Tennessee Valley Authority

Regional Energy Resource Council

Chattanooga, Tennessee

February 2 and 3, 2015


welcome

Safety Moment

THE PROMISE WE MAKE TO EACH OTHER

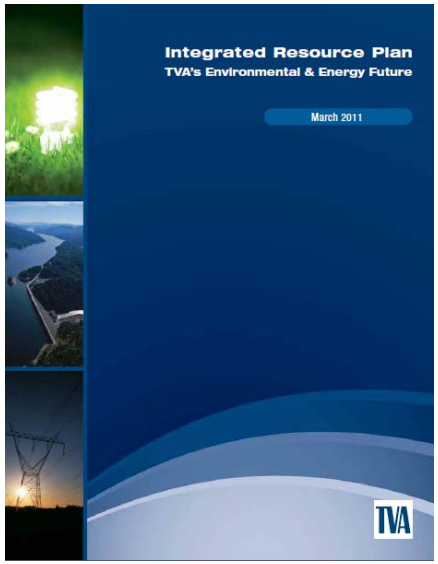
In the unlikely event of a building emergency,

TVA and Hotel Staff will direct you to shelter or exit.

TVA Welcome and Today's Meeting Purpose

February 2015 Meeting Purpose

- Provide update and briefing on preliminary results of the IRP
- Develop advice around the IRP process to date in terms of range of resources studied, depth of analysis, stakeholder involvement and continuing to provide low-cost, reliable power
- Introduce emerging energy policy issues for discussion and future consideration



RERC Meeting Protocols

Agenda

- Agenda prepared and approved by the Designated Federal Officer (DFO) in consultation with Council Chair
- Agenda distributed to Council and published in the Federal Register prior to each meeting
- Topics may be submitted to the DFO by any member of the Council, or non-members, including members of the public

Meeting Minutes

- DFO will ensure that minutes are prepared for each meeting, approved by the Chair, and made available to Council members

Voting

- Any member of the Council may make a motion for a vote
- Recommendations to TVA Board shall require an affirmative vote of at least a simple majority of the total Council members present on that date
- Council members may include minority or dissenting views

Discussion

- DFO (or his designee) will facilitate and ensure good order during all open discussions
- Only one speaker or attendee is permitted to comment at a time
- To be recognized by the Chair (or meeting facilitator) in order to provide comment, please turn your name card on its side

Agenda

Day 1: Monday February 2

10:30	Welcome from Council Chair	Dus Rogers
10:35	Introductions	Council Members
10:40	Safety Moment	Beth Keel
10:45	TVA Welcome	Joe Hoagland
10:55	RERC Protocols	Jo Anne Lavender
11:00	Agenda Review	Lavender
11:05	Environmental Policy Update	Brenda Brickhouse
11:25	October 2015 Meeting Recap	Gary Brinkworth
11:30	IRP Status	Brinkworth
12:00	Lunch	
1:00	Preliminary IRP Results	Tom Rice
1:45	Questions	Lavender / RERC
2:00	IRP Report and Next Steps	Brinkworth
2:30	Break	
2:45	IRP SEIS	Chuck Nicholson
3:05	Preliminary Council Discussion	Lavender / RERC
4:00	Day 1 Closing Comments	Rogers / Hoagland
4:15	Adjourn	

Agenda (Cont'd)

Day 2: Tuesday, February 3

6:45 – 8:00	Systems Operation Center Tour (closed to public)	RERC
8:30	Welcome	Lavender
8:40	TVA Update	Hoagland
9:00	Public Comment Period	
10:00	Break	
10:15	Changing Utility Market Place	Hoagland
10:45	Council Discussion – Changing Utility Market Place	Lavender / RERC
11:00	IRP Recap from Day 1	Brinkworth
11:15	Council Advice	Lavender / RERC
11:55	Closing Comments and Adjourn public portion of meeting	Rogers / Hoagland
12:00	Lunch	
1:30	Operation Center Tour (closed to public)	RERC

RERC Advice Questions

1. *What is your view of TVA's IRP Process to date in terms of:*
   - *Including a broad range of resources that TVA could use to meet its future energy needs*
   - *Depth of analysis*
   - *Stakeholder involvement*
   - *Continuing to provide low-cost, reliable power*

Environmental Policy Update

Brenda Brickhouse

Vice President, Energy & Environmental Policy

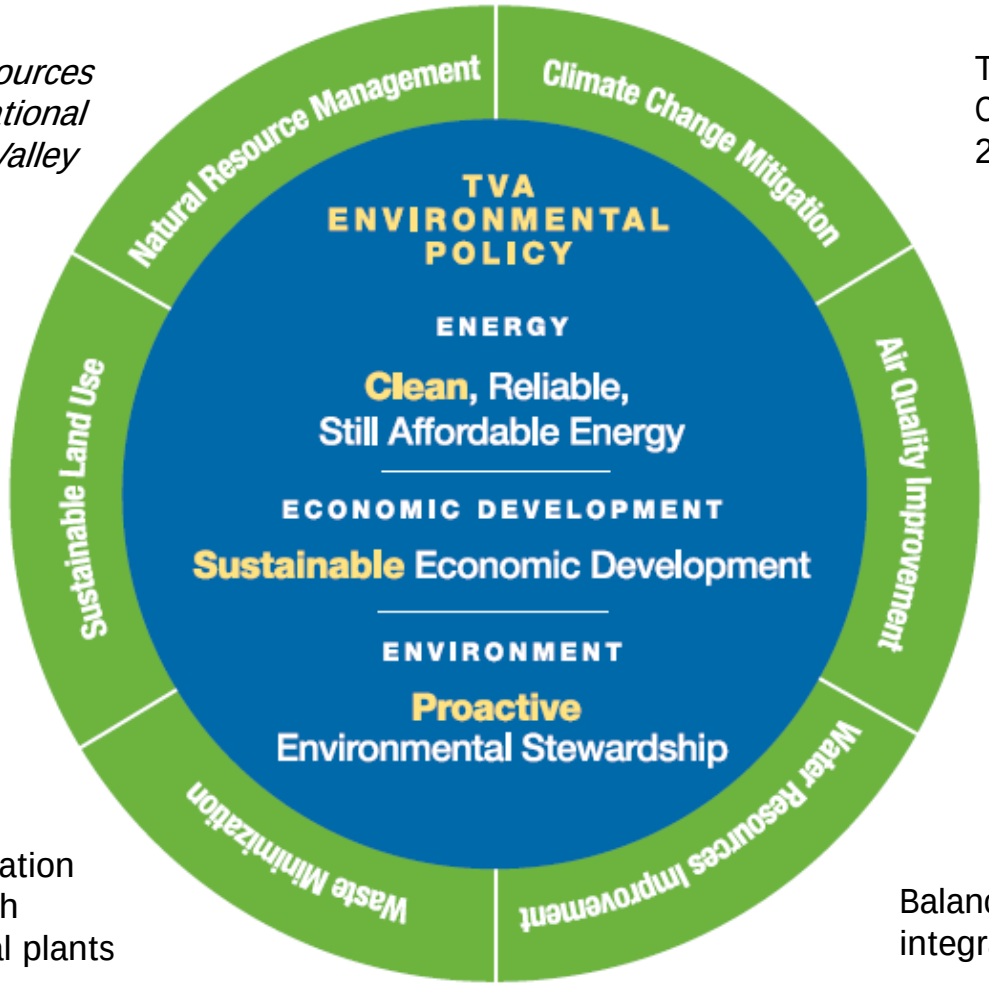
Environmental Policy

TVA Environmental Policy

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

Protecting natural resources while providing recreational opportunities for the Valley

Managing public lands by maintaining environmental health while balancing the need for sustainable development



TVA is projected to reduce CO2 emissions 40% below 2005 levels by 2020

- Emissions are down over 90% from past highs
- TVA's impact on regional air quality has been significantly reduced

- Reduced CCP generation
- Increased dry fly ash management at coal plants
- Kingston Recovery

Balancing the needs of an integrated river system

Key Planning Assumptions

Over the next decade, we will be subject to more stringent regulations requiring exceptional environmental controls and clean energy expectations

- Air
- Waste
- Carbon/Renewables
- Water/Natural Res.

Impacts to Business Planning

Coal Ash: Closure for existing coal ash impoundments → Dry ash conversions, lined landfills & pond closures

Effluent Limitation Guidelines: Wastewater treatment system upgrades and dry fly ash handling → New NPDES Limits, Advanced Wastewater Treatment Systems

316(b) : Regulation of cooling water intakes
* applies to nuclear as well as coal and combined cycle gas → Increased monitoring, new screens and more cooling tower operations

New Endangered Species and Critical Habitats → More constraints & requirements on new projects & operations

GHG Emission Guidelines for Existing Units / Fleets → Restrictive Dispatch, Fleet Planning, Clean Energy Requirements & Accounting

GHG NSPS for New Units → No New Coal

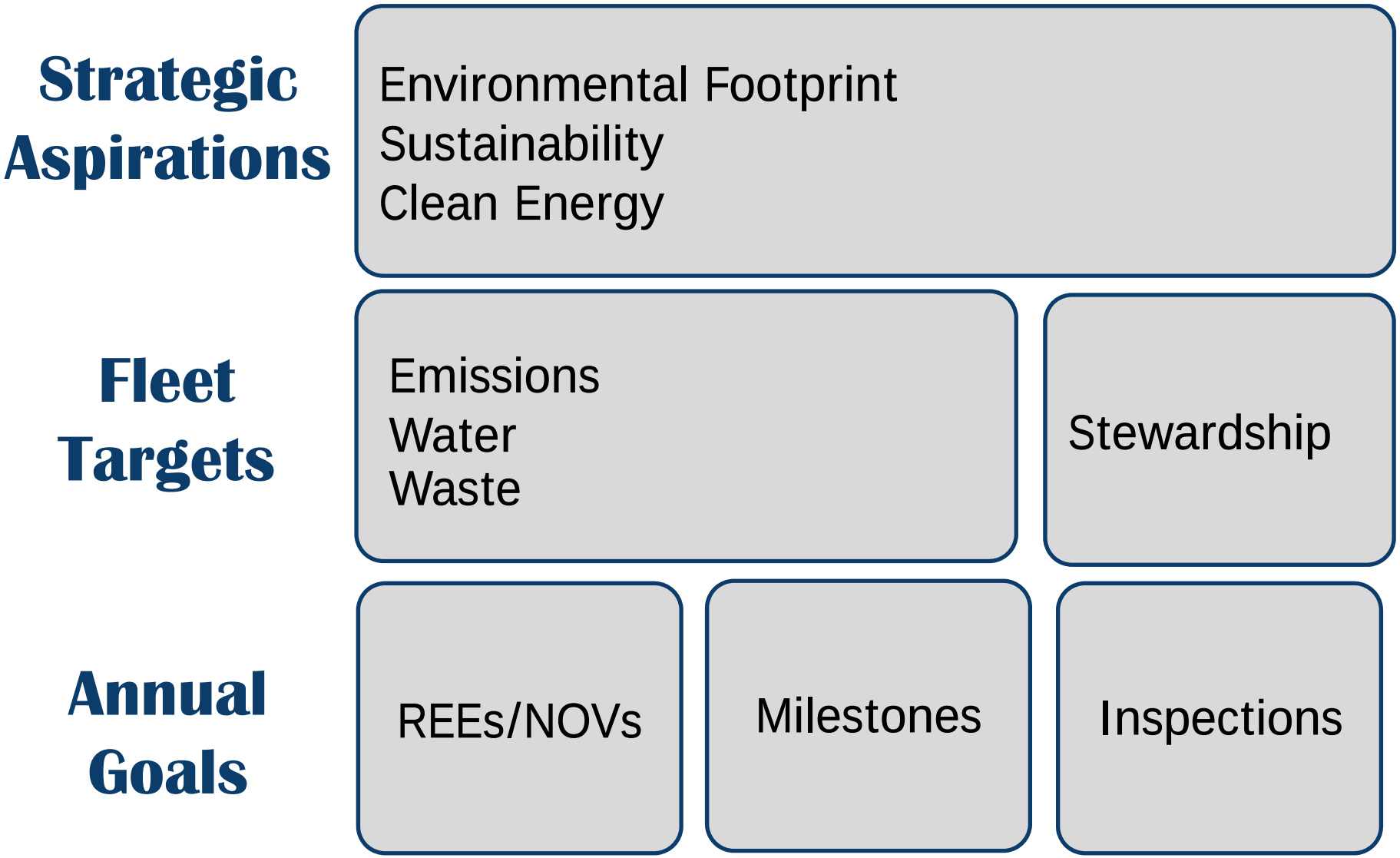
Utility MACT: 1-year extension available for controls or projects → Retire Coal Plants, Maintain/Enhance Controls, More Stringent Limits

CSAPR

NAAQS

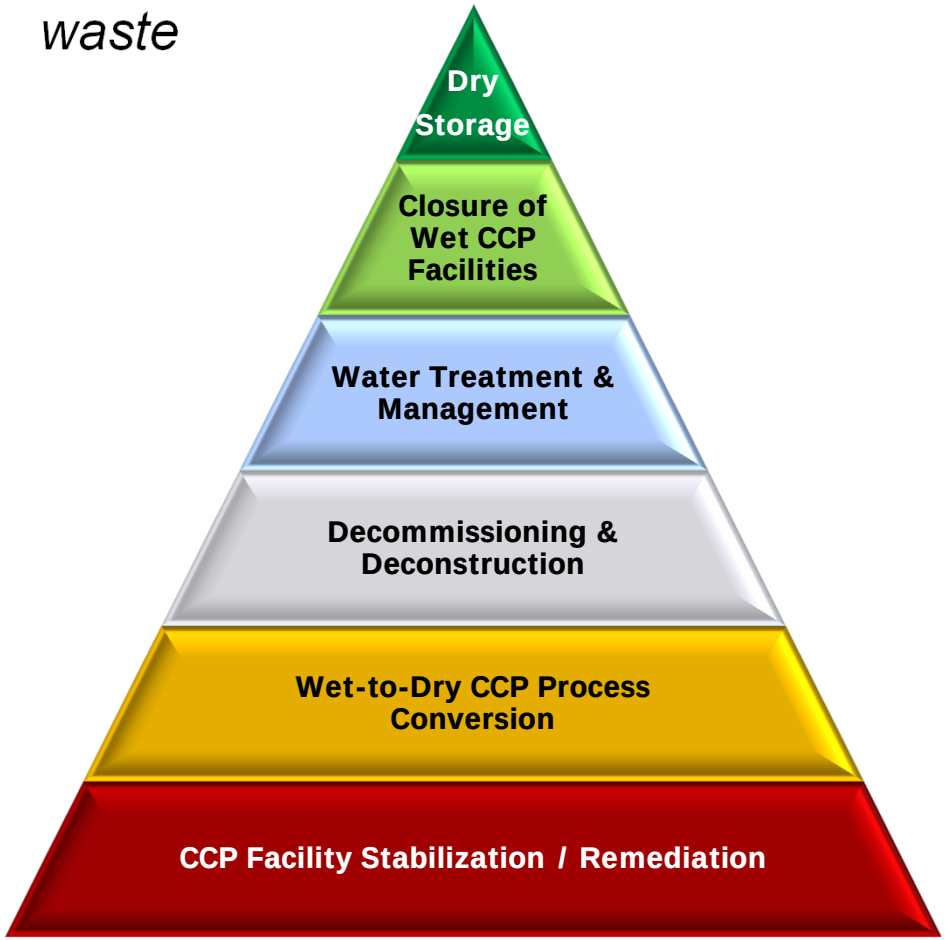
Clean Energy → Renewables, EE, DR, non-emitting sources,

Performance Metrics



Coal Combustion Residuals (CCR)

Applies to new and existing landfills and impoundments regulating CCRs as a Subtitle D – Non-hazardous waste



Existing Facilities

- Operating criteria (inspections, dust control, storm water considerations,)
- Inactive surface impoundments closed w/in 3 years avoid add'l regulations
- Unlined existing facilities must close if contaminating groundwater

New Facilities

- Location restrictions (aquifer, seismic and unstable areas)
- Liner requirements

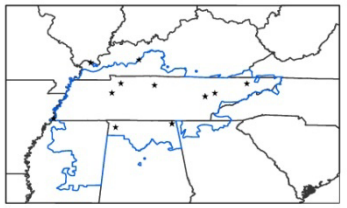
Groundwater

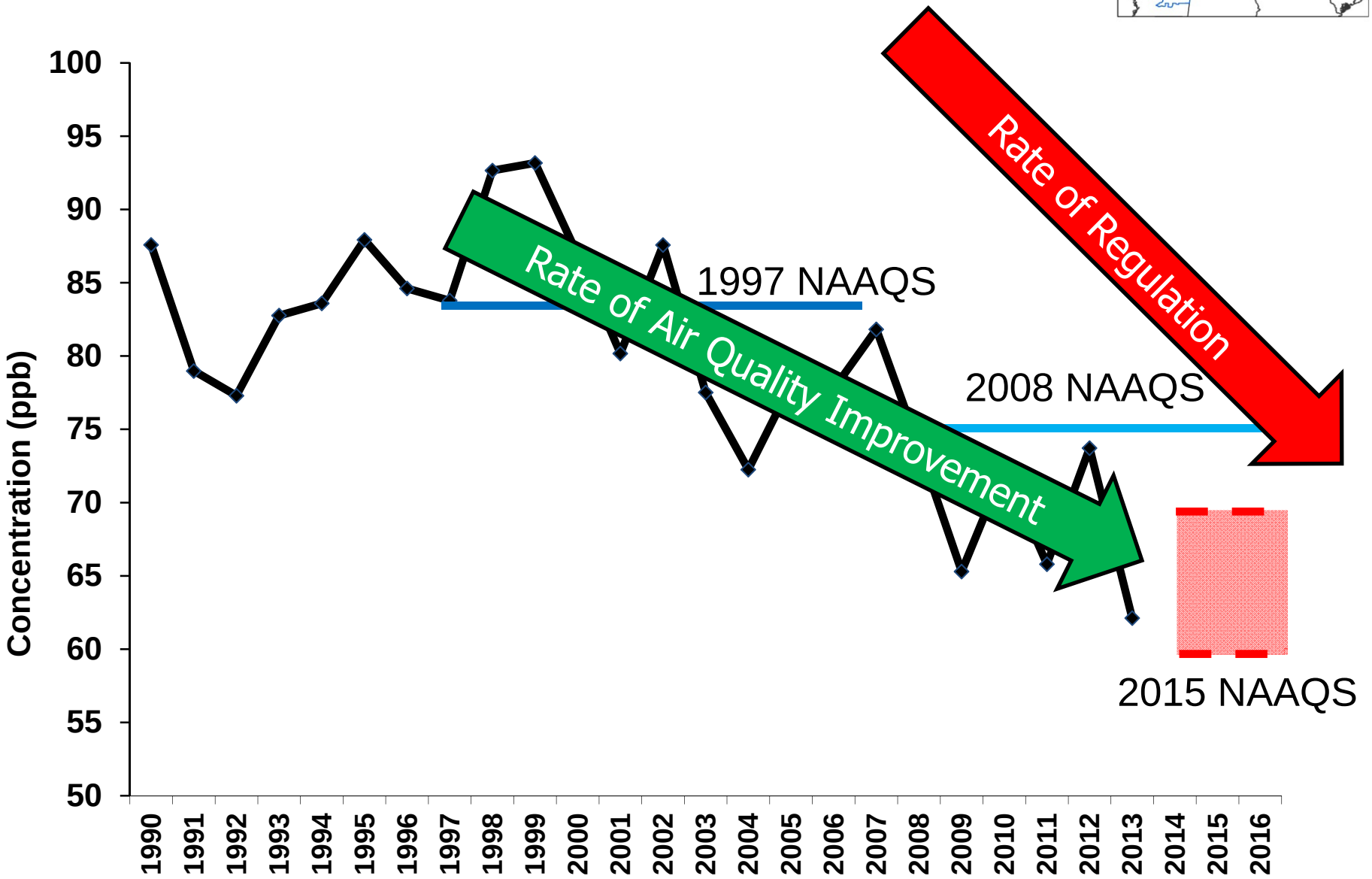
- Monitor all landfills and impoundments
- Requires Assessment and Corrective Actions as needed

