2015 Integrated Resource Plan

IRPWG Meeting

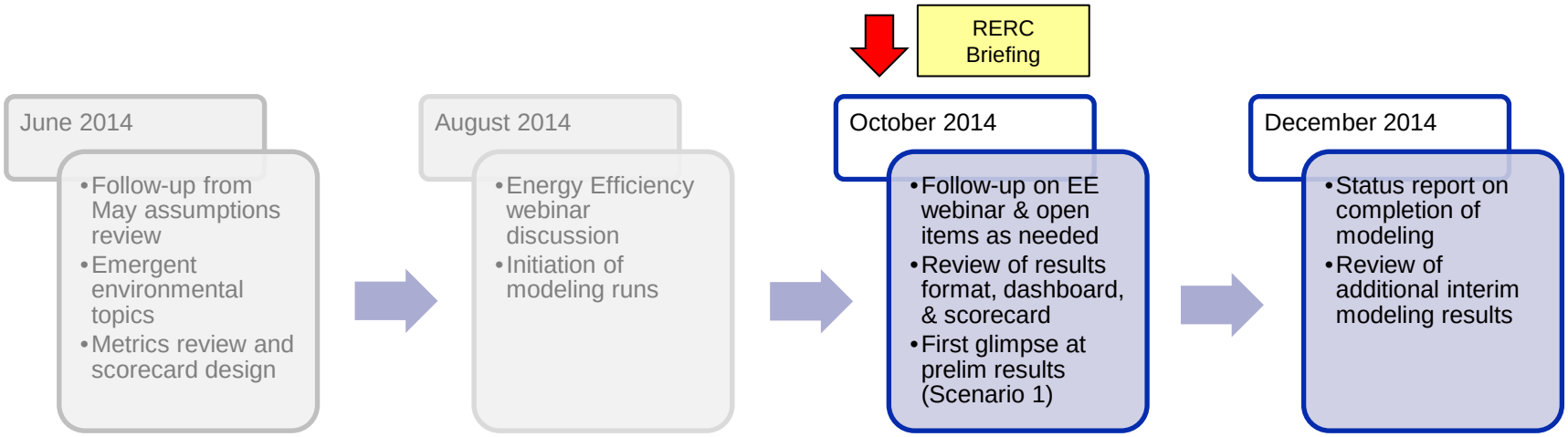
Session 9

October 7th , 2014

IRPWG Meeting – October Agenda

9:00	Welcome – IRP Status and Session Objectives	Randy McAdams
9:15	Update on Public Meetings/Board Meetings	Joe Hoagland
9:30	Revised 2015 IRP Work Plan	Gary Brinkworth
9:45	Introduction to Preliminary Planning Results	Gary Brinkworth
10:15	Revisit Planning Assumptions for Scenario 1 (Current Forecast) Descriptions of the Selected Strategies	Candy Cooper
10:30	Break	
10:45	Detail Preliminary Planning Results for Scenario 1 Stakeholder Feedback	Candy Cooper
12:30	Lunch	
1:30	Overview of the 2015 Scorecard and Dashboard	Gary Brinkworth
2:30	Break	
2:45	Questions on Posted Items and/or Feedback on Today's Session	Randy McAdams
3:15	Next Steps and IRP Schedule	Randy McAdams
3:30	Adjourn	

October 7th IRPWG Meeting Objectives

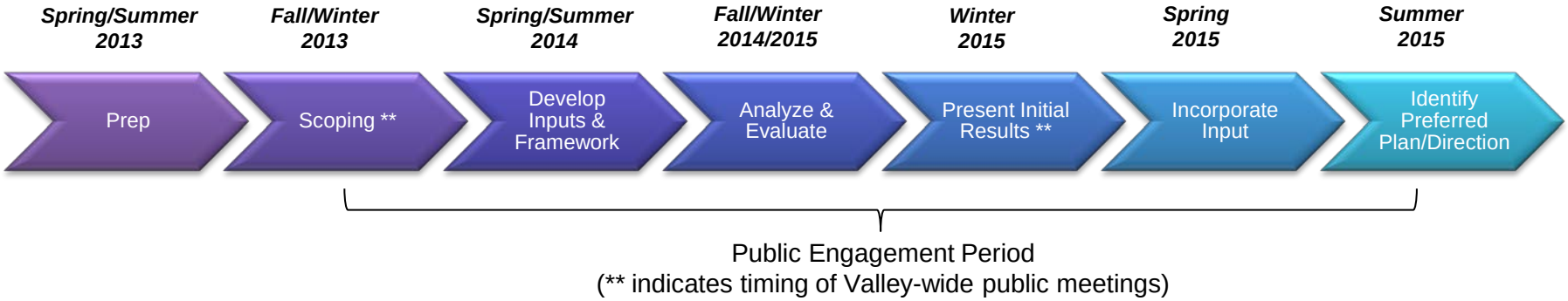


During this meeting we aim to accomplish the following objectives:

- Review the preliminary case results from Scenario 1
  - We will be showing results from 5 runs out of more than 1800 times the model will be run: Results are not intended to show conclusions
  - Today's main objective to understand how the model is working
- Present and explain the proposed 2015 scorecard and dashboard format and construct
- Solicit reaction to presentation formats (raw results, scorecards, dashboard) and metrics selection in the context of preliminary results
- Provide an opportunity for follow up questions on the EE webinar and/or posted items

