2015 Integrated Resource Plan

IRPWG Meeting

Session 6

April 29-30, 2014

IRPWG Meeting – April Agenda

	Day 1	
9:30	Welcome	Randy McAdams
9:45	Introduction to Stochastic Modeling and Application to the IRP	Scott Jones
10:30	*Break*	
10:45	Modeling Approach for Energy Efficiency	Edward Colston
11:45	*Lunch*	
12:30	Overview of Commodity Methodology Forecasting	Connie Trecazzi/ Patrick Obrien
1:15	Methodology for Evaluating the IRP Economic Impact	Wesley Nimon
2:00	*Break*	
2:15	Metrics Discussion	Gary Brinkworth
4:00	*Adjourn*	

	Day 2	
9:00	Summary of Previous' Day Metrics Discussion	Gary Brinkworth
9:30	Overview of the Current Power Supply Plan	Scott Self
10:30	*Break*	
10:45	Summary of Proposed Strategies	Gary Brinkworth
11:30	Next Steps	Randy McAdams
11:45	*Adjourn*	

2015 IRP Schedule: Major Project Phases and Milestones

***The 2015 IRP is intended to ensure transparency and enable stakeholder involvement*.**

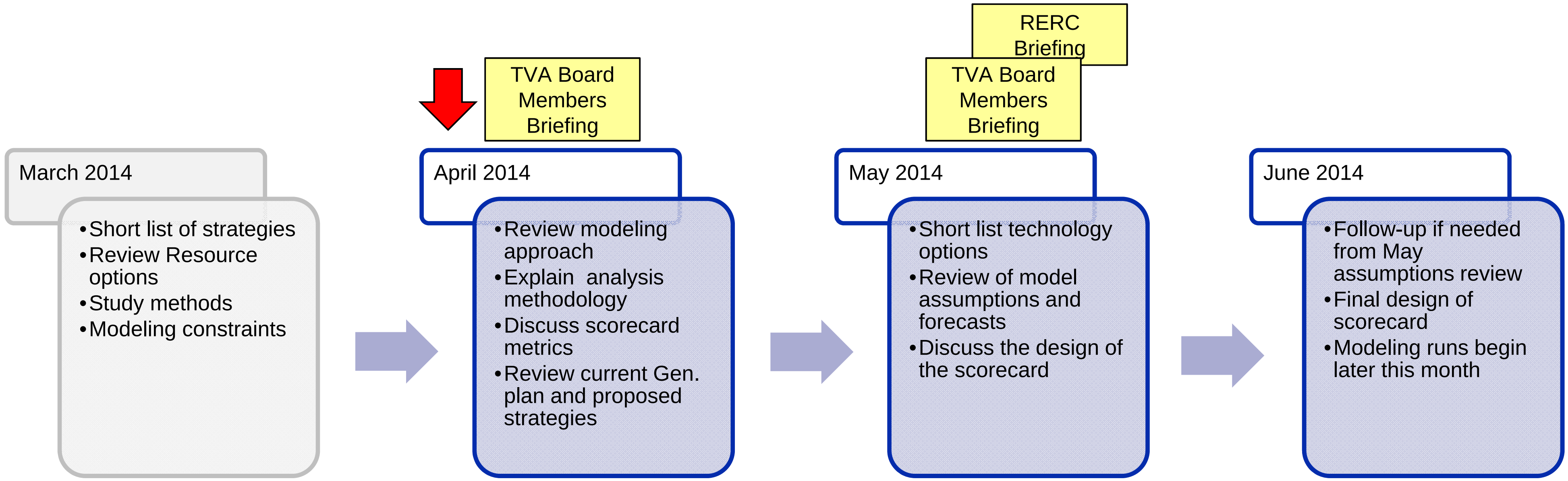
Spring/Summer 2013	Fall/Winter 2013	Spring 2014	Summer 2014	Fall 2014	Fall/Winter 2014	Spring 2015
Prep	Scoping **	Develop Inputs & Framework	Analyze & Evaluate	Present Initial Results **	Incorporate Input	Identify Preferred Plan/Direction

Public Engagement Period
(** indicates timing of Valley-wide public meetings)

Key tasks/milestones in this study timeline include:

- Establish stakeholder group and hold first meeting (Nov 2013)
- First modeling runs (June 2014)
- Publish draft Supplemental Environmental Impact Statement (SEIS) and IRP (Nov 2014)
- Complete public meetings (Jan 2015)
- Final publication of SEIS and IRP and Board approval (exp. Spring 2015)

April 29th-30th IRPWG Meeting Objectives



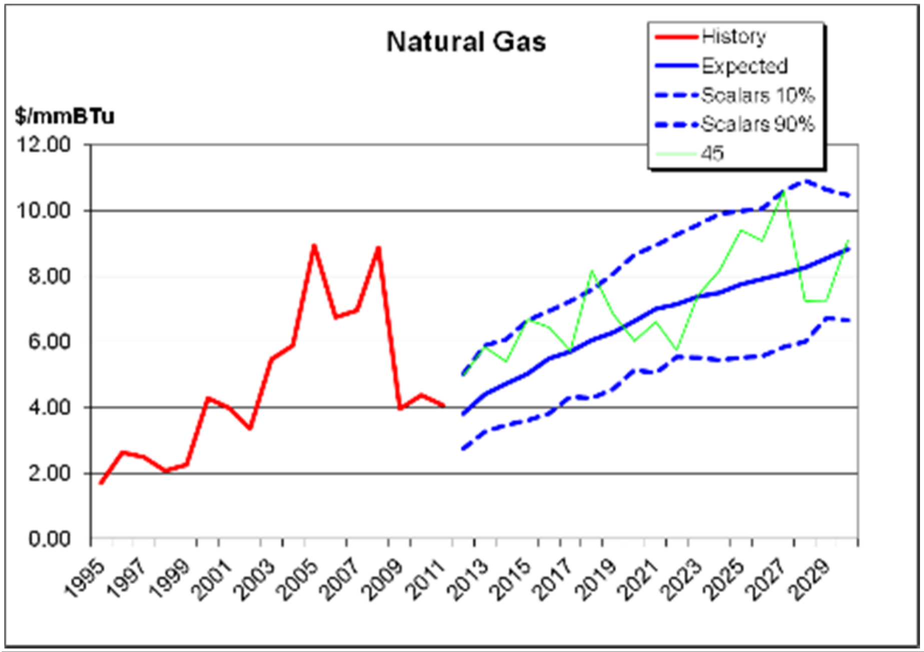
During today's meeting we aim to accomplish the following objectives:

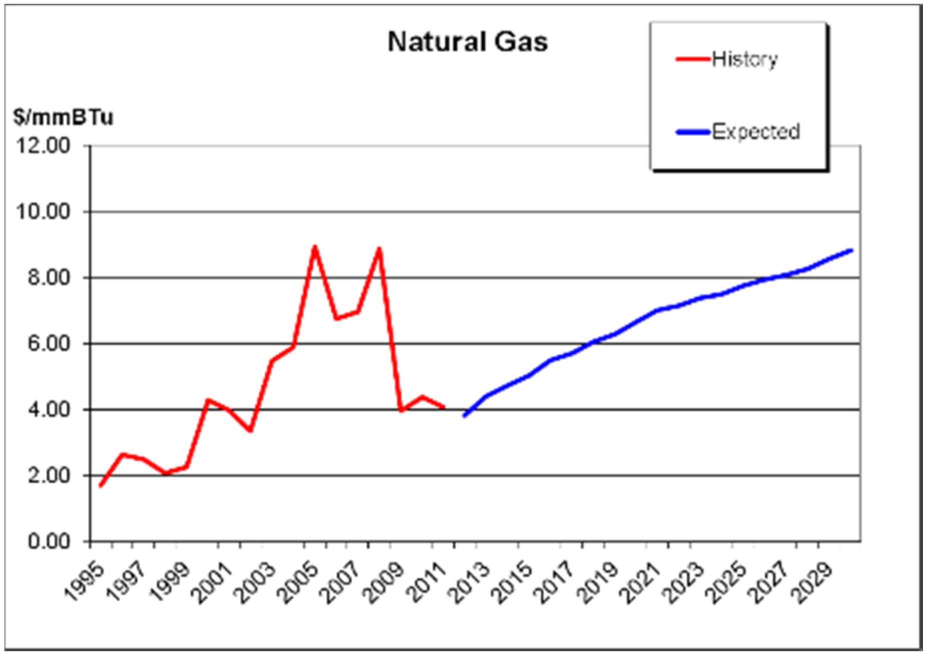
- Provide a detail explanation on the modeling approach in certain areas, as it was requested by the group during April's session:
  - Energy Efficiency
  - Commodity Forecast
- Explain basic concepts on stochastic analysis of portfolios
- Discuss with the group the approach to metrics that TVA is currently considering
- Review the current generation plan and the proposed strategies, as it was requested by the group during April's session
- Explain the next steps in order to prepare for the May session

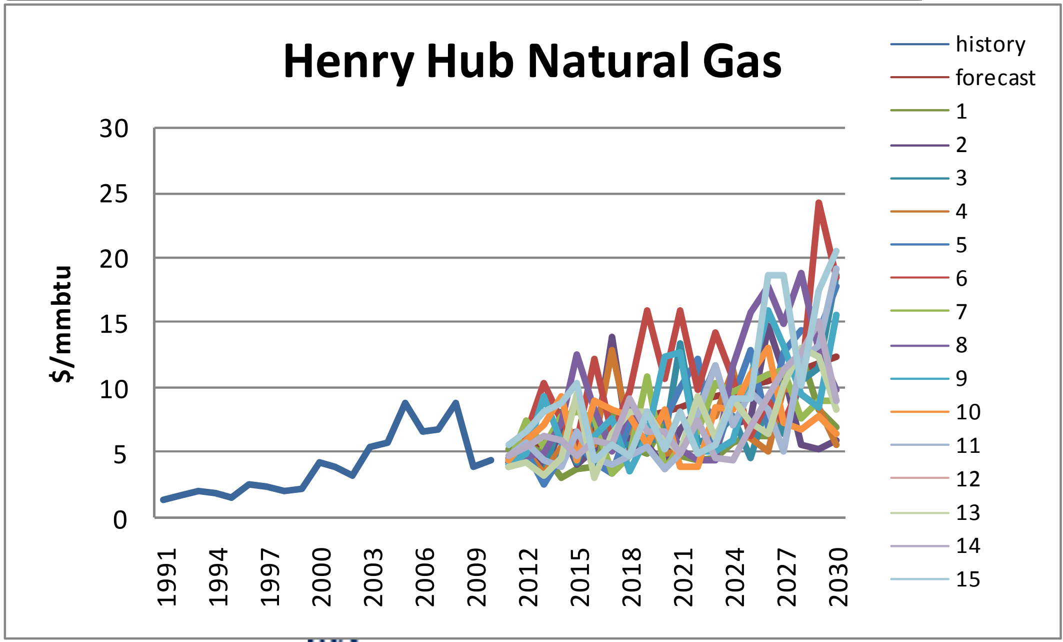
Considering Uncertainty in Resource Planning

- **Forecasts will inevitably be wrong**! Variability is a result of supply/demand disruptions, weather, market conditions, technology improvements, and economic cycles

- Monte Carlo simulation allows for a better understanding of the richness of possible futures, as well as their likelihoods, so that plans can be made proactively, as opposed to reactively





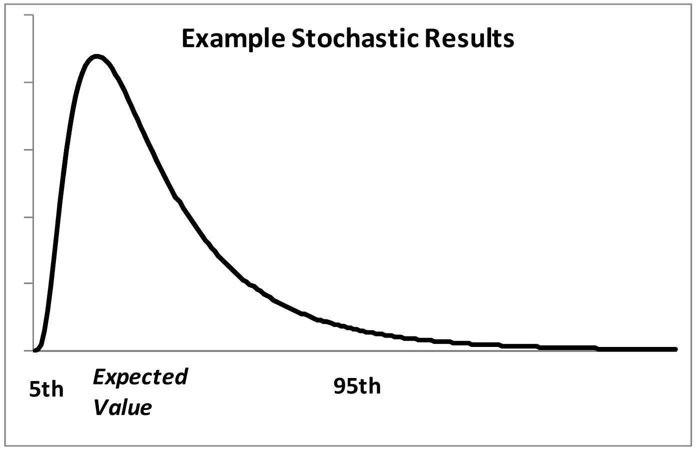


Considering Uncertainty in Resource Planning

Stochastic Analysis of Production Cost and Financials Bound Uncertainty

- A stochastic model estimates probability distributions of potential outcomes by allowing for simultaneous random-walking variation in many inputs over time

- At TVA, a representative Monte-Carlo distribution comprised of 72 stochastic iterations is developed for each of the portfolios (plan cost)
  - A sample stochastic result is shown to the right

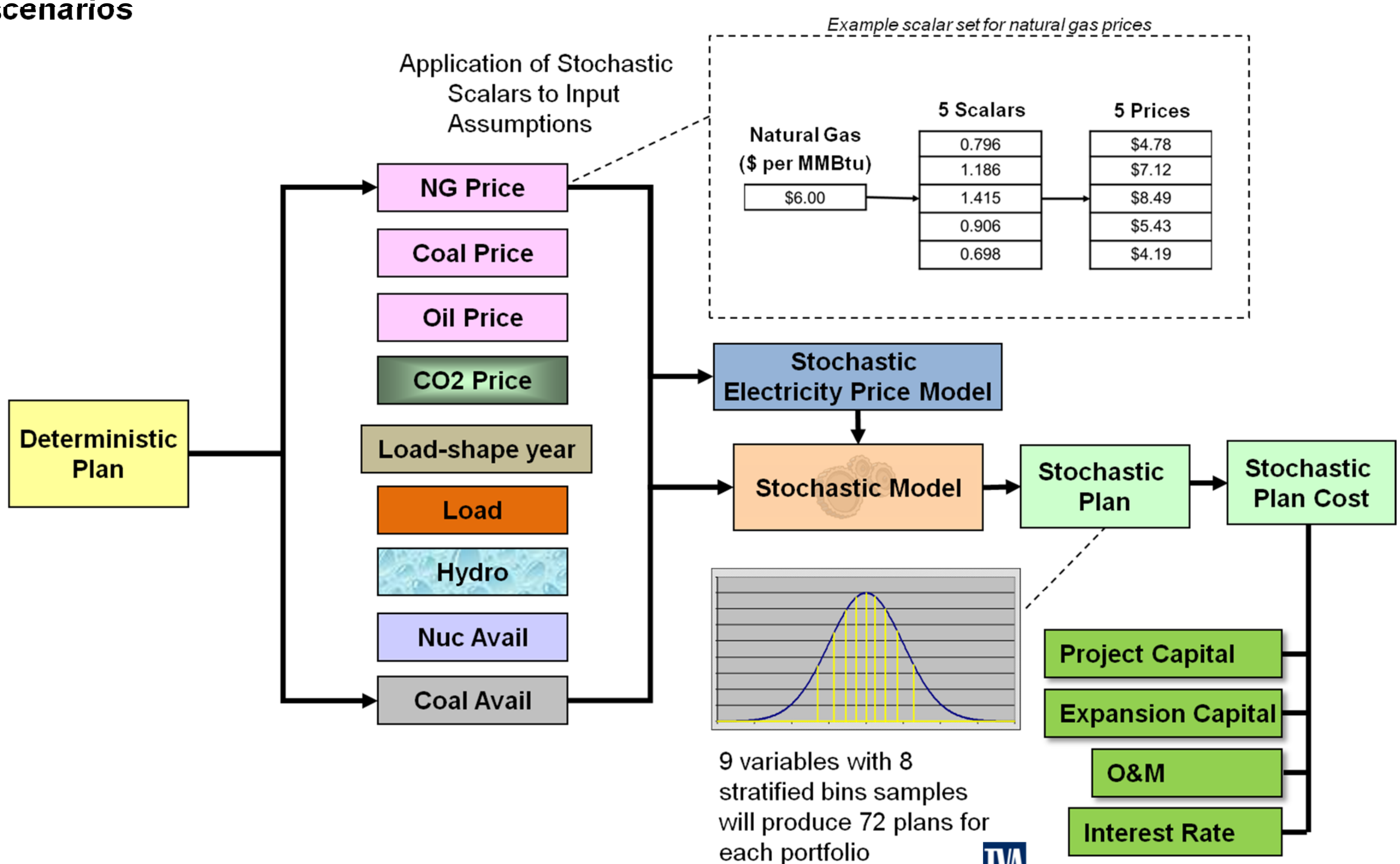


- The following uncertainties vary in each of the stochastic runs
  - Gas price
  - Coal price
  - Oil price
  - CO_2 allowance price
  - Load Shape Year
  - Electricity demand
  - Electricity price
  - Interest rates
  - O&M costs
  - Capital costs
  - Hydro generation
  - Fossil availability
  - Nuclear availability

- Ranking metrics (cost and risk) are computed based on the expected values produced from these stochastic iterations

Portfolio Stochastic Analysis

- Many **variables have been examined to determine which have the greatest impact to TVA's production costs. This list represents many of the top driver's of TVA's production costs**
- **Other variables such as EE/DR impacts and costs, changes in load shapes, construction delays, legislative rulings, CCS breakthroughs, and game-changing technology can best be modeled as scenarios**



Parameters for Creating Distributions

Latin Hypercube Sampling

- Advanced method of Monte Carlo draws which reduces the required number of samples while maintaining correlation, mean, standard deviation, and other moments of the distributions

2 Time Frames (2 Factor Model)

- Annual and Monthly (seasonal)

Simple and Complex Distributions

- Normal, Lognormal, Uniform, Triangular
- Constant Variance (CV) – requires standard deviation only (i.e. outages)
- Random Walk (RW) – requires volatility only (i.e. stock prices)
- Mean Reverting Random Walk (MR-RW) – requires volatility and mean reversion rate (i.e. hydro)

Distribution Adjustors

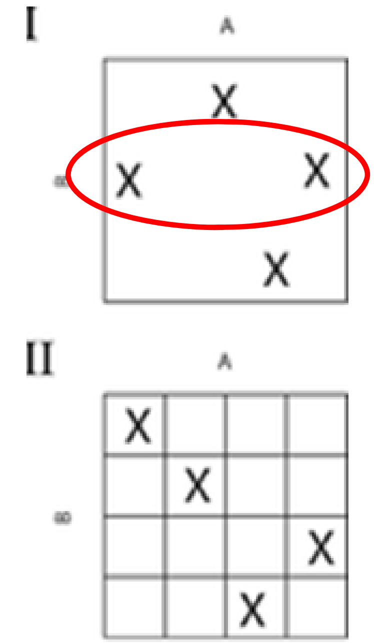
- Skewness and Kurtosis Inputs
- Max and Min Values
- Smoothing

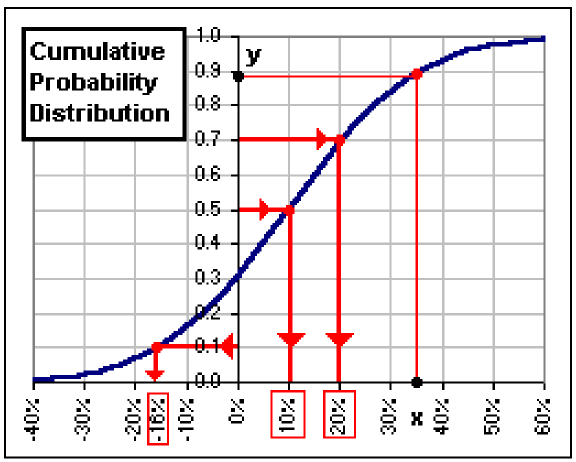
Distribution characteristics can vary annually and/or monthly

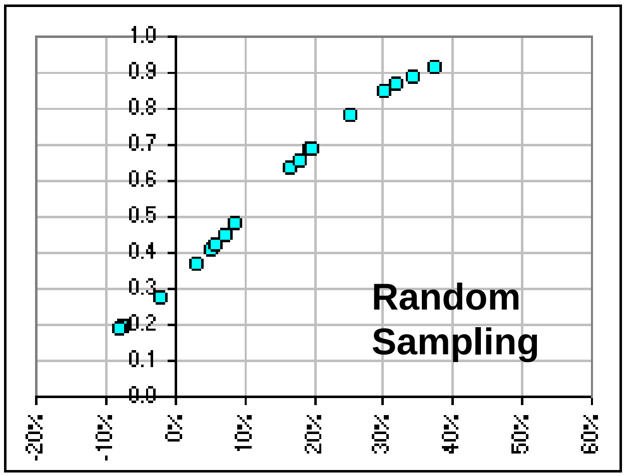
Latin Hypercube

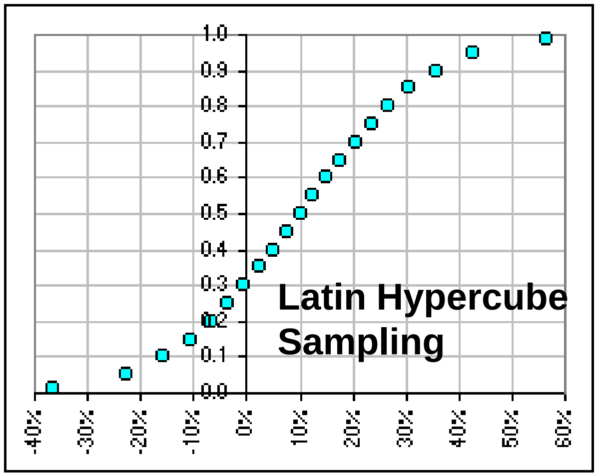
Latin hypercube sampling (LHS) is a statistical method for generating a sample of plausible collections of parameter values from a multidimensional distribution:

- In **random sampling** new sample points are generated without taking into account the previously generated sample points. One does thus not necessarily need to know beforehand how many sample points are needed
- In **Latin Hypercube sampling** one must first decide how many sample points to use and for each sample point remember in which row and column the sample point was taken
- Extrapolating this out to more samples, the Latin Hypercube sampling fills out the distribution better than random samples.