Closure

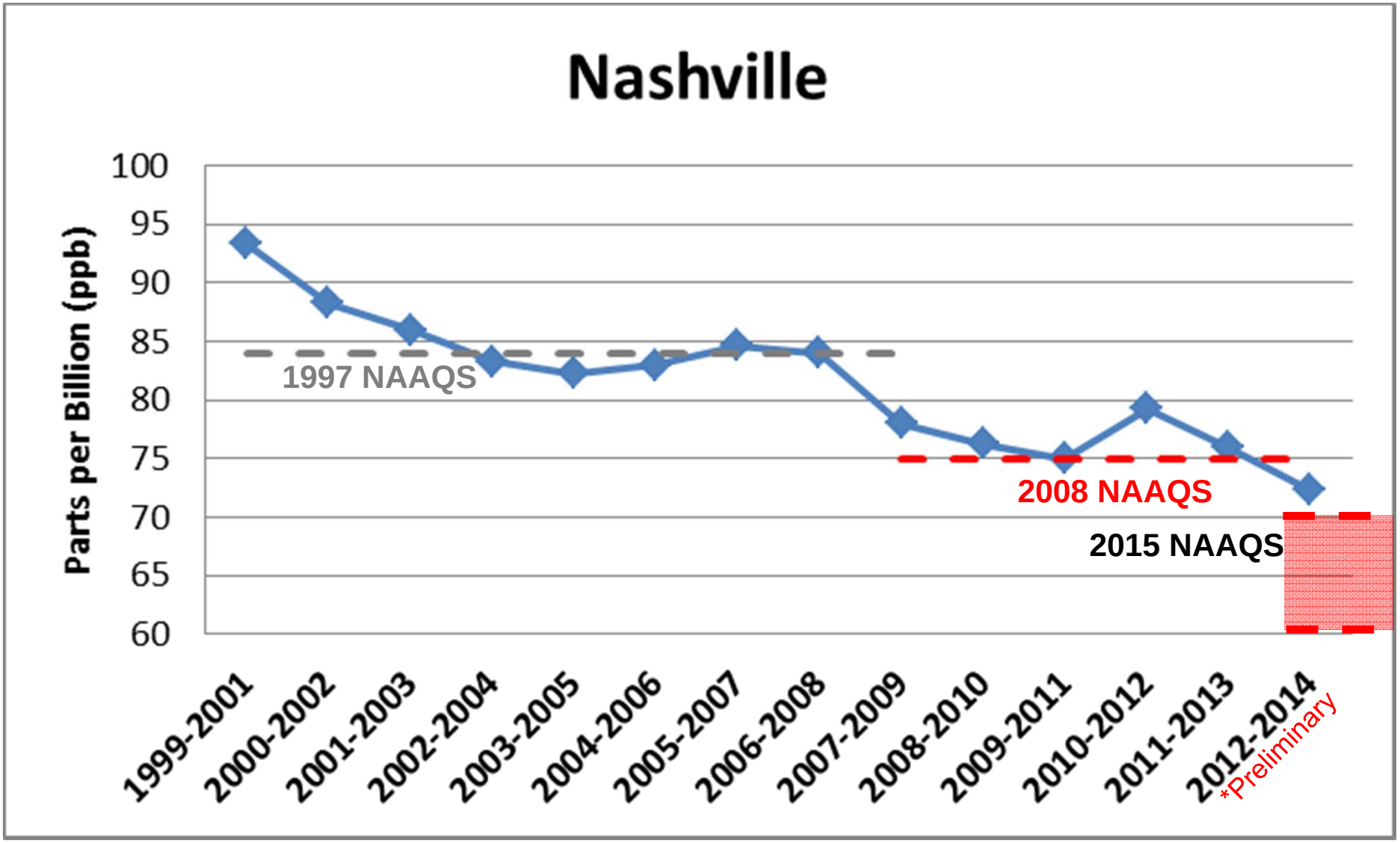
- Specified timeframes and requirements for in-place or removal
- Recordkeeping and notifications

Regional Ozone Concentrations



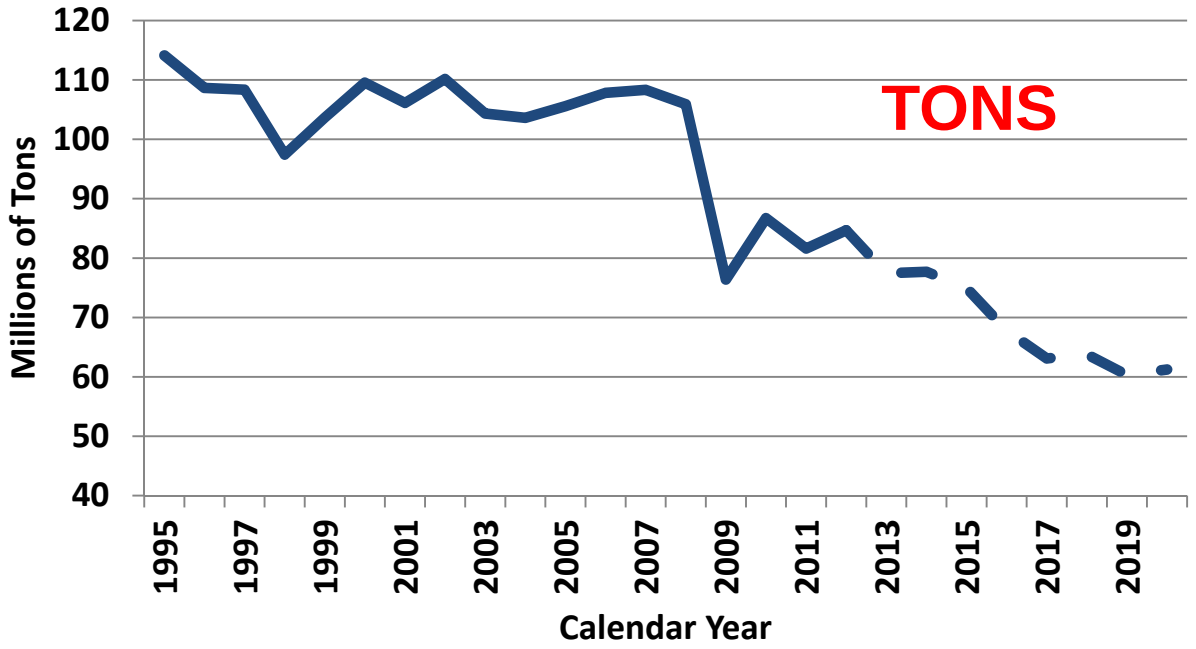


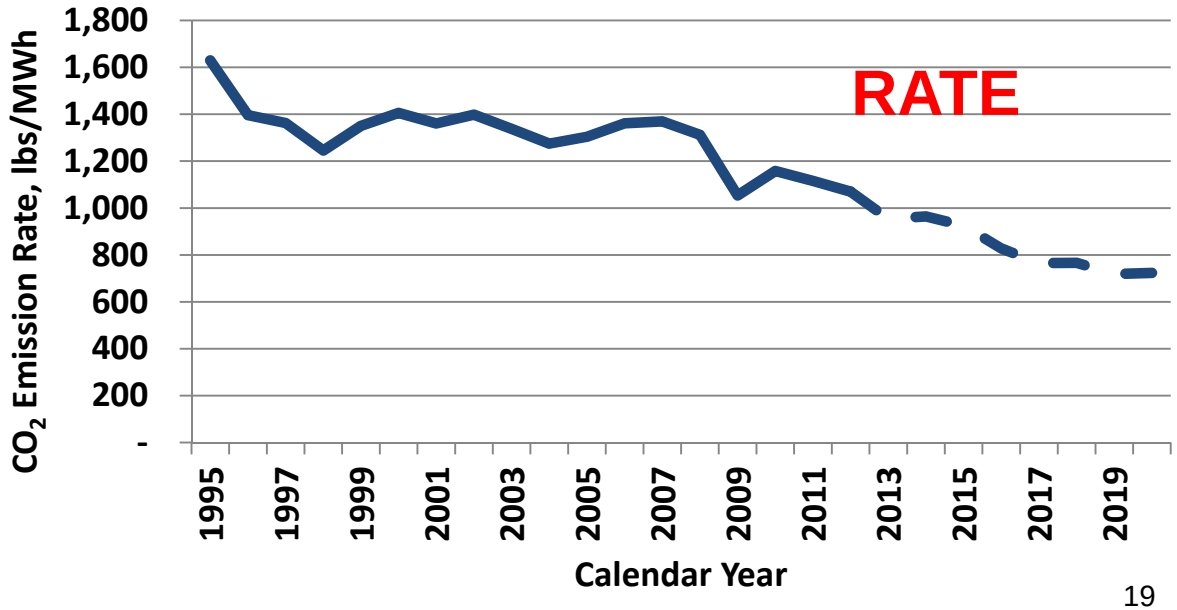
Ozone Trend in Nashville Area



TVA CO_2 Emissions and Progress for our Customers

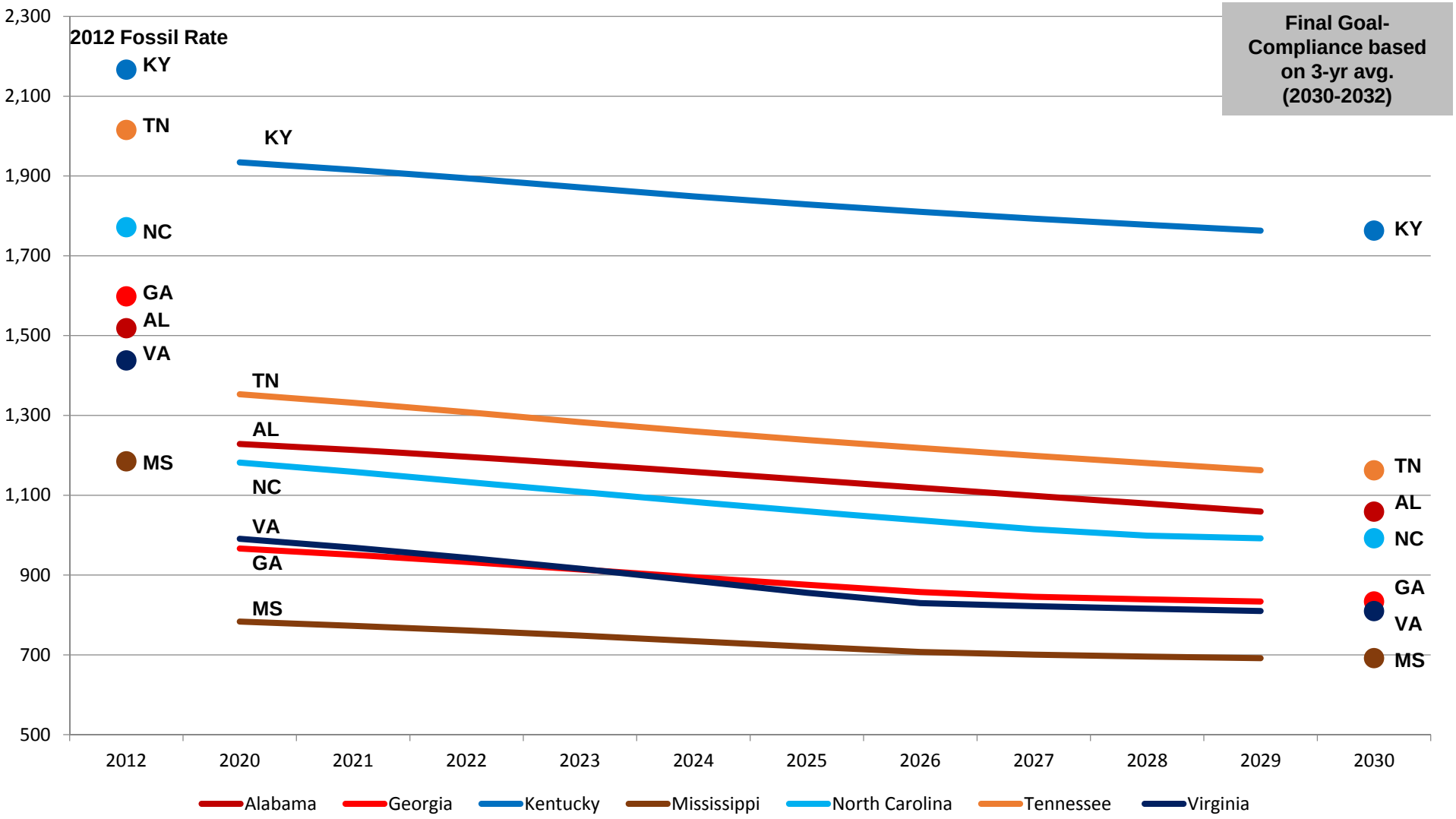
- TVA's asset decisions have reduced CO_2 emissions
- TVA has reduced CO_2 emissions 30% below 2005 levels (stated goal of the Clean Power Plan)
- TVA is projected to reduce CO_2 emissions 40% below 2005 levels by 2020
- TVA delivers electric power containing ~1100 lbs/ MWh and is on track improve that to ~700lbs/MWh by 2020
- TVA provides an attractive combination of price (¢/kWh) and carbon content (lbs/MWh)





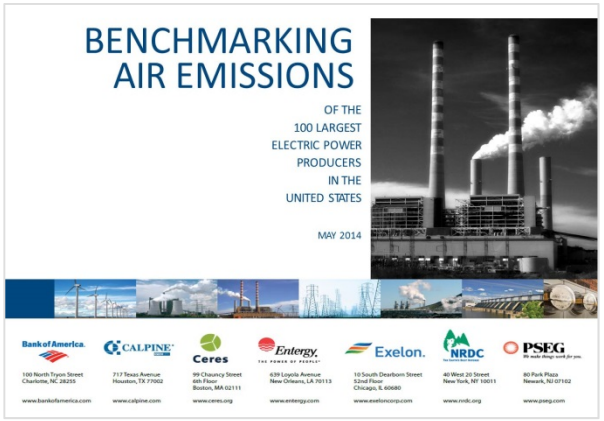
Valley State Proposed Emission Guidelines

111(d) Compliance Rate (lbs/MWh)



THREE CARBON Rates to Benchmark

What the **Media** sees:



What the **customer** sees:

What the **regulator will** see:

+

NGCC CO_2 Emissions Adjusted for Re-dispatch

CO_2 Rate for Clean Power Plan

+

Adjusted NGCC Generation

+

New & "At-Risk" Nuclear Generation

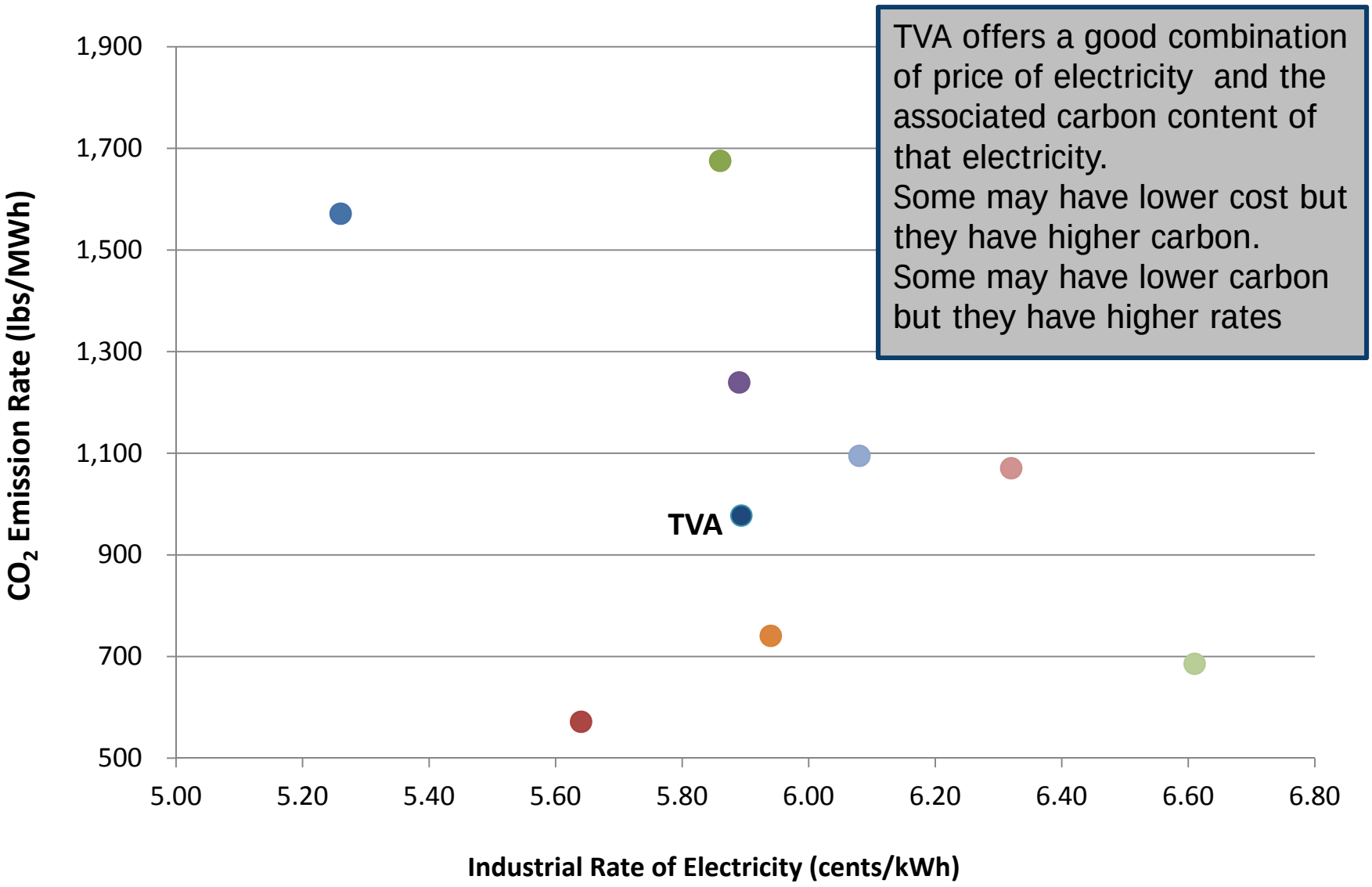
+

Renewable Generation

+

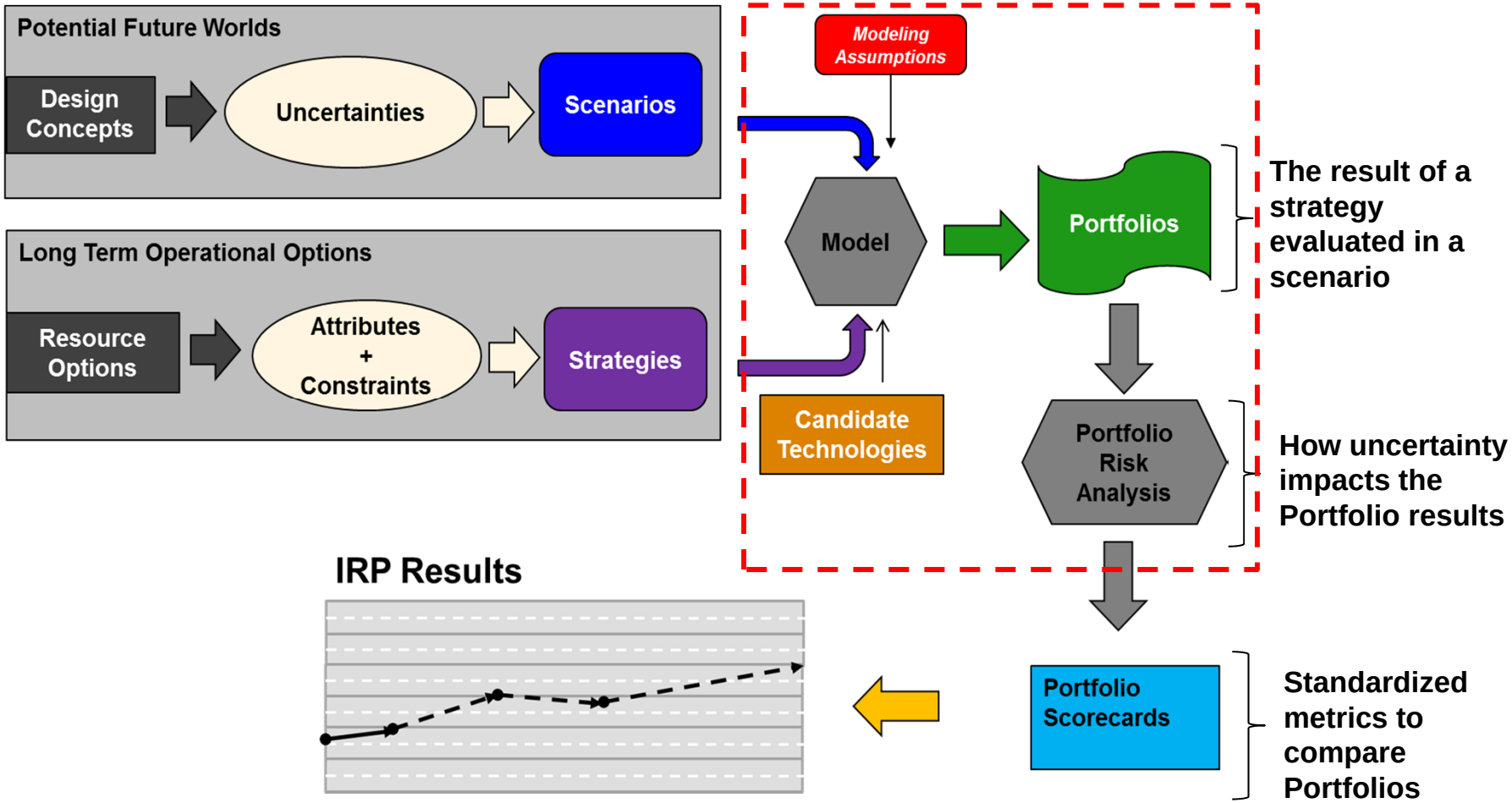
Demand-Side EE

2013 Carbon Performance vs. Industrial Rate of Electricity



Data Sources: U.S. EIA, U.S. EPA CEMS

IRP: Where We Were in the Process



Renewables and EE Resources in the IRP

- In the 2015 IRP study, solar, wind and energy efficiency resources are selectable
  - In the prior IRP, these resources were fixed inputs into the study process

