



2015 INTEGRATED RESOURCE PLAN

IRPWG Meeting

Session 11

January 26 & 27

Day 1

IRPWG Meeting – January 26th Agenda

	<u>Day 1</u>	
8:30 am	Welcome – Session Objectives	Randy McAdams
8:45 am	Brief Review of December Follow-up Items	Tom Rice
	Overview of Uncertainty and Financial Analysis (plan cost & risk)	Tom Rice
12:00 pm	Lunch	
1:00 pm	Strategies Assessment Process Review	Gary Brinkworth
1:05 pm	Cost and Risk Assessment	Gary Brinkworth
1:45 pm	Environmental Stewardship Assessment	Chuck Nicholson
2:15 pm	Flexibility Assessment	Gary Brinkworth
2:45 pm	Break	
3:00 pm	Valley Economics Assessment	Tim Sorrell
3:30 pm	Wrap Up	Randy McAdams
4:00 pm	Adjourn	



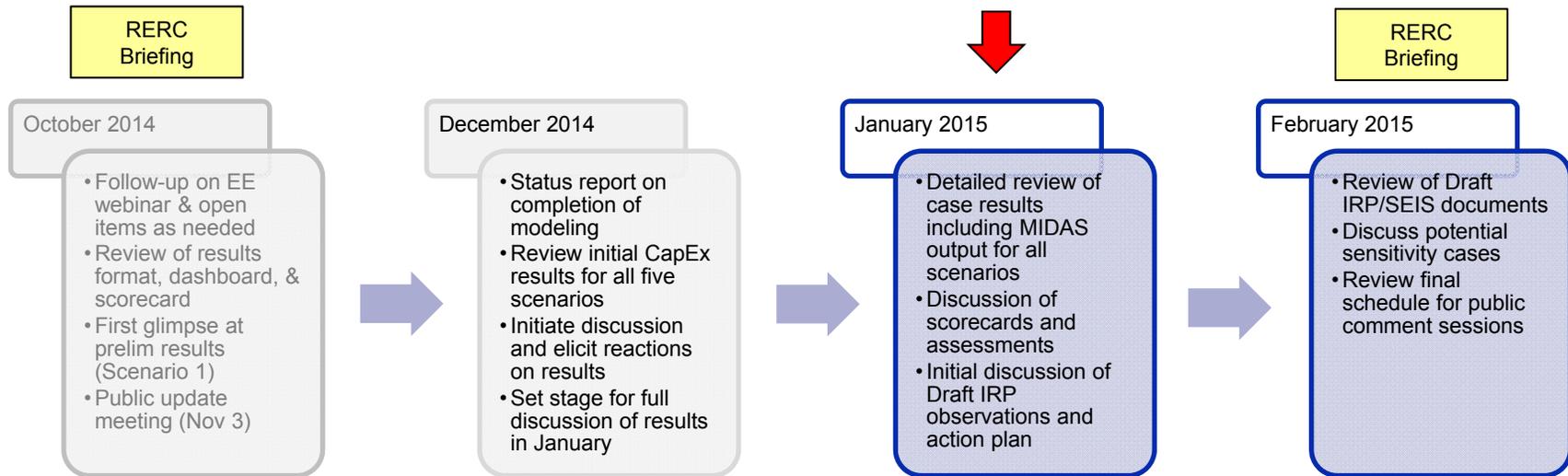
IRPWG Meeting – January 27th Agenda

	<u>Day 2</u>	
8:30 am	Day 2 Agenda and Objectives	Randy McAdams
8:45 am	Recap of Day 1 (observations)	Randy McAdams
9:00 am	Individual Observations and Feedback: 5 Min Per Member	Randy McAdams
10:30 am	Break	
10:45 am	Group Discussion (45 min.)	Randy McAdams
11:30 am	Next Steps (In this case is important to explain in detail steps until draft)	Gary Brinkworth
11:50 am	Wrap-up	Randy McAdams
12:00 pm	Adjourn	





January 26th – 27th IRPWG Meeting Objectives



During this meeting, we aim to accomplish the following objectives:

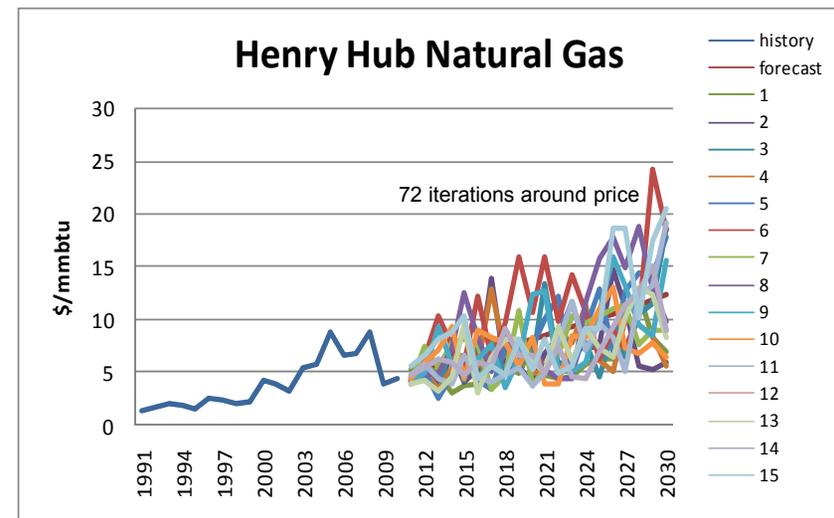
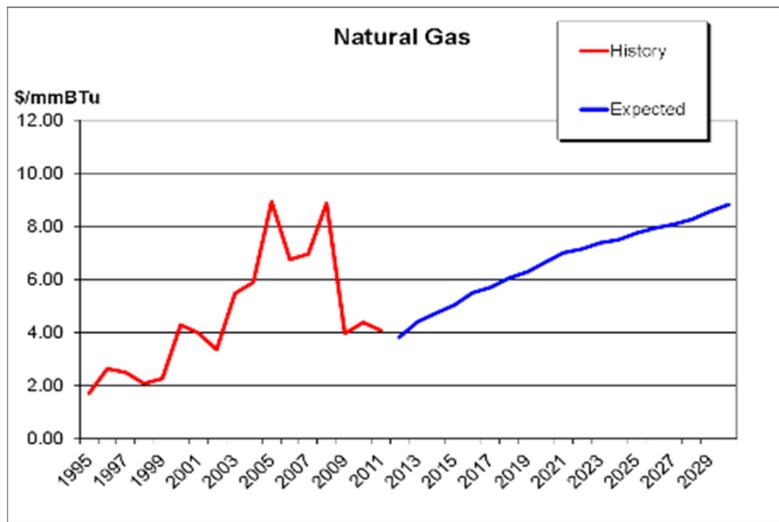
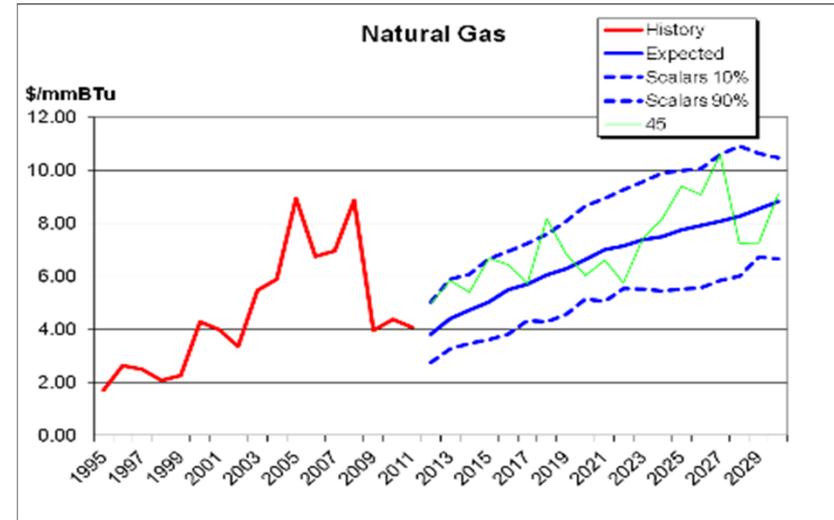
- ◆ Follow up on questions/comments from the December meeting
- ◆ Review the detailed MIDAS results for all scenarios
- ◆ Walk through results of the category assessments
- ◆ Capture stakeholder feedback and reactions on resource plans and assessment results
- ◆ Outline action plan and next steps for completing and releasing the Draft IRP