Example 1: Monthly Variation
Weather-Only Load Uncertainty

Source of Range

Historical weather normalized and non-weather normalized data, heating & cooling degree days,

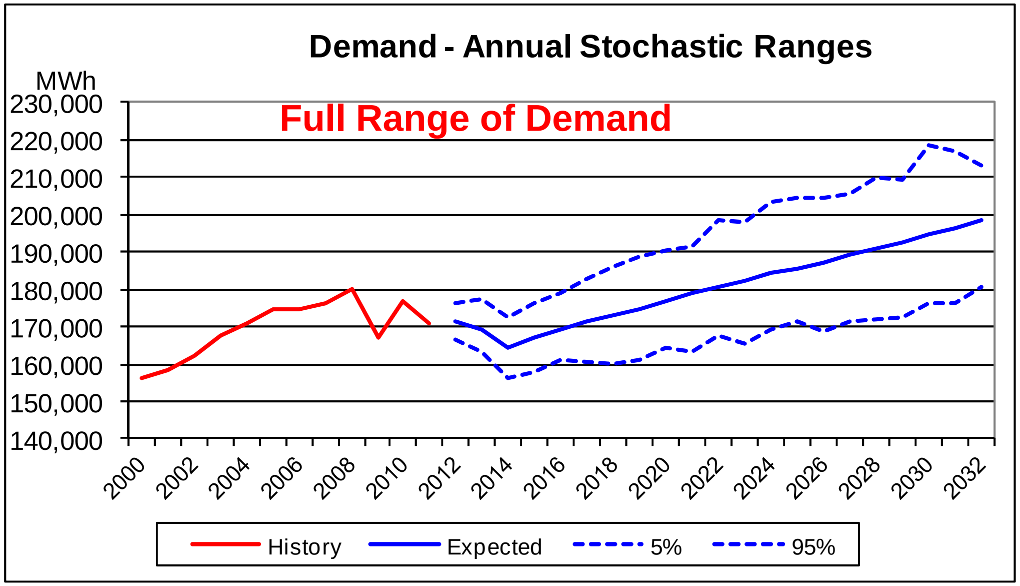
Distribution

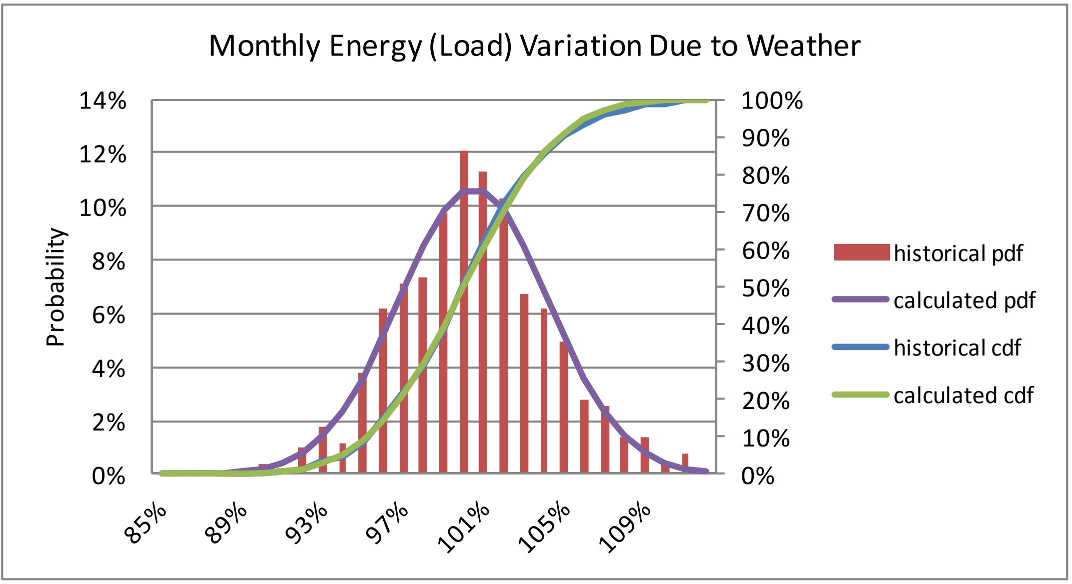
1 factor, Log-normal, mean reverting, random walk

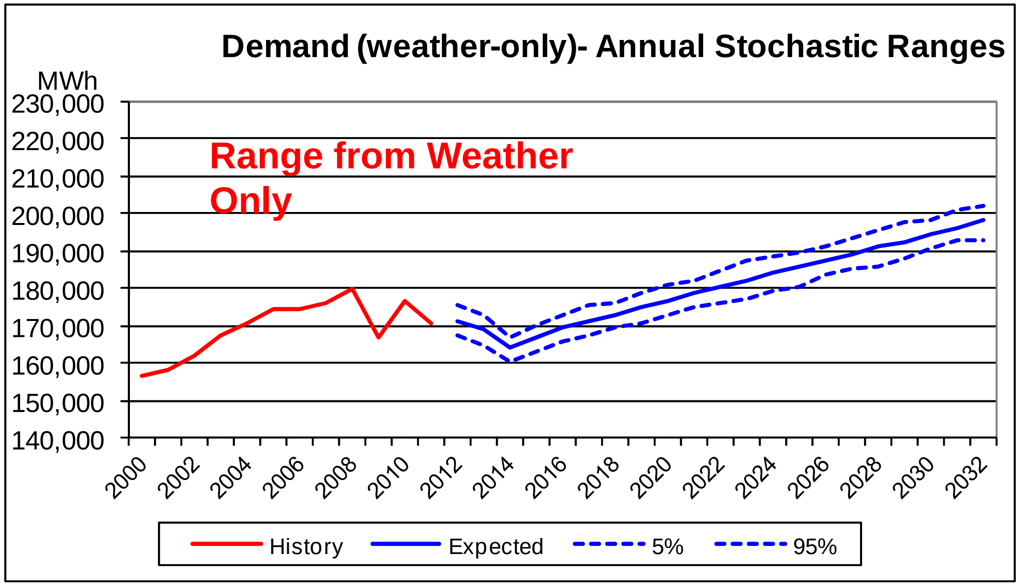
	Volatility	Mean reversion rate
Monthly	3.7%	1.4 months

Correlated with

None







Example 2: Annual Variation
Load Uncertainty (including Weather)

Source of Range

Historical weather normalized and non-weather normalized data, heating & cooling degree days

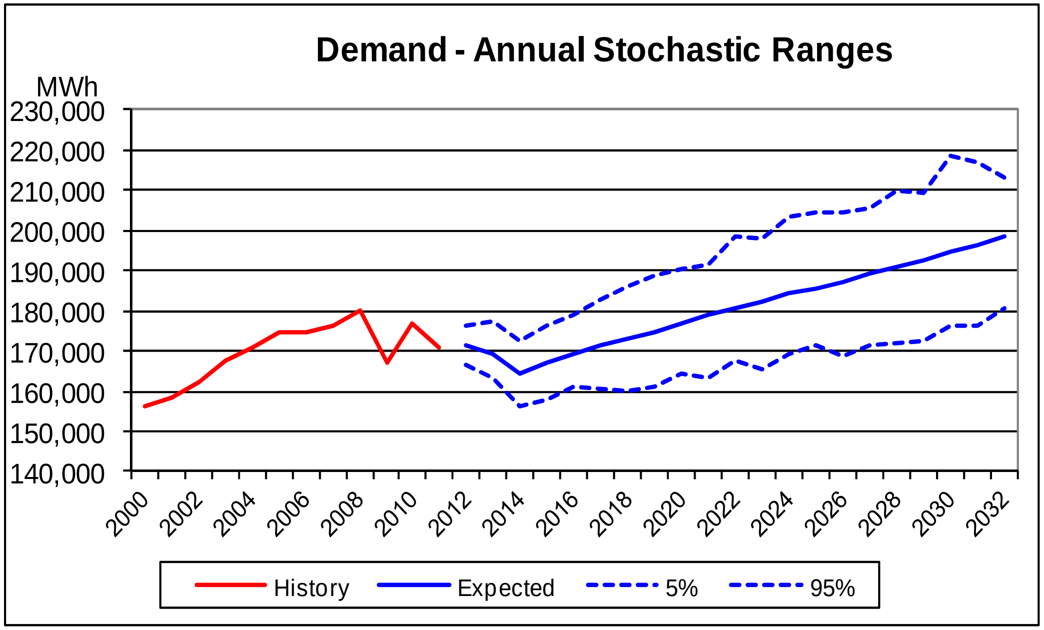
Distribution

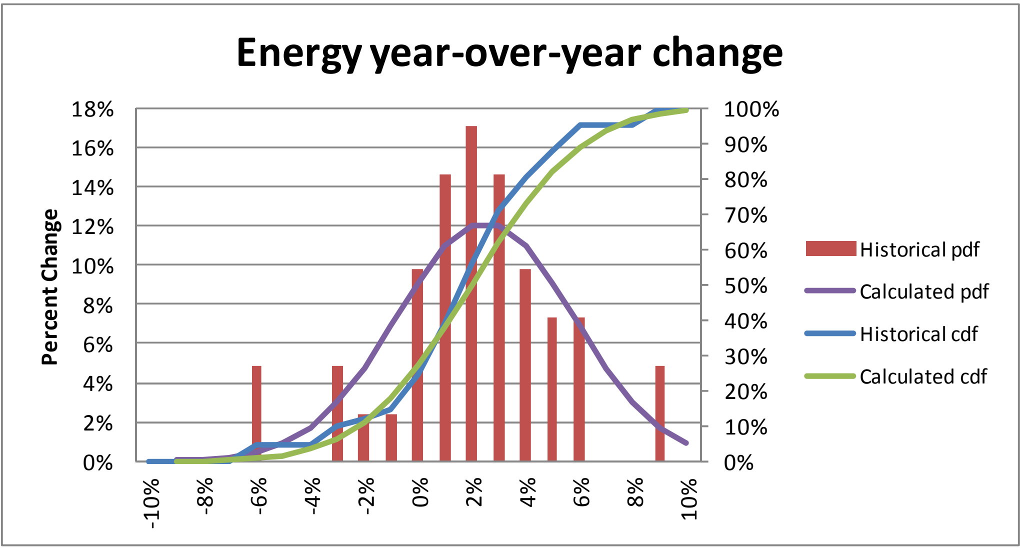
2 factor, Log-normal, mean reverting, random walk

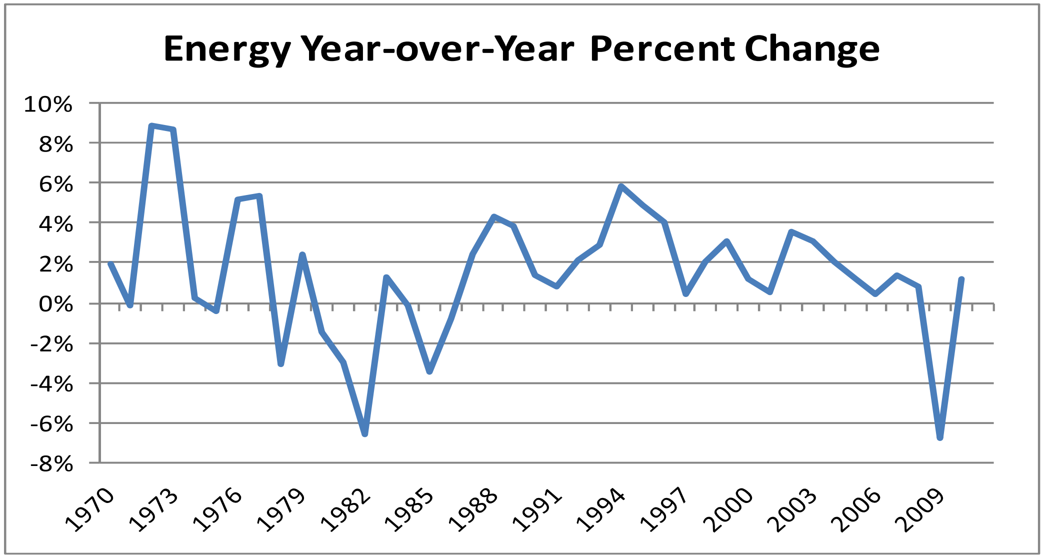
	Volatility	Mean reversion rate
Annual	1.8%	2 – 6 years
Monthly	3.7%	1.4 months

Correlated with

Reserve Margin, Hydro

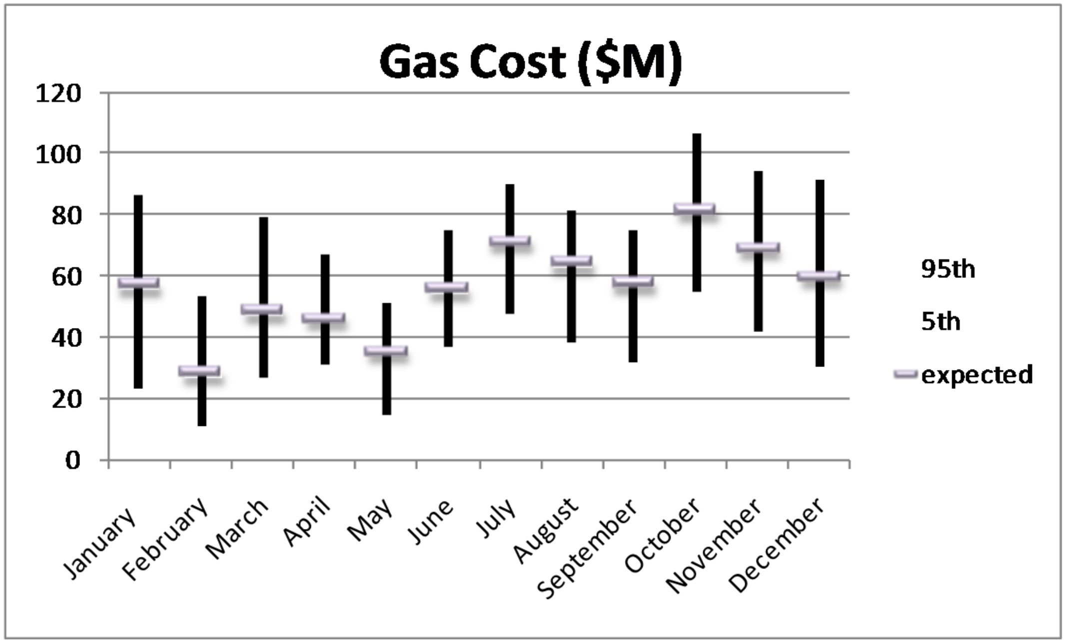


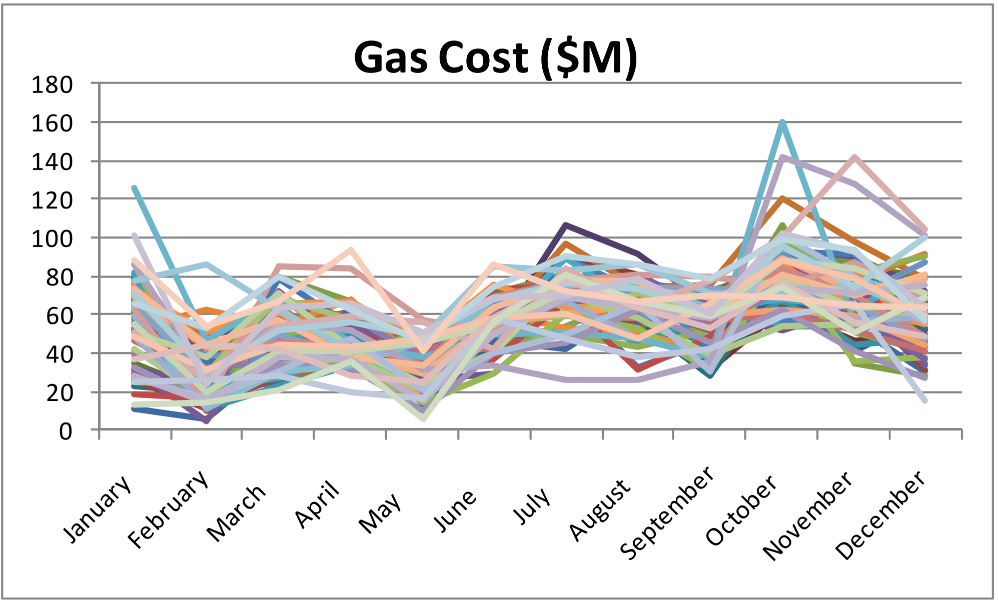


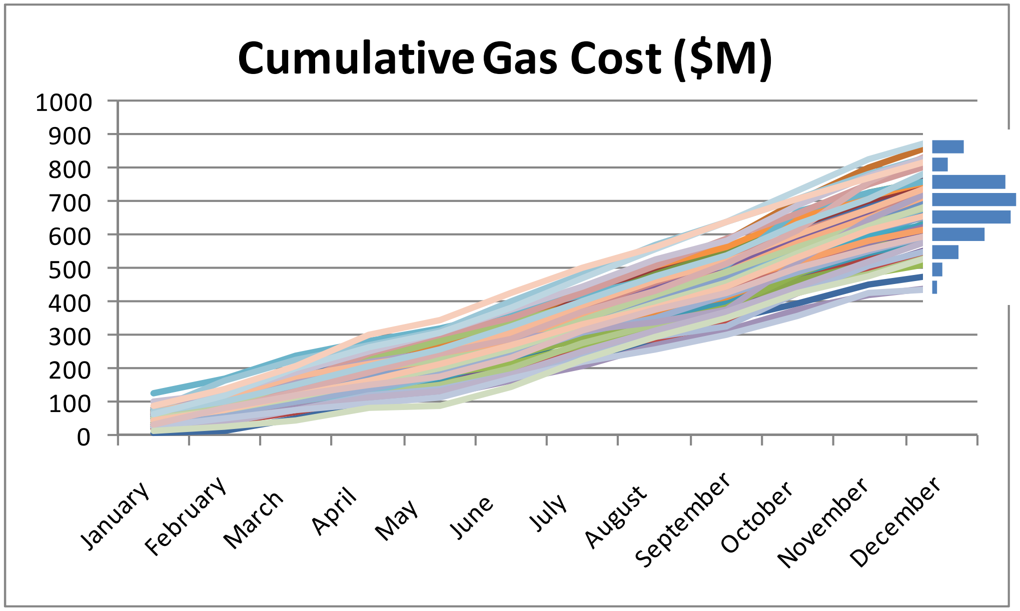


Example 3:
Stochastic Production Cost Results

- This example shows select draws of portfolio gas costs
- Output is available for each unit or unit group and by month or year