2015 IRP/SEIS Revised Schedule: Major Phases/Milestones

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

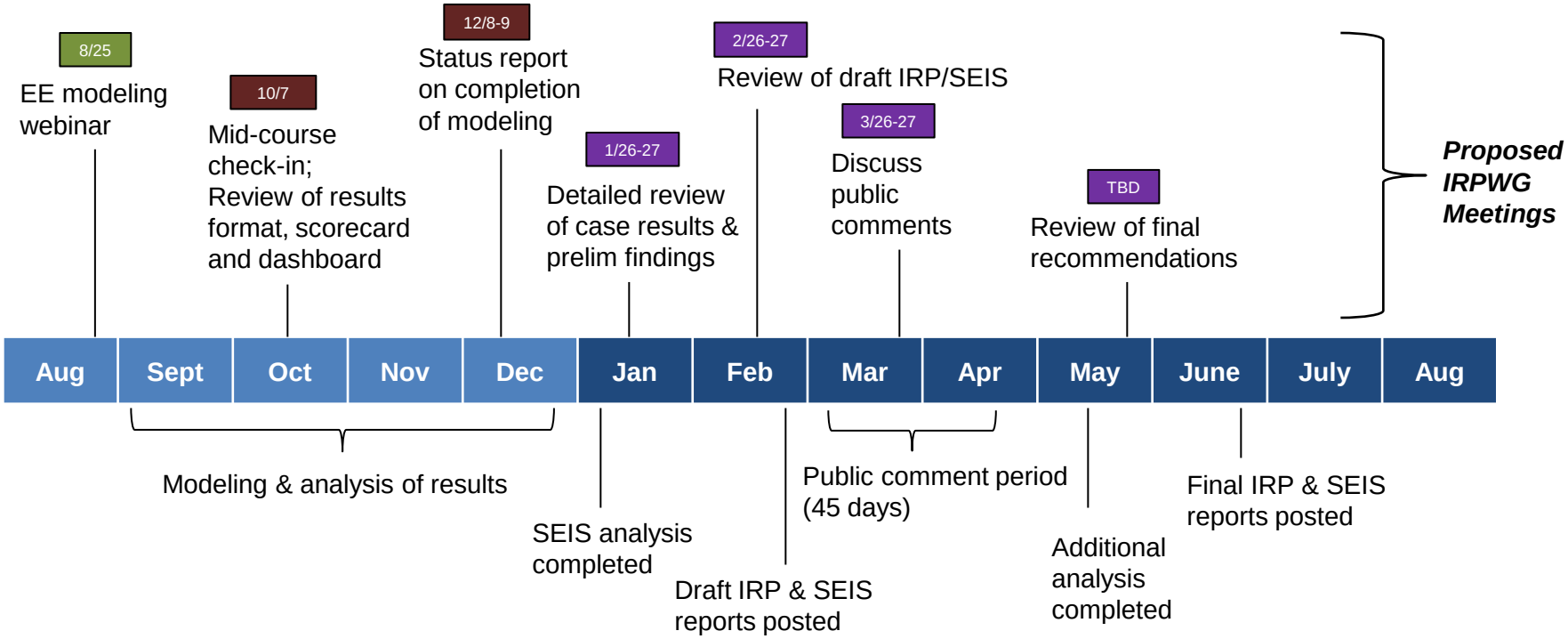


Key tasks/milestones in this revised study timeline include:

- Complete modeling runs – December 2014
- Detailed review of case results & prelim findings – January 2015
- Publish draft Supplemental Environmental Impact Statement (SEIS) and IRP – February 2015
- Complete public meetings on draft results – April 2015
- Final publication of SEIS and IRP and Board approval – June 2015

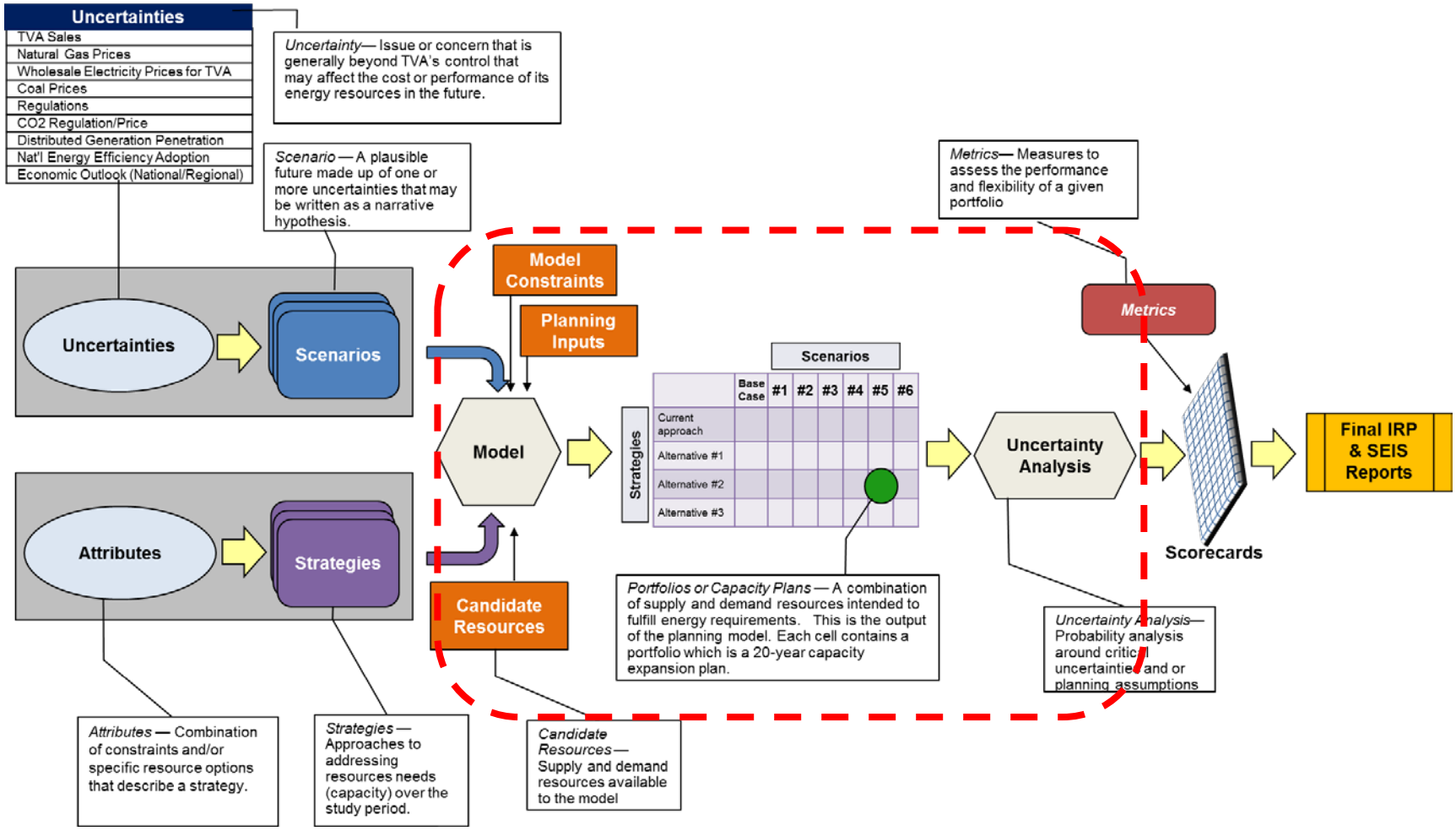
In the original schedule, completion was targeted for Spring 2015

