



Regional Energy Resource Council

April 17-18, 2019
Knoxville, Tennessee



Safety Moment



Building Emergency Plan

Term 3 RERC Members

Michael Butler

Tennessee Wildlife Federation

Wayne Davis*

University of Tennessee

Rodney Goodman

Habitat for Humanity

Dan Ionel

University of Kentucky

Wes Kelley

Huntsville Utilities

Doug Lawyer

Knoxville Chamber

Peter J. Mattheis

Tennessee Valley Industrial Committee

Shari Meghreblian

State of Tennessee (retired)

Jennifer Mundt

State of North Carolina

Jeremy Nails

Morgan County Economic Development
Association

Alice Perry**

State of Mississippi

Doug Peters

Tennessee Valley Public Power
Association

Derwin Sisnett

Gestalt Community Schools

Stephen Smith

Southern Alliance for Clean Energy

Charles Snavelly

Commonwealth of Kentucky

John Warren

Commonwealth of Virginia

Lloyd Webb

Olin Chlor Alkali

Susan R. Williams

SRW & Associates

*RERC Chair

** Retired from the RERC June, 2018

Introductions



- Name
- Organization and Role
- Your favorite, or least favorite, aspects of the Spring season



Agenda and Meeting Protocols

Agenda – April 17, 2019

1:00	Welcome and Introductions
1:10	Safety Moment Building Emergency Plan
1:15	RERC Overview and Meeting Protocols Jo Anne Lavender Overview of Agenda Update / Discuss on RERC Bylaws
1:20	Today's Meeting Purpose DFO Joe Hoagland or Alt DFO
1:30	Refresh on 2019 IRP Development Process Hunter Hydass and Amy Henry
2:00	Break
2:15	Recap of Public Comment Period and High Level Public Comment Topics Amy Henry and Matthew Higdon
3:15	Break to prep for public comment session
3:30	Public Comment Session
4:30	Recap and Adjourn Day 1

Agenda – April 18, 2019

8:30	Welcome, Recap and Day 2 Overview	
8:40	Moving to the Final IRP <ul style="list-style-type: none">- Use of Public Comments- Sensitivities- Forming a Recommendation	
10:00	Break	
10:15	IRP Discussion & Questions Respond to Questions	Jo Anne
11:00	Break	
11:15	Next Steps and Wrap Up Preview June meeting -- plans	
11:30	Lunch on site or to-go	

RERC Discussion Questions

- 1. What key points are most interesting to you from the public comment topics?**
- 2. What should TVA consider as it creates a final recommendation for the 2019 IRP?**

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



RERC Bylaws and Procedures

Khurshid Mehta, Office of the General Counsel
Liz Upchurch, Enterprise Relations and Innovation

RERC Bylaws and Operating Procedures

- Established by the Agency for their FACA groups to guide and communicate group operations.
- TVA is considering updating these bylaws in two primary areas:
 - Clarify in person attendance and process for allowing virtual attendance in extreme circumstances
 - Update the definition of a quorum



TVA Update

Meeting Purpose and Recap

Joe Hoagland, Designated Federal Officer

TVA / DFO Update

Recap Term 3 Meetings

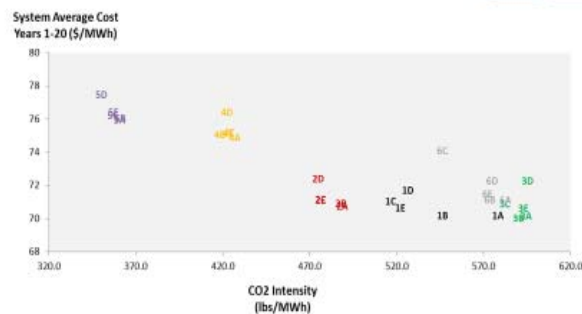
- 6 Meetings held so far in Term 3
- 4 Focused on the 2019 IRP development process:
 - **June 14, 2018**, Advice provided on focus areas and public engagement for the 2019 Integrated Resource Plan
 - **September 5, 2018**, Sentiments provided around the 2019 IRP Scenarios and Strategies
 - **December 18, 2018**, Advice provided on metrics and scorecards; Considerations as TVA applies these metrics
 - **February 19-20, 2019**: Focus on the Draft IRP and EIS; Discussion on the process and engagement; Public Open House.
 - **Today and Tomorrow**: Focus on moving from Draft IRP to Final; About forming a final recommendation.

February 19-20, 2019 Meeting - Recap

Incremental Capacity by 2038



Portfolio Cost and CO2 Tradeoff



Public Open House – 2019 Draft IRP and EIS



- Informational Posters and TVA experts available
- RERC Listening Session begins at 5:00 PM

Regional Energy Resource Council 45



Today's Meeting Purpose

- Provide informational topics on the 2019 Integrated Resource Plan
 - Overview update
 - Additional analysis so far
 - Key steps to move from draft to final IRP and develop final IRP recommendation
 - Ensure you have what you need to develop an advisory statement to the TVA Board in June.
- Host a Public Listening Session
- Hear your views:
 - On the public comments received;
 - On considerations for TVA as it works to develop a final IRP recommendation.



