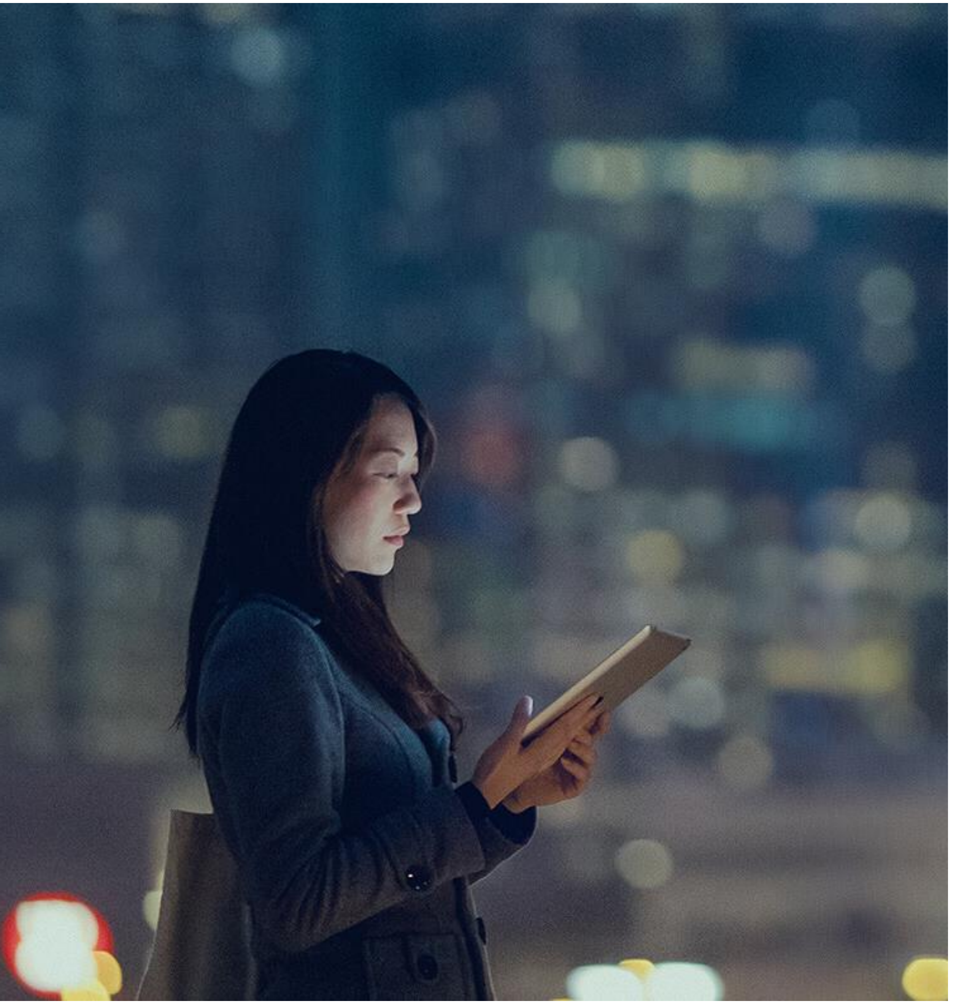
Integrated Resource Plan and Transmission Analysis PSAT Meeting

August 14, 2019

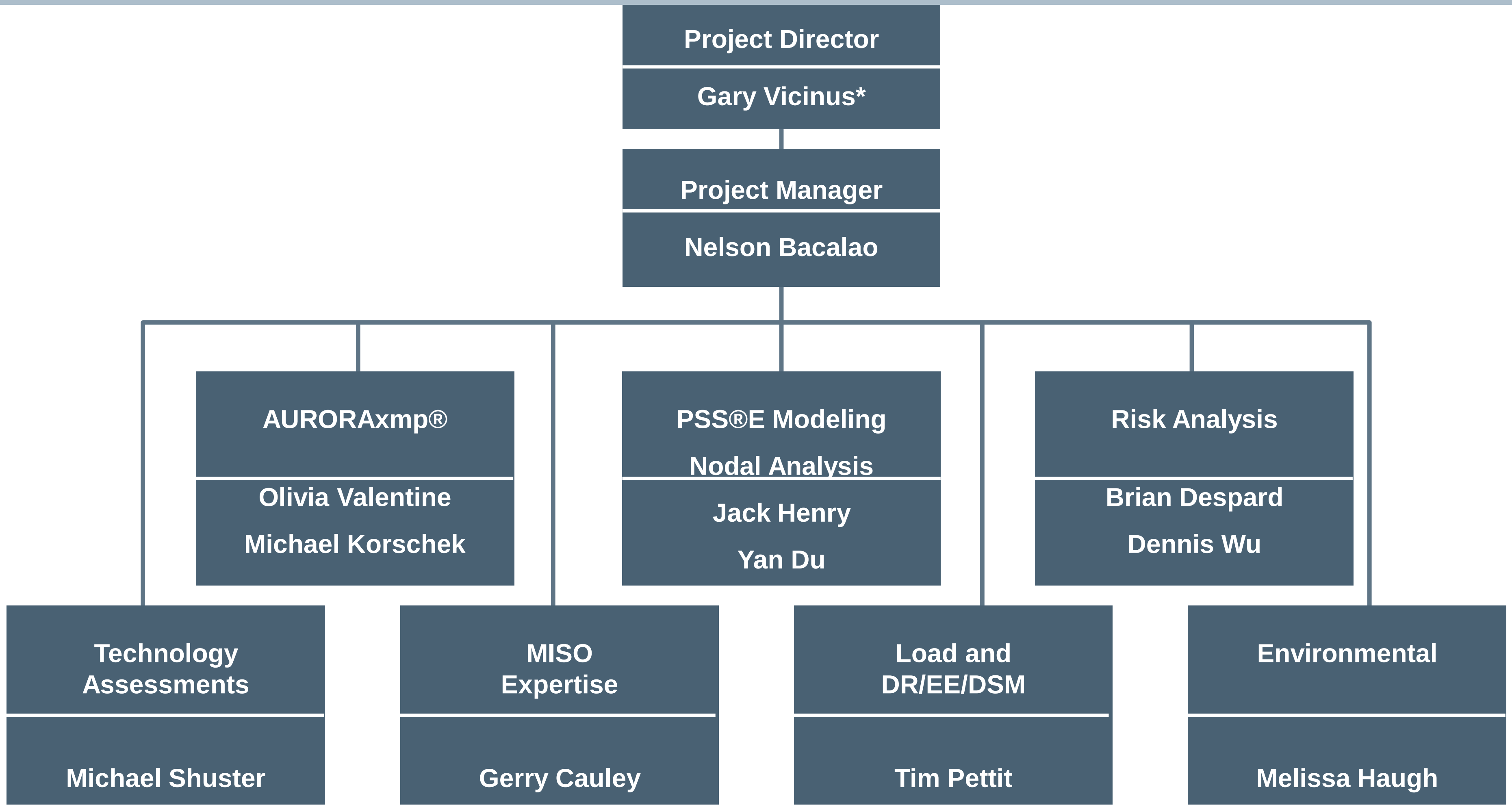
Agenda



- Introductions and Project Team
- Background
- IRP Approach
  - Generation Analysis
  - Transmission Analysis
  - Balancing Authority Gap Analysis
- Comments and Q&A

Company & Project Team Introduction

Siemens Team Organization



***Gary Vicinus is also responsible for the Stakeholder Process**

PTI – Solutions that Maximize Client's Business Value

Energy Business Advisory

Opening doors to future value creation

- Integrated Resource Planning
- Integrated G, T, and D planning
- Storage and Microgrid Assessments
- Forecasting and Risk Assessments
- Transaction Advisory
- Risk Management Advisory

Power System Consulting

Complete set of analysis, design & optimization studies

- Steady-state System Studies
- Dynamic System Studies
- Transient System Studies
- Protection & Control System Studies
- Power Quality and Grounding Studies
- Transmission and Distribution Planning
- Nodal Production Cost Analyses

Software and Training

State-of-the-art system planning and data management

- Planning and Simulation of Power Systems
- Planning and Simulation of Pipe Networks
- Model and Data Management
- Dynamic and Protection Security Assessments in Operation
- PSS®E, PSS®SINCAL, PROMOD, AURORAxmp®

PSAT Engagement Plan

Start of IRP August 14, 2019	Monthly Meetings through September, and March	Objectives and Expectations
Describe the purpose of the IRP Describe the methodology that will be followed Gather PSAT insights into some key IRP issues	Next meetings: • Provide guidance to • Scenarios • Input assumptions • Options to be considered • Alternative Strategies • Preliminary results	Get commitments to participate Support the stakeholder process Guidance and perspective