2015 IRP/SEIS Revised Schedule: Major Phases/Milestones (Cont.)

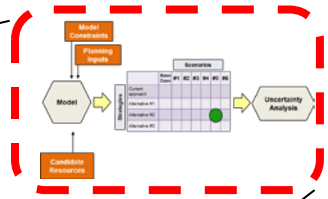


This meeting schedule may have to be adjusted based on the outcome of the modeling task

The Modeling Process



The Modeling Process Involves Five Steps



1 Capacity Optimization Model Run (CapEx)

2 Review case results for reasonableness (QA/QC)

3 Conduct Stochastic (uncertainty) Analysis (MIDAS)

4 Review/validate case results and metrics (by scenario)

5 Populate Scorecard

Full scenario set

Today's Review of Scenario 1 Results

- During today's session we will review raw results for Scenario 1 – Current Outlook
- These preliminary results reflect completion of Step 1 of the modeling process only – can present expected values but no detailed stochastic analysis yet
- In addition, it is important to remember that what we will see today is only a small slice of all the model runs that will be subject to analysis
- Raw results are covered in the **NDA agreement**, so the morning session will be open only to those who have executed an NDA

IRP Matrix	**Scenarios**				
Planning Strategy	**1 Current Outlook**	**2 Stagnant Economy**	**3 Growth Economy**	**4 De-Carbonized Future**	**5 Distributed Marketplace**
A. The Reference Plan	1A	2A	3A	4A	5A
B. Meet an Emission Target	1B	2B	3B	4B	5B
C. Lean on the Market	1C	2C	3C	4C	5C
D. Doing More EE	1D	2D	3D	4D	5D
E. Focusing on Renewables	1E	2E	3E	4E	5E
X. Scenario 1 Reference case	1X				

25 standard cases; 72 stochastic iterations; additional sensitivity runs: over 1800 model runs

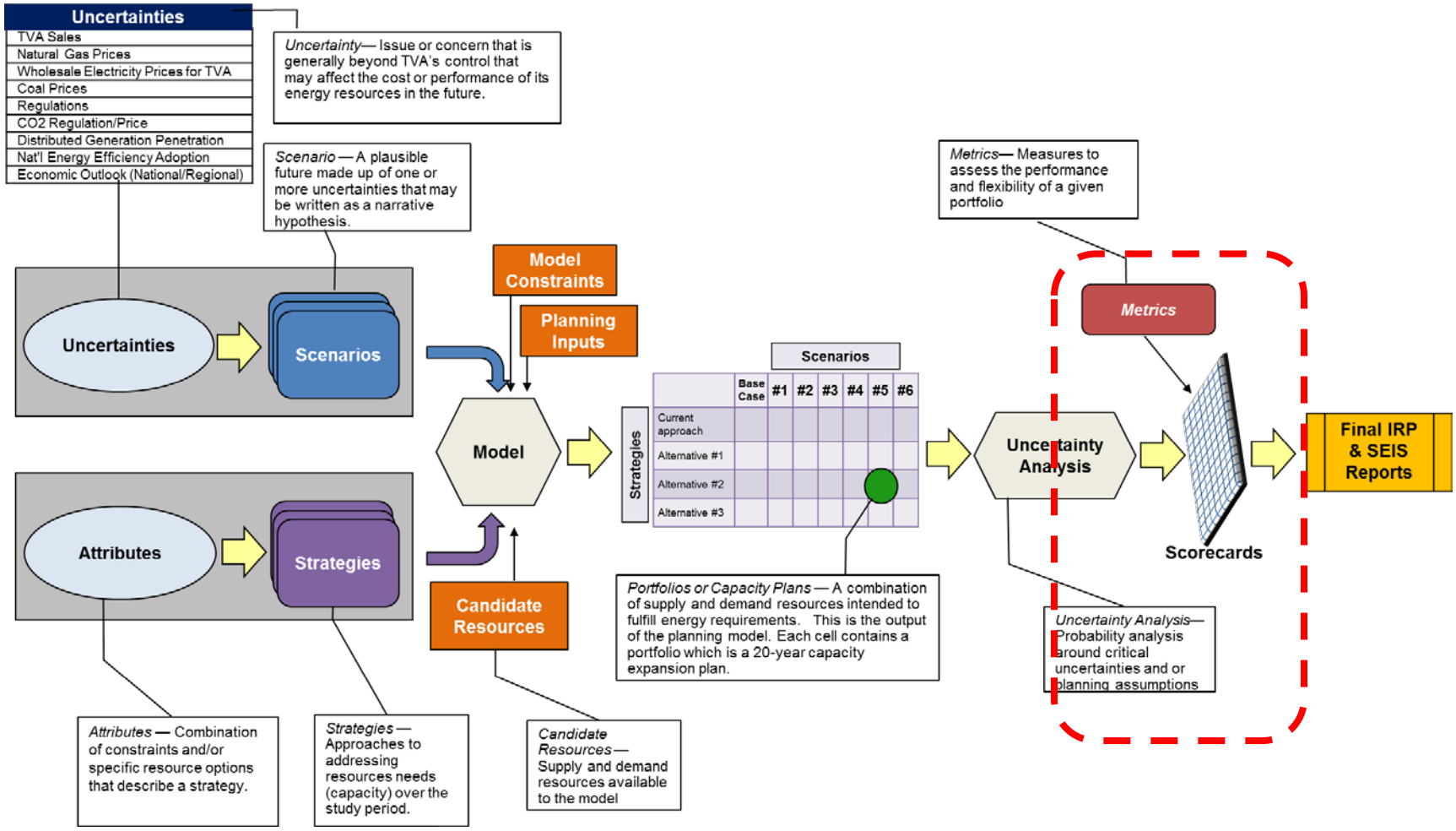
Scenarios and Strategies Selected

Scenarios	
1. Current Outlook	• Current outlook for the future TVA is using for resource planning studies
2. Stagnant Economy	• Stagnant economy results in flat to negative growth, delaying the need for new generation
3. Growth Economy	• Rapid economic growth translates into higher than forecasted energy sales and resource expansion
4. De-Carbonized Future	• Increasing climate-driven effects create strong federal push to curb GHG emissions: new legislation caps and penalizes CO2 emissions from the utility industry and incentivizes non-emitting technologies
5. Distributed Marketplace	• Customers' awareness of growing competitive energy markets and the rapid advance in energy technologies produce unexpected high penetration rates in distributed generation and energy efficiency

Strategies	
A – The Reference Plan	• Traditional utility "least cost optimization" case
B – Meet an Emission Target	• Resources selected to create lower emitting portfolio based on an emission rate target or level using CO2 as the emissions metric
C – Lean on the Market	• Most new capacity needs met using PPA or other bilateral arrangements • TVA makes a minimal investment in owned assets
D – Doing More EE	• Majority of capacity needs are met by setting an annual energy target for EE (e.g., minimum contribution of 1% of sales)
E – Focusing on Renewables	• Majority of new capacity needs are met by setting immediate and long-term renewable energy; includes hydro • Utility-scale approach is targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024

All Slides in this section are TVA Confidential - Covered under NDA.
To be shared during meeting only.

