2015 Integrated Resource Plan

Energy Efficiency Seminar

February 10, 2015

Energy Efficiency Seminar Agenda

Time	Topic	Speaker
10:00 – 10:15	Welcome and Introductions	Matt Murray / Joe Hoagland
10:15 – 10:30	Overview of TVA's IRP Process	TVA (Gary Brinkworth)
10:30 – 11:00	Industry Approach to Energy Efficiency Evaluation in Planning Studies	Navigant (Dan Bradley)
11:00 – 11:45	Energy Efficiency Block Design	TVA (Ed Colston)
11:45 – 12:15	**Working Lunch**	
12:15 – 1:00	IRP Model Execution and Selected Initial Results	TVA (Tom Rice)
1:00 – 1:15	Regional View of Energy Efficiency	SEEA (Mandy Mahoney)
1:15 – 1:45	Energy Efficiency Benchmarking	ScottMadden (Peden Young)
1:45 – 2:00	Views on Energy Efficiency Modeling Approach	SACE (John Wilson)
2:00 – 2:15	Assessment of the TVA Methodology	Navigant (Mark Klan)
2:15 – 2:30	**Break**	
2:30 – 3:30	Seminar Audience Q&A	ScottMadden (moderator)
3:30 – 4:00	Concluding Remarks and Close	TVA (Joe Hoagland)

Key Goals and Takeaways

- Understand how TVA models energy efficiency as a resource within the TVA integrated resource planning approach
- Understand energy efficiency design parameters and impacts on resource planning results
- Convey different energy efficiency modeling approaches and results across the industry
- Share and vet additional energy efficiency resource modeling perspectives and concerns

Input from today's seminar will be shared with the IRP Working Group

Will the coffee still be there in the future?

- Will the coffee still be there in the future?
- With that same flavor/quality?
- In that same amount?

Overview of TVA's IRP Process

Gary Brinkworth

Tennessee Valley Authority

The Resource Planning Process

Resource Planning is a common tool in the utility industry to identify the least cost solution to meet customer demand over a long horizon (usually 20 years or longer).

- **Develop Load Forecast** — Project customer demand for electricity in the future
- **Define Existing Resources** — Define the resources currently available to meet customer demand and how that will change in the future
- **Establish Need for Resources** — Compare future customer demand with existing resources
- **Identify Resource Options** — Identify all resources (supply- and demand-side) that will be considered to meet future need
- **Analyze Portfolios** — Test different resource combinations (portfolios) to evaluate performance
- **Select Preferred Portfolio** — Select the preferred combination of resources

Why This Is Important to Customers

- Planners are essentially developing a road map for TVA. This road map will guide decision makers and support TVA's overall mission:
  - Low cost reliable power
  - Environmental stewardship
  - Economic development

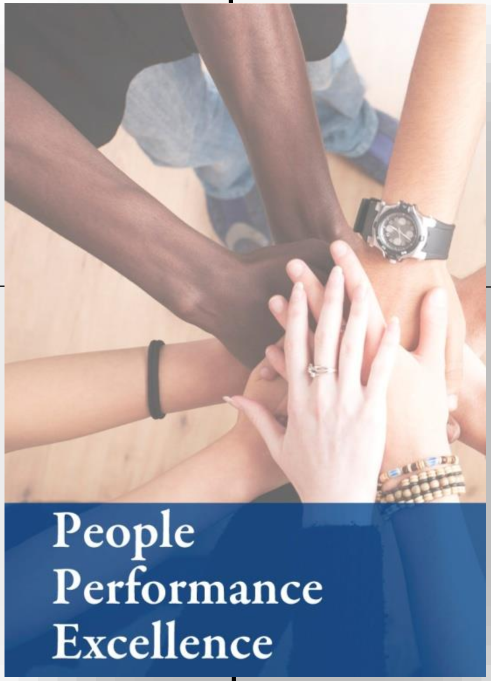
- This road map outlines changes that, if implemented, will impact the cost to produce the power and the net environmental effects of producing that power

- So it's important for customers to be aware of the direction we are headed and the current thinking about how we plan to get there

The IRP Must Be Consistent with TVA's Mission

RATES:
maintain low rates

ASSET PORTFOLIO:
meet reliability expectations & provide a balanced portfolio



STEWARDSHIP:
be responsible stewards

DEBT:
live within our means

"Scenarios and Strategies" Establish the Planning Framework

Scenarios	Planning Strategies

Scenarios

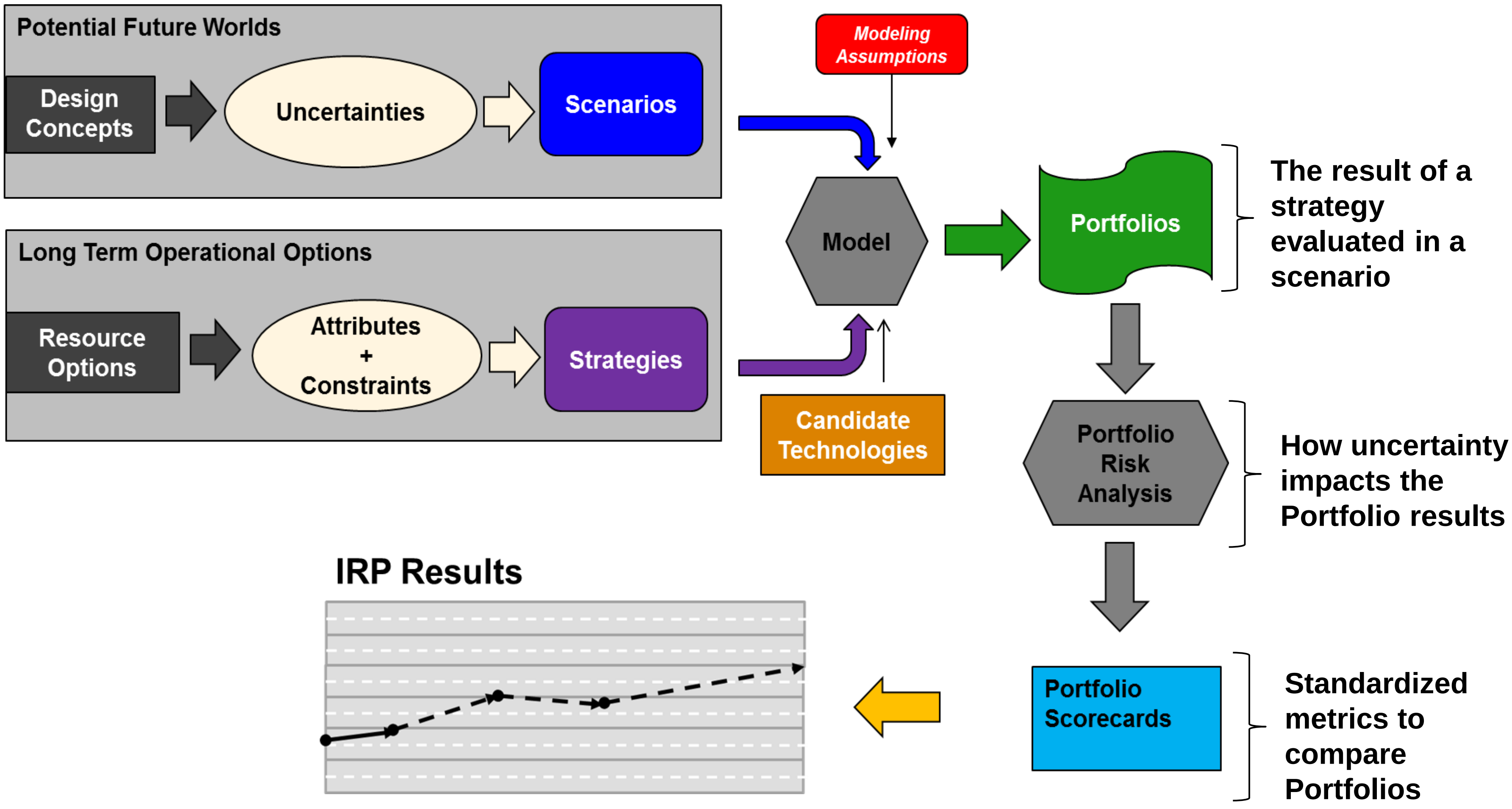
- Describe potential outcomes of factors (uncertainties) outside of TVA's control
- Represent possible conditions and are not predictions of the future
- Include uncertainties that are volatile and could significantly impact operations such as:
  - Commodity prices
  - Environmental regulations

Planning Strategies

- Test various business options within TVA's control
- Defined by a combination of resource assumptions such as:
  - EEDR portfolio
  - Nuclear expansion
  - Energy storage
- Consider multiple viewpoints
  - Public scoping period comments
  - Assumptions that would have the greatest impact on TVA long-term

A well-designed strategy will perform well in many possible scenarios

How the Resource Planning Process Works



Goals For An Optimal Resource Plan

Low Cost

- Minimizing cost critical to economic efficiency, and mandated by the TVA Act
- Does not imply purely least-cost due to risk considerations
- Lowest cost option should be chosen between competing plans of roughly equal risk; the lowest cost wins

Risk Informed

- TVA must manage many risks on behalf of customers, including construction costs, fuel costs, and availability
- Risks should be clearly understood and consciously accepted or mitigated

Environmentally Responsible

- TVA must have a clear understanding of the environmental impacts of its decisions and seek alternatives that best support our Vision and Mission
- Option with better environmental impact should be chosen in situations where economics are inconclusive and risks are generally balanced.

Reliable

- TVA has built a reputation of reliability
- Certain assets are inherently more reliable than others. Others, like wind and solar, are more intermittent requiring backup generation
- Other types of assets, particularly some of TVA's oldest coal assets, are less reliable than others

Diverse

- TVA should strive to insulate customers from extreme market fluctuations
- Diversity can be measured by the degree to which a portfolio is robust in a wide variety of futures
- TVA's IRP captures the value of diversity by scoring how well various portfolios perform under subjected shocks
- The most diverse portfolios succeed in a large number of worlds, even if it is not clearly superior in any single world

Flexible

- A sound generation plan will allow decision-makers the flexibility to learn more about future environments before making decisions that would be costly to reverse
- For example, installing scrubbers on marginal coal assets may have positive returns under current conditions, but what happens if new EPA regulation results in significant compliance costs?

IRP Process Flowchart at TVA

An IRP is a special form of resource planning that seeks to optimize supply-side and demand-side contributions to make up a least cost plan. TVA's process for conducting an IRP differs slightly from what's typical in the industry.

Traditional Resource Planning Tasks

Unique to TVA – related to NEPA[1] compliance

Inputs & Framework

- Scenarios and strategies
- Assumptions and constraints
- Candidate resources
- Metrics and scorecard
- Public meetings

Analyze & Evaluate

- Model runs
- Transmission evaluations
- Review with stakeholders

Present Findings

- Prep and issue draft report
- Issue draft env. report
- Public meetings

Re-evaluate

- Refresh analytics
- Prep updated reports

Recommend

- Stakeholder briefings
- Board action
- Issue final report and final env. report

1 – National Environmental Policy Act

Today's discussion will focus on how TVA models energy efficiency as a resource in its integrated resource plan

Part 1:

Block Design

Development of fundamental design parameters for the EE blocks.

Part 2:

Block Selection

Identify the quantity and schedule of EE blocks using the resource optimization model.

Iteration required

- Block costs
- Ramp-rate

- Uncertainty
- Risk

Industry Approach to Energy Efficiency Evaluation in Planning Studies

Dan Bradley

Navigant Consulting

Utilities take many different approaches to Integrated Resource Plans ("IRPs") – including approaches to Energy Efficiency ("EE") evaluation

» IRPs are *long-term* plans to meet forecasted annual peak and energy levels - plus a reserve margin balancing its objectives and mandates and by minimizing system cost

» In IRP analyses forecast energy and peak are met through existing and planned resources which include:
- Supply side resources
- Demand side resources → includes EE
- Transmission

» For this workshop, Navigant reviewed previous analyses[1] and utility and agency IRPs across the country with different electricity market structures

[1] Particularly helpful was the Regulatory Assistant Project's January 2013 report titled *The Treatment of Energy Efficiency in Integrated Resource Plans* by Dave Lamont and John Gerhand, available at www.raponline.org/document/download/id/6368

EE Can Be Set External or Internal to Utility IRP

» EE programs are mandated by regulators or policy or can be driven by the utility

Utility	Regulator	Policy
Depends on what utility willing to spend on EE	Sometimes in IRP docket, sometimes in unique docket	i.e., Energy Efficiency Resource Standard (EERS)

» The EE level is usually informed by potential studies and stakeholder input

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Overview of Approaches to EE in Planning

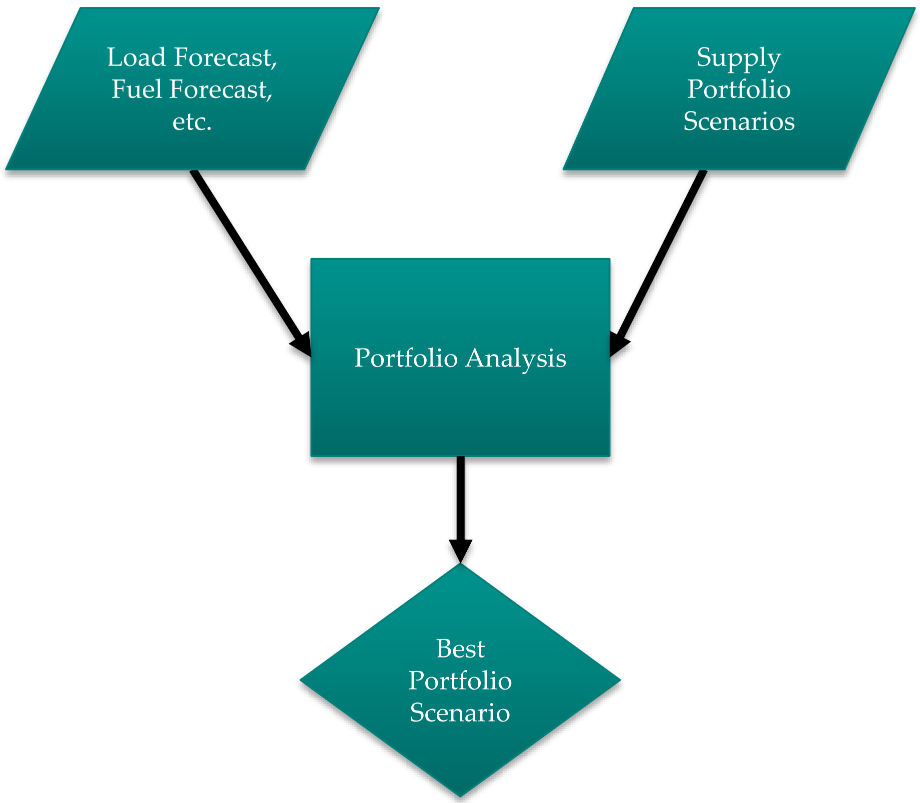
- Approaches to including EE in IRPs range along a spectrum from including an assumed "externally-derived" EE in the load forecast to treating EE as a supply resource

- Also instances where states or utilities utilize a hybrid of these approaches
- Even where EE is set by an external source, some level of back-and-forth between utilities and that external source, so that EE targets are not typically developed completely independent from resource planning

Historically EE is Input to IRP; This is Beginning to Change

- Historically energy EE dealt with in load forecast – particularly where EE is ‘externally derived”- and included only to meet statutory goals
- Importance of EE as a cost-effective way to meet load has been increasing, and is expected to continue to do so as states implement EE policies and the EPA’s 111(d) carbon regulation (i.e. the Clean Power Plan) goes into effect
- Shift at some utilities to include EE as a supply-resource

Illustrative IRP Process



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Overview of 3 Approaches to Treatment of EE in IRP

- **Demand Side:**
  - **Load Modifier**: EE deducted from load forecast which is then used in IRP
- **Supply Side**:
  - **Supply Curve:** EE is included as a supply option and represented as a ***fixed, continuous supply curve*** developed from an EE potential study for the utility's specific territory. The modeling of a supply curve limits the ability of the model to optimize
  - **Resource Blocks**: EE is included as a supply option and represented as one or more "blocks" defined by performance characteristics and cost which are dynamically selected year by year

Navigant reviewed IRPs of select organizations for this workshop to present a variety of approaches toward EE in IRPs

- Navigant reviewed 8 organizations and selected 4 case studies for this workshop:
  - Georgia Power – utility determines EE level externally
  - Xcel Energy – Commission determines EE level
  - Northwest Power and Conservation Council – treats EE as a supply resource
  - PacifiCorp – treats EE as a supply resource
- Additional examples are shown in the appendix
- Despite the different approaches in these case studies, each represents a very robust and sophisticated methodology

Commission Determines EE level Externally and Treats as Reduction to its Load Forecast

- The Colorado Public Service Commission (PSC) defines EE as either a supply-side resources or demand-side resource
- Colorado's EERS requires that the PSC set energy and peak demand targets for investor-owned utilities, including Xcel
  - Set under a separate docket from the resource plan (called an Electric Resource Plan or ERP in Colorado)
  - Utilities and other stakeholders have the opportunity for input through the docket
  - Xcel's initial targets, set in 2007, were higher than the legislative minimum
    - Reduction in energy sales of half of projected growth, or 1.15% of sales, by 2018
  - In 2011 the PSC raised Xcel's targets to 130% of the 2007 targets
- EE targets are used to adjust the load forecast used in the ERP downward

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Utility Determines EE level External to IRP and Treats as Reduction to its Load Forecast

- Georgia Power developed EE assumptions externally from resource modeling, then uses those to reduce its load forecast
- Georgia Power develops its DSM portfolio forecast using the Nine Step process laid out by the Georgia Public Service Commission (PSC) in 2010
- Includes stakeholder involvement and works with
  - Demand Side Management Working Group (DSMWG) throughout
  - Third party consultant on the first two steps
- DSMWG includes stakeholders from the PSC, Georgia Power, and other relevant companies and non-profit organizations

Nine Step Process

1. Update Technology Catalog with consultant
2. Technical and economic potential study with consultant
3. Update DSM Measures that pass total resource cost (TRC) test (using Technology Catalog and potential study)
4. Bundle measures into programs
5. Company shares data/feedback with DSMWG as reasonable
6. Company performs economic screening of programs it selects, provides justification to DSMWG for those not selected
7. Finalize programs included and adjust load forecast accordingly
8. Sensitivity analysis to include at least one aggressive DSM change case, developed with assistance of DSMWG
9. Use cost difference between base case and DSM change case to determine avoided generation cost impact of DSM

Council Determines EE level Externally and Treats as Supply Side Resource

- Converts potential study data[1] into supply curves[2]
- Time-effect used to produce hourly (8760) load shape
- Costs/benefits time-weighted to determine value
  - Includes all costs/benefits regardless of who incurs/ accrues
- Modeled value includes savings on the wholesale power market and the value of deferring the need to add transmission and distribution (T&D) system capacity
  - Value of offsetting generation
    - Future power prices uncertain, so price forecast adjusted to incorporate the value that conservation provides as a hedge against future market price volatility
  - Value of offsetting T&D expansion
    - Value of avoiding transmission costs included in wholesale market prices
    - Used avoided distribution system cost that is representative of total area covered
- *Council was authorized through the Northwest Power Act to develop and maintain a regional power plan for Idaho, Montana, Oregon and Washington – utilities in these states not mandated to implement this plan*

Costs/Benefits included in EE Value

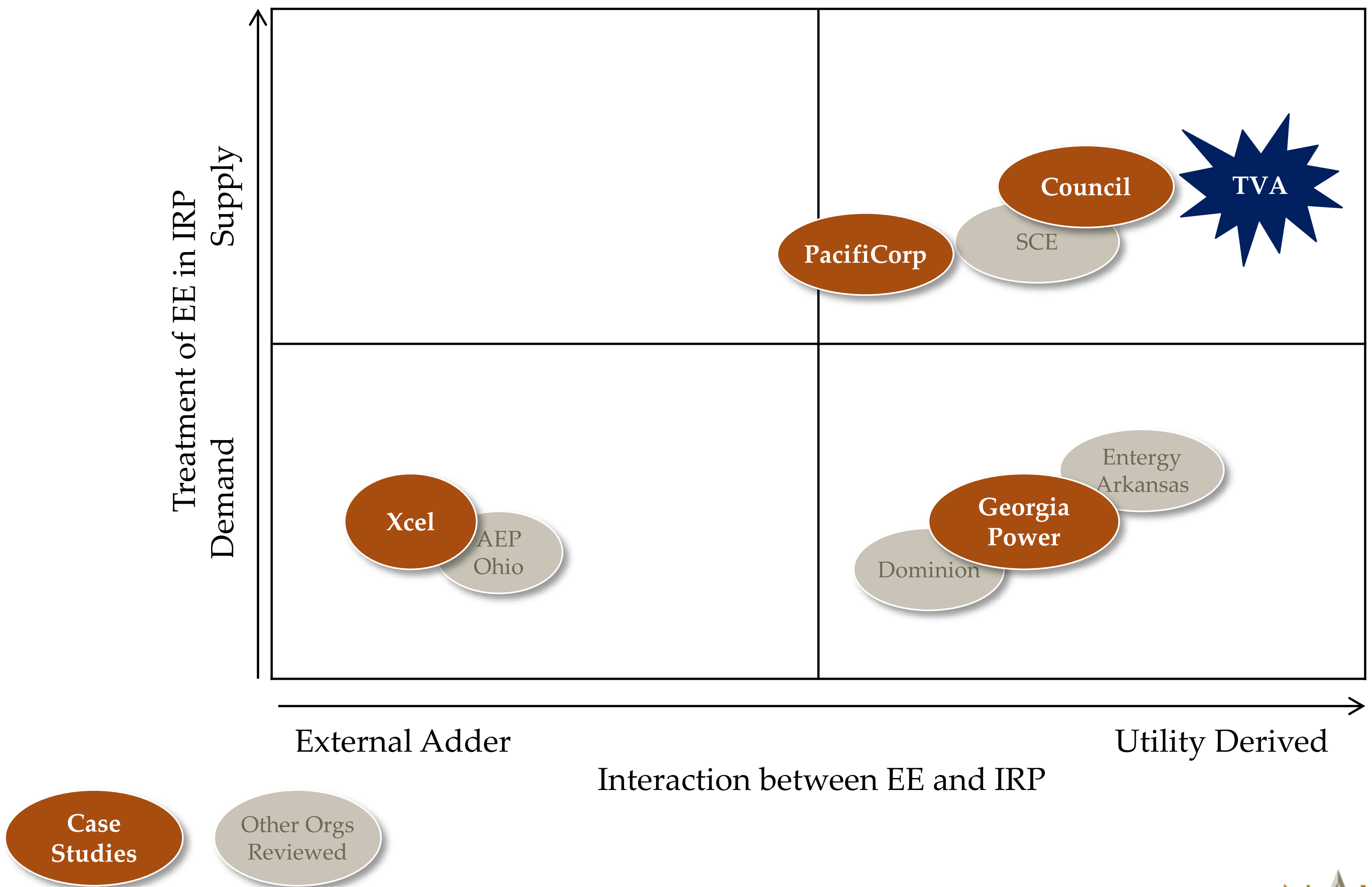
- Energy system costs and benefits
- Non-energy costs and benefits
- Other fuel costs
- O&M costs and benefits
- Periodic-replacement costs
- Risk-mitigation benefits

[1] Data for over 1,400 measures
[2] Northwest Power Act directs council to give conservation a 10% cost advantage over generation sources, which council does by adjusting supply curves downward by 10%

Council Determines EE level Externally and Utility Treats as Supply Side Resource

- Uses the NPCC plan to develop EE supply curves to include in its own resource planning modeling
  - Adjusted value provided by offsetting generation, T&D expansion deferral, and stochastic risk reduction for locational-specific values
  - Consolidated supply curves further into nine groups based on levelized cost
  - Historical EE acquisition rates are backed out of the load forecast prior to modeling

Comparative Illustration of Approaches Taken to EE in IRP



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Takeaways

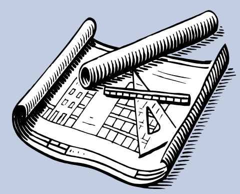
- Utilities incorporate EE into their resource planning in a variety of ways, and the approach does not appear to depend strictly on state EE policies, geographic location, or whether or not a state has a regulated or deregulated energy market
- Current trends show utilities moving away from forcing externally-derived EE into load forecasting and toward modeling EE resources comparable to supply-side resources – some optimize around resource blocks
- This seminar should serve to increase understanding of TVA's IRP approach in the context of industry trends

Energy Efficiency Block Design

Ed Colston

Tennessee Valley Authority

The EE Modeling Concept



Part 1:

Block Design

Development of fundamental design parameters for the EE blocks.

