Southeast Energy Exchange Market

Design & Study Proposal

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Cambridge Energy Solutions

- Cambridge Energy Solutions (CES-US) is a software company with a mission to develop software tools for participants in electric power markets.

- CES-US provides information and tools to assist market participants in analyzing the electricity markets on a locational basis, to forecast and value transmission congestion, and to understand the fundamental drivers of short- and long-term energy prices

- CES-US staff are experts on market structures in the US, system operations, and related information technology.
  - Assef Zobian – Founder and President
  - Asser Zobian – Vice President
  - Sean Meany – Director of Market Analysis
  - Thomas Conner – Transmission Modeling Engineer

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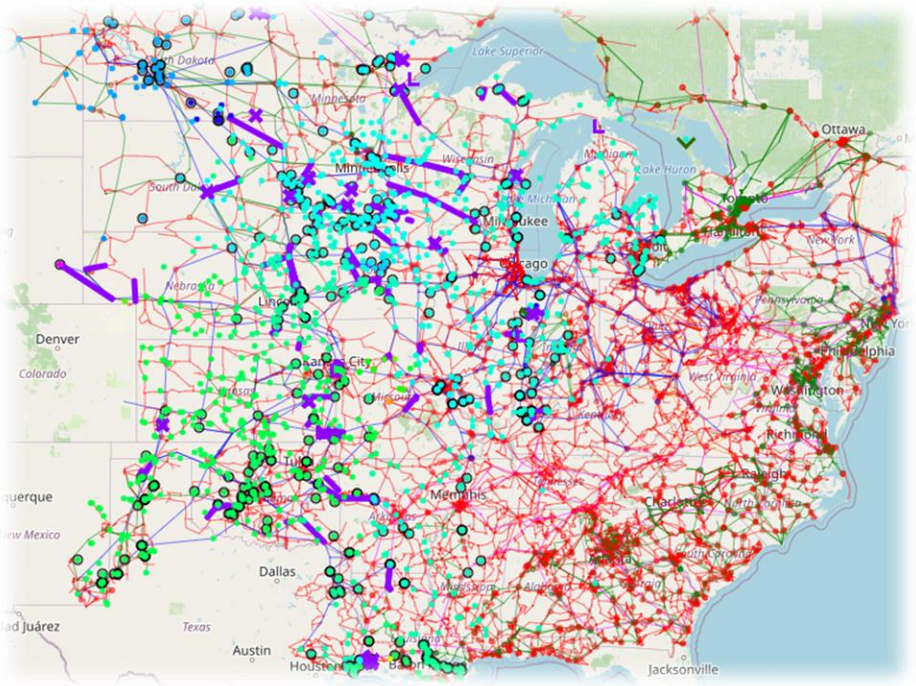
The Story

- While ~70% of US power utilities operate as a participant of an energy market with an Independent System Operator (ISO), the Southeast Region remains vertically-integrated with no centralized regional coordination.
- The vertically-integrated utilities are currently evaluating a step towards market design with the Southeast Energy Exchange Market (SEEM).
  - The exchange market would *not* include an independent, centralized authority to operate or regulate the power system.
  - The participating utilities would maintain their independence and maintain full control of their generation and transmission assets.
  - The goal of the energy exchange market is to provide clarity and transparency in bilateral power transfers while allowing for more efficient generation dispatch, increasing interface transmission capacity utilization, and providing a foundation for future features (e.g. reserve sharing).
- In this presentation
  - Discuss the differing aspects and benefits between vertically-integrated utilities and ISO markets
  - Discuss some of the proposed aspects of the SEEM
  - Describe our study goals and design to evaluate potential implementations of the SEEM

Presentation Outline

- Vertically-Integrated Utilities
  - Reliability
  - Operations & Planning Coordination
- ISO Markets
  - Transparency & Reliability
  - Transmission Utilization
  - Generation Efficiency & Development
  - Energy Imbalance Market Design
  - Day-Ahead Market Advantages
- Southeast Energy Exchange Market (SEEM)
  - Overview
  - Transmission Utilization
  - Generation Efficiency & Development
  - Questions
  - Future
- SEEM Study Proposal
  - Overview
  - FRCC Variation
  - Scenarios 1-5
- Industry Engagement



