2015 Integrated Resource Plan

IRPWG Meeting

Session 8

June 19th-20th , 2014

IRPWG Meeting – Afternoon of June 19th Agenda

Day 1		
2:00pm	**Welcome and overview of Day's 1 & 2**	Randy McAdams
2:15pm	**Feedback from June 18 Public Meeting**	Gary Brinkworth
2:30pm	**Emergent Environmental Topics** - Overview of Section 111(d) Implications (GHG rule) Summary	Hunter Hydas
	- Overview of the National Climate Assessment	Joe Hoagland
3:00pm	**Metrics Update** - Detailed Explanation of the selected metrics (purpose, definition, formula) - Discussion of Metrics used for scoring versus reporting	Gary Brinkworth
5:15pm	**Wrap Up**	Randy McAdams
5:30pm	*Adjourn*	

IRPWG Meeting – June 20th Agenda

Day 2		
8:30am	**Recap from Previous Day/Overview of Day 2**	Randy McAdams
8:45am	**Metrics Review and Scorecard Design** - Continue and close any open items from Day 1 Metrics discussion - Scorecard design Overview - Scorecard design options review and discussion - Gather group's feedback	Gary Brinkworth
10:45am	*Break*	
11:00am	**Update on Scenarios Assumptions** - Review feedback received during May session - TVA's Response	Gary Brinkworth
11:30am	**Wrap Up**	Randy McAdams
11:45am	*Lunch and Adjourn*	

Feedback from June 18th Public Meeting

Material Presented

- IRP/SEIS Schedule Review
- IRP Status Update
  - Recap of the scenarios
  - Review of the Planning Strategies
  - Summary of Resource Options
  - A Look at Metrics & Scorecard Design
- Next Steps

Feedback Received

- Meeting was well attended ; approximately 20 people in person, an additional 35 people participating on line via webinar
- IRP process received favorable comments including, “The IRP process is robust with high integrity”.
- Questions about the IRP process included:
  - How the 2015 IRP results would impact existing power purchase agreements
  - If EPA section 111d would factor into the current plans for the 2015 IRP
  - How EE and renewables targets are used in the different strategies
  - If TVA will be developing specific programs that incentivize the installation of rooftop solar in collaboration with the LPC’s

Overview of Section 111(d) Implications (GHG rule) Summary

- President's Climate Action Plan instructed EPA to craft a rule to regulate CO2 emissions from existing power plants under CAA section 111(d)

- June 2 EPA released the proposed "Clean Power Plan"
  - EPA's proposal defines the "Best System of Emission Reductions"
  - EPA is defining the "system" broadly as the state's electrical system
  - Sets Emission Guidelines on a state-by-state basis for existing fossil units (lbs CO2/MWh)
  - EPA starts with a 2012 baseline for fossil emissions and generation
  - Many early actions that have reduced CO2 emissions are being used by EPA to establish more stringent emission guidelines

Best System of Emission Reduction (BSER) – Building Blocks

When calculating state goal emission rates, EPA considered four building blocks:

Block 1: Lowering carbon intensity of generation at individual affected EGUs (e.g., **heat rate improvements**)

Block 2: Reducing utilization of the most carbon-intensive affected EGUs to the extent that can be accomplished cost-effectively by **shifting generation to less carbon-intensive existing fossil fuel-fired EGUs**, including NGCC under construction

Block 4: Reducing utilization of carbon-emitting EGUs to the extent that can be accomplished cost-effectively by increasing **demand-side energy efficiency**

Block 3: Reducing utilization of carbon-emitting EGUs to the extent that this can be accomplished cost-effectively by **expanding new, lower (or no) carbon-intensity generation**

111(d) Process Timeline

WE ARE HERE

June 2014
- EPA proposes "Emission Guidelines" for States for existing power plants based on "Best System of Emission Reductions"

June 2015
- EPA finalizes "Emission Guidelines" (Litigation begins)

June 2016
- States file **State Plans** setting "Standards of Performance" for affected units

June 2018
- States file plans if they are working with multi-state, regional or RTO/ISO approaches

2020
- Compliance begins; Full compliance 2030

Clean Power Plan and the IRP

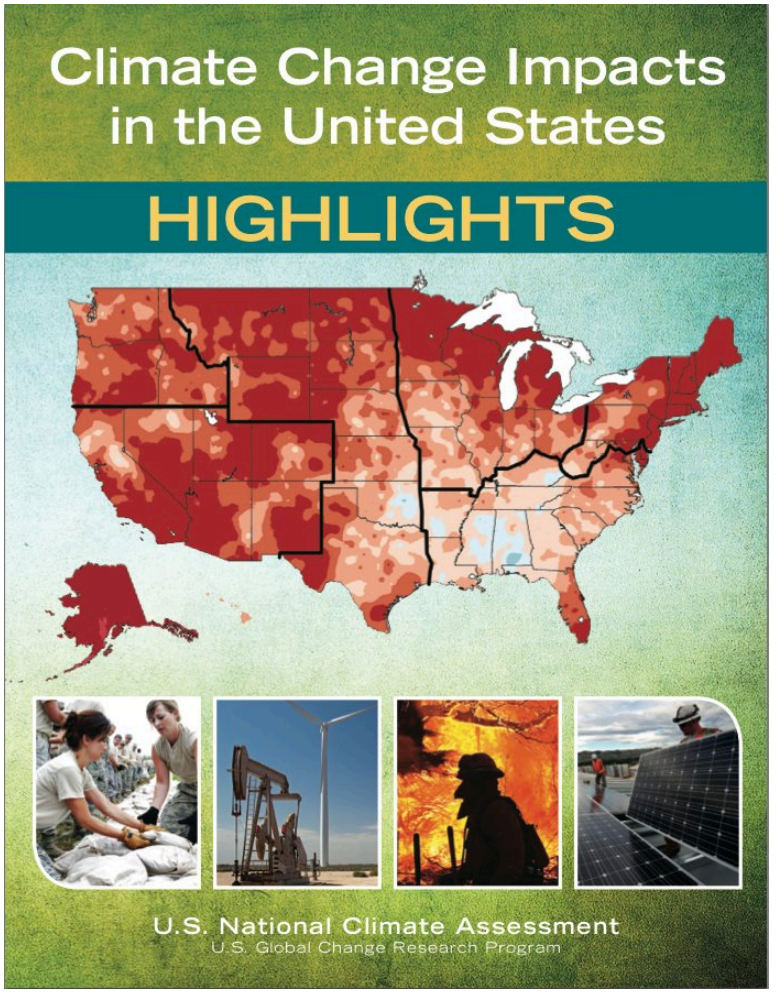
- It is too early in the rulemaking process to provide a definitive answer on the compliance impact to TVA and the Valley states
- The levels of reductions can only be met through decreasing coal generation, increasing utilization of lower-emitting sources, and diversifying the generation portfolio to include more non-emitting generation options
- TVA has included a carbon price in its IRP scenarios to represent the varying degrees of impact that this rule may have on its generating fleet. There is no need to change these inputs as the range of prices will envelope the impact of this rule
- IRP scenarios and strategies all have varying amounts of generation resources and capture the building blocks that EPA has included in the Proposed Rule
- These runs will provide insight for future compliance planning