- Block costs
- Ramp-rate

Part 2:

Block Selection

Identify the quantity and schedule of EE blocks using the resource optimization model.

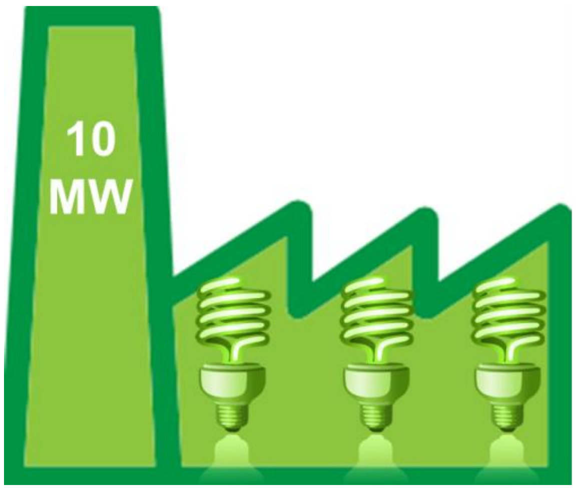
- Uncertainty
- Risk

Iteration required

Enhancing EE Resource Modeling

Attributes	2015 IRP
Structure	Sector Blocks
Basis	Pricing Tiers Extrapolated from Single Portfolio
Assumption Level	Pricing Tier Break Points
Labor Intensity	Moderate
Ease of Modification	Moderate
Selection Flexibility	Block by Block
Modeling Outcome	Preferred Path/EE Level
Model Compatibility	New Approach

Making Energy Efficiency into a Power Plant



Plant built in 10 MW blocks

Block Characteristics:

- Capacity factor equivalent
- Load Shape
- Cost to build program
- Time to implement
- Lifetime of Program
- Installed Cost / kwh

- Three Primary Sectors: Residential, Commercial, Industrial

Definition and Development of Tiers

- Started with FY15 energy efficiency portfolio
- Three cost tiers identified along with "Must Run" category
- Blocks were grouped by sector based on commonality of market and similarity of load shape
- Minimum block sizes were set at 10 MW to test selection capabilities of the modeling process and for uniformity in scale and sizing to allow flexibility
- Corresponding GWh impacts vary by sector
- Blocks are proxies of program designs, not actual programs or increases to existing programs

Residential Programs	Block Weight
New Homes	12%
Self Audit	2%
In Home Energy Evaluation	20%
Manufactured Homes	16%
Heat Pump	10%
eScore	40%

Industrial Programs	Block Weight
Tailored Solutions for Industry	54%
Custom Industrial	10%
Standard Rebate	36%

Commercial Programs	Block Weight
Custom Commercial	10%
Standard Rebate	90%

Definition and Development of Blocks

- Must Run represents the impacts of projected programmatic efforts required by TVA's Compliance Agreement with EPA (rounded to next whole block)
- Tier 1 represents escalation of basic costs associated with current (FY15 Plan) portfolio by sector; escalated at standard rates through time
- Tier 2 is comprised of a step-function increase in Tier 1 incentives and fixed costs; escalated at standard rates through time

Must Run Blocks	2014	2015	2016	2017	2018
Residential	2	2	1	1	0
Commercial	2	2	3	3	0
Industrial	4	2	0	0	0

Average Unweighted Increases Relative to Base			
Tier 2	**Residential**	**Industrial**	**Commercial**
ERS Incentives	60%	70%	70%
ERS Variable Costs	30%	70%	70%
ERS Fixed and Low Variable	15%	10%	10%
ERS Other	15%	70%	70%
Tier 3	**Residential**	**Industrial**	**Commercial**
ERS Incentives	120%	200%	200%
ERS Variable Costs	65%	200%	200%
ERS Fixed and Low Variable	30%	20%	20%
ERS Other	50%	200%	200%

Translating Customer Meter Impact to System Impact

Savings at End-Use Meter → **Net-to-Gross Factor** → **T&D Losses** → **System Impact**

12.2 MW
61 GWh

X 77 % X 1.065

10 MW
50 GWh

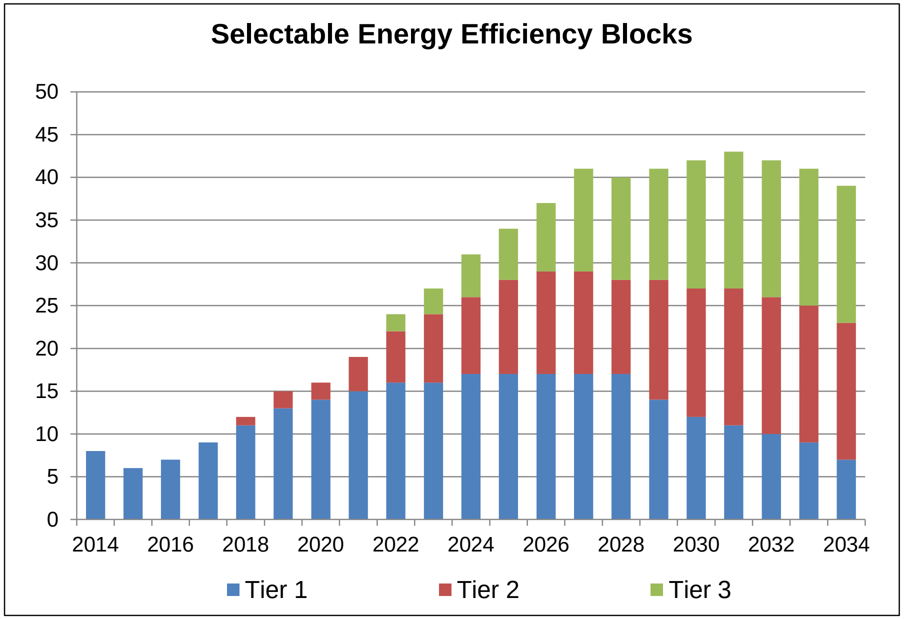
1 System Block

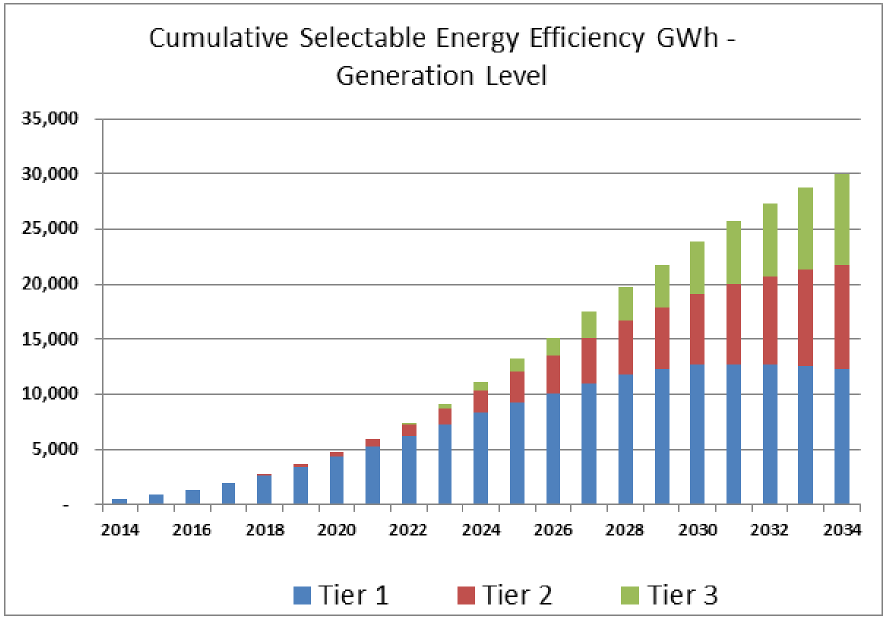
Program impacts at the end-user's meter translate to fewer system impacts

Summary of Block Ramp Rates & Other Parameters

Block Parameters	Residential	Commercial	Industrial
MW per Block	10	10	10
GWh per Block	50	59	72
Ramp Rate (Yr 1 - 5)	25%	25%	25%
Ramp Rate (Yr 6 -15)	20%	20%	20%
Ramp Rate (Yr ≥16)	15%	15%	15%
Max Blocks per Year	23	12	8
Lifespan Tier 1	17	15	12
Lifespan Tier 2	13	13	10
Lifespan Tier 3	13	13	10
Initial Cost Ranges (Millions)	$20.7 to 38.0	$11.6 to 33.4	$11.5 to 33.0

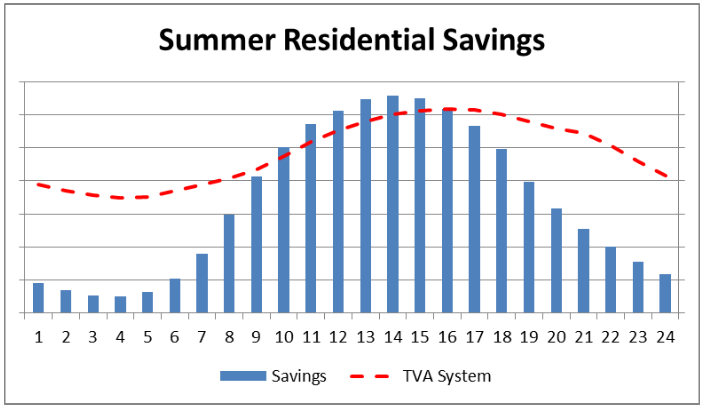
- Tier 3 was developed using a step-function increase in Tier 2 incentives and fixed costs; escalated at standard rates through time
- Step-function increases and max limits were developed by program design staffs
- Iterative changes to model inputs included declining growth rate, adjusted Tier 2/3 lifespans, exhaustion of Tier 1 blocks

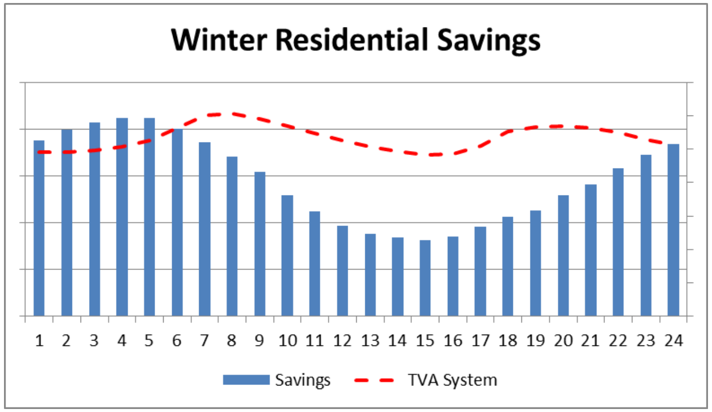


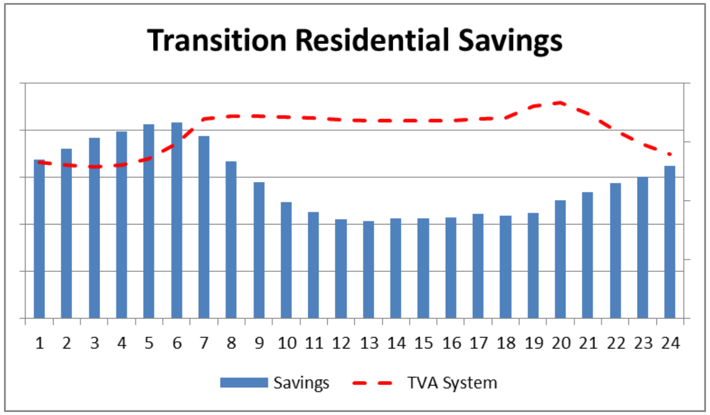


Block Load Shapes

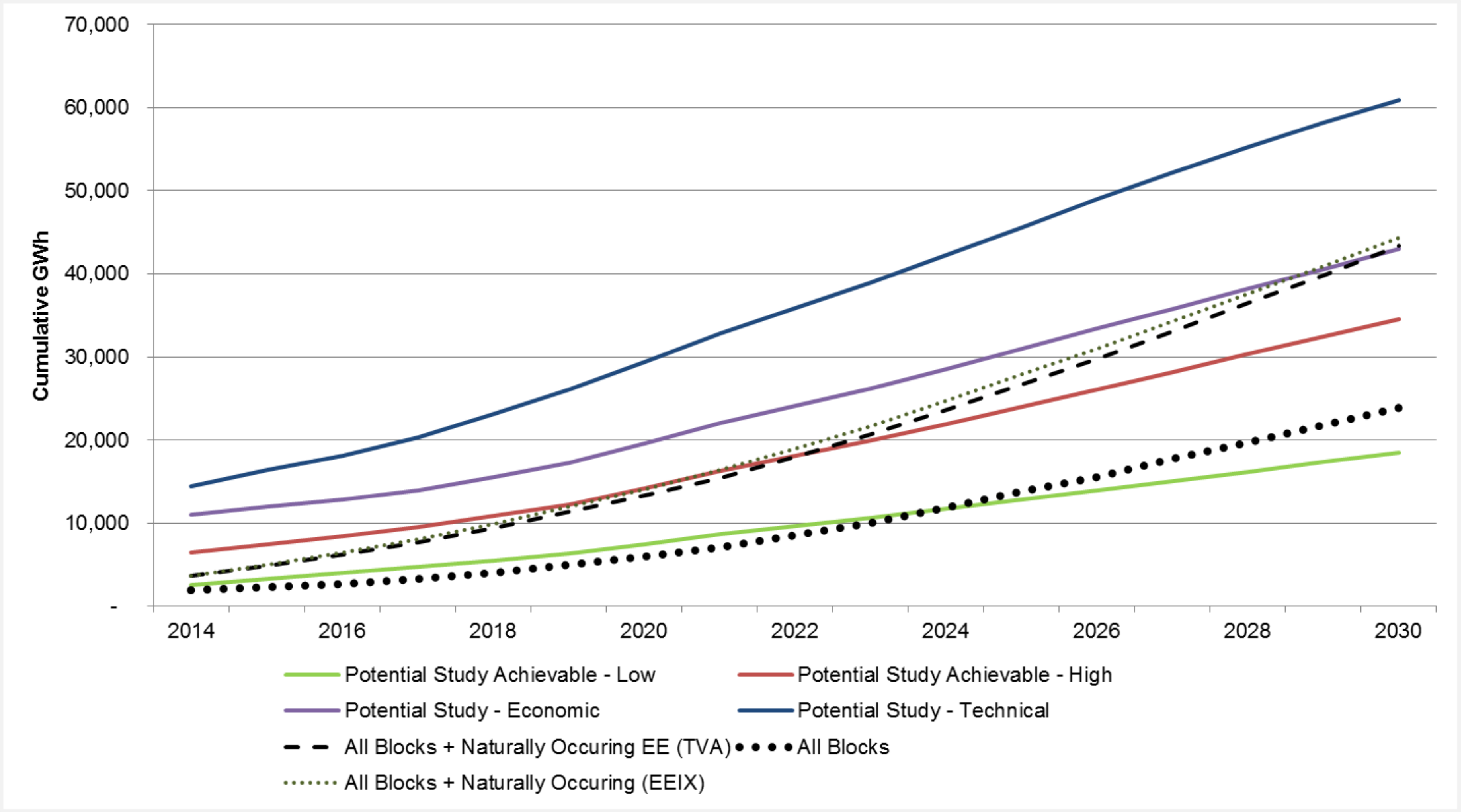
- Programs are developed to provide system impacts which mitigate higher generation costs and system loads during peaks
- The charts illustrate the relative shape of a Residential Block compared to the overall peak day TVA load shape
- The demand reduction impact of each block, regardless of Sector, is 10 MW at the time of TVA's summer peak; impacts in other seasons vary as illustrated below





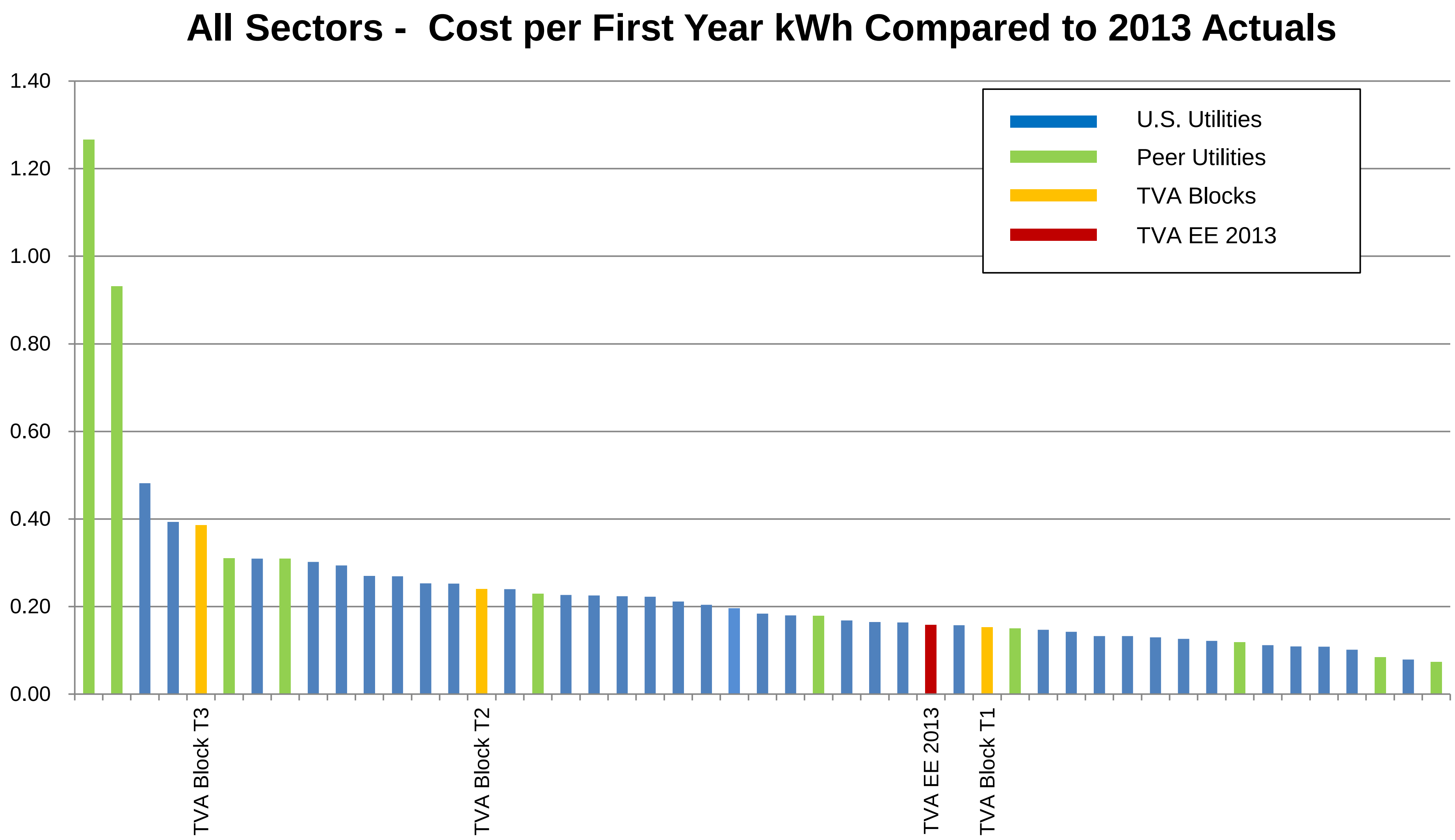


Alignment with the Valley Potential Study (Generation Level Savings)