Vertically-Integrated Utilities (VIU)

VIU - Reliability

- Vertically-integrated utilities put a strong focus on high reliability.
  - The role of transmission is to provide for the highly reliable delivery of unconstrained generation resources.
  - Generation is operated and developed with ample reserve margins to prevent any energy shortfall, within reason.
- Unconstrained Generation Resources
  - Historically energy costs were driven by large, centralized generation resource and their associated fuel costs.
    - The transmission system underwent regular cycles of rebuilds and large-scale improvements with rapidly growing system load.
  - The most efficient commitment and dispatch of the price-driving base-load generation was prioritized over the lowest-cost approach to transmission development ("Gold-plating the system").
    - The transmission system is studied and planned at various system conditions with comprehensive N-G-1 and higher-order P-events to result in no transmission congestion.
- "Overbuilt" Generation Resources
  - Historically, vertically-integrated utilities endeavored to insulate customers from price-sensitivity to potentially volatile fuel prices by developing a generation portfolio with a diverse fuel mix.
  - By maintaining ample reserve margins, vertically-integrated utilities insulate customers from energy shortage risks by prioritizing reliability and flexibility over cost efficiency during peak load or generation outage.

VIU – Operations & Planning Coordination

- By owning both generation and the bulk transmission system, a vertically-integrated utility can co-optimize the planning and development of large power system assets within that utility's service area (not on a regional level).
  - Generation resources can be planned and sited with strategic transmission project identification and development.
  - Transmission and generation outage planning/coordination can be optimized to provide the most reliable and efficient asset outage schedule.
- Planning and operational challenges are simplified by coordinated modeling data and assumptions with aligned goals across generation and transmission functions within the integrated utility.
  - Complex studies with comprehensive data sets such as those required by voltage and stability-based studies and analysis can be readily performed to proactively reinforce reliability.

ISO Markets

ISO Markets – Transparency & Reliability

- Data transparency results in clarity around pricing mechanisms and the efficient development and use of the transmission system and generation assets
  - ISO markets with diverse market products for energy, capacity, ancillary services and transmission rights further lend transparency and competitive efficiency to market price formation while also supporting future system reliability
- ISO Markets maintain a high-level of data transparency through the posting of both operational and planning data
  - Pricing data and price formation design
  - Planned, forecasted, and actual outages
  - Interconnection studies, transmission planning studies, and coordinated interconnection studies
- ISOs maintain high system reliability through a centralized, coordinated operations organization with advanced modeling and analysis tools, regional coordination, and strong situational awareness

ISO Markets – Transmission Utilization

- Transmission is primarily planned and developed to ensure the reliable delivery of power from generation location to load.
  - Generation is incentivized to conform to existing transmission.
  - Transmission is developed based on either reliability or cost/benefit metric, where only economic projects that respond to the generation market developments are planned.
- Transmission open access allows for market participants to use the transmission system on a non-discriminatory basis for the most efficient allocation of capacity.
  - Advanced operations & planning tools (nodal production cost models) are utilized to ensure reliability during constrained and outage scenarios.
- Strategic, economic transmission projects targeted at increasing dispatch efficiency can be justified by observed congestion costs.
  - A lack of confidence in proactive "planning-grade" production-cost-model ability to accurately capture real-world congestion savings can sometimes cause this process to lag market reality.

ISO Markets – Generation Efficiency & Development

- Generation resources are committed and dispatched in the most efficient manner (by the ISO as offered by market participants) for the given state of the transmission system using Security-Constrained Unit Commitment (SCUC) and Economic Dispatch (SCED).
- Ancillary services, including generation reserve margins, can be procured through the market, optimized, and supported from a wide geographical area.
- In order to ensure deliverability of generation resources and ancillary services, hourly production cost models are used in both operations and planning to proactively forecast and adjust to changing system conditions.
- With an ISO processing prospective generation interconnection requests through a fair and just process, fully-competitive, efficient generation development is ensured.