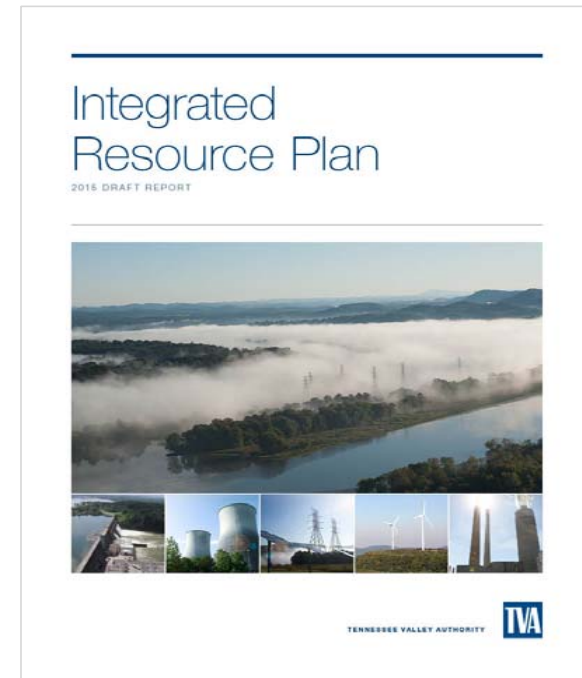
2019 IRP Update

Hunter Hydas and Amy Henry

TVA's Integrated Resource Plan

The IRP is a study of how TVA could meet customer demands across a variety of future environments

A programmatic Environmental Impact Statement (EIS) accompanies the IRP to analyze the impacts associated with an updated IRP to the Valley.