Stakeholder Engagement Plan

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Start of IRP August 14, 2019	Midpoint of IRP (November)	Conclusion of IRP (March)
Engage wide range of stakeholders from the beginning of the process • Inform, educate and listen • Provide high level overview of what to expect • Allow for comments and clarifications	Share • Strategies to be considered • Options • Input Assumptions • Alternative Scenarios • Screening Analysis Give an opportunity to comment and recommend	Present findings of the study and the recommended strategy and portfolio of assets Provide an opportunity for comment and recommendations

Project Schedule

Name	Duration	Start	Finish
Kickoff Meeting Preparation	4 days	Jul-19	Jul-19
Project Kickoff Meeting	1 day	Jul-19	Jul-19
Develop Objectives, Metrics & All IRP Input Assumptions	29 days	Jul-19	Aug-19
Stakeholder Meetings	2 days	Aug-19	Aug-19
Screen Resource Optioins (Technologies)	14 days	Aug-19	Sep-19
Develop Baseline & Stochastic Inputs	14 days	Aug-19	Sep-19
Stakeholder Meetings	2 days	Sep-19	Sep-19
Supply Strategies & Selection of Portfolio Options	30 days	Sep-19	Oct-19
Select Portfolios for Risk Analysis	2 days	Oct-19	Oct-19
Stakeholder Meetings	2 days	Oct-19	Oct-19
Perform Risk Analysis	31 days	Oct-19	Nov-19
Stakeholder Meetings	2 days	Nov-19	Nov-19
Initial Transmission Analysis	14 days	Nov-19	Nov-19
Perform Gap Analysis	7 days	Nov-19	Dec-19
Draft IRP Report	14 days	Dec-19	Dec-19
Refinement of Risk Analysis	32 days	Dec-19	Jan-20
Select Best Portfolio	4 days	Jan-20	Jan-20
In-Depth Transmission Analysis	65 days	Jan-20	Mar-20
Stakeholder Meetings	2 days	Feb-20	Feb-20
Final IRP Report	14 days	Mar-20	Apr-20
Stakeholder Meetings	2 days	Apr-20	Apr-20

Background

Integrated Resource Planning (IRP)

Why Do an IRP	What is an IRP
Offers presented to MLGW have been incomplete and self directed - An Integrated Resource Plan will be • Independent and unbiased • Comprehensive regarding strategies and options • Address the risk associated with market, regulatory and technology uncertainty • Compare the TVA Full Requirements Contract to alternatives on an equivalent basis (generation, plus transmission, plus balancing, plus services) • Reflect the opinions and views of PSAT and Stakeholders • Reflect the objectives of MLGW, PSAT and Stakeholders	The purpose of an IRP is to provide a plan for energy resource (primarily generation and demand side programs) development to meet future load and compare the status quo (TVA FRC to market and self generation options) • The plan must be *forward looking* and reflect views of future regulations, market conditions and expectations of technology changes • The plan will suggest what portfolio of generating assets (power plants), energy efficiency programs and transmission adjustments best meets its' future needs • The plan must meet future regulatory requirements, and provide for a reliable supply of power to customers at lowest reasonable cost. • The IRP is quickly evolving to something more complex. Resilience is one driver that requires that distribution and transmission solutions be considered with generation solutions. Large renewable development will also require a more integrated solution.

Existing Studies Review (MLGW)

	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

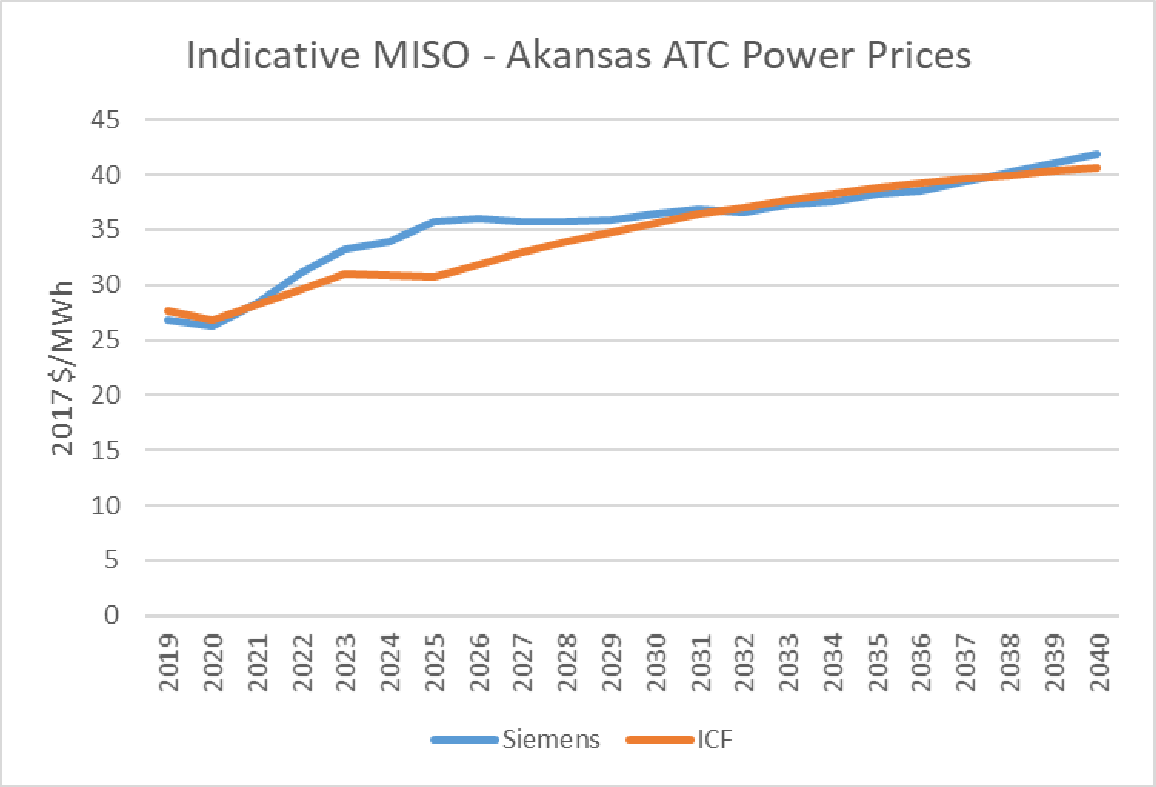
Existing Studies Review

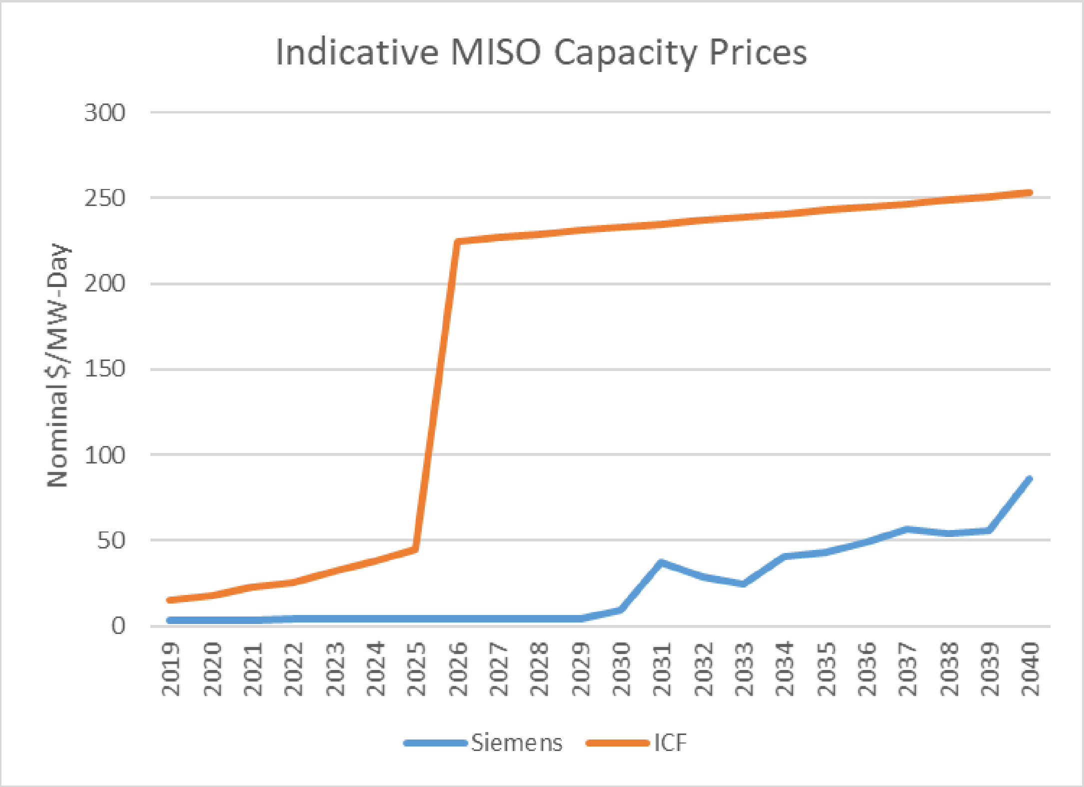
	ICF (Bellefonte Developer)	ACES	Brattle (Friends of the Earth)	GDS (MLGW)	Siemens
Study Horizon	2024 to 2043	2024 to 2038	2024 and 2050	2022	2019 to 2038
Model	IPM Zonal with PROMOD nodal	Probabilistic resource planning model and financial model	Power System Optimizer	Full nodal analysis using PROMOD IV	Aurora Zonal and PROMOD Nodal, PSS/E
Combined Cycles and Gas Peakers	Can be procured as physical hedge	13% of portfolio energy comes from CC 900MW 4% comes from 650MW Quick Start peakers	For higher renewable scenario, 26-32% of Supply Portfolio comes from renewable energy in 2024, 89-100% comes from renewable energy in 2050	One scenario includes 2 new CC's, and 6 new CT's (new capacity of 2,606 MW)	TBD
Nuclear or Baseload	Bellefonte (1350 MW, 70% of MLGW' energy) for $39/MWH with a 2.1% annual inflator	No nuclear – 1GW market PPA	-	Four scenarios, three of them include Bellefonte	TBD
Market Purchase	Physical Hedges or Spot Market	7% of portfolio energy comes from MISO (market access)	For Balancing purposes	-	TBD