ISO Markets – Energy Imbalance Market Design

- An Energy Imbalance Market (EIM) is a voluntary organization of Balancing Authorities (BAs) or resource pools that participate in a shared Security Constrained Economic Dispatch (SCED) with a centralized clearinghouse.
- An EIM differs from a full ISO market implementation in that it consists solely of a coordinated regional economic dispatch, other market structures, and rules need not apply to EIM participants.
  - This allows for an EIM to include the voluntary participation from both vertically-integrated utilities as well as ISO markets to fully utilize the transmission system to reach the most economic dispatch in real-time
- While other ISO market functions, sharing of ancillary services, or even a day-ahead EIM can also be considered for integration into an EIM, the voluntary participation combined with BA independence separates the EIM from an ISO market and allows the participants to maintain many vertically-integrated utility attributes.
  - Vertically-integrated generation and transmission ownership
  - Discrete transmission rights ownership and acquisition (OASIS)
  - Separate unit commitment
  - Independent generation and transmission planning processes
  - Limited regional coordination in either operation or planning of transmission or generation assets

ISO Markets – Day-Ahead Market Advantages

- The Day-Ahead (DA) market serves a vital role in an ISO market by supporting reliability, efficiency, competition, and risk-hedging.
- Reliability is reinforced in a DA market by providing an "early-warning" indicator for system operators of both a potential energy shortfall, as well as critical transmission impacts.
    - System operators are prepared to make critical commitment, dispatch, and outage adjustments as needed to ensure operational reliability in real-time.
- Efficiency is driven by allowing competitive, speculative participation in the DA market to drive convergence between DA assumptions and real-time performance, and allow for the development of long-term markets and additional market products.
- Both transmission congestion and energy price risk can be hedged using the DA market directly and also in ancillary financial services and products that are tied to the DA market.

Southeast Energy Exchange Market (SEEM)

SEEM – Overview

- The main goal of the SEEM is to provide an automated, streamlined system for the buying, selling, and transfer of power through the vertically-integrated utilities in the Southeast Region.
  - More responsive and reactive to system conditions than typical bilateral contracts and agreements
- These automated generation bids and energy trades will be incorporated into each participant's economic dispatch, thereby creating a pseudo-regional economic dispatch.
  - With the current system still representing voluntary bilateral energy trades with a separate transmission acquisition process reliant on operational-study-determined Available Transfer Capacity (ATC), the SEEM would produce an incrementally-more economic regional dispatch rather than an optimal one.
- While sharing the same fundamental concept as an EIM, this design differs from the lack of a centralized entity or clearinghouse in administration of the energy bids and trades.
  - Effectively a centralized system of automatically integrated voluntary bilateral energy trades to increase efficiency and flexibility between generation resources in the region

SEEM – Generation Efficiency & Development

- By streamlining and integrating energy and transfer costs directly into operational commitment and dispatch decisions, ATC can be more fully utilized if economic.
    - The SEEM goal is to bring more clarity and automation into the discovery of these economic opportunities.
- Additional clarity and communication around the interface limitations between regions with the goal of maximizing transfer capability
- Additional communication and coordination around outages that would impact the ATC in order to preserve regional dispatch flexibility
- Potential for identification of regional transfer capability transmission improvements in order to further increase regional dispatch efficiency

SEEM – Transmission Utilization

- Regional generation dispatch efficiency can be incrementally improved when certain conditions are met and system conditions dictate opportunity.
  - Dispatch efficiency will be positively impacted primarily in instances where available ATC can be leveraged to address changing system conditions with a bilateral energy transfer rather than a more expensive internal dispatch.
  - The SEEM's ability to proactively determine ATC and transmission costs will be crucial in supporting the goal of increased regional efficiency and flexibility.
  - As the SEEM's operation results in a more efficient regional economic dispatch pattern, it can over-time support more efficient unit commitment decisions as operators take advantage of additional buying and selling opportunities that are still compatible with robust contingency planning.
- Any transparency or clarity into the energy price formation of the Southeast Region driven by the SEEM could be the first step in supporting competitive generation development.
  - The SEEM's voluntary, bilateral nature between existing large utilities does not naturally lend itself to the additional clarity and accessibility needed for competitive generation development.