Note: Potential Study Source – Tennessee Valley Authority Energy Efficiency Potential Study 2012 Update, EnerNOC Utility Solutions Consulting, Report No. 1360.2

TVA block design costs are aligned with the industry

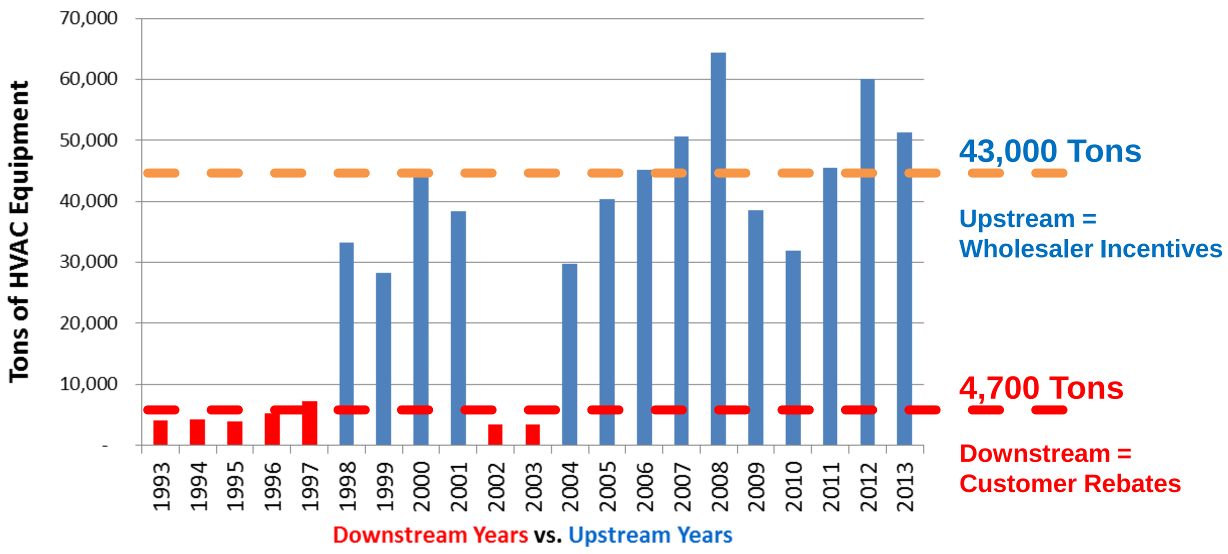


Source: Replication of "E Source DSM Achievements and Expenditures, 2013"

Creative Approaches Required for Step Change in EE Implementation

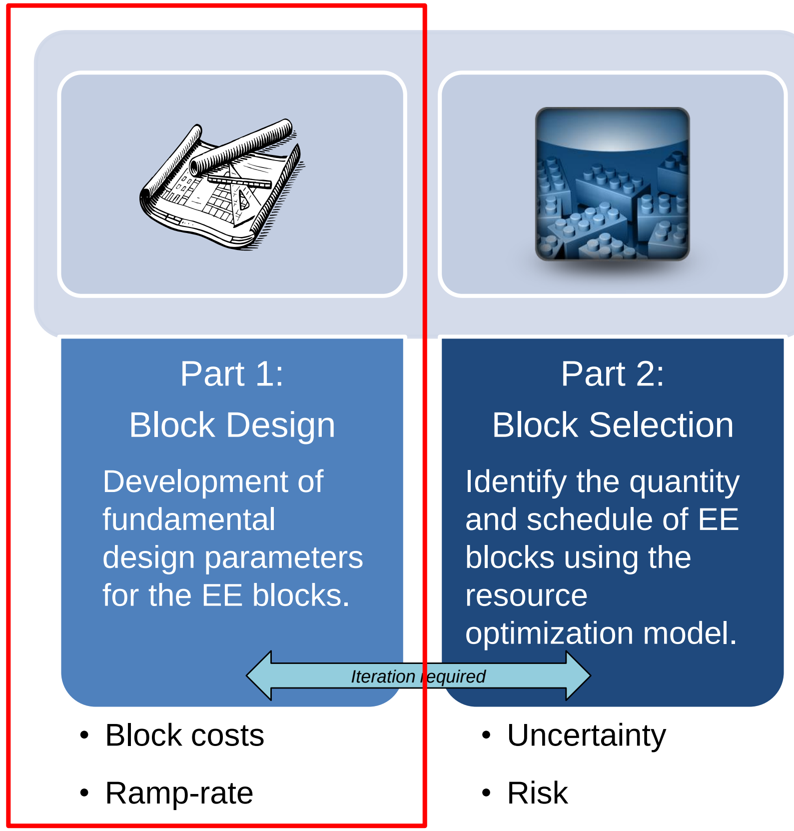
- Maximum incremental annual savings of all blocks represents roughly six times the annual incremental amount achieved thus far
- By 2033, cumulative savings from all selectable blocks represents almost 15% of supply resources
- Reaching targets in this range will require innovative approaches
- There are, however, many proven designs that have yet to be deployed in the Valley

Example of Step Change – PG&E



Energy Efficiency Block Design Summary

- Block Characteristics defined to provide inputs necessary for modeling:
  - Ramp rates
  - Net system impacts - MW and GWh
  - Block costs
  - Aggregate load shapes
- Comparison to other utilities indicates reasonable alignment with cost per kWh
- Maximum selection of blocks remains within bounds of potential study



IRP Model Execution and Selected Initial Results

Tom Rice

Tennessee Valley Authority

The EE Modeling Concept

Part 1: Block Design

Development of fundamental design parameters for the EE blocks.

Part 2: Block Selection

Identify the quantity and schedule of EE blocks using the resource optimization model.

Iteration required

- Block costs
- Ramp-rate

- Uncertainty
- Risk

Resource Modeling Approach

Why Model EE and DR as supply side resources?

- To allow full portfolio optimization
- To clearly demonstrate value proposition
- To allow flexible, nimble response to changing business environments

Challenges:

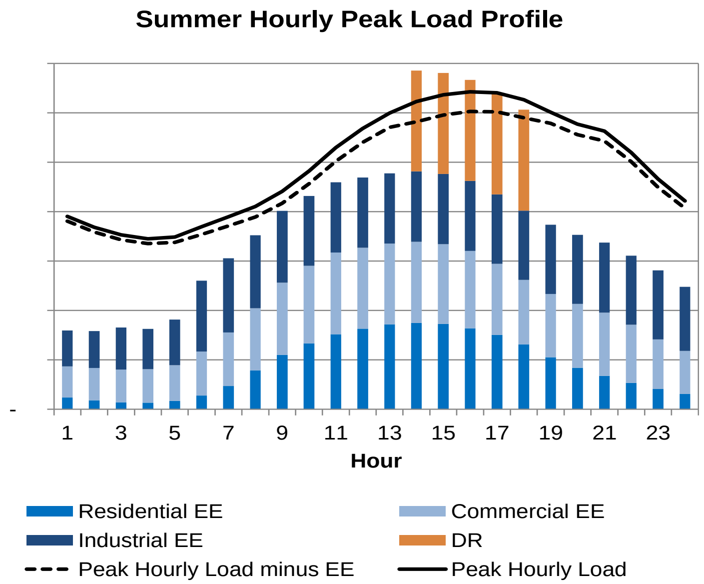
- Typical EE modeling approach (as a load modifier) doesn't lend itself to an easy transition to supply side modeling
- How to account for cost changes over time
- How to account for uncertainty on load shapes
- How to acknowledge our unique structure and the fact that we do not own the relationship with the end-use customer
- How to account for delivery risk uncertainty

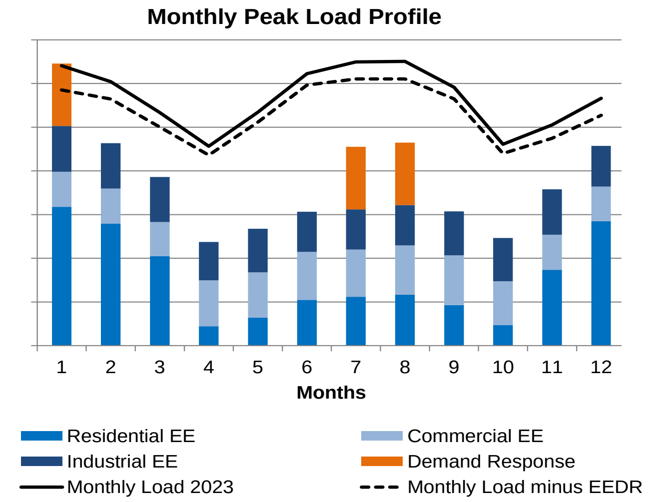
Resource Characteristics

- Chart illustrates the combined impact of energy efficiency and demand response on the hourly load shape for a typical summer day

- The variable EE shape over a majority of hours during the day resembles the cycling nature of ar intermediate resource like a natural-gas combined cycle unit (NGCC)

- Monthly shapes differ by sector with residential following weather patterns more closely than commercial or industrial



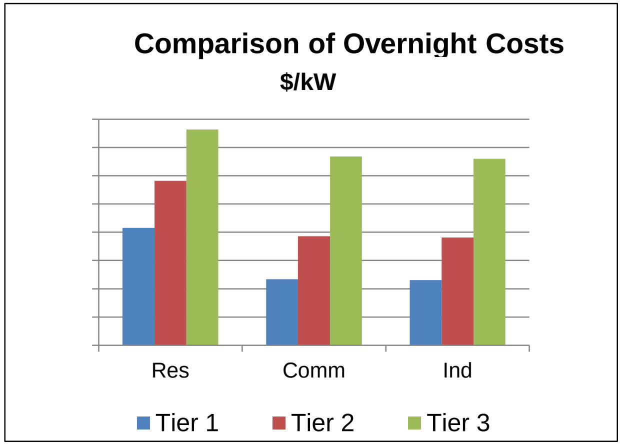


EE Expansion Options & Performance Assumptions

Expansion Option Assumptions

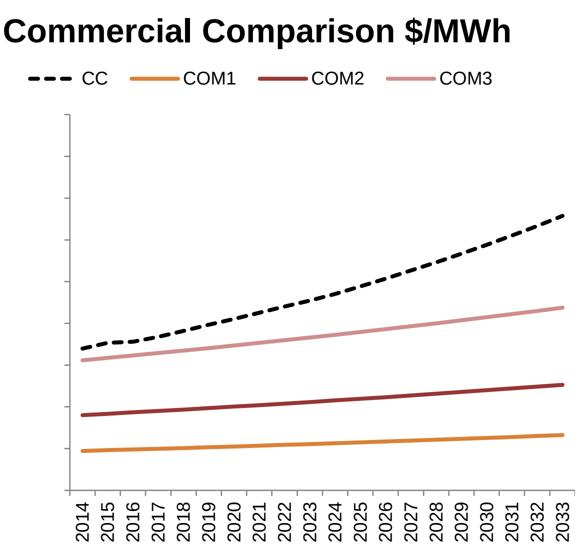
- Each unit is 10 MW at summer peak
- Units represent the three sectors; residential, commercial, and industrial
- Each sector is then divided into three tiers (or price points)
- Capacities vary by month
- All tiers within each sector utilize the same energy profile
- Annual energy patterns do not change over the time horizon
- Costs are expensed in the first year of selection

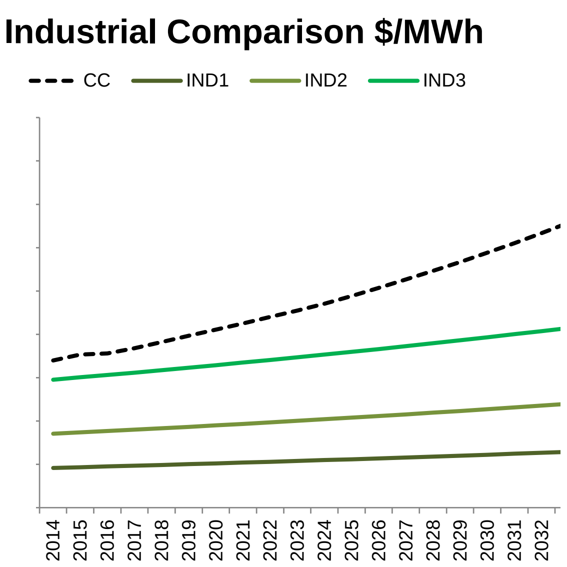
	Res Tier 1	Res Tier 2	Res Tier 3	Com Tier 1	Com Tier 2	Com Tier 3	Ind Tier 1	Ind Tier 2	Ind Tier 3
Unit Characteristics									
Nameplate Capacity (MW)	10	10	10	10	10	10	10	10	10
Summer Full Load Heat Rate (Btu/kWh)	-	-	-	-	-	-	-	-	-
Unit Availability (Yr)	2014	2022	2026	2014	2019	2022	2014	2018	2022
Annual Outage Rate	-	-	-	-	-	-	-	-	-
Book Life (Yrs)	17	13	13	15	13	13	12	10	10

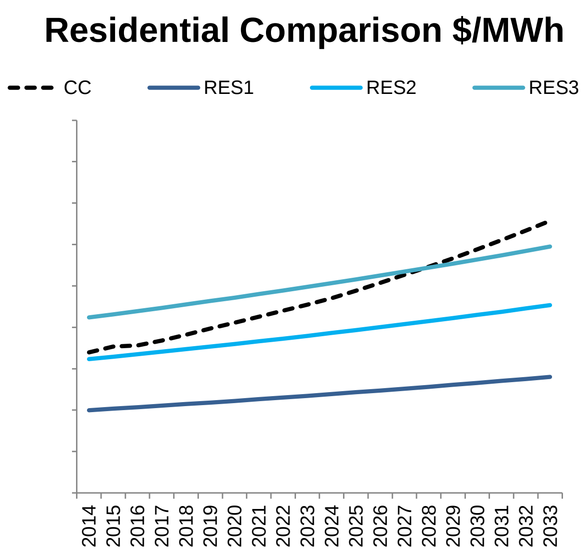


EE Cost Projections Over Time before Uncertainties

- EE blocks are compared below to a combined cycle plant; given the capacity factors of our EE assumptions they most closely resemble an intermediate to baseload resource in energy profile
- EE costs over time increase at slightly less than inflation. This means that EE becomes cheaper over time in real terms







** $/MWh costs above do not reflect any adjustments for uncertainty*

Comparison to Supply Side Resources

- Supply Side resources have many characteristics directly modeled in resource planning tools
- Demand side resources possess some characteristics that are similar to supply side but there are key differences
- One additional key difference is that our EE assumptions include some level of technology improvement over time, while supply side resources are the same today and at the end of the study

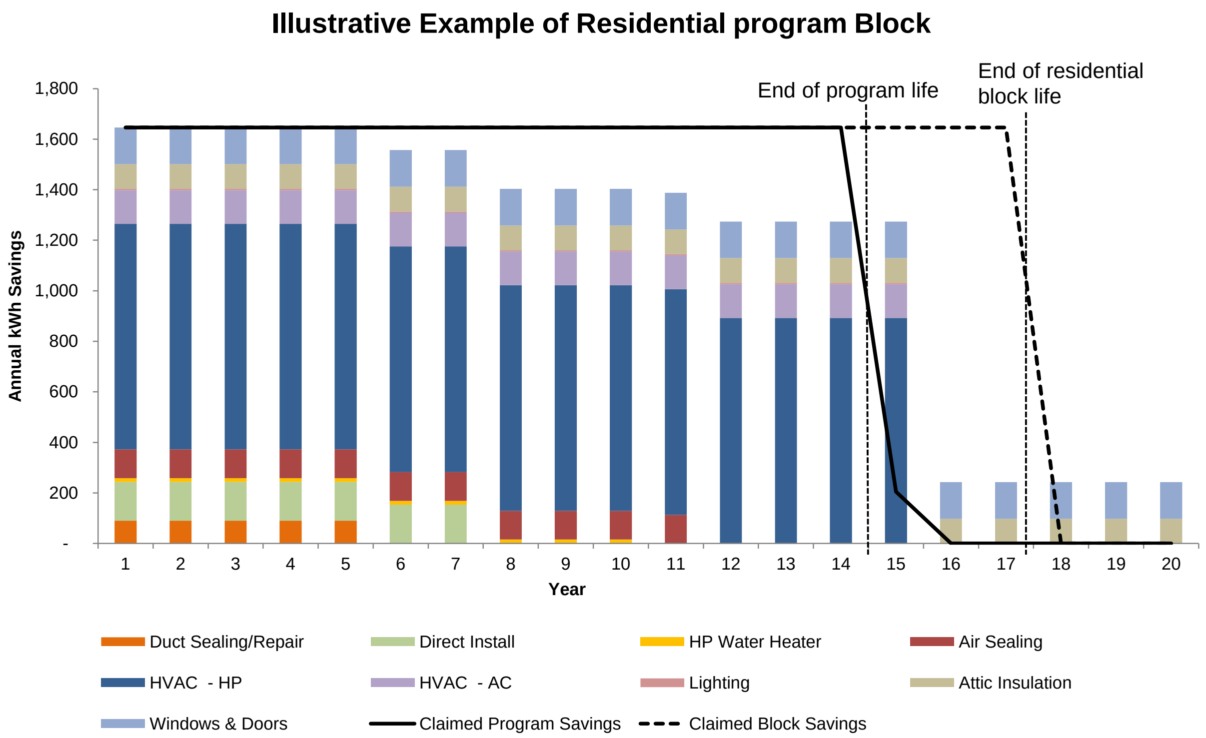
	SUPPLY SIDE COMPARISON						
	Com EE	Ind EE	Res EE	New CC	New CT	New Coal w/ CCS	AP1000
Year Available	2014	2014	2014	2019	2018	2028	2026
Outage Rate				✓	✓	✓	✓
Heat Rate				✓	✓	✓	✓
Fuel Costs				✓	✓	✓	✓
Fuel CAGR				✓	✓	✓	✓
CO_2 Costs				✓	✓	✓	✓
CO_2 CAGR (starts in 2022)				✓	✓	✓	
O&M costs	✓	✓	✓	✓	✓	✓	✓
O&M Escalation	✓	✓	✓	✓	✓	✓	✓
Transmission Contingency Cost				✓	✓	✓	✓
Project Contingency Cost				✓	✓	✓	✓
Capital Costs				✓	✓	✓	✓
Escalation of capital				✓	✓	✓	✓
Capacity Factor	✓	✓	✓	✓	✓	✓	✓
Technology shifts	✓	✓	✓				

Drivers of Uncertainty

- Uncertainty exists with all resource types and is modeled in different ways. For Energy Efficiency we consider two primary sources of uncertainty: Design and Delivery Uncertainty
- Design Uncertainty exists for the following reasons:
  - Blocks are "proxies" for programs not yet developed some of which represent as-yet undeveloped technologies
  - Blocks are a blend of measures with different lifespans and each with a different underlying load shape
- Delivery Uncertainty is driven by several factors:
  - The fact that TVA does not own the relationship with most end-use customers in the valley
  - Experience in other jurisdictions around non-performance (realization rate) for both energy and demand
  - Uncertainty around the impact of future codes and standards on program design and deliveries: are EE program deliveries as certain in 2033 as they are in 2015?