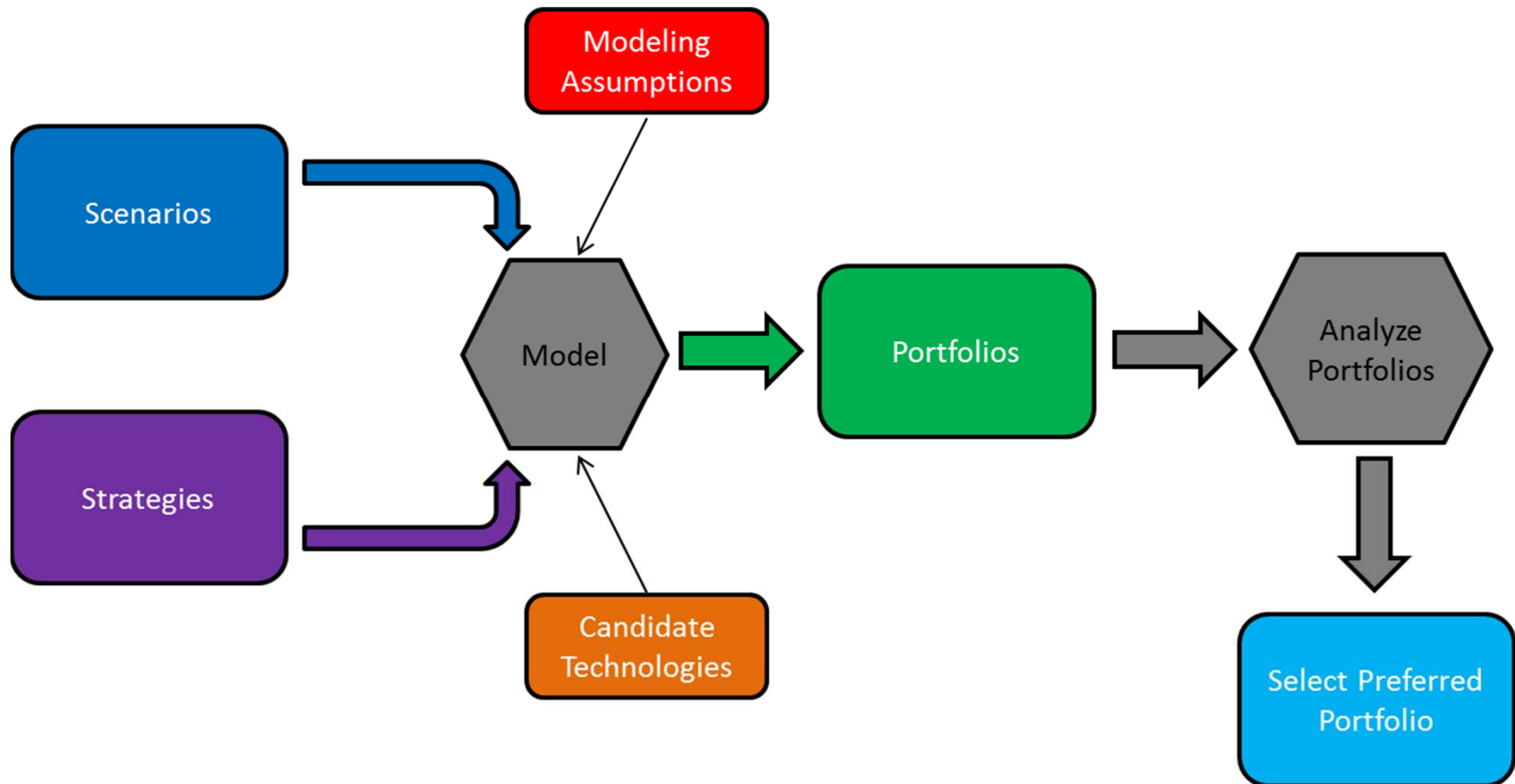


2019 IRP Focus Areas

- System flexibility
- Distributed Energy Resources
- Portfolio diversity



How the Resource Planning Process Works



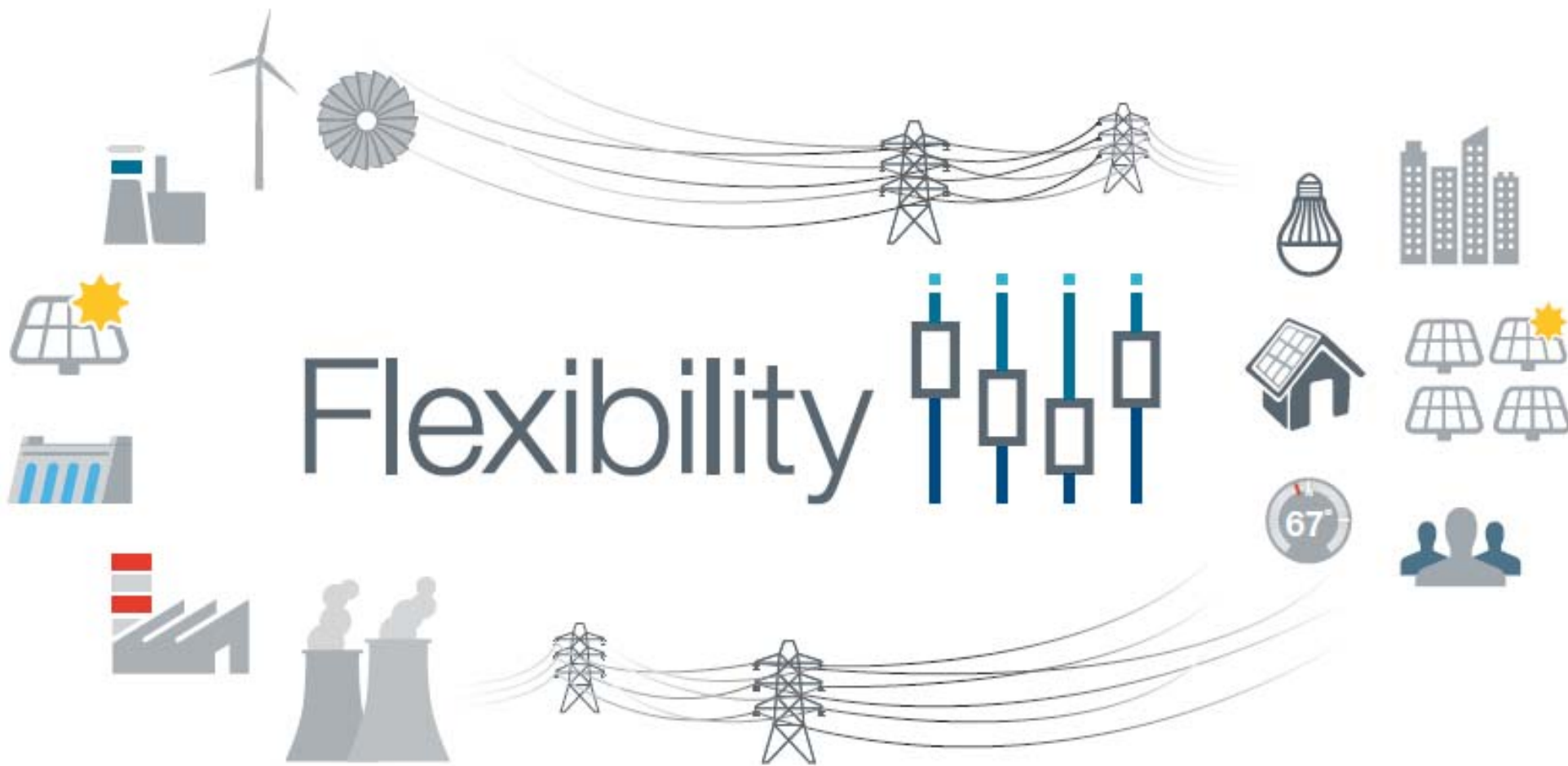
Integrated Resource Planning

- Collaboration with stakeholders to envision the generation needs of the future
- Based on least-cost planning foundation
- Provides foundation for developing long-range financial plans
- Considers a number of potential futures to help predict changes in the marketplace



The IRP functions like a compass, not a GPS

Flexibility



EIS Process

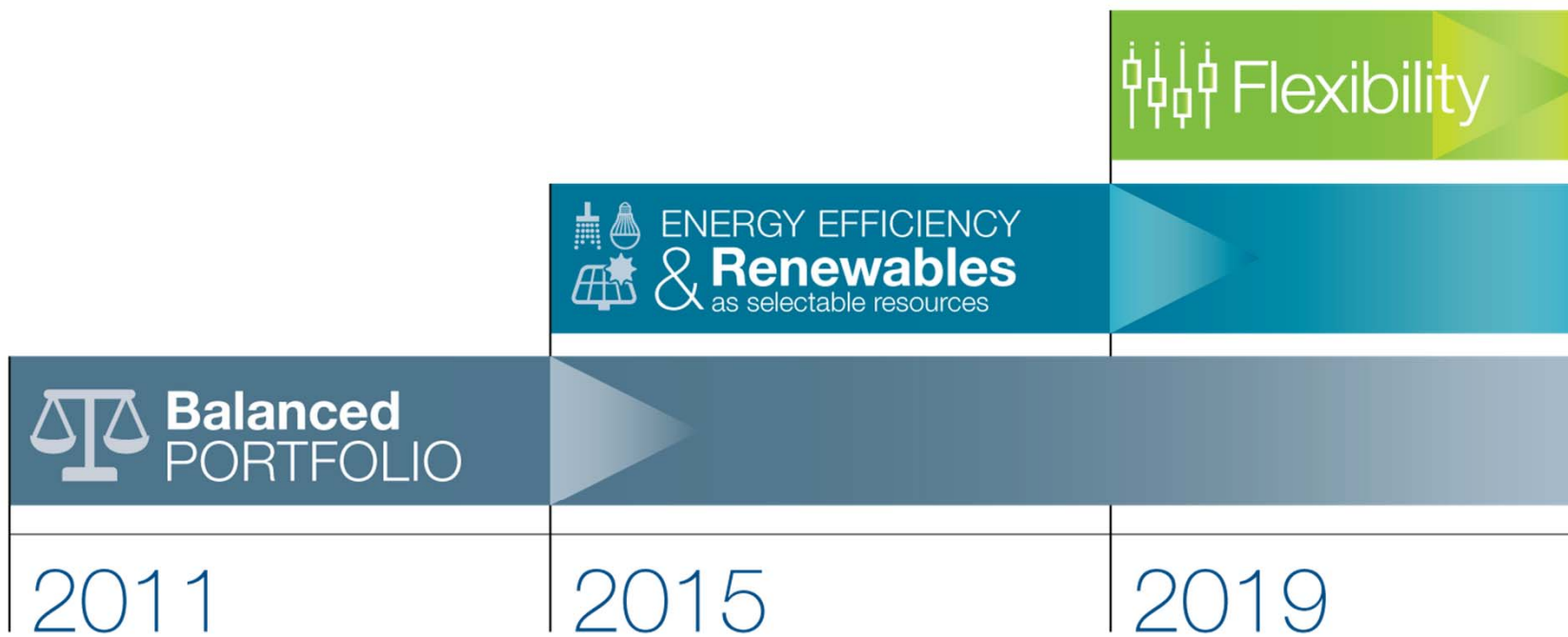


IRP Process



(** indicates timing of Valley-wide public meetings)