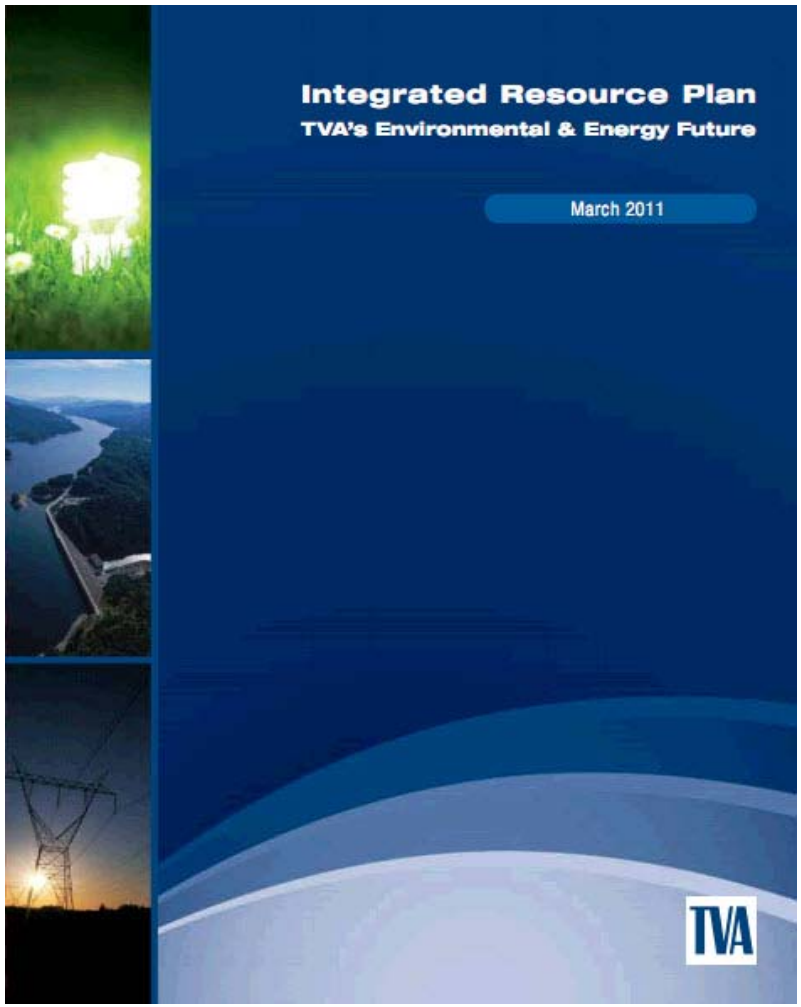
- Now that the optimization model can select these resources, the timing and amount will depend on the need for new resources, the cost of resource alternatives (capital and operating expenses), and the availability/performance of each resource option

- Some of the metrics being considered for the IRP scorecard will allow TVA to assess the risk associated with portfolios that contain a significant penetration of solar, wind, or EE
  - Current modeling architecture requires these 3 resource types to be represented as “fixed energy patterns” to capture the hourly shape of the energy production (or savings)
  - This modeling approach reduces the ability to fully explore the uncertainty around the performance of these resources
  - TVA is continuing to consider other approaches to better include aspects of this uncertainty in the study process

The Basics of Integrated Resource Planning

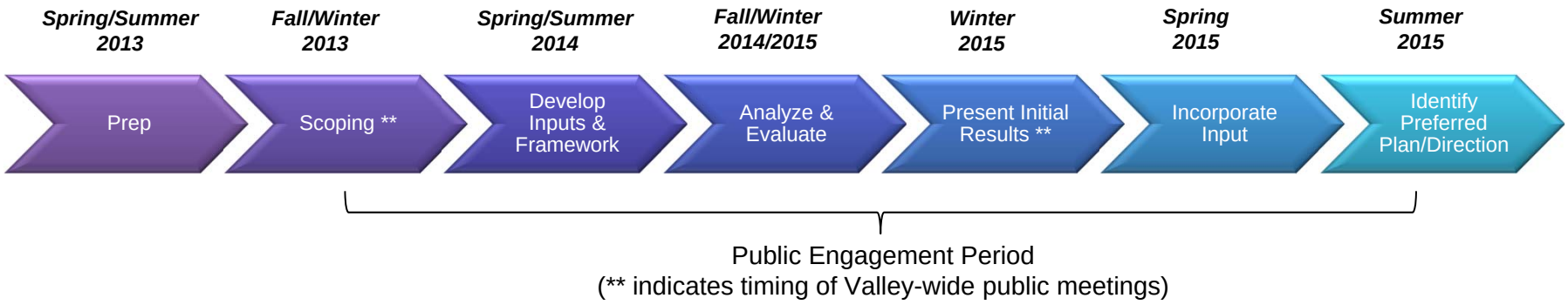
A “Good” Integrated Resource Plan Will:

- Guide power system planning without overly constraining options
- Seek to minimize total costs to customers
- Allow for flexible and proactive responses to changes in key drivers
- Keep environmental impacts to a minimum



2015 IRP/SEIS 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

Scenarios and Strategies

Scenarios	
1 - Current Outlook **2033:189 TWh**	• Current outlook for the future TVA is using for resource planning studies
2 - Stagnant Economy **2033: 180 TWh**	• Stagnant economy results in flat to negative growth, delaying the need for new generation
3 - Growth Economy **2033: 197 TWh**	• Rapid economic growth translates into higher than forecasted energy sales and resource expansion
4 - De-Carbonized Future **2033: 172 TWh**	• 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 **2033: 156 TWh**	• 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	
X - Baseline Case	• Legislatively mandated, traditional least cost optimization, **EE/Renewables scheduled**
A - The Reference Plan	• Legislatively mandated, traditional least cost optimization, **EE/Renewables optimized**
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 – Focus on Long-Term, Market-Supplied Resources ***(formerly Lean on the Market)***	• Most new capacity needs met using longer-term PPA or other bilateral arrangements • TVA makes a minimal investment in owned assets
D – Maximize Energy Efficiency ***(formerly Doing More EE)***	• 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
E – Maximize Renewables ***(formerly Focusing on Renewables)***	• 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

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

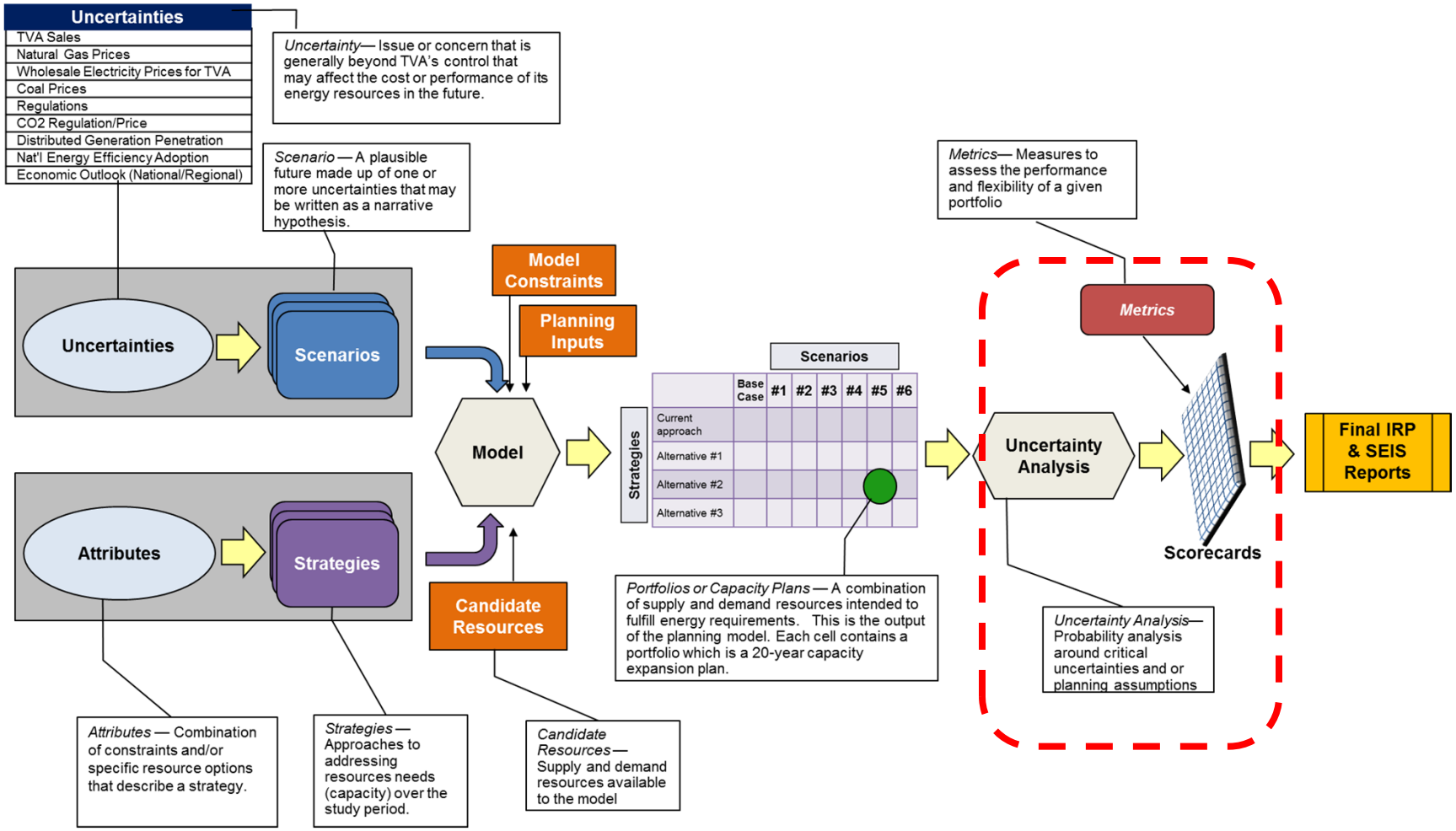
SOLAR ***
- Utility-scale one-axis tracking photovoltaic
- Utility-scale fixed-axis photovoltaic
- Commercial-scale large photovoltaic
- Commercial-scale small photovoltaic

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*
*** Developing new methodology*
**** Collaborative effort with stakeholders*

The Modeling Process



Major Assumptions in the 2015 IRP

- **Scenario planning approach (also used in the 2011 study) includes:**
  - 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

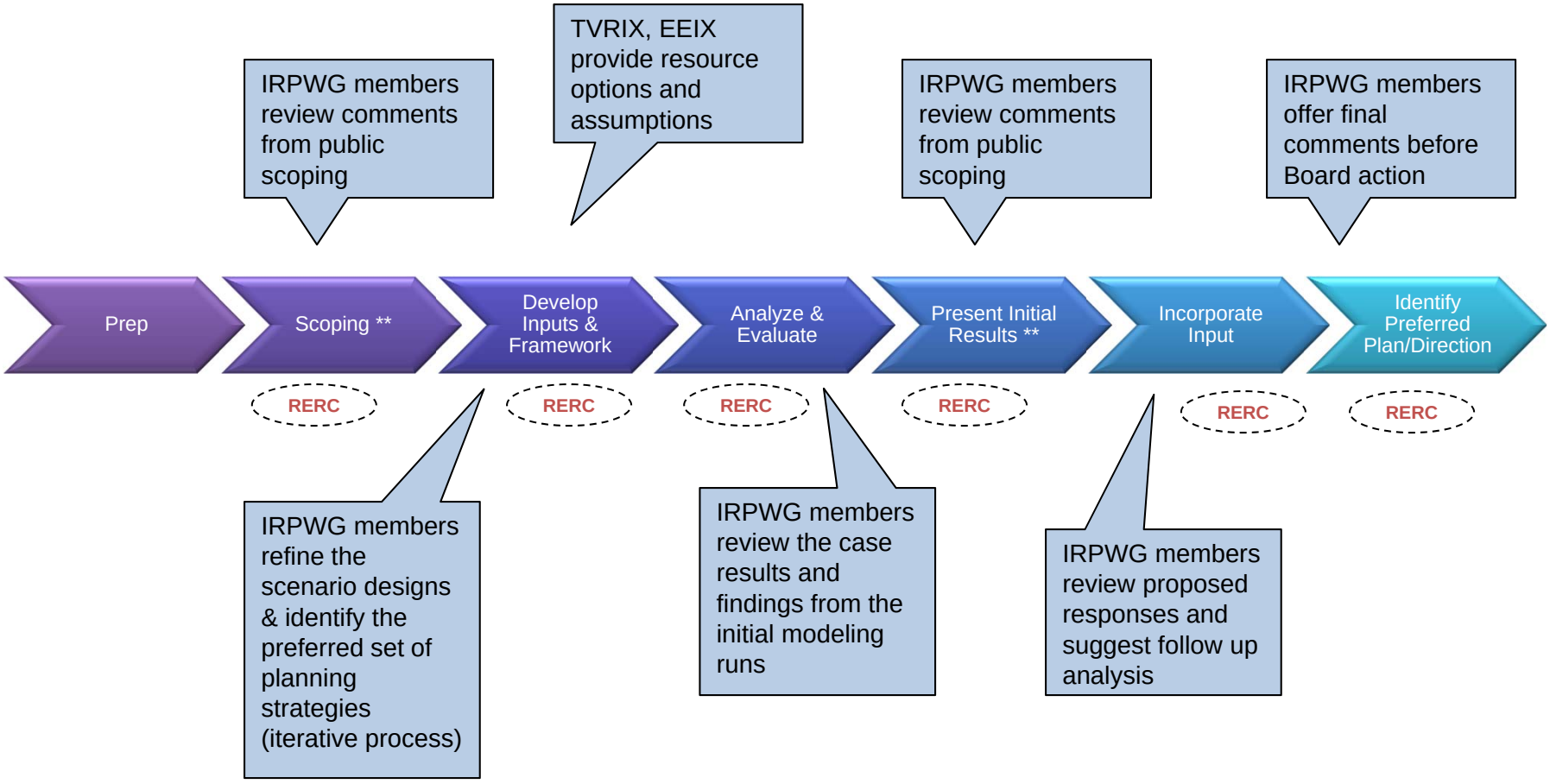
- **Solar, wind, EE & DR treated as selectable resource options in the models**
  - In the 2011 IRP, these options were developed separately and loaded into the model

Rigorous Analytical Approach

- The IRP study uses three phases to ensure a comprehensive evaluation of alternative resource plans
  - Scenario Analysis uses multiple plausible futures as framework for testing planning strategies (resource plan optimization)
  - Uncertainty Analysis re-evaluates these resource plans by applying random variation in key input variables (loads, fuel prices, capital costs, etc)
  - Sensitivity Analysis tests the robustness of the findings by modifying key assumptions to better understand how significant those assumptions might be (like declining capital costs for solar)
- Metrics based on the modeling results in each of these phases are included on the scorecards and dashboard used to assess overall performance of a given planning strategy

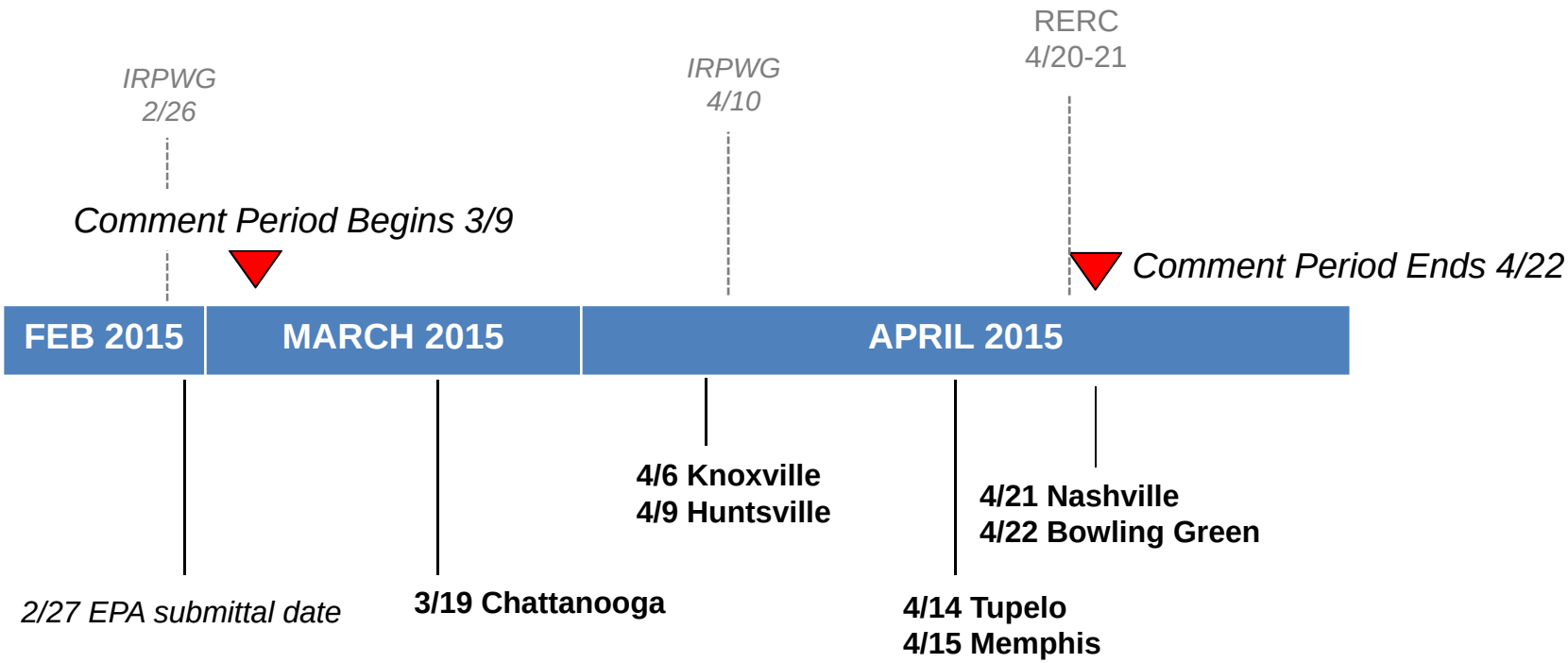
In the 2015 IRP, scenario analysis has been conducted on 5 planning strategies in 5 different scenarios, resulting in 25 unique optimized resource plans. Uncertainty analysis solves for 72 random draws around each of these plans, resulting in a total of 1,800 cases. Sensitivity analysis is ongoing.