Brief Review of December Follow-up Items

TVA Considering Uncertainty in Resource Planning

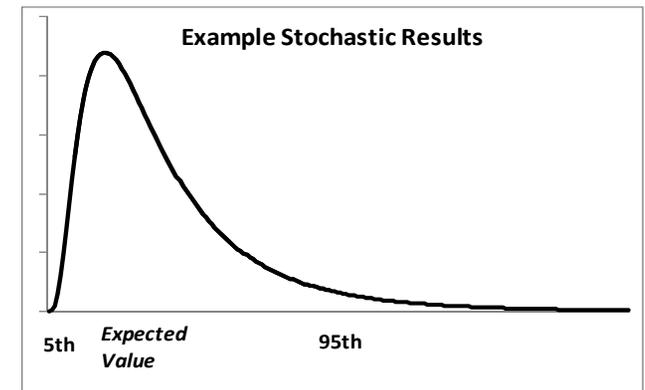
- ◆ **Forecasts will inevitably be wrong!** Variability is a result of supply/demand disruptions, weather, market conditions, technology improvements, and economic cycles
- ◆ Monte Carlo simulation allows for a better understanding of the richness of possible futures, as well as their likelihoods, so that plans can be made proactively, as opposed to reactively



TVA 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
 - CO₂ 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.





Scorecard Metrics

TVA Selected Scoring Metrics – Definitions/Formulas

Category	Scoring Metric	Formula
Cost	PVRR (\$Bn)	= Present Value of Revenue Requirements over Planning Horizon
	System Average Cost Years 1-10 (\$/MWh)	= $\frac{\text{NPV Rev Reqs}_{(2014-2023)}}{\text{NPV Sales}_{(2014-2023)}}$
Risk	Risk/Benefit Ratio	= $\frac{95^{\text{th}}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)} - 5^{\text{th}}_{(PVRR)}}$
	Risk Exposure (\$Bn)	= 95 th Percentile _(PVRR)
Environmental Stewardship	CO ₂ (MMTons)	= Average Annual Tons of CO ₂ Emitted During Planning Period
	Water Consumption (Million Gallons)	= Average Annual Gallons of Water Consumed During Planning Period
	Waste (MMTons)	= Average Annual Tons of Coal Ash and Scrubber Residue During Planning Period
Flexibility	System Regulating Capability	= $\frac{\sum (\text{Regulating Reserve} + \text{Demand Response} + \text{Quick Start})}{\text{Peak Load}}$
Valley Economics	Per Capita Income	= Percent Difference in Per Capita Personal Income Compared to Reference Case (for each scenario)

TVA Reporting Metrics – Definitions/Formulas

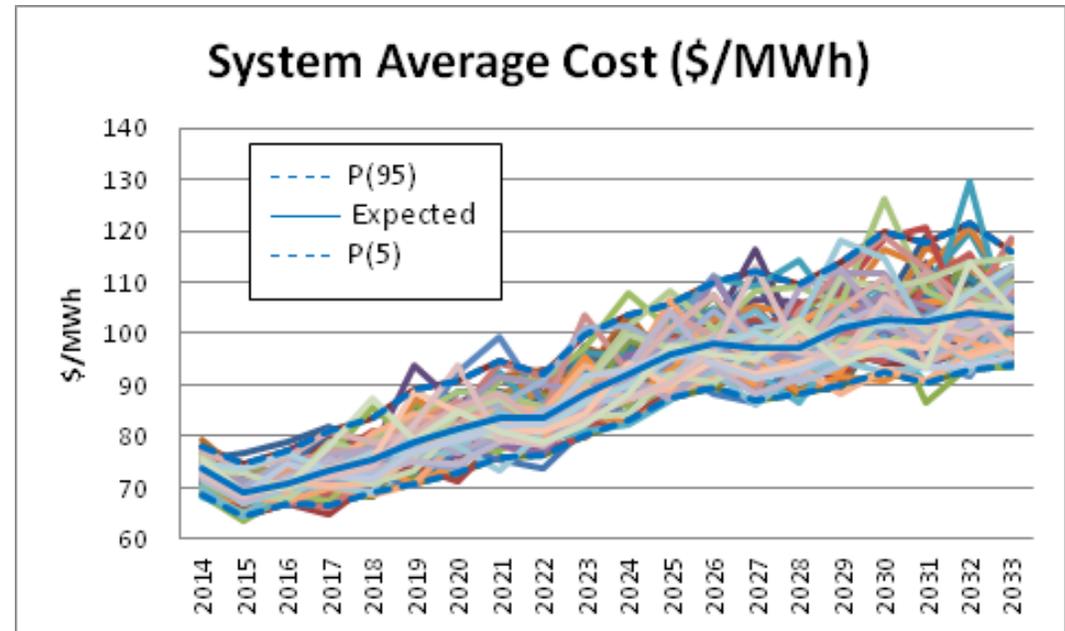
Category	Reporting Metric	Formula
Cost	System Average Cost Years 11-20 (\$/MWh)	$= \frac{\text{NPV Rev Reqs}_{(2024-2033)}}{\text{NPV Sales}_{(2024-2033)}}$
Risk	Cost Uncertainty	$= 95^{\text{th}}_{(PVRR)} - 5^{\text{th}}_{(PVRR)}$
	Risk Ratio	$= \frac{95^{\text{th}}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)}}$
Environmental Stewardship	CO ₂ Intensity (Tons/GWh)	$= \frac{\text{Tons CO}_2_{(2014-2033)}}{\text{GWh Generated}_{(2014-2033)}}$
	Spent Nuclear Fuel Index (Tons)	Expected Spent Fuel Generated During Planning Period
Flexibility	Variable Energy Resource Penetration	$= \frac{\text{(Variable Resource Capacity)}_{(2033)}}{\text{Peak Load}_{(2033)}}$
	Flexibility Turn Down Factor	$= \frac{\text{“Must run”} + \text{“Non-Dispatchable (Wind/Solar/Nuclear) }_{(2033)}}{\text{Sales}_{(2033)}}$
Valley Economics	Employment	Difference in Employment Compared to Reference Strategy

Present Value of Revenue Requirements (PVRR) Detail

- ◆ In setting rates to cover the costs set out in the TVA Act, TVA uses a wholesale rate structure that is comprised of a base rate and a fuel rate (fuel cost adjustment or FCA) .
- ◆ In setting the base rates, TVA uses a debt-service coverage (DSC) methodology to derive annual revenue requirements. Under the DSC methodology, rates are calculated so that an entity will be able to cover its operating costs and to satisfy its obligations to pay principal and interest on debt. This ratemaking approach is particularly suitable for use by entities financed primarily, if not entirely, by debt capital, such as TVA.
- ◆ TVA's revenue requirements (RR) for costs or projected costs (other than the fuel, purchased power, and related costs covered by the fuel rate) are calculated under the DSC methodology as the sum of the following components:
 - Operating and maintenance costs;
 - Tax equivalents (other than the amount attributable to fuel cost-related revenues);
 - Other costs in accordance with the TVA Act; and
 - Debt service coverage
- ◆ TVA's debt trajectory as outlined in our 2015 long range financial plan is maintained in the RR totals
- ◆ PVRR is simply the present value of annual revenue requirements over the study period