Example 4:
Hydro Generation Uncertainty

Source of Range

Historical

Distribution

Log-Normal, mean reverting, random walk

Mean reversion rate

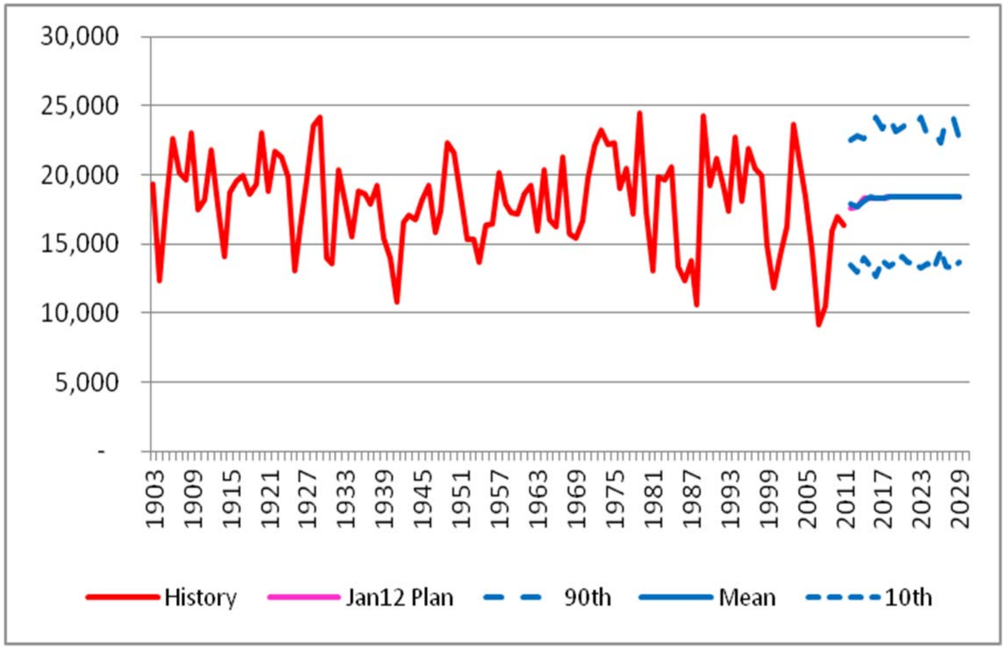
6 months

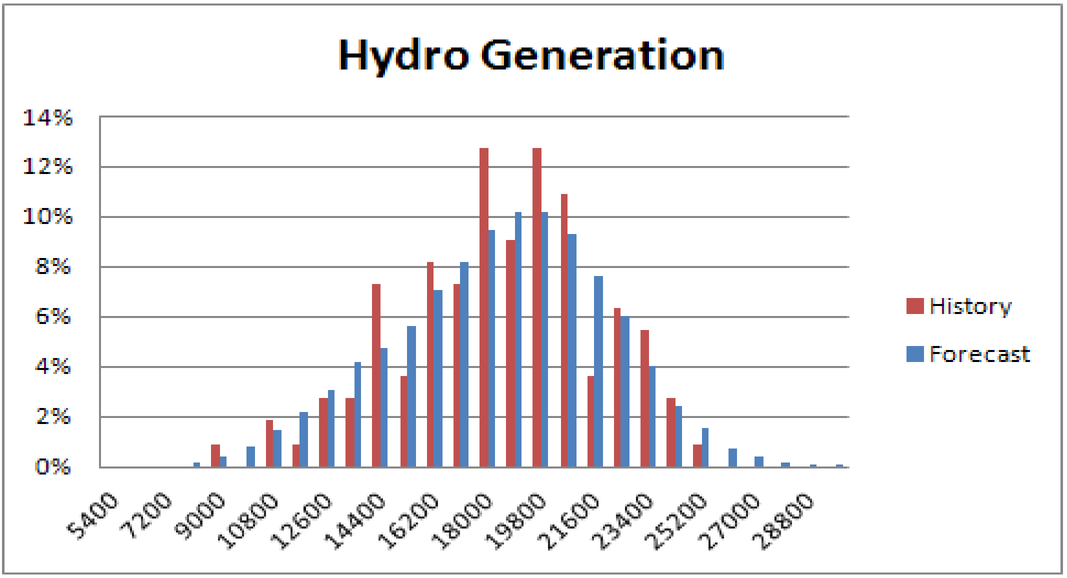
Standard Deviation

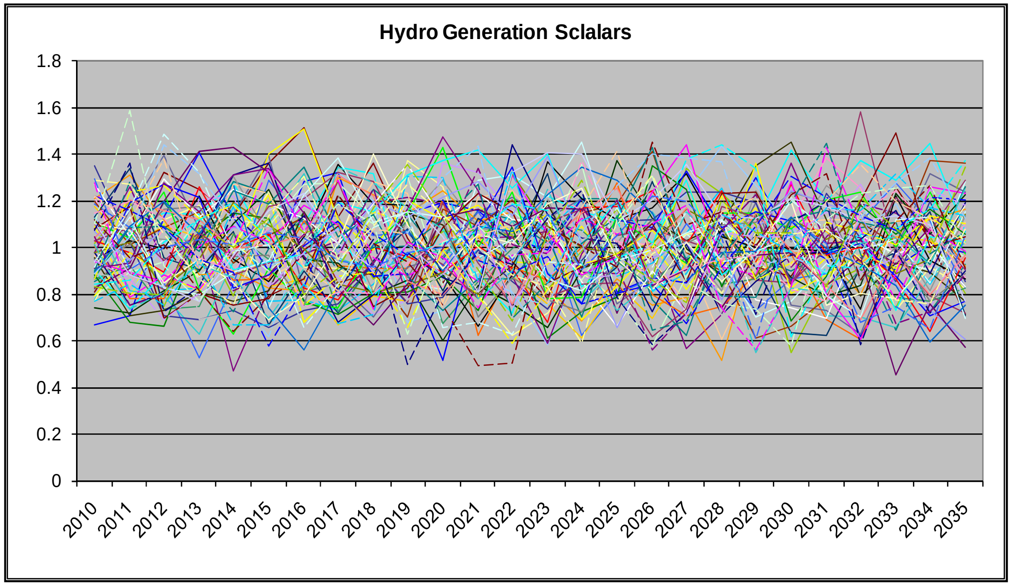
Defined by month from 3% to 21%

Skewness

-4

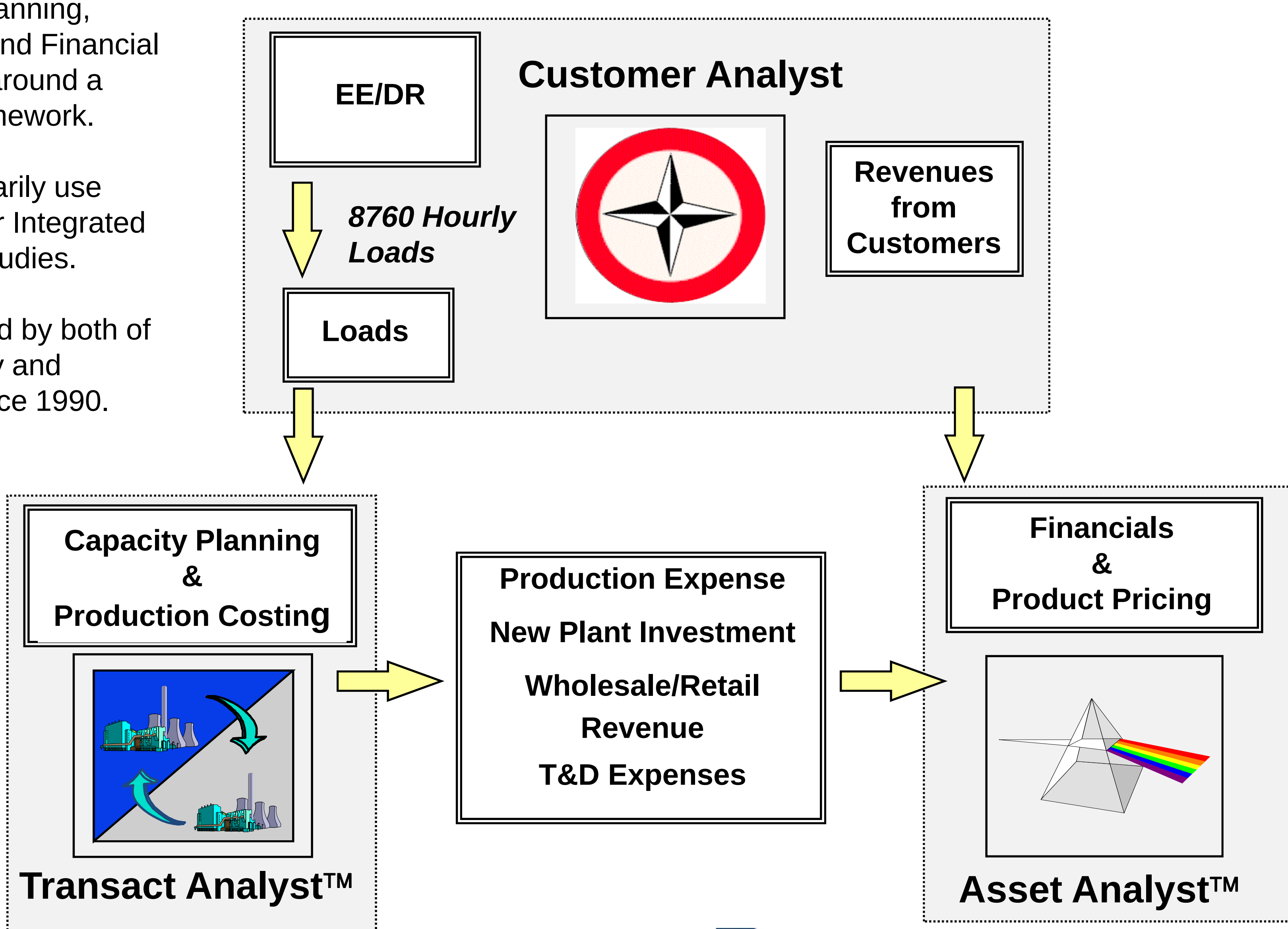






TVA uses MIDAS as the Modeling Tool

- MIDAS is an integrated Load Analysis, Capacity Planning, Production Costing, and Financial Reporting suite built around a decision analysis framework.
- Ventyx Advisors primarily use Capex and MIDAS for Integrated Resource Planning studies.
- MIDAS has been used by both of TVA IRP's extensively and numerous studies since 1990.

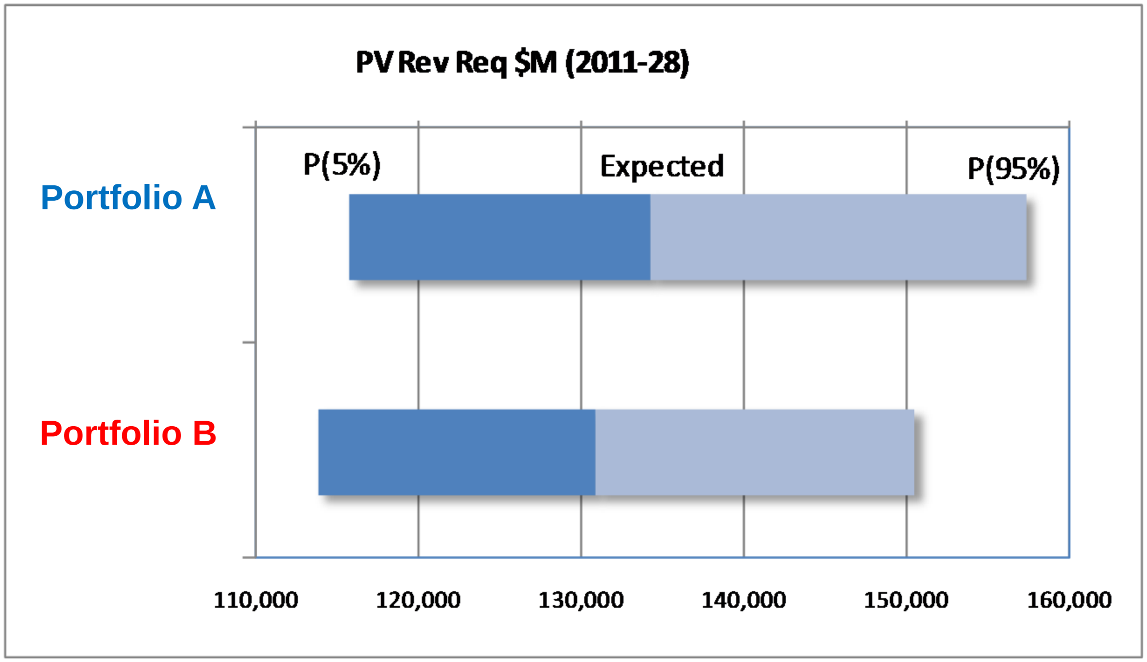


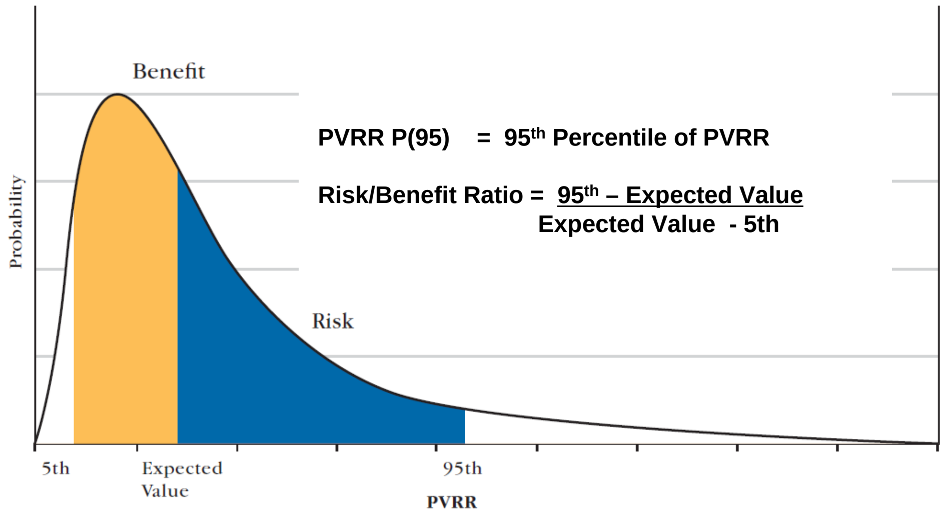
Conclusion: Monte-Carlo Analysis Captures Risk

Portfolio B has both lower costs and less cost variance.

The Monte-Carlo results are derived from production cost simulations using distributions around many of the top drivers of TVA's costs including:

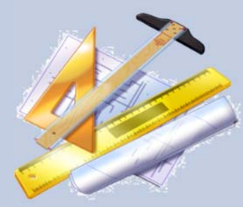
- Demand
- Coal and gas prices
- Plant availability
- Hydro availability
- CO2 allowance prices
- Electricity prices
- Interest Rates
- Capital costs
- O&M costs





The Proposed EE Modeling Concept

- Enhanced approach to modeling and selection of EE as a resource in the IRP study
- Involves a 2-step process
  - Design of selectable “blocks” of EE that represent program bundles organized by customer sector (residential, commercial, industrial)
  - The optimization of the timing and quantity of EE in the resource plan by treating EE as a resource that competes with other options
- Today’s discussion will focus on the fundamental design parameters (Part 1 of 2); next month’s meeting will include a discussion of the selection process (Part 2 of 2)

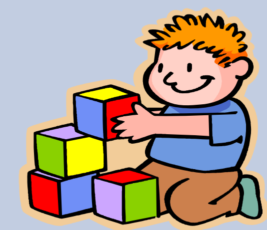


Part 1:

Block Design

Development of fundamental design parameters for the EE blocks.

Responsibility of the EnergyRight Solutions team



Part 2:

Block Selection

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

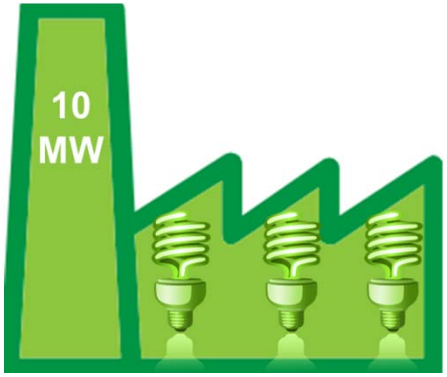
Responsibility of the Enterprise Planning team

Iteration required

EE Resource Selection: Blocks vs. Portfolios

Attributes	2011 IRP	2015 IRP
Structure	◆ Discrete Portfolios	◆ Sector Blocks
Basis	◆ Multiple Detailed Program Designs	◆ Pricing Tiers Extrapolated from Single Portfolio
Assumption Level	◆ Program Design Details	◆ Pricing Tier Break Points
Number of Detailed Portfolios	◆ Six	◆ One
Labor Intensity	◆ High	◆ Moderate
Ease of Modification	◆ Very Low	◆ Moderate
Selection Flexibility	◆ All or None	◆ Block by Block
Modeling Outcome	◆ Preferred Path/Portfolio	◆ Preferred Path/EE Level
Model Compatibility	◆ Relatively High	◆ 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 Pricing Tiers; Three Primary Sectors – Residential, Commercial, Industrial**
- **For Comparative Purposes, Initial Lifetime Program Costs for the Portfolio Range from 1.16 ¢/kWh to 2.74 ¢/kWh Across Tiers**
- **Maximum of 58 Annual Incremental Blocks Selectable by Model**
  - **32 Residential**
  - **15 Commercial**
  - **11 Industrial**
- **Program Maximum Expansion Rate of 30% per Year**
- **Maximum Incremental Percentage of Sales Ranges from 0.3% to 2.0%, Averaging 1.6%**

Definition and Development of Blocks

- Started with current portfolio submitted for FY15 planning cycle
- 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, 8760 load shapes, life spans, etc. vary by sector

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

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

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

Conservation Voltage Regulation (CVR)	**Block Weight**
CVR	100%

Definition and Development of Blocks (Cont.)

- 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 while holding incentives at current portfolio levels; 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
CVR	0	2	3	4	6

Definition and Development of Blocks (Cont.)