Existing Studies Review

	ICF (Bellefonte Developer)	ACES	Brattle (Friends of the Earth)	GDS (MLGW)
Total Savings	$7.9 billion (2024 to 2043)	$9.2 billion (2024 to 2038)	$240 to $333 MM per year relative to TVA	$417.8 MM for 2022
TVA full service costs ($/MWh)	$75/MWh in 2024 to $95/MWh in 2038	From $70/MWh to $100/MWh in 2038 (2.1% annually increase)	~$75/MWh	"Energy only" cost of production is $18.5/MWh; full-delivered, all requirements cost is ~$66.0/MWh
Portfolio Cost (Partial cost)	$57/MWh without regulatory/transmission; $68/MWh with regulatory/transmission	$38/MWh to $81/MWh (energy, capacity, ancillary services, and network transmission charges in 15-year horizon)	$50/MWh Lowest cost portfolio for 2024, $55/MWh lowest cost portfolio for 2050 (Gas focused)	Averaged $47/MWh for portfolio without wind; Averaged $48/MWh for portfolio with wind

Existing Studies Review – Energy and Capacity Prices





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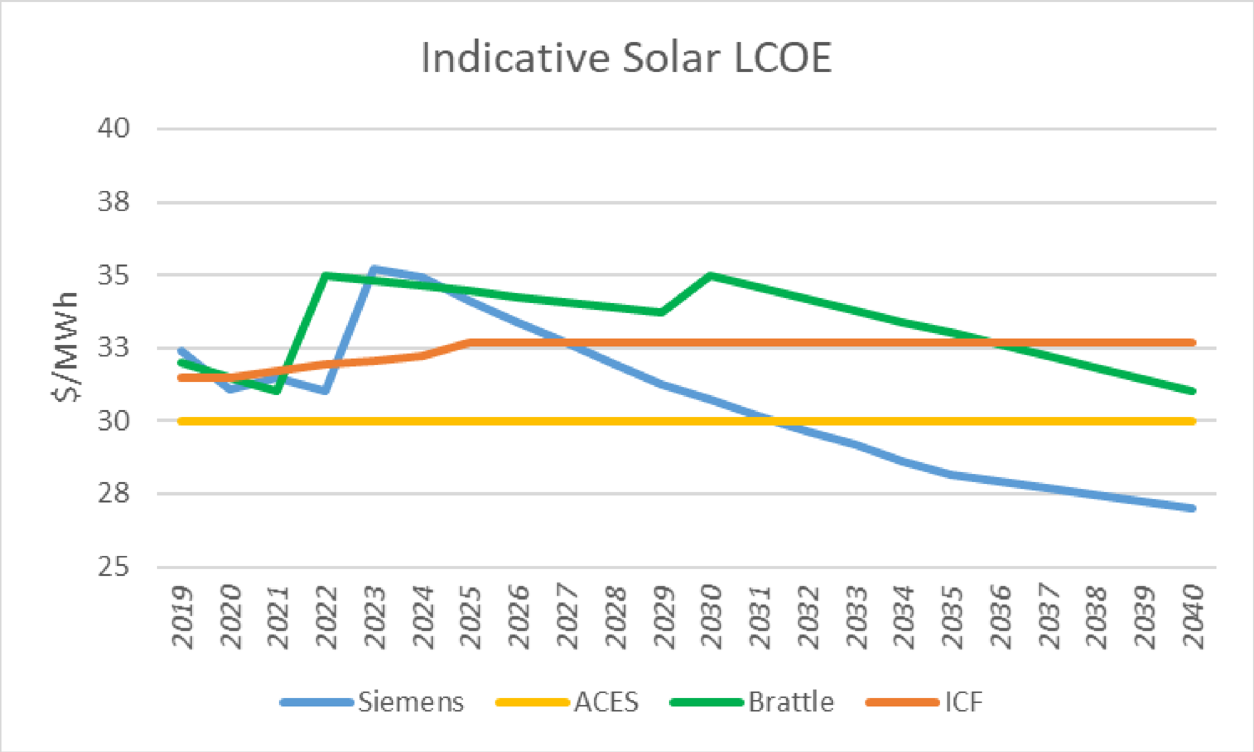
Indicative Solar LCOE
40
38
35
33
30
28
25
$/MWh
2019
2020
2021
2022
2023
2024
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2026
2027
2028
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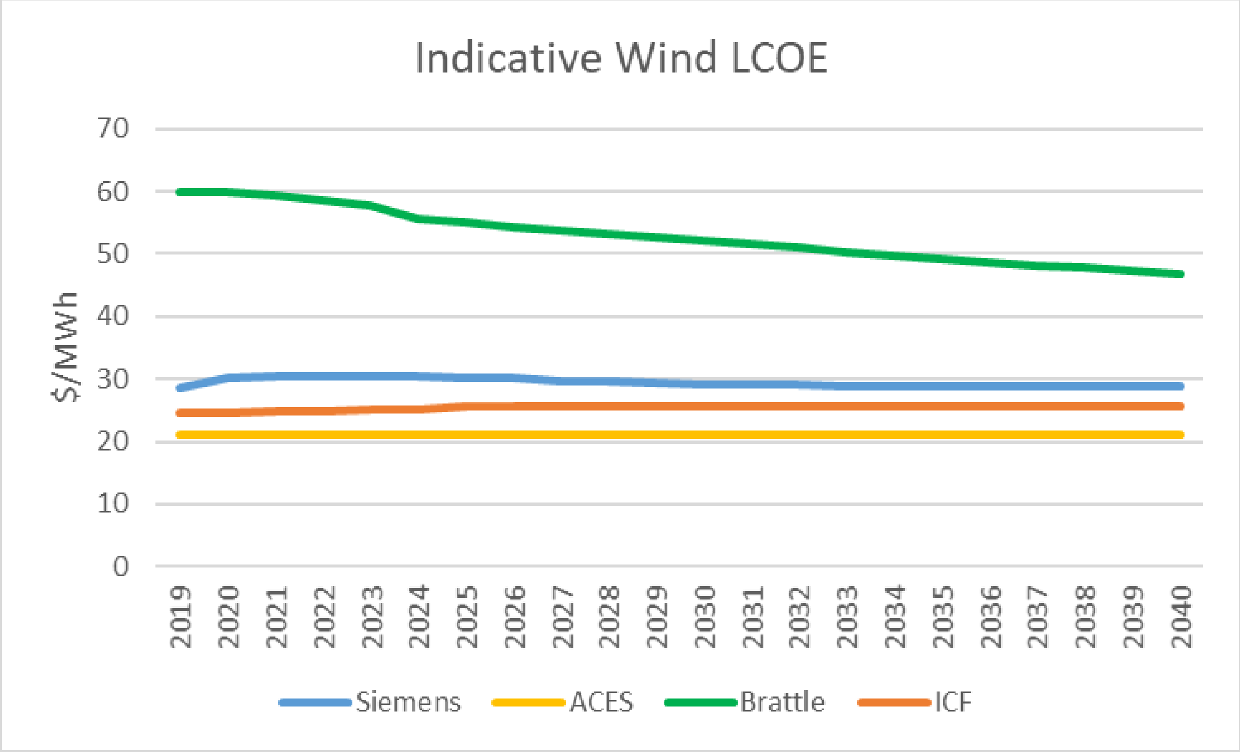
Siemens
ACES
Brattle
ICF