TVA System Average Cost

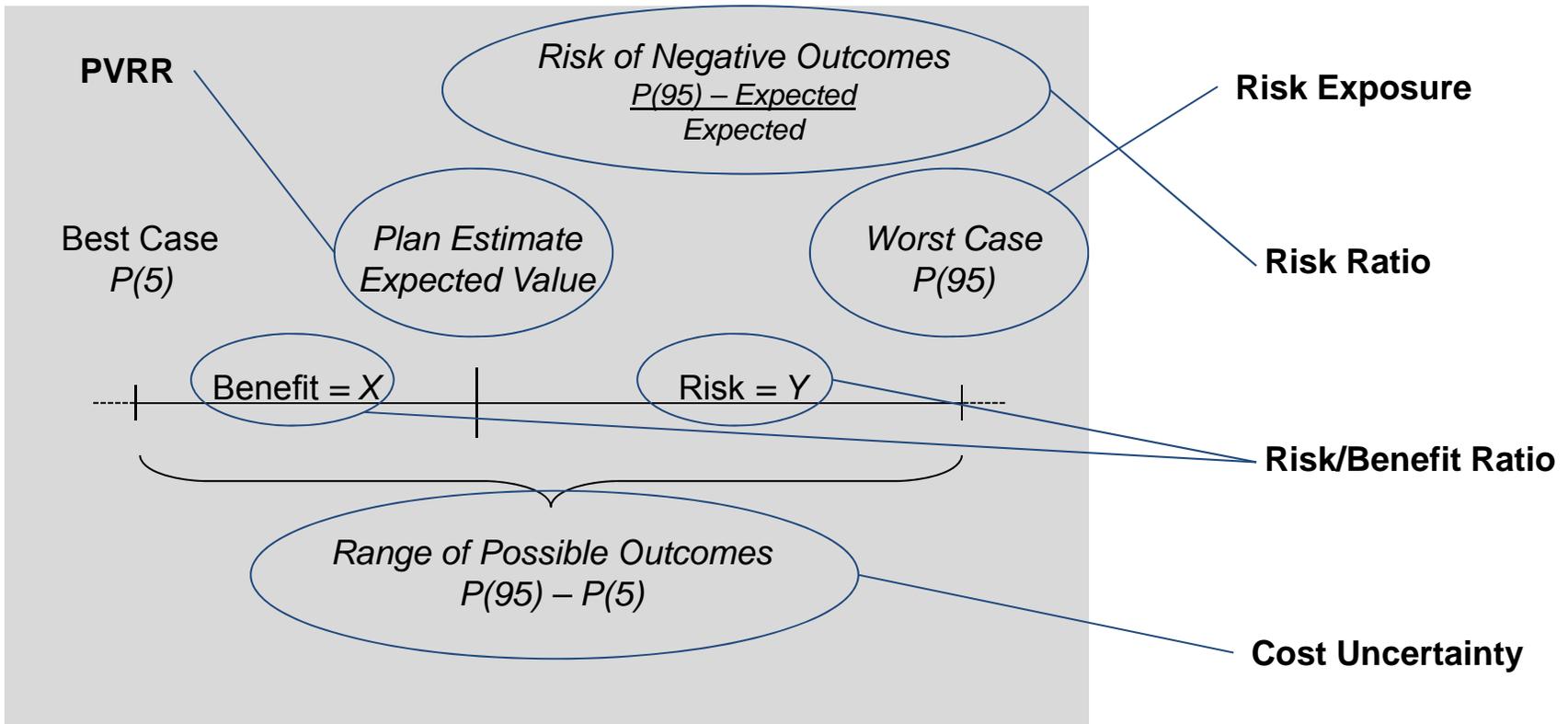
- ◆ System Average Cost is a rate impact proxy calculated by dividing the annual Revenue Requirements (\$) by electricity sales (MWh).
- ◆ TVA has divided the System Average Cost metrics into:
 - First 10 years or system average cost (\$/MWh) for 2014-2023
 - Second 10 years or system average cost (\$/MWh) 2024-2033
- ◆ This metric provides cost relative to sales. Sales are the net of TVA's load less energy efficiency.
- ◆ The stochastic analysis provides a range around system average cost similar to other measures.



TVA Financial Risk Metrics

Are actual plan costs more likely to be higher or lower than we expect?

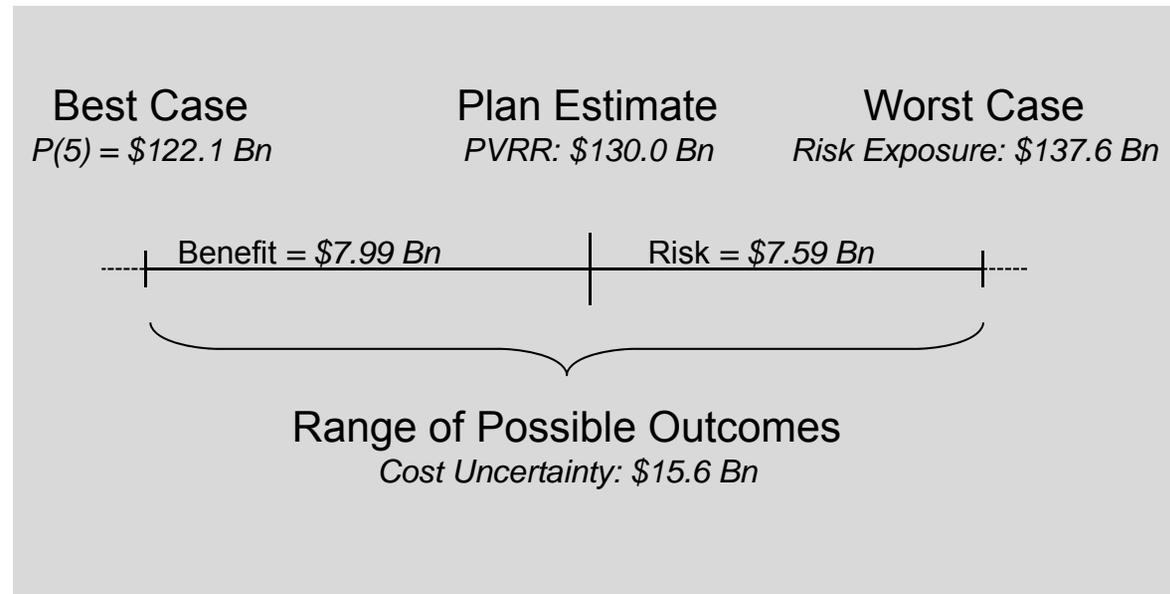
If we underestimate the costs, what could the worst-case scenario look like?



TVA Understanding Financial Risk: Example

Strategy A

- ◆ The range of possible outcomes for Strategy A is likely to be about \$15.6 Bn
- ◆ Actual plan costs are slightly more likely to fall below the expected value of \$130 Bn than above it. Therefore the Risk/Benefit ratio is <1 , or 0.953
- ◆ If we have underestimated the costs, the worst case scenario would suggest a total cost of about \$137.6 Bn





Strategy A Financial & Risk Metrics



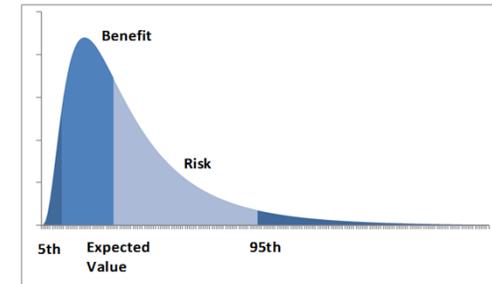
Overall Results



Selected 2015 IRP Metrics – Cost & Risk

Scoring Metrics

Cost	PVRR (\$Bn)	=	Present Value of Revenue Requirements over Planning Horizon
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Risk	Risk/Benefit Ratio	=	$\frac{95^{\text{th}}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)} - 5^{\text{th}}_{(PVRR)}}$
	Risk Exposure (\$Bn)	=	95 th Percentile _(PVRR)



