



# Environmental and Energy Update

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Brenda Brickhouse

Vice President, Environment & Energy Policy

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# TVA Environmental Policy

*... provide cleaner, reliable and still-affordable energy, support sustainable economic growth in the Tennessee Valley, and engage in proactive environmental stewardship*

## Key Actions

Protect natural resources and provide recreation opportunities

Manage an integrated river system



Reduce solid and hazardous waste

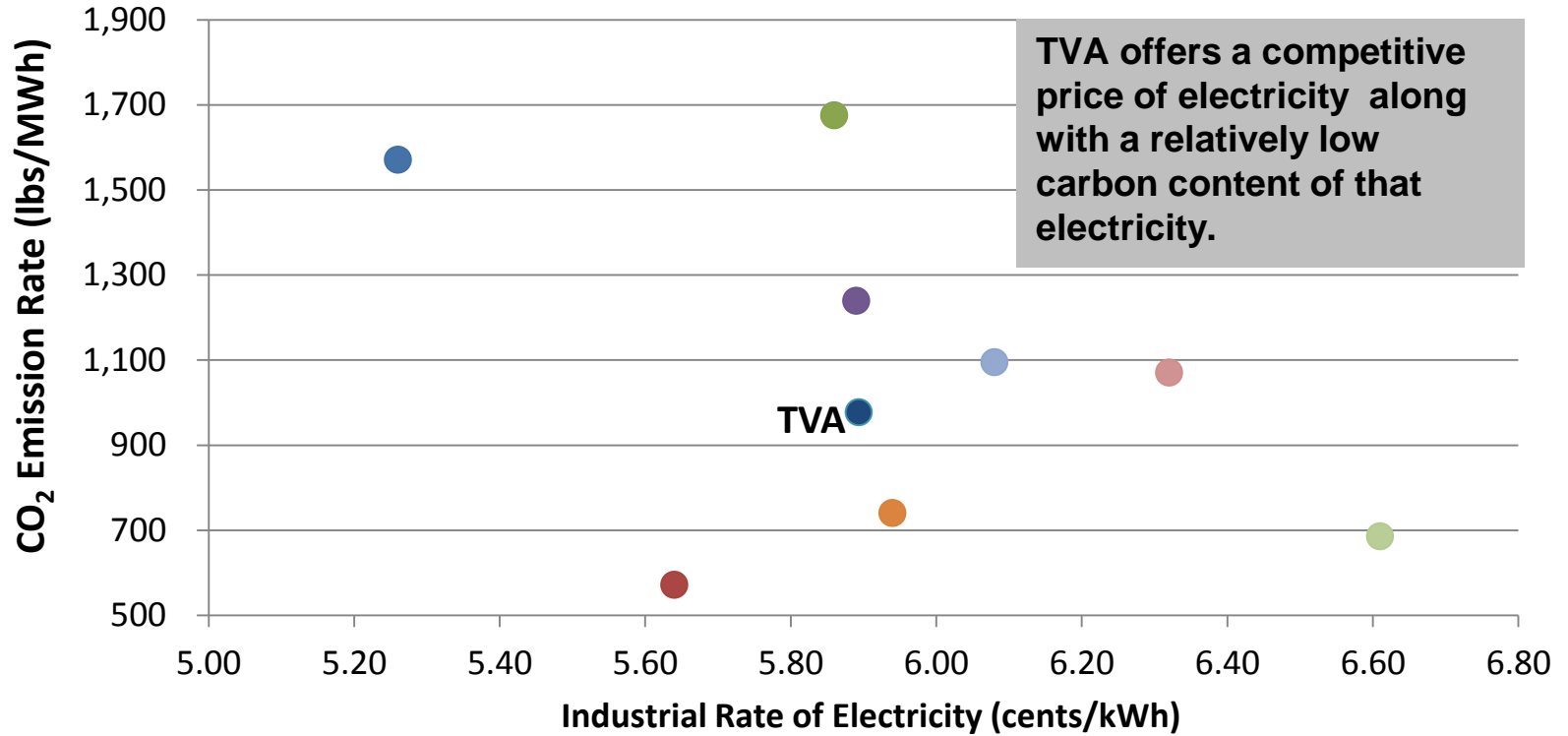
Support sustainable economic development