Analyzing the Impact to TVA

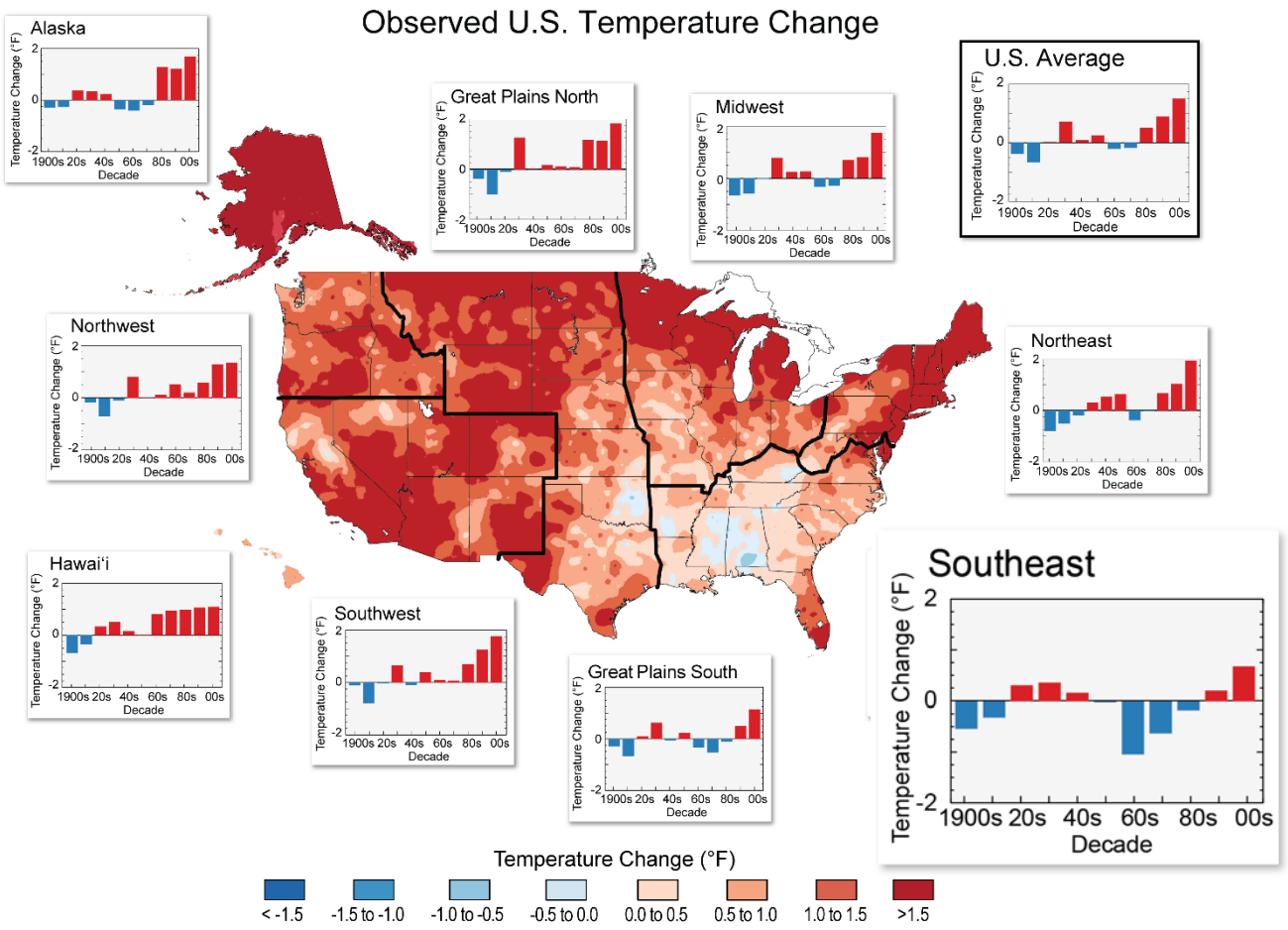
- The final rule, post litigation, will be different from the Proposed Rule
- TVA is analyzing the impact of this proposed rulemaking to be able to develop constructive comments back to EPA, engage with the Valley states, and communicate with our stakeholders
- This is a complex rule. It appears EPA is setting more stringent emission guidelines in states that have made early reductions in CO2.
- Beyond the CO2 reductions from early actions and current plans, this rule may require additional reductions from uneconomic decisions on heat rate improvements, dispatch, renewables, and energy efficiency

Overview of National Climate Assessment

- Third National Climate Assessment (NCA3) published May 6, 2014
- The Global Change Research Act of 1990 requires an assessment report at least every four years
- Assessments are produced by the U.S. Global Change Research Program (USGCRP), a collaboration of 13 Federal science agencies
- Process included a 60 member Federal Advisory Committee
- Written by 240 authors drawn from academia; local, state, tribal and Federal governments; and the private and nonprofit sectors.
- TVA directly participated in multiple review processes and provided comments
- Similar to the IRP process, NCA3 uses internationally agreed upon modeling scenarios to analyze a broad set of possible “futures” that depend upon key economic assumptions (i.e. – what climate policy, if any, looks like)
- TVA’s first Agency-wide adaptation plan was made available (for public comment) in 2012
- TVA has recently updated its climate adaptation plan in response to the findings of the new NCA