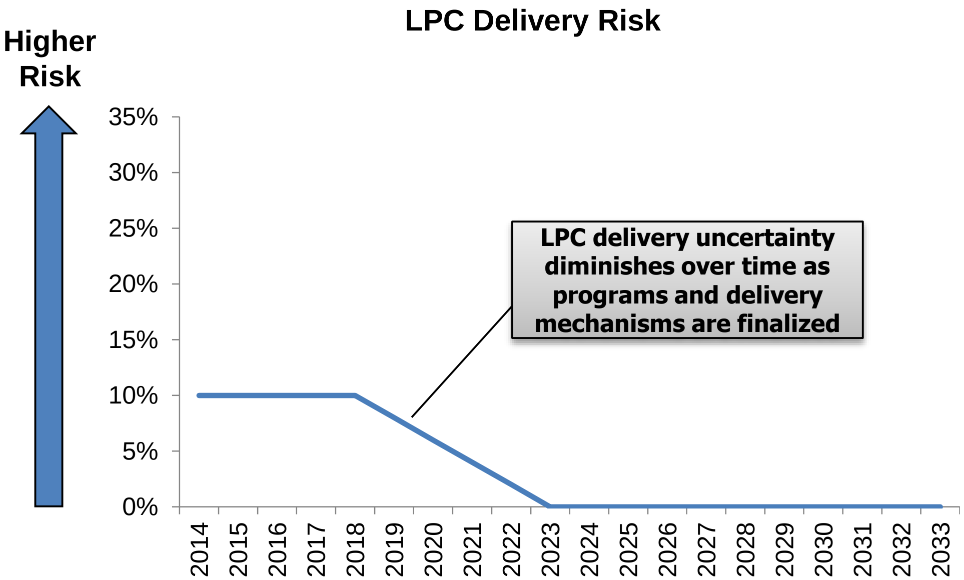
Design Uncertainty

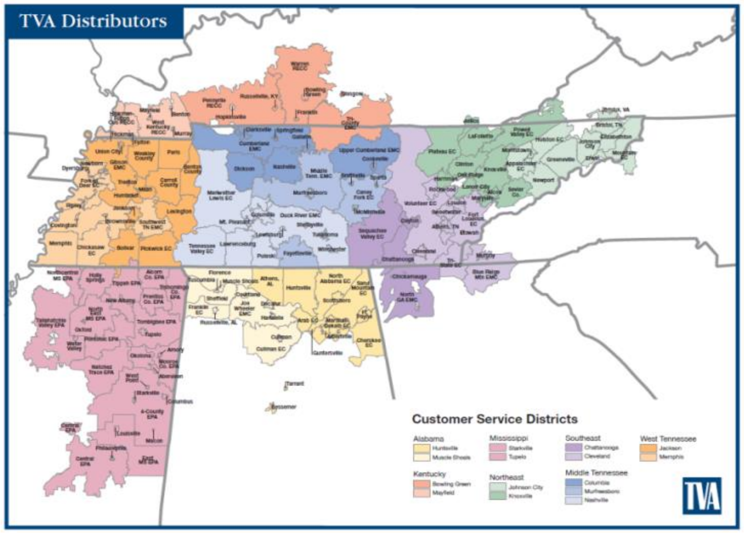
- Blocks modeled for EE represent proxies for programs not yet developed.
  - This is a reasonable approach for a long-term IRP geared towards strategic direction
  - We assume some risk projecting programs forward that are not yet designed
- As an example, the assumptions around block design include weighting programs with different lifespans into one block
  - Reasonable approach in our construct but introduces risk into long term resource planning



Delivery Uncertainty: End Use Customer Relationships

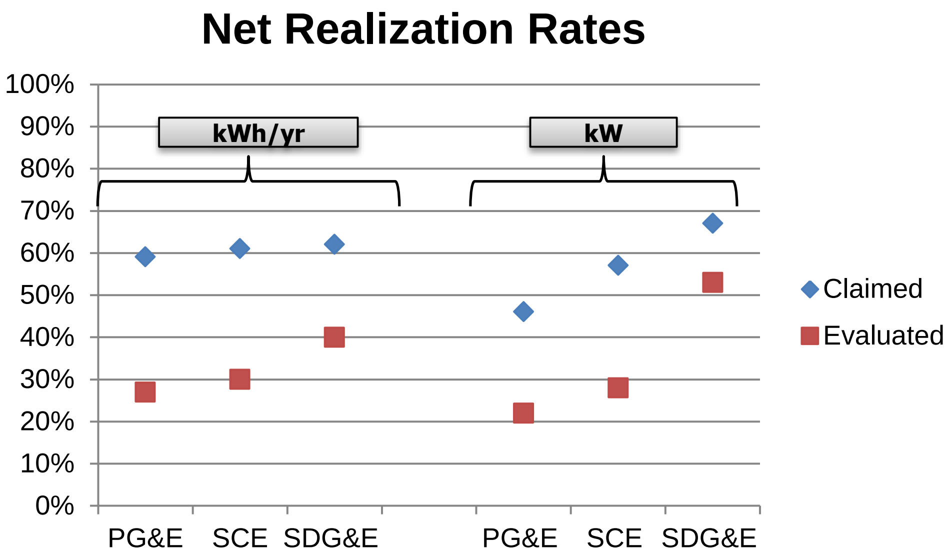
- TVA is not the end-use provider in most cases, and there is risk in how the 155 local power companies would vary in their delivery of EE programs
- We believe that this uncertainty diminishes over time as delivery mechanisms are developed and refined with our LPC customers





Delivery Uncertainty: Realization Rate

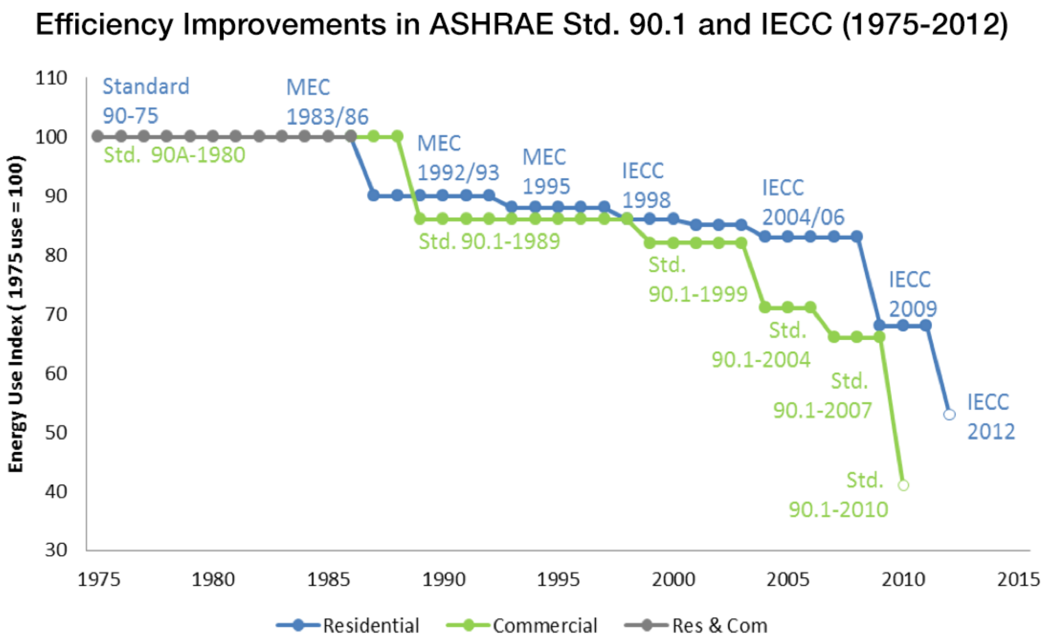
- Realization rate is a ratio of measured vs. estimated energy reduction
- A 2014 study on California's Custom Impact Evaluation found realization rates on the order of 50-60% for some programs
  - TVA has different market drivers and the opportunity to learn from their experience
  - Example illustrates that delivery risk exists even in more mature markets
- TVA has risk in that future program assumptions have not been designed or undergone M&V to establish robust estimates.
- This uncertainty increases over time



Itron, Inc. and KEMA/DNV GL. March 14, 2014. *2010-12 WO033 Custom Impact Evaluation Report*. pp.1.10-1,.11f

Uncertainty in Timing and Impacts of Codes and Standards

- Graph demonstrates increasing stringency on codes and standards up to 2012
- TVA's load forecast models the impact of known standards as load reductions
- Our EE modeling assumes that over the 20 year study period TVA programs can be developed to exceed whatever the then-current standards may be
- This introduces delivery risk (increasing over time) because we cannot predict the timing or impact of future standards



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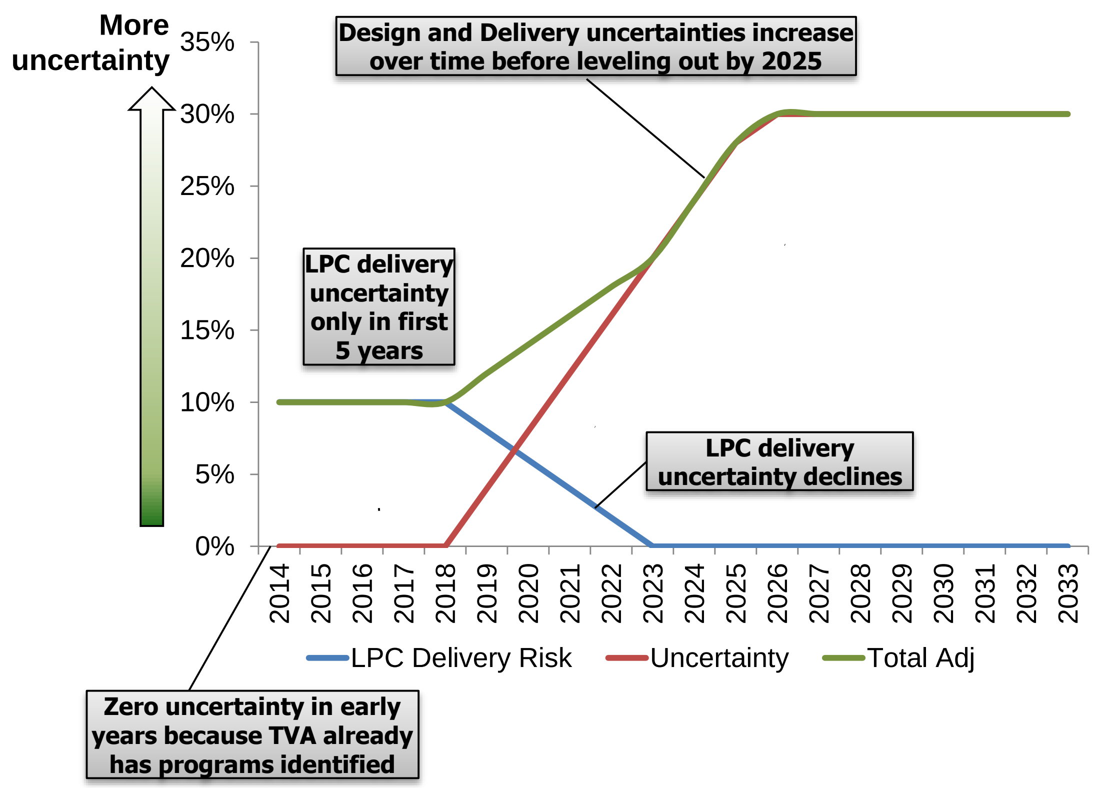
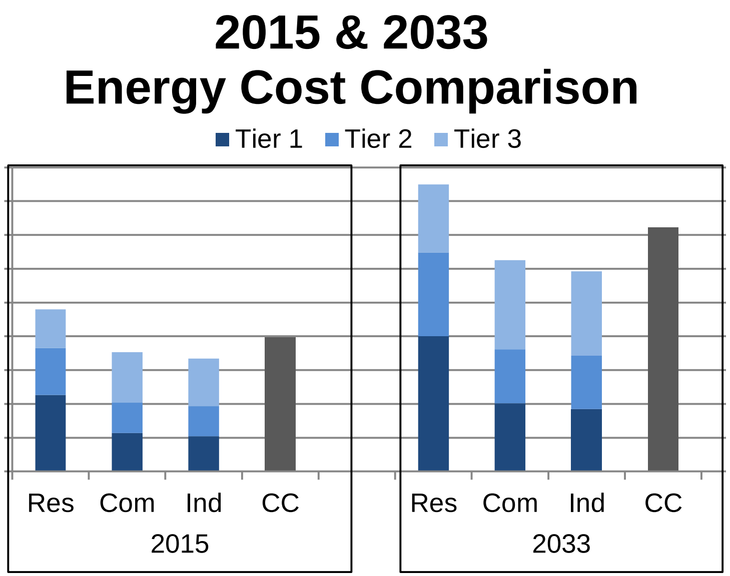
Uncertainty / Planning Factor Adjustment

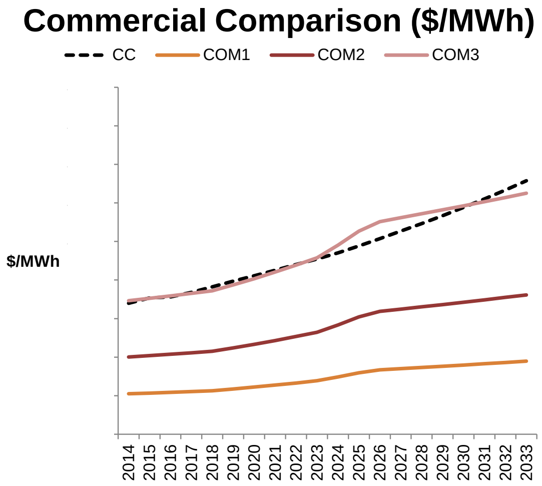
- A planning factor was used in order to acknowledge various uncertainties
- Years 1-5 reflect LPC delivery uncertainty; at year 6 this begins declining
- Design Uncertainty and Delivery Uncertainty begin low, increase over time, and level out by the mid 2020s
- This is an approximation – not a precise calculation – but is meant to be reflective of how uncertainties increase over time

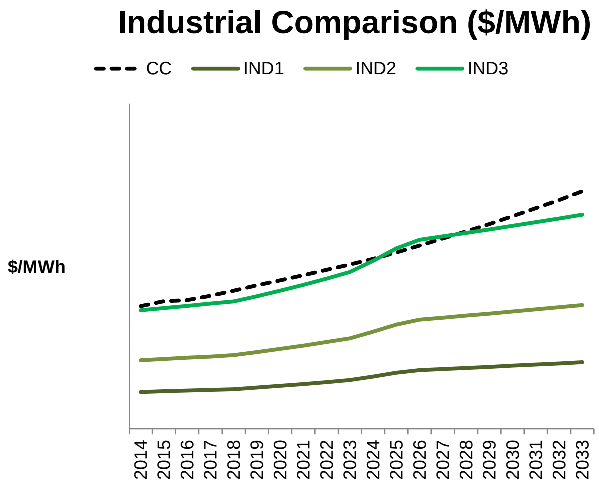


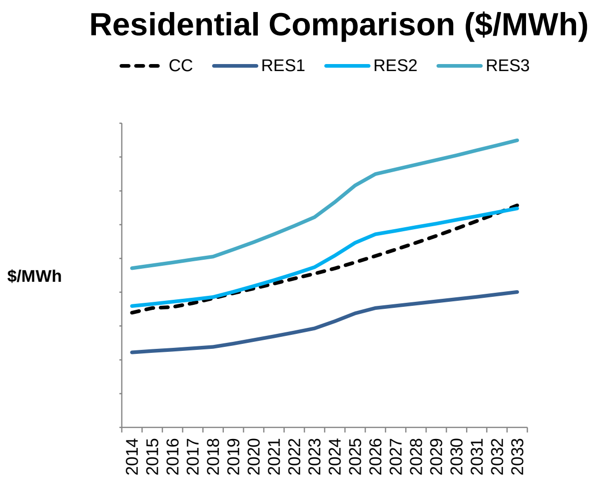
All-In EE Levelized Costs After Planning Adjustment

- **Most of the EE blocks remain cheaper than a natural gas combined cycle (CC) unit over the study period**
  - Only Residential Tiers 2 and 3 become more expensive after planning adjustment









*CAGR = 3% for each of the sectors

Stochastic Analysis Captures Cost and Demand Uncertainty; Planning Adjustment Captures Design & Delivery Uncertainty

Stochastic Analysis of Production Cost and Financials Bound Uncertainty

- The range around EE costs are directly driven by distributions on O&M cost escalations and indirectly by demand and weather patterns (load shape)
- Traditional resources have many factors that can change both their costs and generation levels, i.e., demand, fuel, O&M, capital costs, CO_2, etc.; uncertainties of all types manifest as cost in the model
- The planning adjustment addresses design and delivery uncertainty which are not otherwise represented
- The planning adjustment is similar in concept and impact to CO_2 costs used to proxy impacts of future regulation

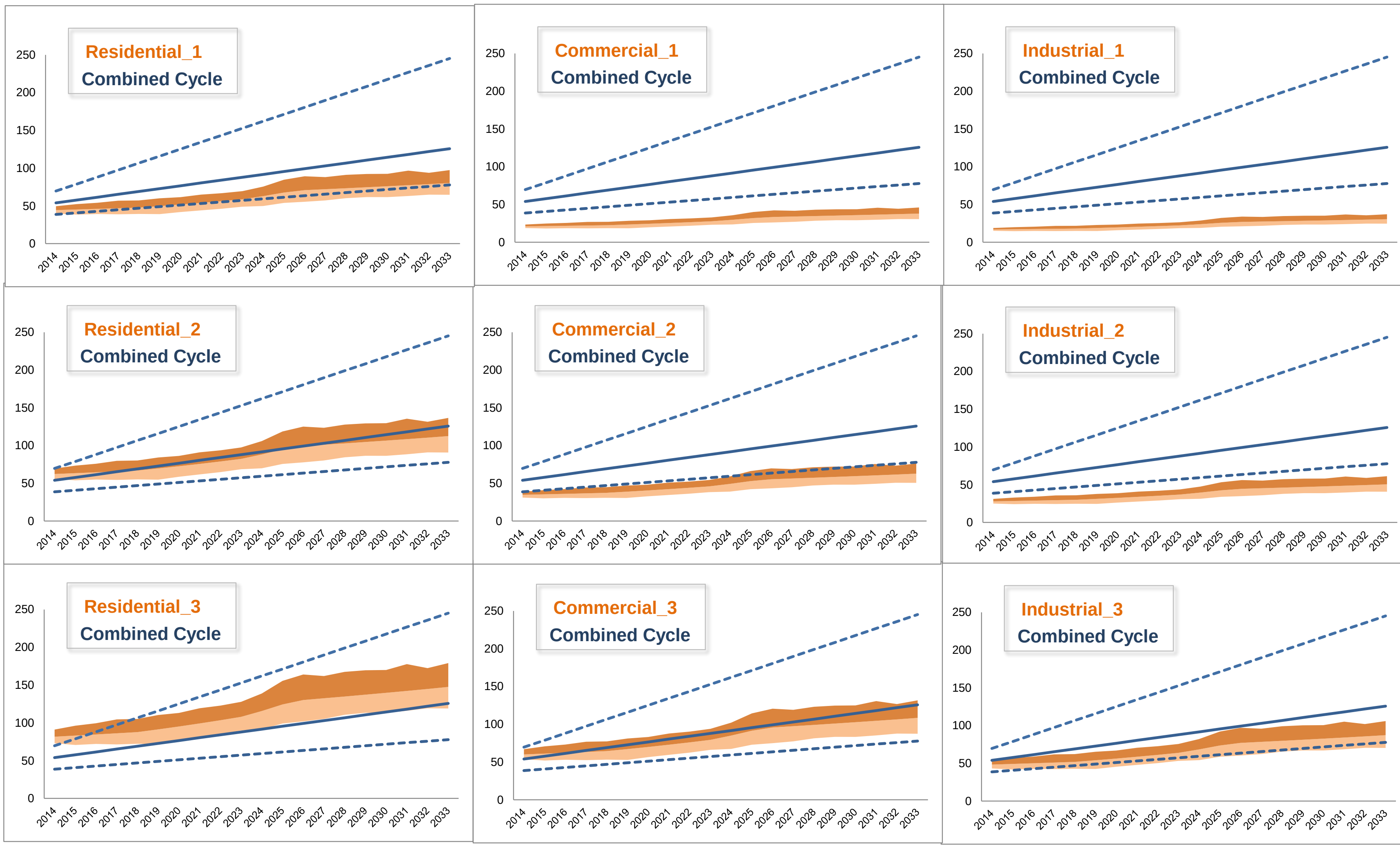
Stochastic Variables

	Diesels	CT	CC	Coal	Nuclear	Hydro	Solar	Wind	Energy Efficiency
Gas price		✔ direct	✔ direct	✔ indirect		✔ indirect			
Coal price		✔ indirect	✔ indirect	✔ direct		✔ indirect			
Oil price	✔ direct	✔ indirect				✔ indirect			
CO2 allowance price	✔ direct	✔ direct	✔ direct	✔ direct					
Electricity price	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect			
Hydro generation		✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ direct			
Plant availability	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ indirect			
Load shape year	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect			✔ indirect
Electricity demand	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect	✔ indirect			✔ indirect
O&M costs	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct
Interest rates		✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	
Capital cost		✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	✔ direct	

direct	✔ (green)
indirect	✔ (red)

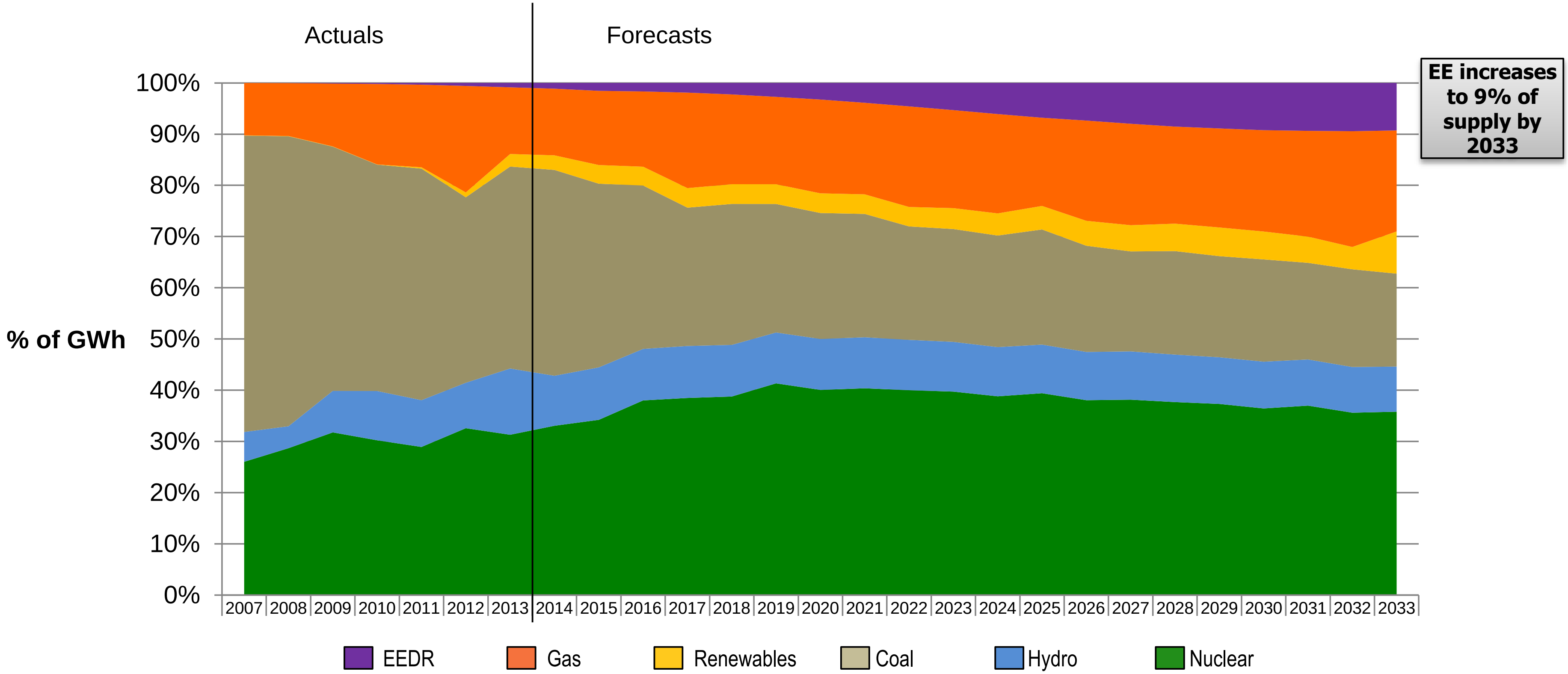
EE cost uncertainty is less than the cost uncertainty of a combined cycle