2015 IRP Formal Stakeholder Engagement Schedule



In addition to this formal stakeholder engagement schedule, the IRP process includes several opportunities for general stakeholder input via quarterly public briefings, website posting, and the public comment period

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
- Both the IRWG session on April 10th and the RERC session on April 20-21 will focus on the comments received and TVA's strategy in developing appropriate responses

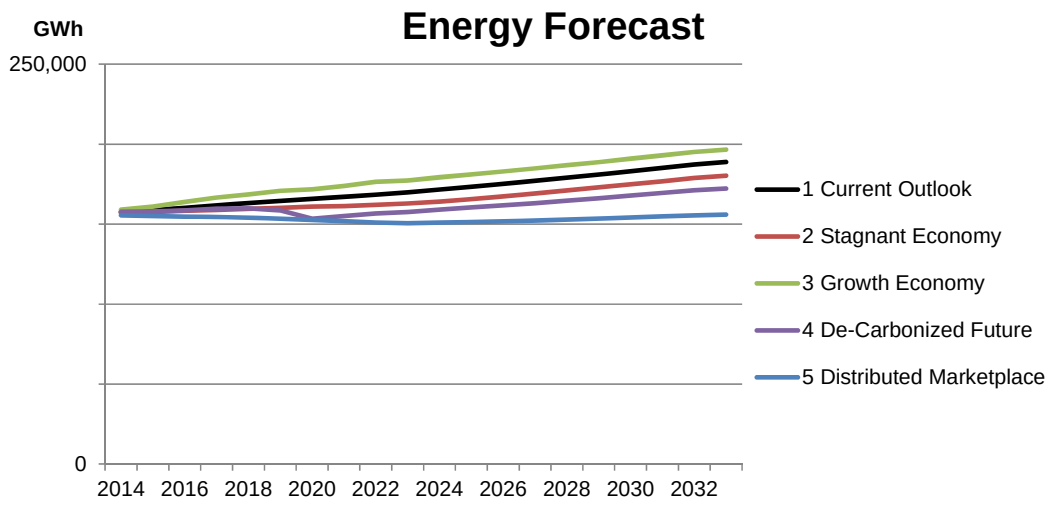
Integrated Resource Plan Update

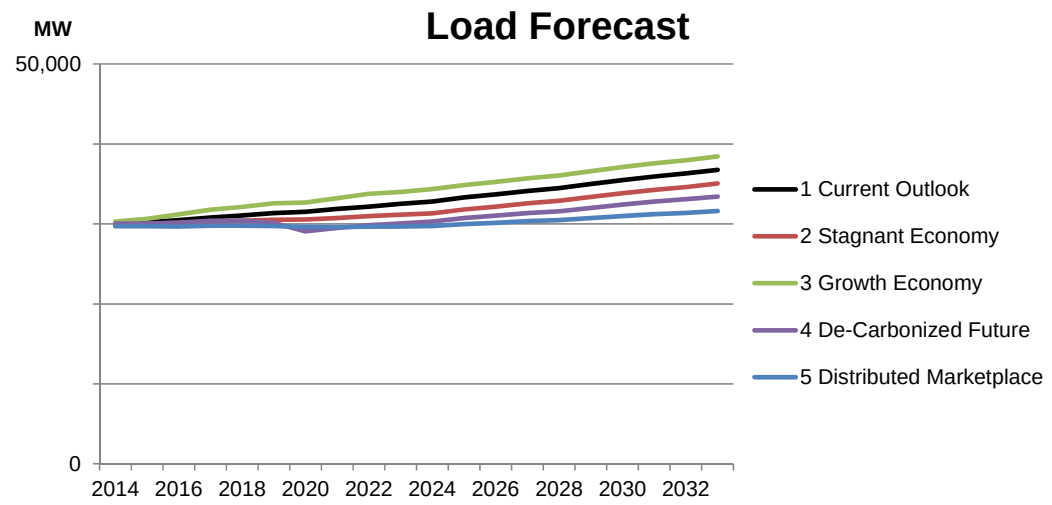
Tom Rice

TVA Enterprise Planning

Key Assumptions: Load Growth

- Current Outlook projects energy growth of approximately 1.0%/year
- Three scenarios project lower load growth than current outlook:
  - Stagnant economy
  - De-carbonized future
  - Distributed marketplace
- Scenario 3 models a modest growth scenario

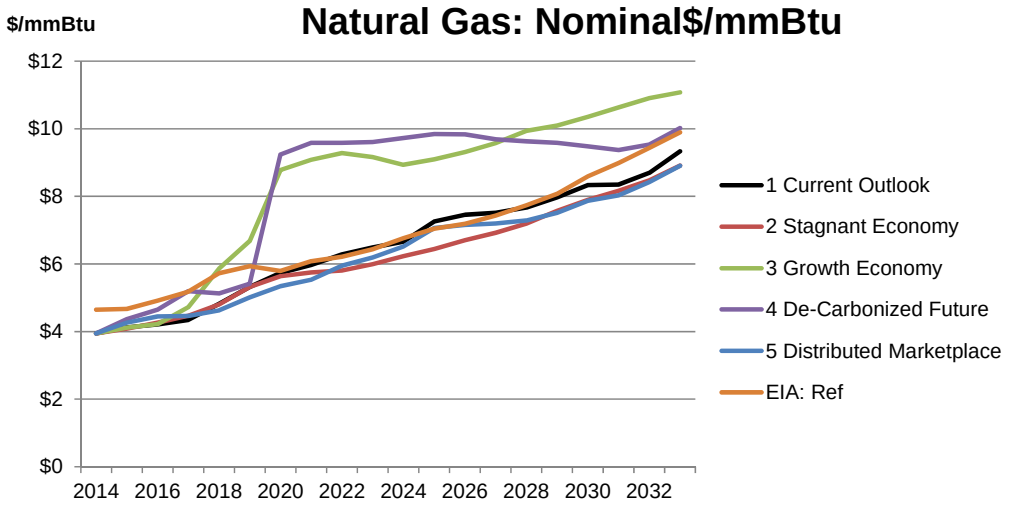




Key Assumptions: Natural Gas Price

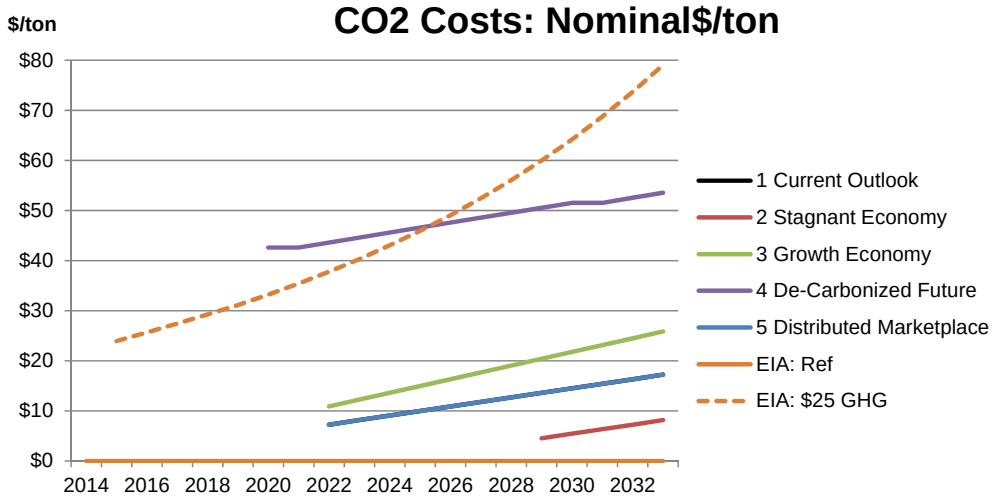
Natural Gas

- Gas prices range from $4/mmBtu - $9/mmBtu for scenarios 1, 2, and 5 (nominal)
- The highest prices are seen in the De-carbonized and Growth Economy scenarios



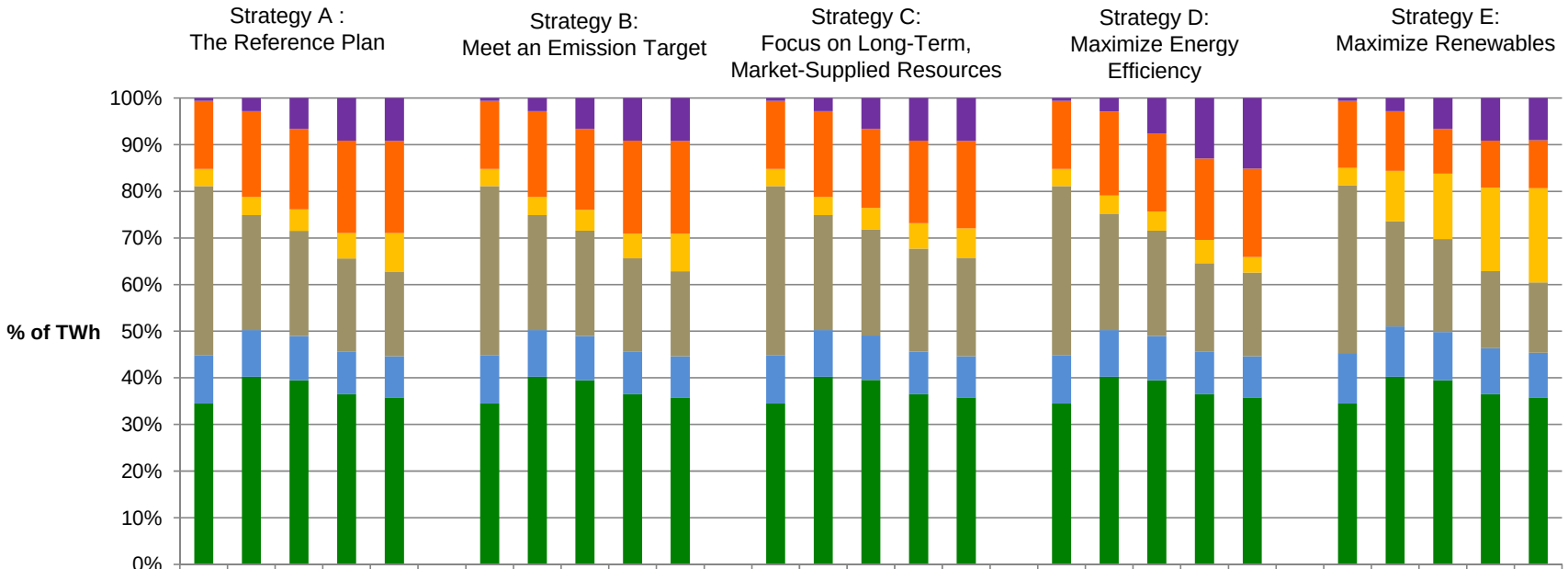
Carbon

- All scenarios forecast a more stringent regulatory future
- The highest CO2 prices are seen in the De-carbonized Future scenario where carbon penalties start at ~$40/ton in 2020 and increase to ~$60/ton
- Scenario 2 has the lowest CO2 penalty that does not start until 2029; scenario 1 and 5 share the same CO2 price assumptions



Resource Selection Results by Scenario

Scenario 1: Current Outlook

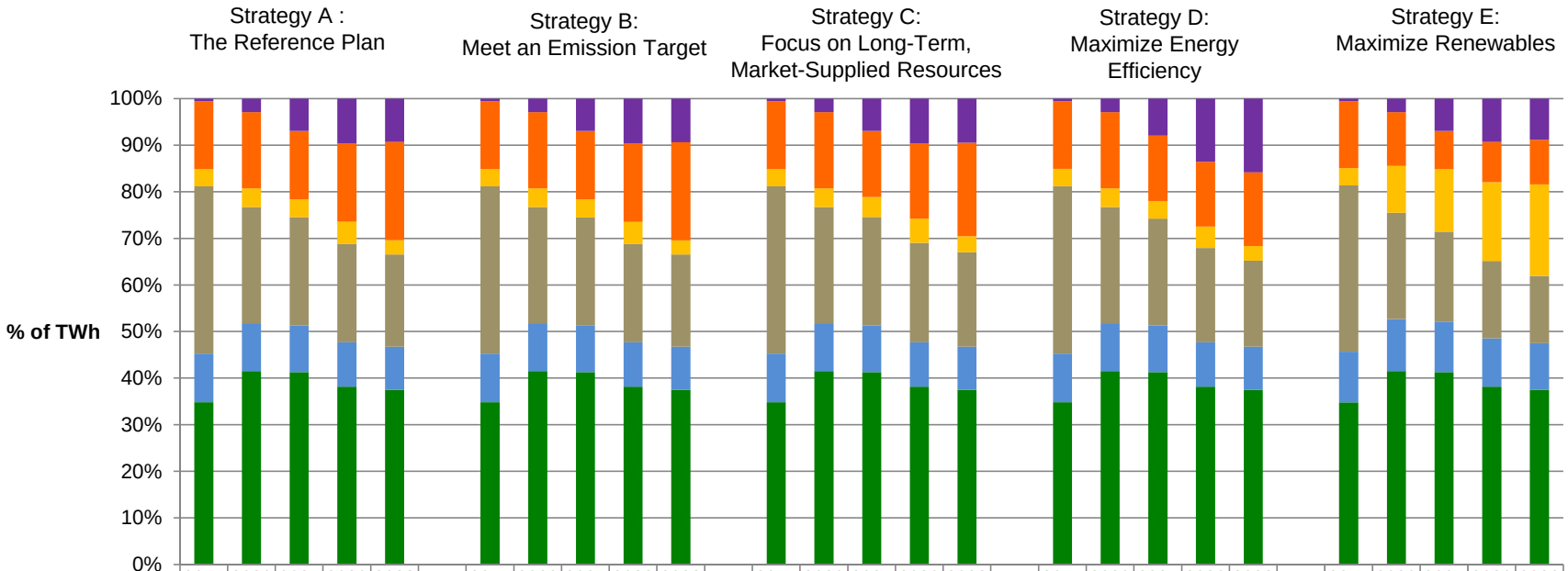


	Strategy A : The Reference Plan					Strategy B: Meet an Emission Target					Strategy C: Focus on Long-Term, Market-Supplied Resources					Strategy D: Maximize Energy Efficiency					Strategy E: Maximize Renewables				
	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033
EEDR	1%	3%	7%	9%	9%	1%	3%	7%	9%	9%	1%	3%	7%	9%	9%	1%	3%	8%	13%	15%	1%	3%	7%	9%	9%
Gas	15%	18%	17%	20%	20%	15%	18%	17%	20%	20%	15%	18%	17%	18%	19%	15%	18%	17%	17%	19%	14%	13%	10%	10%	10%
Renewables	4%	4%	5%	5%	8%	4%	4%	4%	5%	8%	4%	4%	5%	5%	6%	4%	4%	4%	5%	3%	4%	11%	14%	18%	20%
Coal	36%	25%	23%	20%	18%	36%	25%	23%	20%	18%	36%	25%	23%	22%	21%	36%	25%	23%	19%	18%	36%	23%	20%	16%	15%
Hydro	10%	10%	10%	9%	9%	10%	10%	10%	9%	9%	10%	10%	10%	9%	9%	10%	10%	10%	9%	9%	11%	11%	10%	10%	10%
Nuclear	35%	40%	39%	36%	36%	35%	40%	39%	36%	36%	35%	40%	40%	36%	36%	35%	40%	39%	36%	36%	35%	40%	39%	36%	36%

Scenario 1: Current Outlook

- Baseload resources: no new builds beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Renewables: solar selections in mid-2020s; HVDC wind selected at the end of the planning horizon
- Gas Peaking: Combustion turbines added in 2020s to meet capacity and peak energy needs
- Gas Intermediate: market purchases of combined cycle assets continue in many cases, but increased energy efficiency and renewable generation displace some future combined-cycle gas additions
- Energy Efficiency: By 2033, about 2,800 MW of additional energy efficiency is selected in most cases. The highest selection is in the “Maximize EE” strategy which selects over 4,600 MWs by 2033.
- Demand Response: approximately 500-600 MW of additional DR by 2033 in many cases
- By 2033, 60% - 75% of energy is from non-emitting sources across scenario 1

Scenario 2: Stagnant Economy

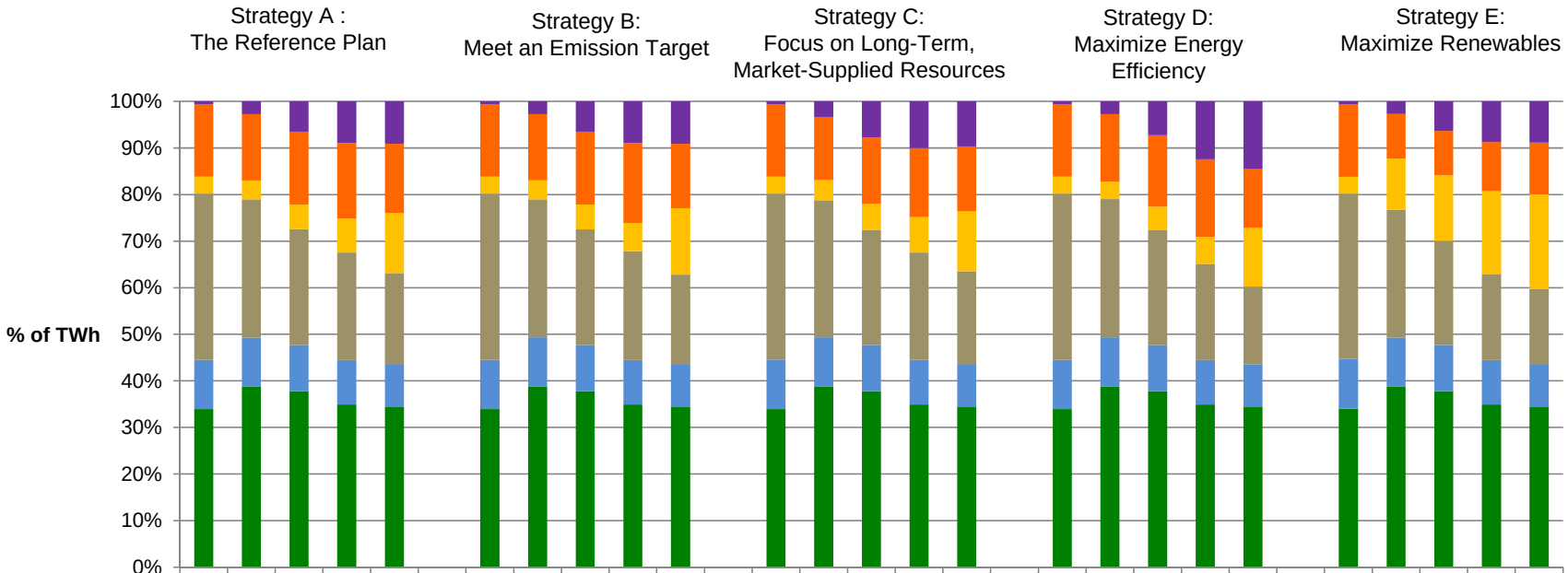


	Strategy A : The Reference Plan					Strategy B: Meet an Emission Target					Strategy C: Focus on Long-Term, Market-Supplied Resources					Strategy D: Maximize Energy Efficiency					Strategy E: Maximize Renewables				
	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033	2015	2020	2025	2030	2033
EEDR	1%	3%	7%	10%	9%	1%	3%	7%	10%	9%	1%	3%	7%	10%	9%	1%	3%	8%	14%	16%	1%	3%	7%	9%	9%
Gas	15%	16%	15%	17%	21%	15%	16%	15%	17%	21%	15%	16%	14%	16%	20%	15%	16%	14%	14%	16%	14%	12%	8%	9%	10%
Renewables	4%	4%	4%	5%	3%	4%	4%	4%	5%	3%	4%	4%	4%	5%	3%	4%	4%	4%	5%	3%	4%	10%	13%	17%	20%
Coal	36%	25%	23%	21%	20%	36%	25%	23%	21%	20%	36%	25%	23%	21%	20%	36%	25%	23%	20%	19%	36%	23%	19%	17%	14%
Hydro	10%	10%	10%	10%	9%	10%	10%	10%	10%	9%	10%	10%	10%	10%	9%	10%	10%	10%	10%	9%	11%	11%	11%	10%	10%
Nuclear	35%	42%	41%	38%	37%	35%	42%	41%	38%	37%	35%	42%	41%	38%	37%	35%	42%	41%	38%	37%	35%	42%	41%	38%	37%

Scenario 2: Stagnant Economy

- Baseload resources: no new builds beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Renewables:
    - Solar selections remain, but at lower level than Scenario 1
    - No HVDC wind in several strategies (A, B, C)
- Gas Peaking: fewer CTs added than Scenario 1, but peaking resources still needed
- Gas Combined-Cycle: fewer additional CCs than Scenario 1. Extension of market CC transactions selected in many cases
- Energy Efficiency:
    - Slightly lower EE volumes than Scenario 1, driven by lower loads
    - By 2033, about 2,600 MW of additional energy efficiency is selected in most cases
- Demand Response: Approximately 500-600 MW of additional DR by 2033 in many cases

Scenario 3: Growth Economy



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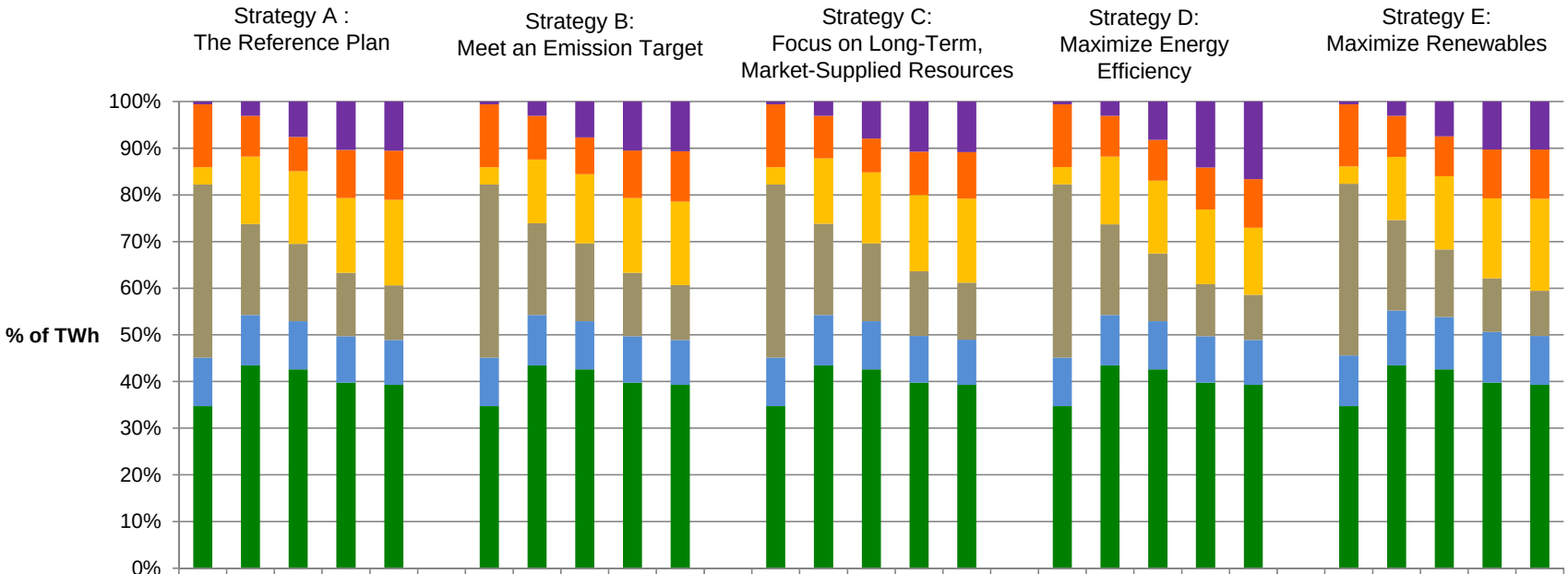
EEDR	1%	3%	7%	9%	9%	1%	3%	7%	9%	9%	1%	3%	8%	10%	10%	1%	3%	7%	12%	15%	1%	3%	6%	9%	9%
Gas	16%	14%	16%	16%	15%	16%	14%	16%	17%	14%	16%	14%	14%	15%	14%	16%	14%	15%	17%	13%	16%	10%	10%	11%	11%
Renewables	4%	4%	5%	7%	13%	4%	4%	5%	6%	14%	4%	4%	6%	8%	13%	4%	4%	5%	6%	13%	4%	11%	14%	18%	20%
Coal	36%	30%	25%	23%	20%	36%	30%	25%	23%	19%	36%	29%	25%	23%	20%	36%	30%	25%	21%	17%	35%	27%	22%	18%	16%
Hydro	11%	11%	10%	10%	9%	11%	11%	10%	10%	9%	11%	11%	10%	10%	9%	11%	11%	10%	10%	9%	11%	10%	10%	10%	9%
Nuclear	34%	39%	38%	35%	34%	34%	39%	38%	35%	34%	34%	39%	38%	35%	34%	34%	39%	38%	35%	34%	34%	39%	38%	35%	34%