Reporting Metrics

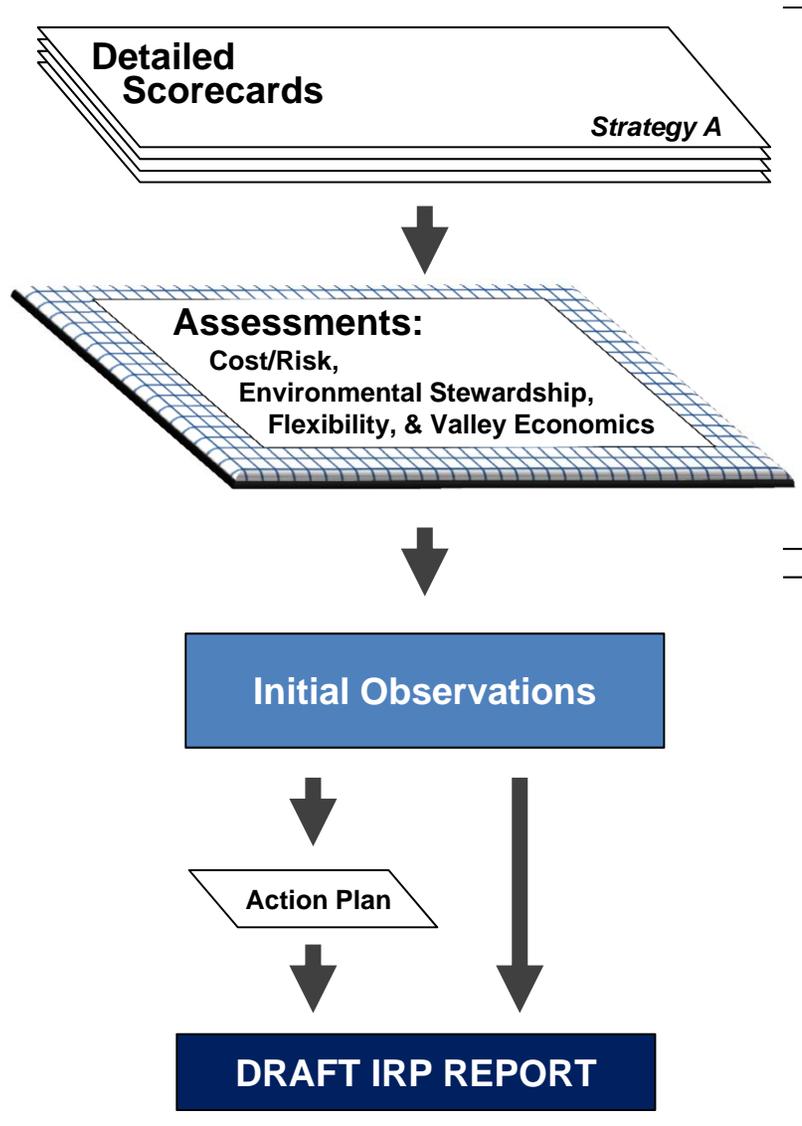
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Risk	Cost Uncertainty	=	$95^{\text{th}}_{(PVRR)} - 5^{\text{th}}_{(PVRR)}$
	Risk Ratio	=	$\frac{95^{\text{th}}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)}}$

- ◆ The selected cost metrics measure the financial impact of a strategy in the short and long terms
- ◆ The risk metrics represent different views of financial risk exposure for each strategy
- ◆ The combination of cost and risk of a particular strategy is the primary evaluation criteria in the IRP



Strategy Assessment Results

TVA Strategies Assessment Process



- ◆ Scorecard data are used to conduct four assessments on how strategies perform in the five evaluation categories
 - Cost and Risk
 - Environmental Stewardship
 - Flexibility
 - Valley Economics
- ◆ The assessments are not intended to produce an overall ranking. Rather, they provide a summary of the performance of the strategies taken from the detailed results presented in the scorecards
- ◆ Based on the results of the assessments, TVA will develop initial observations for inclusion in the Draft IRP
- ◆ The observations will consist of detailed commentary on how each strategy performs as well as questions or findings that will require future research or refinement of the analysis
- ◆ The requirements for future research will be integrated into an action plan that will be included in the Draft IRP

Cost/Risk Assessment

The objective of this assessment is to gain a better understanding of the relative performance of different strategies around total plan costs and financial risk.

The analyses performed provide different views and perspectives around this performance by answering the following questions:

- ◆ Question 1: How do the total cost of the strategies compare from a long-term and short-term perspective?
 - What will be the likely perception from the average end use customer?

- ◆ Question 2: Which strategies present higher financial risk?
 - How certain are we of our cost estimates for each strategy?
 - Are the actual costs more likely to end up greater than our expected cost, or less than our expected cost?
 - If we underestimated the costs, what could the worst case outcome look like?

- ◆ Question 3: How do strategies perform when we combine total cost and financial risk views?
 - Are there trade-offs between cost and financial risk?



Cost/Risk Assessment Summary of Observations

- ◆ Strategies A, B, and C, are clustered as top performers from a cost and risk perspective
- ◆ All strategies show similar results during the first decade of the study and most of the divergence is seen during the second half of the study
- ◆ EE is a competitive resource, and the optimum level deserves further analysis:
 - The right amount will reduce the total system cost (PVRR), and therefore it will be expected that the average electrical bill of the end consumer will be lower than if the EE was not implemented
 - On the other hand, system average cost may be higher as a result of lower generation levels in the later years of the study

Other comments or observations?



Environmental Stewardship Assessment



Environmental Stewardship Assessment

The objective of the environmental assessment is to gain some understanding of the relative performance of different strategies with respect to the environmental impact by asking the following questions:

- ◆ What impact will the proposed strategy have on water consumption?
- ◆ What impact will the proposed strategy have on solid waste generation?
- ◆ What impact will the proposed strategy have on CO2 emissions?

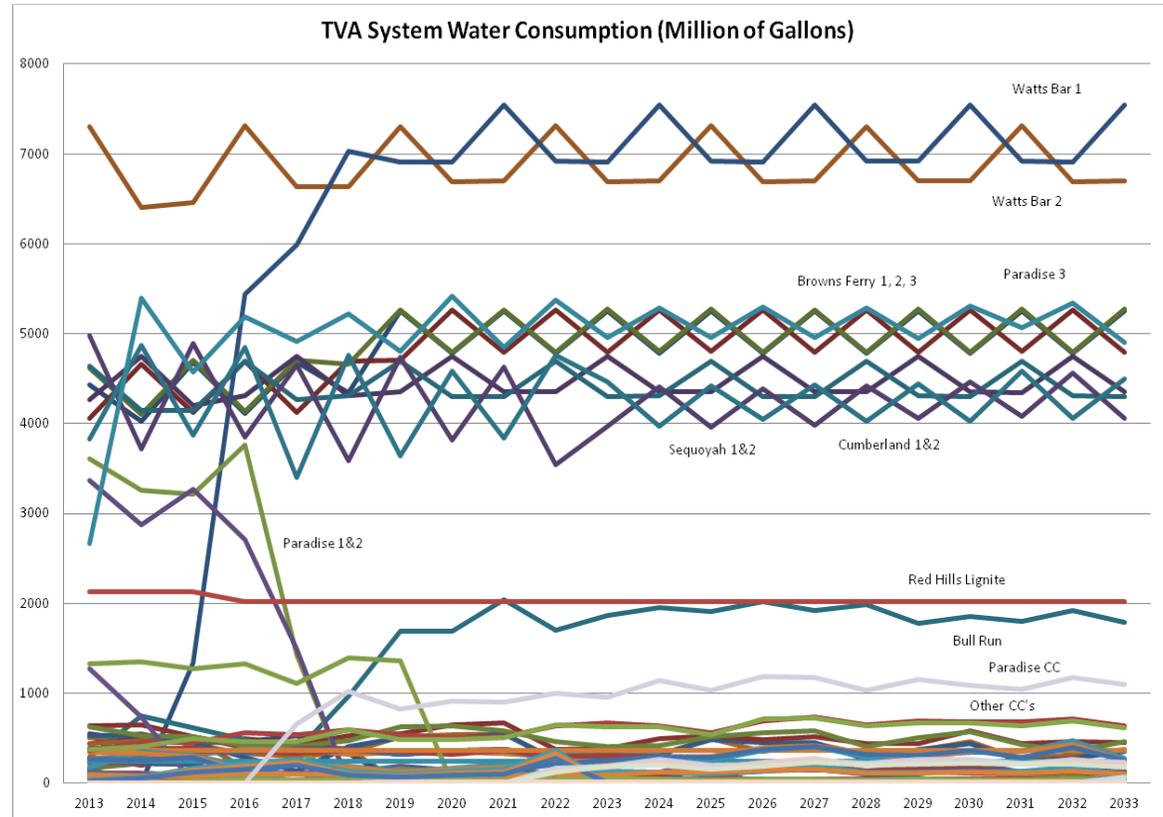




Environmental Stewardship Assessment Water Consumption

Example: Water Consumption by Resource - Case 1A

- ◆ Water consumption is composed of three components: withdrawal, return and forced evaporation
- ◆ Net withdrawal (withdrawal less return) amounts to about 100 million gallons per day or about 1% of gross withdrawal
- ◆ Nuclear plants are the largest consumers of water both due to their size, amount of generation, and need for cooling water
- ◆ CT's, Diesels, Solar, and Wind use no cooling water*