- The EE uncertainty band is driven cost uncertainty on the escalation rate over time
- The uncertainty band around CC costs are much wider due to fuel, emissions, O&M, capacity factor, and capital cost uncertainty



2015 Integrated Resource Plan

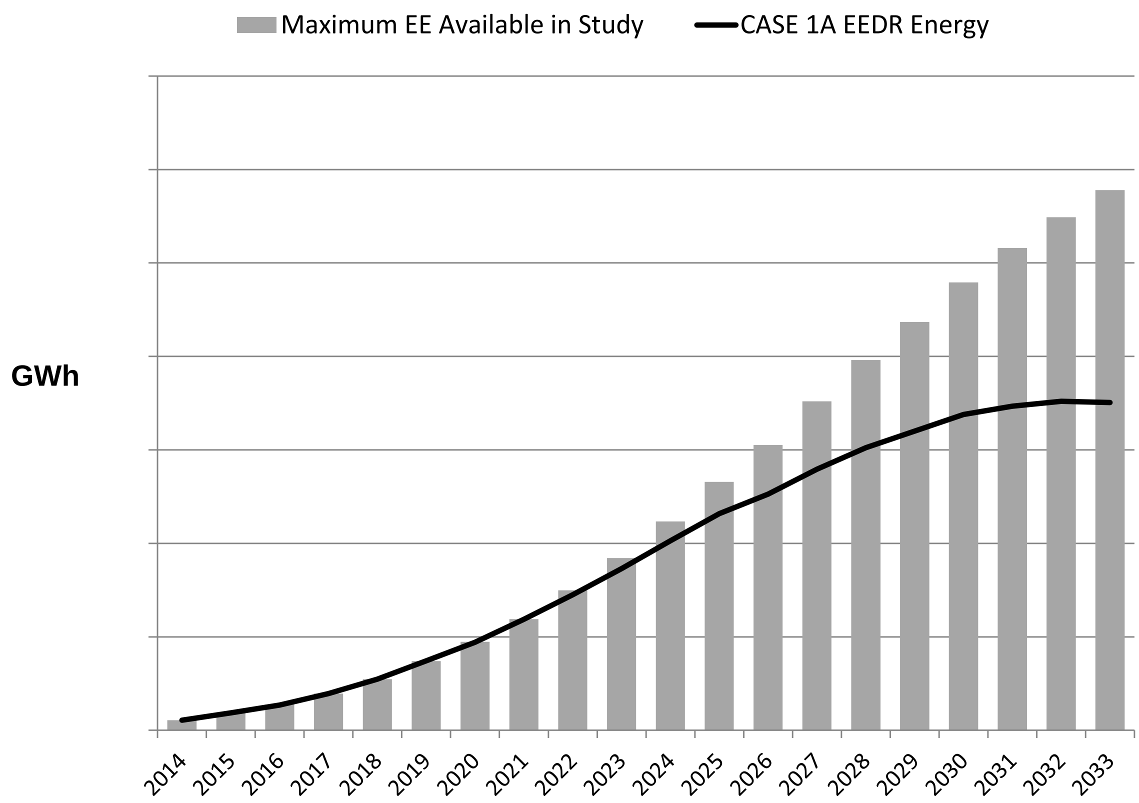
Sample Results



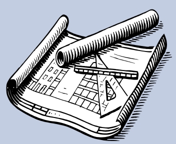
- IRP analysis covers full EE spectrum in order to get a robust set of results
- Impacts of the uncertainty planning factor and various sensitivity cases are being analyzed
- TVA's "Maximize Energy Efficiency" Strategy tests the impacts of selecting all available EE blocks

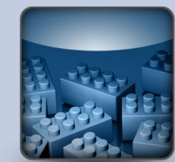
Sample IRP Results Demonstrate Range of Outcomes

- TVA's IRP results show substantial EE growth over the planning horizon
- One of our Strategies "Maximize EE" explicitly tests selecting all available EE from the study
- In any case, over the first ~5 year period growth in EE in many cases is at the maximum ramp rates



IRP Model Execution and Selected Initial Results Summary





Part 1:
Block Design

Development of fundamental design parameters for the EE blocks.

Part 2:
Block Selection

Identify the quantity and schedule of EE blocks using the resource optimization model.

Iteration required

- Block costs
- Ramp-rate

- Uncertainty
- Risk

Long Term Resource Planning is an inherently uncertain task, and EE is no exception

- EE is a competitive resource that introduces additional uncertainties around design and delivery that are unique from traditional resources
- TVA's approach accounts for these uncertainties with a planning adjustment, which we hope to refine over time as programs are developed, measured, and verified
- The IRP modeling framework has produced a robust set of results that demonstrate the value Energy Efficiency brings to the portfolio, including cases that test the boundary cases for EE

TVA's next step is to develop internal business processes to leverage this dynamic approach in resource planning

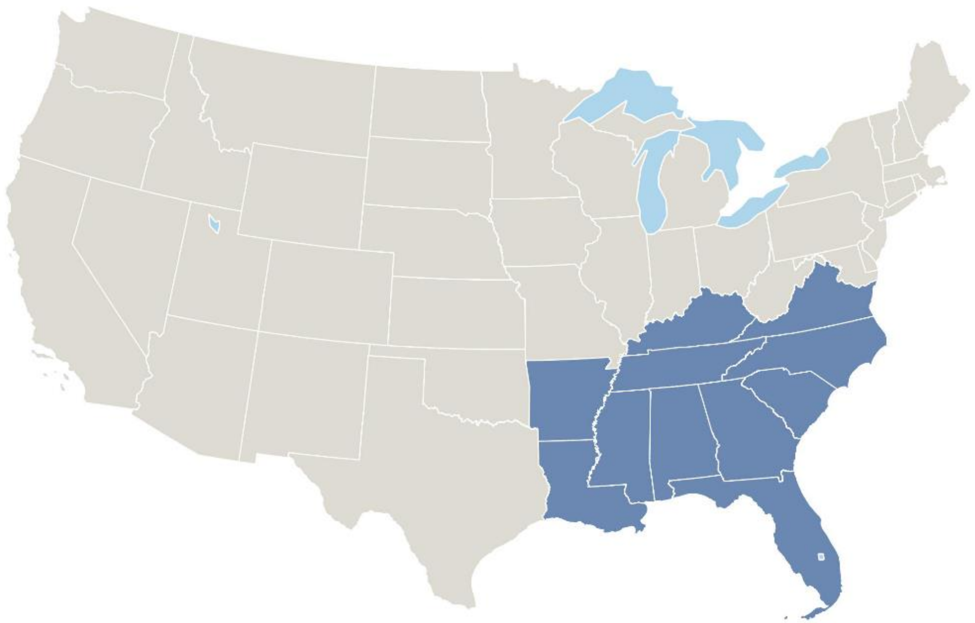
Regional View of Energy Efficiency

Mandy Mahoney

Southeast Energy Efficiency Alliance

SEEA SERVES THE SOUTHEAST

The Southeast Energy Efficiency Alliance (SEEA) promotes energy efficiency as a catalyst for economic growth, workforce development and energy security. We do this through collaborative public policy, thought leadership, outreach programs, and technical advisory activities.



Regional Energy Efficiency Organization

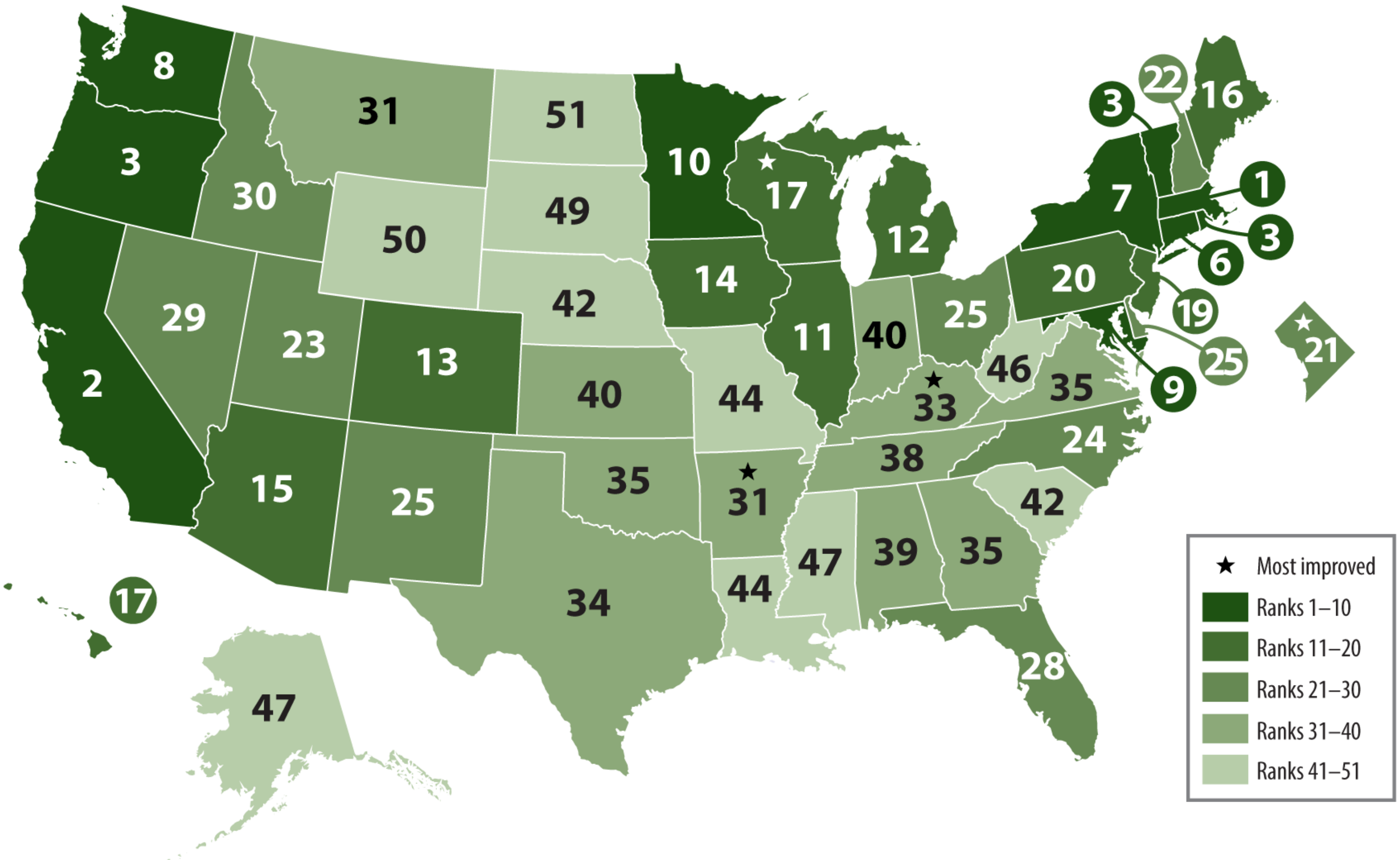
Eleven-state footprint

Non-profit, non-partisan

SEEA
SOUTHEAST ENERGY EFFICIENCY ALLIANCE

ENERGY EFFICIENCY $\neq$ ENERGY CONSERVATION

A REGION OF OPPORTUNITY

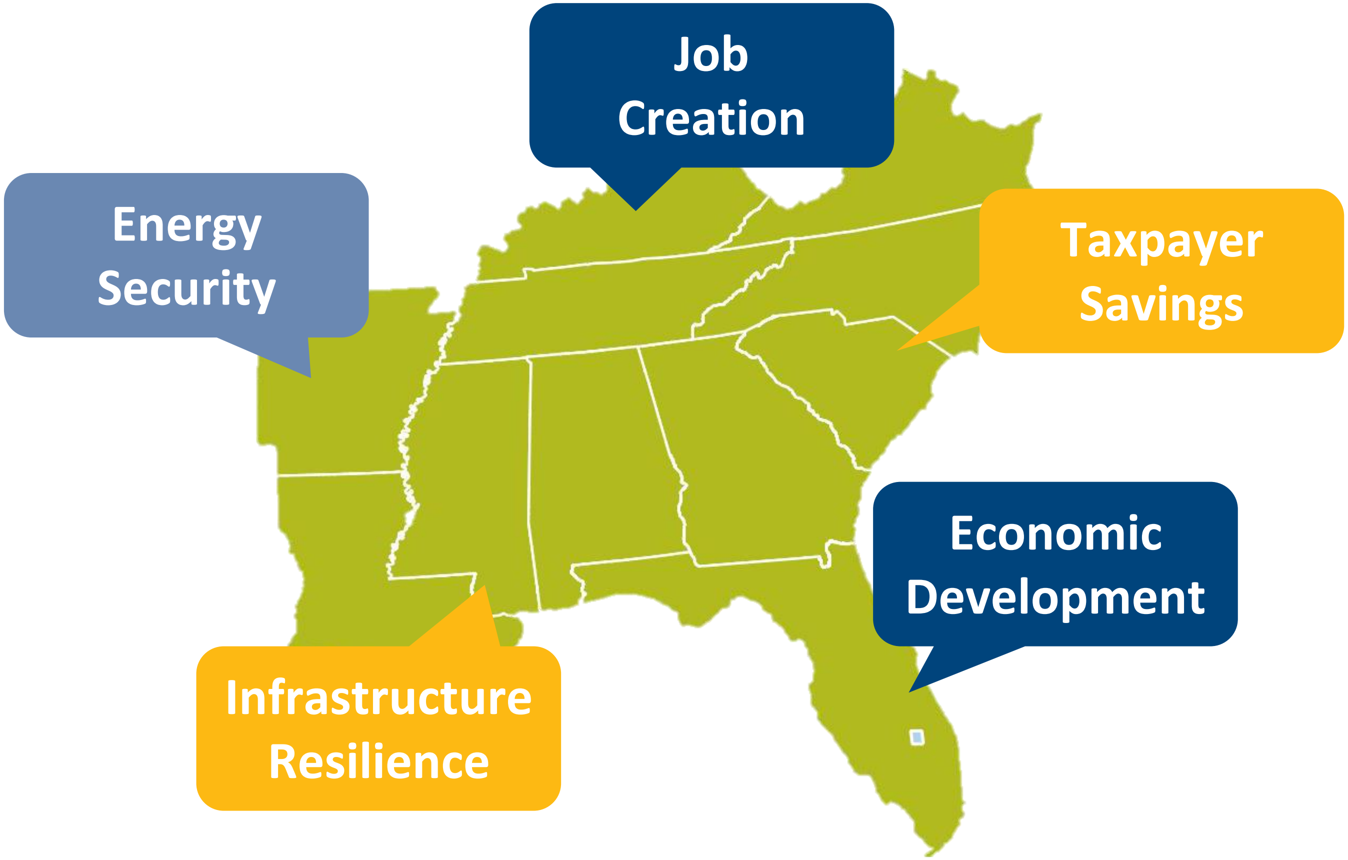


SEEA
SOUTHEAST ENERGY EFFICIENCY ALLIANCE

- Building Energy Codes
- Appliance Standards
- Financing Programs
- Utility EE Programs
- Combined Heat and Power (CHP)
- Energy Performance Contracting
- Behavioral
- Lead by Example (State and Local Governments)
- Benchmarking
- Non-Utility Residential, Commercial and Industrial Initiatives

ROBUST EE OPPORTUNITIES

ENERGY EFFICIENCY'S STRATEGIC ROLE



SEEA
SOUTHEAST ENERGY EFFICIENCY ALLIANCE

BUT
ENERGY EFFICIENCY IS NOT A SILVER BULLET

BRIDGING RESOURCES TO MAKE EE—ACCESSIBLE, BITE-SIZED, AND TAILORED TO THE NEEDS OF THE SOUTHEAST

SEEA
SOUTHEAST ENERGY EFFICIENCY ALLIANCE

Thank you!

Mandy Mahoney, President
Southeast Energy Efficiency Alliance

mmahoney@seealliance.org

SEEA
SOUTHEAST ENERGY EFFICIENCY ALLIANCE

Energy Efficiency Benchmarking

Peden Young

ScottMadden Management Consultants

Energy Efficiency Benchmarking

ScottMadden was asked to look at how the initial results compare to other utilities' energy efficiency programs

Benchmarking Scope and Methodology

- Current State
  - Current TVA data was compared to the results of a recent a study done by E Source capturing energy efficiency achievements and trends through 2013
  - The study captured data from 47 utilities across the country
- Long-Term Projections
  - Initial EE results from the draft IRP were benchmarked against projections from TVA's regional peers
  - Data was collected from publically available integrated resource plans and public service commission filings

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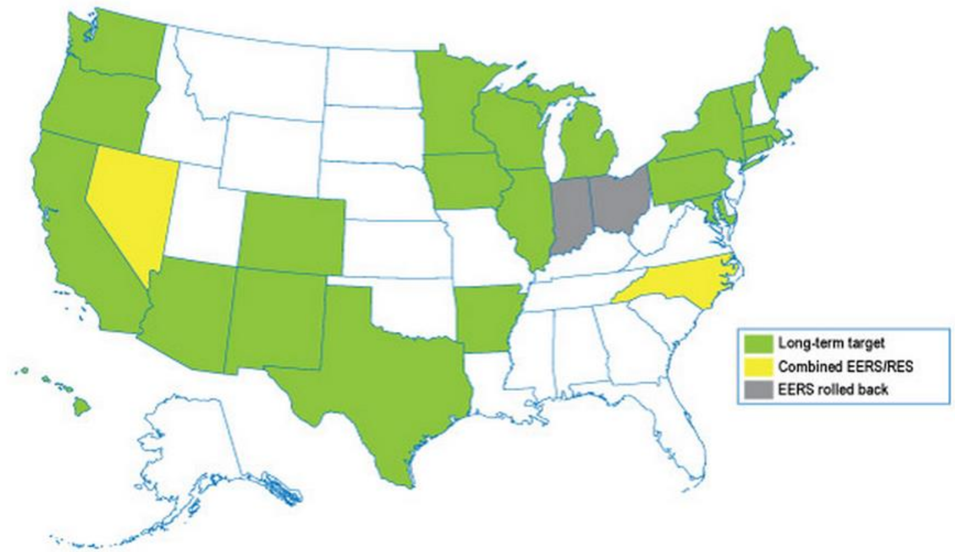
Policy Has Been A Main Driver of Energy Efficiency

In general, energy efficiency achievement is higher in areas with Energy Efficiency Resource Standards (EERS)



Source: State Energy Efficiency Standards: Policy Brief, ACEEE

- Targets are typically expressed in terms of an Annual Energy Savings Rate

$$= \frac{\textit{Incremental Annual Energy Savings}}{\textit{Prior Year Retail Energy Sales}}$$

- Strongest EERS are in Mass, RI & VT targeting an annual energy savings rate of about 2.5%
- North Carolina and Arkansas are the only states in the Southeast to have adopted a statewide EERS

