2015 Integrated Resource Plan
Project Quarterly Update
November 3, 2014

About Tonight's Meeting

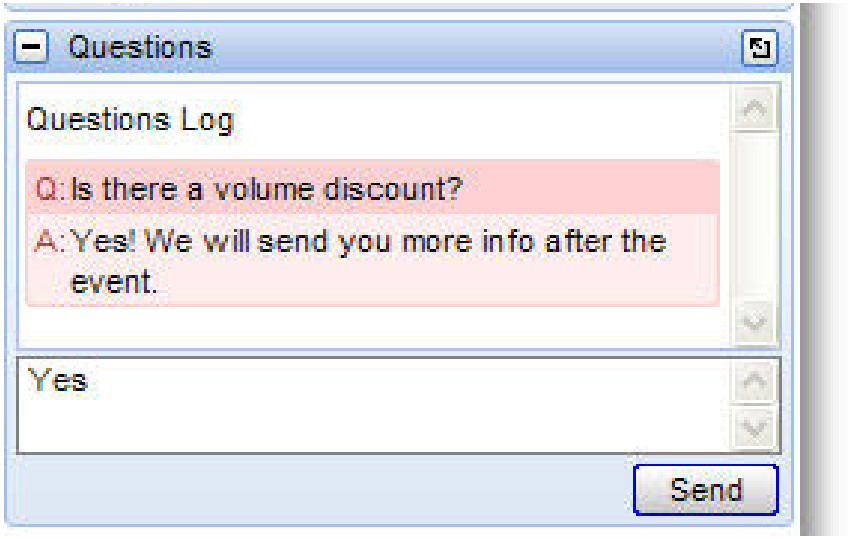
- This is both a live meeting, and a Webinar.

- Webinar participants are muted.

To ask questions:

- Live meeting attendees can ask questions by coming to the podium at the front of the room.

- Webinar attendees can submit Questions using the Question tool on the Webinar toolbar



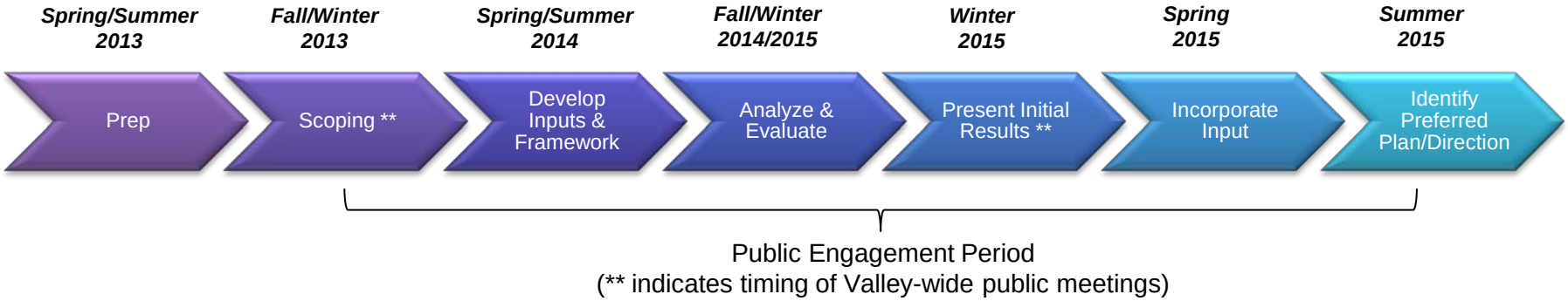
Quarterly Update Session - Agenda

- Welcome
- Safety Moment
- IRP Schedule Review
- IRP Status Update
  - Recap of the process
  - Scenario/Strategy framework
  - Major Assumptions & Enhancements
  - Current status
  - Metrics & Scorecard
  - Dashboard concepts
  - Next Steps & Milestones
- Questions
- Closing Remarks