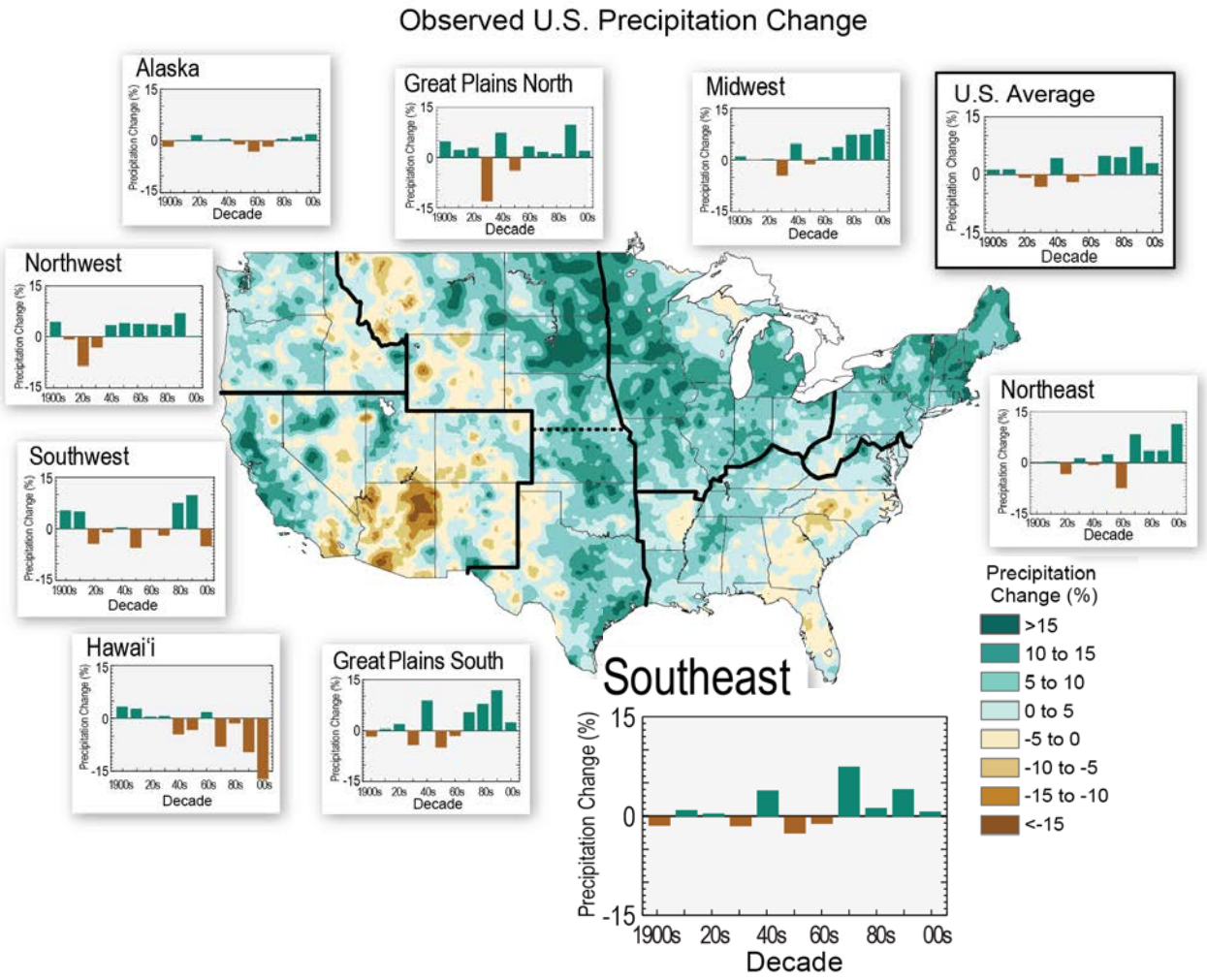


NCA3 – Observed Temperature Change– U.S. and Regional



- Southeast U.S. is one of the few regions globally not to exhibit an overall warming trend in surface temperature over the 20th century
- This 'warming hole" also includes parts of the Great Plains and Midwest regions
- In recent years (since the 1970s), temperatures have increased steadily across the region
- The most recent decade (2001-2010) is the warmest decade on record for the Southeast region

NCA3 – Observed Precipitation Change– U.S. and Regional



- Significant trends in average precipitation have been detected
- The fraction of these trends attributable to human activity is difficult to quantify because the range of natural variability in precipitation is large
- Southeast long-term trends are wetter in fall and drier in summer
- More dry spells and more heavy rains are projected
- Extreme wetness and extreme dryness are projected to increase in many areas

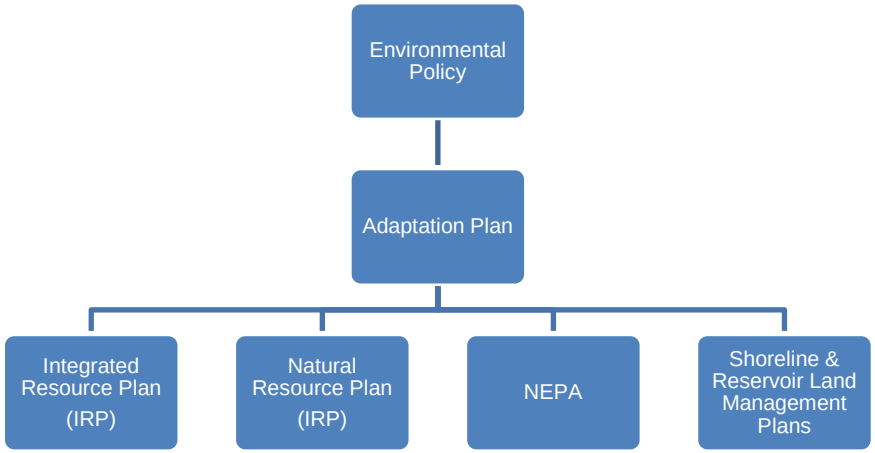
NCA3 – Observations Summary

- Southeast U.S. is one of the few regions globally not to exhibit an overall warming trend in surface temperature over the 20th century
- In recent years (since 1970s), temperatures have steadily increased across the region. 2001-2010 has been the warmest decade on record
- Significant trends in Southeast average precipitation have been detected
- It is difficult to attribute the fraction of these trends to human activity because the range of natural variability in precipitation is large
- Southeast long-term trends are wetter in fall and drier in summer
- Generally more dry spells and more heavy rain events are projected
- TVA directly participated in multiple review processes and provided comments
- A summary of the NCA3 observations for the Southeast U.S. is available at: http://scenarios.globalchange.gov/sites/default/files/NCA-SE_Regional_Scenario_Summary_20130517_banner.pdf

Climate Adaptation Strategies

TVA's climate adaptation strategies with implications to generation planning include:

- A balanced portfolio that provides low cost, reliable power
- A lower environmental footprint that supports sustainable economic growth and proactive environmental stewardship
- Climate Resilience will be incorporated into these strategies:



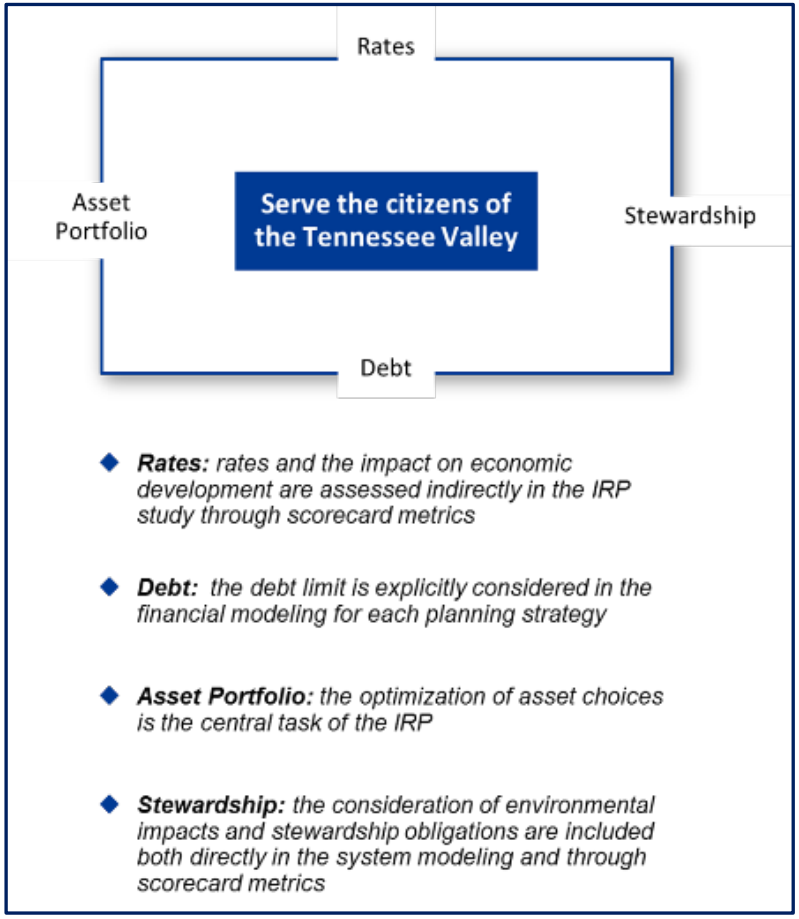
IRP Studies: Drowning in a Sea of Information

- An IRP study can produce an overwhelming amount of case data
  - In TVA's 2011 IRP Study, we evaluated over 3,000 simulations
- How do you begin to sort out all that data and identify the preferred resource plan?
- What sort of ranking or filtering algorithm would you employ?
  - Present value of revenue requirements?
  - Risk tolerance?
  - P/L ratio or other balance sheet indicator?
  - All of these?
- How do you engage stakeholders and decision-makers in the plan selection process?

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 requires the use of metrics that go 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 develop candidate metrics
  - Stakeholders make other suggestions and help to shape the final set of evaluation metrics
- How metrics are described and presented makes a big difference in how effective they are.

TVA Strategic Imperatives



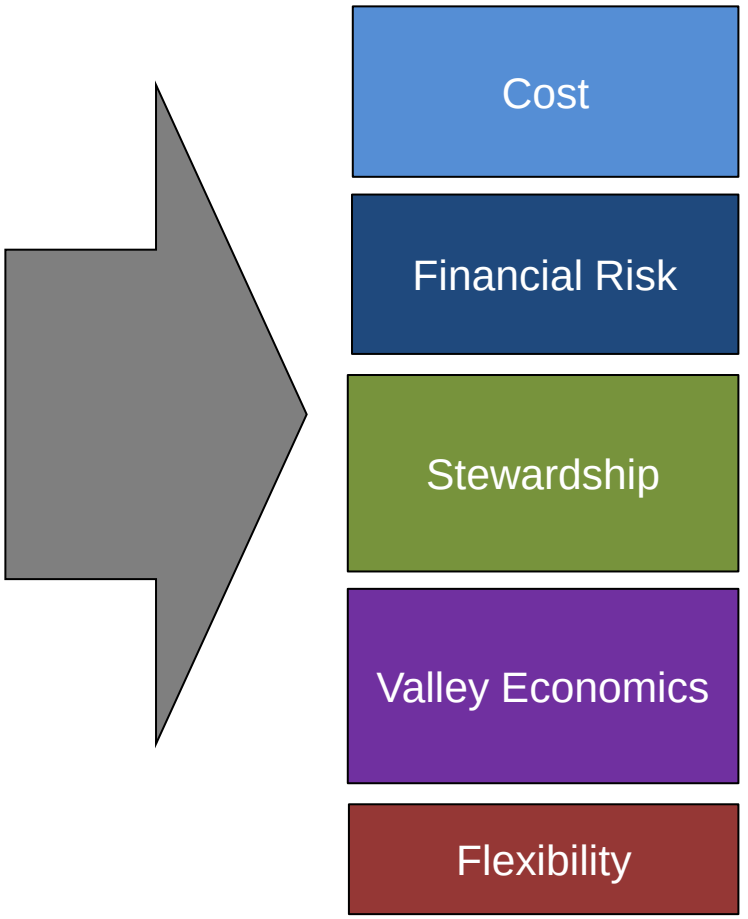
- ***Rates:*** *rates and the impact on economic development are assessed indirectly in the IRP study through scorecard metrics*
- ***Debt:*** *the debt limit is explicitly considered in the financial modeling for each planning strategy*
- ***Asset Portfolio:*** *the optimization of asset choices is 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*

Categories of IRP Metrics

Factors Influencing Category Selection

- Policy objectives and goals frame the IRP study
- Least-regrets planning at TVA uses scenario analysis methods combined with a robust assessment of uncertainty to identify alternative resource plans
- Plans need to be evaluated using a broad set of criteria in order to determine the plan that best positions the utility for success in multiple future conditions
- TVA uses a scorecard designed to capture the key aspects of our mission as the mechanism to help decision-makers select the preferred resource plan
- The scorecard criteria (categories of metrics) are also discussed with stakeholders to ensure they represent a broad value set
- It's unlikely any one single resource plan will score high in all criteria; variation in scores stimulate the trade-off discussion that leads to the choice of the preferred plan

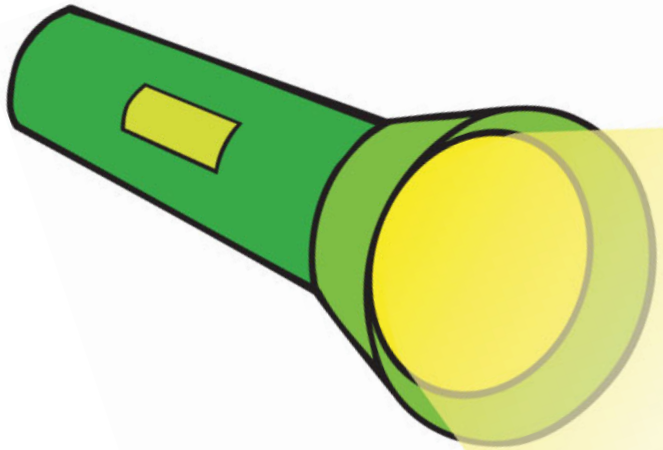
Metrics Categories



- Anything missed?
- Any concerns?