- Tier 2 is comprised of a step-function increase in Tier 1 incentives and fixed costs; escalated at standard rates through time

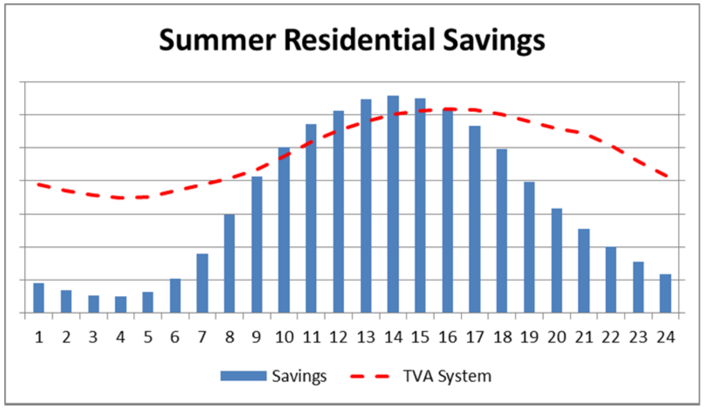
Average Unweighted Increases Relative to Base			
Tier 2	**Residential**	**Industrial**	**Commercial**
ERS Incentives	50%	70%	70%
ERS Variable Costs	26%	70%	70%
ERS Fixed and Low Variable	15%	10%	10%
ERS Other	19%	70%	70%
Tier 3	**Residential**	**Industrial**	**Commercial**
ERS Incentives	100%	200%	200%
ERS Variable Costs	51%	200%	200%
ERS Fixed and Low Variable	25%	20%	20%
ERS Other	29%	200%	200%

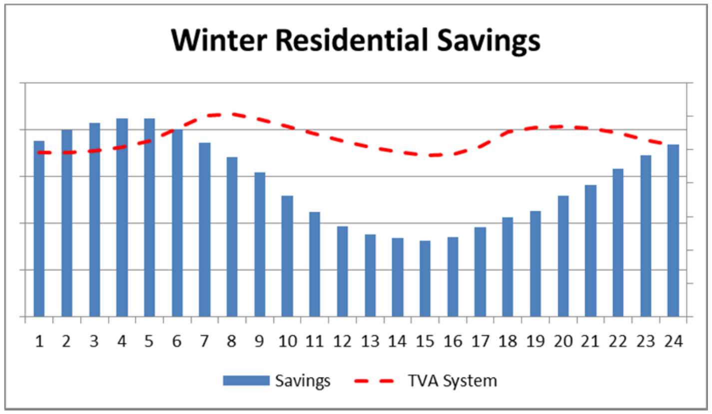
- Tier 3 was develop using a step-function increase in Tier 2 incentives and fixed costs; escalated at standard rates through time
- Step-function increases and max limits were developed by program design staffs

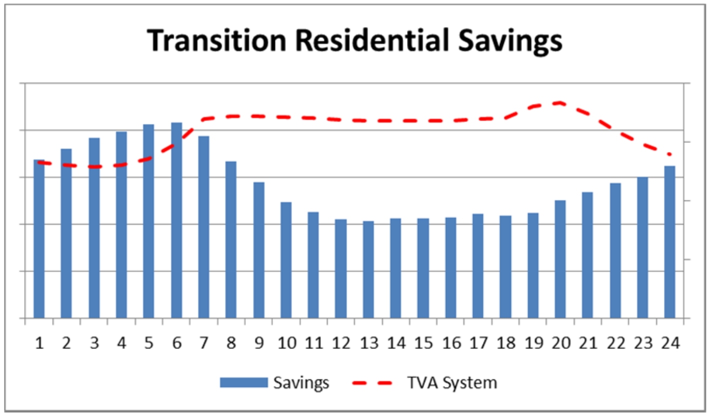
Block Design Parameters	Res	Comm	Ind
MW per Block @ Customer Meter	10	10	10
GWh per Block @ Customer Meter	50	59	72
Gross Installs	16,091	1,135	10
Max Gross Blocks per Year	32	15	11
Max Growth per Year (%)	30%	30%	30%

Illustrative Depiction of a Block

- Programs are developed to provide system impacts which mitigate higher generation costs and system 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

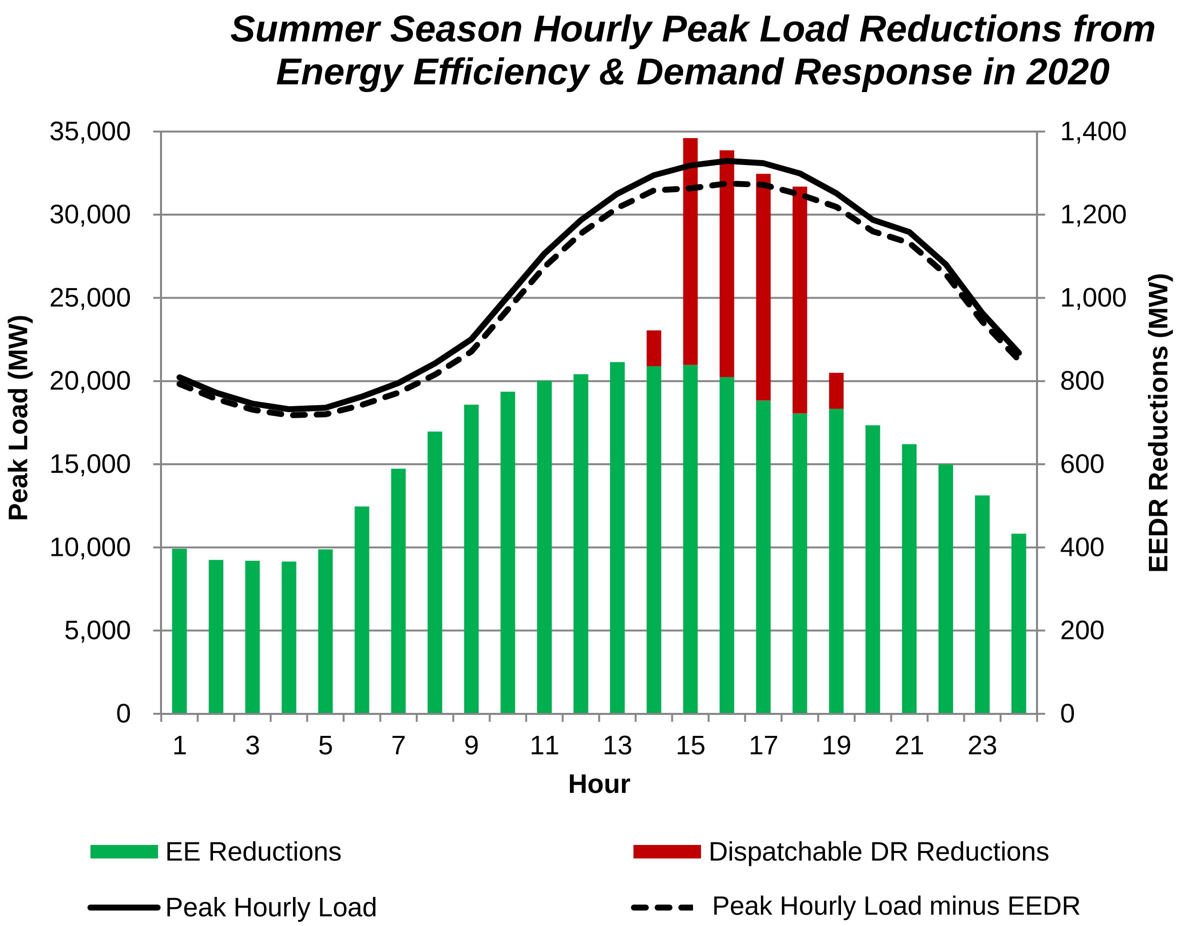






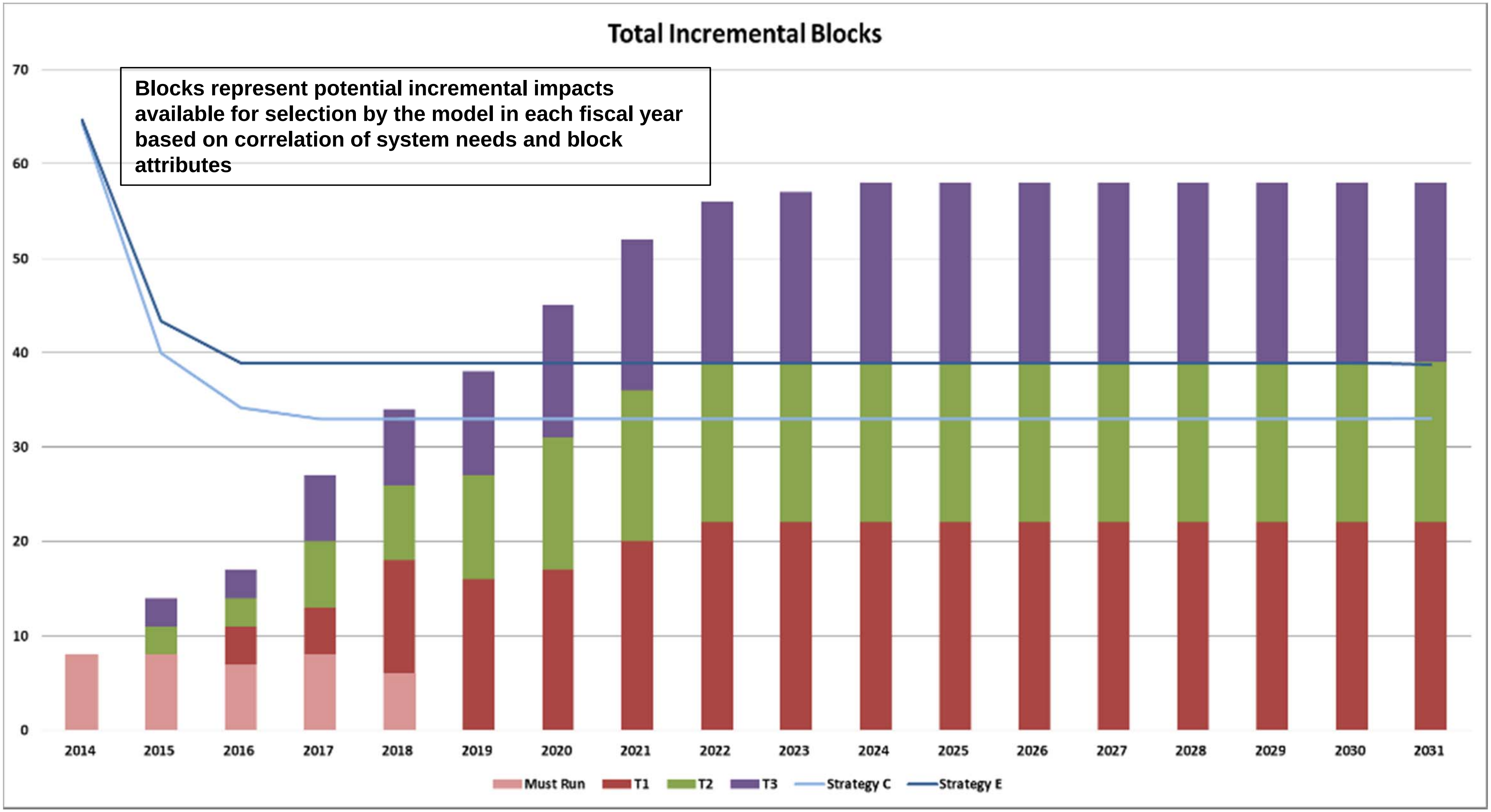
EE Functions Like an Intermediate Resource

- This 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 an intermediate resource like a natural-gas combined cycle unit (NGCC) and benefits flow through to customers mainly as reduced fuel costs
- On-peak impacts from DR are similar to the contribution of a peaking resource (like CT), which flow through to customers as avoided costs of building new capacity
- As a resource, EE programs are selected for their life spans, averaging:
  - Residential 17 years
  - Commercial 15 years
  - Industrial 12 years
  - CVR 10 years



Including EEDR in the resource mix allows TVA to achieve the load following benefits of a NGCC without exposure to fuel risk.

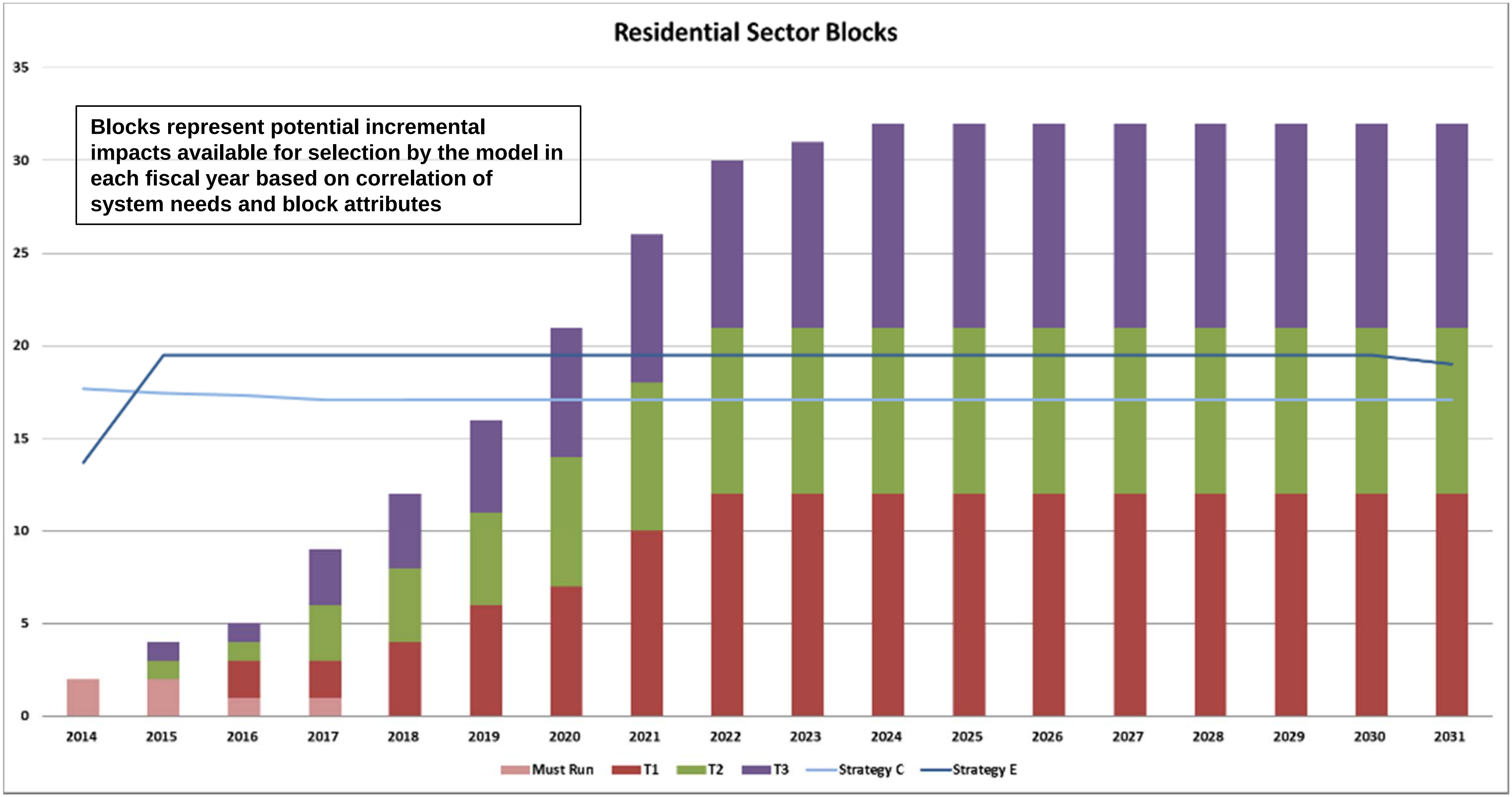
Total Sector Blocks



Note: Impacts are Gross at the Meter

Strategy C – Diversity Focused Resource Portfolio from 2011 IRP
Strategy E – EEDR & Renewables Focused Resource Portfolio from 2011 IRP

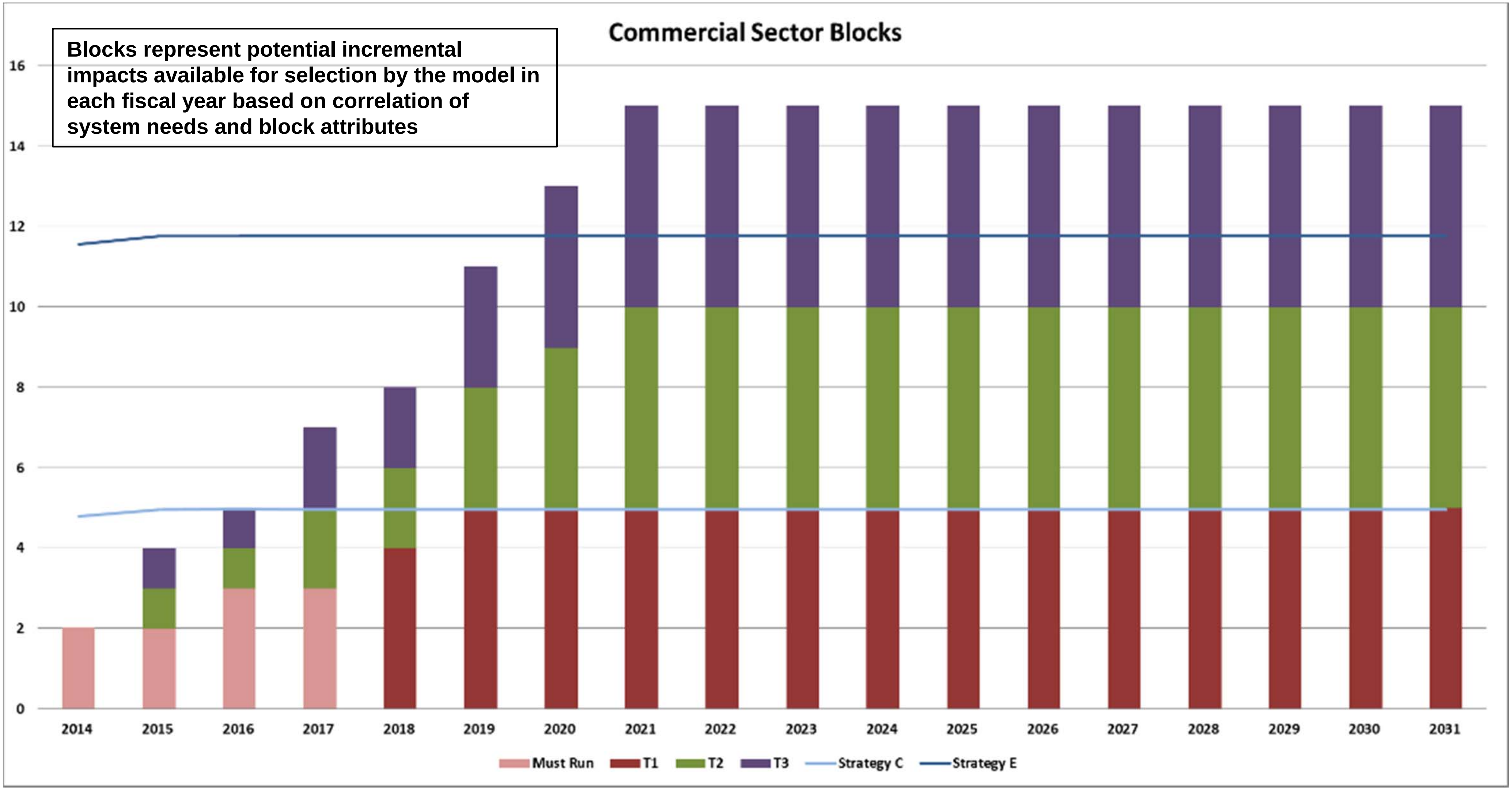
Residential Sector Blocks



Note: Impacts are Gross at the Meter

Strategy C – Diversity Focused Resource Portfolio from 2011 IRP
Strategy E – EEDR & Renewables Focused Resource Portfolio from 2011 IRP