Indicative Wind LCOE
70
60
50
40
30
20
10
0
$/MWh
2019
2020
2021
2022
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2025
2026
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2028
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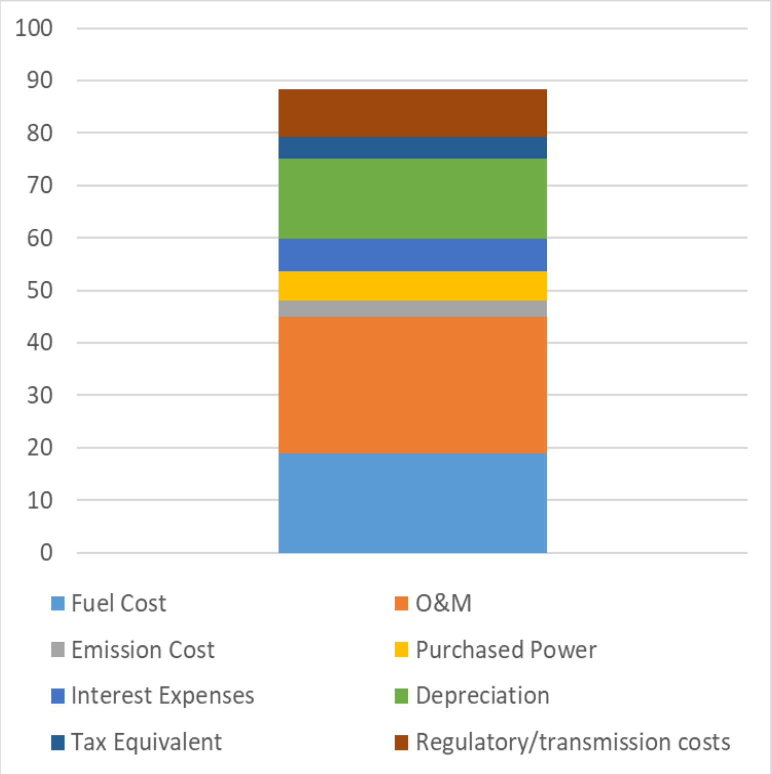
2040
Siemens
ACES
Brattle
ICF

Overview of TVA's FRC Cost Breakdown

- TVA full requirements contract must be assessed (with TVA's support)
  - Generation costs
    - Fuel costs
    - O&M
    - Capital cost
      - Interest /depreciation
  - Transmission costs
    - O&M, Capital Cost
  - Stranded cost recovery
  - Premiums/Overhead
    - e.g. bond retirement
  - Other costs (identify)

Type	Cost* $/MWh
Fuel Cost	18.9
O&M	26.1
Emission Cost	3
Purchased Power	5.6
Interest Expenses	6.3
Depreciation	15.3
Tax Equivalent	4.1
Regulatory/transmission costs	9
Total Cost of Power	79
Selling Price to LPC	88

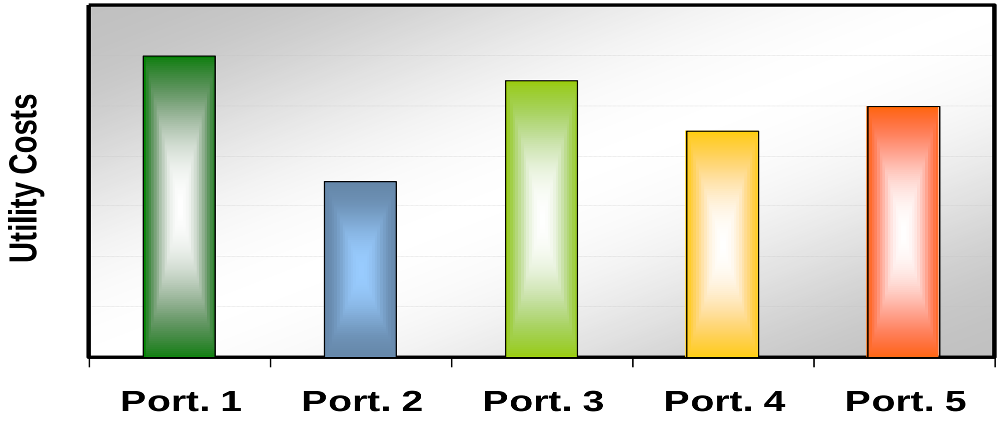


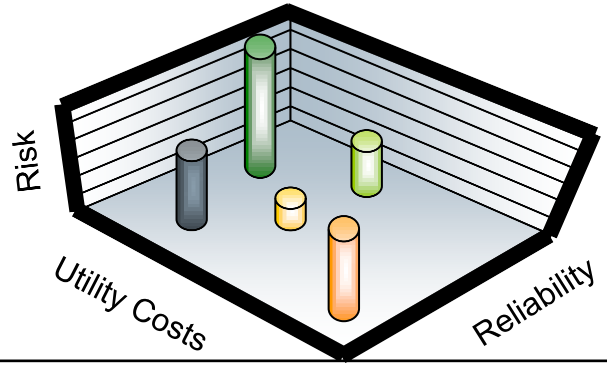
*TVA cost breakdown by ICF

Siemens Approach

Siemens Approach Considers Multiple Objectives

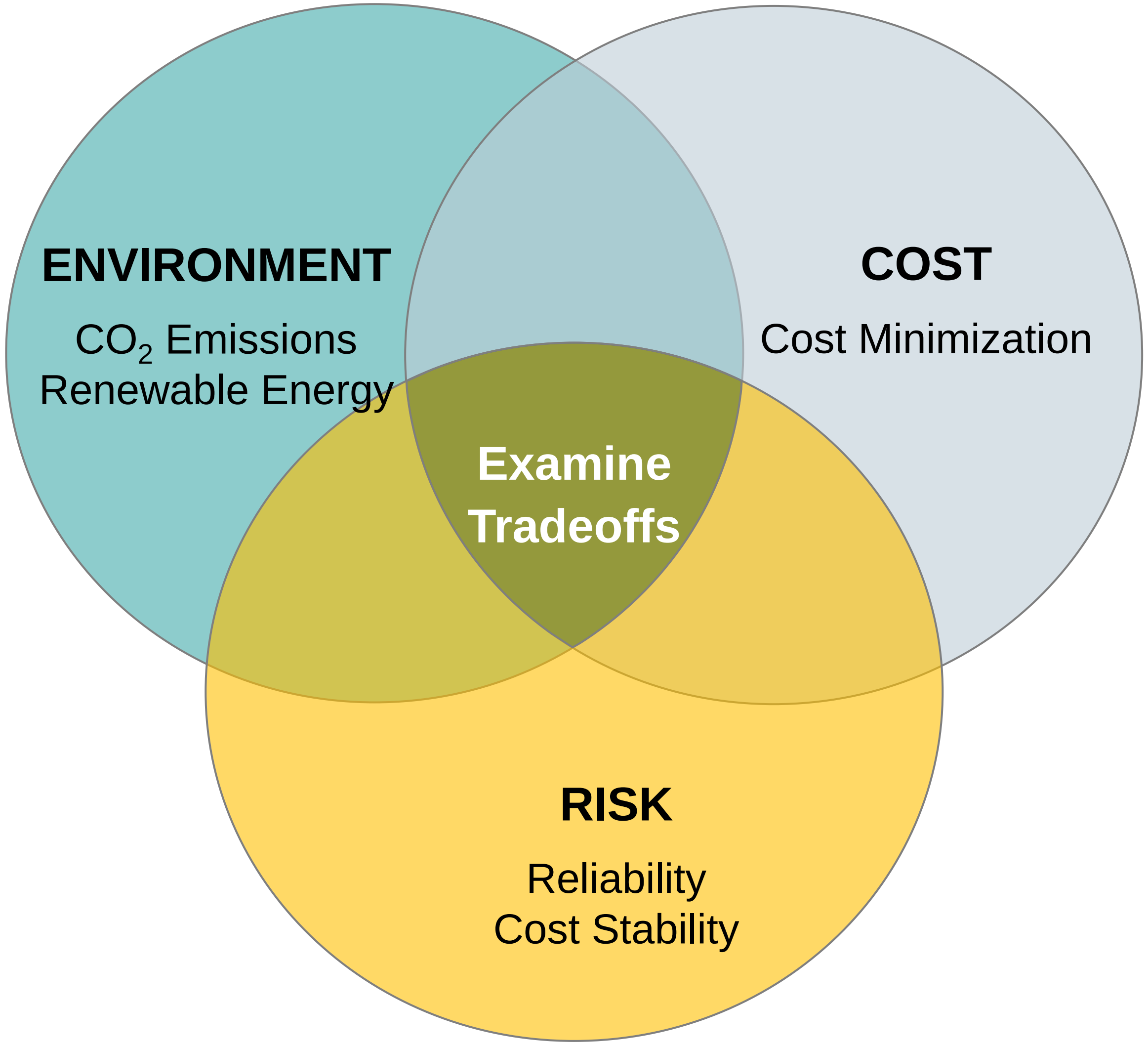
Traditional Approach	Siemens Approach
▪ Process focuses on minimizing utility costs ▪ Portfolio evaluation is one-dimensional ▪ T & D resources are not fully integrated	▪ Utilities have multiple objectives: Reliability, stability, sustainability, resilience and cost are all important objectives. ▪ Process focuses on the simultaneous evaluation of multiple objectives and tradeoffs - Rate stability - Utility cost minimization - Reliability and resilience