Scenario 3: Growth Economy

- Baseload resources: no new builds beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Renewables: significantly higher renewable selections than Scenario 1, driven by higher solar availability. HVDC is a bit sooner and other wind assets (MISO) are selected in a few cases.
- Gas Peaking: additional CTs are selected and are added sooner than Scenario 1
- Gas Combined-Cycle: extension of market CC transactions selected in many cases
- Energy Efficiency:
    - Slightly higher EE volumes than Scenario 1, driven by higher loads
    - By 2033, about 2,800 – 3,000 MW of additional energy efficiency is selected in most cases except in Strategy D which has up to 4,800 MW
- Demand Response: up to 600 MW of additional DR by 2033 in many cases

Scenario 4: Decarbonized Future



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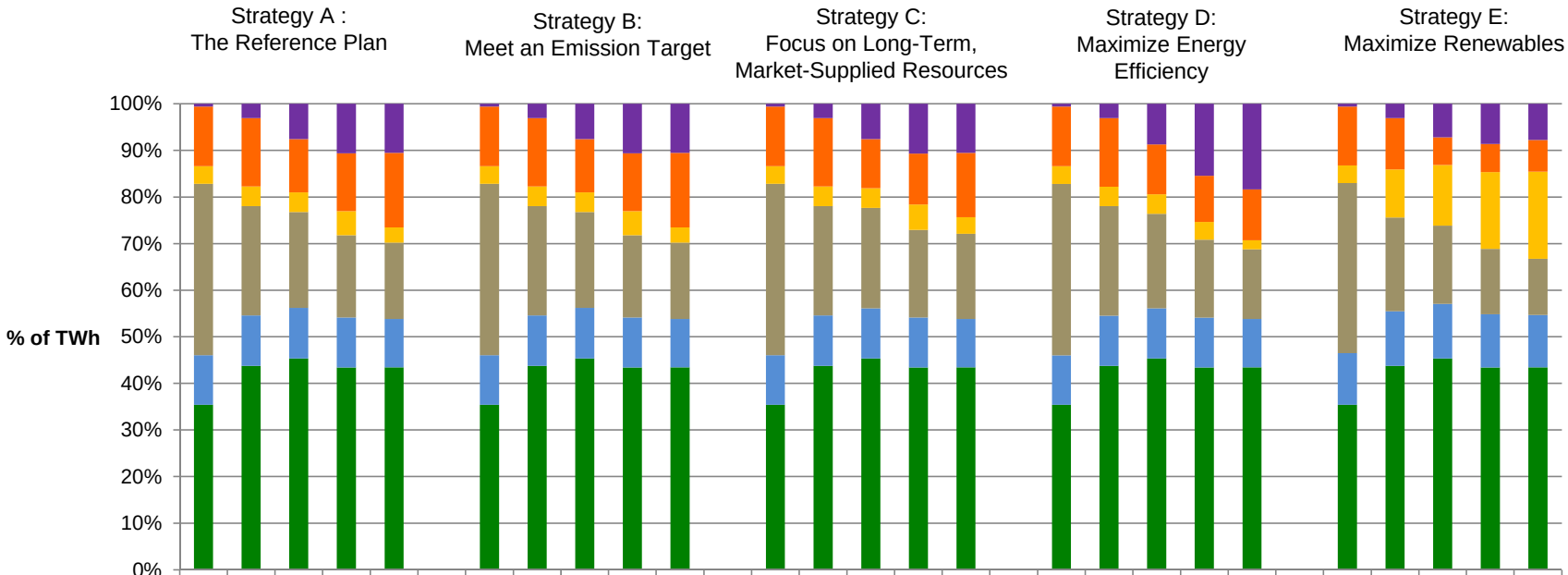
EEDR	1%	3%	8%	10%	11%	1%	3%	8%	10%	11%	1%	3%	8%	11%	11%	1%	3%	8%	14%	17%	1%	3%	7%	10%	10%
Gas	14%	9%	7%	10%	11%	14%	9%	8%	10%	11%	14%	9%	7%	9%	10%	13%	9%	9%	9%	10%	13%	9%	9%	10%	11%
Renewables	4%	14%	16%	16%	18%	4%	14%	15%	16%	18%	4%	14%	15%	16%	18%	4%	14%	16%	16%	14%	4%	14%	16%	17%	20%
Coal	37%	19%	17%	14%	12%	37%	20%	17%	14%	12%	37%	20%	17%	14%	12%	37%	19%	15%	11%	10%	37%	19%	14%	12%	10%
Hydro	10%	11%	10%	10%	10%	10%	11%	10%	10%	10%	10%	11%	10%	10%	10%	10%	11%	10%	10%	10%	11%	12%	11%	11%	10%
Nuclear	35%	43%	43%	40%	39%	35%	43%	43%	40%	39%	35%	43%	43%	40%	39%	35%	43%	43%	40%	39%	35%	43%	43%	40%	39%

Scenario 4: Decarbonized Future

- Baseload resources: no new builds beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Additional fossil units retired driven by carbon penalty and lower loads. Higher EE and Renewables targets (Strategies D and E) force additional retirements
- Renewables: significantly higher renewable selections than Scenario 1 driven by carbon penalties and gas prices
- Gas Peaking: significantly fewer CTs built
- Gas Combined-Cycle: no additional CCs built beyond Allen and Paradise but market purchases of gas assets are selected
- Energy Efficiency: slightly higher EE volumes than Scenario 1
- Demand Response: up to 600 MW of additional DR by 2033 in many cases

Scenario 5: Distributed Marketplace



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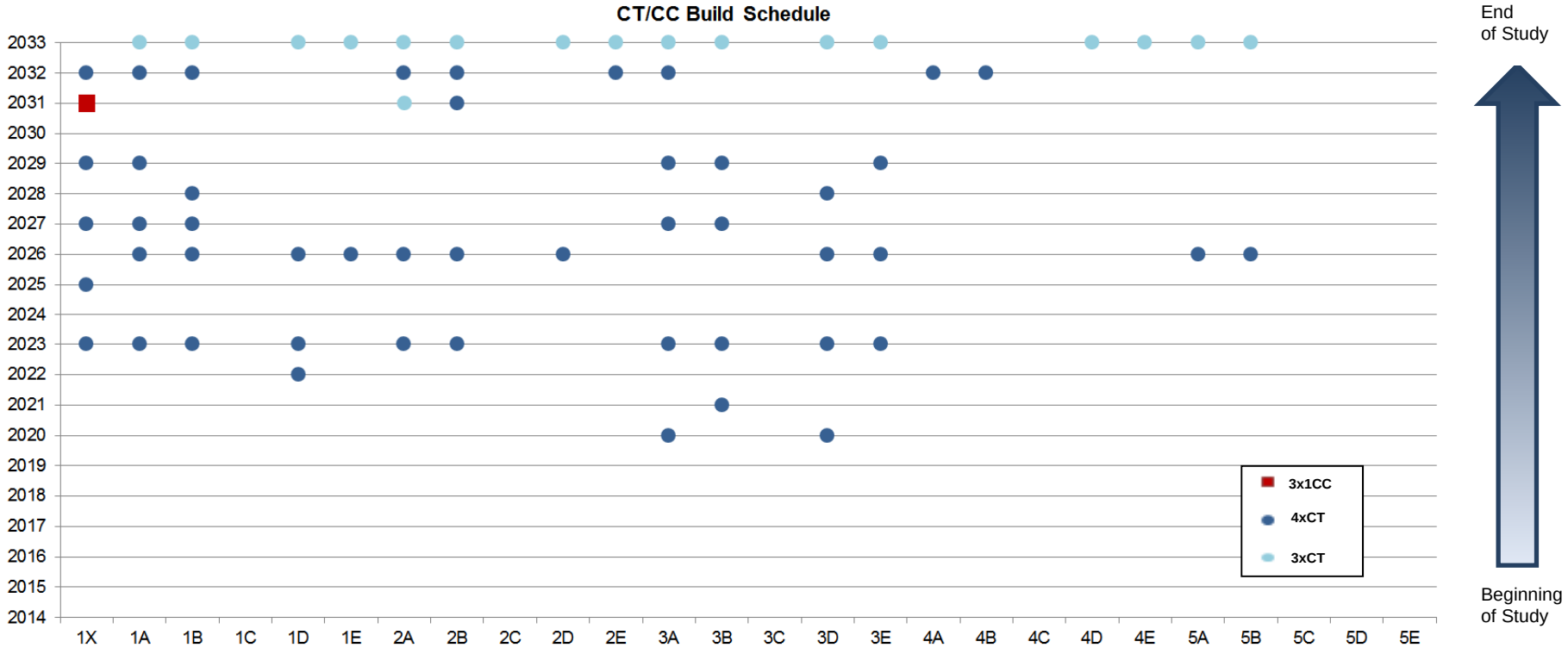
EEDR	1%	3%	8%	11%	11%	1%	3%	8%	11%	11%	1%	3%	8%	11%	11%	1%	3%	9%	15%	18%	1%	3%	7%	9%	8%
Gas	13%	15%	11%	12%	16%	13%	15%	11%	12%	16%	13%	15%	11%	11%	14%	13%	15%	11%	10%	11%	13%	11%	6%	6%	7%
Renewables	4%	4%	4%	5%	3%	4%	4%	4%	5%	3%	4%	4%	4%	5%	4%	4%	4%	4%	4%	2%	4%	10%	13%	16%	19%
Coal	37%	23%	21%	18%	16%	37%	23%	21%	18%	16%	37%	23%	22%	19%	18%	37%	23%	20%	17%	15%	36%	20%	17%	14%	12%
Hydro	11%	11%	11%	11%	10%	11%	11%	11%	11%	10%	11%	11%	11%	11%	10%	11%	11%	11%	11%	10%	11%	12%	12%	11%	11%
Nuclear	35%	44%	45%	43%	43%	35%	44%	45%	43%	43%	35%	44%	45%	43%	43%	35%	44%	45%	43%	43%	35%	44%	45%	43%	43%

Scenario 5: Distributed Marketplace

- Baseload resources: no new builds beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
- Very low loads drive additional fossil unit retirements
- Renewables: lower utility and commercial scale renewable additions due to low loads (recall that scenario includes high distributed renewable assumptions)
- Gas Peaking: few gas builds or market purchases
- Gas Combined-Cycle: no additional CCs built beyond Allen and Paradise. Some existing contracts are extended
- Energy Efficiency: lower EE selections than Scenario 1
- Demand Response: lower DR volumes than most other scenarios

Gas Builds

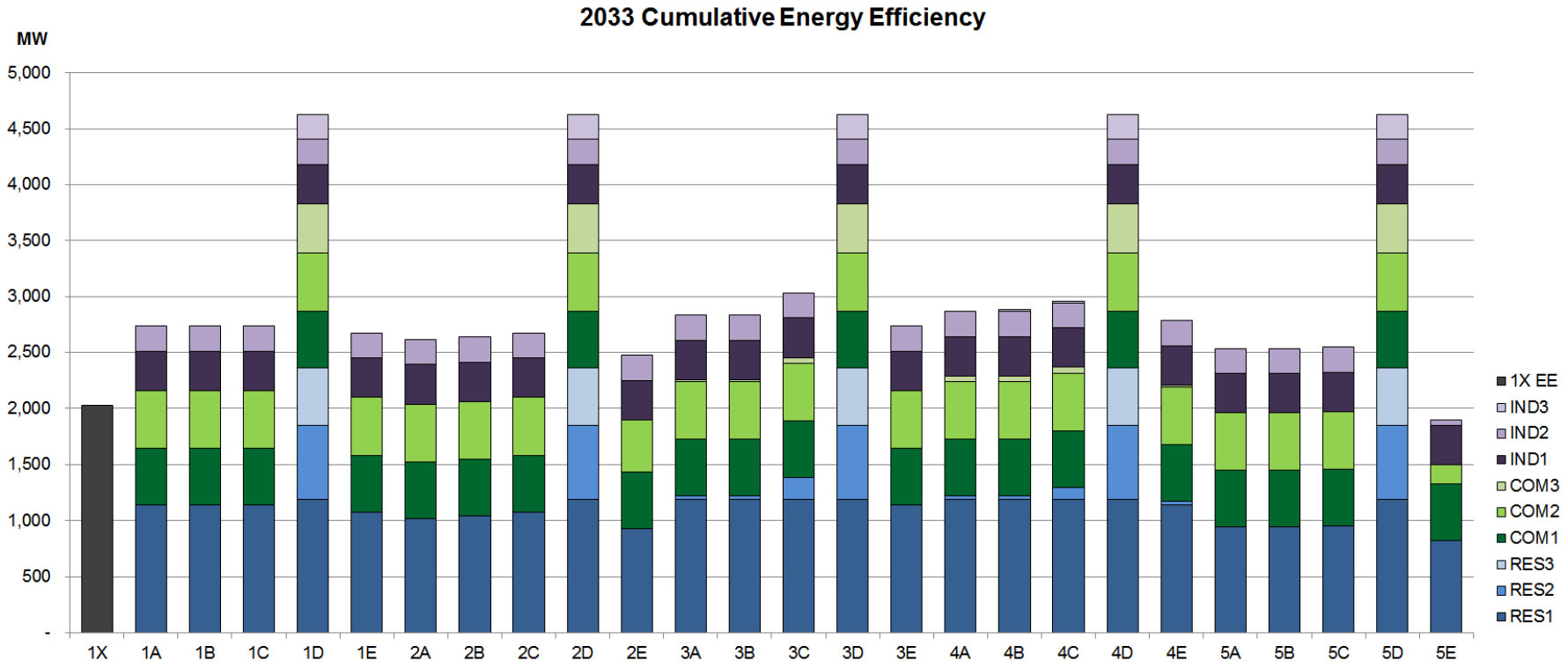
1X – The Base Case
1A – The Reference Plan
1B – Meet an Emission Target
1C – Focus on Long-Term, Market-Supplied Resources
1D – Maximize EE
1E – Maximize Renewables



- Fewer CC builds across the scenarios due to the high volumes of EE and renewable resources (but market gas assets are added in many scenarios)
- Peaking resources are chosen in most scenarios to balance out the portfolio
- Few builds in scenarios 4 and 5 due to low loads (and CO2 penalty in Scenario 4)

Energy Efficiency

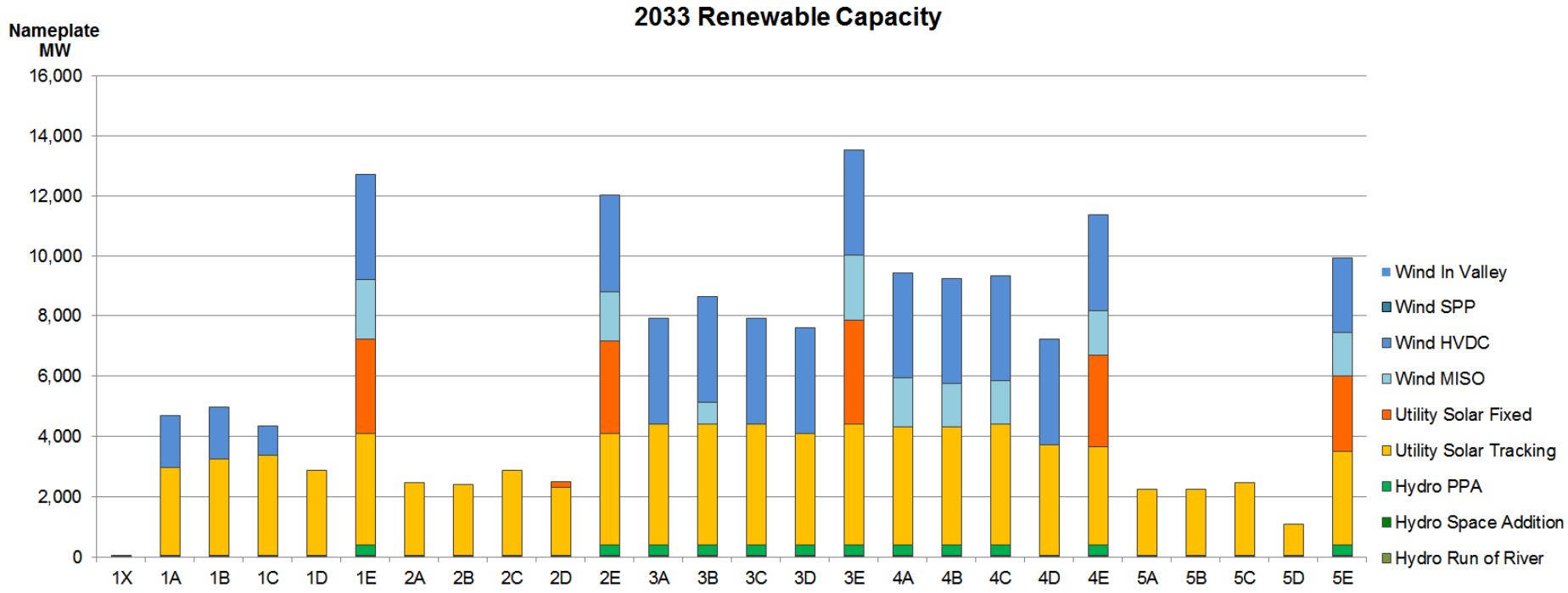
1X – The Base Case
1A – The Reference Plan
1B – Meet an Emission Target
1C – Focus on Long-Term, Market-Supplied Resources
1D – Maximize EE
1E – Maximize Renewables



- Higher Energy Efficiency volumes in many cases resulting from cost assumptions and program shapes
- Strategy D ('Maximize EE') introduces significant EE resources to the TVA portfolio