Safety First – Fall Driving Tips

2015 IRP/SEIS Revised Schedule: Major Phases/Milestones

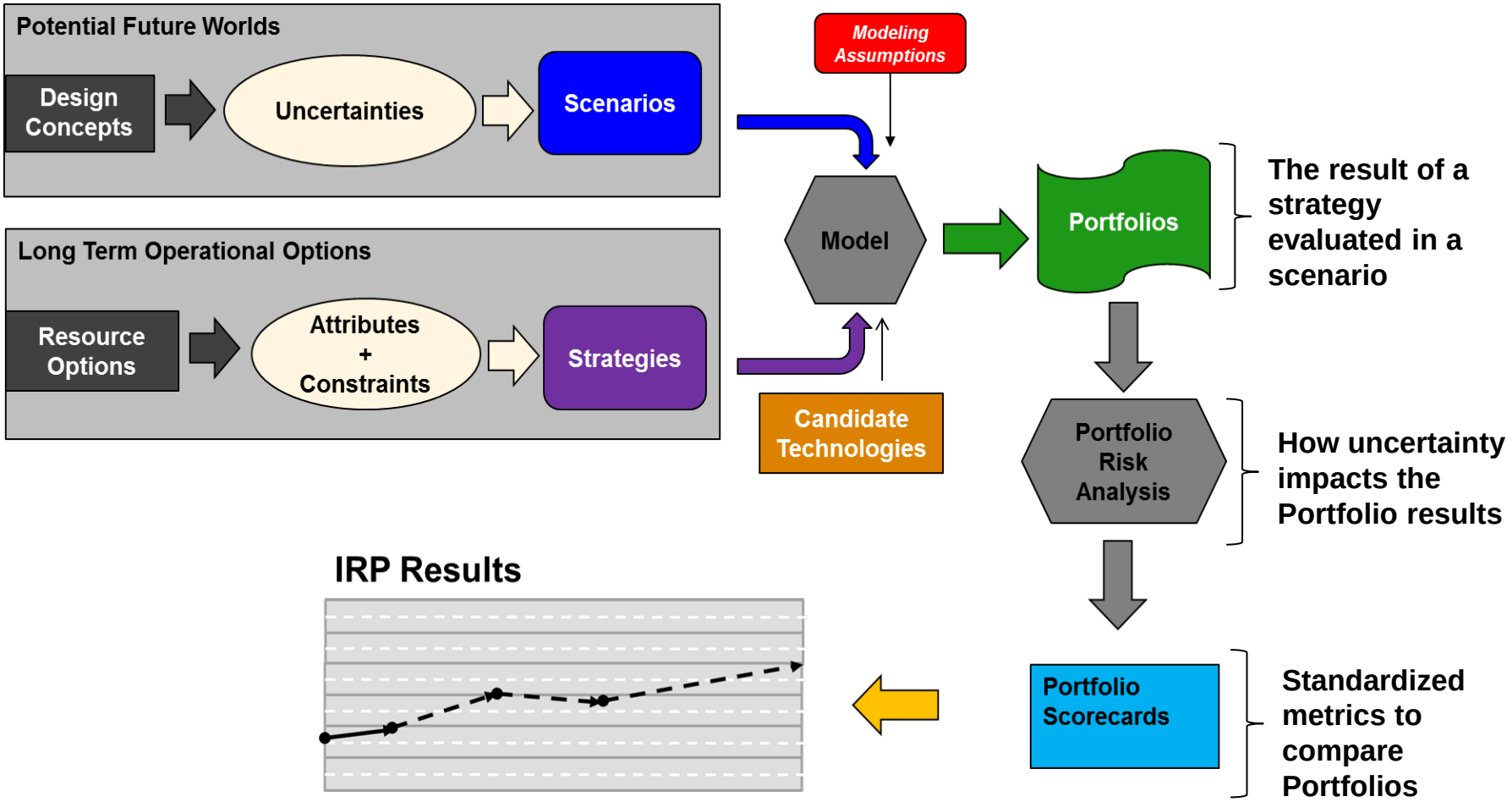
The 2015 IRP is intended to ensure transparency and enable stakeholder involvement.