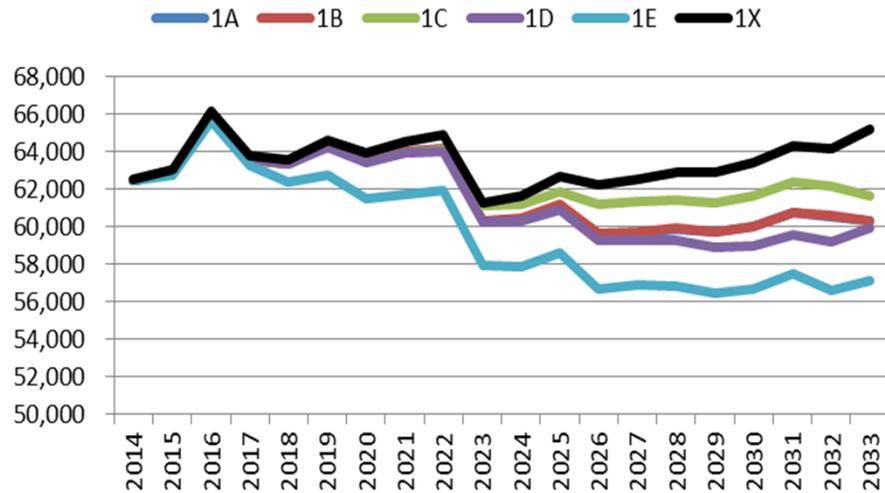
* Note: CT's use some water, but the quantity is minimal such that TVA doesn't model that use as part of consumption



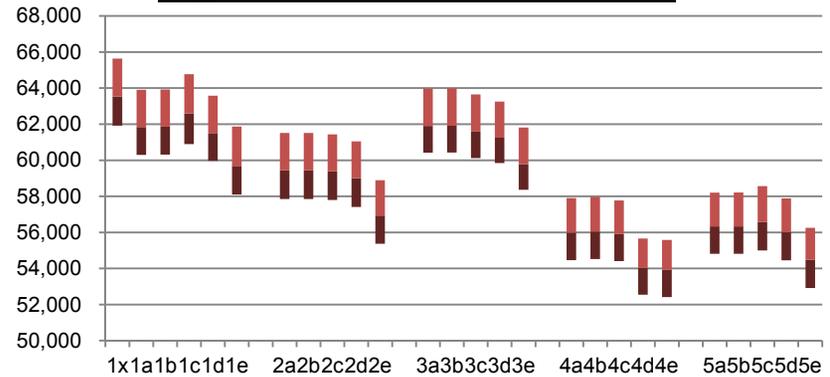


Environmental Stewardship Assessment Water Consumption (Cont'd)

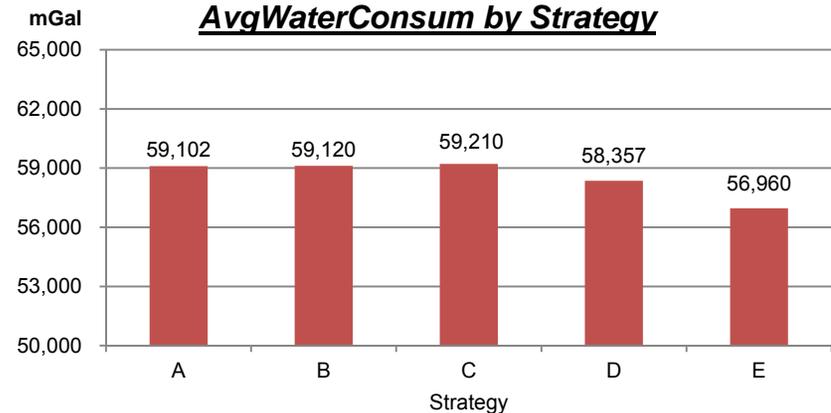
Avg Water Consumption mmGal



AvgWaterConsum mmGal 2014-33



AvgWaterConsum by Strategy



- ◆ Average water consumption declines over time in all strategies
- ◆ Variation across scenarios within a particular strategy ranges from 10.5% for A/B to 13.8% for Strategy D. This is largely driven by the variation in load growth in the different scenarios
- ◆ Average water consumption across the five strategies ranges from 56,960 for Strategy E to 59,210 for Strategy C or 2,250 million gallons. This represents a variation of about 4%





Environmental Stewardship Assessment Waste Generation

Waste metric calculation not yet complete. This slide will be updated at the meeting.



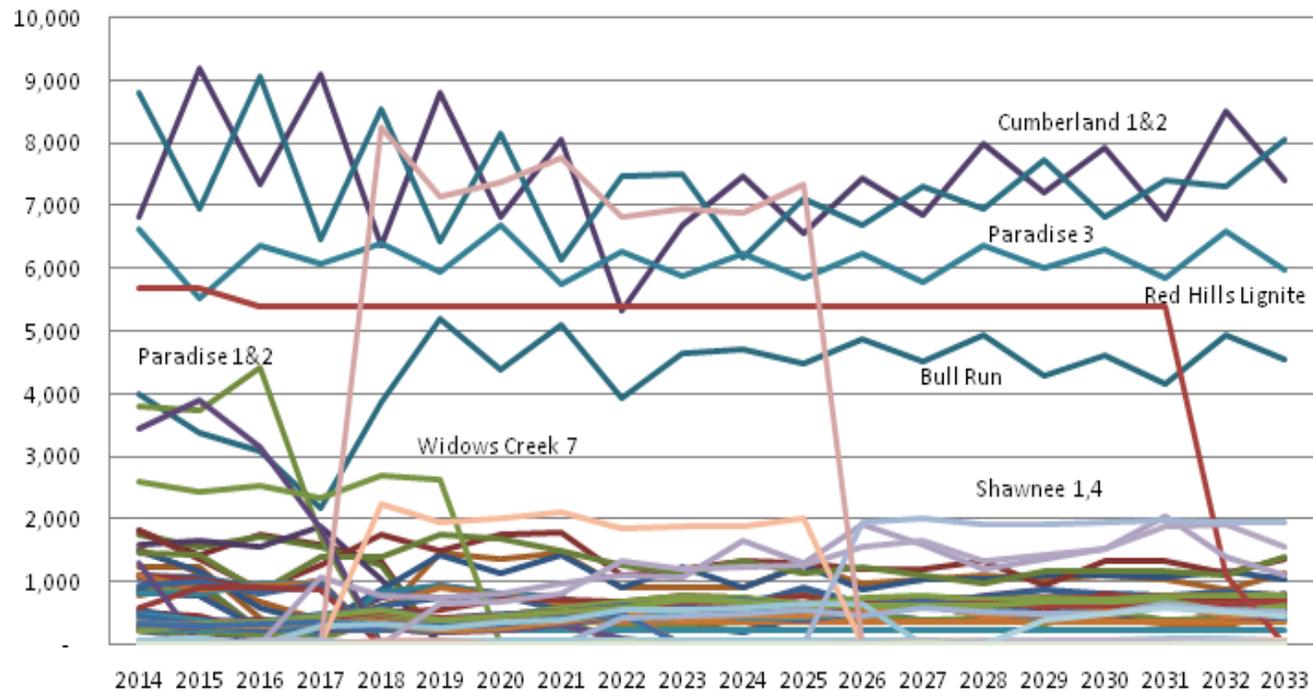
* Note: CT's use some water, but the quantity is minimal such that TVA doesn't model that use as part of consumption