The Modeling Process: Scoring



TVA is Proposing Five Categories of Metrics

Metric Category	Description
Cost	■ The objective of the cost metrics is to measure the impact of a strategy in terms of total cost to TVA in terms of both capital and operating expenses ■ The aim is to measure the financial effort to implement the strategy both in the long and the medium term ■ Cost metrics are not intended to measure the impact on rates
Risk	■ Risk metrics only focus on financial risks ■ They intend to measure the "certainty" of the calculated total cost and the risk exposure for a particular strategy
Environmental Stewardship	■ The objective of these metrics is to evaluate the environmental impact of a particular strategy
Flexibility	■ These metrics aim to evaluate two critical aspects of meeting quality of power requirements: — Energy supply is available when needed — Under fast changes in demand, the system is agile enough to respond ■ All possible portfolios are required to meet the minimum Capacity Reserve Margin of 15%
Valley Economics	■ The intention of these metrics is to measure the economic impact that the capital and operational expenditures associated with the implementation of a plan will have on TVA's service territory

Types of Metrics

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

- Definition
- Calculation
- Insights provided

Scorecard

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

Scorecard 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 scorecard

Proposed Scorecard Metrics – Definitions/Formulas

Scorecard Metric	Definition/Formula
System Average Cost ($/MWh) Year 1-10	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 will fall 95% of the time based on stochastic analysis
CO2 Avg Tons	The annual average tons of CO2 emitted over the study period
Water Consumption	The annual average gallons of water consumed over the study period
Waste	The annual average quantity of coal ash, sludge & slag projected based on energy production in each portfolio
Flexibility	*Note: TVA is still considering a number of Flexibility metrics to be used for evaluating results. A list of the different metrics being considered is included later in this document*
% 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
Flexibility
Valley Economics

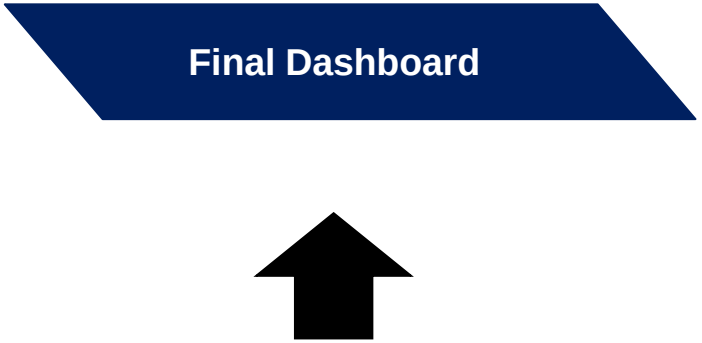
Proposed Reporting Metrics – Definitions/Formulas

Reporting Metric	Definition/Formula
System Average Cost ($/MWh) Year 11-20	Average system cost for the second 10 years of the study, computed as the levelized annual system average cost (revenue requirements in each year divided by sales in that year)
Cost Uncertainty	The predicted variation in plan cost from the stochastic analysis, determined by using the difference between the tails of the distribution; the range in which plan costs will fall 90% of the time
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
CO_2 Intensity	The CO_2 emissions expressed as an emission intensity; computed by dividing emissions by energy generated
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
Flexibility	*Note: TVA is still considering a number of Flexibility metrics to be used for evaluating results. A list of the different metrics being considered is included later in this document*
Employment	The change in employment expressed relative to a baseline future

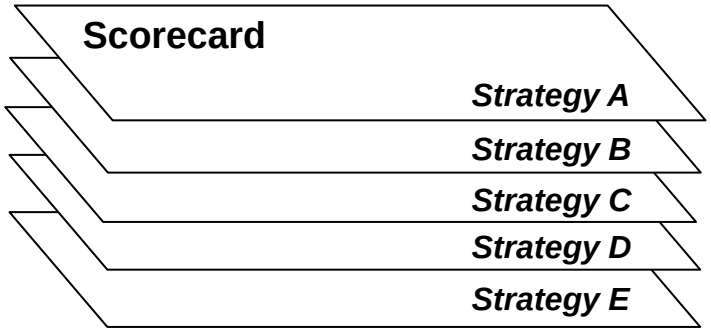
Cost
Risk
Environmental Stewardship
Flexibility
Valley Economics

2015 IRP Results Presentation

- The presentation of results will be based on a two tier reporting scheme:



- The dashboard is a one-page representation of the performance of all strategies across the five metric categories
- Results will be presented in a numerical and graphical manner to facilitate the communication of the results to a general audience
- Categories are not weighted although metrics within one category may be combined (e.g., Risk Benefit Ratio and Risk Exposure)



- The scorecard will provide analysts and stakeholders with detailed information about the performance of each strategy
- Scorecard metrics will be presented numerically with colors to easily illustrate relative values
- Scorecards are not intended for use in reporting information to the general public

Scorecard Design - Prototype

Example: 2011 Planning Strategy C - Diversity Focused Resource Portfolio

Raw Values	Cost		Risk		Environmental Stewardship			Flexibility	Valley Economics
Scenarios	PVRR	Sys Avg Cost (Yr 1-10)	Risk/Benefit Ratio	Risk Exposure	CO2	Water	Waste	N/A	% Change in Per Capita Income
1. Economy Recovers Dramatically	169.13	78.76	1.38	208.65	1,673	4,663	438	N/A	0.60
2. Environmental Focus is a National Priority	132.04	75.36	1.29	158.90	1,418	4,214	427	N/A	N/A
3. Prolonged Economic Malaise	114.02	77.40	0.89	123.48	1,210	3,749	382	N/A	N/A
4. Game-Changing Technology	134.93	76.00	1.14	155.66	1,408	4,256	397	N/A	N/A
5. Energy Independence	131.23	75.64	1.16	152.91	1,422	4,200	424	N/A	N/A
6. Carbon Regulation Creates Economic Downturn	104.81	75.55	0.91	117.48	1,035	3,503	315	N/A	0.10
7. Spring 2010 Baseline	130.06	75.94	1.14	149.58	1,427	4,305	414	N/A	N/A