Continue to reduce air emissions over 90%

# Scaling up Clean Generation

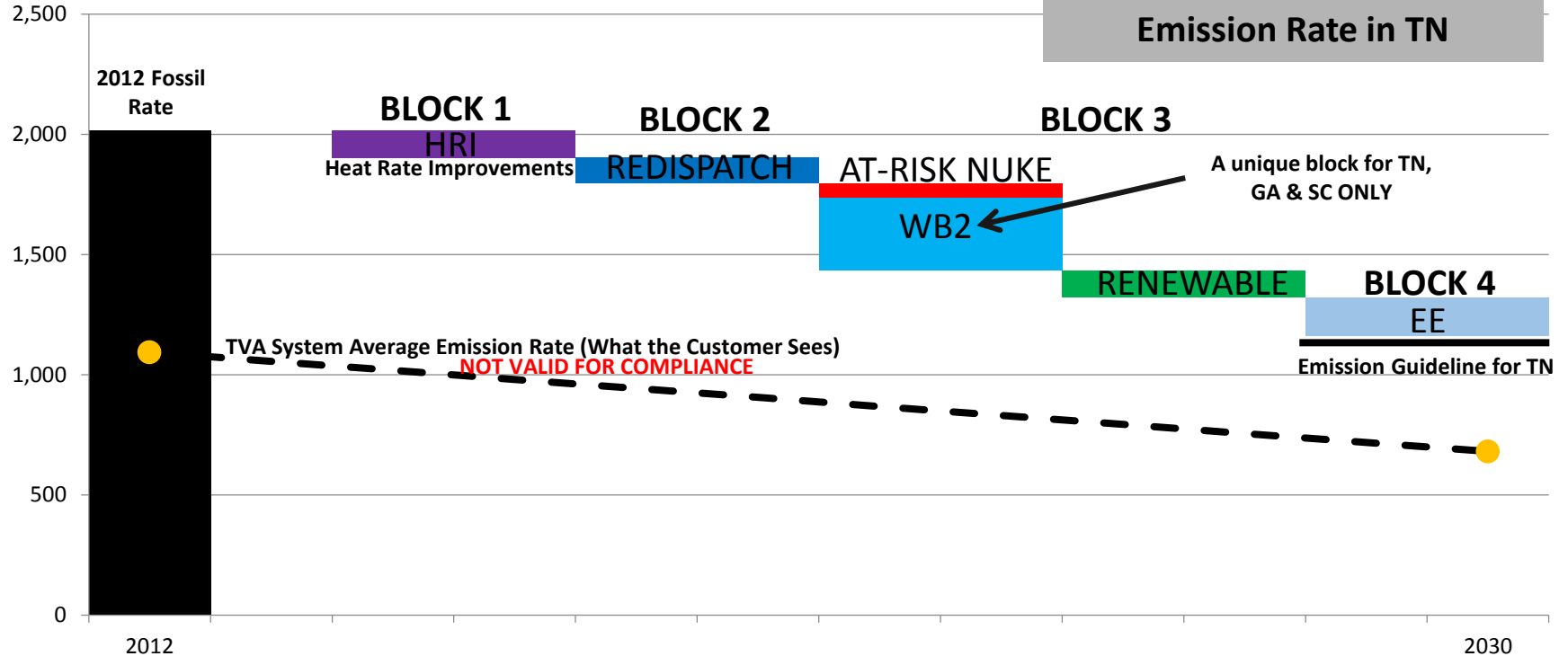


# 2013 Carbon Performance vs. Industrial Rate of Electricity