INTEGRATED Resource Plan 2019



2019 IRP Schedule: Schedule & Milestones

The 2019 IRP Study Approach is intended to ensure transparency & enable stakeholder involvement



(** indicates timing of Valley-wide public meetings)

Key Tasks/Milestones in this study timeline include:

- Establish stakeholder group and hold first meeting (Feb 2018)
- System modeling (June - December 2018)
- Publish draft EIS and IRP (Feb 2019)
- Complete public meetings (March 2019)
- Board approval and final publication of EIS and IRP (expected Summer 2019)

Stakeholder Engagement is a Cornerstone of TVA's IRP Process

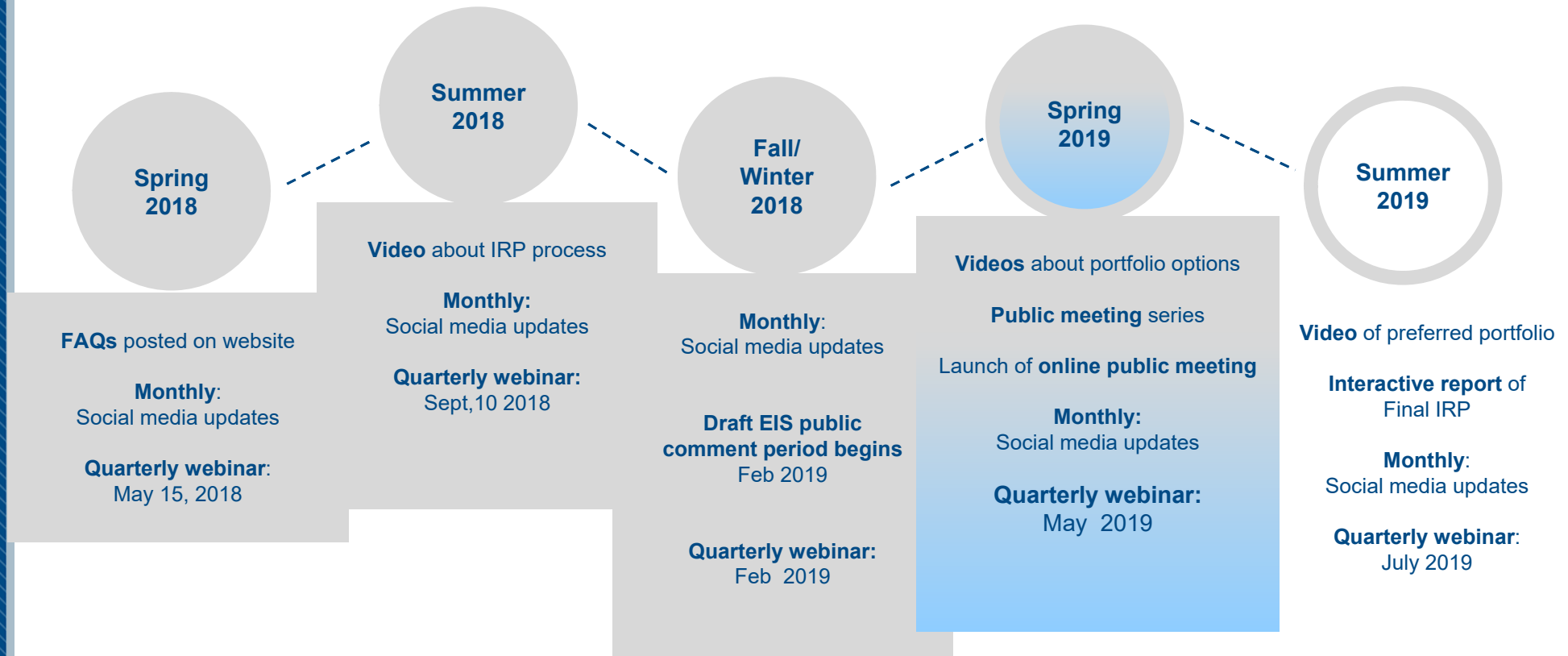
- TVA's Integrated Resource Planning is unique
- More informed decision-making
- Better outcomes
- As a federal agency, TVA complies with the National Environmental Policy Act (NEPA)

2019 IRP Working Group

- Diverse Representatives
 - 8 customer representatives, including:
 - 12 stakeholder representatives, including:
 - > 3 energy and environmental non-governmental organizations
 - > 3 from research and academia with expertise in distributed energy resources (DERs)
 - > 2 from state government
 - > 2 representing economic development
 - > 2 representing community and sustainability interests
- Robust meetings to share details/ gain input
- 12 Meetings held through March, 2019