N/A: 2011 data not available

DESIGN

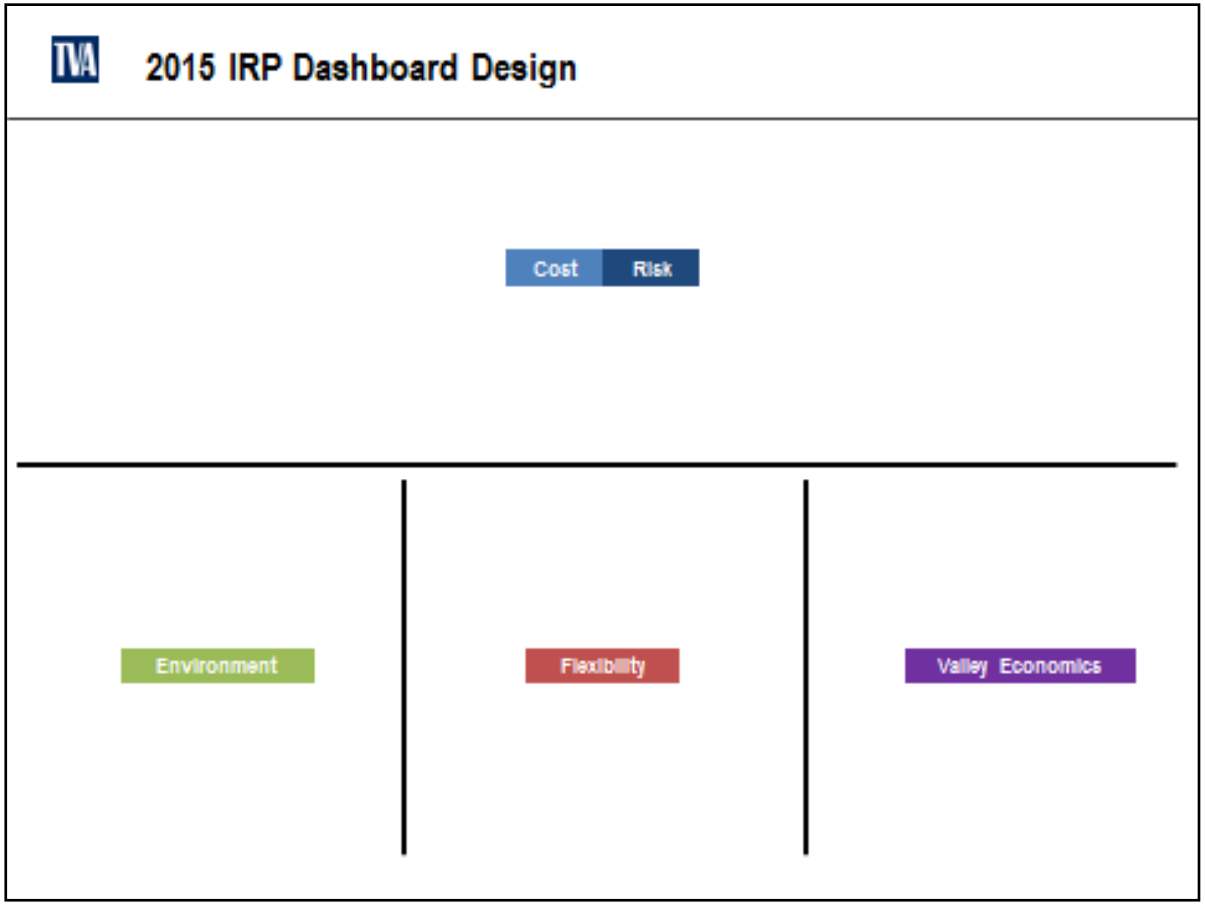
- A scorecard will be created for each strategy showing how it performs in the different scenarios. As an example, the graphic above shows the proposed 2015 IRP Detail Scorecard using the results of Strategy C from the 2011 IRP
- Scorecard metrics will be presented in tables showing the results in the original raw values

USE

- Using this type of scorecard allows stakeholders and decision-makers with some technical background to discuss and evaluate options having access to aggregated and detailed information

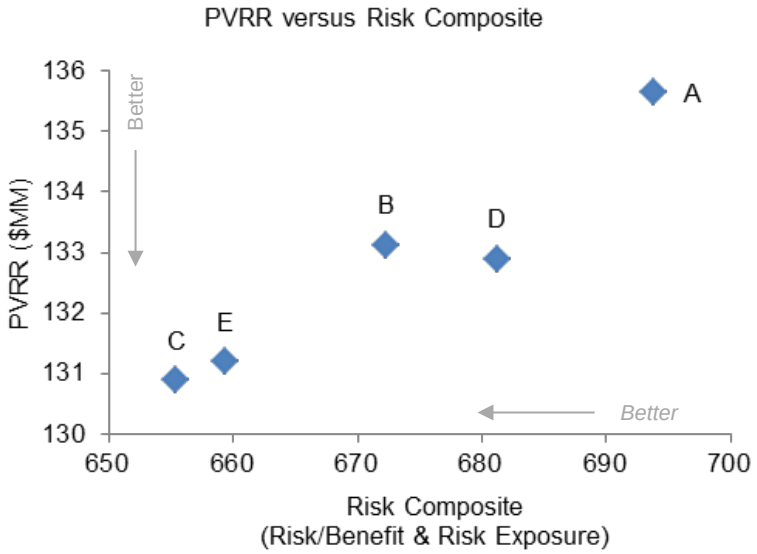
Dashboard Design - Prototype

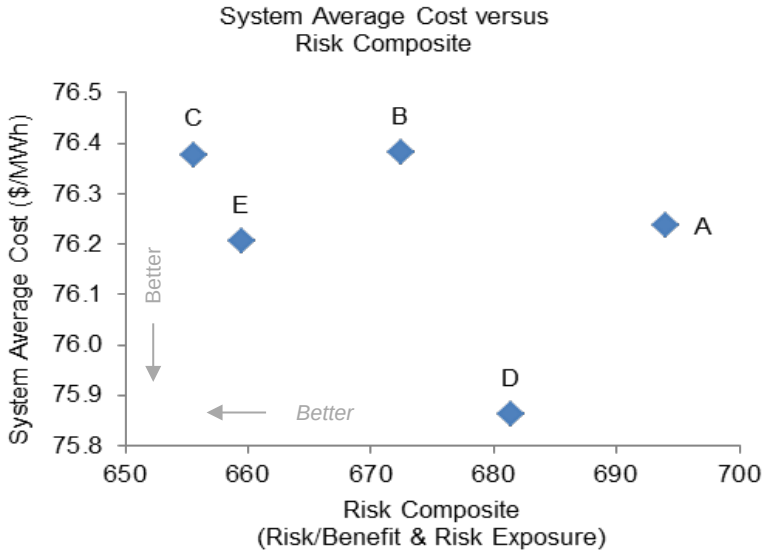
The purpose of the dashboard is to provide a one-page comparison of strategy performance