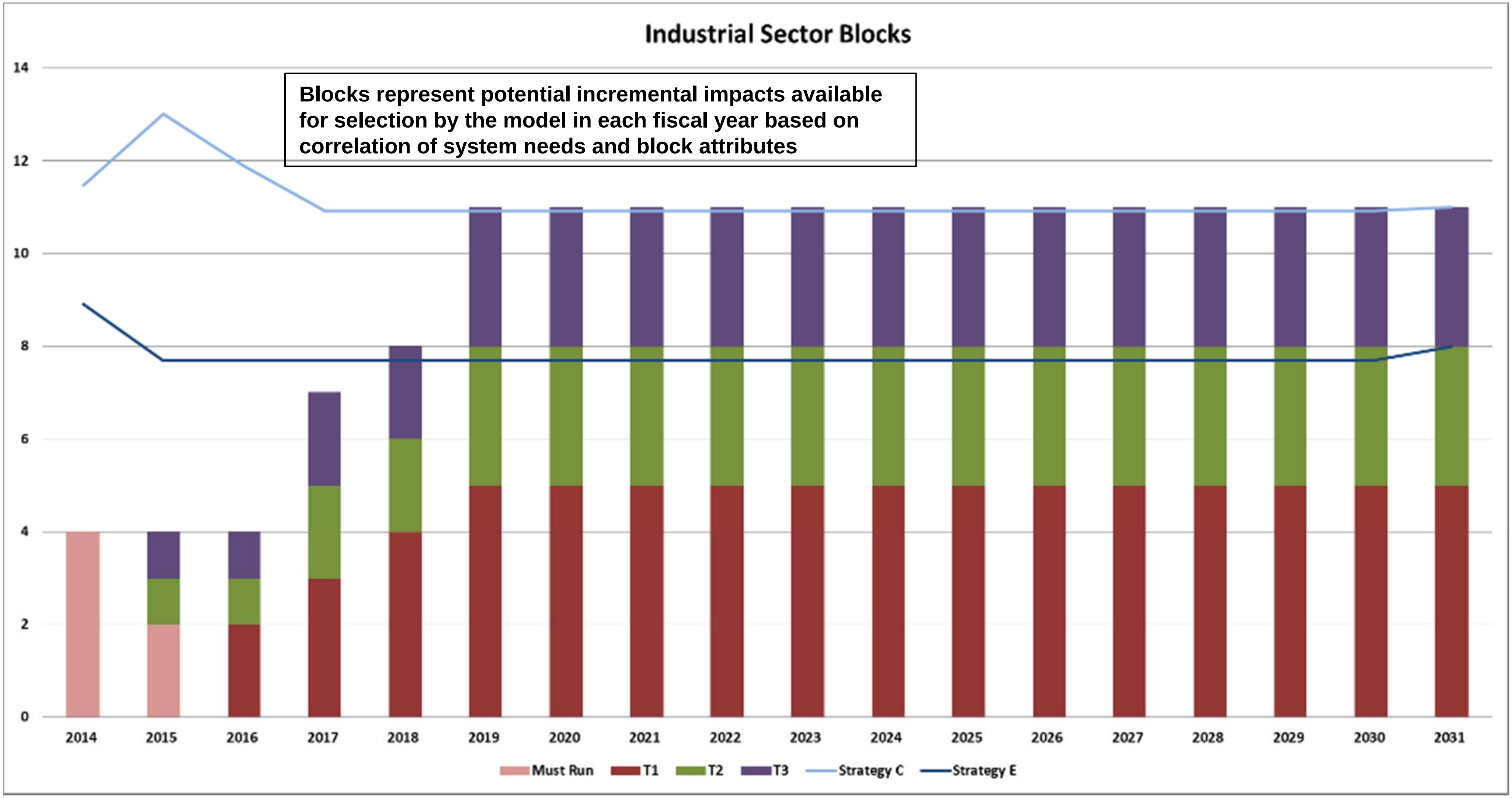
Commercial Sector Blocks



Note: Impacts are Gross at the Meter

Strategy C – Diversity Focused Resource Portfolio from 2011 IRP
Strategy E – EEDR & Renewables Focused Resource Portfolio from 2011 IRP

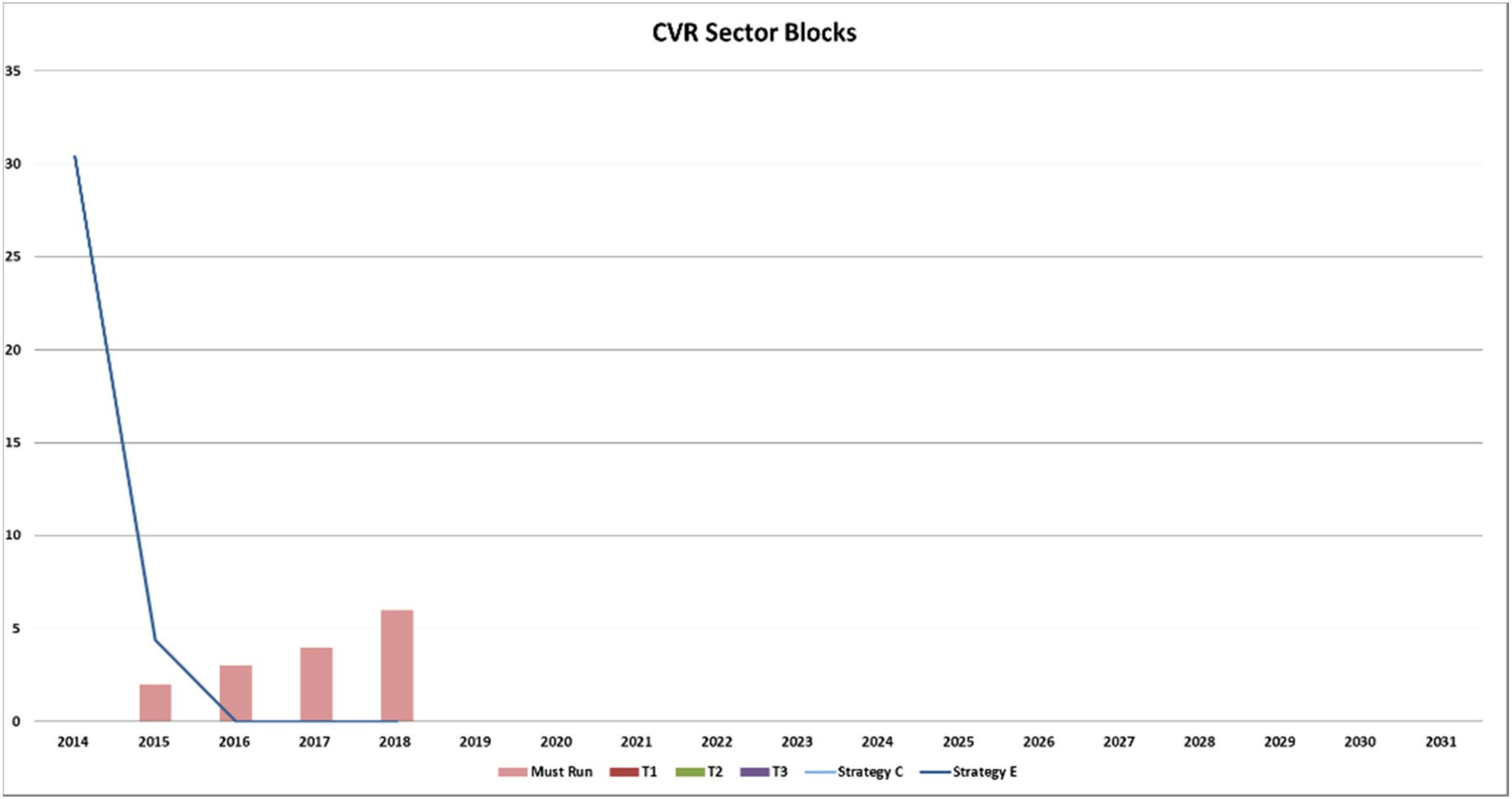
Industrial Sector Blocks



Note: Impacts are Gross at the Meter

Strategy C – Diversity Focused Resource Portfolio from 2011 IRP
Strategy E – EEDR & Renewables Focused Resource Portfolio from 2011 IRP

CVR Blocks

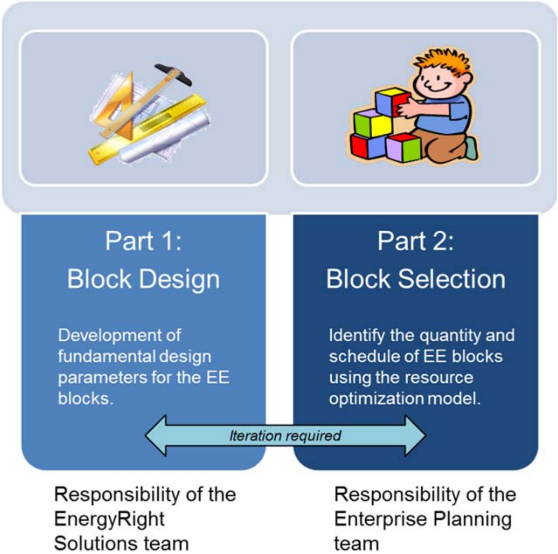


Note: Impacts are Gross at the Meter

Strategy C – Diversity Focused Resource Portfolio from 2011 IRP
Strategy E – EEDR & Renewables Focused Resource Portfolio from 2011 IRP

Next Steps

- Perform test runs of model using draft blocks
- Adapt blocks if necessary to address any anomalies noted in test runs
- Finalize operational parameters of blocks to address fluctuating system needs identified by the model
  - "Smoothing the curve"
  - Ramp rates, both positive and negative
  - Maximum growth rates
- Run the model with scenarios and full complement of other inputs
- Check results using portfolio value approach



Commodity Forecasting in the Context of the 2015 IRP

- TVA identified 3 commodities as critical uncertainties for the IRP's planning scenarios:

Uncertainty	Description
TVA Sales	◆ The customer energy requirements (GWh) for the TVA service territory including losses; it represents the load to be served by TVA
Natural Gas Prices	◆ The price ($/MMBtu) of the commodity including transportation
Electricity Prices into TVA	◆ The hourly price of energy ($/MWh) at the TVA boundary; used as a proxy for market price of power
Coal Prices	◆ The price ($/MMBtu) of the commodity including transportation
Regulations	◆ All regulatory and legislative actions, including applicable codes and standards, that impact the operation of electric utilities excluding CO2 regulations
CO2 Regulation/Price	◆ The cost of compliance with possible CO2 related regulation and/or the price of cap-and-trade legislation, represented as a $/Ton value
Distributed Generation Penetration	◆ National trending of distributed generation resources and potential regional activity by customers or third party developers (not TVA)
Nat'l Energy Efficiency Adoption	◆ An estimate of the adoption of energy efficiency measures by customers nationally; a measure of interest/commitment of customers in general to adopt EE initiatives
Economic Outlook (National/Regional)	◆ All aspects of the regional and national economy including general inflation, financing considerations, population growth, GDP and other factors that drive the overall economy

- Forecasting the value of these commodities is a complex process that involves a very high volume of data:
  - The process is iterative since commodity values affect each other and they also impact the value of the rest of the critical uncertainties
  - TVA uses state-of-the-art tools and methodologies to define the commodity values

- In this section, we will introduce market drivers behind the commodity values and present the tools and methodologies used at TVA

Natural Gas Forecast Drivers

Supply

Gas Plays:
- Shale Gas
- Tight Gas
- Conventional Offshore

Gas Type:
- Dry Gas
- Wet Gas
- Oil Associated Gas

Production Costs:
- Local infrastructure
- Labor
- Drilling technique
- Regulations
  - Emissions
  - Zoning
  - Water use

Transportation

Pipeline Transport Costs:
- Interstate Transmission
- Intrastate Transmission
- Local Distribution Companies

Pipeline Constraints:
- Interconnects
- Receipt/Delivery Points
- Compression
- NIMBY

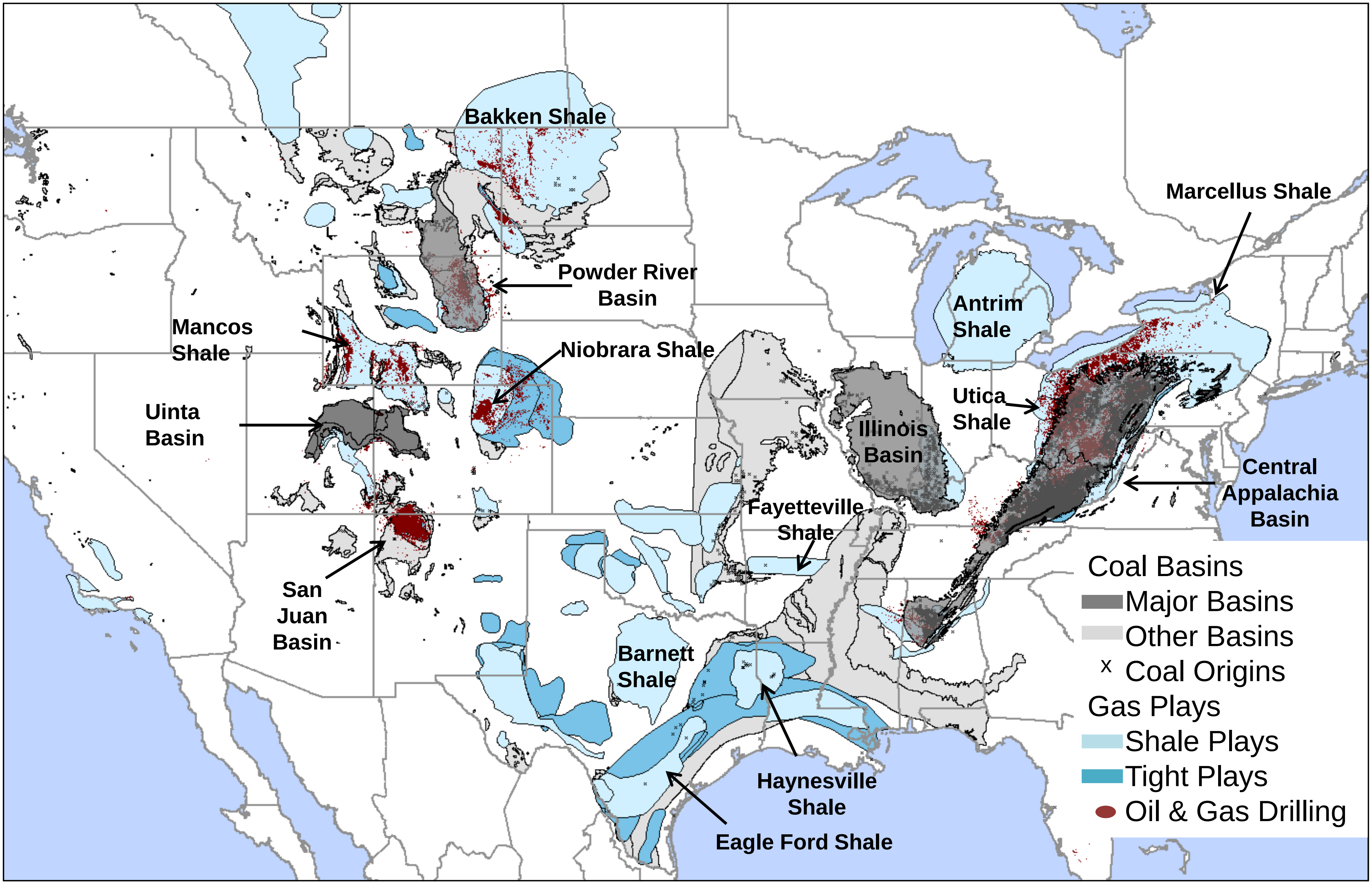
Demand

Demand Factors:
- Economic Outlook
- Regulation
- Storage

Traditional Demand:
- Residential
- Commercial
- Industrial
- Electric Power

Emerging Demand:
- LNG Exports
- NGV Demand
  - Oil & Gas Equipment
  - Locomotives
  - Bunker Fuel
  - Fleet Vehicles
  - OTR Trucks

Commodity Forecast Drivers – Fuel Supply



Coal Forecast Drivers

Supply

Coal Reserves:
- Bituminous
- Sub-bituminous
- Lignite

Production Type:
- Underground
  - Longwall
  - Continuous Miner
- Surface

Production Costs:
- Local infrastructure
- Labor
- Regulations
  - Reclamation
  - Emissions
  - Zoning
  - Water use

Transportation

Transport Costs:
- Rail
- Barge
- Truck
- Fuel

Transport Constraints:
- Congestion
- Infrastructure

Demand

Demand Factors:
- Economic Outlook
- Regulation
- Stocks

Demand Type:
- Commercial
- Industrial
- Electric Power
- Exports

Electricity Forecast Drivers

Supply

Electricity Generation / Plant Characteristics:

- Unit type: Coal, Natural Gas, Nuclear, Hydro, Pumped Storage, Wind, Solar, Fuel Oil, Other – biomass, refuse
- **Fuel Prices** – monthly, annual
- Long term capacity expansion
- Unit retirements (esp. coal)
- Wind and Solar hourly availability by zone
- **Emission rates & prices**
- Capacity, Heat Rate
- **Location (zone dispatch stack)**
- **VOM**, FOM, Start Up Costs
- Forced Outage Rates, Must Run
- Start & Retire Dates
- Minimum up and down time

Transportation

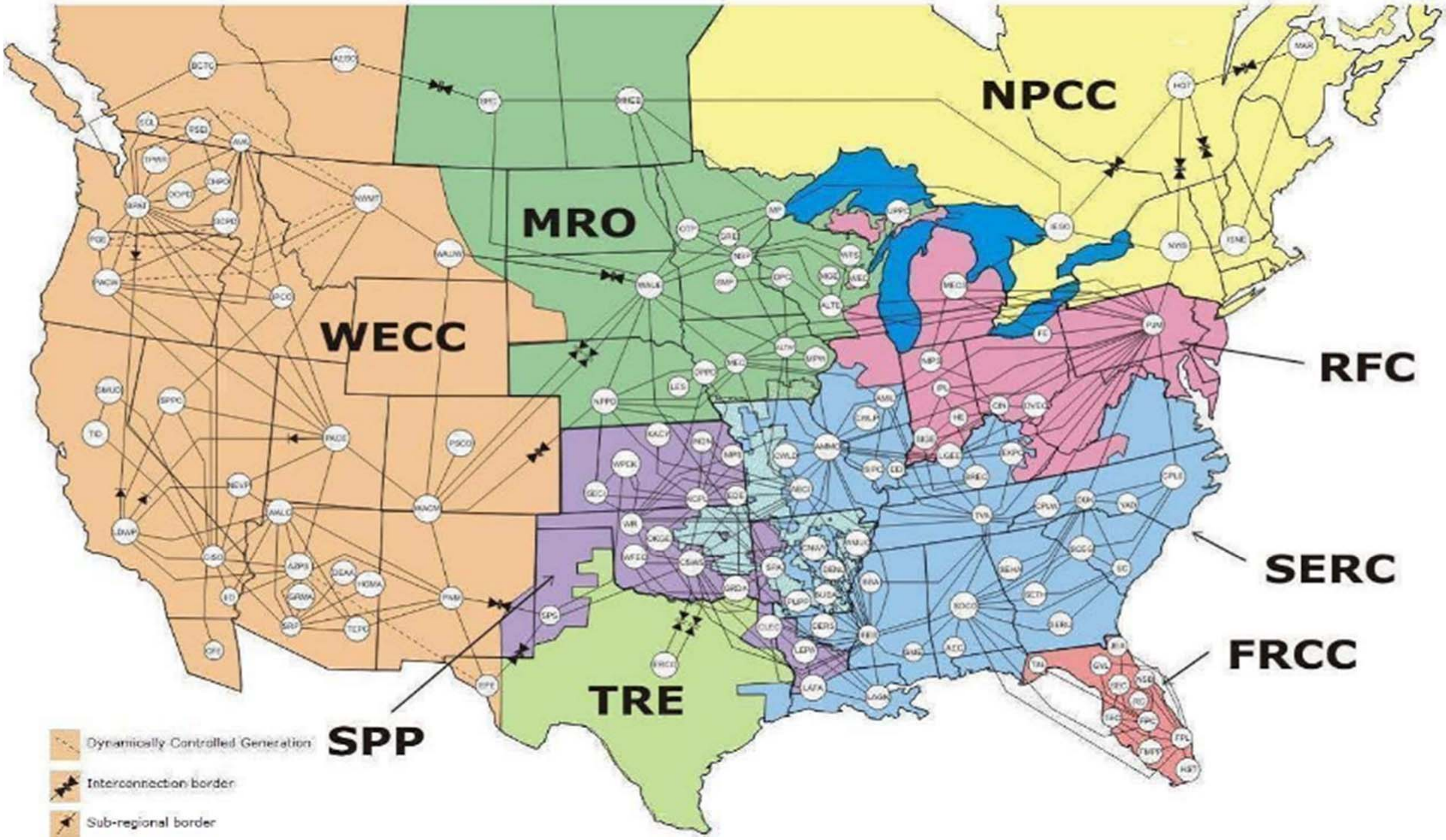
- Transmission Lines
- Transmission constraints between zones
- Wheeling charges