Identifying and Evaluating Tradeoffs

Customer Perspective

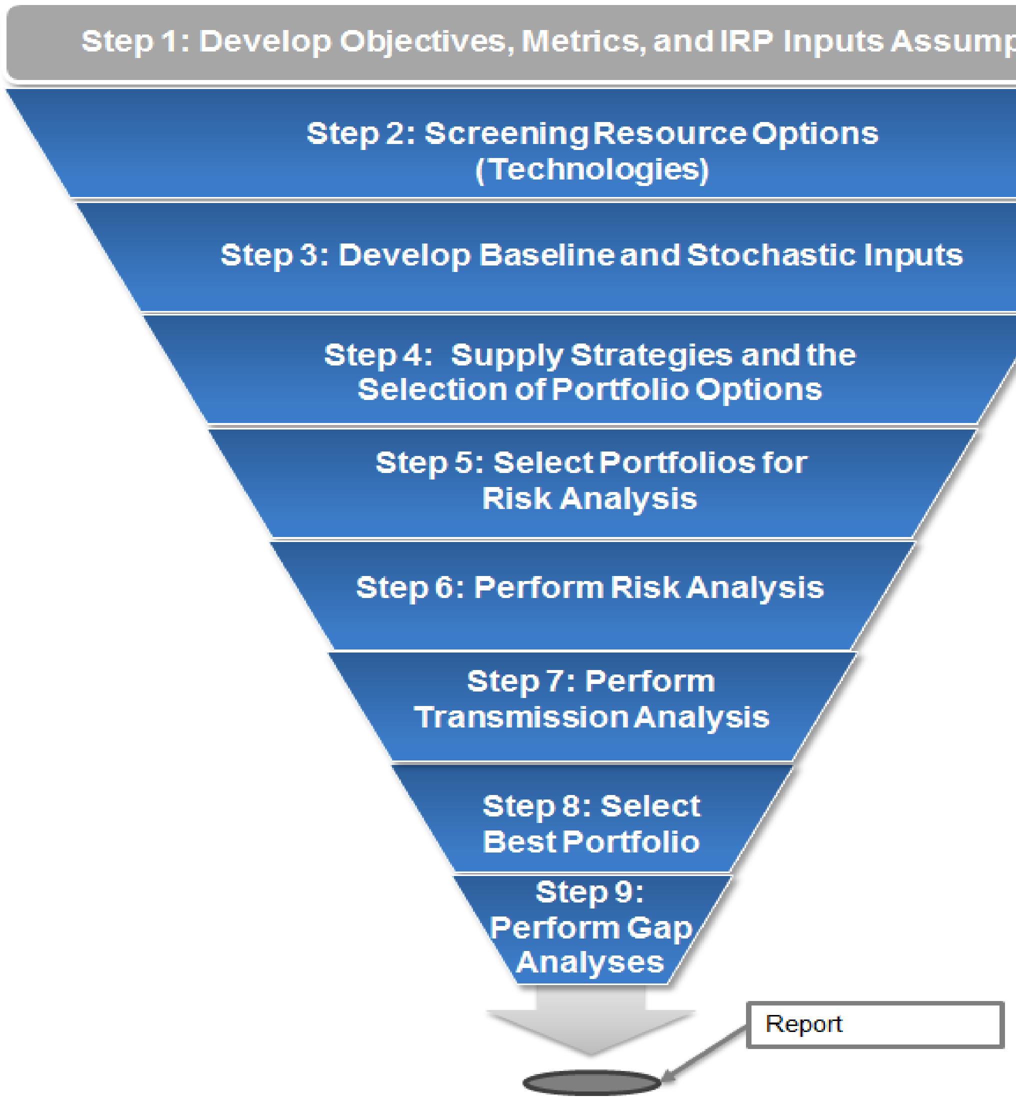


Supply Options (Discuss and Comment)

- **TVA Full Requirements Option**
  - A base case of MLGW's current supply which is a full-requirements contract with TVA for comparison purposes with other supply options. With TVA being a public utility, we may simply be able to draw from its latest IRP, which should provide details on its recommended path.

- **Self Supply Options**
  - **Self Build**
    - Select and screen various resource self-build options with input from MLGW on the various types of generation technologies, demand-side and energy efficiency, and other known available capacity and energy alternatives.
  - **Market**
    - Select and screen the option of purchasing all energy and capacity from MISO.
  - **Combination**
    - Select and screen any combination of self-build and market transactions to maximize cost savings to MLGW over the study period.

IRP Structured Approach



List of Objective and Metrics used in other IRPs – Discuss and Comment (Some use diversity/flexibility as well)

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OBJECTIVES (illustrative)	METRICS (illustrative)
Least Cost (financial viability)	PV of revenue requirements (everyone)
Reliable	Meets or exceeds Loss of Load Hour (LOLH) or FERC/NERC requirements
Resilient	Able to maintain supply to critical loads, timely restoration of supply to customers (PREPA, OUC)
Sustainable	Carbon (proxy) or total emissions (most everyone)
Economic Growth	Job creation (occasional)
Stability (Volatility)	95% (worst) outcome (everyone) Exposure to Market (energy and capacity) – (many)

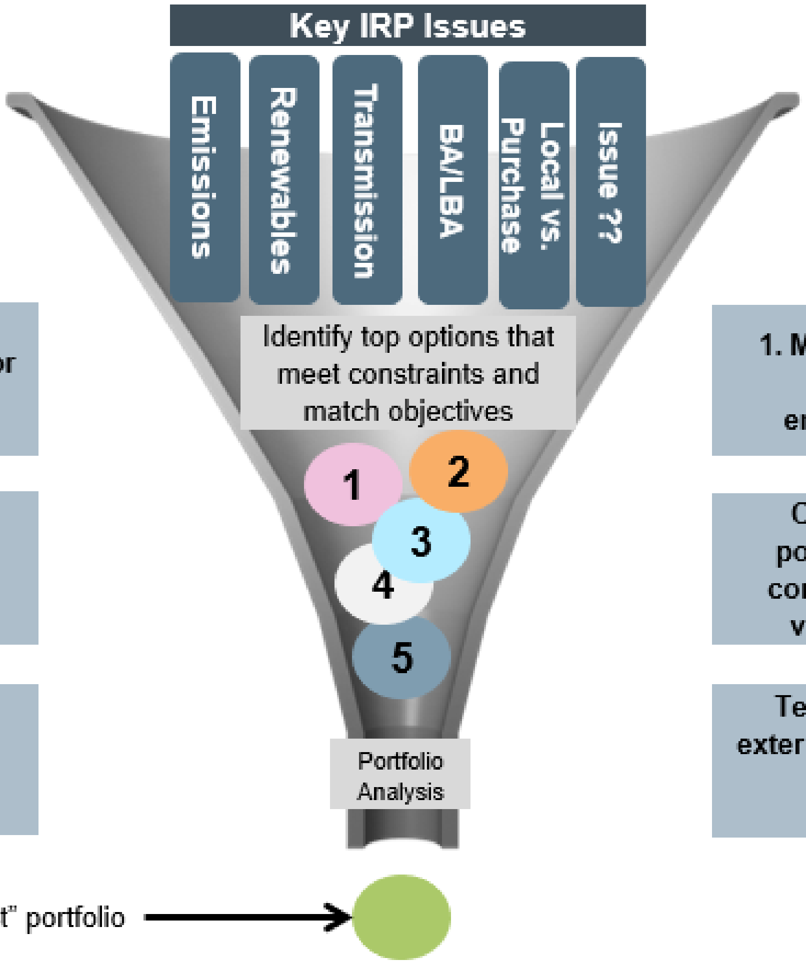
Key Issue: Selection of Resource Options

Task

Screen feasible options for each “issue category”

Combine individual options into integrated portfolios

Perform quantitative scenario-based risk analysis



Select “best” portfolio

Approach

1. Meet planning constraints;
2. Rank by cost and environmental performance

Collaborate to construct portfolio options that meet constraints and incorporate various strategy options

