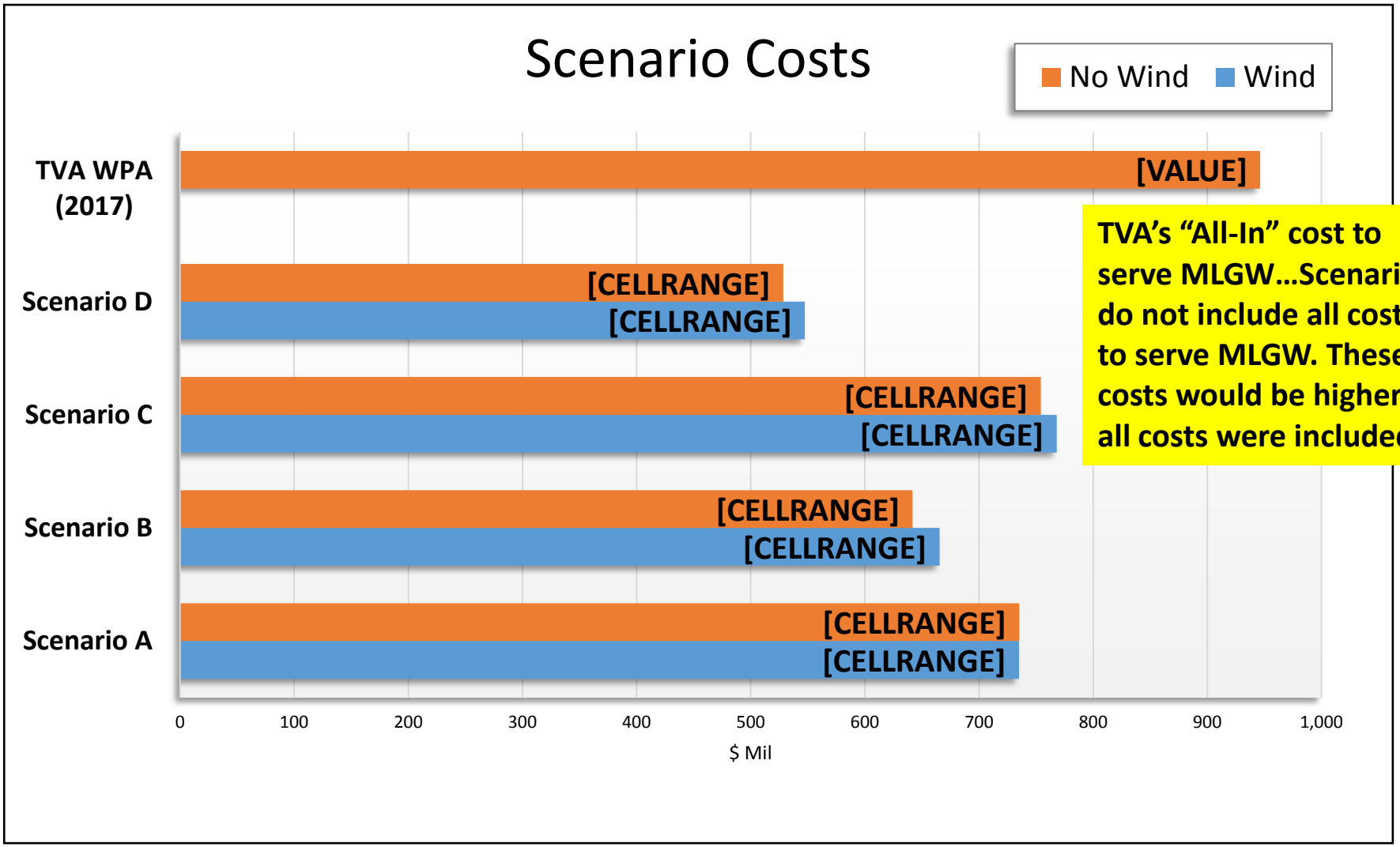
Energy Methodology & Assumptions

- Utilized a large footprint (excludes Florida, New England, NE Canada, and Saskatchewan) containing load, generation, and nodal modeling (substation level analysis)
- The analysis used PROMOD IV (program used for modeling) production cost software and the latest MISO database for the Calendar Year of 2022
- Captures unit generation, transmission congestion, and load costs. Does not include capacity costs/value
- TVA Business-As-Usual Case represents continuation of current wholesale power agreement that includes capacity costs. PROMOD results for TVA fleet include production costs only (fuel + operations & maintenance)

Energy Methodology & Assumptions (cont.)