Demand

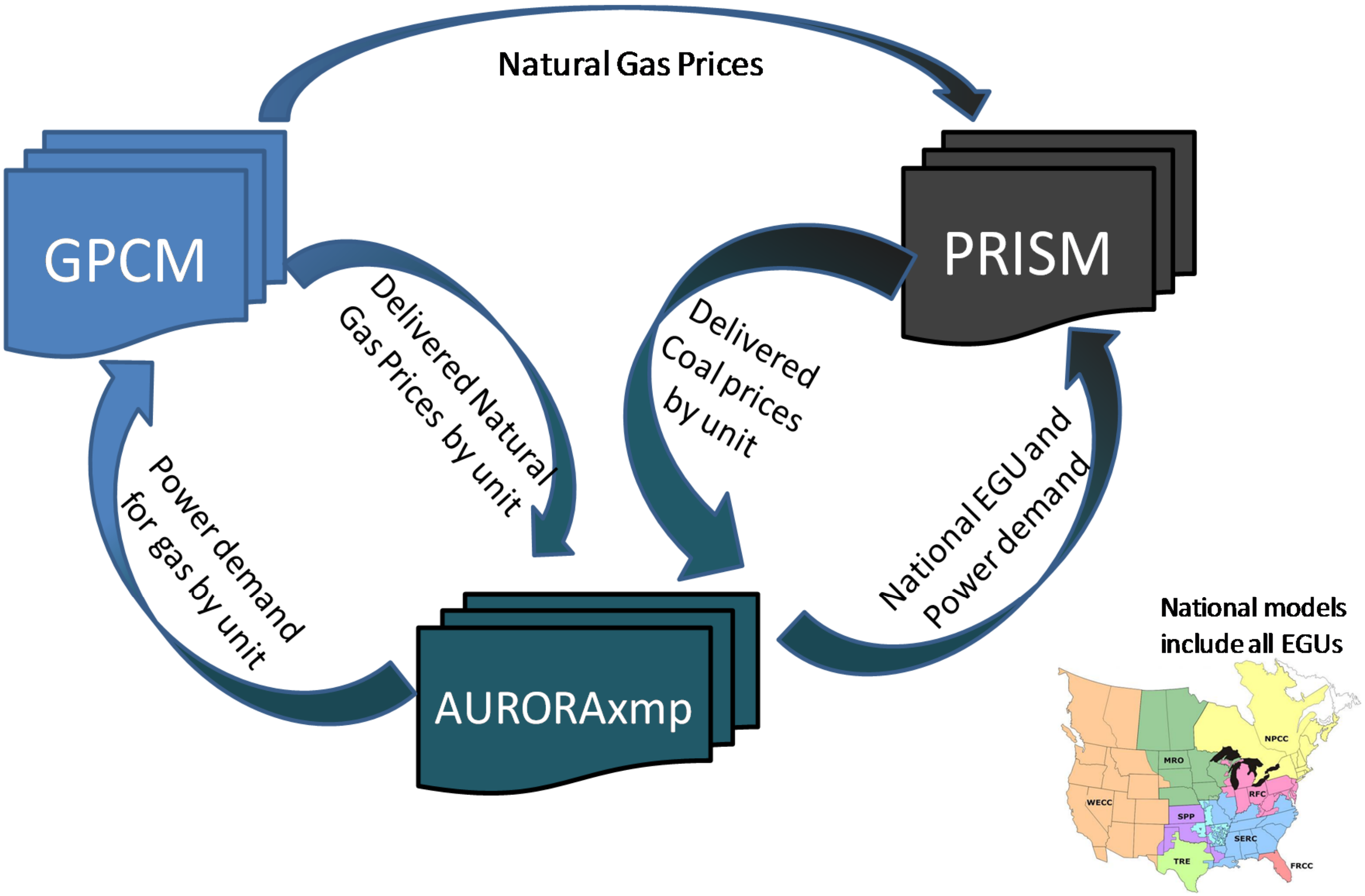
- National Demand Escalation
- Zonal Demand
- **Hourly Demand Shapes**
- Weather Normalized
- Inflation assumptions

Note: Main drivers in blue

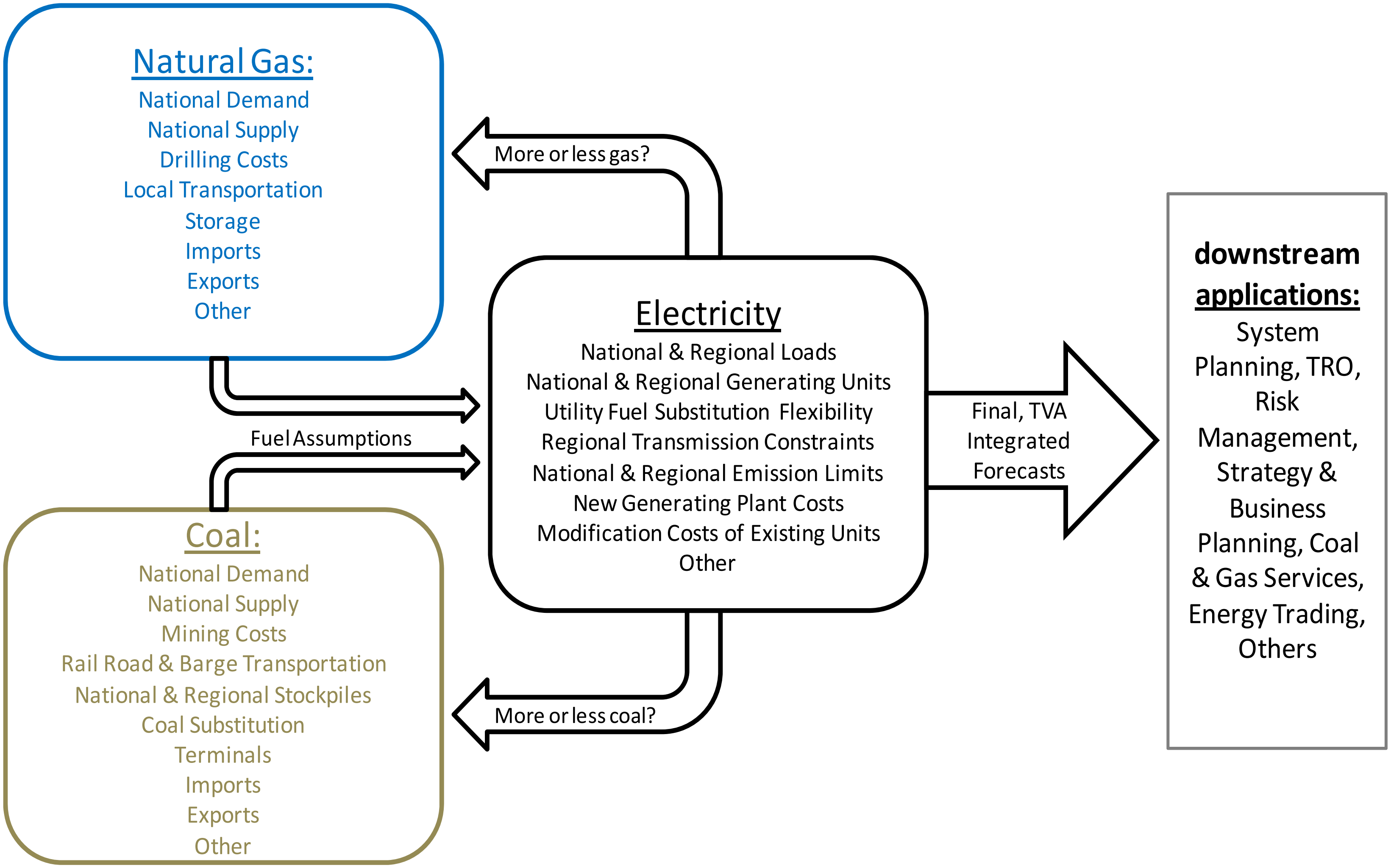
National Zones



Model Integration



Model Integration



TVA's Forecasting Models Overview – Natural Gas

Model: GPCM Natural Gas Market Forecasting System

Vendor: RBAC, Inc.

Characteristics:

GPCM contains more than 200 existing and proposed pipelines, 400 storage areas, 85 production areas, 15 LNG import / export terminals, and nearly 500 demand centers.

The output from GPCM consists of the following types of items:

- Production and spot market prices by region
- Pipeline receipts from producers by zone
- Pipeline flows from zone to zone
- Transportation prices and discounting by pipeline and zone
- Transfers between pipelines at interconnects
- Injections into and withdrawals from storage
- Deliveries by pipelines to customers
- Gas supply available to each customer in each region
- Market clearing prices in each region

TVA's Forecasting Models Overview - Coal

Model: PRISM

Vendor: Wood Mackenzie

Characteristics:

PRISM contains over 1500 coal mines in all of the major US coal basins, and includes detailed information about coal quality, heat content, sulfur content and transportation routes across the country along with over 13,000 electricity generating units.

The output from PRISM consists of the following types of items:

- Annual prices curves by coal quality and location
- Regional supply curves by year
- Regional coal demand by year

TVA's Forecasting Models Overview - Electricity

Model: AURORAxmp

Vendor: EPIS, Inc.

Characteristics:

Over 13,000 generating units in 80+ zones. Detailed unit information including capacity, heat rates, emission rates, fuel costs, VOM, etc.

Features:

- Multi-zone, transmission-constrained dispatch
- Hourly optimized unit commitment
- User-specified timeframes – hourly, daily, monthly and yearly
- On-peak/off-peak pricing
- Emissions costs and caps
- Advanced user-friendly interface
- Day-ahead, monthly and long-term price forecasts
- Prices by market areas, zones or trading hubs
- Advanced hourly commitment and dispatch logic

2015 IRP Scenarios – Expected Outcomes & Next Steps

Uncertainties (Relative to Current Forecasts)		Prolonged Stagnant National Economy (DE2)	Economic Boom (EG1)	Decarbonized Energy Future (SE1)	Customer Driven Competitive Resources (CP1)
	Natural Gas Prices	Very Low	High	Low	Low
	Coal Prices	Low	High	Same	Low
	Electricity Prices into TVA	Low	High	High	Low

Next Steps Include:

- Analyzing interaction among uncertainties
- Finalize detailed commodity values by scenario

2011 IRP Economic Impact Process and Metrics

- Economic metrics were included in the 2011 IRP scorecard to provide a general indication of the impact of each strategy on the economic conditions in the TVA service area.
- The impacts were represented by the change in total employment and personal income indicators as compared to the impacts under Strategy B (Baseline Plan) in Scenario 7 (Reference Case – Spring 2010)
- The process used was consistent with the methodology employed by TVA for programmatic region-wide EIS studies:
  - Direct expenses by TVA stimulate economic activity
  - At the same time, the costs of electricity reduces customers' income
  - These "direct effects" are input into a model (REMI) that accounts for interactions both within and outside the region and projects personal income and employment estimates by strategy and scenario
  - These indicators are then divided by the baseline values to produce the % change metric.

- The analysis was conducted using only two of the seven scenarios that represented the highest and lowest growth futures
- The findings indicated there was no significant change from the baseline in either the short-term or long-term metrics across the 5 planning strategies

		Percent difference from IRP Base Case:			
		Total Employment		Total Personal Income	
Strategy	Scenario	Average 2011-2028	Average 2011-2015	Average 2011-2028	Average 2011-2015
A	1	0.1%	-0.4%	0.1%	-0.2%
	6	-0.4%	-0.4%	-0.4%	-0.3%
B	1	1.0%	0.3%	0.8%	0.3%
	6	-0.3%	-0.4%	-0.3%	-0.3%
C	1	0.9%	0.2%	0.6%	0.2%
	6	0.2%	-0.2%	0.1%	-0.1%
D	1	1.2%	0.4%	1.0%	0.3%
	6	-0.1%	-0.4%	-0.2%	-0.4%
E	1	0.8%	0.0%	0.6%	0.0%
	6	0.3%	-0.1%	0.2%	-0.1%
R	1	0.9%	0.2%	0.7%	0.2%
	6	0.2%	-0.2%	0.1%	-0.1%

Scenario

1 Economy Recovers Dramatically
2 Environmental Focus is a National Priority
3 Prolonged Economic Malaise
4 Game-Changing Technology
5 Energy Independence
6 Carbon Legislation Creates Economic Downturn
7 Current Situation

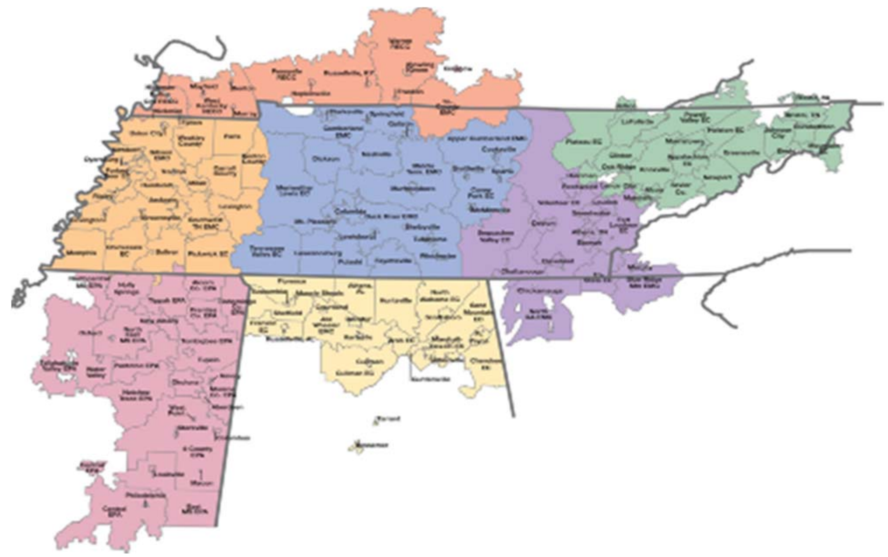
Planning Strategy

A Limited Change in Current Resource Portfolio
B Baseline Plan Resource Portfolio
C Diversity Focused Resource Portfolio
D Nuclear Focused Resource Portfolio
E EEDR & Renewables Focused Resource Portfolio
4R Recommended Portfolio

Baseline is Scenario 7, Strategy B

TVA Region Economic Impact Metric for the 2015 IRP

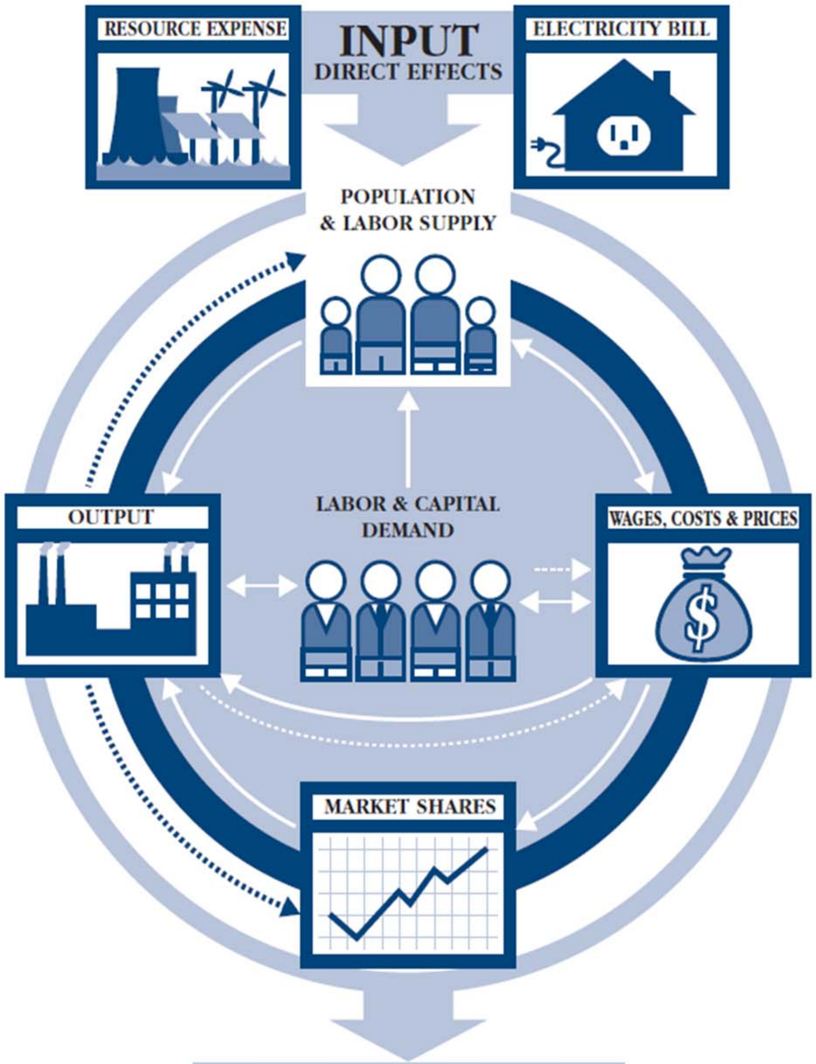
- **Economic development is part of TVA's mission since 1933**
  - Recruiting major industrial operations
  - Encouraging location & expansion of companies
  - Helping communities develop
  - Offering support to entrepreneurs, women, & starting new businesses



- **Goals of Economic Impact Metric**
  - Broad measure of general economic well-being
  - Comparable across strategies
  - Reflects % of expenditures sourced in TVA region
    - Renewable vs. Non-Renewable generation
  - Considers both positive and negative economic impacts
    - Higher power prices imply lower disposable income
    - Higher construction costs stimulate economic activity
- **Proposed Metric:** % Change in Per Capita Personal Income