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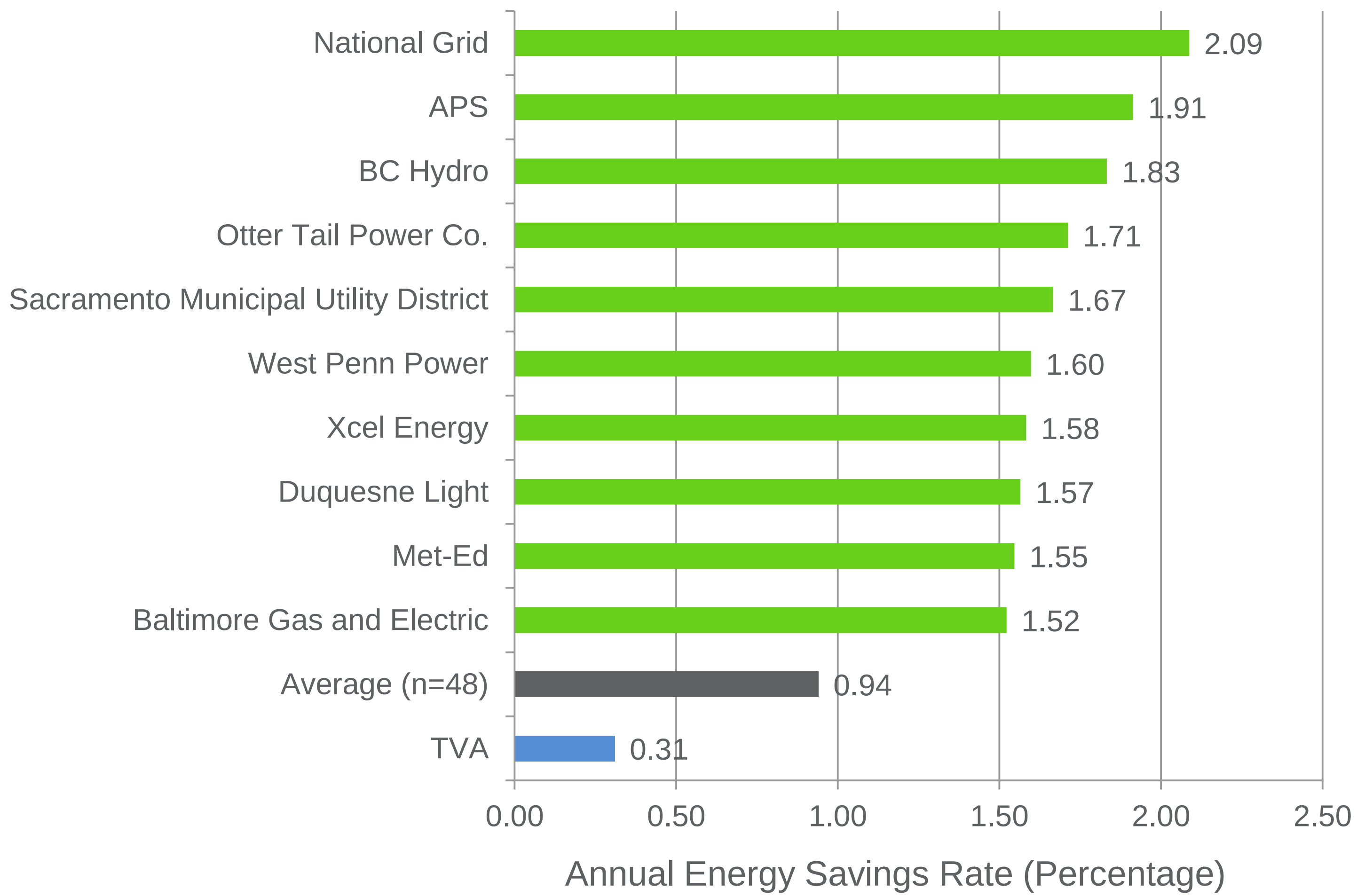
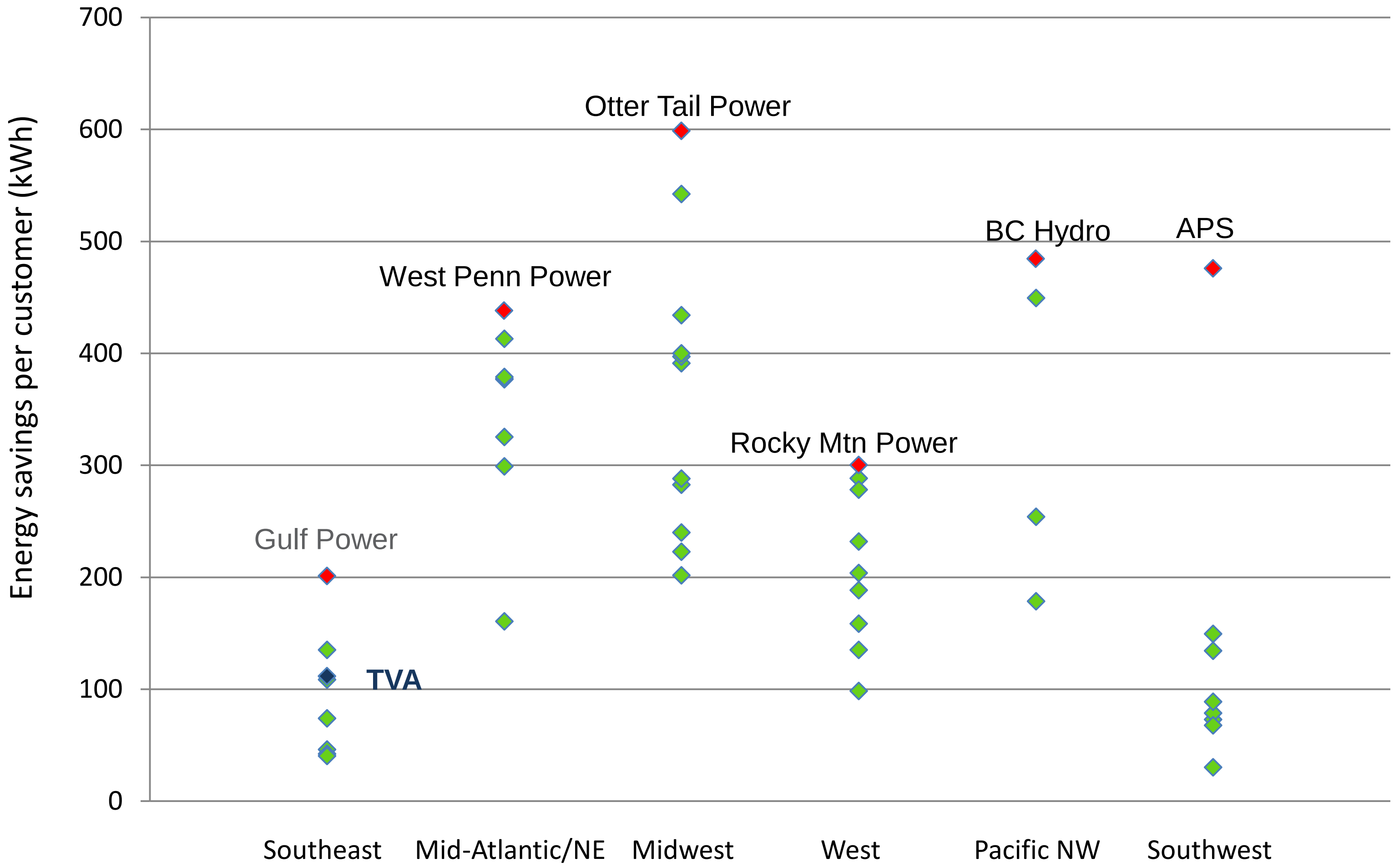
Survey Results Reflect This Regional Trend

2013 Annual Energy Savings Rates: Top 10



* TVA values exclude renewables, and budget/expenditures include overhead
Replication of "E Source DSM Achievements and Expenditures, 2013," page 10

TVA's Savings Per Customer Are Aligned With Regional Peers



* TVA values exclude renewables, and budget/expenditures include overhead.
Replication of "E Source DSM Achievements and Expenditures, 2013," page 30

Current State Benchmarking

3-Year Trend: Average Energy Savings Rate Holds Steady

* TVA values exclude renewables, and budget/expenditures include overhead
Replication of "E Source DSM Achievements and Expenditures, 2013," page 11

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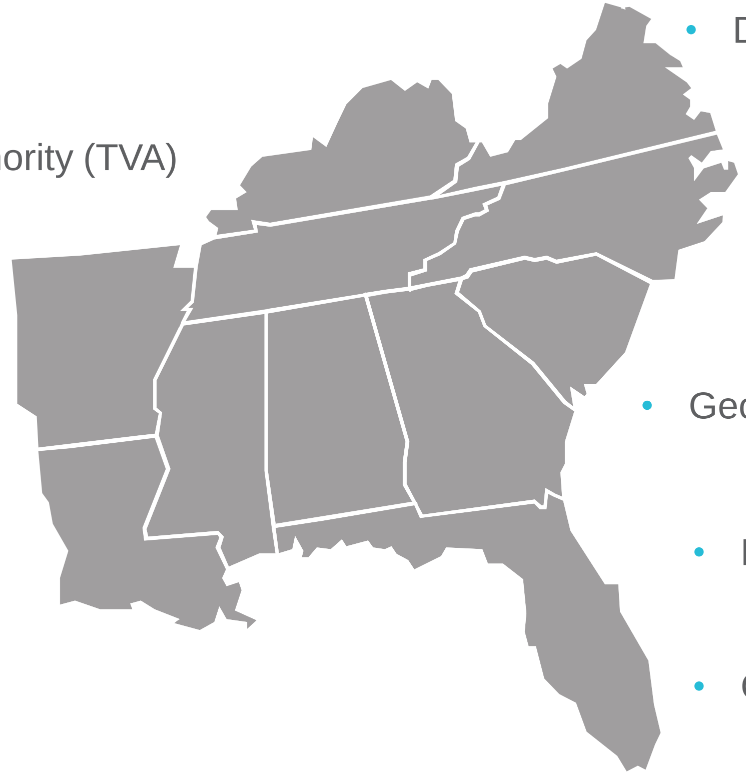
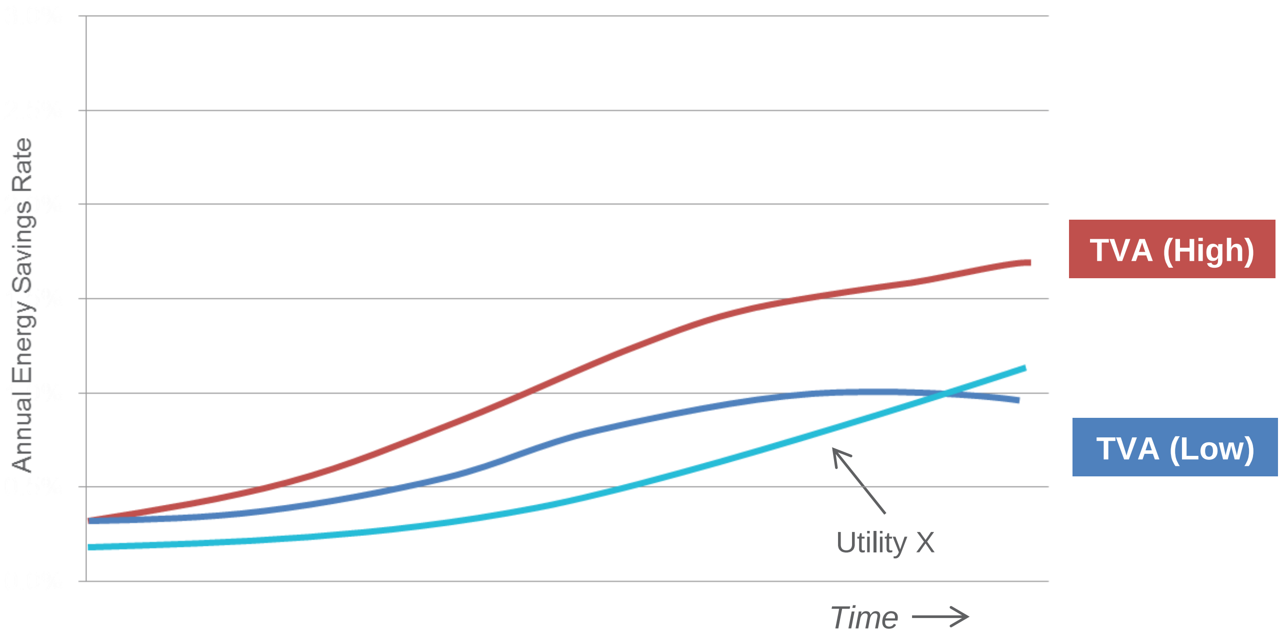
Benchmarking Peer Group

- The following utilities were used as a benchmarking peer group to help TVA understand how the initial IRP results compare to plans of other utilities in the region



- Tennessee Valley Authority (TVA)
- Entergy Arkansas
- Dominion (DOM)
- Duke Energy Progress (DEP)
- Duke Energy Carolinas (DEC)
- Georgia Power Company (GPC)
- Florida Power and Light (FPL)
- Gulf Power

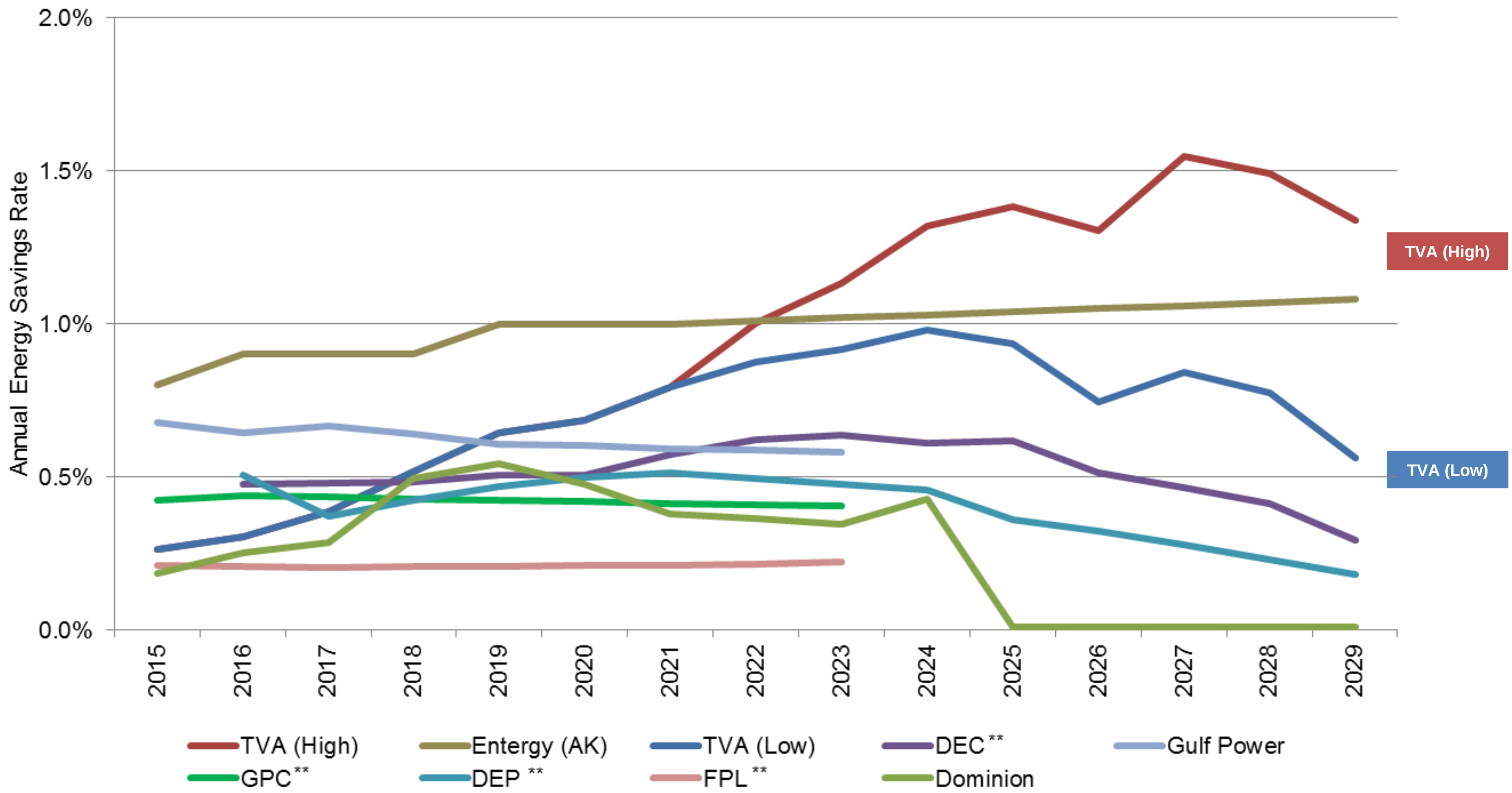
How to Read the Benchmarking Results (Illustration)



- The TVA curves represent the range of outcomes in the Current Outlook Scenario based on preliminary results

TVA (High)	Maximize Energy Efficiency
TVA (Low)	Reference Plan

TVA and Regional Peers



Sources and notes:
State Energy Efficiency Standards: Policy Brief, ACEEE; Commission Filings and Orders; Utility IRPs
** TVA results are based on EE savings at the generator (net of free ridership) and end user sales. Data represents initial 2015 IRP results only. Figures do not represent a recommended direction or specific plan*
*** Duke Energy Carolinas (DEC); Duke Energy Progress (DEP); Florida Power & Light (FPL); Georgia Power Company (GPC)*
**** Extrapolations were made in some cases when exact data was not available.*

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Views on Energy Efficiency Modeling Approach

John Wilson

Southern Alliance for Clean Energy

cleanenergy.org
Southern Alliance for Clean Energy

Views on TVA EE Modeling Approach

Presentation to

TVA "Evaluating Energy Efficiency in Utility Resource Planning" Meeting

February 10, 2015

John D. Wilson & Natalie Mims

TVA is Taking a New Approach

- **Dialogue has worked: TVA has been responsive to stakeholder input**
  - ➢ Comments on 2011 IRP
  - ➢ Comments during 2015 IRP process

- **SACE agrees that TVA's decision to evaluate energy efficiency as a resource is challenging, and applauds TVA for taking on this effort.**

- **SACE agrees that energy efficiency should be evaluated in the same way that all resources are, and that there are benefits and risks to each resource.**

Draft 2015 IRP Reduces EE

EEDR	2020 Goal	2030 Goal
2011 IRP, adjusted*	2700 MW	3800 MW
Draft 2015 IRP	**1000 MW**	**3200 MW**
Reduction in IRP Goals	1700 MW	600 MW
Maximum Achievable	**2500 MW**	**5900 MW**

*** 2011 IRP goals adjusted to reflect 1100 MW of avoided capacity achieved through EEDR programs 2008-13.**

Maximum achievable based on Chandler, S. and M. Brown, *Meta-Review of Efficiency Potential Studies and Their Implications for the South*, Georgia Tech, Working Paper #51, August 2009; assuming a 66% load factor for EE.

Concerns About EE Potential Assumptions and Methods

1. **Cap on growth rate for energy efficiency**

Improved values could increase near-term EE by as much as 70%.

2. **High costs for Tier 2 & Tier 3**
   - Tier 1 costs are reasonable

3. **“Risk premium” adds cost, not risk, to contingency factors**

Result:
EE Tier 3 costs are four times greater than current program costs, Roughly equal to the costs if Tier 3 programs failed.

This is not a “risk premium,” it is an assumption of program failure.

Concern 1: TVA's Growth Rate Caps

- **Method is OK**
- **Strongly disagree that the values selected by TVA are appropriate**
  - Growth cap is more restrictive than industry experience in the first five years
  - Growth cap is more relaxed than industry experience after EE programs scale up
- **Improved values could increase EE by 70% during the first five years relative to the Draft 2015 IRP.**

TVA's EE Growth Caps

- **Program expansion rate maximum of:**
  - 25% of prior year savings, per year for years 1-5
  - 20% of prior year savings, per year for years 6-15
  - 15% of prior year savings, per year after year 16
- **Annual savings capped at <1% of retail sales until 2021.**

Year	Growth Cap (25% of Prior Year Savings)	Maximum Program Size (Percent of Retail Sales)
2014		0.30%
2015	0.08%	0.38%
2016	0.09%	0.47%
2018	0.12%	0.59%
2019	0.15%	0.73%
2020	0.18%	0.92%

Evidence that Growth Can Be Greater

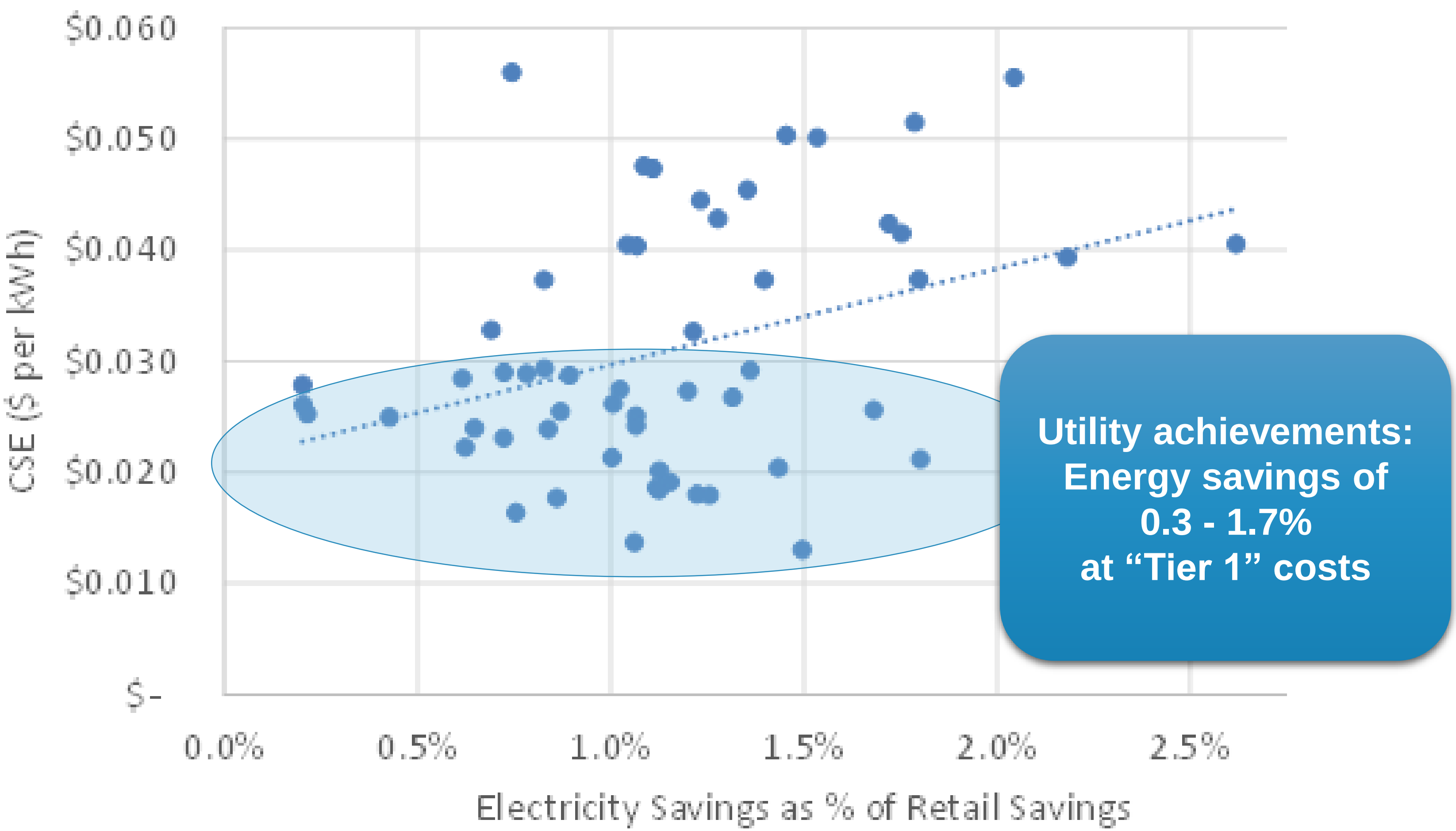
Actual Savings	2010	2011	2012	2013
Gulf Power				
Savings	n/a	0.35%	0.61%	0.80%
Growth rate			74%	31%
Georgia Power				
Savings	n/a	0.16%	0.26%	0.39%
Growth rate			50%	63%
Kentucky				
Savings	0.07%	0.15%	0.25%	0.52%
Growth rate		114%	67%	108%
Growth Cap	**2013**	**2014**	**2015**	**2016**
TVA				
Max Program Size	0.30%	0.38%	0.47%	0.59%
Growth Rate		25%	25%	25%

Concern 2: TVA's Program Cost Assumptions

- **Accept that "tiers" are needed for model to "work," but they do not reflect reality.**
- **Tier 1 costs are a reasonable basis for estimating the future cost of all energy efficiency.**
- **The model should not need such high (and unjustified) costs for Tier 2 & 3 to "work," and the artificial cost enhancement has no place in the final results.**