- Scenario A: MLGW as its own Balancing Authority (BA) w/ Bellefonte
  - Bellefonte is delivered to MLGW via Firm Point-to-Point (PtP) Transmission
  - MLGW holds Firm PtP to MISO for peak load (loss of Bellefonte)
- Scenario B: MLGW as its own BA w/ Bellefonte and MLGW self-build resources
  - Bellefonte is delivered to MLGW via Firm PtP Transmission
  - MLGW holds hourly non-Firm service to and from MISO for sales and purchases
- Scenario C: MLGW in MISO w/ Bellefonte
  - Bellefonte is delivered to MISO via Firm Point to Point (PtP) Transmission
  - MLGW holds Firm PtP to MISO for peak load (Pseudo-Tie and loss of Bellefonte)
- Scenario D: MLGW in MISO w/o Bellefonte
  - MLGW holds Firm PtP to MISO for peak load (Pseudo-Tie)
  - Procures all energy from MISO
  - No hedging

Summary of Scenarios



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Summary

- Bellefonte costs are well above market energy prices under modeled gas prices. Comparison of MISO scenarios (D minus C) shows a **($200MM)** differential owning Bellefonte in MISO vs MISO-only. Bellefonte and TVA provide a capacity benefit.
- New, efficient thermal generation provides hedges against market prices, and should provide energy margins to offset load costs, but requires capital.
- Purchasing strictly from the market provides opportunities for low-cost power, but provides no protection from scarcity energy pricing. Capacity can be procured from the MISO market but prices fluctuate annually.

Bellefonte Project Risks

Issues associated with Bellefonte Project viability

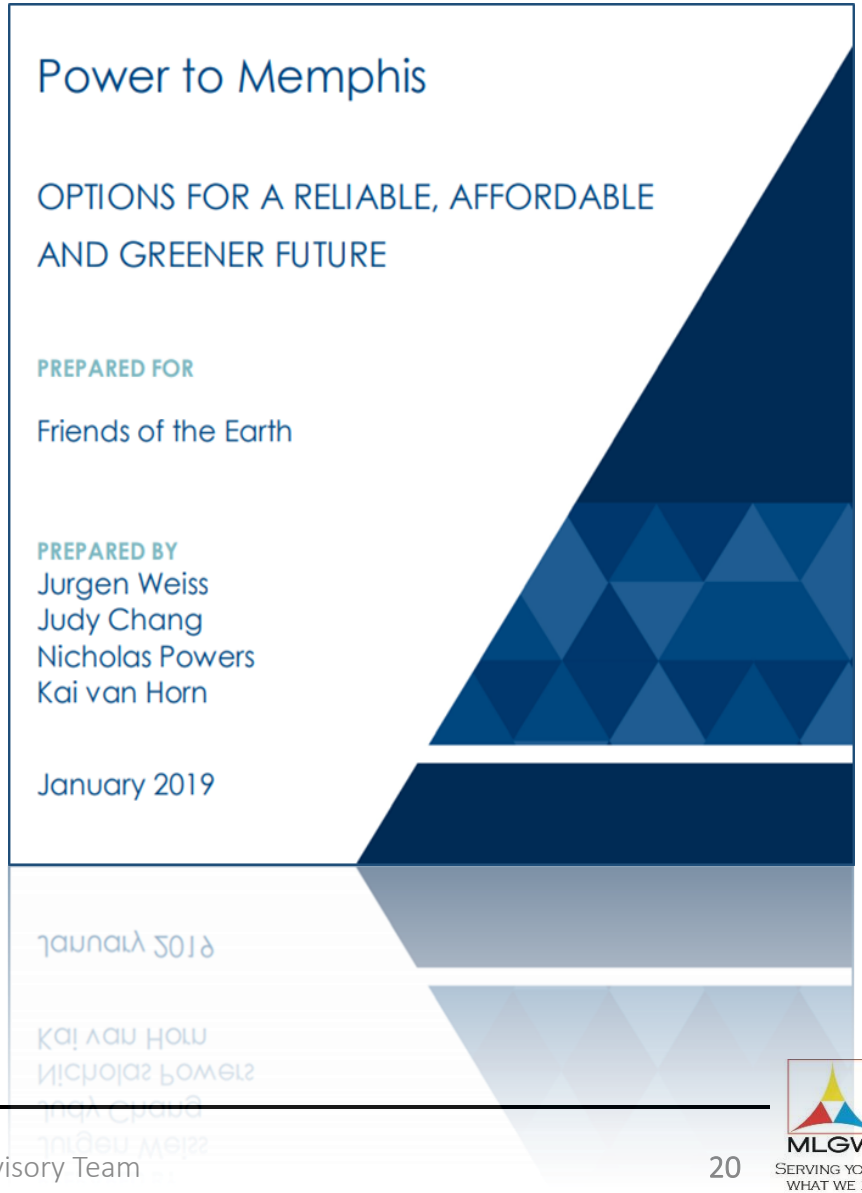
- Framatome's (French nuclear reactor construction engineering company) technical expertise with this reactor design
- Many original equipment vendors no longer in existence requiring reverse engineering of components
- Lack of a detailed engineering analysis of the existing plant systems and equipment
- Use of Maximum Guaranteed Price (MGP) contracts with penalties assessed to the contractors for schedule delays may be unrealistic
- Progressing from fuel load to commercial operation in three months may be unrealistic
- Ability to hire and train operators and development of a plant simulator may be problematic