Test each portfolio against external market risks and all key metrics (Full portfolio assessment)

Key Issue: Portfolio Expansion Strategies – Discuss and Comment

Supply Side Plan Technologies

- Generation Options: Solar PV, wind, biomass, utility-scale storage, combined cycles, flexible peakers (frame type or aeros), reciprocating engines, existing capacity retrofits, nuclear
- Demand Side Options: Energy efficiency, demand response
- Multiple strategies will be assessed as following:
  - Strategy 1: Full Requirements Contract with TVA
  - Strategy 2: Self Supply
  - Strategy 3: MLGW-MISO
  - Strategy 4: Mixture of strategy 2 and 3 that embodies a combination of the benefits of each strategy
- Combination of scenarios and strategies can define portfolios and address a wide range of issues:

Scenarios / Portfolios		Portfolios			
		BAU	Self Supply	MISO	Combination
State of the World	Scenario 1	P1	P2	P5	P6
	Scenario 2	P1	P3	P5	P7
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Scenarios – Discuss and Comment

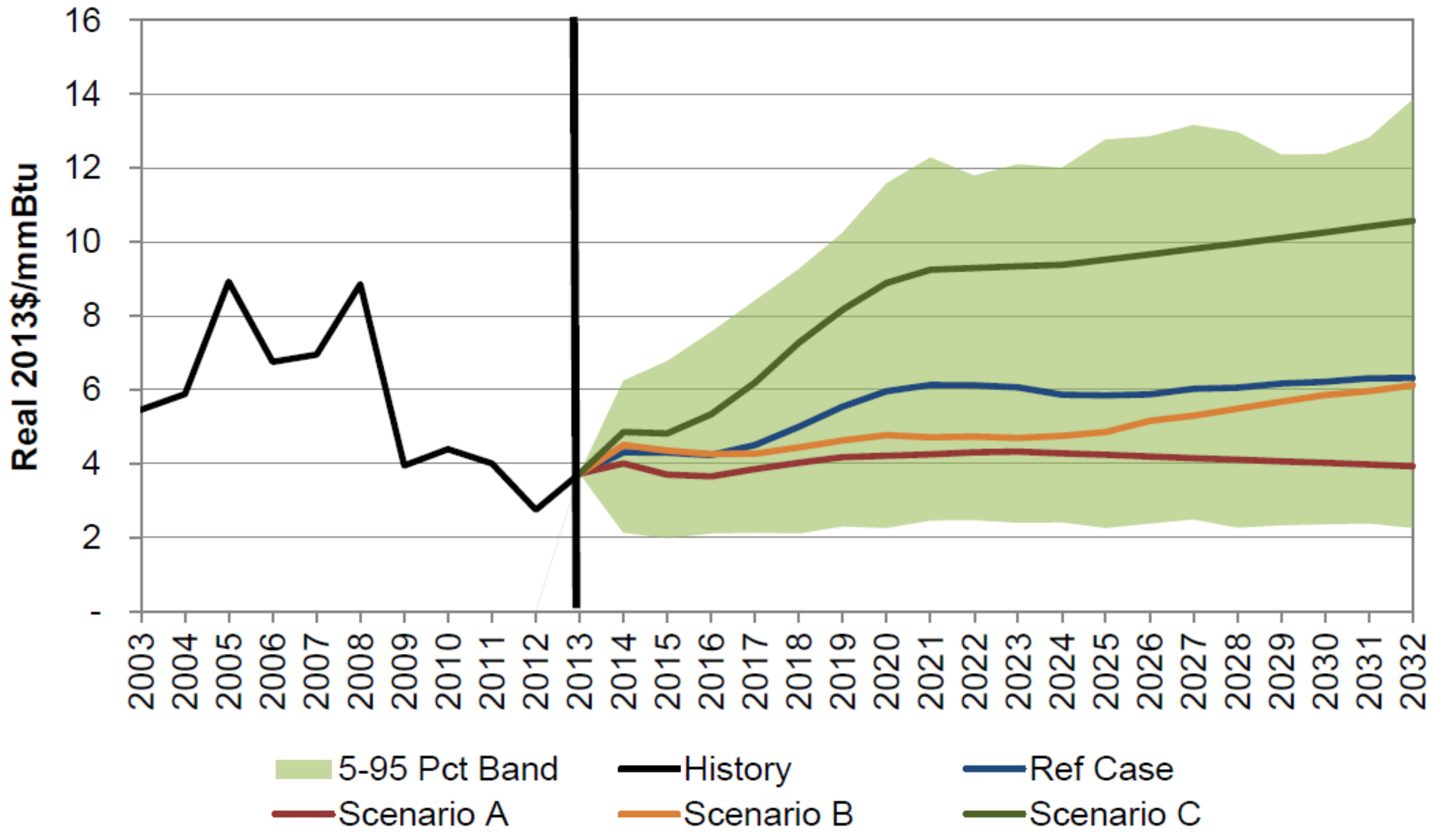
Siemens will utilize scenario based modeling to evaluate various regulatory constructs. The base case is considered the most likely future. The alternative scenarios are shown as higher than, lower than, or the same as the base case.

	CO2	Gas Reg.	Water Reg.	Economy	Load	Gas Price	Coal Price	Renewables and Storage Cost	EE Cost
Base Case	ACE		ELG	Base	Base	Base	Base	Base	Base
High Tech	Low CO2 Tax		ELG	Higher	Higher	Lower	Lower	Lower	Lower
High Reg.	High CO2 Price	Fracking Ban	ELG	Lower	Lower	Higher	Lower	Higher	Higher

*No bottom ash conversion required based on size of the unit and delay requirement for 2 years