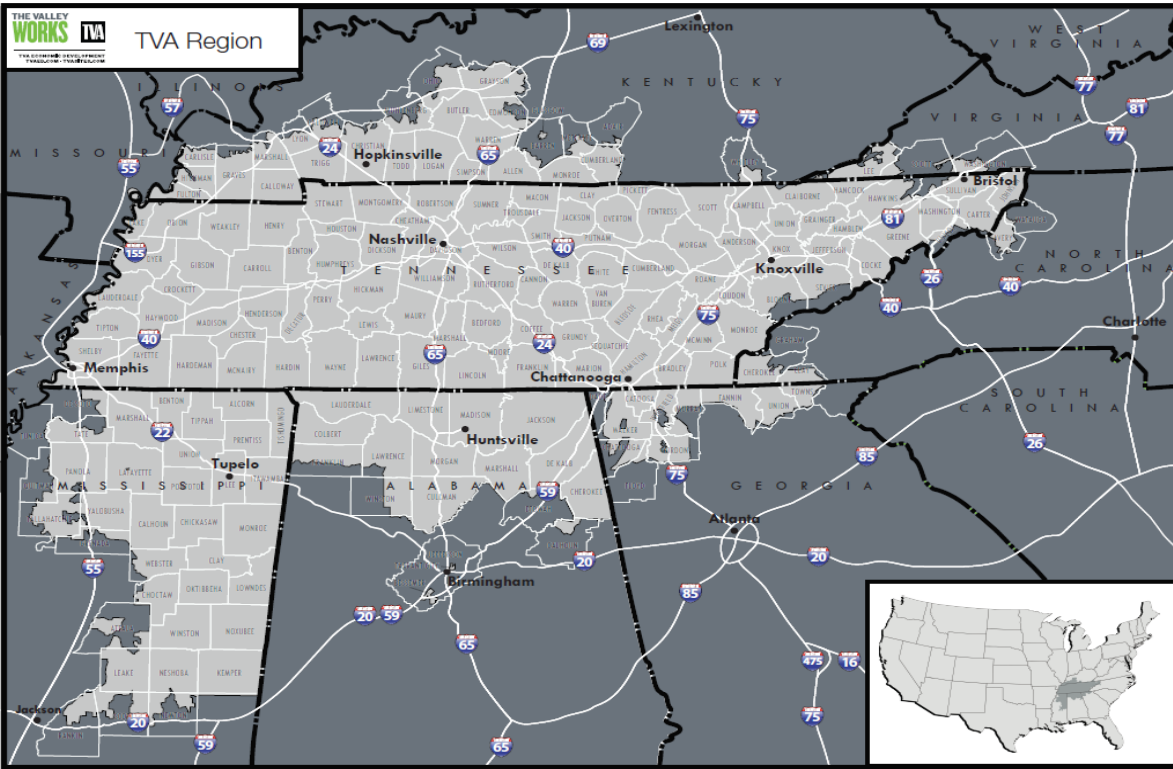
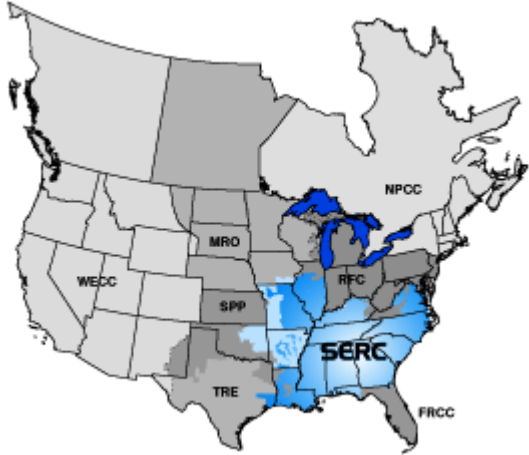


# Establishing the Emissions Guideline in Tennessee

111(d) Compliance  
Rate (lbs/MWh)