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 – Summer 2015

How the Resource Planning Model Works



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 – Focusing on Renewables	• Majority of new capacity needs are met by setting immediate and long-term renewable energy targets; includes hydro • Utility-scale approach is targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024

Power Resource Options* Considered in the IRP

NATURAL GAS FIRED
- Simple cycle combustion turbine (CT3x)
- Simple cycle combustion turbine (CT4x)
- Combined cycle two on one (CC2x1)
- Combined cycle three on one (CC3x1)

COAL FIRED
- Integrated Gas Combined Cycle (IGCC)
- Pulverized Coal 1x8 (PC1x8)
- Pulverized Coal 2x8 (PC2x8)
- Integrated Gas Combined Cycle with Carbon Capture and Sequestration (IGCC CCS)
- Pulverized Coal 1x8 with Carbon Capture and Sequestration (PC1x8 CCS)
- Pulverized Coal 2x8 with Carbon Capture and Sequestration (PC2x8 CCS)

NUCLEAR
- Pressurized water reactor (PWR)
- Advanced pressurized water reactor (APWR)
- Small Modular Reactor (SMR)

HYDRO ***
- Hydro dam expansion project: Spill addition
- Hydro dam expansion project: Space addition
- Run of river

UTILITY-SCALE STORAGE
- Pumped-hydro storage
- Compressed air energy storage (CAES)

BIOMASS ***
- New direct combustion
- Repowering

SOLAR ***
- Utility-scale one-axis tracking photovoltaic
- Utility-scale fixed-axis photovoltaic
- Commercial-scale large photovoltaic
- Commercial-scale small photovoltaic

WIND ***
- Midcontinent Independent System Operator (MISO)
- Southwest Power Pool (SPP)
- In valley
- High Voltage Direct Current (HVDC)

ENERGY EFFICIENCY**
- Treating Energy Efficiency as a resource in 10 MW blocks

* All data for options verified by Navigant

*** Collaborative effort with stakeholders

** Developing new methodology

Goals For An Optimal Resource Plan

Low Cost

- Minimizing cost critical to economic efficiency, and mandated by the TVA Act
- Lowest cost option should be chosen between competing plans of roughly equal risk; the lowest cost wins

Risk Informed

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

Environmentally Responsible

- TVA must have a clear understanding of the environmental impacts of its decisions and seek alternatives that best support our Vision and Mission
- The IRP includes metrics that help capture some of these impacts (beyond just impacts on plan cost)

Reliable

- TVA has built a reputation of reliability
- Planning studies focus on long-term reliability measures traditionally based on conventional resource characteristics, like outage rates and seasonal de-rates
- As the resource mix changes, TVA may need to include additional measures to capture characteristics of intermittent or non-dispatchable resources

Diverse

- TVA should strive to insulate customers from extreme market fluctuations
- Diversity can be measured by the degree to which a portfolio is robust in a wide variety of futures
- TVA's IRP captures the value of diversity by scoring how well various portfolios perform under uncertainty

Flexible

- A sound generation plan will allow decision-makers the flexibility to learn more about future environments before making decisions that would be costly to reverse
- In this IRP, TVA is attempting to measure flexibility in the context of the changing resource mix

Major Assumptions in the 2015 IRP

- **Scenario planning approach (also used in the 2011 study) includes:**
  - Plausible futures intended to stress resource choices
  - Range of economic forecasts, demand/energy projections, fuel prices, CO2 costs, and other key drivers
  - Uncertainty exposure (risk) tested using probability distributions around key variables

- **A diverse set of resource options are available for selection**
  - Conventional resources like nuclear, coal and gas units
  - Market power purchases and/or acquisitions
  - Biomass and small hydro expansion
  - Multiple wind and solar choices
  - Energy efficiency & demand response alternatives

- **Strategies have been developed to answer some key questions about**
  - Minimizing emissions
  - Market reliance vs. building assets
  - Promoting a greater commitment to EE
  - Increasing the contribution of renewables in the mix