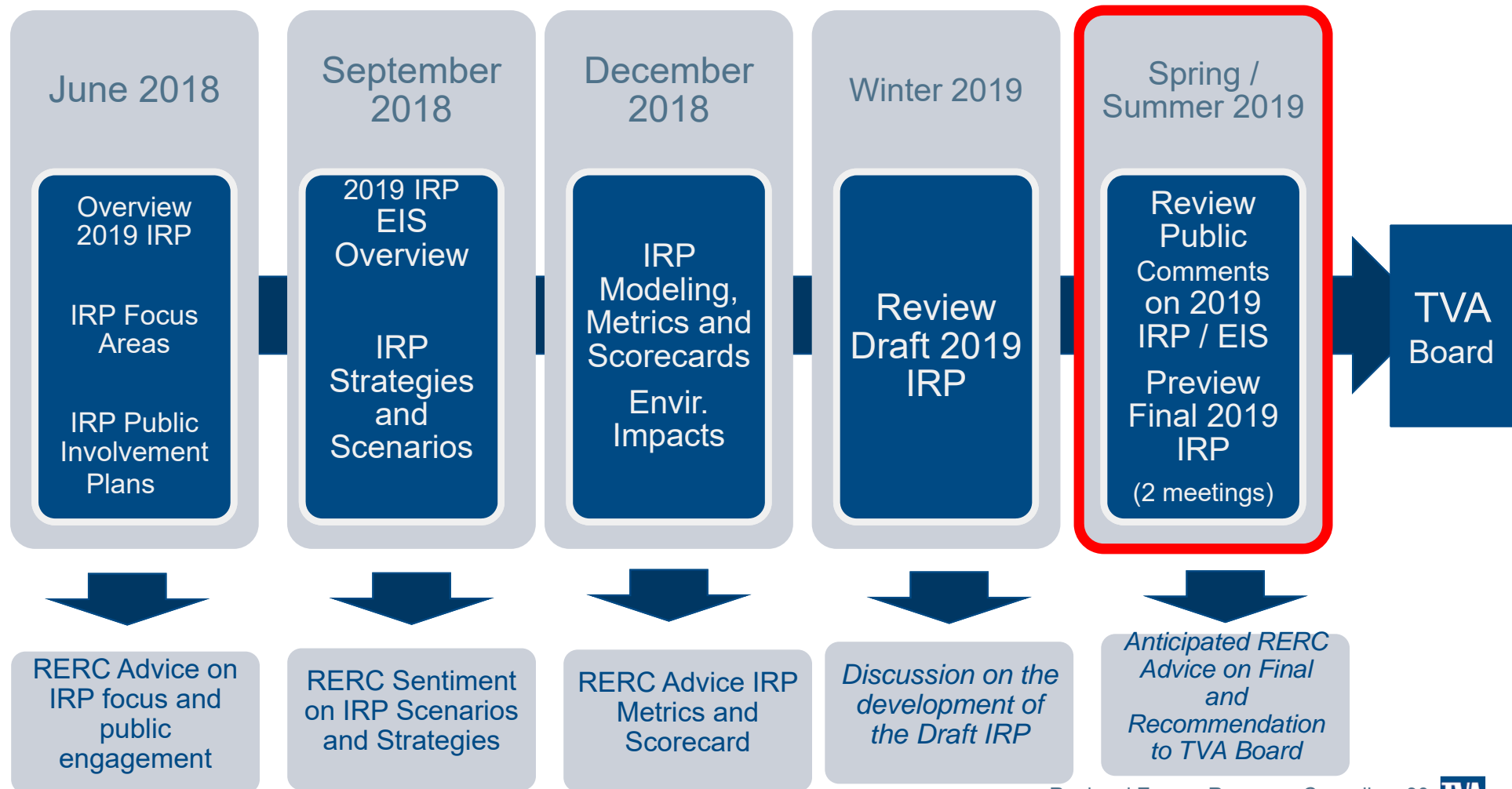


IRP Public Outreach



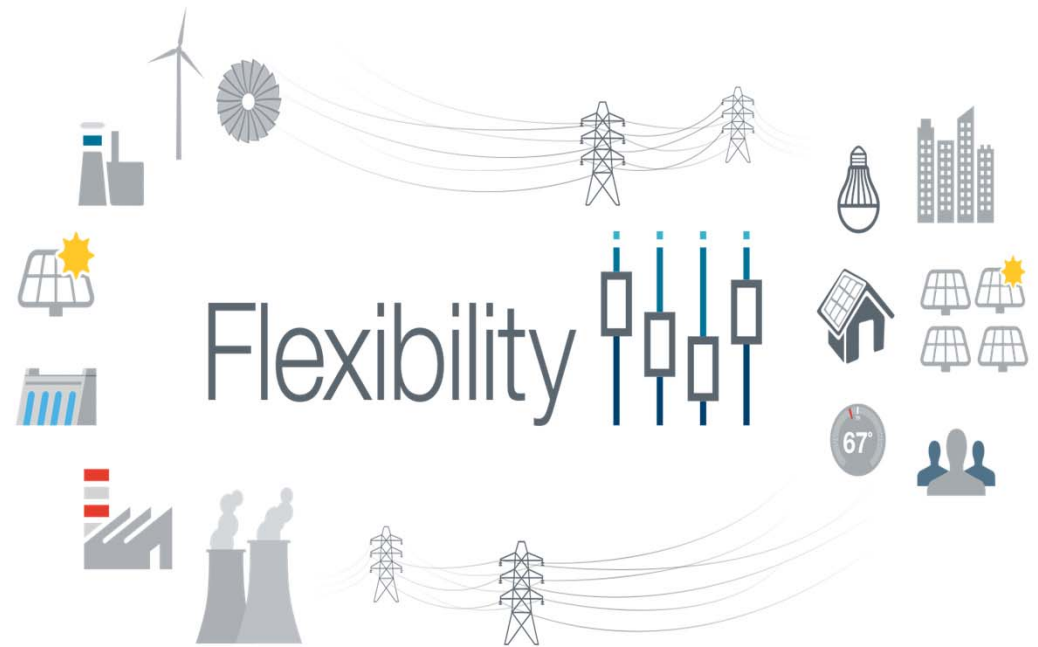
Note: Dates Subject to Change

RERC Review and Input to 2019 IRP



IRP Communications Objectives

- Educate various audiences about IRP and its importance
- Keep various audiences informed throughout the IRP process
- Use simple language to explain technical concepts
- Gather input and gain buy-in from customers and stakeholders



IRP Public Outreach

Outreach to Stakeholders & Public

- Social Media Campaign
 - Facebook
 - LinkedIn
 - Twitter
 - Instagram
 - YouTube
- Other Formats
 - Videos
 - Interactive Report
 - IRP Fact Sheet
 - IRPWG Meeting Summaries
 - FAQs on Website

WHAT IS AN INTEGRATED RESOURCE PLAN (IRP)?