Environmental Stewardship Assessment CO₂ Emissions

Example: CO₂ Emissions by Resource (ktons)- Case 1A

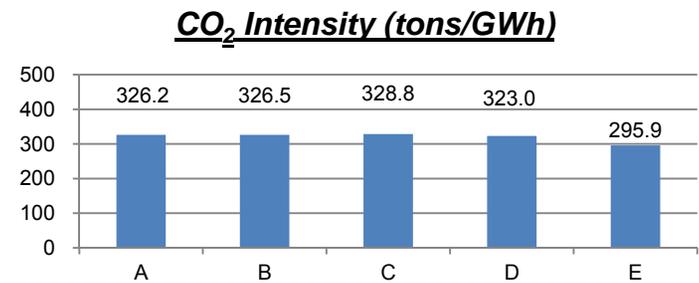
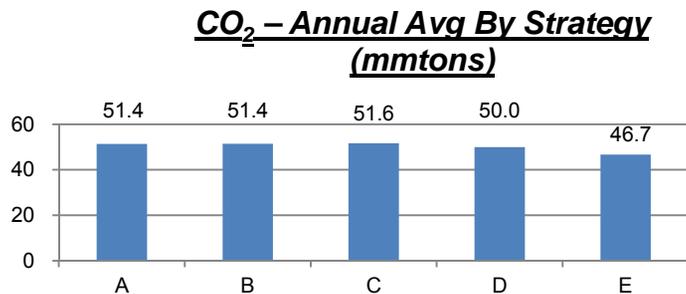
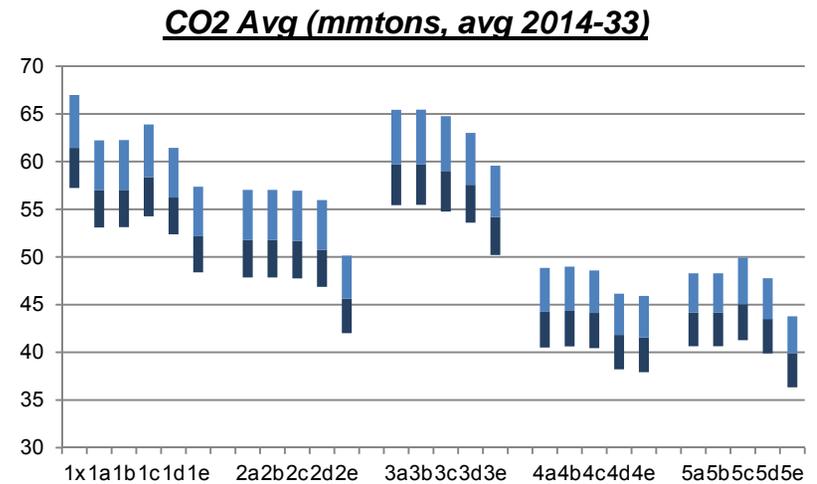
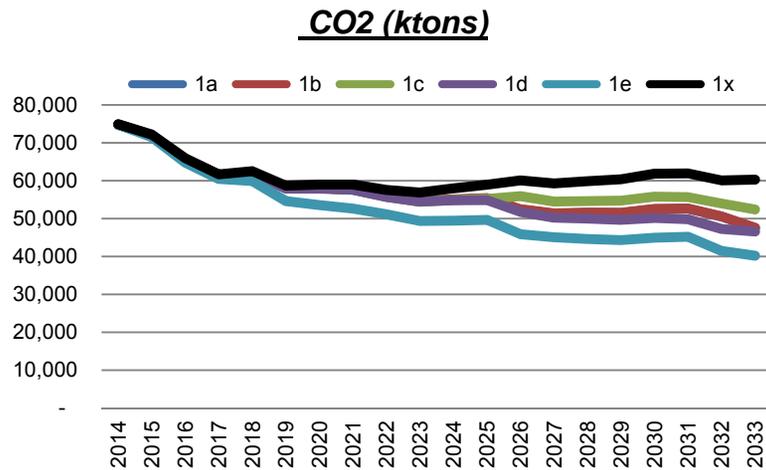


- ◆ The scorecard metric for CO₂ is Average Annual Tons of CO₂ emitted during the planning period
- ◆ Emissions are calculated using specific emissions rates for each type of generation based on fuel source
- ◆ Gross emissions are largely driven by scenario assumptions (variations in total system load)





Environmental Stewardship Assessment CO₂ Emissions (Cont'd)



- ◆ CO₂ emissions vary largely by scenario but decline over time for all strategies
- ◆ Strategies A, B, and C have similar CO₂ emissions profiles across the scenarios coming in about 3% above Strategy D and about 10 % above Strategy E
- ◆ Obviously strategy E achieves the lowest intensity at 296 tons/GWh which is about 10% lower than A,B and C and about 8% lower than D





Environmental Stewardship Assessment Summary of Observations

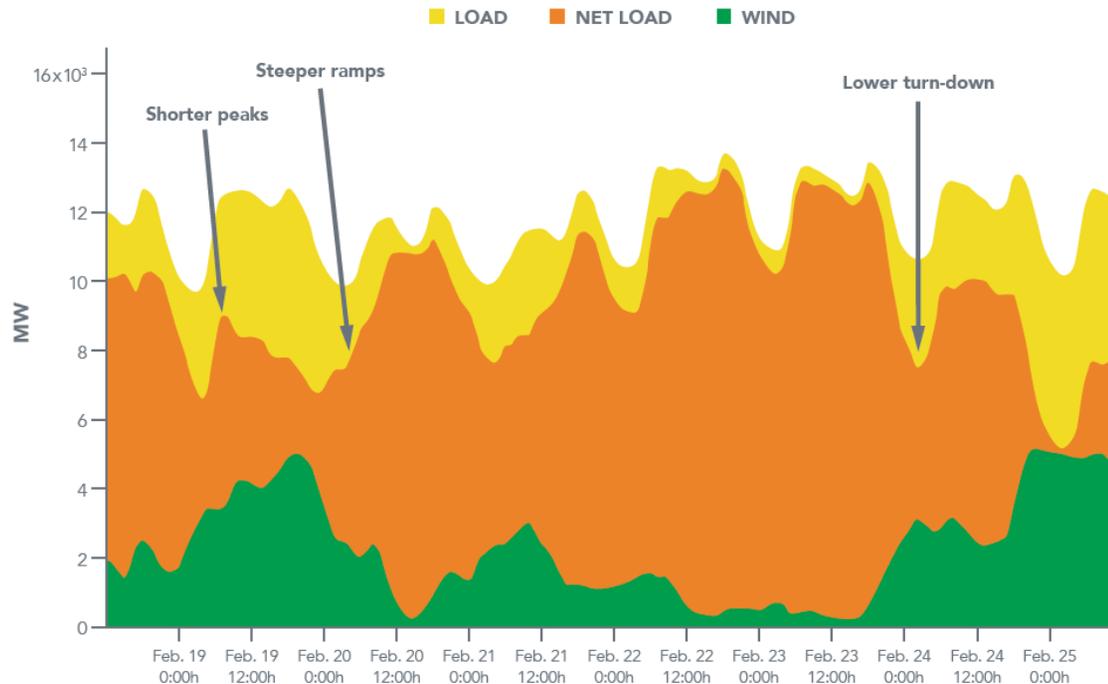
- ◆ In both categories (Water and CO₂), Strategy C imposes the largest environmental impact followed closely by A/B and then D

- ◆ Strategy E demonstrates an improvement relative to the other strategies
 - 7%-10% lower CO₂ emissions
 - 3%-4% less water consumption

Other comments or observations?