SEEM – Questions

- As stated by its prospective participants, the SEEM is still in the exploratory stages with several design and implementation details under discussion.
  - Will there be any centralized "external" entity?
    - Who will handle system administration, management, maintenance, improvements, etc?
    - How will disputes or contingent-recall situations be managed and resolved?
  - How will the transmission-rights acquisition process be streamlined and improved?
    - How can the SEEM's 15-minute interval process be supported without significant improvements in the transmission-rights acquisition process?
    - Will OASIS requests still be the primary portal and process for procuring transmission?
    - Will operational ATC studies become more streamlined/automated to support transmission-rights acquisition for the SEEM?
    - How can any transmission-rights acquisition improvement be equitability applied to any participant in the Southeast Region (e.g., IPPs)?
  - Will there be additional data and price-formation clarity driven by the SEEM?
    - Will the results of the SEEM's integration of area energy and transmissions costs by posted publicly?
    - Will various entity forecast data be posted to support the SEEM: load forecasts, renewable generation forecast, outage forecasts, etc.?

SEEM – Future

- Initial implementation targeted at minimizing start-up costs with no large, centralized entity or complex software/hardware overhaul
  - Potential for gradual implementation of centralized processes and procedures as comfort in the SEEM arrangement grows along with additional features and complexity
- Potential for increased focus on regional planning coordination in both transmission development and outage planning to maximize the efficiencies gained through the SEEM
- Potential for regional reserve sharing and other ancillary service sharing in the SEEM
- Potential for incremental integration of transmission aspects into the SEEM
  - Automated transmission-rights acquisition
  - Sub-regional pricing based on transmission seams
  - Basic implementation of transmission congestion pricing on interfaces and seams

SEEM Study Proposal

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SEEM Study – Overview

- We will **fully model the entire Southeast Region**, both zonally and nodally, in order to evaluate the changing energy, transmission, and overall system production costs with each scenario.
- Our study will analyze and compare 5 primary scenarios with varied levels of regional integration.
  1. **Current (Independent BAs) –** Current configuration of the Southeast Region
  2. **SEEM Dispatch ("Non-centralized" EIM Fixed-Costs) –** Proposed SEEM regional structure with regional dispatch flexibility but fixed transaction (transmission) costs
  3. **Basic EIM –** Proposed SEEM regional structure with regional economic dispatch with no transaction costs
  4. **Limited ISO –** Proposed SEEM regional structure with regional economic dispatch, no transaction costs, and regional economic unit commitment
  5. **ISO Market –** Full SEEM regional flexibility limited only by real transmission capacity (not conservative planning-based ATC)
- For scenarios 2-5 we will run two primary variations
  - **Base** – Existing defined SEEM participants
  - **FRCC** – Existing defined SEEM participants with the addition of FRCC
- Additional sensitivities will be studied under the above scenarios when appropriate
  - Reserve sharing and joint ancillary services
  - Interregional system upgrades to increase ATC
  - Increased outage coordination
  - Increased regional renewable penetration
  - MISO N↔S transfer impacts

SEEM Study – Overview Matrix

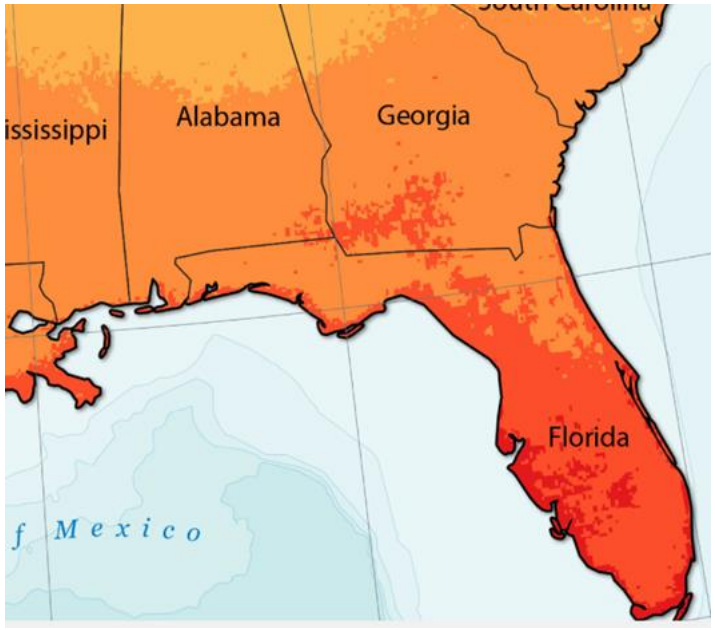
Scenarios	Regional Dispatch	No Transaction Costs	Regional Commitment	No ATC Limitation
#1 - VIU				
#2 - SEEM	✓			
#3 - EIM	✓	✓		
#4 - Lim. ISO	✓	✓	✓	
#5 - ISO	✓	✓	✓	✓