Guiding Principles for Metrics

Guiding principles for metrics selected for use in the IRP study include:



- Metrics must help distinguish between options
- Metrics must be able to show quantitative and/or qualitative differences between strategies as evaluated against scenarios using MIDAS as the modeling tool
- Metrics must be readily understood by the various IRP study stakeholder groups
- Metrics must be “calculatable” (able to be derived) using existing and available measurements, statistics and records data

Summary - Candidate Metrics By Category

Cost	Financial Risk	Stewardship	Valley Economics	Flexibility
Expected Value PVRR 20y	Risk Ratio	CO2 Avg Tons	Employment	Non-dispatchable energy ratio
ExpVal PVRR 10y	Risk-Benefit Ratio	CO2 Tons/MWh	Growth Personal Income	% dispatchable capacity for load following
Sys Avgerage Cost ($/MWh) 10y	Risk Exposure	Thermal Loading	% change in per capita income	
Sys Avg Cost 5y	Cost Uncertainty	Waste Disposal (coal ash & nuclear fuel)		
Sys Avg Cost 2011-2018 ($/MWh)	Uncertainty of fixed energy schedules	Water consumptive use		
		Spent nuclear fuel index		
		Coal Waste Produced		

Used in 2011 IRP

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, computed as the levelized annual system average cost (revenue requirements in each year divided by sales in that year)
System Average Cost 5y	Average system cost for the first 5 years of the study

Used in 2011 IRP

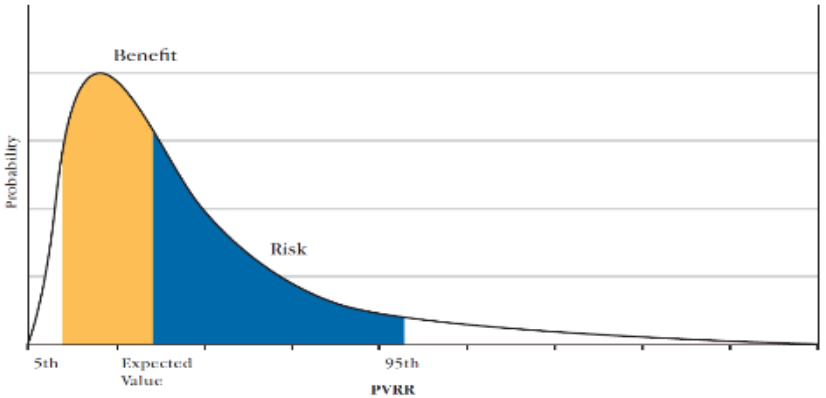
Candidate Metrics – Financial Risk

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)
Risk Exposure	The point on the plan cost distribution below which the likely plan costs from the stochastic analysis will be 95% of the time
Cost Uncertainty	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.
Uncertainty of Fixed Energy Schedules	Production (GWh) from fixed energy pattern resources divided by the total sales in each year. Intended to capture actual variation in production from solar/wind/EE not represented in modeled energy patterns or stochastic ranges for those resources.

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 = $\frac{95^{th} - \text{Expected Value}}{\text{Expected Value} - 5^{th}}$



Used in 2011 IRP

Candidate Metrics – Stewardship

Metric	Definition
CO2 Avg. Tons	The annual average tons of CO2 emitted over the study period
CO2 Tons/MWh	The CO2 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

Candidate Metrics – Valley Economics

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 – Flexibility

Metric	Definition
Non-Dispatchable Energy Ratio	Energy produced from resources that are not dispatchable (wind, solar, EE, nuclear) divided by the total sales in each year.
% dispatchable capacity for load following	% of fully dispatchable capacity available for load following starting from peak to minimum load

Types of Metrics in the 2011 IRP

- The scorecard is intended to facilitate a trade-off analysis by displaying key metrics that capture aspects of cost, risk, environmental stewardship and economic development impacts
- Based on discussions with stakeholders, two types of scorecard metrics were developed for use in the 2011 IRP Study
  - Ranking Metrics were used to quantify the financial impacts of a portfolio (20-year resource plan).
  - Strategic Metrics were developed to capture other parts of TVA's mission that would not be fully captured in the Ranking Metrics.
- Ranking Metrics were weighted and used to establish rank order of portfolios , reflecting greater analytical rigor needed to develop these values. Strategic Metrics were used to provide additional insight in the trade-off analysis.

RANKING METRICS		STRATEGIC METRICS	
Costs - both long term and short term metrics based on plan costs	Risk – both upside exposure & risk/benefit balance	Environmental – CO2 footprint, water (thermal), waste disposal	Economic Impacts – total employment & growth in personal income

Types of Metrics

Metrics serve two different purposes in the IRP Process depending upon:

- Definition
- Calculation
- Insights provided

SCORING

- Well understood characteristics
- Industry standard measures
- Supports numerical comparison

Scoring metrics will be directly used in the scorecard portions of the IRP results to provide clear and measurable comparisons amongst the resource portfolios created in each scenario

REPORTING

- Optional/advanced measures
- Developmental
- Informative/Supplemental

Reporting metrics will be tabulated in the appendix and used in the narrative portions of the IRP &SEIS to capture other aspects of the resource portfolios that are not included in the strategy scorecard

Present Scorecard Metrics vs Report Metrics

SCORING	REPORTING
Sys Average Cost ($/MWh) 10y	Uncertainty of fixed energy schedules
Expected Value PVRR 20y	Cost Uncertainty
Risk/Benefit Ratio	Risk Ratio
Risk Exposure	Water Consumptive Use
CO2 Tons /MWh	Spent Nuclear Fuel Index
CO2 Avg Tons	Coal Waste Produced
Thermal Loading	Waste Disposal (coal ash & nuclear fuel)
Non-dispatchable Energy Ratio	%Dispatchable Capacity for Load Following
% Change in Per Capita Income	Employment