Illustration of the Effect of Variable Resources on Daily Load Changes



We define flexibility as the ability of the system to respond to daily load changes

The analyses shown in this section evaluate the relative performance of the different strategies by trying to answer the following questions:

- ◆ Question 1: What is the capacity of the system to respond to ramp-ups?
- ◆ Question 2: What is the capacity of the system to respond to ramp-downs?
- ◆ Question 3: How exposed is the system to potential flexibility challenges?



Flexibility Assessment Summary of Observations

- ◆ Strategies A, B, C and D are clustered as leading strategies from a flexibility perspective
- ◆ Strategy E shows the lowest capacity to respond during ramp-ups and ramp-downs
- ◆ A final caveat is that variable energy generation does not appear to be a significant issue within the planning window based on the initial IRP results, however, TVA must pay close attention to this issue and analyze the effect increased variable energy in its system

Other comments or observations?



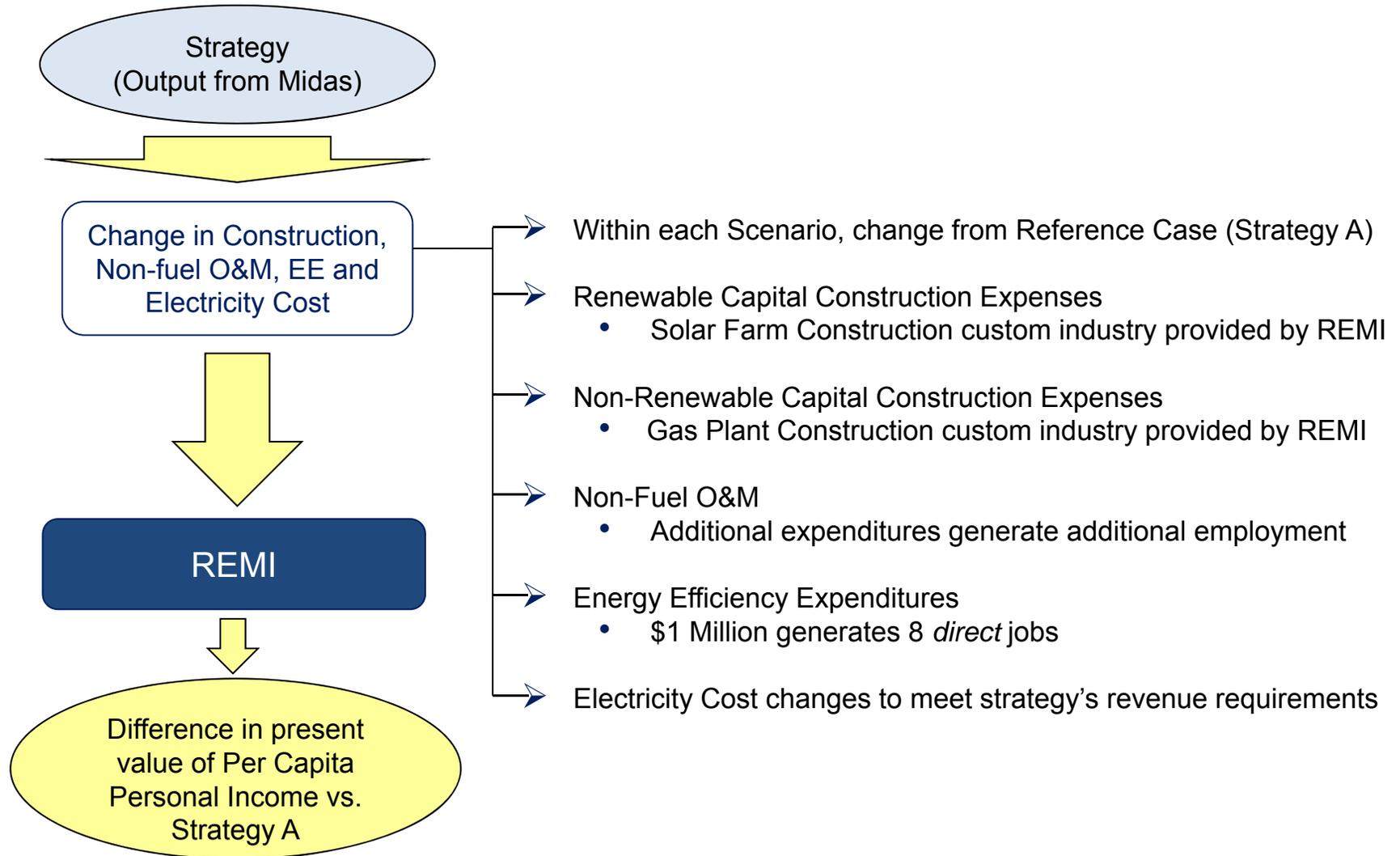
Valley Economics Assessment

The objective of the economic assessment is to gain some understanding of the relative performance of different strategies with respect to the economic impact by asking the following question:

- ◆ How will a particular strategy effect Tennessee Valley per capita income over the next 20 years?



Valley Economics Assessment Economic Metric Calculation Process



- 2% discount rate from 2014 through 2033 on constant dollar impacts
- Strategies ranked within each Scenario



Wrap Up



Summary of Assessment Observations

Strategy	Assessment Observations
A. The Reference Plan	<ul style="list-style-type: none"> • Relatively low PVRR and System Average Cost (1st Ten Years): essentially identical to Strategy B • Lowest System Average Cost in the second ten years of the study • Low financial risk: risk/benefit ratio less than one; second lowest risk exposure • Higher environmental impact compared to Strategies D and E • Demonstrates flexibility
B. Meet an Emission Target	<ul style="list-style-type: none"> • Results are practically identical to strategy A
C. Lean on the Market	<ul style="list-style-type: none"> • Strategy with the lowest PVRR and lowest risk • Higher environmental impact than the the rest of strategies • Shows higher system regulating capability than the rest of strategies but lower system turndown factor
D. Doing More EE	<ul style="list-style-type: none"> • Higher PVRR than A/B, or C due to required EE volumes • Low system average cost during the first decade, but increasing levels of EE and lower sales during the second decade result in high system average cost during the second decade • Comparable to strategies A,B and C on flexibility due to reduced sales • Low environmental impact, second only to Strategy E
E. Focusing on Renewables	<ul style="list-style-type: none"> • Highest PVRR overall due to enforcement of renewable energy targets (highest or second highest in all scenarios) • Highest risk/benefit ratio of any strategy (greater than 1.0) • Lower flexibility performance than the rest of strategies • Lowest environmental impact





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12:00 pm	Adjourn	





Individual Observations and Feedback

- ◆ The goal of this session is to give each and every stakeholder group an opportunity to speak so that we can capture your input
- ◆ We would like to hear from you about your feedback on the preliminary results of the draft IRP process: your main observations and any areas you perceive may require further analysis
- ◆ Guidelines
 - Each group will have five minutes to discuss any observations, feedback, questions, or input
 - The five minutes for your group may be split among representatives or handled by a single representative
 - Stakeholders will be respectful while others are speaking and respectful of the time limit when it is his/her turn to provide input
 - This is not a time for debate or response (we will have time for that later). During this session, we want to capture each participant's input

- ❖ You have seen the expansion plan results (December)
- ❖ You now have the information on how plans perform with regard to the evaluation metrics (Today)
- ❖ Think about it tonight, and we would like to hear from you tomorrow





Group Discussion

- ◆ After the stakeholder feedback session tomorrow, we will engage in a 45 minute open discussion
- ◆ This will be the opportunity for members to respond to comments and dig deeper into issues raised during the feedback session or pose additional comments relevant to the IRP process
- ◆ Example discussion topics may include:
 - Reactions to the trends in expansion plans
 - Discussion of energy mix implications
 - Surprises in the assessment results
 - Thoughts on potential public response to results



Adjourn



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During this session, we aim to accomplish the following objectives:

- ◆ Provide each stakeholder group an opportunity to share comments/input
- ◆ Engage in a dynamic discussion of the Draft IRP results
- ◆ Ensure understanding of next steps in the IRP process