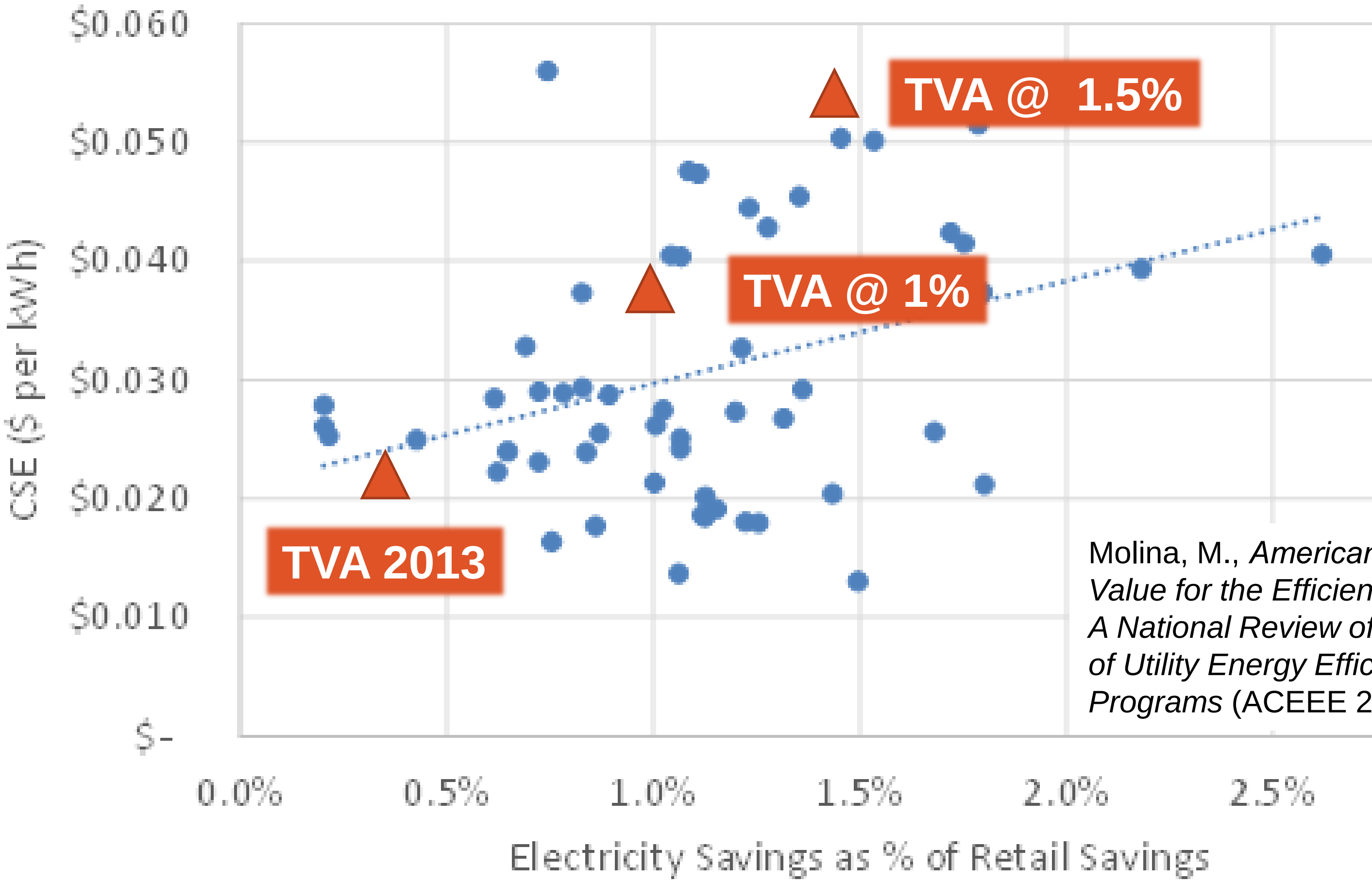
	Cost (LCOE)	Annual Savings (GWh)
Tier 1	1.3 – 3 cent/kWh	500 -1000
Tier 2	1.5 – 5 cents/kWh	50 -1000
Tier 3	3 – 6.5 cents/kWh	250 -1000

Program Costs Are Not Mainly Related to Program Size



cleanenergy.org Southern Alliance for Clean Energy

Tier 2 and 3 Costs Suggest TVA Would Become the Connecticut of the Southeast



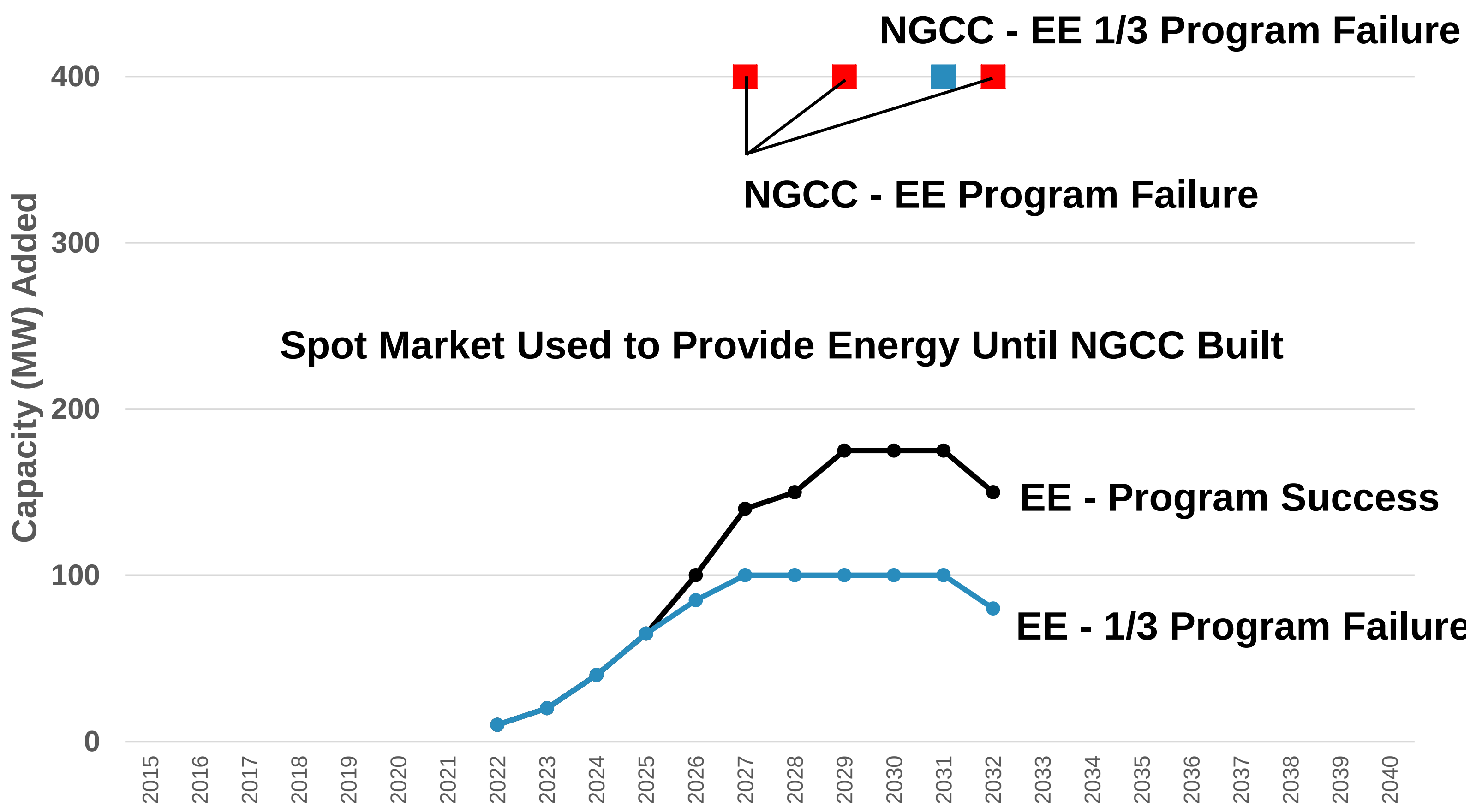
Molina, M., *American's Best Value for the Efficiency Dollar: A National Review of the Cost of Utility Energy Efficiency Programs* (ACEEE 2014).

Concern 3: TVA's Risk Premium Assumptions

- **SACE agrees with TVA that EE has risks**
- **The "risk premium" is really a "failure assumption"**
- **TVA modeled EE Tier 3 costs to be four times greater than current program costs**
- **Tier 3 costs are modeled at roughly the same cost as if the programs completely failed**
- **No utility should plan to implement EE programs at a cost that is equal to the cost of failure**
- **TVA's method: Model *<u>cannot</u>* show the benefits of EE as a least-cost resource**

Resource	Capital Contingency	Cost Escalation at Market Trend	Risk Premium	Stochastic Risk
EE Tier 1	✓	✓	10-30%	✓
EE Tier 2	✓	No	10-30%	✓
EE Tier 3	✓	No	20-30%	✓
NGCC	✓	✓	-	✓
Renewables	✓	Close	-	✓
Nuclear	✓	✓	-	✓

EE is a Low-Risk Resource (Focus on Tier 3 Block)



How TVA Gets to Four Times Costs

- **Historical EE cost**
  - Consistent with industry experience, costs escalate at 2% annually from current costs, no contingency factor
- **High-cost EE**
  - EE programs are delivered, but using Tier 3 cost, no contingency factor
- **High-cost EE w/contingency**
  - Tier 3 cost plus 20% contingency factor
- **High-cost EE w/contingency and risk premium**
  - 30% risk premium applied to cost & contingency factor

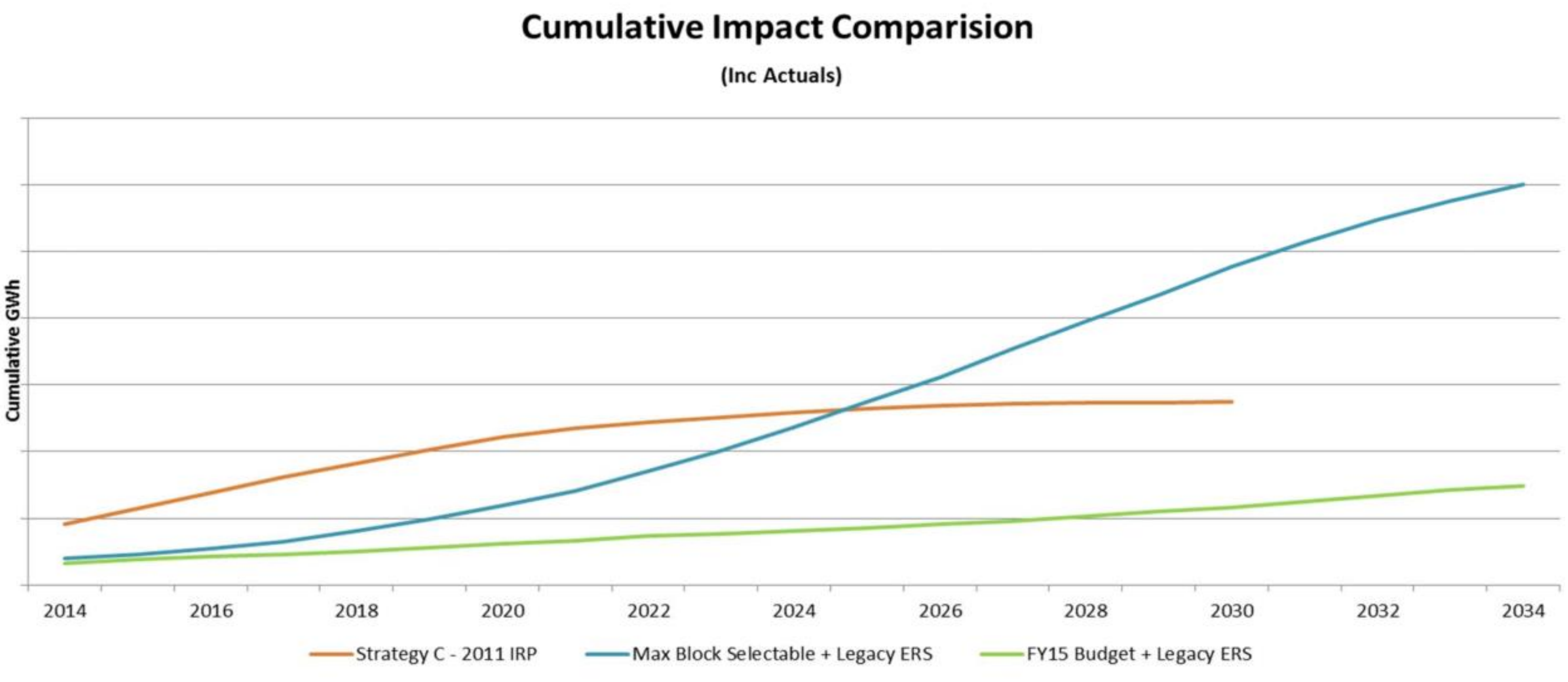
Risk Premium: Roughly Breakeven With 100% Program Failure

PVRR ($mm)	EE Success	1/3 Program Failure	100% Program Failure
Historical EE Cost	$ 754	$ 1,496	$ 2,939
High-cost EE	$ 1,988	$ 2,335	
High-cost EE w/contingency	$ 2,386	$ 2,605	
High-cost EE w/risk premium	$ 3,084	$ 3,074	

- **High-cost EE w/risk adder equals 100% program failure**
- **Because the costs are no different, the risk premium effectively assumes 100% program failure**

Appendix
Solutions and Additional Data

Growth Caps Limit Model Below 2011 IRP Decision



Growth Rate Cap Solutions

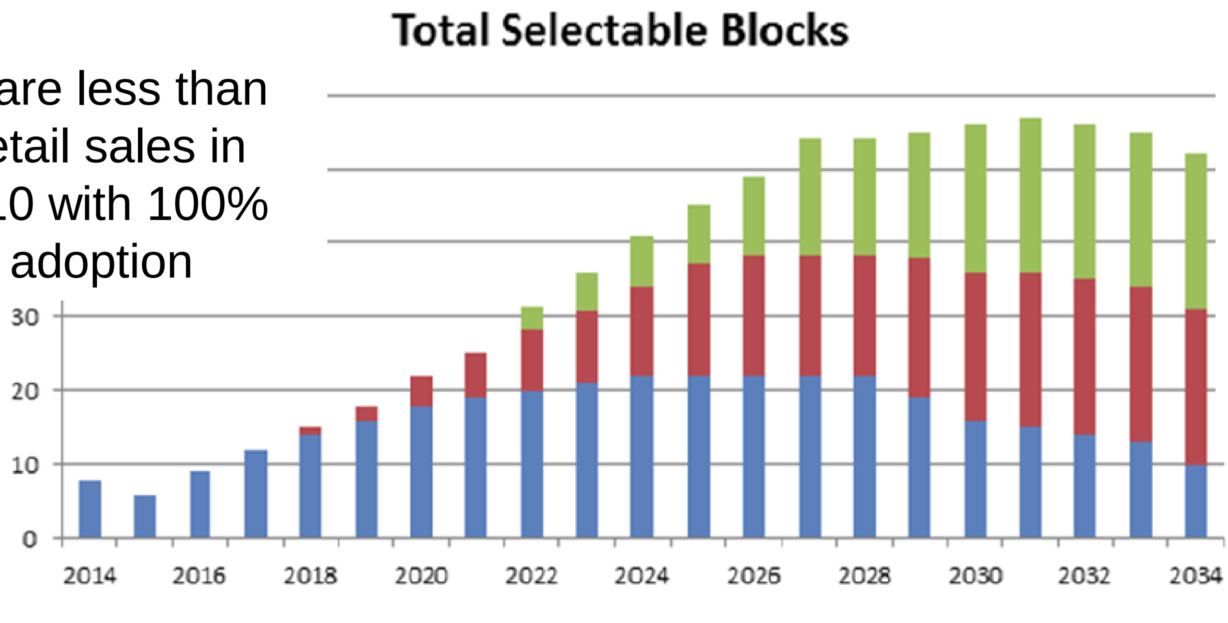
- **Not Recommended: Higher growth rate caps**
  - 40% cap: At 0.3% of retail sales, growth to 0.42% is realistic … but at 1% of retail sales, growth in one year to 1.4% of retail sales is unrealistic.
- **Inverse cap structure**
  - Example: Assume maximum program size of 1.5% of retail sales, growth capped at 20% of difference between current program and maximum.
    - 0.3% + (1.5% - 0.3%) x 20% = 0.54%
    - 1.0% + (1.5% - 1.0%) x 20% = 1.1%
- **Inverse cap + load growth structure**
  - Example: Also assume programs can expand by 10% of load growth. Examples given are at 1% and 2% load growth.
    - 0.3% + (1.5% - 0.3%) x 20% + 1% * 10% = 0.64% (or 0.74%)
    - 1.0% + (1.5% - 1.0%) x 20% + 1% * 10% = 1.2% (or 1.3%)
  - Note: If load contracts (stochastically) then program cap would also contract.
  - 10% of load growth assumption: for example, 50% participation rate with 20% average savings for new construction / load sources

Impact of Switching to Inverse Cap + Load Growth

Year	TVA Cap (% of Retail Sales)	Alternative Cap @ 1% Load Growth (% of Retail Sales)
2014	0.30%	0.30%
2015 (Y1)	0.38%	0.64%
2016	0.47%	0.91%
2018	0.59%	1.13%
2019	0.73%	1.30%
2020 (Y5)	0.92%	1.44%
Cumulative	**3.4%**	**5.7%**

TVA's Program Cost Assumptions

Savings are less than 1% of retail sales in years 1-10 with 100% block adoption



Savings are less than 1.5% of retail sales in years 10-20 with 100% block adoption

	Cost (LCOE)	Annual Savings (GWh)
Tier 1	1.3 – 3 cent/kWh	500 -1000
Tier 2	1.5 – 5 cents/kWh	50 -1000
Tier 3	3 – 6.5 cents/kWh	250 -1000

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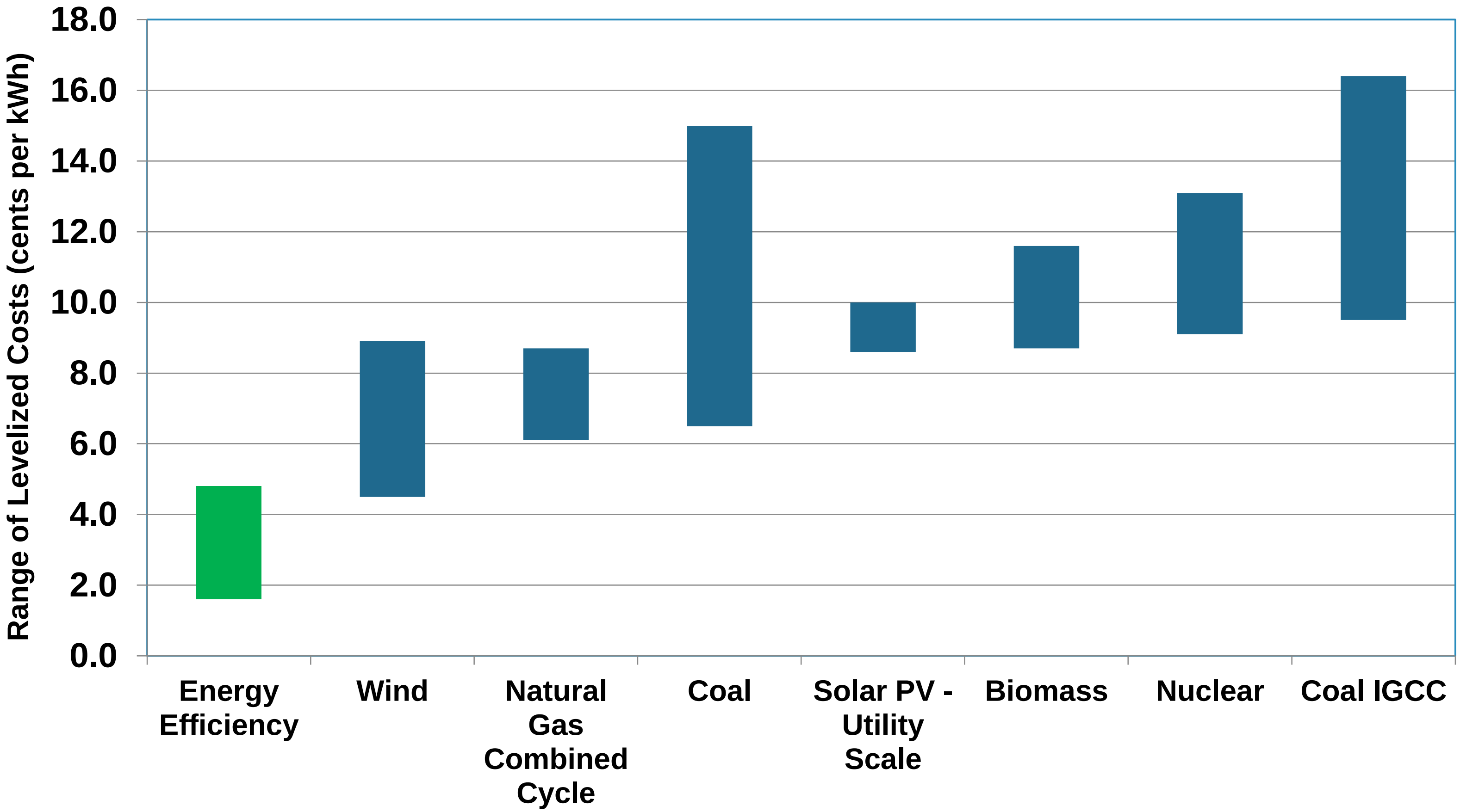
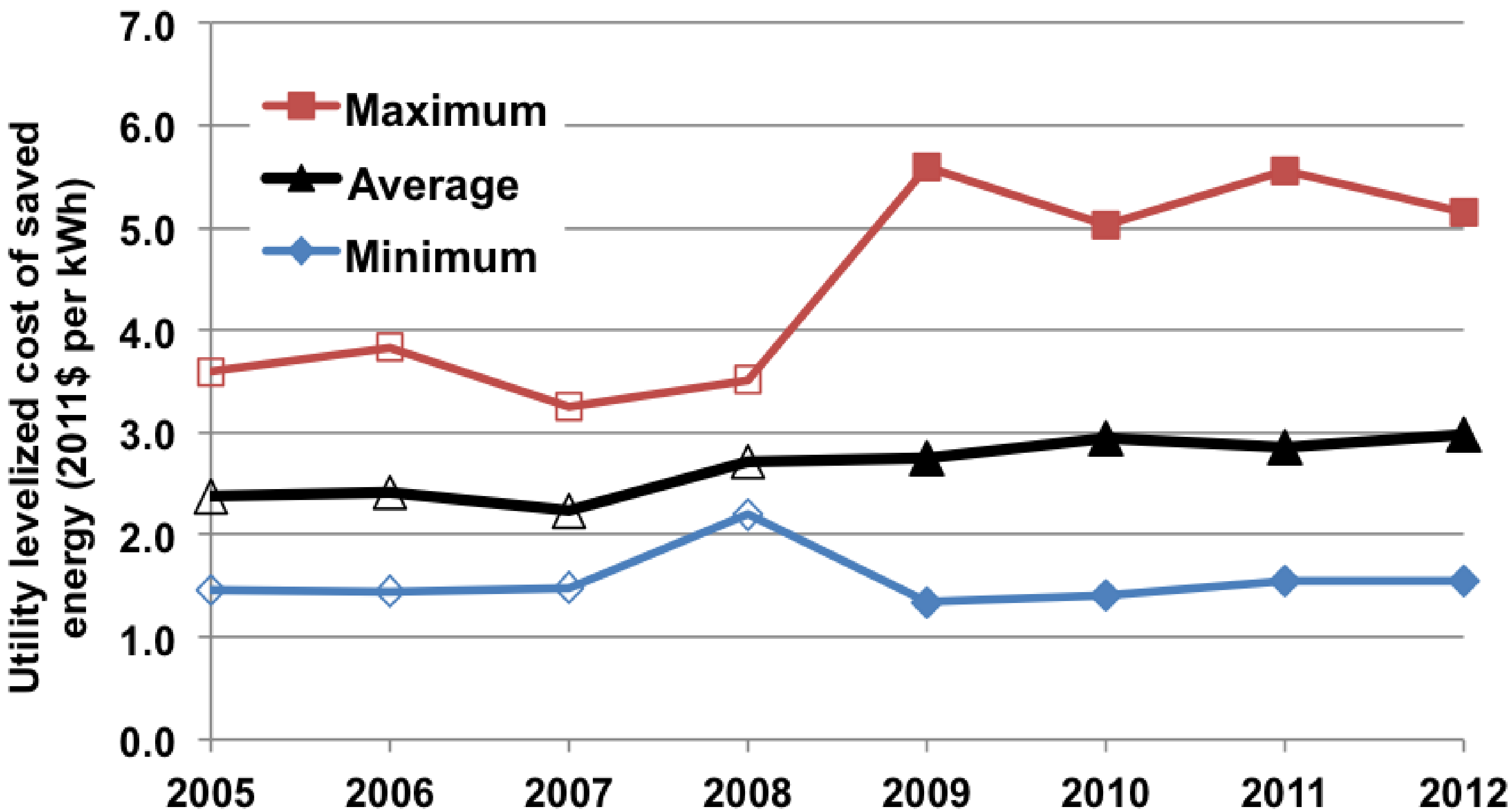
Resource Costs