Enhancements In This IRP

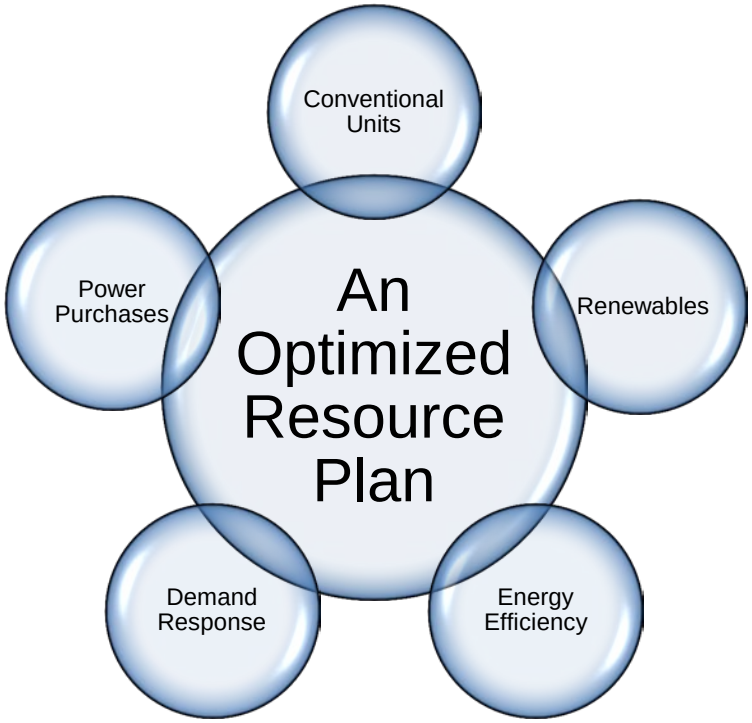
- **EE-as-a-resource represented by unique modeling solution**
  - Uses cost tiers and customer adoption assumptions to define resource availability
  - Energy pattern shapes ensure proper representation of program design
  - Portfolio of programs are modeled in each market sector (residential, commercial, industrial)

- **Worked collaboratively with stakeholders to develop unit characteristics for multiple wind and solar options**
  - Wind & solar have declining costs over time due to technology innovation
  - Capacity factors and net dependable capacity credit values represent different geographical or technology assumptions
  - Solar/wind represented as "power purchases" with a fixed energy pattern to capture proper availability and production characteristics

- **Solar, wind, EE & DR treated as selectable resource options in the models**
  - In the 2011 IRP, these options were developed separately and loaded into the model

Dynamic Resource Selection

- The process for identifying the optimized (least-cost) resource plan includes identifying the lowest-cost combination of resources that meets the need for power in each year of the study
  - The resource plan is the combination of these annual least-cost solutions
- The 2015 IRP treats renewables (biomass, hydro, wind, solar), energy efficiency, and demand response similar to more conventional resources for the purpose of selection
  - These options have unit-like characteristics
  - The amount selected will depend on the need for power, the cost of all available options, and the performance characteristics of each option



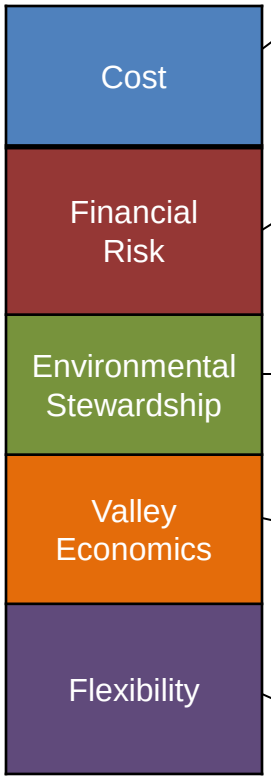
The mix of resources will depend on the strategy assumptions and the scenario framework

Modeling & Analysis Is Ongoing

- Assumptions and input data were reviewed/validated by independent third party experts from Navigant Consulting
- Key assumptions reviewed by stakeholder working group in May-June
- TVA resource planners engaged in model runs and review of detailed case results

- Once all case modeling is complete & validated, scorecard metrics are produced

Populating the Scorecard Categories



Cost includes both the long-range cost of the resource plan (present value of customer costs) as well as a look at short term average system cost (an indicator of possible rate pressure)

Financial Risk measures the variation (uncertainty) around the cost of the resource plan by assessing a risk/benefit ratio and computing the likely amount of cost at risk; both of these indicators use data from probability modeling