The IRP is a decision support tool that helps guide us on how to best meet future electricity demand.

WHAT IS THE IRP SCOPING REPORT?

Your feedback is a vital part of developing the IRP.

The Scoping Report and comments received during the comment period.

IN THE REPORT:

- View final strategy consideration in
- See a summary of
- View comments

Public Outreach Events

- Quarterly public webinars
- Public scoping meetings
- Public meetings
- Online meetings

HAVE YOUR VOICE HEARD!

Your feedback is a vital part in helping us to develop a balanced resource portfolio that meets the needs of our many diverse communities across the Valley!

NOW! VISIT TVA.COM/IRP TO:

- View content from public scoping meetings
- See slides from past webinars
- Join our mailing list
- Request more information on the IRP

COMING SOON!

- Webinar with update on IRP progress
- Public meetings in your area
- Online meeting with comment function

Regional Energy Resource Council 35



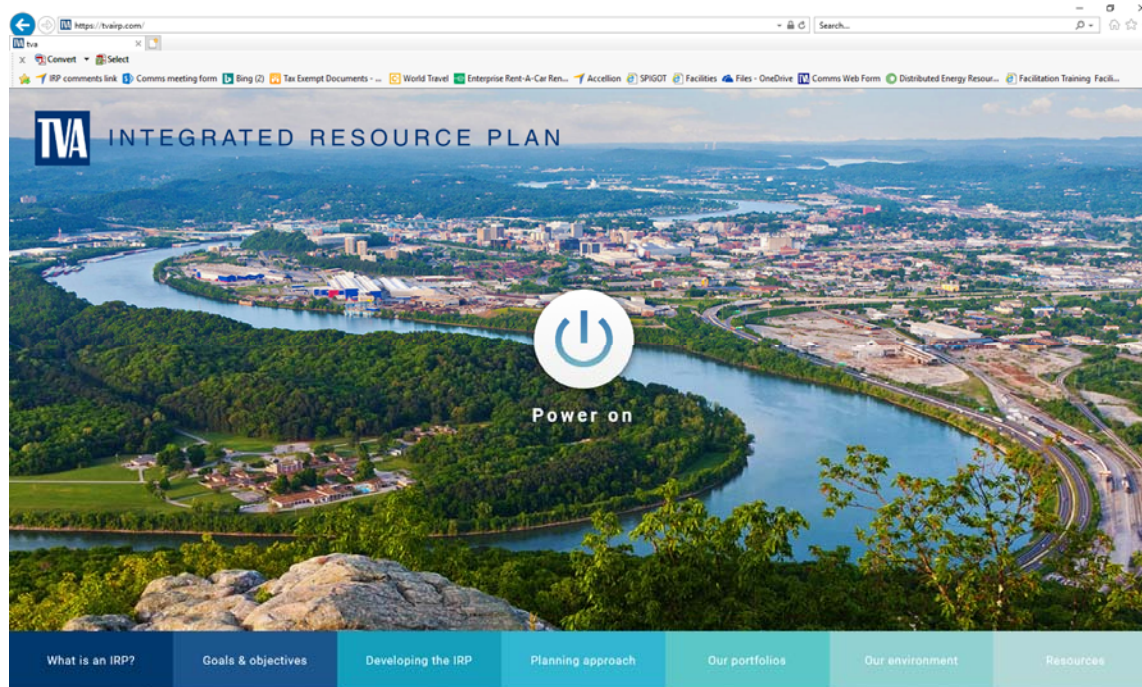
TVA – 2019 IRP Website



www.tva.com/irp

- 11,500 page views
- Average 3.34 minutes per visit
- Peak Traffic – 426 page views on Feb 15, 2019

2019 Draft IRP Interactive Report



www.tvairp.com

- Feb 18, 2019 - Apr 15, 2019
- 800 page views
- Average 5.28 minutes per visit
- City of Chattanooga had the highest number of users -- 155





Recap of Public Comment Period and Key Topics

Amy Henry and Matthew Higdon

Draft IRP/EIS Comment Period Summary

- TVA released the Draft IRP and EIS on February 15, 2019, initiating a public review period that concluded on April 8th.
- TVA hosted seven public meetings around the Valley and held one public webinar.
- TVA's website included an *Interactive Report* for the public to learn about the IRP.
- During the comment period, TVA received over 300 comment submittals on the Draft IRP/EIS, as well as a petition signed by more than 979 individuals (Sierra Club).

2019 IRP Public Meetings

- February 26 - Public Webinar (105 attendees)
- February 27 - Knoxville (39 attendees)
- March 18 - Memphis (56 attendees)
- March 19 - Huntsville (48 attendees)
- March 20 - Chattanooga (31 attendees)
- March 21 - Nashville (99 attendees)
- March 26 - Bowling Green (17 attendees)



Draft IRP/EIS Comment Period Summary

Organizations that provided comments on the Draft IRP/EIS include:

Tennessee Wildlife Federation
Tennessee Department of Environment and Conservation
Metro Government of Nashville
Tennessee Solar Energy Association
Center for Biological Diversity
City of Oak Ridge
City of Knoxville
The Climate Reality Project
Tennessee Citizens for Wilderness Planning
Tennessee Interfaith Power and Light
Tennessee Valley Industrial Committee
Tennessee Valley Public Power Association
Alabama Solar Association
Senator Rand Paul
U.S. Department of the Interior

U.S. Environmental Protection Agency
Kentucky State Clearinghouse
Mississippi Department of Archives and History
Tennessee Historical Commission
Virginia Department of Historic Resources
Southern Alliance for Clean Energy
Southern Environmental Law Center
Sierra Club (includes a petition)
Southern Renewable Energy Association Citizen's Climate Lobby, Knoxville Chapter
Conservation Fisheries, Inc.
American Petroleum Institute
Sunrise Movement, Knoxville
Universal Fibers Systems
NAACP
Energy Alabama