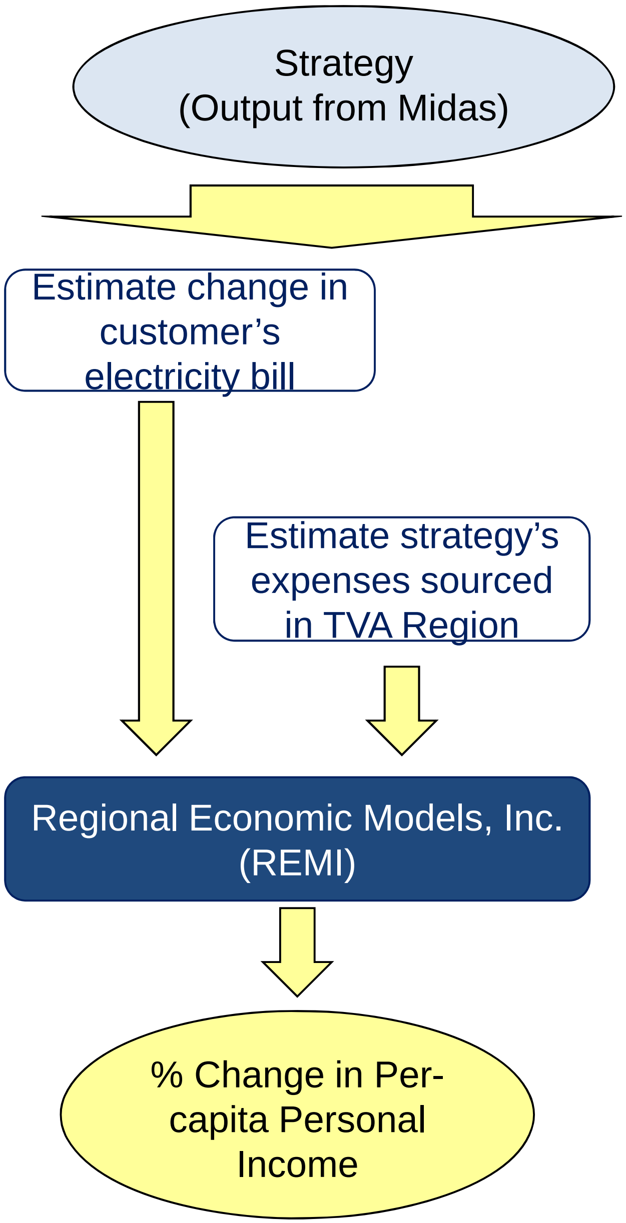
Using Regional Economic Models, Inc. (REMI)

- **Tailored to the TVA Region by REMI**
- **Nationally & Internationally Recognized**
  - — Used by 100+ universities, state and local governments, utilities, and consulting firms across the U.S. and Europe
- **Designed specifically for scenario analysis**
- **Thousands of equations model interactions**
  - — Output
  - — Labor & Capital Demand
  - — Population & Labor Supply
  - — Wages, Costs, & Prices
  - — Market Shares



Per Capita Personal Income
Single measure of economic prosperity of TVA Region

2015 IRP Regional Economic Impact Process



- Grows as needed to meet strategy's revenue requirements
- Higher cost strategies generate higher electricity bills

- Construction Expenses
  - Construction expenditures increase employment & spending
- Non-Fuel O&M
  - Additional expenditures generate additional employment
- Fuel Expenditures
  - Renewables – no fuel cost
  - Non-Renewables – assumed purchased outside TVA Region

- % Change in per-capita personal income
  - Calculated relative to a reference case

Example: Expenses Sourced in TVA Region by Year

“An Assessment of the Economic, Revenue, and Societal Impacts of Colorado’s Solar Industry” by The Solar Foundation, October 2013 (p.20):

“For residential and small commercial installations, it was assumed that 50% of materials and equipment used to install, operate, and maintain these systems were purchased locally. Assuming that larger systems would be more likely to attract out-of-state project developers and engineering, procurement, and construction (EPC) firms, the locally purchased percentage assumption decreased for both the large commercial (25%) and utility (0%) market segments... A review of SEIA’s *National Solar Database* revealed that Colorado has a number of companies involved in the manufacture of mounting equipment, inverters, and other electrical components.”

Year 2020

Annual Expenditures ($M)

Difference from Base Strategy

	Capital		Non-Fuel O&M		Fuel	
	Renew	NonR	Renew	NonR	Renew	NonR
Strategy 1	$80	$20	$60	$40	$0	$50
Strategy 2	$20	$80	$40	$60	$0	$80

% of Expenditures Sourced in TVA Region

Input Needed

	Capital		Non-Fuel O&M		Fuel	
	Renew	NonR	Renew	NonR	Renew	NonR
Strategy 1	25%	15%	100%	100%	100%	0%
Strategy 2	25%	15%	100%	100%	100%	0%

Expenditures Sourced in TVA Region ($M)

Difference from Base Strategy

	Capital		Non-Fuel O&M		Fuel	
	Renew	NonR	Renew	NonR	Renew	NonR
Strategy 1	$20	$3	$60	$40	$0	$0
Strategy 2	$5	$12	$40	$60	$0	$0

Renew= Renewable NonR = Nonrenewable

2015 Process Improves 2011 IRP

2011 IRP

- Did not differentiate between expenditures sourced inside vs. outside the region
- Only extreme economic scenarios modeled
- Two metrics evaluated the economic impact
  - Total Employment
  - Per Capita Personal Income

2015 IRP

- Process defined to incorporate expenditures sourced in the region vs. outside the region
- modeling all scenarios is planned
- Single metric to evaluate the economic impact
  - Per Capita Personal Income

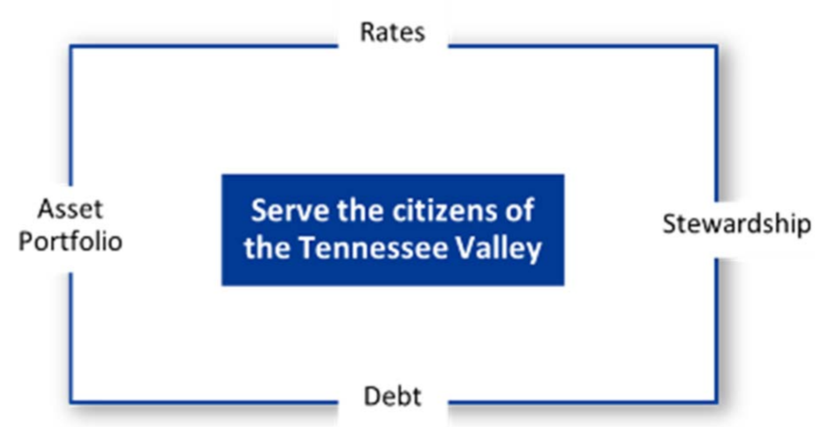
Feedback from the Working Group – Economic Impact

- Any additional sources that should be considered for the key assumptions
- Other questions/comments?

Metrics Facilitate Selecting a Plan Consistent With Goals

- Metrics do help focus the evaluation of plan results, if done correctly
- Metrics need to reflect the utility's (and the stakeholder's) goals and priorities
  - TVA's broader mission required the use of metrics that went beyond typical resource planning values to include stewardship and economic development factors.
- Metrics need to be clear and easy for stakeholders and decision-makers to understand, which implies that metric design needs to consider these groups
  - Internal teams at TVA developed candidate metrics
  - Stakeholders made other suggestions and helped to shape the final set of evaluation metrics
- And how metrics are described and presented makes a big difference in how effective they are.

TVA Strategic Imperatives



- ***Rates:*** *rates and the impact on economic development are assessed indirectly in the IRP study through scorecard metrics*
- ***Debt:*** *the debt limit is explicitly considered in the financial modeling for each planning strategy*
- ***Asset Portfolio:*** *the optimization of asset choices is the central task of the IRP*
- ***Stewardship:*** *the consideration of environmental impacts and stewardship obligations are included both directly in the system modeling and through scorecard metrics*

IRP Benchmark

IRP Metrics Used by Peers

The table below provides a comparison of the IRP evaluation criteria used by each of the utilities.

- On average, utilities consider three to four criteria when evaluating potential IRP portfolios
- All utilities include some measure of cost in the evaluation (PVRR at a minimum)
- Most utilities include reliability metrics and environmental metrics as well
- The most common measure of environmental impact is emission levels
- APS is the only company to specifically consider water use in the evaluation

Evaluation Criteria	DEC 2013	FPL 2013	GPC 2012	PCQ 2013	PEC 2012	DOM 2013	ETR 2012	APS 2012
Financial Measures								
Present Value of Revenue Requirement (PVRR)	✓	✓	✓	✓	✓	✓	✓	✓
Cummulative CapEx								✓
Levelized Cost of Power (fixed & variable costs)							✓	
Price Growth					✓			
Shareholder Value			✓					
Risk Measures								
Risk			✓	✓				
Fuel Price Volatility					✓			
Fuel Diversity	✓	✓						
Reliability			✓	✓				
Flexibility	✓		✓					
Long-term Viability			✓					
Load/Generation Capacity Balance		✓						
Environmental Impact Measures								
Environmental Footprint	✓							
Emission Levels		✓		✓	✓			✓
Environmental Compliance			✓					
Water Use								✓

Four Evaluation Criteria Were Considered in the 2011 IRP

- These criteria were aligned with TVA's business mission and objectives and they are similar to the ones used by peers

- Within each criteria, several metrics defined:
  - Cost:
    - Expected PVRR 20 years
    - Avg System Cost 7 years
  - Risk:
    - Risk Ratio
    - Risk-Benefit Ratio
  - Environmental Stewardship:
    - CO_2 Average Tons
    - Thermal Loading
    - Waste Disposal
  - Economic Impacts:
    - Total Employment in the region
    - Per Capita Personal Income

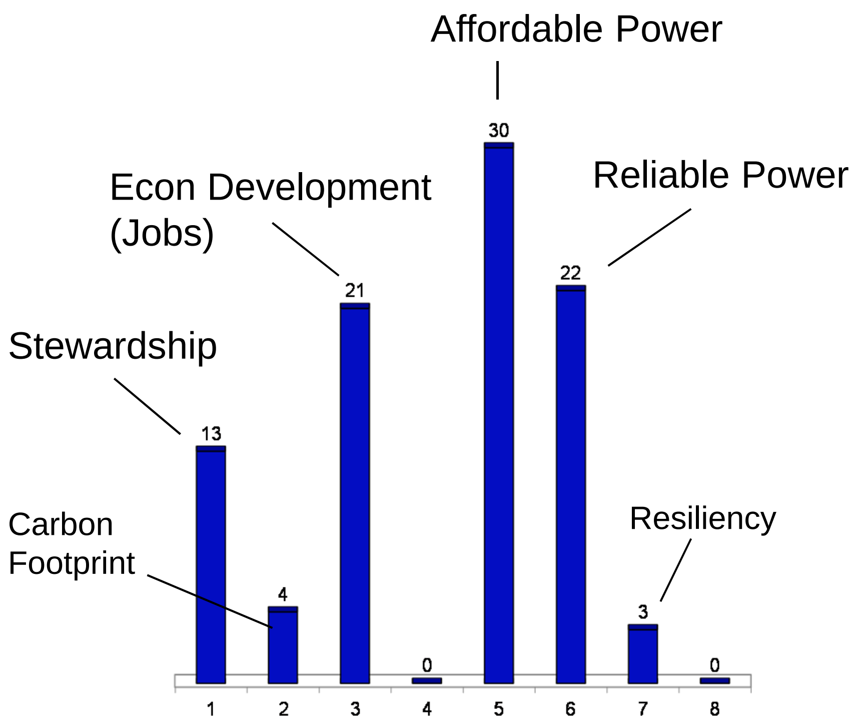
<u>2011 RP Evaluation Criteria</u>

Costs - both long term and short term metrics based on plan costs	Environmental Stewardship– CO_2 footprint, water (thermal), waste disposal
Risk – both upside exposure & risk/benefit balance	Economic Impacts – total employment & growth in personal income

TVA is Proposing a Fifth Criteria Based on Input From the RERC

Ranking of Policy Priorities – RERC

- Polling of the energy policy advisory group provides some insight into their perspective on TVA priorities around energy policy/strategy
- These results are taken from a working session conducted in January 2014



IRP Evaluation Criteria

- Costs - both long term and short term metrics based on plan costs
- Environmental – CO_2 footprint, water (thermal), waste disposal
- Risk – both upside exposure & risk/benefit balance
- Economic Impacts – total employment & growth in personal income
- Reliability/Resiliency

RERC Advice on Framework for Evaluating Strategies

"The Council believes that TVA must balance certain priorities, including environmental stewardship, competitive rates, system reliability, economic development, and workforce impact. TVA must not allow focus on near-term cost reduction to undermine its essential priorities of technology innovation in both supply-side and demand-side technologies"

"Given TVA's responsibilities as articulated in the TVA Act, it has a broader imperative than investor-owned utilities. Business decisions should reflect the interest of all stakeholders in the Tennessee Valley. An important consideration should be the impact of decisions on local communities."

"The Council recommends the TVA Board considers, in its deliberations, the importance of ensuring system reliability, including voltage impacts, in addition to economic analysis when making asset decisions."

Feedback from the Working Group – Evaluation Criteria

- Any additional evaluation criteria that should be considered?
- Other questions/comments?

2015 Integrated Resource Plan

IRPWG Session (Day 2)

April 30, 2014

Knoxville

IRPWG Meeting – April Agenda

	Day 1	
9:30	Welcome	Randy McAdams
9:45	Introduction to Stochastic Modeling and Application to the IRP	Scott Jones
10:30	*Break*	
10:45	modeling Approach for Energy Efficiency	Edward Colston
11:45	*Lunch*	
12:30	Overview of Commodity Methodology Forecasting	Connie Trecazzi/ Patrick Obrien
1:15	Methodology for Evaluating the IRP Economic Impact	Wesley Nimon
2:00	*Break*	
2:15	Metrics Discussion	Gary Brinkworth
4:00	*Adjourn*	

	Day 2	
9:00	Summary of Previous' Day Metrics Discussion	Gary Brinkworth
9:30	Overview of the Current Power Supply Plan	Scott Self
10:30	*Break*	
10:45	Summary of Proposed Strategies	Gary Brinkworth
11:30	Next Steps	Randy McAdams
11:45	*Adjourn*	

Summary of Metrics Discussion

Candidate Metrics by Category

Category	Metrics
Costs - both long term and short term metrics based on plan costs	5 metrics: expected value PVRR (20 yr and 10 yr), system average cost $/MWh (10yr, 7yr and 5yr)
Risk – both upside exposure & risk/benefit balance	6 metrics: risk ratio, risk-benefit ratio, P(95), P(95)-P(5), performance uncertainty, climate risk
Environmental – CO_2 footprint, water (thermal), waste disposal	7 metrics: CO_2 average tons, CO_2 tons/MWh, thermal loading, waste disposal, water consumptive use, spent nuclear fuel index, coal waste produced
Economic Impacts – considering per capita income changes	3 metrics: employment, growth in personal income, % change in per capita income
Reliability/Resiliency	3 metrics: non-dispatchable capacity ratio, availability by resource type, flexibility

Candidate Metrics - Cost

Metric	Definition
Expected Value PVRR 20y	The total plan cost (capital & operating) expressed as the present value of revenue requirements over the study period (20 years). This value is generated from the stochastic analysis (the expected value of the probability distribution of plan costs).
Expected Value PVRR 10y	The total plan cost (PVRR) over the first 10 years of the study
System Average Cost ($/MWh) 2011-2018	Short term (7 yr) plan cost expressed on a per unit of energy basis. This value is sometimes called the levelized cost.
System Average Cost ($/MWh) 10y	Average system cost for the first 10 years of the study
System Average Cost 5y	Average system cost for the first 5 years of the study

Used in 2011 IRP

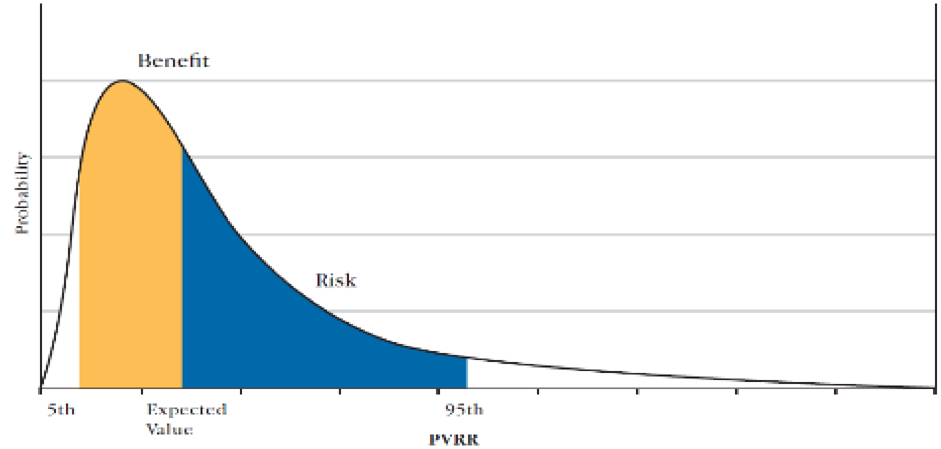
Candidate Metrics - Risk

Metric	Definition
Risk Ratio	A measure of risk that the plan cost will exceed the expected value. This metric is developed by computing the ratio of the upper (higher cost) section of the cost distribution (between P(95) and the expected value) divided by the expected value (see the graphic below)
Risk-Benefit Ratio	A measure of the balance in plan cost uncertainty; captures the likelihood of higher costs and the opportunity for lower costs by computing a ratio using the 5th and 95th percentiles of the cost distribution (see graphic below)
P(95)	The point on the plan cost distribution below which the likely plan costs from the stochastic analysis will be 95% of the time
P(95)-P(5)	The predicted variation in plan cost from the stochastic analysis, determined by using the difference between the tails of the distribution (see the graphic below); the range in which plan costs will fall 90% of the time.
Performance Uncertainty (risk) for Wind/Solar	A measure of the operational variability of non-dispatchable resources and the likelihood of actual performance deviating from forecasted performance
Climate Risk	A measure of risk related to climate change; determined by extracting "draws" that contain the extreme weather assumptions from the tail of the cost distribution

PVRR P(95) = 95th Percentile of PVRR
PVRR P(5) = 5th Percentile of PVRR

Risk Ratio = $\frac{95^{th} - \text{Expected Value}}{\text{Expected Value}}$

Risk/Benefit Ratio = $\frac{95^{th} - \text{Expected Value}}{\text{Expected Value} - 5th}$



Used in 2011 IRP

Candidate Metrics – Environmental Stewardship

Metric	Definition
CO_2 Avg. Tons	The annual average tons of CO_2 emitted over the study period
CO_2 Tons/MWh	The CO_2 emissions expressed as an emission intensity; computed by dividing emissions by energy generated
Thermal Loading	A measure of the BTUs delivered to the plants' condensers based on energy generated by resource type; this is a proxy for thermal loading/discharge impacts.
Waste Disposal (coal ash & nuclear fuel)	This metric identifies waste impact (coal and nuclear) based on the cost of handling the waste generated—the assumption is that the costs of disposal is a proxy for the wastes' impacts on the environment.
Water Consumptive Use	An index to track the water consumption by resource type
Spent Nuclear Fuel Index	A measure of the quantity of spent nuclear fuel that is projected to be generated based on energy production in each portfolio
Coal Waste Produced	The quantity of coal ash, sludge & slag projected based on energy production in each portfolio

Used in 2011 IRP (green shading: CO2 Avg. Tons, Thermal Loading, Waste Disposal)

Candidate Metrics – Economic Impact

Metric	Definition
Employment	The change in employment expressed relative to a baseline future
Growth Personal Income	The change in personal income expressed relative to a baseline future
Change in per capita income	The change in per capita personal income expressed as a change from a reference portfolio in each scenario

Used in 2011 IRP

Candidate Metrics – Reliability

Metric	Definition
Non-Dispatchable Capacity Ratio	The amount of non-dispatchable resources (like solar and wind) included in each portfolio expressed as a % of the total installed resources in the portfolio
Availability by Resource Type	Resource availability based on forced outage and maintenance outage rates by technology
Flexibility (EPRI)	This metric still under study

Summary - Candidate Metrics By Category

Cost	Risk	Env Stewardship	Econ Impacts	Reliability
Expected Value PVRR 20y	Risk Ratio	CO2 Avg Tons	Employment	Non-dispatchable capacity ratio
ExpVal PVRR 10y	Risk-Benefit Ratio	CO2 Tons/MWh	Growth Personal Income	Availability by resource type
Sys Avgerage Cost ($/MWh) 10y	P(95)	Thermal Loading	% change in per capita income	Flexibility (EPRI)
Sys Avg Cost 5y	P(95)-P(5)	Waste Disposal (coal ash & nuclear fuel)		
Avg System Cost ($/MWh) 2011-2018	Performance uncertainty (risk) for wind/solar	Water consumptive use		
	Climate Risk	Spent nuclear fuel index		
		Coal Waste produced		

This list of candidate metrics is still being evaluated by TVA. Not all of these metrics will become part of the evaluation scorecard.