Renewable Expansion

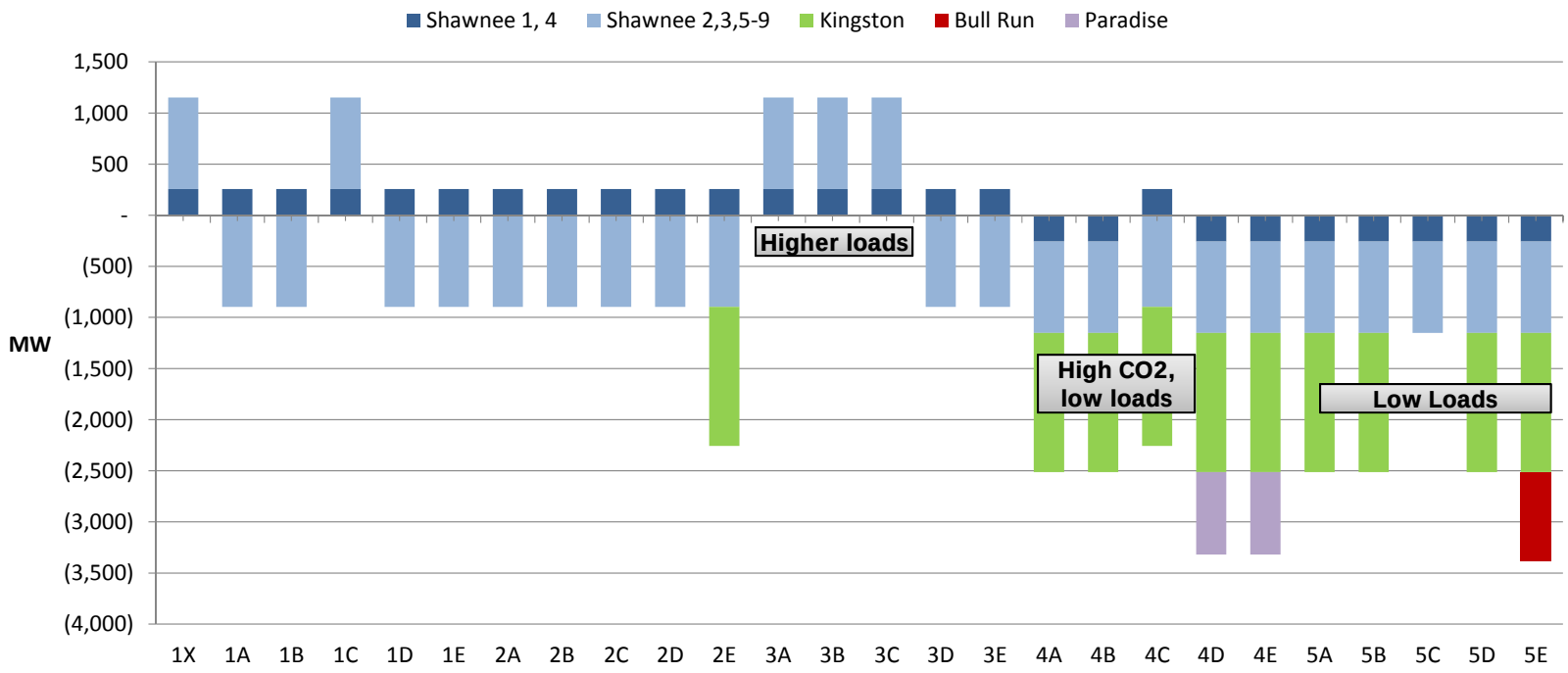
1X – The Base Case
1A – The Reference Plan
1B – Meet an Emission Target
1C – Focus on Long-Term, Market-Supplied Resources
1D – Maximize EE
1E – Maximize Renewables



- Utility solar becomes economic towards the mid-2020's and between 1,000- 4,000 MW utility solar tracking is selected across cases
- Wind additions generally occur late in the study window unless driven by high CO2 prices, high loads, or renewable targets

Coal Selections

1X – The Base Case
1A – The Reference Plan
1B – Meet an Emission Target
1C – Focus on Long-Term, Market-Supplied Resources
1D – Maximize EE
1E – Maximize Renewables



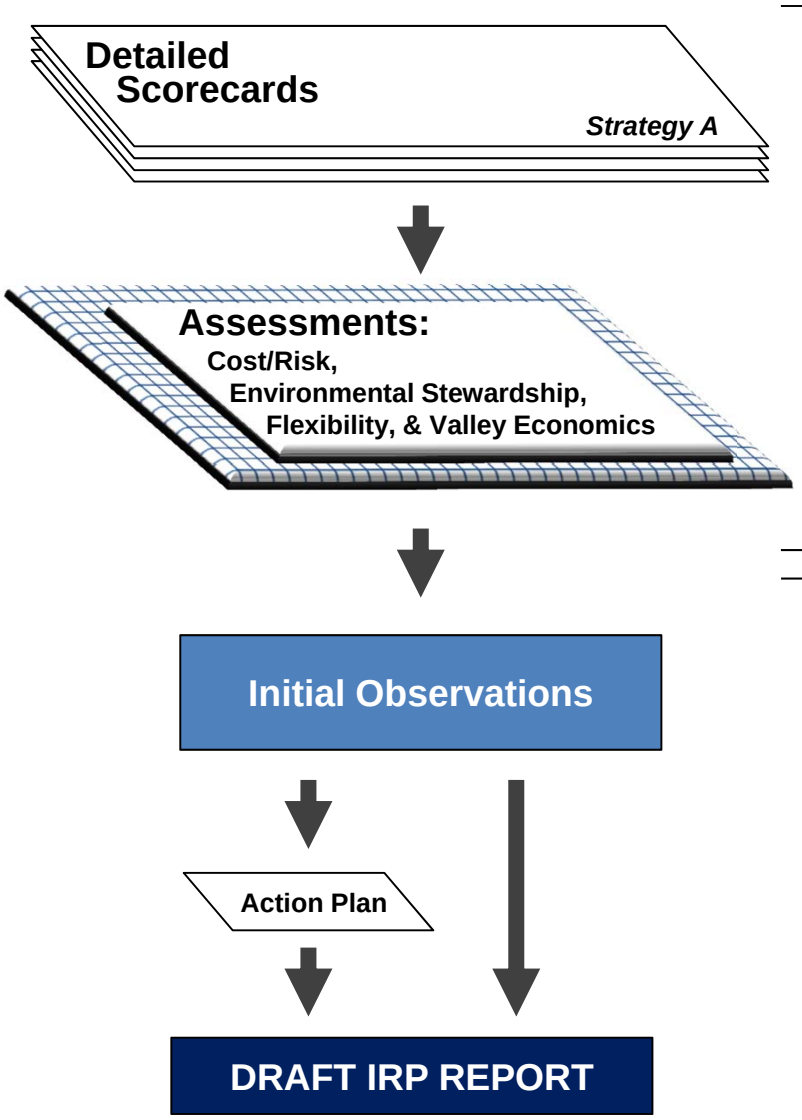
- Controlled coal units are retained in most cases; low loads and high CO2 cases result in higher coal retirements
- Small load growth (Scenario 3) results in Shawnee 2,3, 5-9 controls
- Low load and high CO2 penalties (Scenario 4) drives more coal retirements than any other scenario
- Low loads (Scenario 5) also drives coal retirements

IRPWG Recap: Key Resource Selection Observations

Capacity Plan Observations/Input:

- There is a need for new capacity in every scenario being modeled
- No additional significant baseload expansion beyond Watts Bar Unit 2 and Browns Ferry extended power uprates
  - Flipside is that most of the variation in expansion plans is around CTs and Renewables
- Retirement/control decision on Shawnee is typically around mid 2020's and is highly dependent on CO2 & pending regulation. There is a narrow margin between control and retire
- Higher EE and Renewable levels than current budget in all cases
  - Solar showing up in mid 2020s; HVDC wind not until early '30s (generally)
  - Seeing tradeoff between EEDR and gas resources
  - Generally selecting more CTs than CCs – EE is acting as an intermediate resource

Strategies Assessment Process



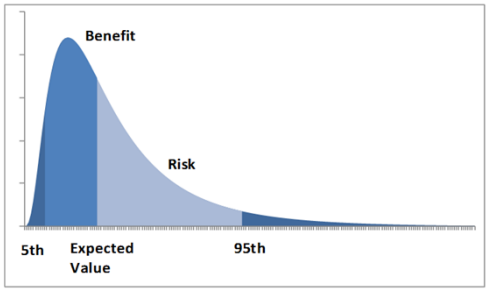
- Scorecard data are used to conduct four assessments on how strategies perform in the five evaluation categories
  - Cost and Risk
  - Flexibility
  - Environmental Stewardship
  - Valley Economics
- The assessments are not intended to produce an overall ranking

- 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
- The activities of the action plan will occur during the period between the Draft and the Final IRP reports

Assessing Plan Cost & Risk

Scoring Metrics

Cost	PVRR ($Bn)	=	Present Value of Revenue Requirements over Planning Horizon
	System Average Cost Years 1-10 ($/MWh)	=	$\frac{\text{NPV Rev Reqs}_{(2014\text{-}2023)}}{\text{NPV Sales}_{(2014\text{-}2023)}}$
Risk	Risk/Benefit Ratio	=	$\frac{95^{th}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)} - 5^{th}_{(PVRR)}}$
	Risk Exposure ($Bn)	=	95^{th} Percentile $_{(PVRR)}$



Reporting Metrics

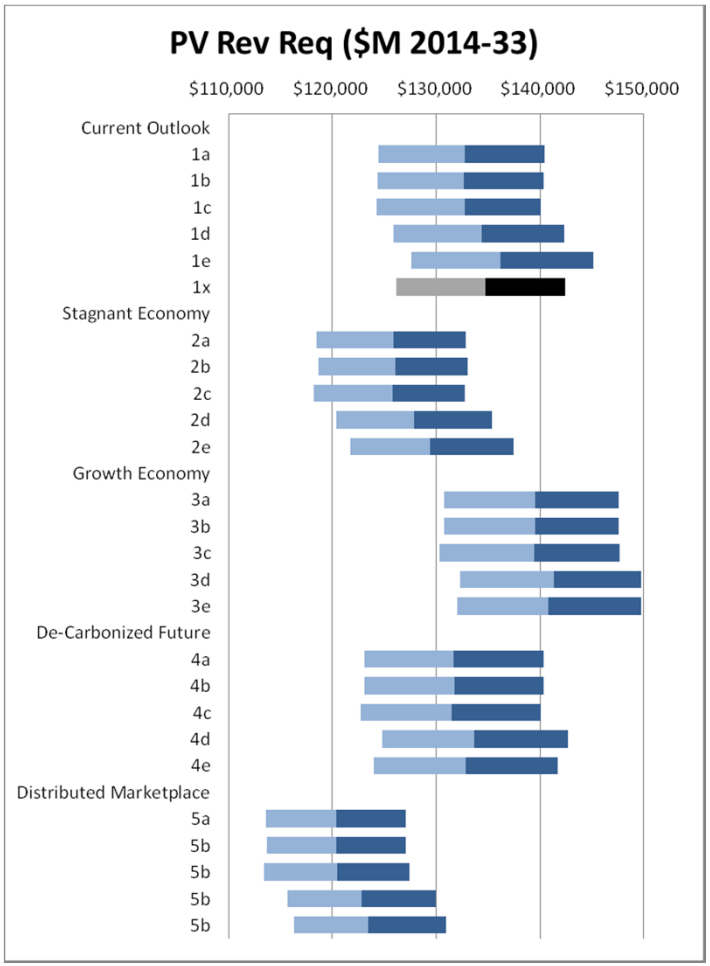
Cost	System Average Cost Years 11-20 ($/MWh)	=	$\frac{\text{NPV Rev Reqs}_{(2024\text{-}2033)}}{\text{NPV Sales}_{(2024\text{-}2033)}}$
Risk	Cost Uncertainty	=	$95^{th}_{(PVRR)} - 5^{th}_{(PVRR)}$
	Risk Ratio	=	$\frac{95^{th}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)}}$

- 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

Cost/Risk Assessment

How do the costs of the strategies compare from a long-term perspective?

PVRR Over 20 Years – All Cases

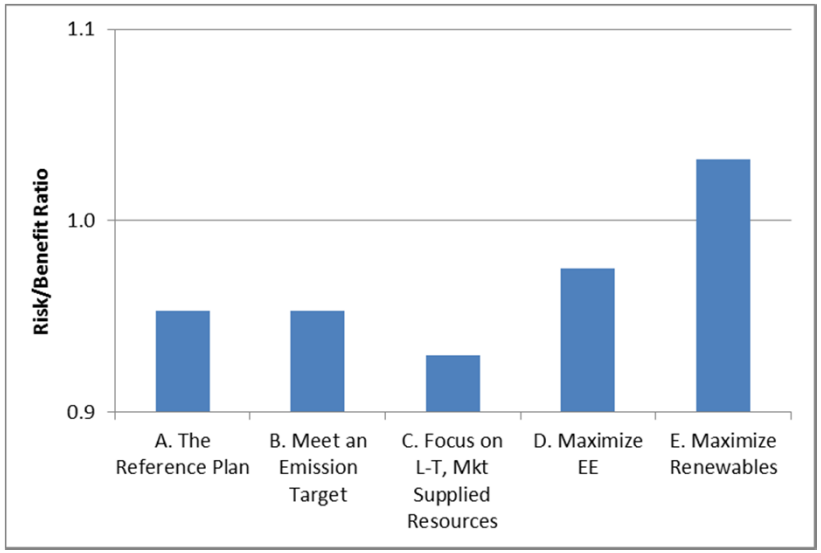


PVRR Over 20 Years – By Strategy

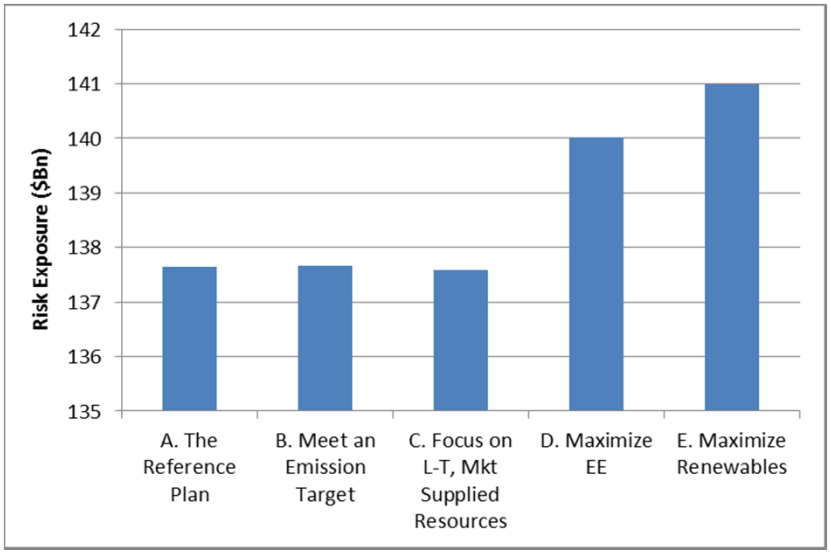
- Strategies A, B, and C lead the way and have roughly the same average PVRR results across all scenarios (Strategy C has the lowest)
- Strategies D and E are likely to have a PVRR that is more than $2 billion more over the 20 year planning period

Cost/Risk Assessment
Which strategies present higher financial risk?

Risk/Benefit Ratio



Risk Exposure



- All strategies except for E have a risk/benefit ratio less than one suggesting actual costs are more likely to fall below the expected value
- Strategy C has the lowest risk/benefit ratio indicating the least financial risk*
- Strategy D has a similar risk/benefit ratio to A,B, and C, but exposes TVA to higher potential costs in a worst case scenario
- Strategy E looks the most risky from a financial perspective with the highest risk/benefit ratio and highest potential costs in a worst case scenario

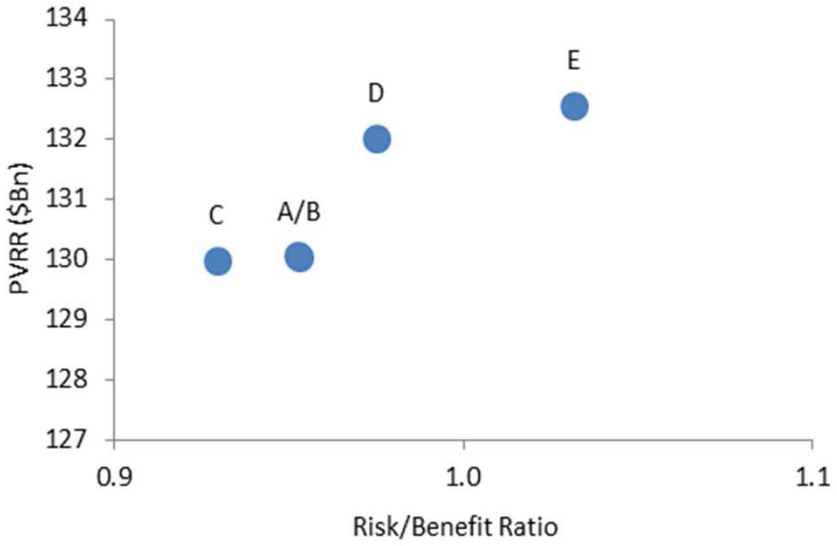
* As discussed, Strategy C relies on a few key assumptions such that the full financial risk may not be captured here

Cost/Risk Assessment

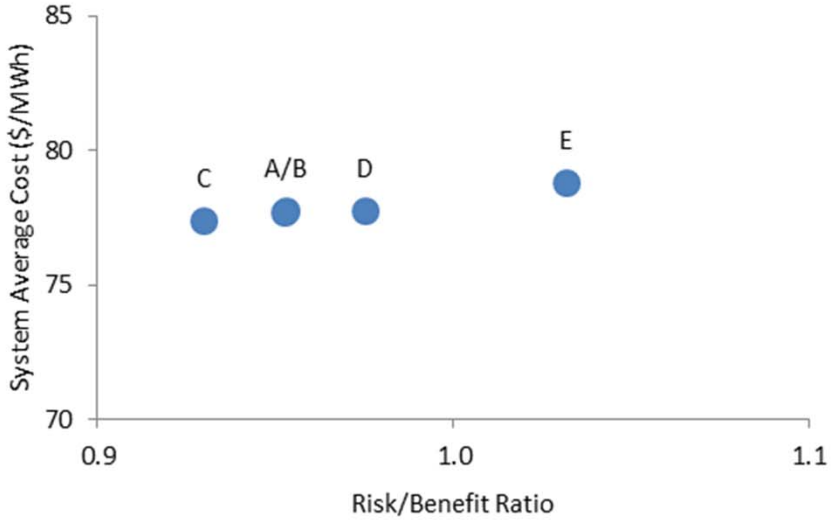
How strategies perform when we combine the total cost and financial risk views?

Cost/Risk Trade-off Charts

20-Year View (Plan Cost)



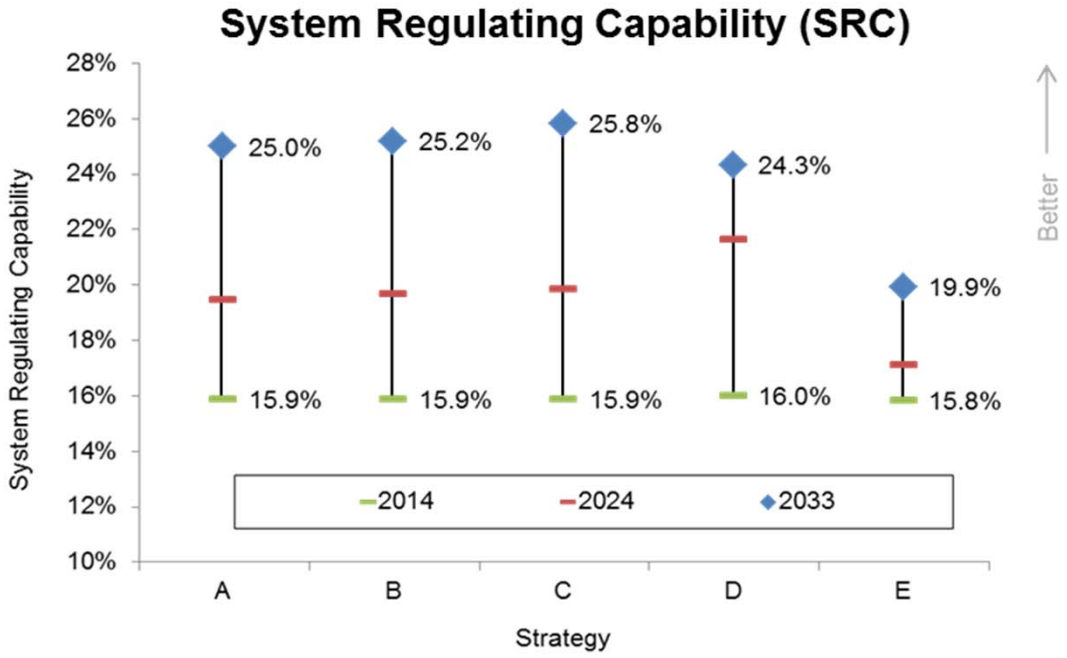
10-Year View (System Avg. Cost)



- Leading performers from a cost/risk perspective will show up in the lower left hand corner of the graphic where cost and risk are the lowest
- Strategies A, B and C are clustered in this area with strategy D showing a variation in performance between the first and second decade of the study that has already been observed
- However, the main take-away from these charts is that there does not seem to be a trade-off between cost and financial risk (the lower the cost, the lower the risk, and vice versa)

Flexibility Assessment

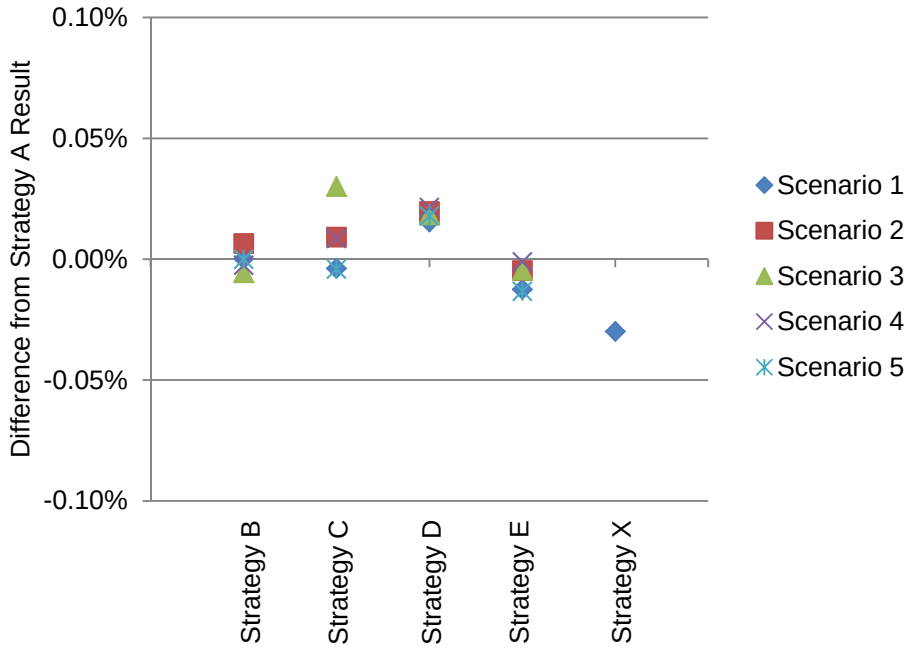
What is the capacity of the system to respond to ramp-ups?