GDS Recommendations

- Obtain data from TVA on the incremental cost of capacity, energy, transmission, and ancillary services required to serve MLGW
- Conduct a “discovery session” with MISO
- Identify transmission transfer limitations with TVA and MISO
- Page 45: “It is GDS’ recommendation that MLGW proceed with developing a complete Integrated Resource Plan which would enumerate cost of owning and operating various resource portfolios over a 20 year study period. MLGW, on a net present value basis, would identify the most cost effective resource portfolio to meet its total capacity and energy requirements on a reliable basis.”

The Brattle Group (Friends of the Earth)

- Analysis of MLGW purchasing renewable portfolio with MISO Integration
- 6 alternatives analyzed – 3 short-term, 3 long-term
- No transmission analysis
- Most economic alternative: "Cost-Minimizing Local" – development of gas-fired combined-cycle and combustion turbine units, and development of locally available utility-scale and distributed solar PV resources
- Identified Savings: $333 MM per year (2024)
- Recommendations: MLGW ends contract with TVA and constructs a portfolio of renewables, battery storage, and natural gas powered energy



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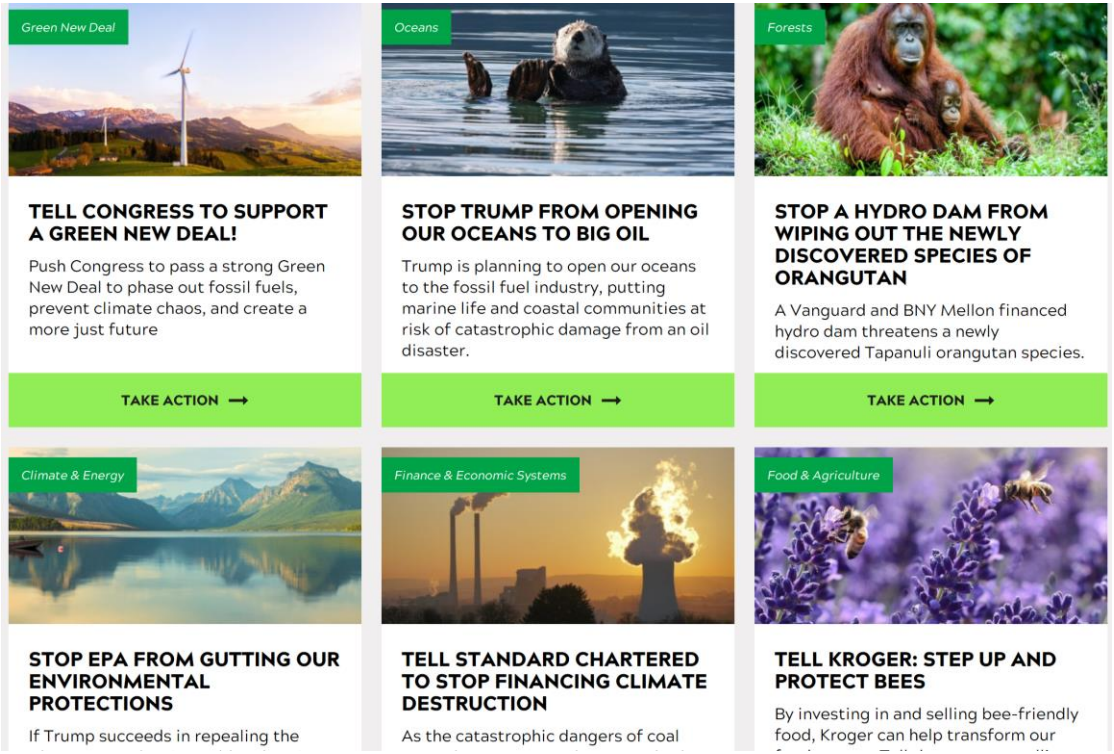
Background

- Study was performed for the organization named Friends of the Earth.
- Friends of the Earth U.S. is a non-governmental environmental organization headquartered in Washington, D.C.

Friends of the Earth



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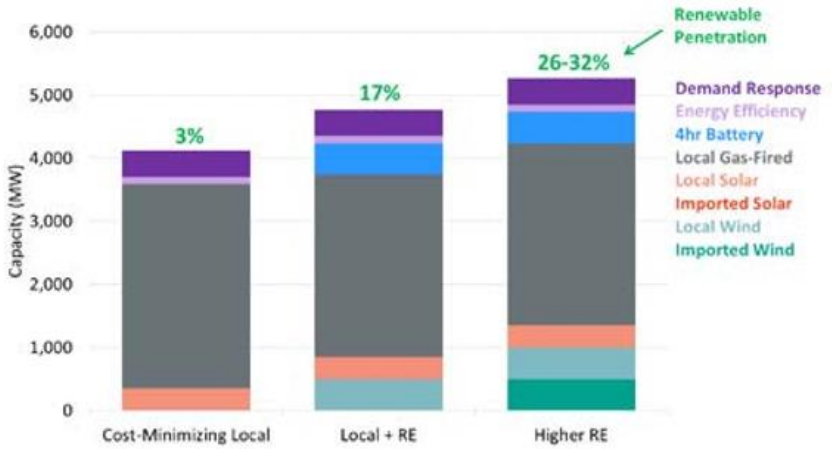
Scenarios modeled