Summary of Assessment Observations

Strategy	Assessment Observations
A. The Reference Plan	<ul style="list-style-type: none">• Relatively low PVRR and System Average Cost (1st Ten Years): essentially identical to Strategy B• Lowest System Average Cost in the second ten years of the study• Low financial risk: risk/benefit ratio less than one; second lowest risk exposure• Higher environmental impact compared to Strategies D and E• Demonstrates flexibility
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Break

Group Discussion

Discussion: IRP Process

- ◆ Further sensitivity analysis considerations?
- ◆ Messaging considerations?
- ◆
- ◆



Discussion: Preliminary Results

- ◆ No new baseload in any case

- ◆ New capacity tends to be gas, renewables, EE, DR

- ◆ Renewables generally appear in the second half of the planning period

- ◆ Interplay or tradeoff between EEDR and gas resources (CCs)

- ◆

- ◆



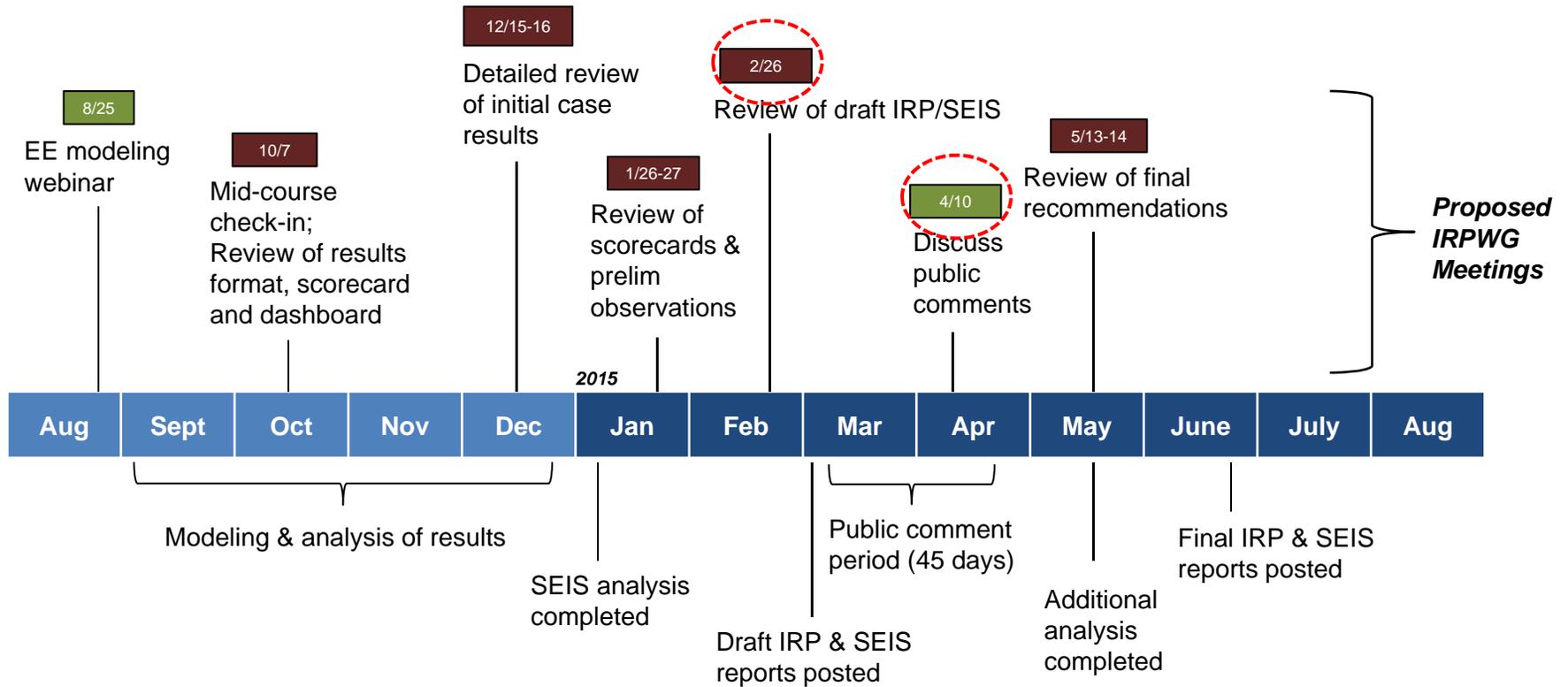
Discussion: Execution

- ◆ Role of LPCs?
- ◆ Public Policy Considerations?
- ◆ Other stakeholders?
- ◆
- ◆

Next Steps



2015 IRP/SEIS Schedule: Major Milestones & Stakeholder Sessions



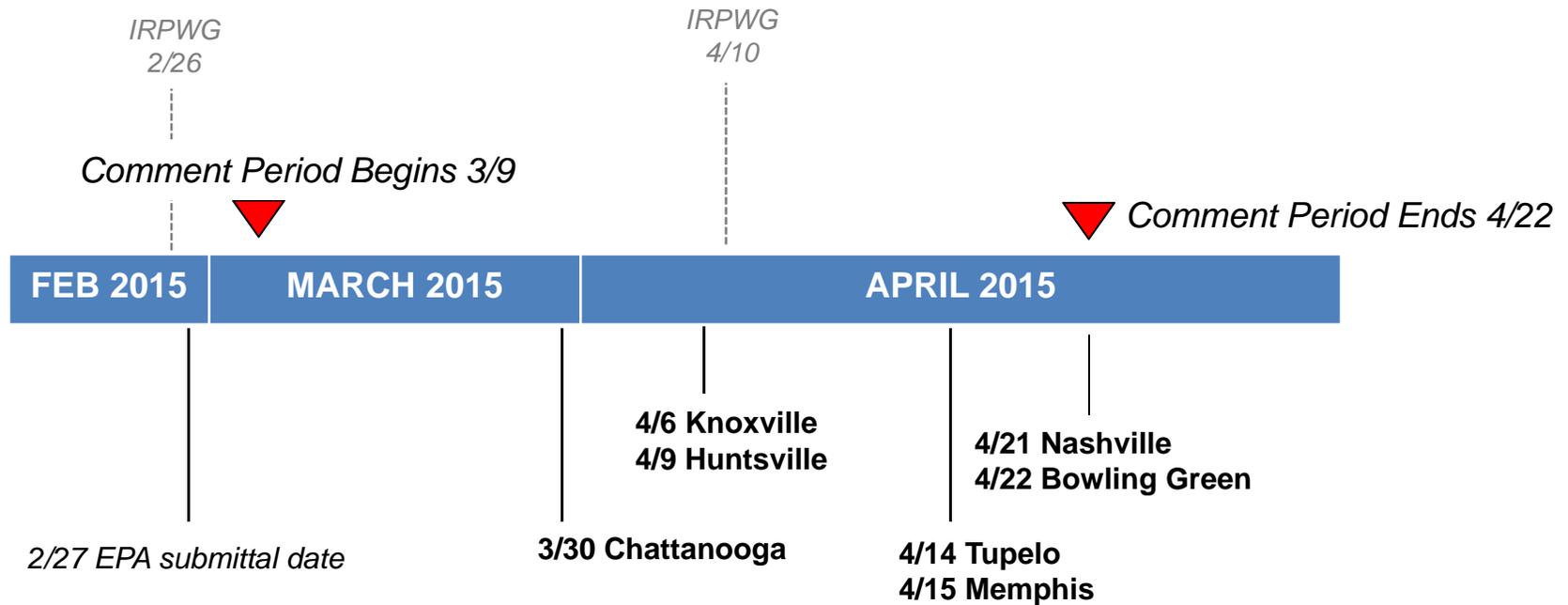
Schedule changes since the December stakeholder meeting:

- February review session shortened to 1 day
- March session cancelled
- April 10th webinar/in-person meeting added (Huntsville)





Public Sessions: Comments on the Draft IRP/SEIS



- Locations are logistics are still being refined; actual dates and places may change prior to the start of the public comment period



Adjourn