- Four sections provide a visual comparison of performance across the five metric categories
- Categories are not weighted although metrics within one category may be combined (e.g., Risk/Benefit & Risk Exposure)
- Dashboard provides all the information needed to evaluate trade-offs and make decisions

Dashboard Category: Cost and Risk



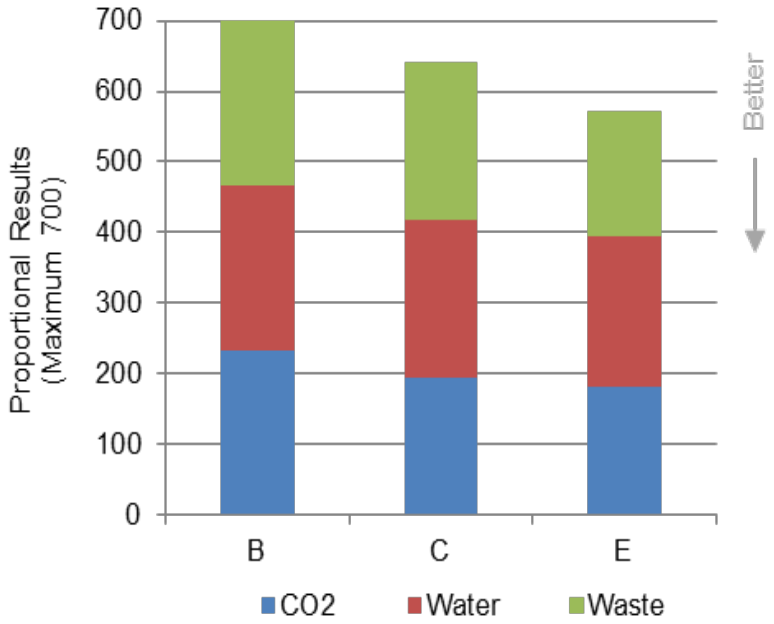


PVRR and System Average Cost are plotted against a Risk Composite

Risk Composite Value

- The Risk Composite value is a combination of Risk/Benefit and Risk Exposure
- Raw results are normalized to allow for the combination of values of differing units
- Methodology for combining metrics will be discussed later in this presentation

Dashboard Category: Environment

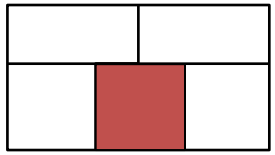


Proportional scores for air, waste, and water are stacked to show a composite Environmental Impact

Composite Environmental Impact Value:

- Raw results are normalized to allow for the combination of values of differing units
- Methodology for combining metrics will be discussed later in this presentation

Dashboard Category: Flexibility



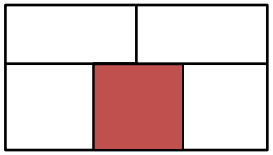
- The flexibility category include metrics that evaluate two critical operational aspects of meeting quality of power requirements:

  1. Energy supply is available when needed
  2. Under fast changes in demand, the system is agile enough to respond
     - Ramps
     - Turn-downs
     - Shorter peaks

- In addition, these metrics will also help in evaluating the risk exposure of a portfolio to limitations on how variable resources are being modeled (this is a model architecture issue)
  - The fixed energy patterns used to model intermittent or non-dispatchable resources do not adequately reflect the variation in performance over time (and therefore the risk assessment) of those resource types
  - This assessment will help TVA refine its uncertainty analysis for portfolios that contain significant contributions from renewables or EE

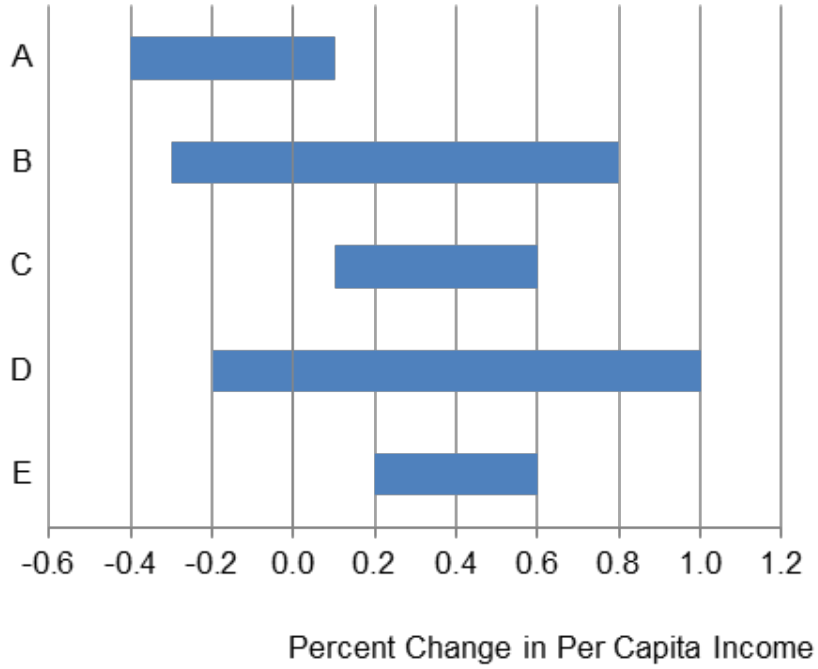
- TVA is still considering potential flexibility metrics to be used for evaluating strategies

Dashboard Category: Flexibility – Candidate Metrics



	Metric	Definition/Formula
Energy supply is available when needed	**Performance Uncertainty for Wind/Solar/EE**	Capacity of fixed energy pattern resources divided by total system capacity. Intended to capture exposure to uncertainty of production from solar/wind/EE not represented in modeled energy patterns or stochastic ranges for those resources.
	Variable Energy Resource Penetration	$\frac{\text{Ave (2014-2033) } \Sigma(\text{Variable Resource Capacity})}{\text{Annual Peak Load}}$
Under fast changes in demand, the system is agile enough to respond	**System Regulating Capability**	$\frac{\Sigma \text{ (Regulating Reserve + Demand Response + Quick Start)}}{\text{Peak Load}}$
	Resource Diversity Index	$\alpha = 1 - \Sigma(xi)^2$ where α is the resource diversity and x is the generation (MWh) share of a given resource type (Coal, Gas, Nuclear, Hydro, Renewables, EEDR). Calculated for the first and last years of planning period.
	Flexibility Turn Down Factor	Energy produced from resources that are “must run” or “non dispatchable” (wind, solar, EE, nuclear, must run) divided by the total sales in each year. Calculated for the first and last years of the planning period.