Draft IRP and EIS Comment Topics

- Support for:
 - distributed generation
 - demand reduction
 - energy storage
- Concern over small amount of energy efficiency in portfolios
- Support for and concern about coal plant retirements
- Increased and earlier adoption of renewable energy
- Concerns about climate change and GHGs
- Support for and opposition to nuclear energy
- Concern about the accuracy of land use metric, particularly for solar generation
- Assumptions of costs for various resources
- Need for more transparency in IRP process and bench-marking
- Operations and role of the IRP Working Group
- Support for increased hydroelectric generation

Support and Challenges for Key Topics

- IRP Process and Transparency:
 - Support: *“appreciates TVA's openness and transparency during the process. TVA provided extensive background on the methodology, inputs, and results of the planning process”*
 - Challenge: *“For the 2019 IRP process TVA benchmarked its supply-side resource assumptions behind closed doors, and does not appear to have sought stakeholder input or industry expertise on demand-side resource assumptions.”*

Support and Challenges for Key Topics

- Renewables

- Support: *“Please move toward more renewable and clean energy solutions as quickly as possible and phase out sources that have a negative impact on our climate.”*
- Challenge: *“Do not invest in renewable (green) power such as solar and wind power which are not economically attractive and only increase consumer's electricity costs.”*

Support and Challenges for Key Topics

- Metrics – Land Use

- Positive: *“Given the large amount of land that is facing energy development and potential changes in land use, would like to discuss the details and implications of solar expansion on land use”*
- Negative: *“the new metric disproportionately affected solar due to its flawed methodology, a reasonable observer can only conclude TVA ignored the IRPWG in order to disadvantage solar energy”*

Commonly Asked Questions



Q&A / RERC Discussion

RERC Discussion

1. What key points are most interesting to you from the public comment topics?



Break – Prepare for Public Listening Session at 3:30

Public Listening Session

- **Public participation is appreciated**
- **This is a listening session; responses are typically not provided**





Thank you and Travel Safely

The RERC will reconvene tomorrow at 8:30





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RERC Meeting Recap – Day 1



Moving to the Final IRP and EIS

Moving to the Final IRP

- Sensitivities
- Forming a Recommendation
- Finalizing the IRP and EIS



Update on Sensitivities

Jane Elliott

What is the Purpose of Sensitivity Analysis?

- Sensitivity analyses are performed to help answer questions meriting further evaluation
- Sensitivity analyses are typically run as variations from Case 1A, the Base Case strategy applied in the Current Outlook scenario, to isolate the impact of a change in one key assumption
- All sensitivities will be run off the updated Base Case reflecting recent plant retirement decisions made by the TVA Board
- Sensitivities will be considered, along with the balance of portfolio results, when developing the 2019 IRP recommendation

2019 IRP Sensitivities

Today

- ✓ Older Gas CT retirements
- ✓ Integration cost and flexibility benefit
- ✓ High and low gas prices (two standard deviations)
- ✓ Solar acceleration and caps
- ✓ Breakeven analysis for storage, wind, CHP and SMR capital costs

Next Meeting

- More stringent carbon penalty (Double decarbonization scenario)
- Increasing ongoing operating costs for coal plants
- Extreme weather case (acute and chronic)
- Increased EE and DR market depth



Older Gas CT Retirements

Gas CT Retirement

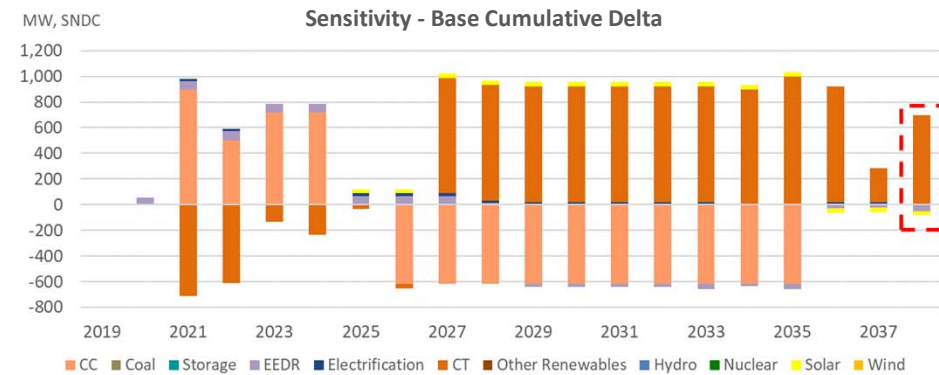
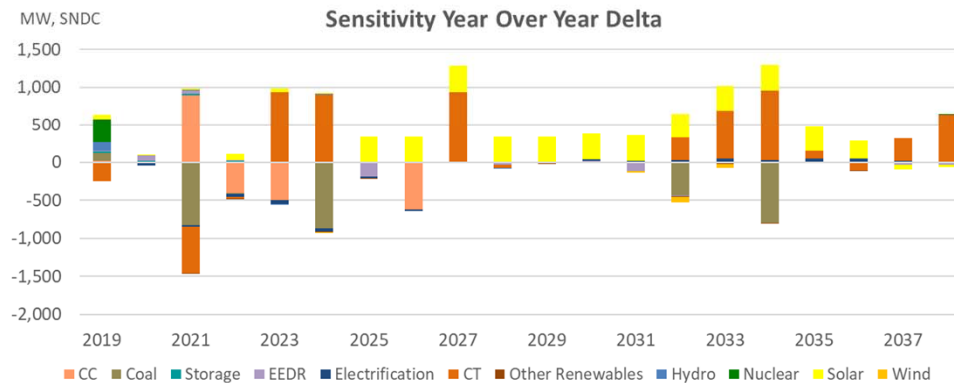
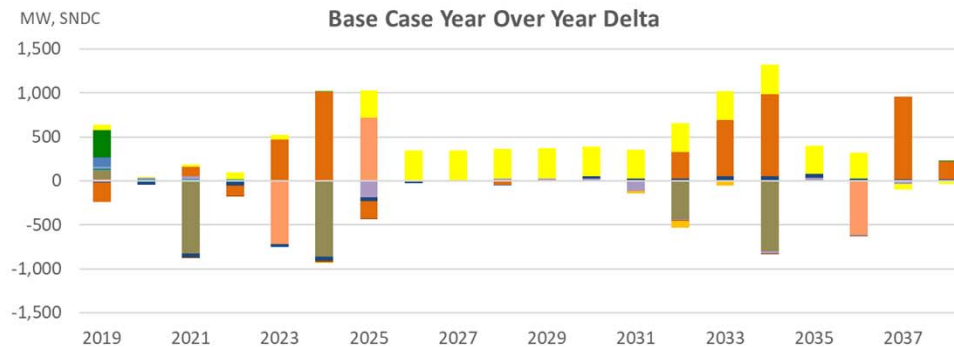
Objective: Perform a sensitivity bounding case to evaluate the potential impact of retiring older Gas CTs on IRP results.