Sensitivities	Reserve Sharing	System Upgrades	Outage Coordination	Increase Renewables	MISO Impacts
#1 - VIU				✓	✓
#2 - SEEM	✓	✓	✓	✓	✓
#3 - EIM	✓	✓	✓	✓	✓
#4 - Lim. ISO	✓	✓	✓	✓	✓
#5 - ISO	BASE	BASE	BASE	✓	BASE

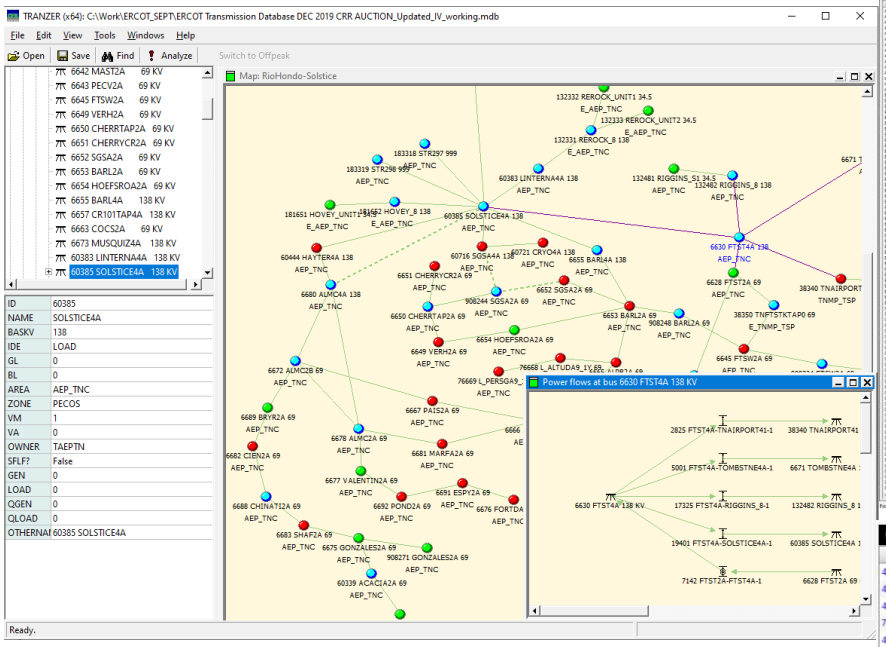
SEEM Study – FRCC Variation

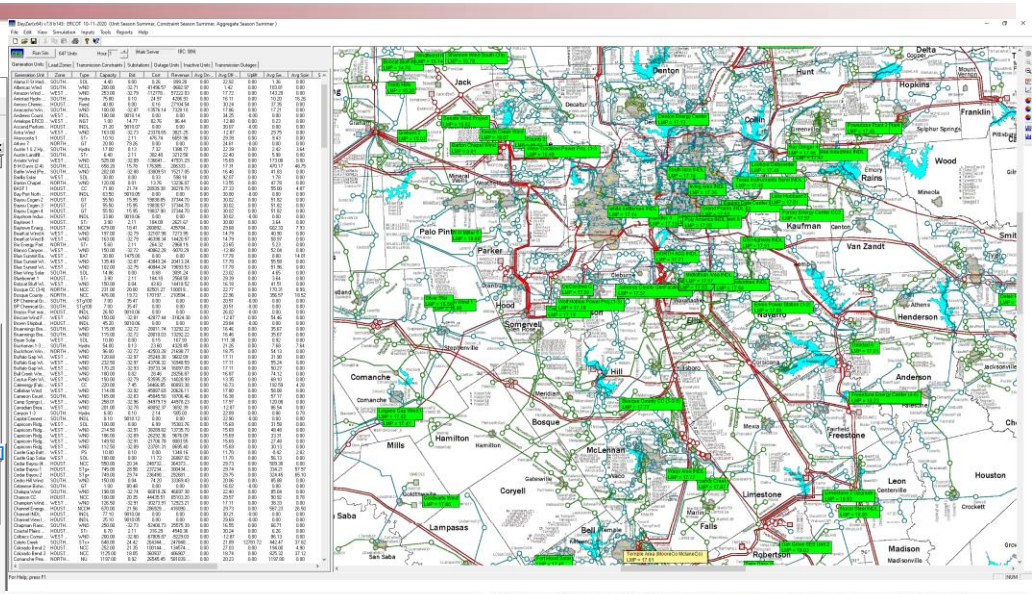
- With the potential merger of FPL and Duke Energy, we will study scenarios 2-5 with both the existing SEEM participants and also the SEEM participants with FRCC explicitly modeled.
- While historically Florida is a net importer and effectively radial from the Southern Company system, the potential for significant expansion of solar penetration as an economic resource could have a dramatic impact on this region in the future.
    - The “increased renewable generation” sensitivity will be biased towards this region for this variation.

Southeast Solar Irradiance *(NREL)*



SEEM Study Tools – DAYZER, TRANZER, & DZNode



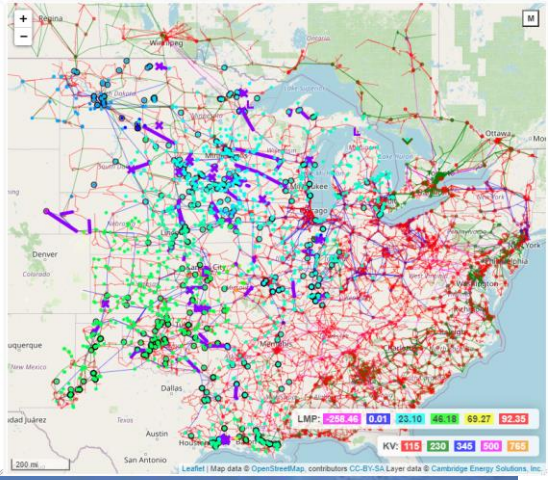


Units | Aggregates | Unit Outages | Impacts

Id	Node Name	Type	LMP	MW	DA LMP	RT LMP