Used in 2011 IRP

Feedback from the Working Group – Metrics

- Any additional metrics that should be considered by TVA?
- What metrics should be retained for the final scorecard?
- Other questions/comments?

To Be Effective, Metrics Need a Scorecard

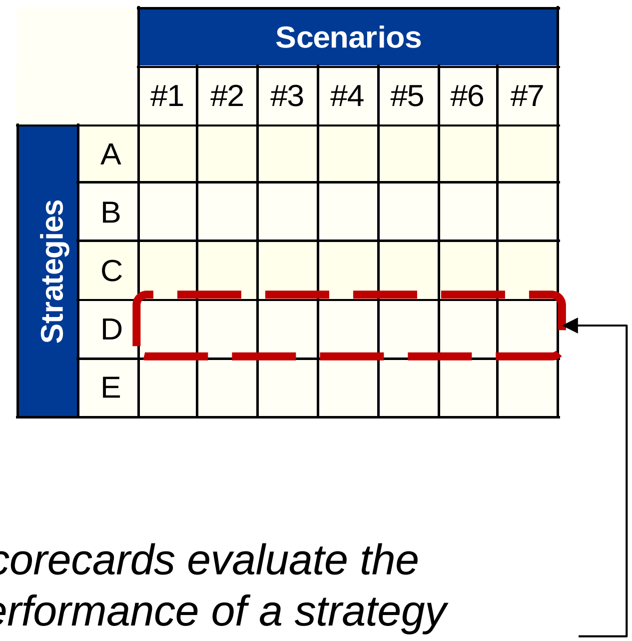
- Metrics need to be presented in a way that facilitates a discussion/debate about trade-offs that lead to the selection of the preferred resource plan

- During the 2011 IRP, we use a scorecard approach to packaging the metrics, so that stakeholders and decision-makers can be fully engaged in the identification of what makes a resource plan "preferred"

- IRP scorecards were developed to reflect components of TVA's mission and strategic principles
  - Cost and risk metrics evaluated quantitative values that reflect traditional utility measures
  - Environmental and economic metrics considered possible impacts of both quantitative and qualitative assessments

- No regrets considerations were used in addition to the scorecard to represent broader implications that can be described, but are not fully represented in the analysis

Scenario Analysis

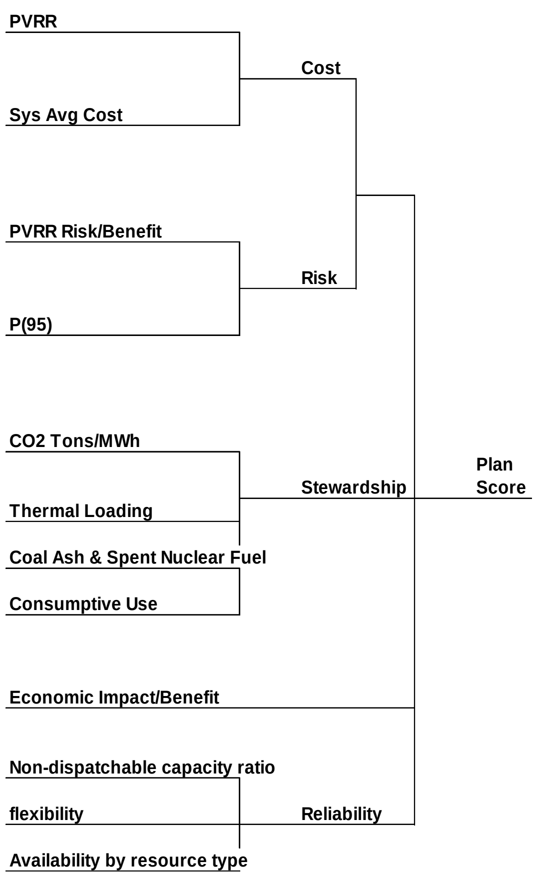


Scorecards evaluate the performance of a strategy across many different scenarios

Scorecard Design

- A scorecard is a visualization mechanism that facilitates the analysis and decision making
- It should not be treated as an algorithm with a mechanical calculation
- It should strike a balance between summarizing and segregating information that facilitates the analysis

Scorecard A



Scorecard B

	Low-Cost Power			Environmental Stewardship		Economic Development	
Portfolios	Cost	Risk	Ranking Metric Score	Carbon Footprint	Composite Impact	Total Employment	Growth in Personal Income
		Total					

- In this example, scorecard A summarizes all metrics under a single score:
  - This method facilitates transparency and communication
  - It may complicate the analysis and discussion towards since business decision making is not arithmetic
- Scorecard B separates Cost and Risk from other Strategic Criteria:
  - This method facilitates analysis and discussion
  - Graphic representations can be misleading

Example:
IRP Scorecard Components in the 2011 IRP

Each portfolio is generated by applying a planning strategy in a scenario

Ranking metrics (financial) are proposed to rank planning strategies

Strategic indicators are paired with ranking metrics to complete the IRP scorecard

	Low-Cost Power			Environmental Stewardship		Economic Development	
Portfolios	**Cost**	**Risk**	**Ranking Metric Score**	**Carbon Footprint**	**Composite Impact**	**Total Employment**	**Growth in Personal Income**
		Total					

Ranking Metric Score = 0.65(Cost score) + 0.35(Risk score)

Definitions

- **Cost (65%):** based on combination of total plan cost (65%) and short-term rate impacts (35%)
- **Risk (35%):** a combination of a risk ratio (65%) and a risk/benefit score (35%)
- **Carbon Footprint:** average annual tons CO_2
- **Composite Impact:** a factor that combines air, water, and waste impacts
- **Economic Development**: differential impacts from a reference case level intended to capture relative growth in regional economic activity.

Example:
2011 IRP Scorecard Build

Scorecards Were Developed to *Score* Strategies Within Scenarios Across Several Dimensions

Step 1

- Planning strategies were ranked by summing scores for a planning strategy in all scenarios
  - Sensitivity analysis was conducted to refine preliminary results and/or capture other portfolio options
  - Preferred planning strategies were selected using ranking and judgment

Low-Cost Power			
Portfolios	**Cost**	**Risk**	**Ranking Metric Score**
Portfolio #1	124	92	113
Portfolio #2	127	96	116
Portfolio #3	99	67	88
Portfolio #4	122	231	160
Portfolio #5	167	89	140
Portfolio #6	143	45	109
Portfolio #7	201	119	172
Total Ranking Metric Score			898

Rank	Planning Strategies	Total Ranking Metrics Scores
1	Planning Strategy B	*Highest*
2	Planning Strategy C	↓
3	Planning Strategy A	↓
4	Planning Strategy D	↓
5	Planning Strategy E	*Lowest*

Step 2

- Selected resource portfolios in the ***preferred*** planning strategies were included in the Draft IRP
  - Based on feedback from external stakeholders, strategic indicators were constructed for selected portfolios and paired with ranking metrics

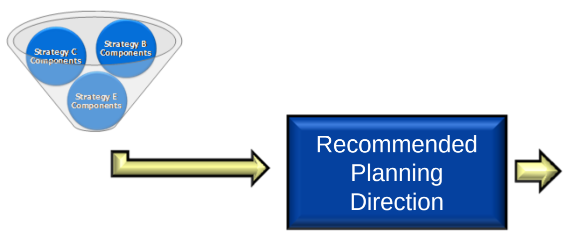
Scorecard for Selected Portfolios

	Ranking Metrics					Strategic Metrics				
	Energy Supply					Environmental Stewardship			Economic Impact	
Scenarios	Plan Cost	Short-Term Rate Impacts	Risk / Benefit	Risk Exposure	Total Plan Score	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	99.43	99.21	97.82	96.78	98.58	◕	●	◕	0.8%	0.6%
2	100.00	99.22	99.79	100.00	99.80	◕	●	◕		
3	99.15	96.03	95.91	97.73	97.72	◕	◕	◕		
4	99.45	99.58	95.32	89.57	96.73	◑	●	◕		
5	99.83	99.50	98.87	99.47	99.56	◕	◕	◕		
6	99.16	95.61	100.00	100.00	98.64	●	◕	◕	0.3%	0.2%
Baseline	99.68	99.77	98.98	98.96	99.45	◕	◕	◕		
				Total Ranking Metric Score	690.47					

Step 3

- Resource portfolios were refreshed and re-scored (as necessary) following public comment period
- A short list of resource portfolios were presented to TVA's Board for consideration
- The Board adopted a *preferred planning direction* by blending options into a final integrated resource plan

Selection of Final Planning Direction



	Ranking Metrics				
	Energy Supply				
Scenarios	PVRR	Short-Term Rate Impact	PVRR Risk/Benefit	PVRR Risk	Total Plan Score
1	99.00	95.13	100.00	99.53	98.36
2	100.00	95.58	99.40	95.30	97.85
3	100.00	100.00	99.81	89.37	97.56
4	100.00	97.40	100.00	95.37	98.36
5	100.00	96.43	100.00	100.00	99.19
6	100.00	100.00	100.00	86.69	96.97
Reference (initial)	100.00	97.24	100.00	97.03	98.70
Reference	99.84	96.66	98.35	97.93	98.50
				Total Ranking Metric Score	785.49

Feedback from the Working Group – Scorecard Design

- How should the metrics be combined or segregated for the scorecard?
- During the March session, the group provided the following feedback regarding scorecard design:
  - Avoid the use of red and green colors
  - Avoid the use of Harvey balls
  - Provide both the summary and the segregated numerical values behind the scores
- Any additional scorecard design considerations?
- Other questions/comments?

Scorecard Color Palette

Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	**781.88**	785.49
B	**C**	**E**	**R**

Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	**781.88**	785.49
B	**C**	**E**	**R**

Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	781.88	785.49
B	**C**	**E**	**R**

Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	781.88	785.49
B	**C**	**E**	**R**

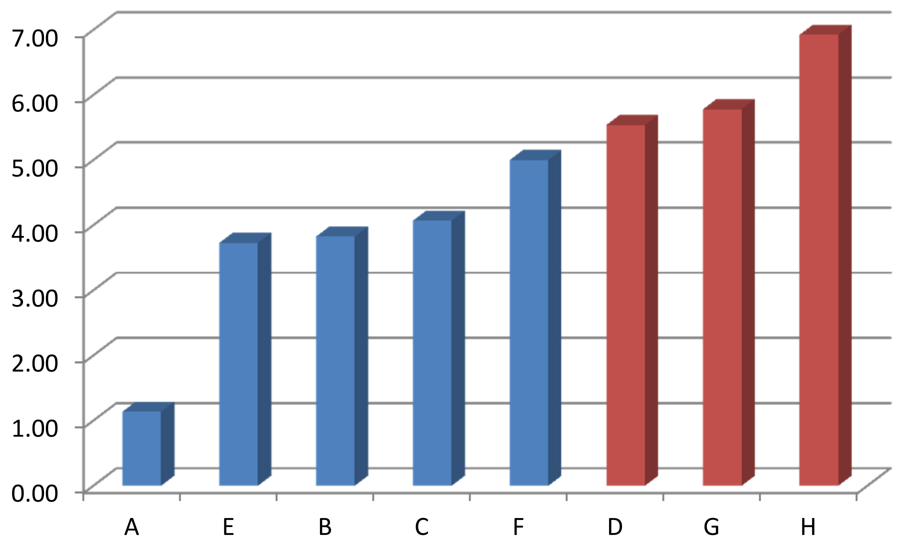
Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	781.88	785.49
B	**C**	**E**	**R**

Total Plan Score			
96.59	98.04	98.57	98.36
96.72	97.08	98.30	97.85
92.23	96.91	95.26	97.56
96.01	98.30	95.48	98.36
97.53	99.04	98.59	99.19
90.51	94.82	96.72	96.97
96.70	99.22	98.96	98.70
96.65	99.45	100.00	98.50
762.96	782.87	781.88	785.49
B	**C**	**E**	**R**

March Survey – Strategies Composite Ranking Results

- The graphics below show the composite results considering the rankings from the 17 participants (11 IRPWG and 6 TVA)
- The Weighted Average score is based on a 50/50 split between IRPWG and TVA

Composite Weighted Average



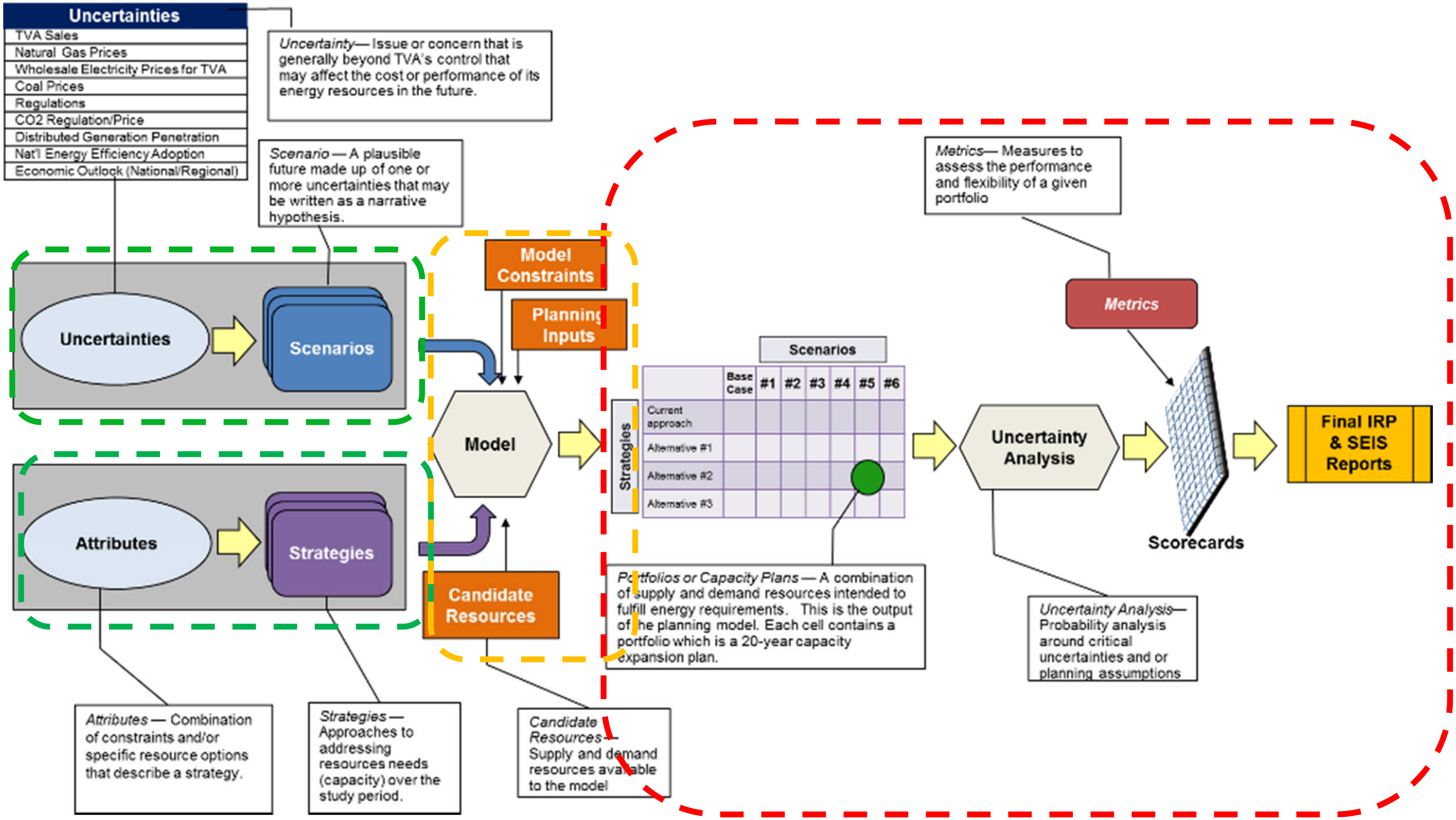
A	*"Traditional" Least Cost Planning*
B	*Meet an Emission Target*
C	*Lean on the Market*
D	*Do Gas Only*
E	*Doing More EEDR*
F	*Embracing Renewables*
G	*Energy-Water Nexus*
H	*No Nuclear*

- The composite ranking shows a strong preference for strategy A and an strong non-preference for strategies D, G and H
- There is consensus around the top 5 ranking strategies
- During the March session, the group asked to review the current generation plan in case there were additional comments on the proposed strategies

IRP 2015 Selected Strategies

STRATEGY	DESCRIPTION
A - "Traditional" Least Cost Planning	• All resource options available for selection; traditional utility "least cost optimization" case
B- Meet an Emission Target	• Resources selected to create lower emitting portfolio instead of focusing only on a traditional least cost approach • This lower emissions plan will be based on an emission rate target or level using CO2 as the emissions metric (the target will be set as a reduction from current emissions forecast) • Additional existing unit retirements may be included in the plan.
C - Lean on the Market	• Most new capacity needs are met using market resources and/or third-party assets acquired through PPA or other bilateral arrangements • TVA makes a minimal investment in owned assets (deployment of EEDR to meet resource needs will continue)
E - Doing More EEDR	• In order to establish TVA as a regional energy efficiency leader, a majority of capacity needs are met by setting an annual energy target for EEDR (e.g., minimum contribution of 1% of sales) • Renewable energy and gas are secondary options with no coal or nuclear additions permitted
F – Embracing Renewables	• In order to establish TVA as a regional renewable leader, a majority of new capacity needs are met by setting immediate and long-term renewable energy targets (e.g., 20% by 2020 and 35% by 2040), including hydroelectric energy • A utility-scale approach is targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024 • EEDR and gas are secondary options with no coal or nuclear additions permitted

2015 IRP Status



Completed

In process

Next steps

Meeting Objectives for IRPWG Through October 2014

RERC Briefing

TVA Board Members Briefing

May 2014
- Short list technology options
- Review of model assumptions and forecasts
- Discuss the design of the scorecard

June 2014
- Follow-up if needed from May assumptions review
- Final design of scorecard
- Modeling runs begin later this month

June 20

July 2914
- NO MEETING

August 2014
- Review of interim modeling results

August 12-13

RERC Briefing

Sept 2014
- NO MEETING

October 2014
- Review of case results & scorecards

Oct 7-8

- Next meeting will be on May 29-30 (Chattanooga)
- Subsequent meeting dates (tentative):
  - June 20 Knoxville
  - August 12-13 TBD (potentially Huntsville)
  - October 7-8 in Chattanooga