- The graph above shows the SRC of the different strategies in years 2014, 2024 and 2033
- Strategy D has a better regulating during the first decade suggesting that the dominant effect is the lower load that the system needs to support
- However, during the second, the the quick response units added strategies A,B and C result in similar levels of regulating capability for strategies A,B,C, and D by the end of the study period
- Strategy E has a higher percentage of non-dispatchable resources (take or pay contracts and renewables) and thus a reduced ability to respond to ramp-ups

Valley Economics Assessment
Summary of Observations

Difference in per capita income relative to Strategy A

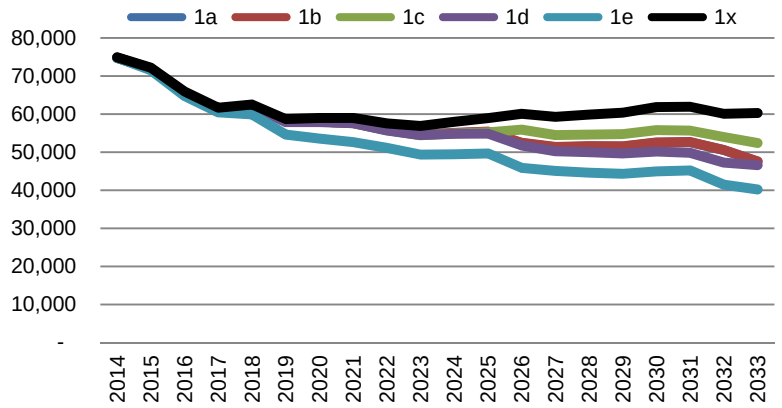


PV of Levelized Annual Per Capita Income ($2013)	
Case 1A	$ 38,074
Case 2A	$ 36,206
Case 3A	$ 39,590
Case 4A	$ 37,502
Case 5A	$ 38,074

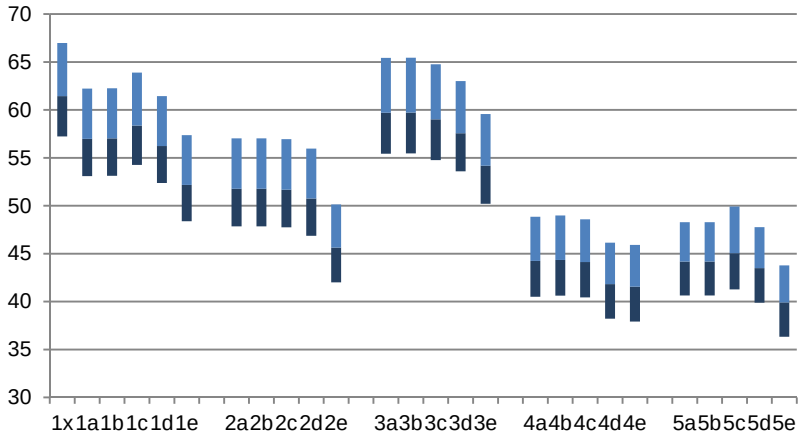
- The differences in per capita income compared to Strategy A are relatively small across all cases
- Differences range from -0.03% in the current budget case 1X to 0.03% in case 3C

Environmental Stewardship Assessment
CO_2 Emissions

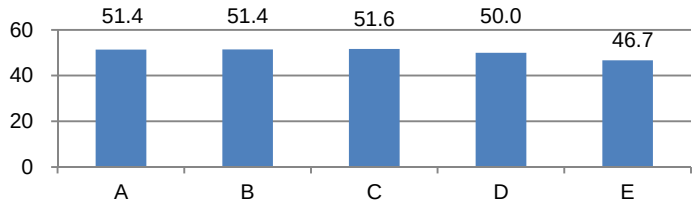
CO2 (ktons)



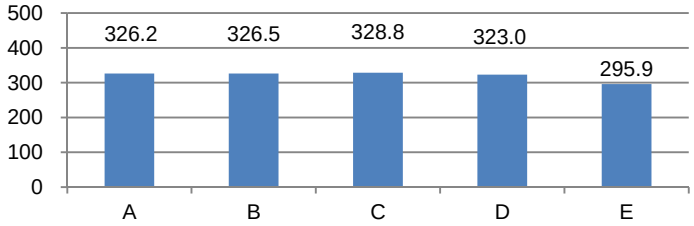
CO2 Avg (mmtons, avg 2014-33)



CO_2 – Annual Avg By Strategy (mmtons)

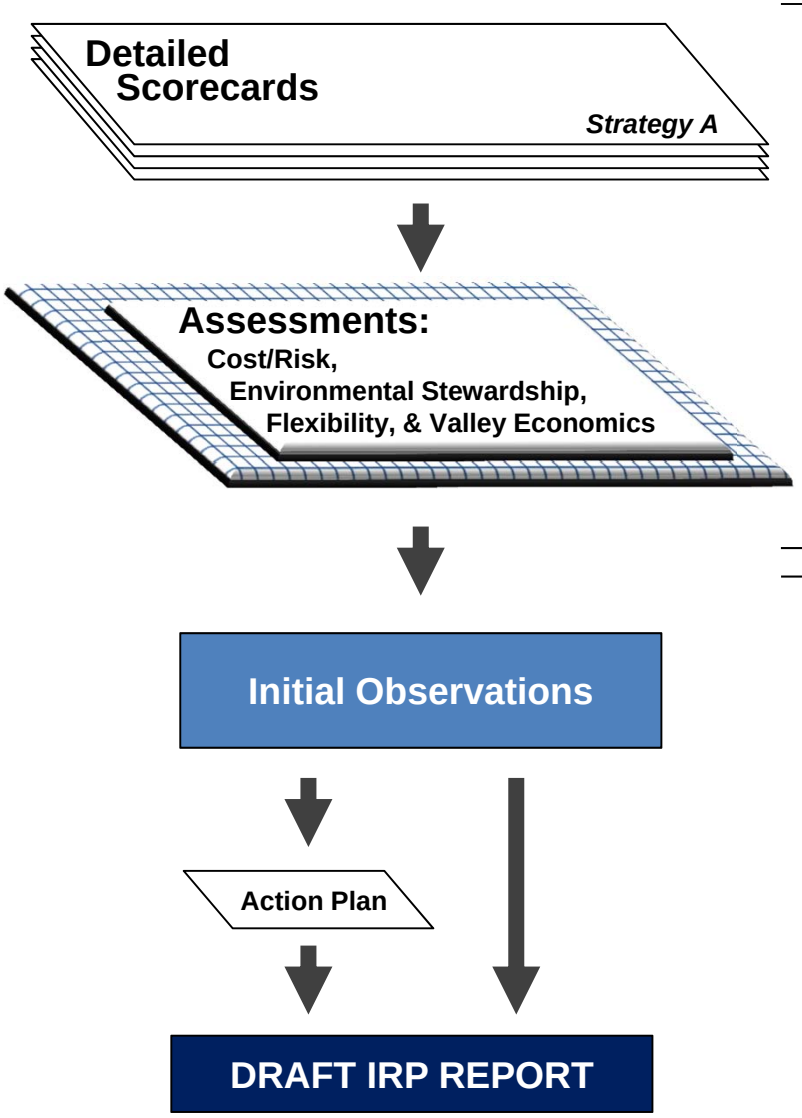


CO_2 Intensity (tons/GWh)



- CO_2 emissions vary largely by scenario but decline over time for all strategies
- Strategies A, B, and C have similar CO_2 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

Strategies Assessment Process



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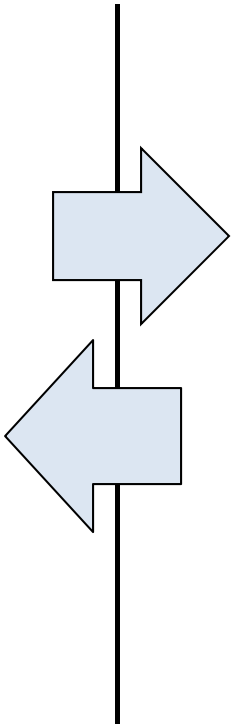
- The observations will consist of detailed commentary on how each strategy performs as well as questions or findings that will require future research or refinement of the analysis
- The requirements for future research will be integrated into an action plan that will be included in the Draft IRP
- The activities of the action plan will occur during the period between the Draft and the Final IRP reports

IRP/SEIS Draft Reports

DRAFT IRP REPORT CONTENTS:

- Overview of the process
- Summary of public involvement
- Need for Power analysis (forecasting)
- Discussion of scenario & strategy development
- Overview of the modeling approach
- Scorecard design
- Summary of the draft results
- Key observations at this stage
- Next steps

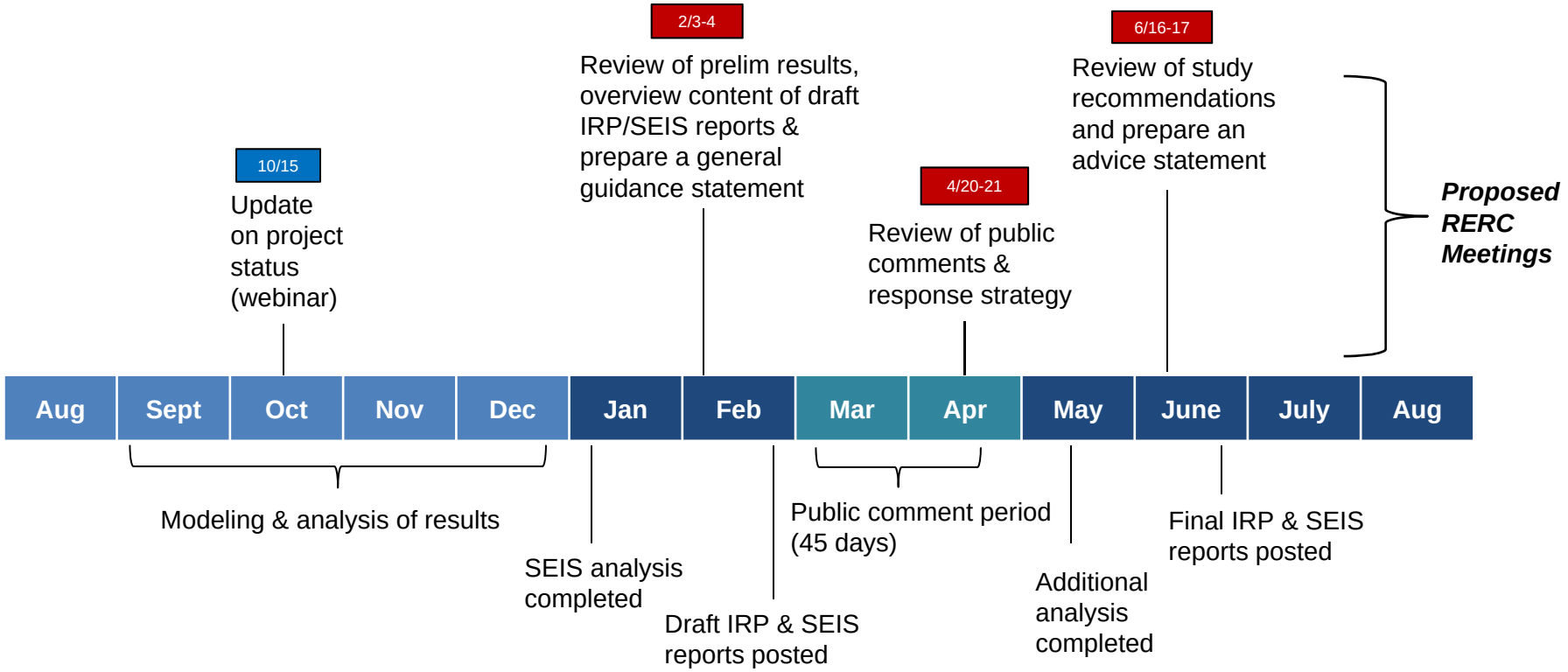


DRAFT EIS REPORT CONTENTS:

- Summary of the resource planning process
- Overview of the TVA power system
- Description of the affected environment
- Description of the energy resource options
- Description of alternative strategies
- Anticipated environmental impacts

Following receipt & review of public and agency comments, final versions of the IRP/SEIS will be produced that include recommendations for Board consideration

RERC Engagement



The meetings shown on this timeline are focused on providing the RERC with sufficient information to develop an advice statement on the IRP. More detailed discussions are scheduled with the IRP stakeholder working group that assist TVA in development of the final IRP study report.

Break

Purpose and Approach of the EIS

Purpose:

- Provide detailed assessment of the environmental impacts of the alternative strategies to facilitate informed decision-making
- Comply with the National Environmental Policy Act (NEPA)
- Through the NEPA process, provide structure for public involvement

Approach:

- Programmatic review with system-wide assessment of environmental impacts
- As plan is being implemented, conduct site-specific assessments of implementing actions tiered from IRP EIS

Contents of the Draft EIS

- Introduction
- Overview of the resource planning process
- Description of the TVA power system
- Description of the affected environment
- Description of energy resource options
- Description of alternative strategies and scenarios
- Description of anticipated environmental impacts

- The Final EIS will contain a summary of the public and agency comments on the Draft EIS and IRP, and TVA's responses to those comments

Environmental Resources Addressed in EIS Impact Analyses

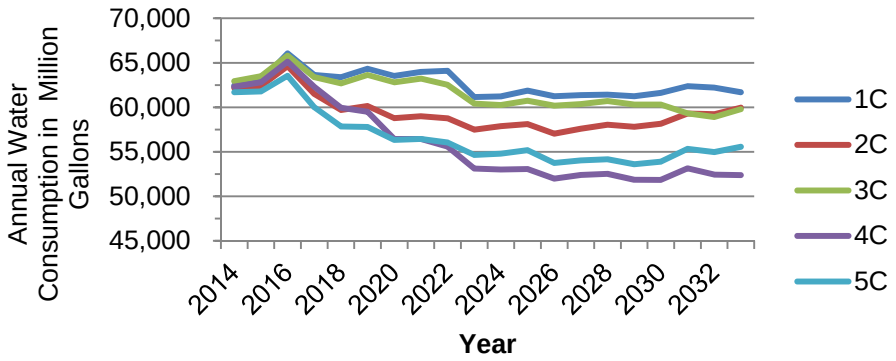
Addressed in detail:

- Air quality with emphasis on SO_2, NO_x, mercury emissions
- Greenhouse gas emissions and climate change
- Water resources with emphasis on water use and consumption
- Fuel requirements
- Waste production with emphasis on coal residuals, spent nuclear fuel
- Land requirements
- Socioeconomics, with emphasis on employment and per capita income

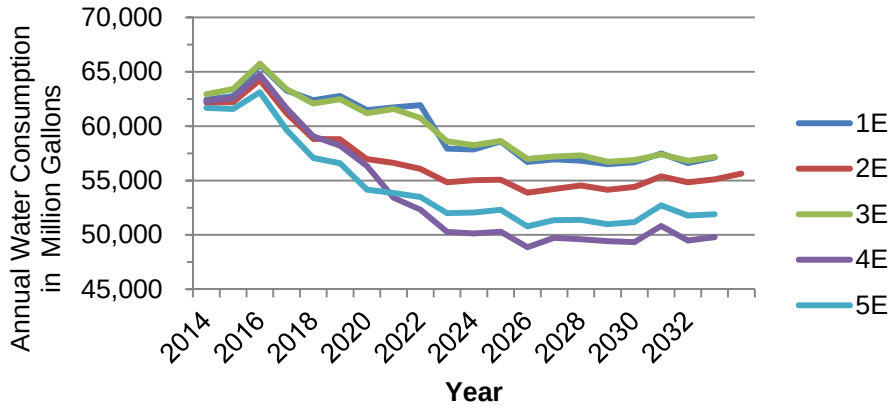
Not addressed in detail:

- Geology
- Groundwater
- Aquatic Life
- Vegetation and Wildlife
- Endangered and Threatened Species
- Wetlands
- Parks and Recreation
- Cultural Resources

Example – Water Consumption



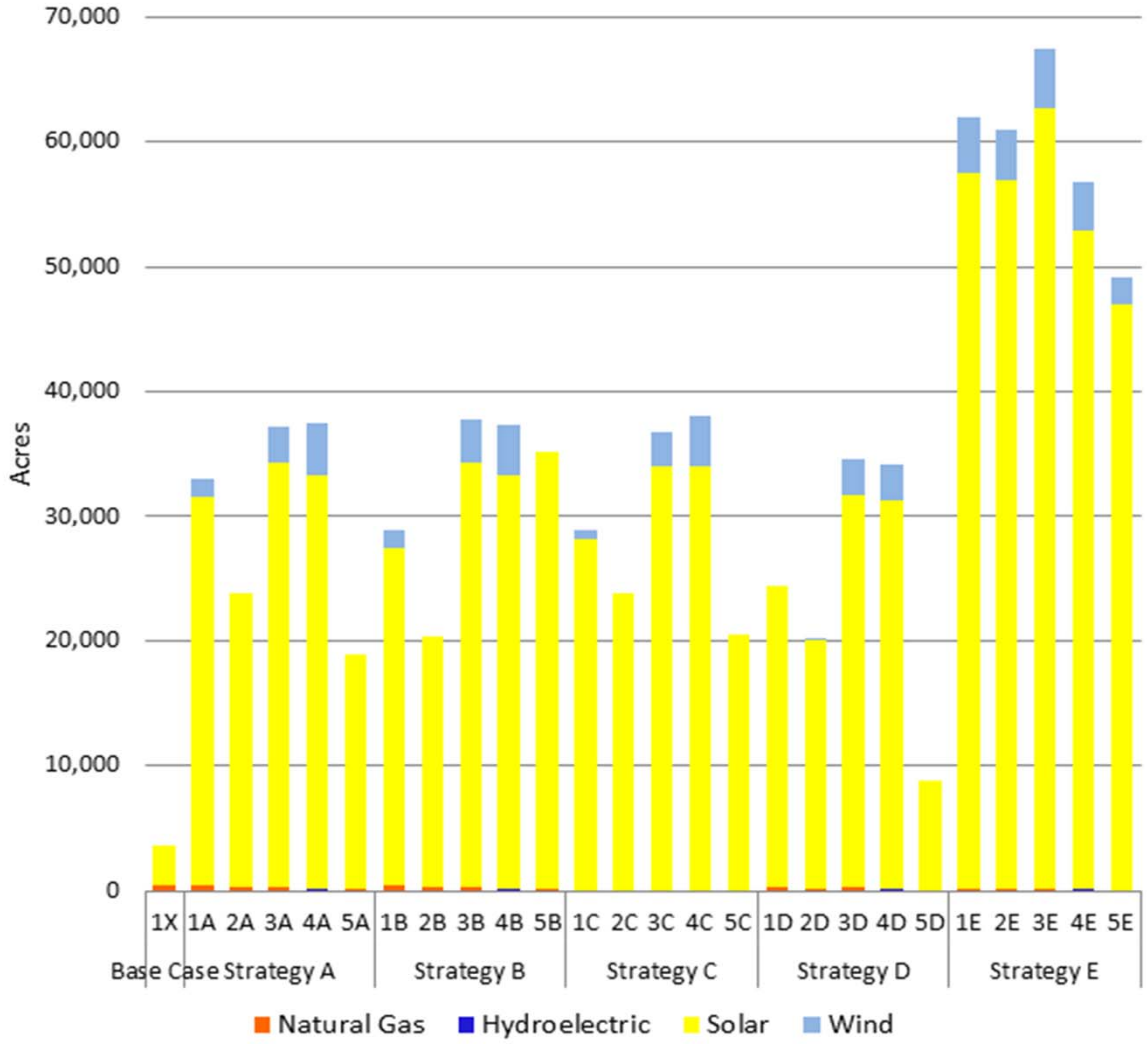
"High" water consumption:
Strategy C – Focus on Long-Term, Market-Supplied Resources
Average of ~59 billion gallons/year



"Low" water consumption:
Strategy D – Maximize Renewables
Average of ~56 billion gallons/year

- The 3 scorecard metrics, CO2 emissions, water consumption, and coal waste production, all decrease over time
- Strategies D and E show the greatest decreases

Example – Land Requirements for Capacity Expansions



Build out through 2033

RERC Advice Questions

1. *What is your view of TVA's IRP Process to date in terms of:*
   - *Including a broad range of resources that TVA could use to meet its future energy needs*
   - *Depth of analysis*
   - *Stakeholder involvement*
   - *Continuing to provide low-cost, reliable power*