4083	A B Brown 1	STc+	26.70	228.00		
4084	A B Brown 2	STc+	26.70	226.10		
4103	AES Shady Point 1	STc100	41.44	125.04		
7866	Aberdeen NGT	NGT	37.25	27.62		
4457	Acadia Energy Center I	NCC	35.96	528.61		
4161	Anadarko 4	CC	37.83	73.46		
4162	Anadarko 5	CC	37.82	73.46		
4163	Anadarko 6	CC	37.81	73.46		
7708	Anadarko GT 9 10 11	GT+	37.93	89.91		
4171	Antelope Valley 1	STc+1	16.23	158.25		
4172	Antelope Valley 2	STc+	16.23	211.00		

Constraints | Transmission Outages

Id	Constraint Name	Type	Price	Flow	DA SP	RT SP
28423	RAUNTEKAM16_1 1:...	Continge...		154.38		
250892	VERM_NCMP_1396 ...	Continge...		124.01		
282427	ACEC_SARAT13_1 5:...	Continge...		64.51		
282572	FORMAN TR12 TR12...	Continge...	215.03	-131.98		
256368	NEWTOCOLFA69_1 ...	Continge...	-100.00	44.77		
28665	ROCHSWABAC16_1 ...	Continge...		168.89		
256274	6966 GT:NIP13103	Continge...	-27.62	134.00	-13.62	
265748	BNE_JFT_DO16_1 1:...	Continge...		171.80		
269696	FOX_LRUTLA16_1 1:...	Continge...		27.67		
269700	ACEC_PETEN13_1 4...	Continge...		55.88		
269748	ACEC_PETEN13_1 4...	Continge...		77.48		