# How will we serve the region in the future?



# Refreshing the 2011 IRP

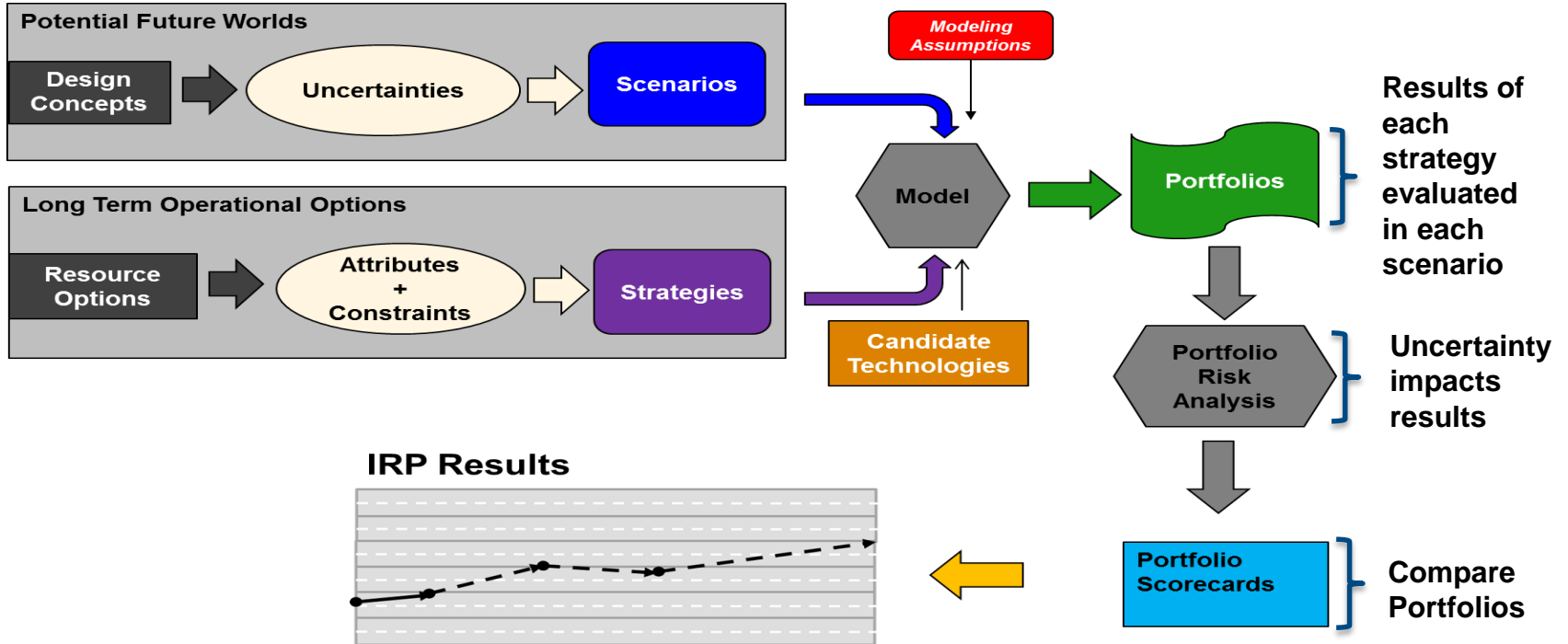
## Solving the Energy Puzzle

- ◆ Significant national and regional changes motivated us to update the study
  - Abundant natural gas
  - Decline in electricity demand growth
  - Completing Watts Bar Unit 2
  - Commitments to retire some coal by 2018
- ◆ Publish draft Supplemental Environmental Impact Statement (SEIS) and IRP – February 2015
- ◆ Complete public meetings – April 2015
- ◆ Final publication of SEIS and IRP and Board approval – summer 2015



*Integrated Resource Planning (IRP) is a special study that tries to balance the mix of energy sources to ensure TVA is successful over a broad range of possible future conditions. This study outlines options that, if implemented, impact cost and environmental effects of producing power.*