NOT USED
Sys Avg Cost 5y
ExpVal PVRR 10y
Sys Avg Cost 2011-2018 ($/MWh)
Growth Personal Income

- Cost
- Risk
- Environmental Stewardship
- Economic Impact
- Flexibility

Metrics Update

Scoring Metrics – Definitions/Formulas

SCORING Metric	Definition/Formula
Sys Average Cost ($/MWh) 10y	Average system cost for the first 10 years of the study, computed as the levelized annual system average cost (revenue requirements in each year divided by sales in that year)
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).
Risk/Benefit Ratio	area under the plan cost distribution curve between P(95)and Expected Value divided by the area between Expected Value and P(5)
Risk Exposure	The point on the plan cost distribution below which the likely plan costs from the stochastic analysis will be 95% of the time
CO2 Tons /MWh	The CO2 emissions expressed as an emission intensity; computed by dividing emissions by energy generated
CO2 Avg Tons	The annual average tons of CO2 emitted over the study period
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.
Non-dispatchable Energy Ratio	Energy produced from resources that are not dispatchable (wind, solar, EE, nuclear) divided by the total sales in each year.
% Change in Per Capita Income	The change in per capita personal income expressed as a change from a reference portfolio in each scenario

Cost
Risk
Environmental Stewardship
Economic Impact
Flexibility

Wrap Up

- Review of new action items from today's discussion
- Preview of tomorrow's agenda
- Any additional concerns / questions

IRPWG Meeting – June 20th Agenda

Day 2		
8:30am	**Recap from Previous Day/Overview of Day 2**	Randy McAdams
8:45am	**Metrics Review and Scorecard Design** - Continue and close any open items from Day 1 Metrics discussion - Scorecard design Overview - Scorecard design options review and discussion - Gather group's feedback	Gary Brinkworth
10:45am	*Break*	
11:00am	**Update on Scenarios Assumptions** - Review feedback received during May session - TVA's Response	Gary Brinkworth
11:30am	**Wrap Up**	Randy McAdams
11:45am	*Lunch and Adjourn*	

Scoring Metrics – Definitions/Formulas

SCORING Metric	Definition/Formula
Sys Average Cost ($/MWh) 10y	Average system cost for the first 10 years of the study, computed as the levelized annual system average cost (revenue requirements in each year divided by sales in that year)
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).
Risk/Benefit Ratio	area under the plan cost distribution curve between P(95)and Expected Value divided by the area between Expected Value and P(5)
Risk Exposure	The point on the plan cost distribution below which the likely plan costs from the stochastic analysis will be 95% of the time
CO2 Tons /MWh	The CO2 emissions expressed as an emission intensity; computed by dividing emissions by energy generated
CO2 Avg Tons	The annual average tons of CO2 emitted over the study period
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.
Non-dispatchable Energy Ratio	Energy produced from resources that are not dispatchable (wind, solar, EE, nuclear) divided by the total sales in each year.
% Change in Per Capita Income	The change in per capita personal income expressed as a change from a reference portfolio in each scenario

Cost
Risk
Environmental Stewardship
Economic Impact
Flexibility

IRP Metrics Used by Peers

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

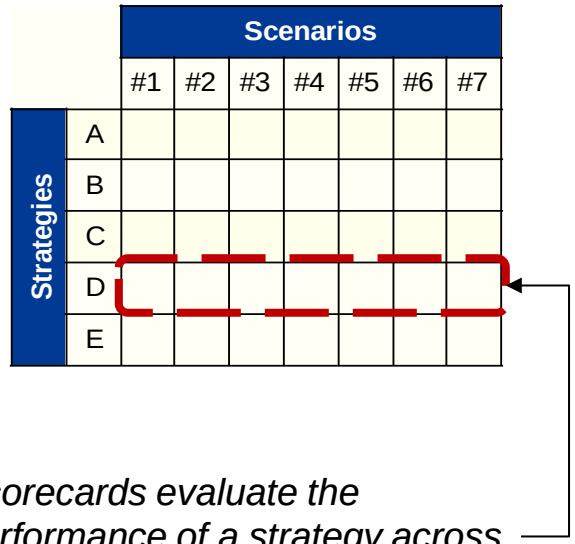
- On average, utilities consider three to four criteria when evaluating potential IRP portfolios
- All utilities include some measure of cost in the evaluation (PVRR at a minimum)
- Most utilities include reliability metrics and environmental metrics as well
- The most common measure of environmental 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 2013	DOM 2013	ETR 2012	APS 2012	TVA 2011	TVA 2015
Financial Measures										
Present Value of Revenue Requirement (PVRR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cumulative 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								✓		✓

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 used a scorecard approach to packaging the metrics, so that stakeholders and decision-makers could 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 Concepts

- A scorecard is a visualization mechanism that facilitates 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 understanding and interpretation of the underlying analysis without requiring decision-makers be familiar with all the details
- The scorecard design should make communication of the key information clear and understandable to stakeholders and the general public
- The structure of the scorecard can take several forms
  - Numerical
  - Visual/relational
  - A combination that can be weighted or un-weighted

Scorecard Finalization Plan

Scorecard Design Review
JUNE 20

- 2011 Scorecard design reviewed with IRPWG
- Key attributes are discussed
- IRPWG provide preferences for attribute options

Scorecard Construction

- TVA evaluates preferences from IRPWG and internal exec team
- Scorecard final design completed and proposed version uploaded to file sharing site
- Stakeholder comments submitted via email

Scorecard Stakeholder Final Review and Feedback
JULY 11th

- Proposed scorecard design added to the agenda for the webinar on EE modeling
- IRPWG members provide final comments (if any)

Scorecard Design Locked

- Final version of scorecard completed
- TVA posts final and locked scorecard design to the file sharing site by July 18th

Design and Use of the 2011 IRP Scorecard

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

Ranking metrics (financial) were proposed to rank planning strategies

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

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					

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

DESIGN

- Metrics were segregated and presented in two groups for each planning strategy against each scenario
- Ranking Metrics were weighted, presented numerically with colors to easily illustrate relative values and used to establish rank order of portfolios using greater analytical rigor
- Strategic Metrics were presented with graphics for qualitative comparison and provided additional insight in the trade-off analysis

USE

- This scorecard design helped facilitate a discussion about trade-offs and identified the strengths and weaknesses of various resource planning strategies thru use of numerical values, color coding and qualitative ranking methods
- Using this type of scorecard allowed stakeholders and decision-makers who were not technical experts (or lacked familiarity with resource planning methods) to participate more fully in the debate around selecting a preferred resource plan

Scorecard Structure

Scorecards often incorporate one or more of the following design options:

1. ***Numerical /Graphical***
   - NUMERICAL
   - GRAPHICAL
   - NUMERICAL/ GRAPHICAL MIX
2. ***Weighting***
   - VALUES
   - WEIGHTED VALUES
   - COMBINED SCORE
3. ***Colors***
   - COLORS
   - NO COLOR
   - ONE COLOR SHADING
4. ***Symbols***
   - HARVEY BALLS
   - ARROWS
   - 5 BAR

2011 IRP Scorecard Attributes

	Ranking Metrics				
	Energy Supply				
Scenarios	Plan Cost	Short-Term Rate Impacts	Risk / Benefit	Risk Exposure	Total Plan Score
1	99.43	99.21	97.82	96.78	98.58
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
Baseline	99.68	99.77	98.98	98.96	99.45
				Total Ranking Metric Score	690.47

Strategic Metrics				
Environmental Stewardship			Economic Impact	
CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
◕	●	◕	0.8%	0.6%
◕	●	◕		
◕	◕	◕		
◑	●	◕		
◕	◕	◕		
●	◕	◕	0.3%	0.2%
◕	◕	◕		

1. *Numerical /Graphical*

- NUMERICAL
- GRAPHICAL
- ● NUMERICAL/ GRAPHICAL MIX

2. *Weighting*

- ● VALUES
- ● WEIGHTED VALUES
- ● COMBINED SCORE

3. *Colors*

- ● COLORS
- NO COLOR
- ONE COLOR SHADING

4. *Symbols*

- ● HARVEY BALLS
- ARROWS
- 5 BAR

● = *attribute of 2011 IRP Scorecard*

Scorecard – Numerical / Graphical Options

Data For Illustration Purposes Only

A

Numerical

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	96.71	97.22	98.81	95.44	97.68
Stagnant Economy	98.77	98.12	99.15	96.79	98.77	98.37	99.65	99.43	99.77
Growth Economy	99.15	97.45	97.66	99.65	99.98	99.11	95.62	98.77	99.47
De-carbonized Future	100	100	99.88	97.87	96.98	97.33	96.29	99.22	96.77
Distributed Marketplace	96.11	99.77	99.91	99.22	98.54	99.59	99.88	100	94.92

B

Graphical

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	●	◑	◕	●	◔	◑	◕	○	◑
Stagnant Economy	◕	◕	●	◔	◕	◕	●	●	●
Growth Economy	●	◑	◑	●	●	●	○	◕	●
De-carbonized Future	●	●	●	◑	◑	◑	◔	●	◔
Distributed Marketplace	◔	●	●	●	◕	●	●	●	○

C

Numerical / Graphical Mix

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	◔	◑	◕	○	◑
Stagnant Economy	98.77	98.12	99.15	96.79	◕	◕	●	●	●
Growth Economy	99.15	97.45	97.66	99.65	●	●	○	◕	●
De-carbonized Future	100	100	99.88	97.87	◑	◑	◔	●	◔
Distributed Marketplace	96.11	99.77	99.91	99.22	◕	●	●	●	○

Scorecard – Weighting

Data For Illustration Purposes Only

Converted Values

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/ Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	96.71	97.22	98.81	95.44	97.68
Stagnant Economy	98.77	98.12	99.15	96.79	98.77	98.37	99.65	99.43	99.77
Growth Economy	99.15	97.45	97.66	99.65	99.98	99.11	95.62	98.77	99.47
De-carbonized Future	100	100	99.88	97.87	96.98	97.33	96.29	99.22	96.77
Distributed Marketplace	96.11	99.77	99.91	99.22	98.54	99.59	99.88	100	94.92

Weighted Values

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
Weights	60%	40%	65%	35%	40%	30%	30%		
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/ Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	59.54	39.02	64.12	35.00	38.68	29.17	29.64	99.44	97.68
Stagnant Economy	59.26	39.25	64.45	33.88	39.51	29.51	29.90	99.43	99.77
Growth Economy	59.49	38.98	63.48	34.88	39.99	29.73	28.69	98.77	99.47
De-carbonized Future	60.00	40.00	64.92	34.25	38.79	29.20	28.89	99.22	96.77
Distributed Marketplace	57.67	39.91	64.94	34.73	39.42	29.88	29.96	100.00	94.92

Combined Score

	COST	FINANCIAL RISK	STEWARDSHIP	ECONOMICS	FLEXIBILITY
Current Outlook	98.56	99.12	97.49	99.44	97.68
Stagnant Economy	98.51	98.33	98.92	99.43	99.77
Growth Economy	98.47	98.36	98.41	98.77	99.47
De-carbonized Future	100	99.17	96.88	99.22	96.77
Distributed Marketplace	97.58	99.67	99.26	100	94.92

Scorecard – Colors Options

Data For Illustration Purposes Only

A

Color

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	96.71	97.22	98.81	95.44	97.68
Stagnant Economy	98.77	98.12	99.15	96.79	98.77	98.37	99.65	99.43	99.77
Growth Economy	99.15	97.45	97.66	99.65	99.98	99.11	95.62	98.77	99.47
De-carbonized Future	100	100	99.88	97.87	96.98	97.33	96.29	99.22	96.77
Distributed Marketplace	96.11	99.77	99.91	99.22	98.54	99.59	99.88	100	94.92

B

No Color

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	96.71	97.22	98.81	95.44	97.68
Stagnant Economy	98.77	98.12	99.15	96.79	98.77	98.37	99.65	99.43	99.77
Growth Economy	99.15	97.45	97.66	99.65	99.98	99.11	95.62	98.77	99.47
De-carbonized Future	100	100	99.88	97.87	96.98	97.33	96.29	99.22	96.77
Distributed Marketplace	96.11	99.77	99.91	99.22	98.54	99.59	99.88	100	94.92

C

One Color Shading

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	99.23	97.55	98.65	100	96.71	97.22	98.81	95.44	97.68
Stagnant Economy	98.77	98.12	99.15	96.79	98.77	98.37	99.65	99.43	99.77
Growth Economy	99.15	97.45	97.66	99.65	99.98	99.11	95.62	98.77	99.47
De-carbonized Future	100	100	99.88	97.87	96.98	97.33	96.29	99.22	96.77
Distributed Marketplace	96.11	99.77	99.91	99.22	98.54	99.59	99.88	100	94.92

Scorecard – Symbols Options

Data For Illustration Purposes Only

A

Harvey Balls

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	●	◑	◕	●	◔	◑	◕	○	◑
Stagnant Economy	◕	◕	●	◔	◕	◕	●	●	●
Growth Economy	●	◑	◑	●	●	●	○	◕	●
De-carbonized Future	●	●	●	◑	◑	◑	◔	●	◔
Distributed Marketplace	◔	●	●	●	◕	●	●	●	○