Adjourn

Tennessee Valley Authority

Regional Energy Resource Council

Chattanooga, Tennessee

February 2 and 3, 2015

Agenda (Cont'd)

Day 2: Tuesday, February 3

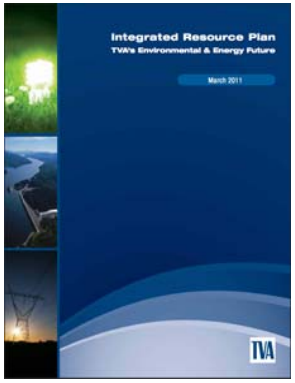
6:45 – 8:00	Systems Operation Center Tour (closed to public)	RERC
8:30	Welcome	Lavender
8:40	TVA Update	Hoagland
9:00	Public Comment Period	
10:00	Break	
10:15	Changing Utility Market Place	Hoagland
10:45	Council Discussion – Changing Utility Market Place	Lavender / RERC
11:00	IRP Recap from Day 1	Brinkworth
11:15	Council Advice	Lavender / RERC
11:55	Closing Comments and Adjourn public portion of meeting	Dus Rogers / Joe Hoagland
12:00	Lunch	
1:30	Operation Center Tour (closed to public)	RERC

Energy Resource Decisions

Planning Strategies	Scenarios					
	Current Situation	#1	#2	#3	#4	#5
Planning Strategy A						
Planning Strategy B						
Planning Strategy C						
Planning Strategy D						
Planning Strategy E						

Other Strategic Considerations

Internal/External Stakeholder Input



TVA Leadership

Financial Health Rates

Reliability Resiliency

Environmental Stewardship

IRP establishes direction for 'The Highway'

Specific 'Lane' decided by TVA Leadership with Business Considerations

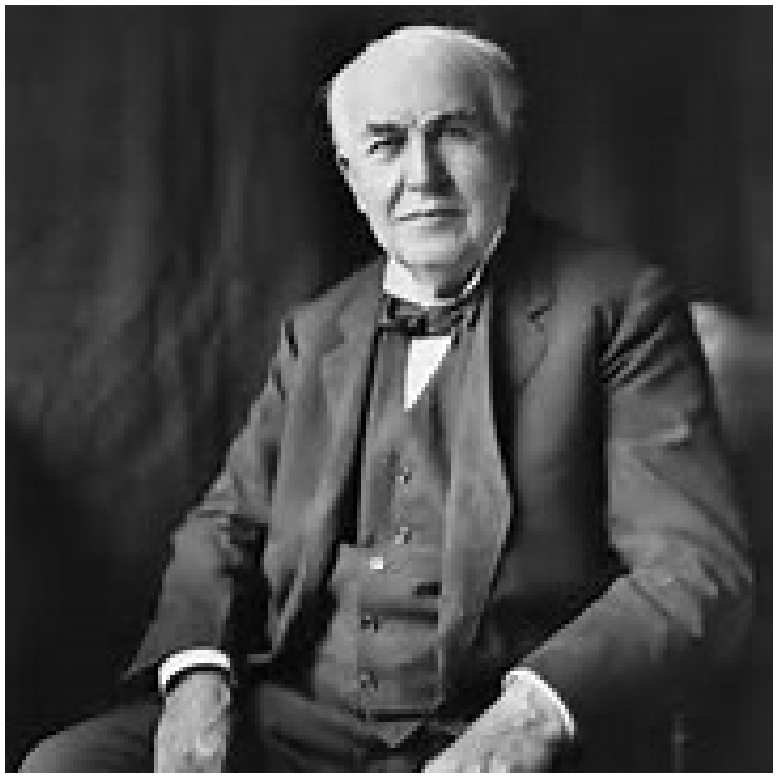
Public Comment Period

- Public participation is appreciated
- This is a listening session; responses are typically not provided
- Members of the public have a set number of minutes for their comments

Public Comment Period

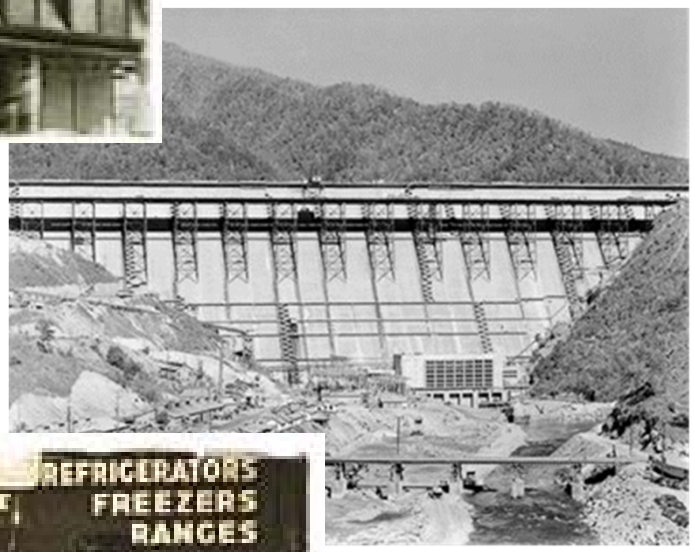
Break

Where We Came From



Thomas Edison

Someday, man will harness the rise and fall of the tides, imprison the power of the sun, and release atomic power. -- Edison



Today's Grid

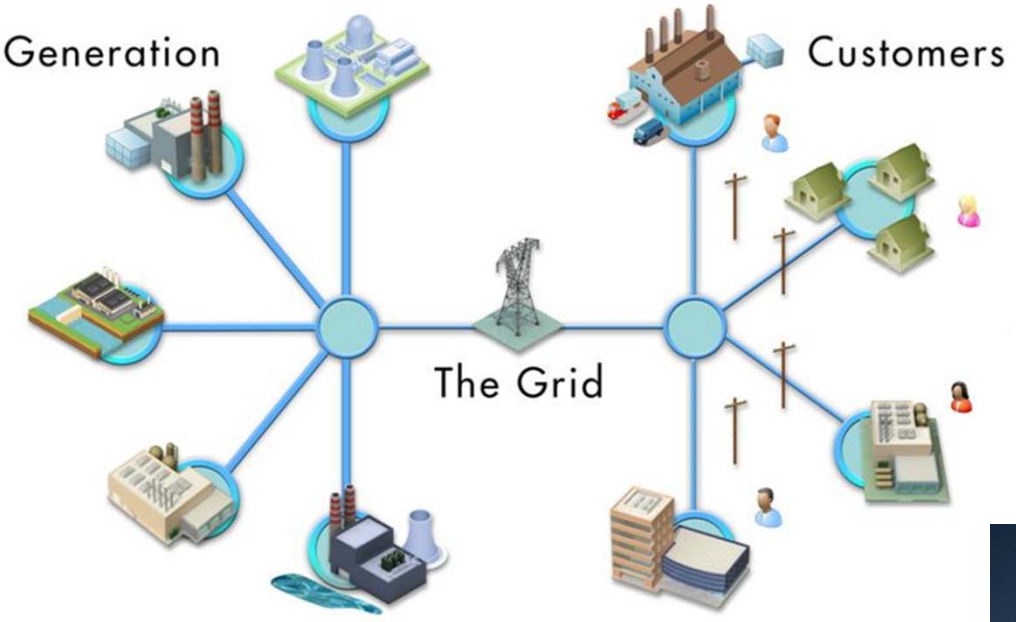


Image Source: EPRI

The Result of the Last 80 Years

- Complete Electrification
- Nationwide Grid
- Large Central Station Assets
- Balanced Portfolio
- High Reliability
- Low Relative Cost

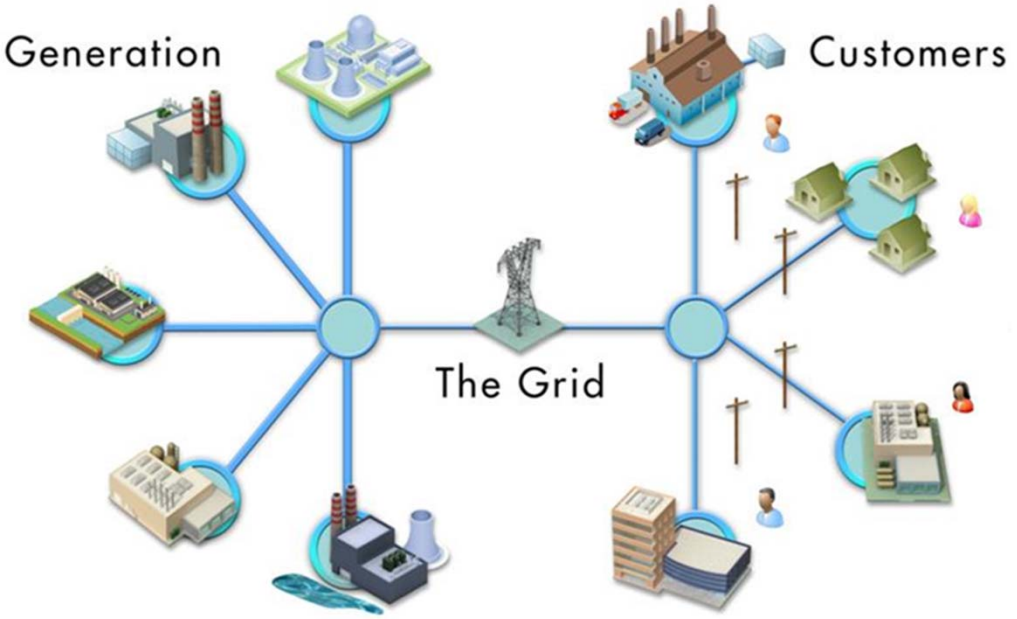
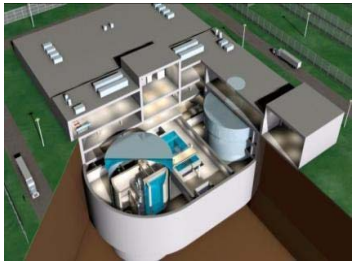


Image Source: EPRI

What is Changing: The Technology



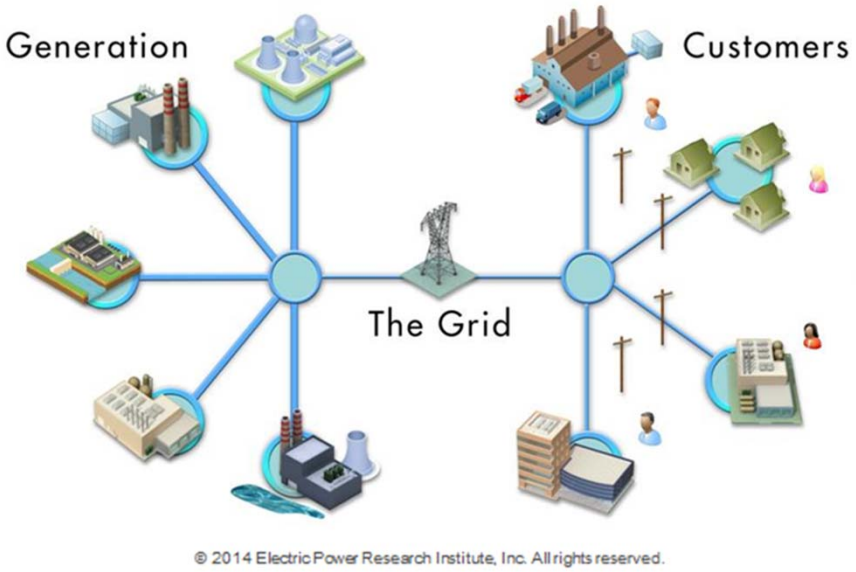


Image Source: EPRI

What is Changing: Extreme Events are More Extreme

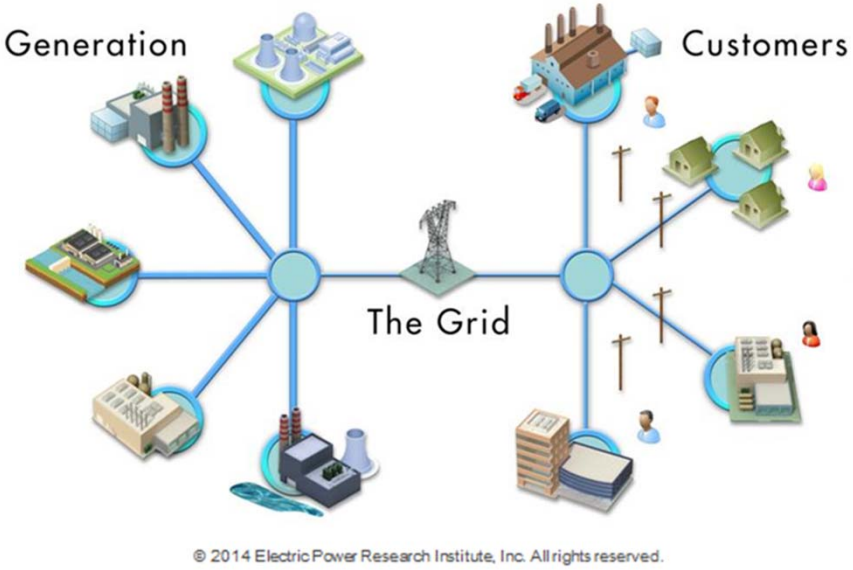


Image Source: EPRI

What is Changing: The Consumer Cares

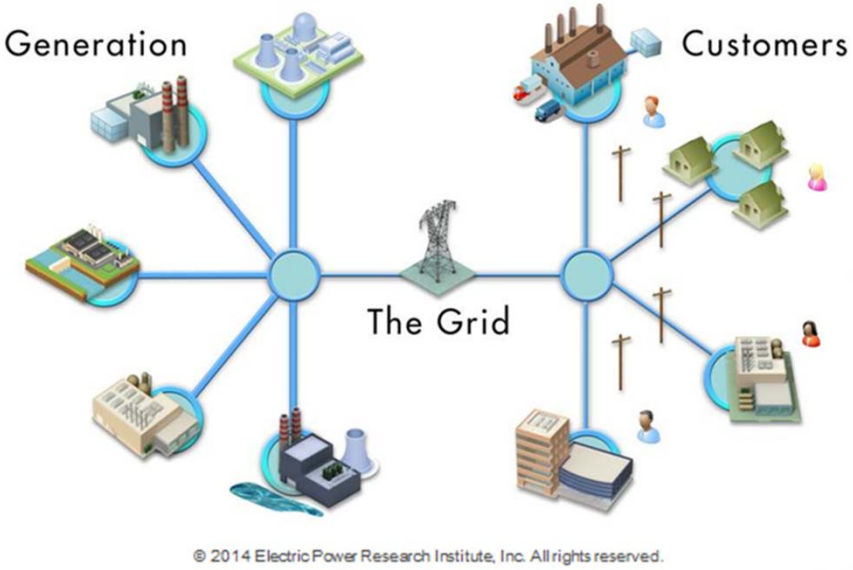


Image Source: EPRI

What is Not Changing: Expectations

- Continued Reliability
- High Resiliency
- Clean and Green
- Continued Low Price

Customers always expect lights to "come on"

The Challenge for TVA

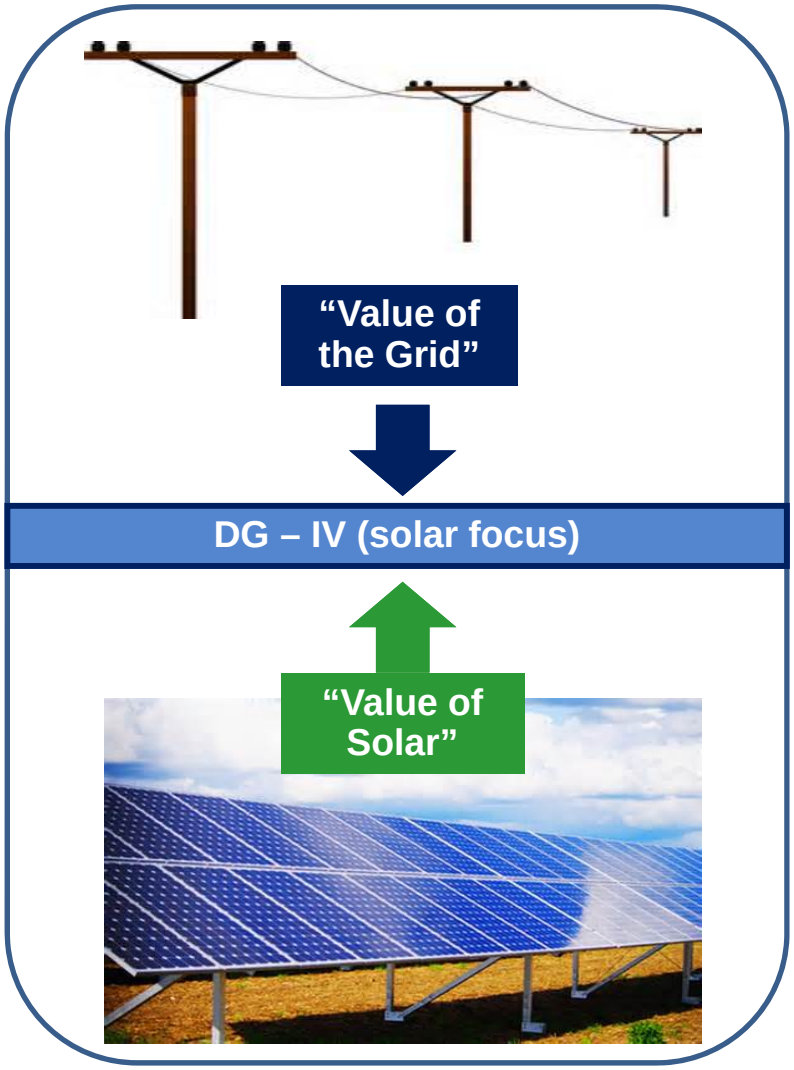
- **No Stranded Assets**
- **Maintain and Increase Reliability**
- **Decentralized Cleaner Generation Portfolio**
- **Giving Customers Choice**

"The work of TVA will never be done, there will always be new frontiers to conquer."

President John F. Kennedy, 1963

While Maintaining the Mission

What is DG-IV?



DG-IV =
'Distributed Generation – Integrated Value'

A process to develop a Methodology to determine the value of DG plus the value of the Grid.

Why Now?

- Dual metering positions TVA to better to determine the value of solar
- Opportunity to be pro-active in determining both the value of solar and the value of the power grid.
- The changing Market Place / more interest in distributed generation and more competitive costs

RERC Discussion Questions – Changing Utility Market Place

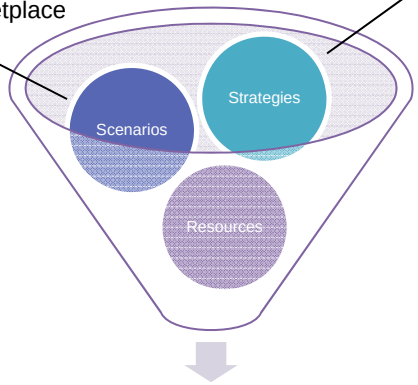
- What strategic implications do you think of relative to the emerging utility marketplace and TVA's preparation for it?
- How can we better brief or engage you in the changing utility marketplace to build your understanding?

2015 IRP: Framework -- Analyze -- Review -- Recommend

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

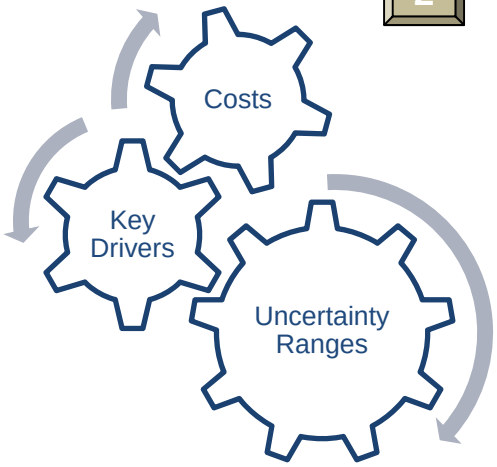
1

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

The IRP Overview (What We Covered on Day 1)

- IRP Basics
- Resource Options
- Modeling Process
- Assumptions & Enhancements
- Analytical Approach
- Stakeholder Engagement
- Update on Study Results
- Assessment Process
- Outline of the draft reports (IRP/SEIS)
- RERC engagement

Summary of Assessment Observations

(to be completed after RERC Day 1)

RERC Advice Questions

1. *What is your view of TVA's IRP Process to date in terms of:*
   - *Including a broad range of resources that TVA could use to meet its future energy needs*
   - *Depth of analysis*
   - *Stakeholder involvement*
   - *Continuing to provide low-cost, reliable power*

Next Steps: Upcoming Meetings

- **Spring Meeting:** April 20 – 21, 2015

  Location: Nashville

  Topic: Draft IRP pubic comments review and feedback

- **Summer Meeting:** June 16-17, 2015

  Location: Knoxville

  Topic: Final IRP review and statement to TVA Board

Thank you and Please Travel Safely!