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SEEM Study – Scenario #1 Current

- Model entire Southeast Region in our DAYZER nodal production cost modeling tool
  - Transmission sourced from MISO models
  - Generation sourced from EIA and other publicly-available sources
  - Interface and firm transmission contracts sourced from OASIS and other publicly-available sources
- Run each company as their own region with separate economic dispatch and economic unit commitment
- Schedule interface based on long-term firm contracts with no additional optimization
- Potential sensitivities
  - MISO N↔S transfer impacts
  - Increased regional renewable penetration

SEEM Study – Scenario #2 SEEM Dispatch

- Expand on the "current" DAYZER model for the Southeast Region
  - Implement the proposed structure of the SEEM with limited regional dispatch only
- Run economic dispatch for all the SEEM participants as a single pool
  - Potential cross-BA economic dispatch impacted by fixed transaction (transmission, scheduling and uncertainty) costs
  - Individual company economic commitment
- Long-term interface contracts modeled, remaining ATC fully utilized by economic dispatch when not limited by fixed transaction costs
- Potential sensitivities
  - MISO N↔S transfer impacts
  - Increased regional renewable penetration
  - Interregional system upgrades to increase ATC
  - Increased outage coordination

SEEM Study – Scenario #3 Basic EIM

- Expand on the "current" DAYZER model for the Southeast Region
  - Implement the proposed structure of the SEEM with regional dispatch
- Run economic dispatch for all the SEEM participants as a single pool
  - Individual company economic commitment
- Long-term interface contracts modeled, remaining ATC fully utilized by economic dispatch
  - ATC utilization is not limited by any additional transactional or other transmission-related costs.
- Potential sensitivities
  - MISO N↔S transfer impacts
  - Increased regional renewable penetration
  - Interregional system upgrades to increase ATC
  - Increased outage coordination

SEEM Study – Scenario #4 Limited ISO

- Expand on the DAYZER "dispatch" model for the Southeast Region
  - Implement the proposed structure of the SEEM with regional commitment
- Run both economic dispatch and economic commitment for all the SEEM participants as a single pool (SCUC and SCED)
- Long-term interface contracts modeled, remaining ATC fully utilized by economic dispatch
- Potential sensitivities
  - MISO N↔S transfer impacts
  - Increased regional renewable penetration
  - Interregional system upgrades to increase ATC
  - Increased outage coordination
  - Reserve sharing and joint ancillary services

SEEM Study – Scenario #5 ISO Market

- Expand on the DAYZER "commitment" model for the Southeast Region
  - Implement a fully-flexible regional nodal transmission market
- Run both economic dispatch and economic commitment (SCED and SCUC) for all the SEEM participants as a single market
- No modeled interface limitations, system transfers only limited to existing transmission constraints (e.g., thermal, voltage, and stability constraints)
- Potential sensitivities
  - MISO N↔S transfer impacts
  - Increased regional renewable penetration
  - Interregional system upgrades to increase ATC
  - Increased outage coordination
  - Reserve sharing and joint ancillary services

Industry Engagement

Industry Engagement

Our goal with this study is to engage the industry in the discussion and analysis surrounding the details, potential, and challenges of the SEEM. We welcome input, feedback, and engagement from our friends in the industry.

- SEEM Market Participants
  - Prospective SEEM participants could be engaged to help with defining both study and modeling assumptions and tuning
  - Opportunity for training on regional production cost modeling studies with sensitivity analysis
  - Discuss implementation challenges and hurdles
- State Public Service Commissions (PSCs)
  - Identify/quantify the benefits (to both consumers and producers) associated with each proposal and the value of each policy alternative
  - Opportunity for modeling assumption tuning and specific sensitivity additions
  - Summarize study results and cost impacts at a sub-regional or state level
- Regulatory (FERC, NERC, SERC, etc.)
  - Discuss SEEM implementation details and impacts compared to a full ISO market implementation
  - Discuss potential future incremental steps to further integrate transmission and other market features in SEEM
- EPRI
  - Opportunity for future-looking impacts of increased renewable integration, microgrids, and other advanced power technologies in the traditionally vertically-integrated Southeast Region