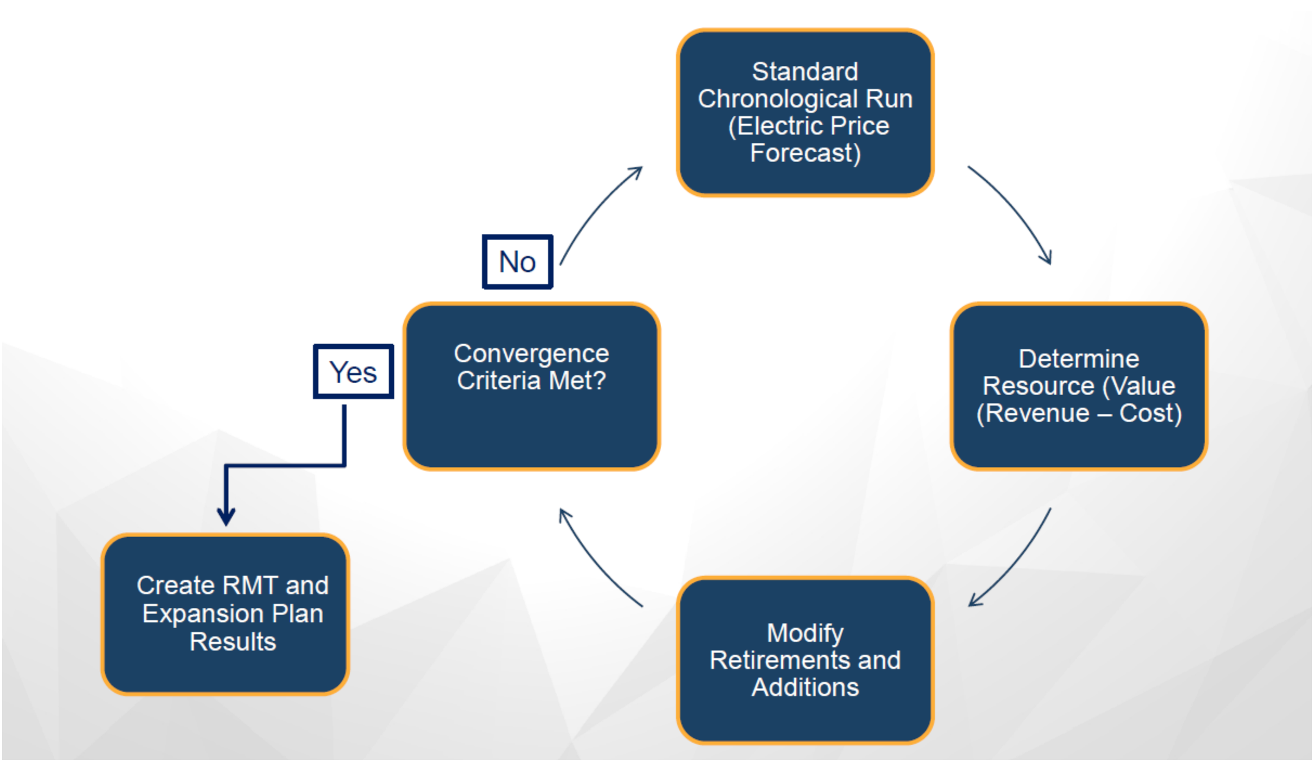
**ACE Delayed for 3 years

States of the World Can be Informed by Stochastics

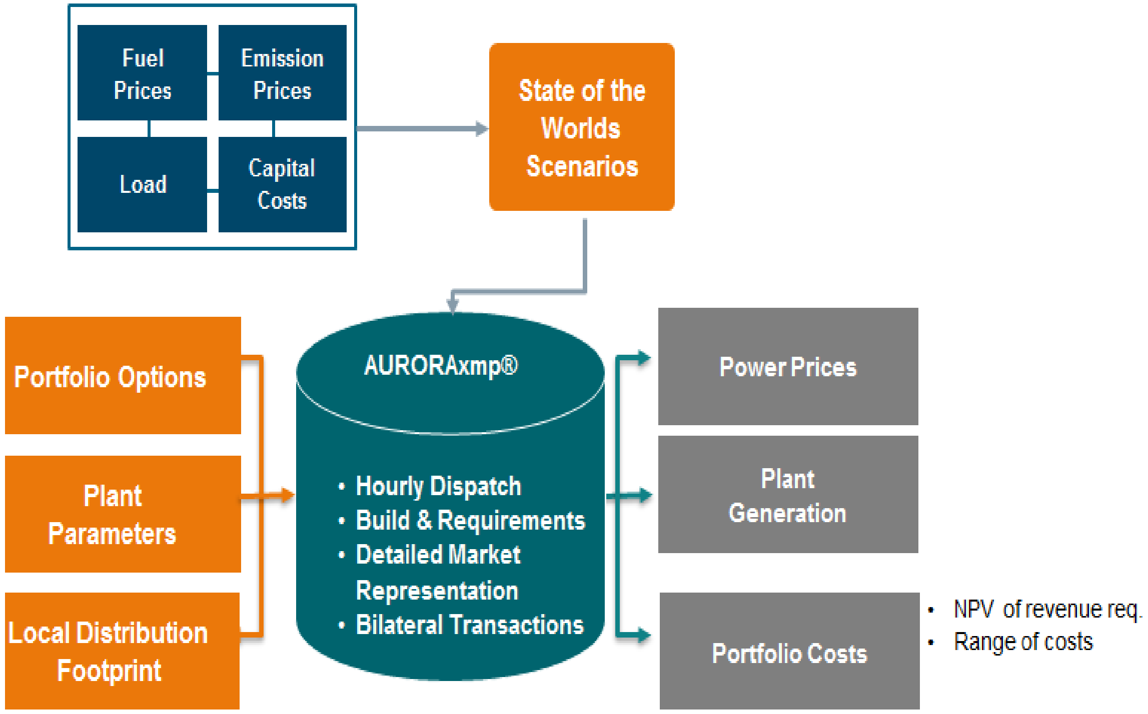


Regional Market Price Forecast, Portfolio Expansion, and Plant Dispatch is Integrated within a Single Production Cost Model

