Environmental and Energy Update

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
TVA offers a competitive price of electricity along with a relatively low carbon content of that electricity.

Data Sources: U.S. EIA, U.S. EPA CEMS
Establishing the Emissions Guideline in Tennessee

The 2030 Emission Guideline is 42% below the 2012 Fossil Emission Rate in TN

111(d) Compliance Rate (lbs/MWh)

- 2012 Fossil Rate
- BLOCK 1: HRI Heat Rate Improvements
- BLOCK 2: REDISPATCH
- BLOCK 3: AT-RISK NUKE
- BLOCK 4: RENEWABLE EE

TVA System Average Emission Rate (What the Customer Sees)

- NOT VALID FOR COMPLIANCE

A unique block for TN, GA & SC ONLY

Emission Guideline for TN

Environmental and Energy Update
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

Potential Future Worlds
- Design Concepts
  - Uncertainties
  - Scenarios

Long Term Operational Options
- Resource Options
  - Attributes + Constraints
  - Strategies

Modeling Assumptions
- Model
- Portfolio Risk Analysis
- Portfolio Scorecards

Results of each strategy evaluated in each scenario
Uncertainty impacts results
Compare Portfolios

IRP Results
## Scenarios and Strategies

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Strategies</th>
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</thead>
<tbody>
<tr>
<td><strong>1 - Current Outlook</strong>&lt;br&gt;2033: 169 TWh</td>
<td>• Current outlook for the future TVA is using for resource planning studies</td>
</tr>
<tr>
<td><strong>2 - Stagnant Economy</strong>&lt;br&gt;2033: 180 TWh</td>
<td>• Stagnant economy results in flat to negative growth, delaying the need for new generation</td>
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<td><strong>3 - Growth Economy</strong>&lt;br&gt;2033: 197 TWh</td>
<td>• Rapid economic growth translates into higher than forecasted energy sales and resource expansion</td>
</tr>
<tr>
<td><strong>4 - De-Carbonized Future</strong>&lt;br&gt;2033: 172 TWh</td>
<td>• 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</td>
</tr>
<tr>
<td><strong>5 - Distributed Marketplace</strong>&lt;br&gt;2033: 158 TWh</td>
<td>• 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</td>
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<table>
<thead>
<tr>
<th>Strategies</th>
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<tbody>
<tr>
<td><strong>X - Baseline Case</strong></td>
<td>• Legislatively mandated, traditional least cost optimization. EE/Renewables scheduled</td>
</tr>
<tr>
<td><strong>A - The Reference Plan</strong></td>
<td>• Legislatively mandated, traditional least cost optimization. EE/Renewables optimized</td>
</tr>
<tr>
<td><strong>B - Meet an Emission Target</strong></td>
<td>• Resources selected to create lower emitting portfolio based on an emission rate target or level using CO2 as the emissions metric</td>
</tr>
<tr>
<td><strong>C – Focus on Long-Term, Market-Supplied Resources (formerly Lean on the Market)</strong></td>
<td>• Most new capacity needs met using longer-term PPA or other bilateral arrangements. TVA makes a minimal investment in owned assets</td>
</tr>
<tr>
<td><strong>D – Maximize Energy Efficiency (formerly Doing More EE)</strong></td>
<td>• Majority of capacity needs are met by setting an annual energy target for EE (priority resource to fill the energy gap). Other resources selected to serve remaining need</td>
</tr>
<tr>
<td><strong>E – Maximize Renewables (formerly Focusing on Renewables)</strong></td>
<td>• Enforce near-term and long-term renewable energy targets; targets met with lowest cost combination of renewables. Hydro is included as a renewable option along with biomass, wind and solar</td>
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Key Assumptions Summary

**TVA Peak Load**

**TVA Energy Demand**

**TVA Gas Price - Nominal**

**CO2 Costs Nominal ($ / metric tonne)**

1. Current Outlook
2. Stagnant Economy
3. Growth Economy
4. De-carbonized Future
5. Distributed Marketplace

Same as 1 Current Outlook
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 CO₂ & 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

<table>
<thead>
<tr>
<th>Category</th>
<th>Scoring Metric</th>
<th>Formula</th>
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<tbody>
<tr>
<td>Cost</td>
<td>PVRR ($Bn)</td>
<td>Present Value of Revenue Requirements over Planning Horizon</td>
</tr>
<tr>
<td></td>
<td>System Average Cost</td>
<td></td>
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<tr>
<td></td>
<td>Years 1-10 ($/MWh)</td>
<td>$\frac{\text{NPV Rev Reqs}<em>{(2014:2023)}}{\text{NPV Sales}</em>{(2014:2023)}}$</td>
</tr>
<tr>
<td>Risk</td>
<td>Risk/Benefit Ratio</td>
<td>$\frac{95^\text{th}<em>\text{(PVRR)} - \text{Expected}</em>\text{(PVRR)}}{\text{Expected}<em>\text{(PVRR)} - 5^\text{th}</em>\text{(PVRR)}}$</td>
</tr>
<tr>
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<td>Risk Exposure ($Bn)</td>
<td>95th Percentile (PVRR)</td>
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<tr>
<td>Environmental Stewardship</td>
<td>CO$_2$ (MMTons)</td>
<td>Average Annual Tons of CO$_2$ Emitted During Planning Period</td>
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<tr>
<td></td>
<td>Water Consumption</td>
<td>Average Annual Gallons of Water Consumed During Planning Period</td>
</tr>
<tr>
<td></td>
<td>(Million Gallons)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste (MMTons)</td>
<td>Average Annual Tons of Coal Ash and Scrubber Residue During Planning Period</td>
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<tr>
<td>Flexibility</td>
<td>System Regulating Capability</td>
<td>$\sum (\text{Regulating Reserve} + \text{Demand Response} + \text{Quick Start}) / \text{Peak Load}$</td>
</tr>
<tr>
<td>Valley Economics</td>
<td>Per Capita Income</td>
<td>Percent Difference in Per Capita Personal Income Compared to Reference Case (for each scenario)</td>
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Remaining 2015 IRP Milestones & Stakeholder Sessions

2/26
- Review draft IRP/SEIS; discuss likely sensitivity cases; preview public session content

1/26-27
- Review of scorecards & prelim observations

2015
- SEIS analysis completed
- Draft IRP & SEIS reports posted
- Public comment period (45 days)
- Additional analysis completed
- Final IRP & SEIS reports posted

4/10
- Discuss public comments

5/13-14
- Review of final recommendations

Proposed IRPWG Meetings

Jan  | Feb  | Mar  | Apr  | May  | June | July | Aug |

Public Comment Sessions
- 3/19 Chattanooga
- 4/6 Knoxville
- 4/9 Huntsville
- 4/14 Tupelo
- 4/15 Memphis
- 4/21 Nashville
- 4/22 Bowling Green
TIME FOR QUESTIONS