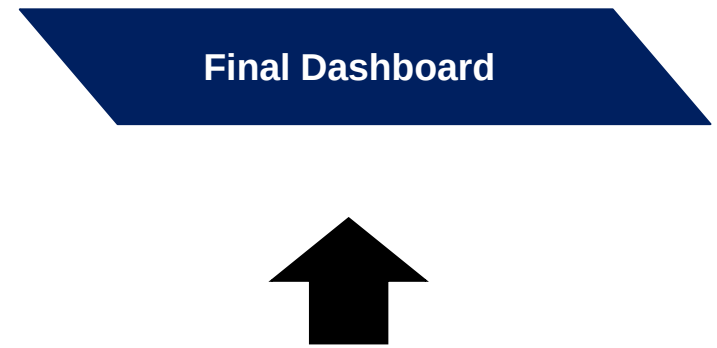
Stewardship captures multiple measures related to the environmental "footprint" of the resource plans, like air emissions and thermal loading impacts

Valley Economics computes the macro-economic effects of the resource plans by measuring the change in per capita income compared to a reference case

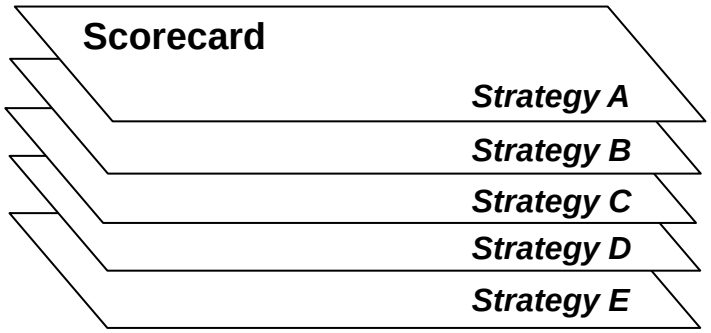
Flexibility is a measure of how responsive the generation portfolio of each resource plan is by evaluating the type/quantity of resources and the extent to which this mix can easily follow load swings

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
- 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

How to Evaluate the Results

- **The dashboard is a visualization mechanism that facilitates decision making**
- **It balances summarizing and segregating information that facilitates interpretation of the underlying analysis for decision-makers**
- **The dashboard design should make communication of the key information clear and understandable**
- **The structure of the dashboard can take several forms**
  - Numerical
  - Visual/relational
  - A combination that can be weighted or un-weighted

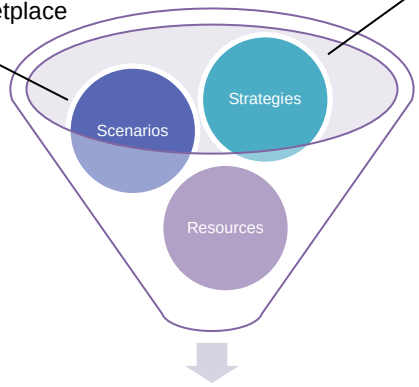
25 standard cases with 72 stochastic iterations and additional sensitivity runs, totaling over 1800 model runs

Next Steps: Complete Modeling & Interpret Results

Current Outlook
Stagnant Economy
Growth Economy
De-carbonized Future
Distributed Marketplace

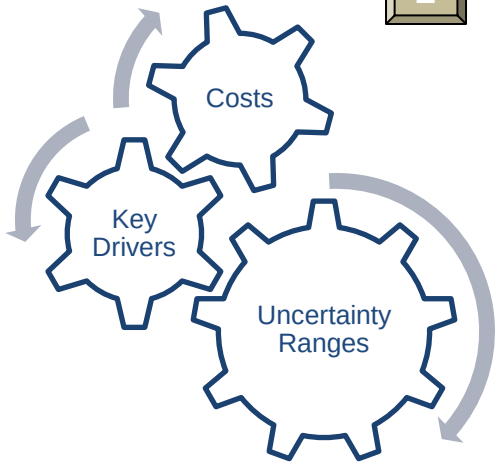
1

Reference Plan
Meet an Emission Target
Lean on the Market
Doing More EE
Focus on Renewables



20yr Resource Plans

2



Plan/Cost Risk Assessment

3

Filtering with Scorecard Metrics

- Cost
- Financial Risk
- Environmental Stewardship
- Valley Economics
- Flexibility

4

Results from multiple case runs will be scored using metrics that capture multiple aspects of TVA's mission. Results would then be summarized on a study dashboard. Preferred resource plans can then be identified based on trade-off analysis across metrics categories and stakeholder input.

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Thank you for attending today's session

For information about the 2015 IRP, go to
www.tva.gov/irp