# How the Resource Planning Process Works



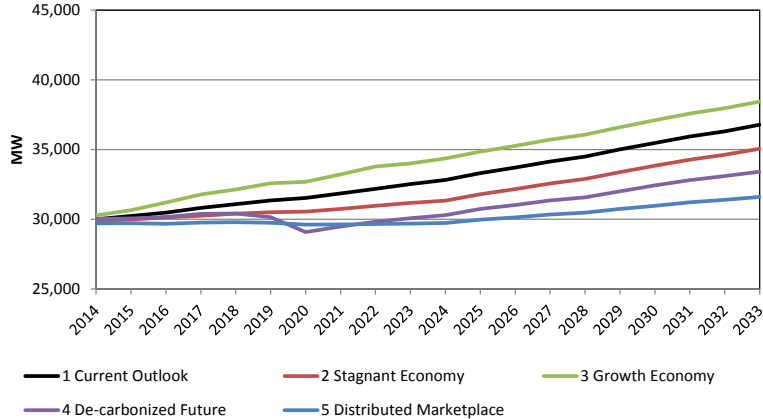
# Scenarios and Strategies

Scenarios	
<b>1 - Current Outlook</b> 2033: 189 TWh	<ul style="list-style-type: none"> <li>Current outlook for the future TVA is using for resource planning studies</li> </ul>
<b>2 - Stagnant Economy</b> 2033: 180 TWh	<ul style="list-style-type: none"> <li>Stagnant economy results in flat to negative growth, delaying the need for new generation</li> </ul>
<b>3 - Growth Economy</b> 2033: 197 TWh	<ul style="list-style-type: none"> <li>Rapid economic growth translates into higher than forecasted energy sales and resource expansion</li> </ul>
<b>4 - De-Carbonized Future</b> 2033: 172 TWh	<ul style="list-style-type: none"> <li>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</li> </ul>
<b>5 - Distributed Marketplace</b> 2033: 156 TWh	<ul style="list-style-type: none"> <li>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</li> </ul>

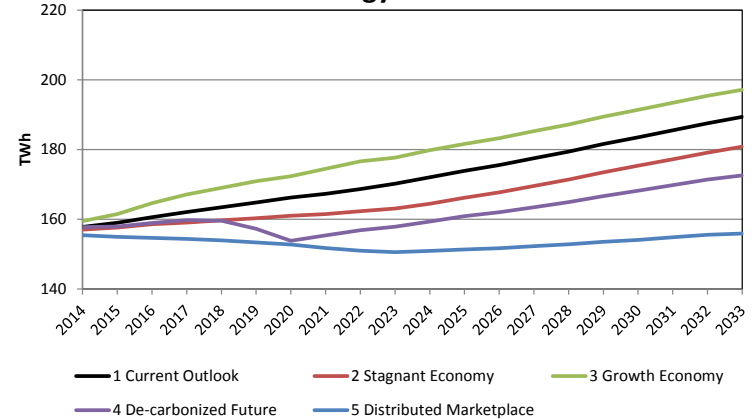
Strategies	
<b>X - Baseline Case</b>	<ul style="list-style-type: none"> <li>Legislatively mandated, traditional least cost optimization, <b><u>EE/Renewables scheduled</u></b></li> </ul>
<b>A - The Reference Plan</b>	<ul style="list-style-type: none"> <li>Legislatively mandated, traditional least cost optimization, <b><u>EE/Renewables optimized</u></b></li> </ul>
<b>B - Meet an Emission Target</b>	<ul style="list-style-type: none"> <li>Resources selected to create lower emitting portfolio based on an emission rate target or level using CO2 as the emissions metric</li> </ul>
<b>C – Focus on Long-Term, Market-Supplied Resources</b> <i>(formerly Lean on the Market)</i>	<ul style="list-style-type: none"> <li>Most new capacity needs met using longer-term PPA or other bilateral arrangements</li> <li>TVA makes a minimal investment in owned assets</li> </ul>
<b>D – Maximize Energy Efficiency</b> <i>(formerly Doing More EE)</i>	<ul style="list-style-type: none"> <li>Majority of capacity needs are met by setting an annual energy target for EE (priority resource to fill the energy gap)</li> <li>Other resources selected to serve remaining need</li> </ul>
<b>E – Maximize Renewables</b> <i>(formerly Focusing on Renewables)</i>	<ul style="list-style-type: none"> <li>Enforce near-term and long-term renewable energy targets; targets met with lowest cost combination of renewables</li> <li>Hydro is included as a renewable option along with biomass, wind and solar</li> </ul>