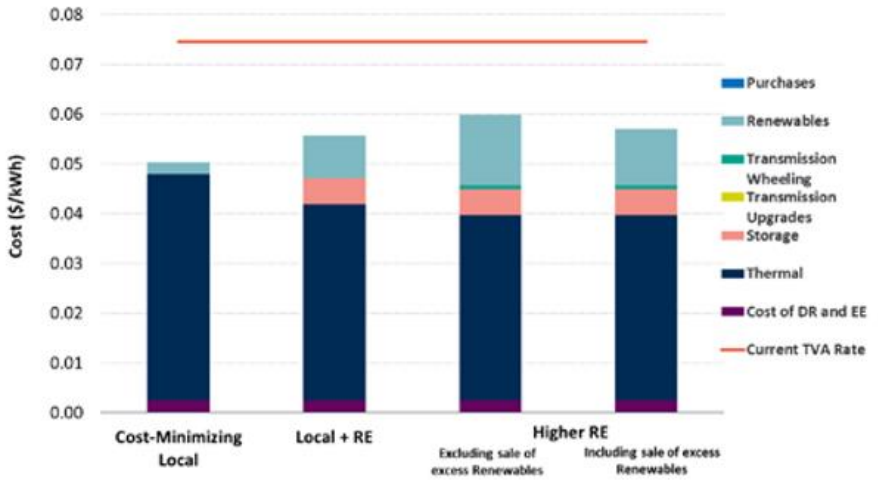
- Essentially six portfolios were modeled
- The portfolios focused on construction of local generation comprised of natural gas fueled generation, significant solar generation combined with battery storage technology and energy efficiency and demand response.
- None of the options modeled included construction of new transmission to MISO and continuously cited transmission access as a significant issue throughout the study.
- MLGW as an “island” scenario.

Portfolio modeled in 2024

2024



(a): Capacity in 2024 Alternative Supply Portfolios

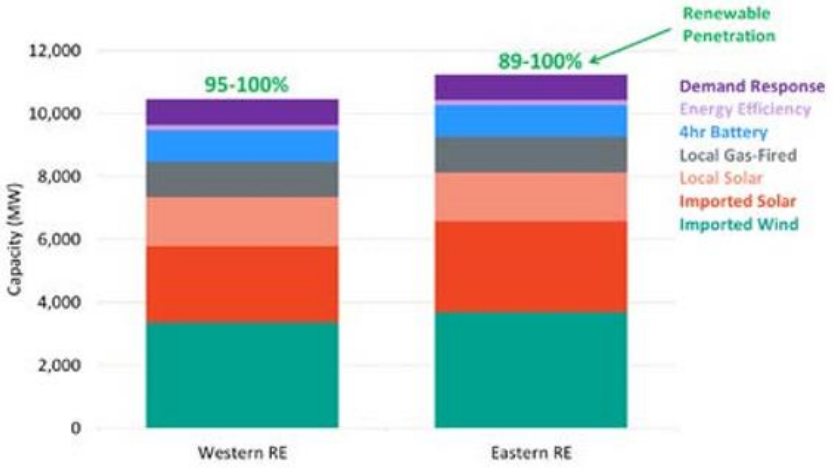


(b): Costs for 2024 Alternative Supply Portfolios

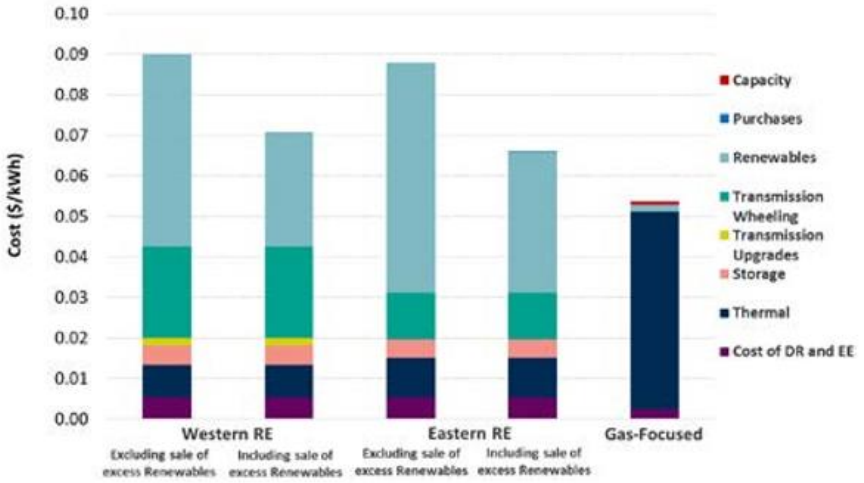
- These 3 nearer term portfolios have lower renewables proposed.