Dashboard Category: Valley Economics



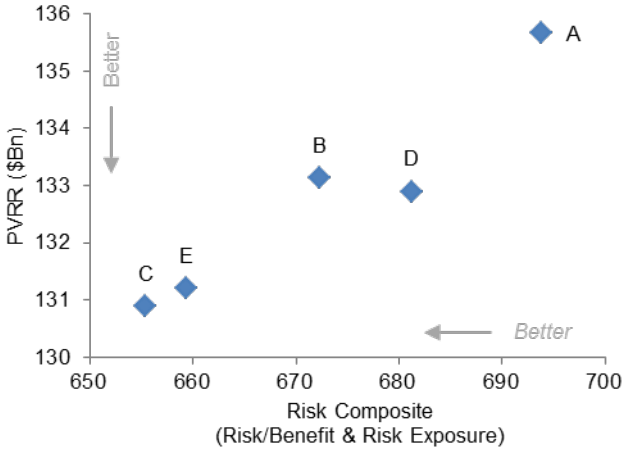
The Valley Economics component will show the range of Percent Change in Per Capita Income across all scenarios for each strategy

Note: the reference economic level is not the same in each scenario. However, this chart is designed to give an overall understanding of potential outcomes across all scenarios

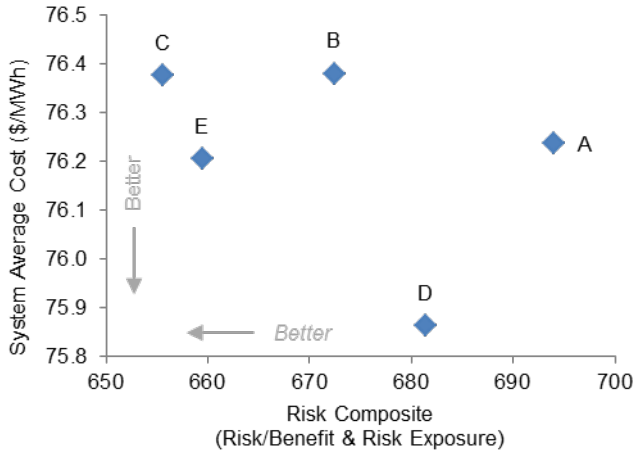
Overview of 2015 Scorecard and Dashboard

Example Dashboard: 2015 Metrics with 2011 Data

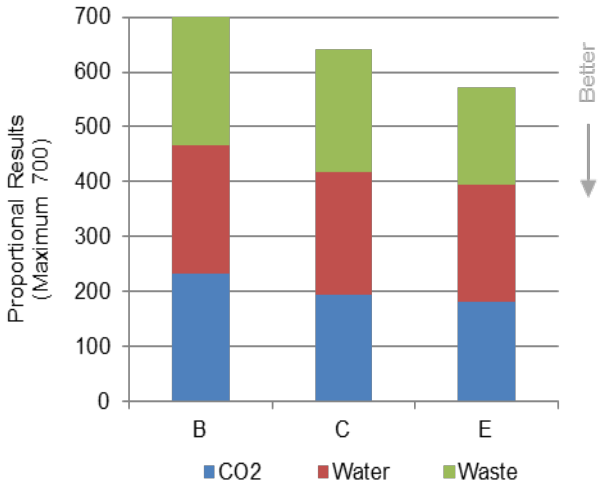
Cost



Risk



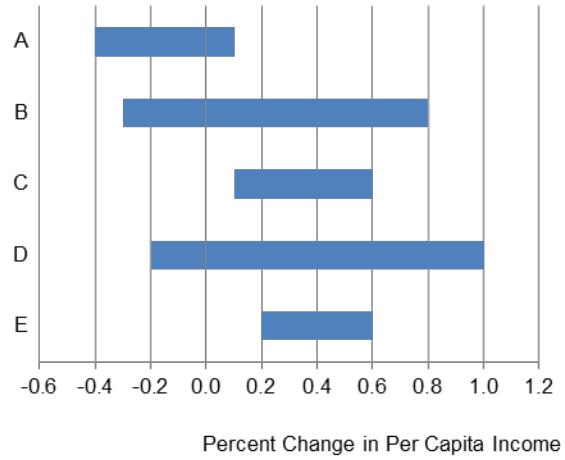
Environment



Flexibility

- 2011 data does not exist to produce this metric
- Considering a number of metrics to address this category
- Final evaluation metrics TBD

Valley Economics



Creating the Dashboard Requires Combining Some Metrics

Results Combination Process

1. Normalize metric results in each scenario
2. Generate overall metric result for each strategy as a sum of scenario results using scenario weights
3. Calculate composite metric result using metric weights

Normalizing Case Results

Raw scorecard values for Risk Exposure Ratio in Scenario 1 are shown to the right

Raw Values

	Strategy	Scenario 1
Risk Exposure	A	225.1
	B	214.5
	C	208.6
	D	215.4
	E	211.1

The highest value (in this case "worst" performance) within a scenario gets a normalized value of 100 (Strategy A)

Strategy C has a Risk Exposure result that is 92.7% of the highest value and thus receives a normalized value of 92.7

Normalized values are used when combining metrics with differing units

Normalized Values

	Strategy	Scenario 1
Risk Exposure	A	100.0
	B	95.3
	C	92.7
	D	95.7
	E	93.8

All other scores are assigned a value based on their relative position to the highest value (Strategy A)

Dashboard Weights and Normalization Summary

Assigning weights enables us to combine metric results for composite evaluation

Category	Combined Metrics	Weights	Normalization
Cost	N/A	N/A	N/A
Risk	Risk/Benefit Risk Exposure	35% 65%	Proportional Scoring (lower is better)
Environmental Stewardship	Air Water Waste	33.3% 33.3% 33.3%	Proportional Scoring (lower is better)
Flexibility	TBD	TBD	TBD
Valley Economics	N/A	N/A	N/A