Long-Term Capacity Expansion

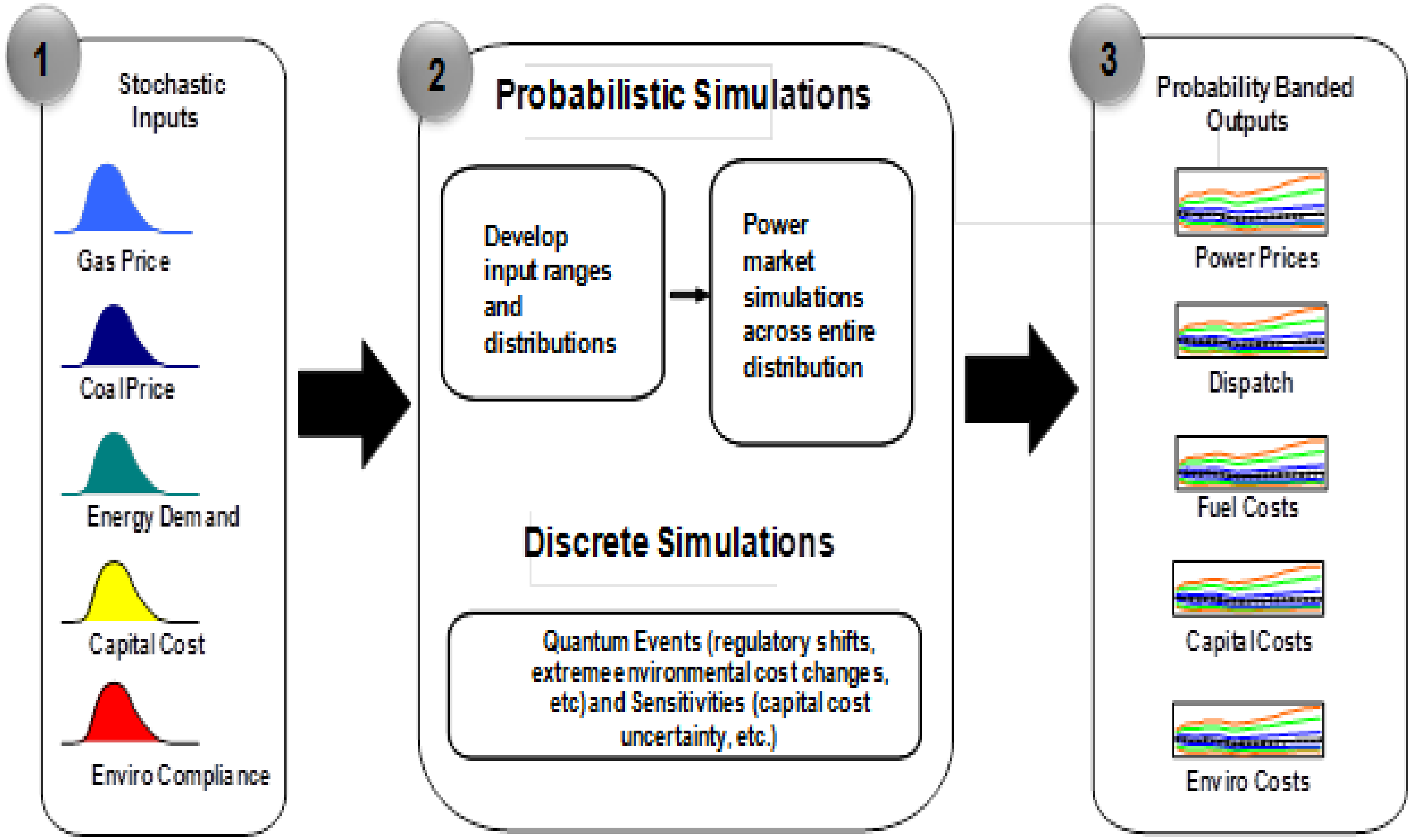


Dispatch Engine



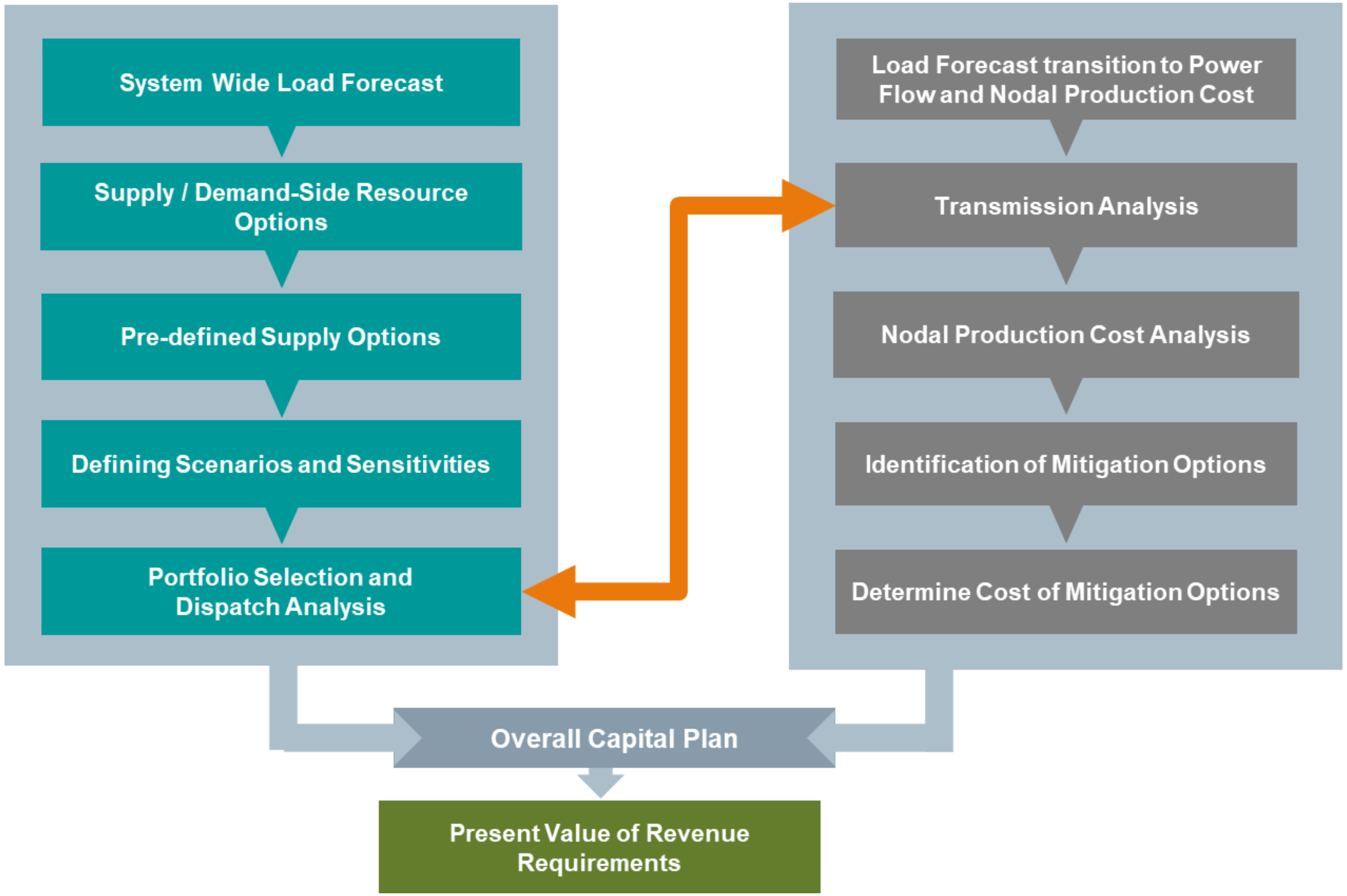
Key Issue: Accounting for Risk – Discuss and Comment

- The risk profiles of each of the Supply Options are different as each may be affected differently by future uncertain outcomes.
  - For example spot market options my result in lower “expected” costs but have much higher volatility
  - FTR have a cost but manage volatility.
  - Self build give more certainty on CapEx / OpEx once in service.
- A discussion of risks and their ranges is a fundamental input to this part of the analysis.



Transmission Assessments Methodology Overview

The Analysis of Supply Options and Transmission Analysis are closely related and Central for the IRP



- The economics of the resources are a function of intrinsic costs and the need (or not) of transmission investments manage associated reliability / congestion issues
- This will affect differently the self supply options and the market (MISO) options.
- Our procedure provides a comprehensive assessment of these impact and costs.

Transmission Analysis Methodology – Expanded Analysis

- Develop intermediate power flow cases from the LTCE results
  - These are cases that are year dependent based on when the LTCE indicates resources are added
  - Representative load and known transmission build out modeled
  - Model anticipated generation dispatch from the nodal production cost models
  - Carry out load flow contingency analysis for complete evaluation of transmission needs
  - Based on the above select the transmission investments required in service dates (new investments may be identified)
- Update the nodal production cost model based on the LTCE results covering selected years
  - Determine the expected dispatch for specific year models to utilize in the power flow model.
  - Update model to reflect transmission additions from power flow.
  - Review congestion in the nodal production cost model to determine if other transmission issues need to be resolved
  - Interaction with power flow analysis may be required if congestion issues found and changes in transmission in service dates are needed
- Update transmission costs in the overall assessment model. Confirm adequacy of LTCE.=.

Transmission Analysis Methodology – Expanded Analysis

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Gap Analysis
Key Issues

Balancing Area Gap Analysis

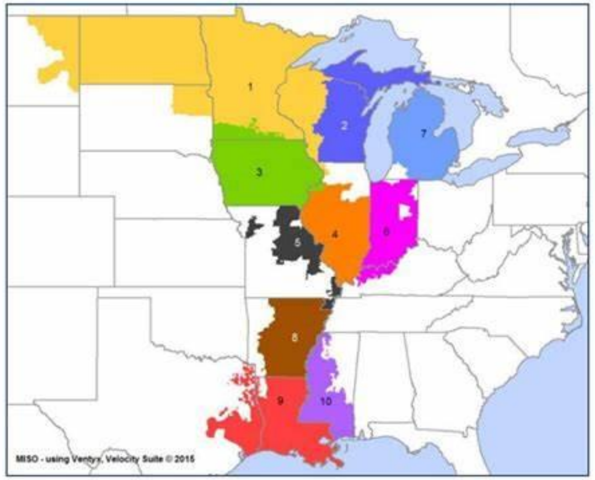
Prepare requirements document

- NERC Balancing Authority (BA)
- MISO Local Balancing Authority (LBA)
- Industry best practices

Review MLGW existing capabilities through interviews and procedure/document review

- Control center: UPS/backup power, security access, and backup of essential functions
- SCADA and control systems capabilities
- Balancing area boundary metering
- Voice and data communications; ability to meet data exchange requirements
- Ability to perform operational and outage planning, real-time control, situational awareness
- Ability to plan and provide operating reserves
- Contingency and emergency response capabilities
- Energy accounting and transaction management capabilities
- Personnel staffing and training
- Cyber security measures

Prepare report and recommendations, including high level costs estimates for planning purposes



Source: MISO

Step 8: Select Best Portfolio (Discuss and Comment)

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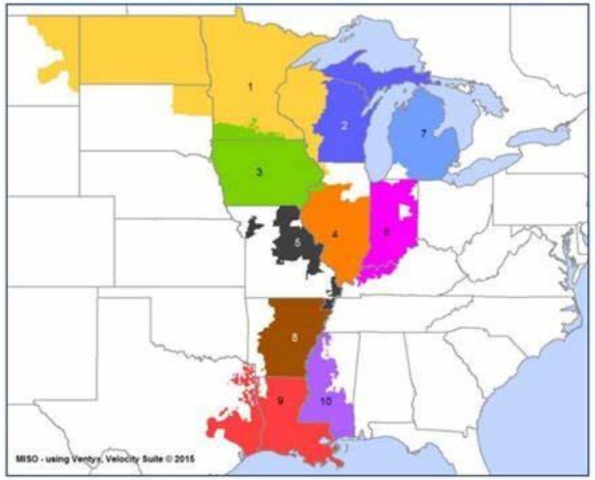
Portfolio /Criteria	Cost	Risk	Environmental	Reliability	Diversity
Portfolio 1	Yellow	Green	Green	Yellow	Green/Yellow
Portfolio 2	Green	Green	Green	Green/Yellow	Green
Portfolio 3	Yellow	Yellow	Green	Green	Green/Yellow
Portfolio 4	Green	Green	Green	Green/Yellow	Green
Portfolio 5	Red	Red	Green	Green/Yellow	Red
Portfolio 6	Red	Red	Green	Green/Yellow	Red
Portfolio 7	Red	Red	Green	Green/Yellow	Red

Index Ranking (0-10 Scale)	0.00	3.00	1.48	2.04	0.66	1.22	4.10	3.84	10.00	9.18	2.07
Assessment (Green < 3.33; Yellow 3.34-6.67; Red > 6.67)	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Green

Green: Index < 3.33
Yellow: Index 3.34 – 6.67
Red: Index > 6.67

Breakout Group Discussions

Break Out Group Questions



Source: MISO

Question 1: Refer to the Objectives and Metrics Slide (following) 30 min

What Changes would you make to the Objectives of the Study?
What Changes would you make to the metrics for each of the Objectives?
Do you believe that weights should be applied to the metrics or not?

Question 2: Refer to the strategies slide (following) 30 min

Do you propose different Strategies be considered in the study?
If so, what strategies would you recommend?
Are there any strategies that are unnecessary?

Question 3: Refer to the scenarios slide (following) 30 min
A Base case, a High Technology Case and a High Regulatory case were recommended
Do you agree that these are relevant?
Are there others that you believe are more important (what would you replace and why)?
Do you have any concerns with the directional changes in key inputs for the cases selected?

List of Objective and Metrics used in other IRPs – Discuss and Comment (Some use diversity / flexibility as well)

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Scenarios – Discuss and Comment

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Increasing Regulation

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Base Case	ACE		ELG	Base	Base	Base	Base	Base	Base
High Tech	Low CO2 Tax		ELG	Higher	Higher	Lower	Lower	Lower	Lower
High Reg.	High CO2 Price	Fracking Ban	ELG	Lower	Lower	Higher	Lower	Higher	Higher

Questions