Portfolio modeled in 2050

2050



(c): Capacity in 2050 Alternative Supply Portfolios



(d): Costs for 2050 Alternative Supply Portfolios

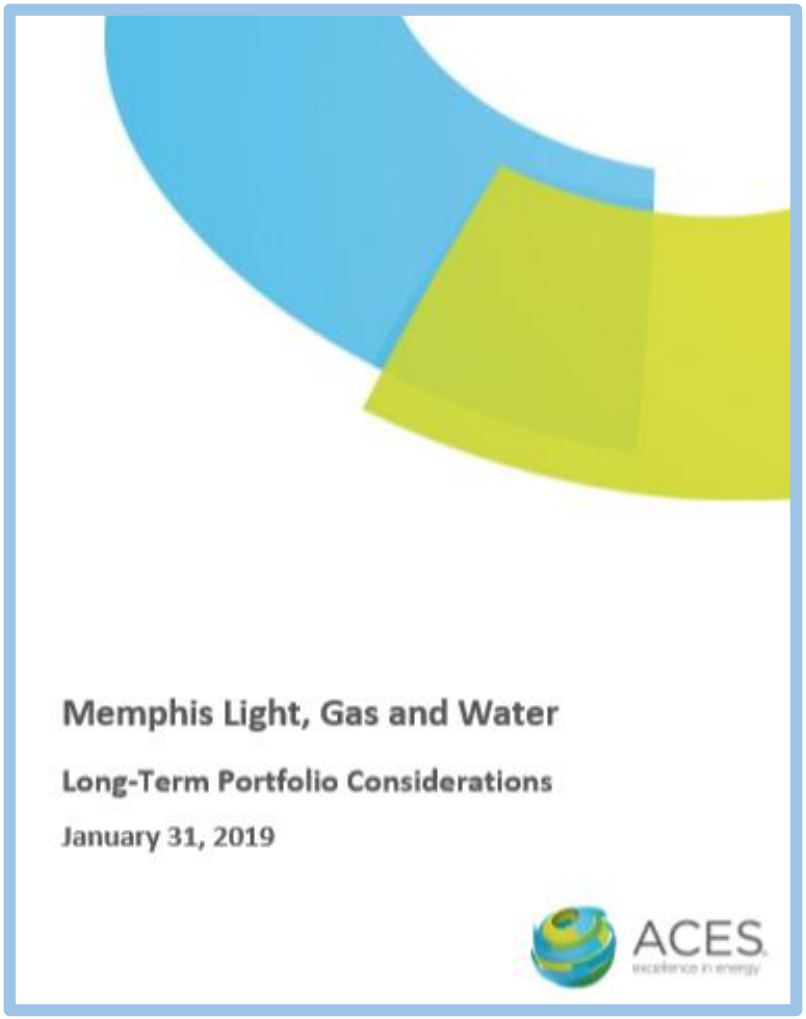
- These 2 longer term portfolios have a high concentration of renewables proposed in a movement away from natural gas.