# Key Assumptions Summary

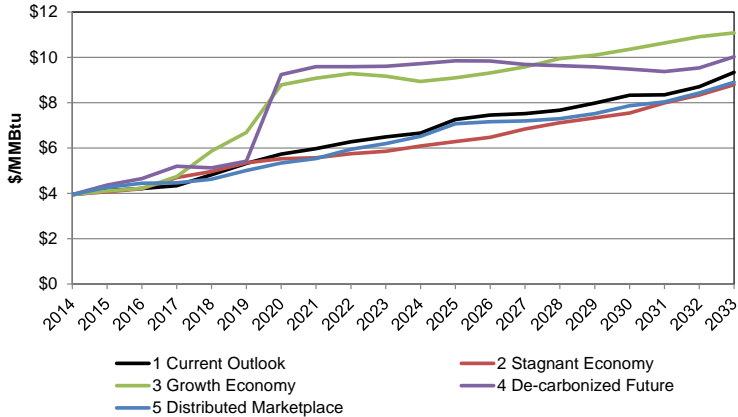
## TVA Peak Load



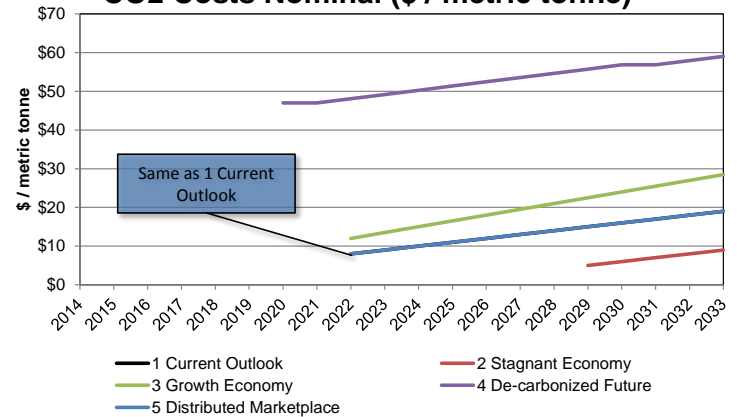
## TVA Energy Demand



## TVA Gas Price - Nominal



## CO2 Costs Nominal (\$ / metric tonne)



# Enhancements In This IRP

## **EE-as-a-resource represented by unique modeling solution**

- Uses cost tiers and customer adoption assumptions to define availability
- Energy pattern shapes ensure proper program design
- Portfolio of programs are modeled in residential, commercial, industrial sectors

## **Collaborated with stakeholders to develop unit characteristics for wind and solar options**

- Wind & solar have declining costs over time due to TI
- Capacity and net dependable capacity 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**

# Key Resource Observations

## Capacity Plan Observations:

- There is a need for new capacity in every scenario
- No significant baseload expansion beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Most expansion is around CTs and Renewables
- Retirement/control decision on Shawnee is mid 2020s depending on CO<sub>2</sub> & pending regulation
- Higher EE and Renewable levels in all cases
  - Solar showing up in mid 2020s; HVDC wind in early '30s
  - Seeing tradeoff between EEDR and gas resources
  - Selecting more CTs than CCs – EE is acting as an intermediate resource

# 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 <sup>th</sup> Percentile <sub>(PVRR)</sub>
Environmental Stewardship	CO <sub>2</sub> (MMTons)	= Average Annual Tons of CO <sub>2</sub> 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)

# Remaining 2015 IRP Milestones & Stakeholder Sessions