Break

Questions on Posted Items / Feedback

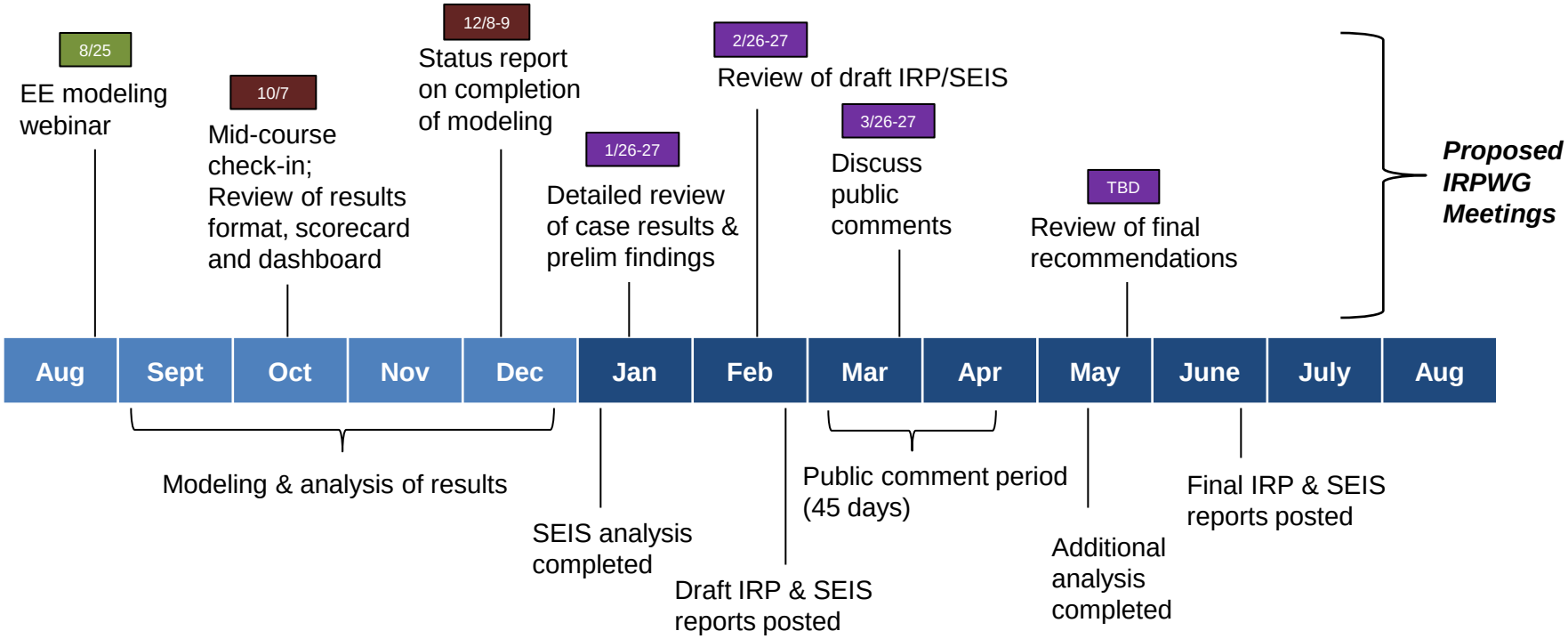
Feedback from the Working Group

Since our last meeting, we have provided the following information to the IRPWG:

- EE Webinar Presentation – August 25th
- Posted, in the shared site, the responses to the questions presented by the group to the following topics:
  - Discussion of flexibility metrics
  - CO2 price trends in scenario design
  - Georgia Power Company metric details
  - Projections of compliance costs for the coal fleet
  - Modeling methods for RE targets in Strategy E
  - Final assumptions for solar/wind capital escalation
  - Wind PPA costs
  - Wind modeling methodology

- **Any questions or comments?**
- **Any additional feedback on today's session?**

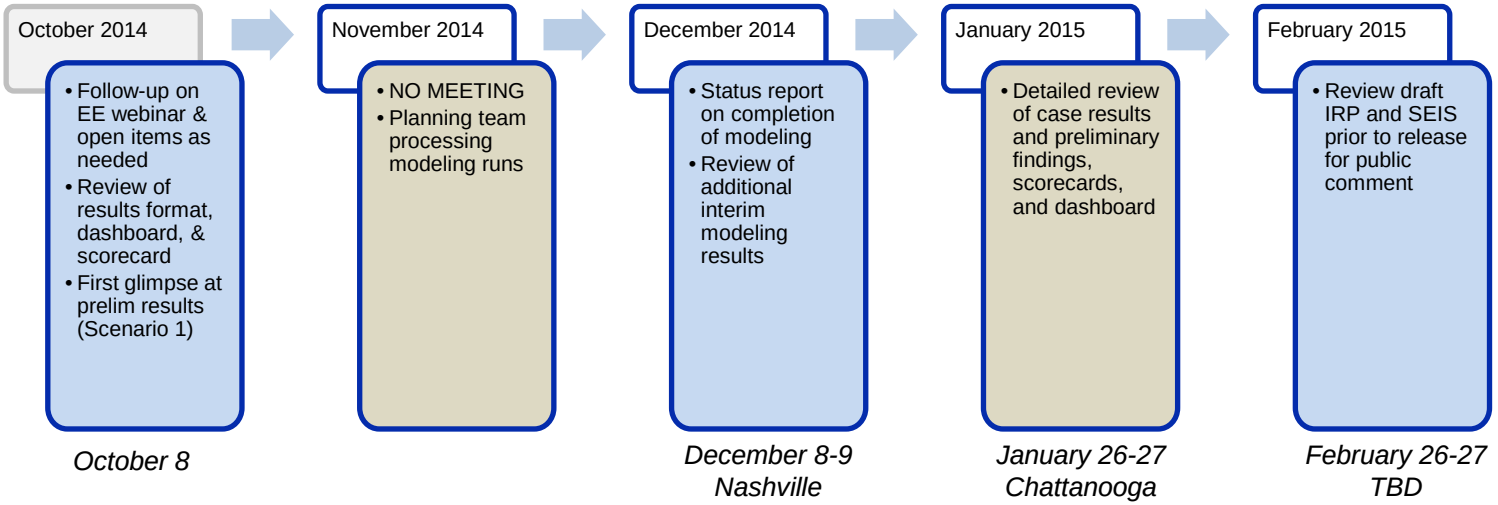
2015 IRP/SEIS Revised Schedule: Major Milestones/IRPWG Dates



This meeting schedule may have to be adjusted based on the outcome of the modeling task

Next-Steps

- IRP Process Schedule Review



- Next meeting will be in middle Tennessee (Nashville area) the 8th and 9th of December
- The agenda of the meeting will be to share the results of model runs completed at that point
- Any additional concerns / questions

Adjourn