B

Directional

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	↑	→	↗	↑	↘	→	↗	↓	→
Stagnant Economy	↗	↗	↑	↘	↗	↗	↑	↑	↑
Growth Economy	↑	→	→	↑	↑	↑	↓	↗	↑
De-carbonized Future	↑	↑	↑	→	→	→	↘	↑	↘
Distributed Marketplace	↘	↑	↑	↑	↗	↑	↑	↑	↓

C

5 Bar

	COST		FINANCIAL RISK		STEWARDSHIP			VALLEY ECONOMICS	FLEXIBILITY
	Expected Value PVRR 20y	Sys Average Cost ($/MWh) 10y	P(95)	Risk/Benefit Ratio	CO2 Tons/MWh	CO2 Avg Tons	Thermal Loading	% change in per capita income	non-dispatchable energy ratio
Current Outlook	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇
Stagnant Economy	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇
Growth Economy	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇
De-carbonized Future	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇
Distributed Marketplace	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇	▂▄▆▇

Update on Scenario Assumptions

Issue	Description	TVA Response
Fundamental Economic Assumptions	A question on the fundamental assumptions about inflation and general economics; asking why stagnant economy and growth economy have similar inflationary outcomes.	The Stagnant Economy Scenario is supported by historical events and concerns of economists across the world today. In the context of historical events, the inflation assumption is conservative. Therefore, no change has been made.
Zero CO2 Price Assumption (Stagnant Economy Scenario)	Objections to assumption of zero CO2 price; the concern was about the reasonableness of this assumption especially to the public.	Recognizing that the initial assumption might be too conservative, TVA has developed a non-zero CO2 price starting at $5/metric ton in 2029 and increasing by $1 per year through 2033.
Timing of CO2 Price Impacts	Some questions about whether the price of CO2 should begin as late as 2022.	TVA's CO2 price forecast takes into account that future requirements may manifest themselves in multiple ways (e.g. EPA NSPS, carbon tax, clean energy standard, efficiency standards or other climate related costs). It's unlikely there will be any national climate or energy legislation prior to 2017. From enactment to impact would likely be 4 or 5 years, which results in a start year of 2022.
GDP Assumptions in the De-carbonized Future Scenario	In the Decarbonized Future, questioned the magnitude of impact on underlying economics; asking why the change in GDP is so (relatively) large. Also, why does the trend on GDP not show sufficient "bounce back" from additional investments likely in a decarbonized future.	Scenario assumed a moderate recession resulting in a GDP loss of ~4.7% in 2033. There is a correlation, supported by the research paper provided by SACE, that higher CO2 prices could result in larger GDP impacts (60% of studies resulted in GDP loss ranging from 0.1% to 5.12%) No revision is recommended, since the ~4.7% GDP loss coupled with high CO2 price falls within the range of possible outcomes.

Wind Modeling Update

- Wind Modeling material was requested during the May meeting
- Drafting and editing of this material is in progress
- Once finalized (and no later than end of June), the information package will be posted to the file sharing site

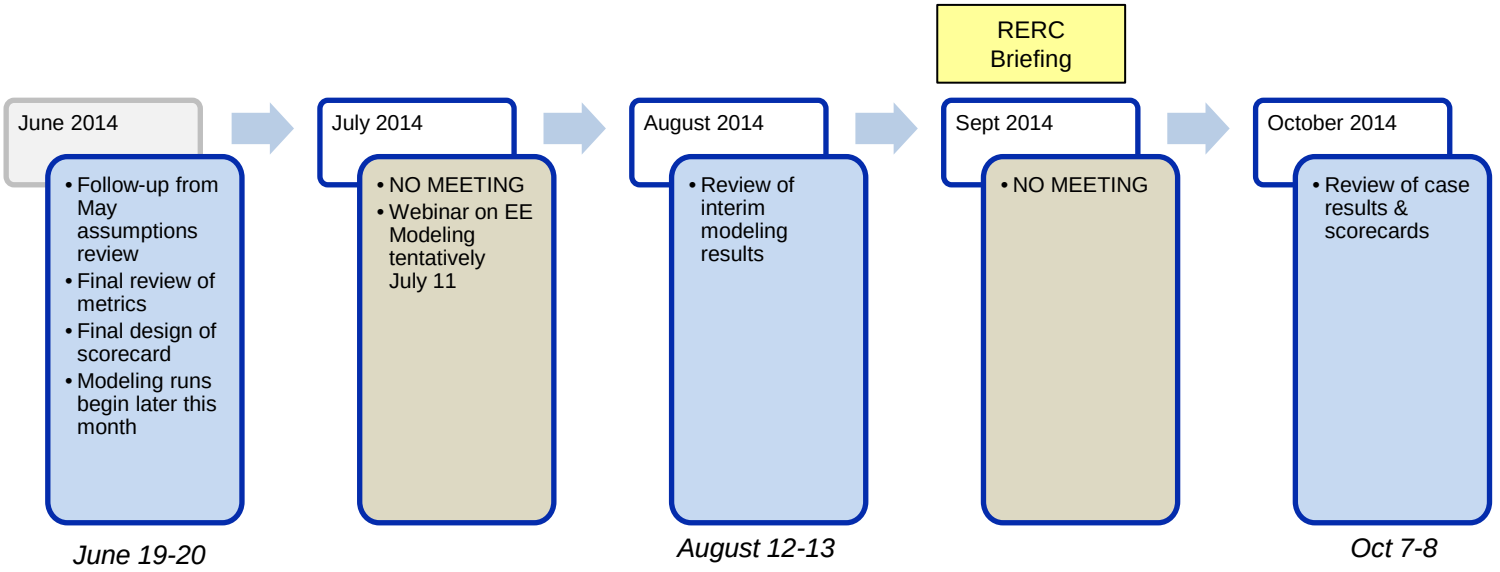
Capacity Factors	In-Valley Wind	Out-of-Valley Wind	HVDC Wind
TVRIX Recommendation	30-40%	55%	55-61%*
IRP Input	30%	40%	55%

Net Dependable Capacity	In-Valley Wind	Out-of-Valley Wind	HVDC Wind
TVRIX Recommendation	8%	14%	40-47%*
IRP Input	14%	14%	14%

*TVRIX recommendation reflects oversubscription of HVDC line, which is not assumed for the IRP

Wrap Up

- IRP Process Schedule Review



- Review of June Meeting New Action Items
- Any additional concerns / questions