Summary

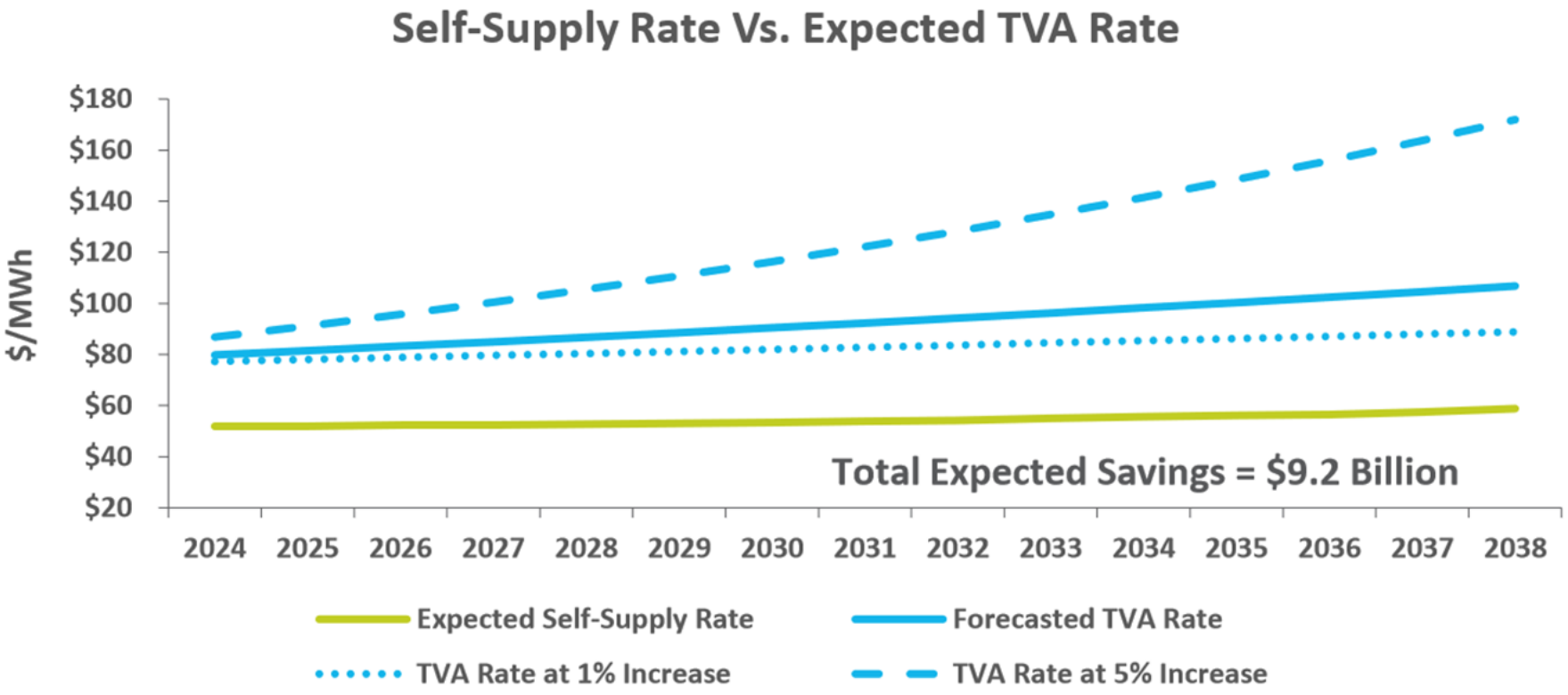
- The Brattle study identifies a range of savings between $240 to $333 million per year relative to TVA.
- The portfolios modeled are heavily dependent on local generation build which generates significant stand-alone risk.
- The portfolios are geared toward renewable sources
  - 3 to 26% in the near-term portfolios
  - 89 to 100% in the long-term portfolios

ACES Power Marketing

- "The purpose of this analysis is to determine if MLGW should consider self-supplying its electricity needs or stay with its all-requirements deal with TVA"
- 22 power supply portfolios were analyzed
- No transmission analysis included
- Most economic portfolio:
- 7% MISO
- 51% 1,000 MW Market Purchase
- 13% 900 MW Combined Cycle
- 25 % 1,000 MW Solar + 500 MW Wind
- 4% 650 MW Quick Start Peaking
- Identified savings: $9.2 Billion over 15 years (2024-2038)
- Recommendations: obtain a full cost-benefit analysis from MISO, and conduct a formal RFP for developers to provide baseload power to MLGW