Energy efficiency program portfolio data from Molina 2014; All other data from Lazard 2014.

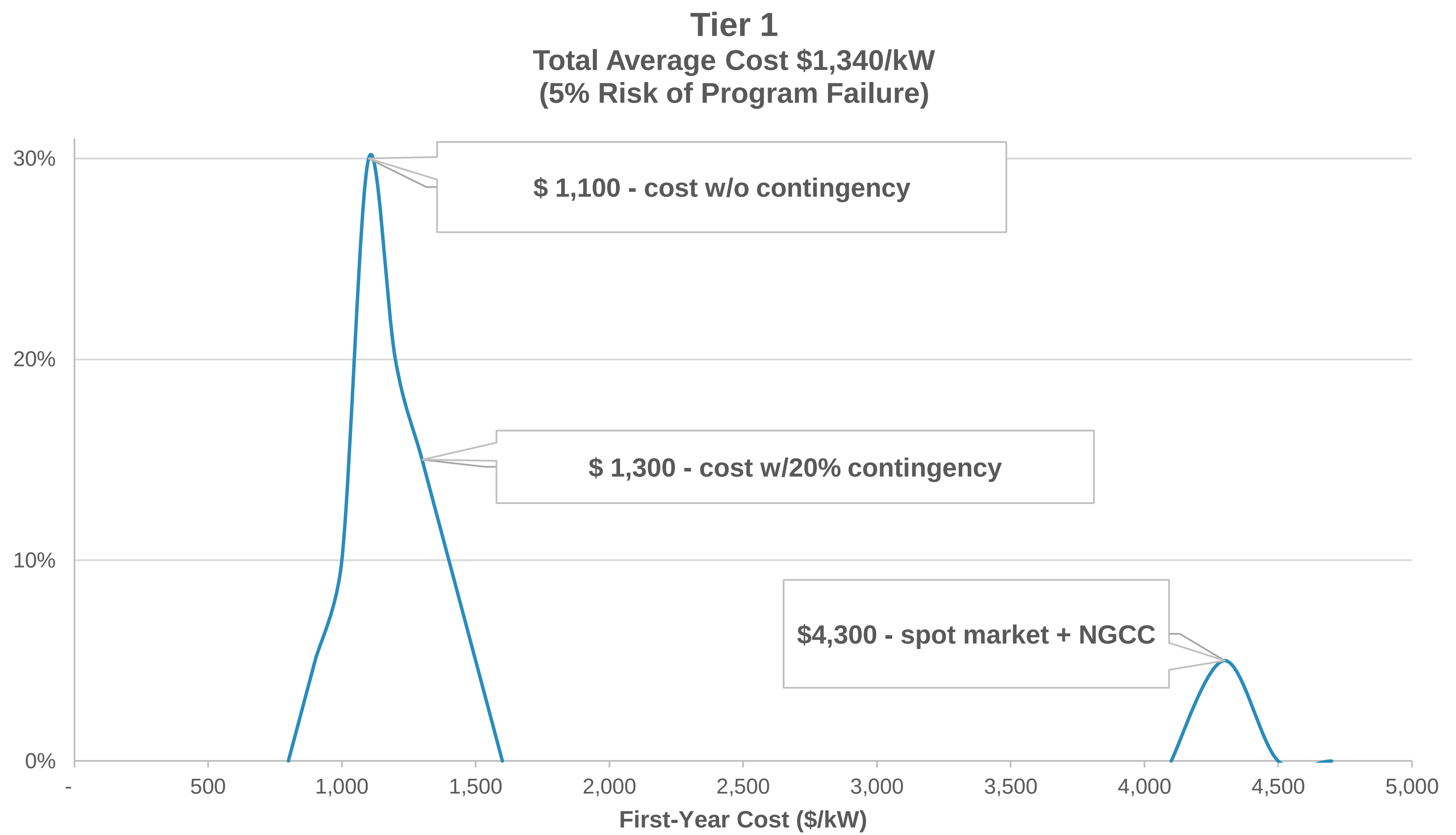
Evidence That Costs Don't Escalate Rapidly



TVA's Risk Premium Assumptions

- **Reasons TVA Gives To Support Risk Premium**
  - Local power companies would vary in how they deliver EE (assumes substantial net downside variation in the short term)
  - Technology, codes & standards, and experience suggests anticipated efficiency resource may not materialize
- **SACE agrees that these are reasonable issues, but other utilities also deal with similar issues without using a "risk premium" in costs**
- **TVA has its own advantages that mitigate risk**
  - Highly contiguous territory, including an entire state, creating greater opportunity for governmental cooperation and lack of "leakage" and "wasted" marketing costs
  - Effectiveness of EE programs in winter adds additional value during winter peak events
  - Lack of shareholder disincentives to investment
  - Opportunity to use debt to finance EE when not needed for capital projects
  - Opportunity to leverage LPCs, local governments, Seven States for additional debt financing of EE programs
  - Others?

Tier 1: Stochastic Risk Solution



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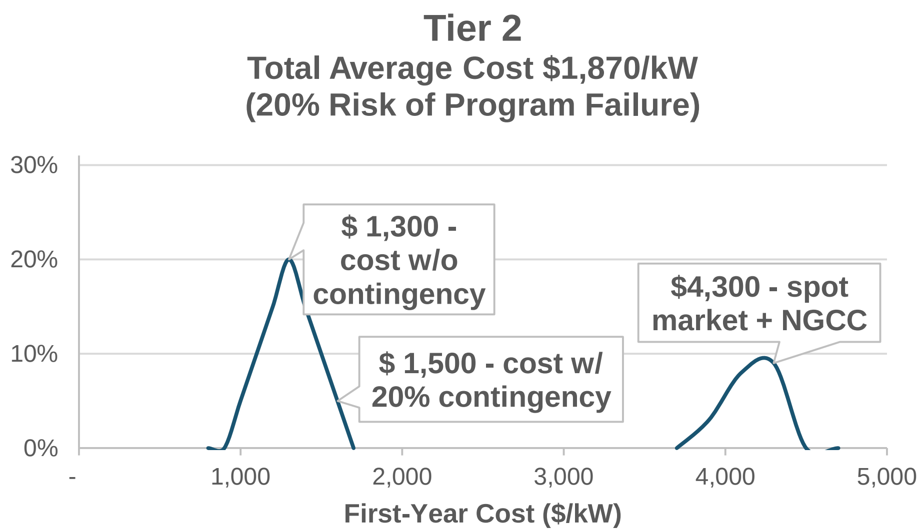
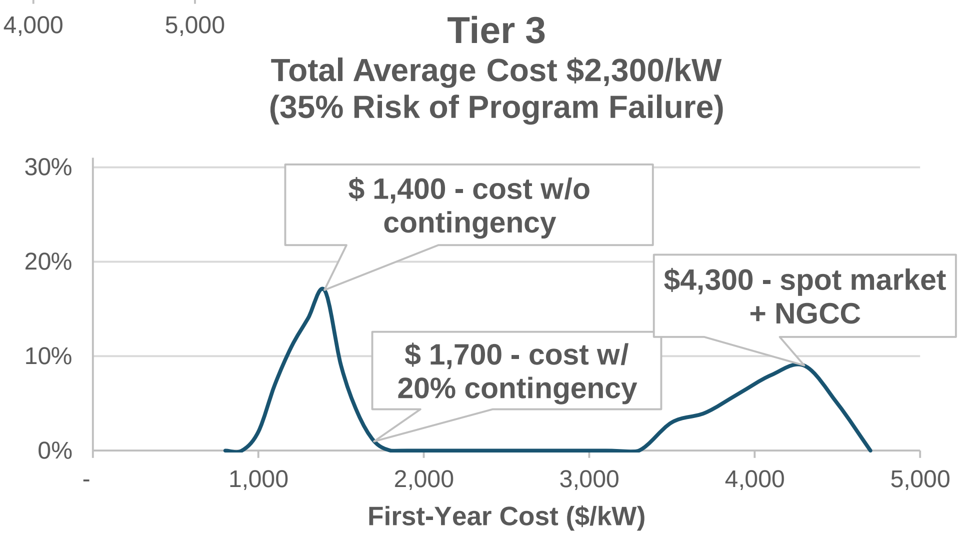
Higher Tiers Solution





Comments on Cost/Risk Solution

Observations

- **Suggested average cost for Tier 3 is a reduction of roughly 1/3**
- **Risk is measured as risk, not as cost**
- **MIDAS should "draw" CO_2 emissions consistent with risk for EE**
  - e.g., for Tier 3, 35% of the time, emissions are equivalent to NGCC with associated costs

Key Assumptions

- **Tier 1: $1,100/kW (@2%)**
- **Tier 3: $2,900/kW (@2%)**
- **Spot market: $100/MWh (@3%)**
- **NGCC: $1,000/kW (@3%, 8% amortization thru 2040)**
- **NGCC Production: $50/MWh (@ 3%)**
- **Discount Rate: 6%**

Assessment of the TVA Methodology

Mark Klan

Navigant Consulting

Introduction and Context

- In Tennessee Valley Authority's (TVA's) current activity to prepare a 2015 Integrated Resource Plan (IRP), they are modifying their approach to handling of Energy Efficiency (EE)
- The new approach considers EE as a selectable resource in capacity expansion modeling and associated resource planning
- In summer 2014, Navigant Consulting, Inc. (Navigant) reviewed the evolving approach in light of both EE programmatic assumptions and system modeling
- Working with TVA program, resource planning, and IRP staff to obtain input and clarifications, Navigant performed an independent assessment
- Navigant submitted its report to TVA on 28 July 2014 ("Review of Energy Efficiency Assumptions and Related System Modeling Approach for Integrated Resource Planning")
- This seminar presentation provides a summary of that assessment

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Scope of Assessment

- Navigant's review of IRP-related EE focused on assumed cost and performance, and the planned incorporation into resource modeling
- Task 1 involved review of cost and performance assumptions for EE, including:
  - Block and sector structure
  - Pricing tiers and breakpoints
  - Program costs and expansion rates
  - Load-shape assumptions
  - Lifespans
  - Cost escalation/de-escalation
- Task 2 emphasized the planned resource modeling approach for EE, including:
  - Overall approach feasibility and reasonableness, especially regarding capacity expansion modeling and fleet strategy
  - EE penetration and modeled ramp-up constraints
  - Balance between realism and modeling simplicity
  - Model implementation strategy to ensure comparability among resource alternatives

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Summary of Results and Insights (1 of 3)

- Overall, TVA's planned approach and assumptions are reasonable, and no major "show-stoppers" have been identified
- In some areas, however, TVA's assumptions appear to lead to a conservative treatment of EE, while other assumptions appear optimistic (mostly due to current data limitations)

<u>Key Comments on EE Program Assumptions Related to IRP Modeling</u>

- TVA estimates for EE Technical Potential and Economic Potential are within a reasonable range, though conservative
  - Both the timing and amount of savings could be affected by including early retirement programs, however
- TVA's three-step process for estimating the annual level of market penetration is reasonable, covering adoption of retrofit measures, replace-on-burnout measures, and translation of results into achievable savings estimates
- Building decay and end-of-measure life treatment appear to overstate savings over the forecast period – probably in the 5-10% range

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Summary of Results and Insights (2 of 3)

<u>Key Comments on EE Program Assumptions Related to IRP Modeling (cont.)</u>

- » Market adoption methodology is relatively static based on expert opinion and non-TVA consumer research, which is reasonable for base case assessments
  - – Approach may not readily accommodate changes to incentive levels and associated program participation rates
- » Load shapes in the TVA EE Technical Resource Manual are developed similarly to some other utilities – in lieu of extensive building metering, the approach is appropriate (and is being updated as EM&V assessments are completed)
- » Method of creating EE blocks that apply load shapes to annual estimates of potential at the measure/end-use level appears reasonable
- » Regarding tier assumptions for EE blocks, Tier 1 blocks appear to be directly mapped from program level assumptions to unique sector blocks of about 10 MW each
  - – Block-level cost structure appears to assume a nearly one-to-one relationship between increased program costs and increased savings, as opposed to Navigant's experience suggesting lower EE impacts for additional incentives

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Summary of Results and Insights (3 of 3)

Key Comments on System Modeling of EE

» Regarding persistence of implemented EE over time, examination of preliminary modeled outcomes suggests a possible upward bias to EE estimates, with higher bias in earlier years

» Considering block comparability in preliminary output, the combination of increasing numbers of installations and decreasing incentives (in real dollars) is counterintuitive, as declining real payments to consumers would likely decrease participation interest

» Regarding cost treatment and its implications for system modeling, there is substantial uncertainty in both cost and performance for the EE blocks available for selection by TVA's capacity expansion model
  – Ongoing TVA EM&V efforts are a step in the right direction to reduce uncertainty

» IRP modeling should allow for effective exploration of alternative strategies under a variety of scenarios, and TVA is generally well-positioned to do this
  – Support for examining sensitivities is less clear, due to limited variability in EE blocks during capacity expansion selection – most of the ability to explore EE variation is in downstream energy modeling after block selection is fixed

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Bottom-Line and TVA Response (1 of 2)

- On balance, TVA appears to be relatively well-positioned to introduce energy efficiency into IRP modeling as a model-selectable resource, as opposed to forcing in pre-set amounts at pre-determined times
- Strong Aspects of TVA Approach:
  - Detailed coordination between EE and Resource Planning groups to provide reasonable inputs and plausible outputs
  - Technical estimates of EE potential and market penetration
  - EE block creation for resource modeling purposes
  - Overall resource modeling methods and ability to evaluate strategies and scenarios
- Areas for Further Work:
  - Approach and preliminary results rely heavily on methods and assumptions that are not yet fully validated (but work is ongoing)
  - Building decay and end-of-measure life treatment
  - Ability to model incentive levels and associated program participation rates
  - Block-level cost structure, performance, and relationship between program costs and savings
  - EE persistence over time

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Bottom-Line and TVA Response (2 of 2)

» As of late July, TVA's resource planning group was exploring modifications to the planned approach, partly based on the Navigant assessment:
  – Adjusting relationship between increased incentives and increased EE achieved
  – Examining a possible risk-adjusted planning factor
  – Examining potential upward bias of EE estimates (through net-to-gross ratios and associated energy impacts)
  – Allowing for building decay and end effects through variation in the annual incremental EE block potential assumption
  – Performing sensitivity analysis related to potential energy standards changes

» Further approach changes being considered include:
  – Modifying EE load shapes across the tiers (which have differing technology)
  – Modifying EE load shapes over time to allow for varying impacts

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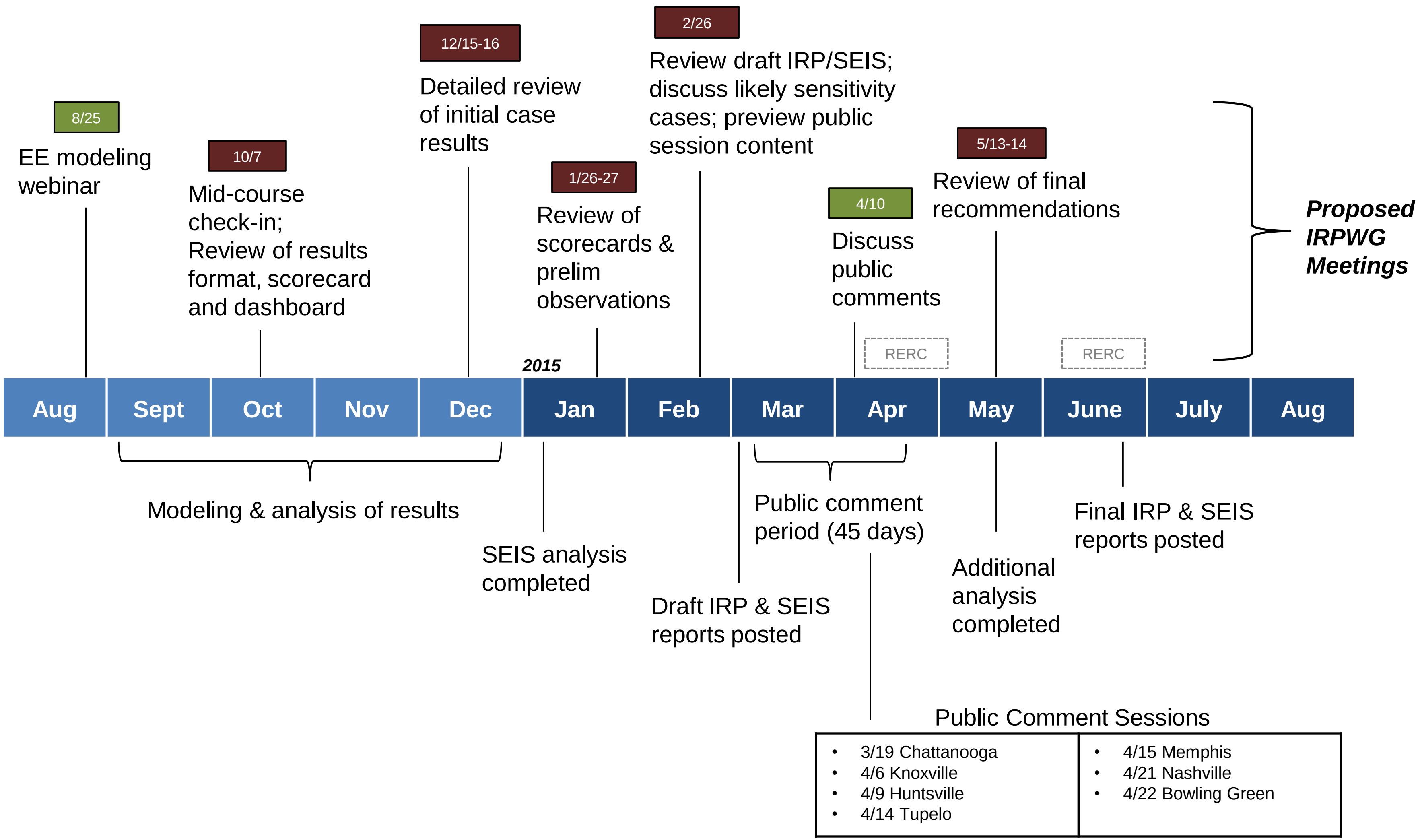
Seminar Audience Q&A

Concluding Remarks and Close

Joe Hoagland

Tennessee Valley Authority

2015 IRP/SEIS Schedule: Major Milestones & Stakeholder Sessions



The Path Forward

- Document the input gathered from today's seminar and vet at the IRP Working Group meeting scheduled for February 26, 2015
- Run sensitivity analysis for select model parameters, e.g., ramp-rate, uncertainty, risk, etc.
- The TVA IRP management team is available to answer additional questions and to gather additional comments

Thank You for Your Participation and Input!