Self Supply Rate vs Expected TVA Rate



ACES modeled 22 portfolios

Initial Portfolio Considerations					
Scenario Number	Scenario	Renewable Goal	Market Exposure/Risk	15-Year NPV of Costs	NPV Rank
1	TVA	No	0%	$10,427,871,355	22
2	All Market	No	100%	$5,748,866,025	5
3	First Take - Baseload + Intermediate + Solar Scenario	No	50%	$5,849,428,187	8
4	Low Fixed Cost Scenario	No	50%	$5,377,285,452	2
5	All Combined Cycle Scenario	No	60%	$6,145,174,272	21
6	Distressed Asset Scenario	No	75%	$5,567,146,480	3
7	High Capacity Exposure Scenario	No	75%	$5,810,001,439	6
8	Iteration 1 - Combined Cycle + Peaking + Renewables	No	55%	$5,699,249,229	4
9	Iteration 2 - Combined Cycle + Peaking + Renewables	No	15%	$5,972,168,718	19
10	Iteration 3 - Combined Cycle + Peaking + Renewables	25%	15%	$5,948,199,037	16
11	Iteration 4 - Combined Cycle + Peaking + Renewables	25%	15%	$5,906,058,122	12
12	Combined Cycle + Renewables	25%	15%	$6,035,756,402	20
13	Combined Cycle + High Renewables	50%	30%	$5,950,879,522	17
14	Iteration 1 - Combined Cycle + Peaking + High Renewables	50%	15%	$5,944,543,048	14
15	Iteration 2 - Combined Cycle + Peaking + High Renewables	50%	15%	$5,935,484,964	13
16	Iteration 3 - Combined Cycle + Peaking + High Renewables	50%	15%	$5,952,162,537	18
17	Iteration 4 - Combined Cycle + Peaking + High Renewables	50%	15%	$5,946,840,460	15
18	Iteration 5 - Combined Cycle + Peaking + High Renewables	50%	15%	$5,220,012,858	1
19	Iteration 6 - Combined Cycle + Peaking + High Renewables	50%	30%	$5,831,855,159	7
20	Iteration 7 - Combined Cycle + Peaking + High Renewables	50%	30%	$5,899,413,757	9
21	Iteration 8 - Combined Cycle + Peaking + High Renewables	50%	30%	$5,901,439,780	11
22	**Final Sample Portfolio**	**25%**	**15%**	**$5,900,030,101**	**10**

Example Self-Supply Scenario

How to Build a Self-Supply Portfolio			
Step	**Portfolio Need**	**Sample Portfolio**	**Portfolio Energy %**
Step 1	Market Access	MISO	7%
Step 2	Baseload Supply	1,000 MW Market Purchase	51%
Step 3	Intermediate Supply	900 MW Combined Cycle	13%
Step 4	Renewable Supply	1,000 MW Solar + 500 MW Wind	25%
Step 5	Peaking Supply	650 MW Quick Start Peaking	4%

- This was portfolio #22 and was used as the focus of the majority of the report.
- The report walked through the building of the portfolio and elaborated on each step.
- In this example, MLGW would build about 1550 MW of generation assets.

Summary

- Strategy of focus involved joining the MISO market along with layered hedges through purchases and building of resources.
- A step by step outline of each portfolio layer is discussed in detail in the study.
- This portfolio projected to save $9.2 billion over a 15 year period, an average of $613 million per year.
- Many “if needed” comments in scenario.

ACES Recommendations

- Contact MISO to assist the process by completing an assessment of the impact of joining the market, including details regarding transmission (if any??) to integrate into MISO.
- Conduct an RFP to determine the availability and cost of the baseload of 1,000 MW supply.
- Determine the skills MLGW needs to acquire or outsource, and how MLGW's business would change when joining MISO.

Review of Studies Conclusions

	ICF	ACES	Brattle	GDS	IRP
20 year load forecasting	No	No	No	No	Yes
Transmission analysis	Partial	No	No	No	Yes
20 year Present Value (PV) of revenue requirements	No	No	No	No	Yes
Risk evaluation (i.e. fuel price volatility, carbon taxes, electric demand)	No	No	No	No	Yes
Public involvement throughout process	No	No	No	No	Yes
Evaluate current and future staffing requirements	No	No	No	No	Yes
Business or special interest led analysis	Yes	Yes	Yes	Yes	No
Scenario and sensitivity analysis to ensure least-cost supply option	No	No	No	No	Yes

Review of Studies Conclusions (cont.)

- None of the studies were a comprehensive analysis of all the issues related to MLGW's power supply.
- All of the studies are indicative that potential savings may be possible (by generally assuming annual TVA price increases).
- The IRP process is intended to identify potential power supply options and to comprehensively examine the associated opportunities and risks.