Approach: Assume all Gas CTs older than 40 years are retired at the earliest possible date (2020), then rerun models to derive impact on capacity expansion plan and metric results.

Gas CTs older than 40 years include:

- Allen CT Plant
- Colbert CT Plant
- Gallatin CT Units 1-4
- Johnsonville CT Units 1-16

Gas CT Retirement Case



- The timing of CT capacity additions shift, and over the course of 20 years there is an increase of ~700 MW of CT capacity
- CT capacity replaces CC capacity starting in 2027 to meet peaking needs



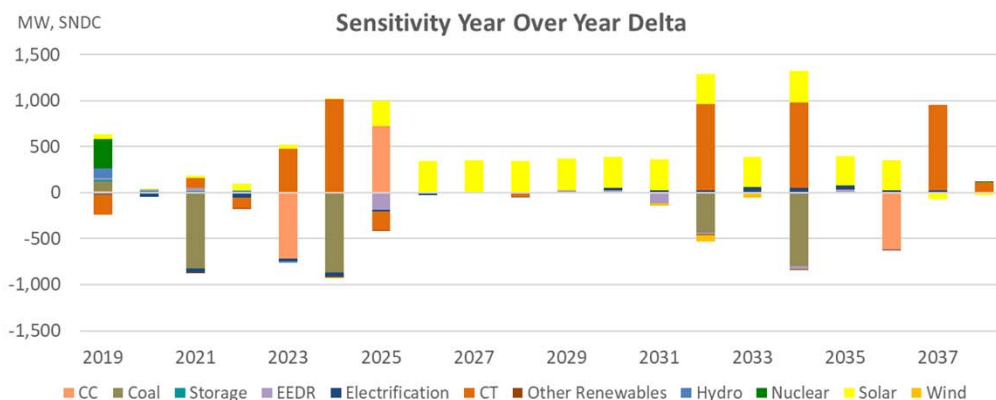
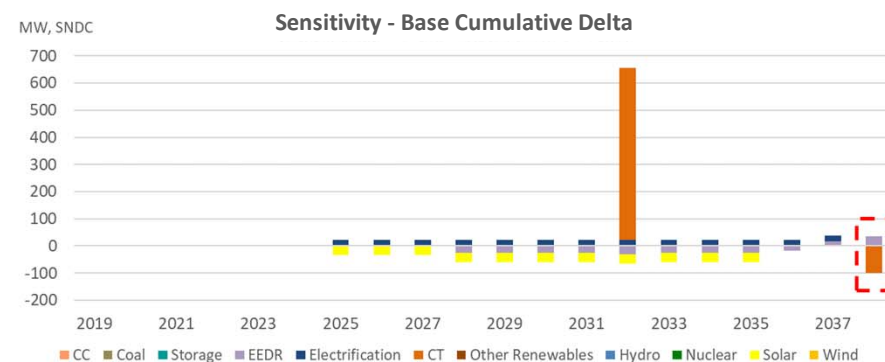
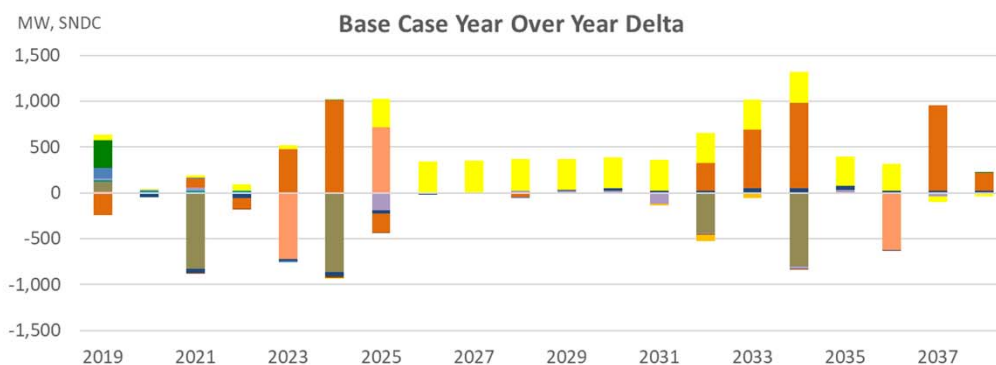
Integration Cost & Flexibility Benefit Case

Integration Cost & Flexibility Benefit Case

Objective: Perform a sensitivity case to evaluate the impact of removing integration costs and flexibility benefits on IRP results.

Approach: Remove solar & wind integration costs and aeroderivative CT & battery flexibility benefits, then rerun models to derive impact on capacity expansion plan and metric results.

Integration Cost & Flexibility Benefit Case



- Minimal impact on the capacity plan over time
- Removing integration costs and flexibility benefits drives timing differences in CT capacity additions but a very similar end result

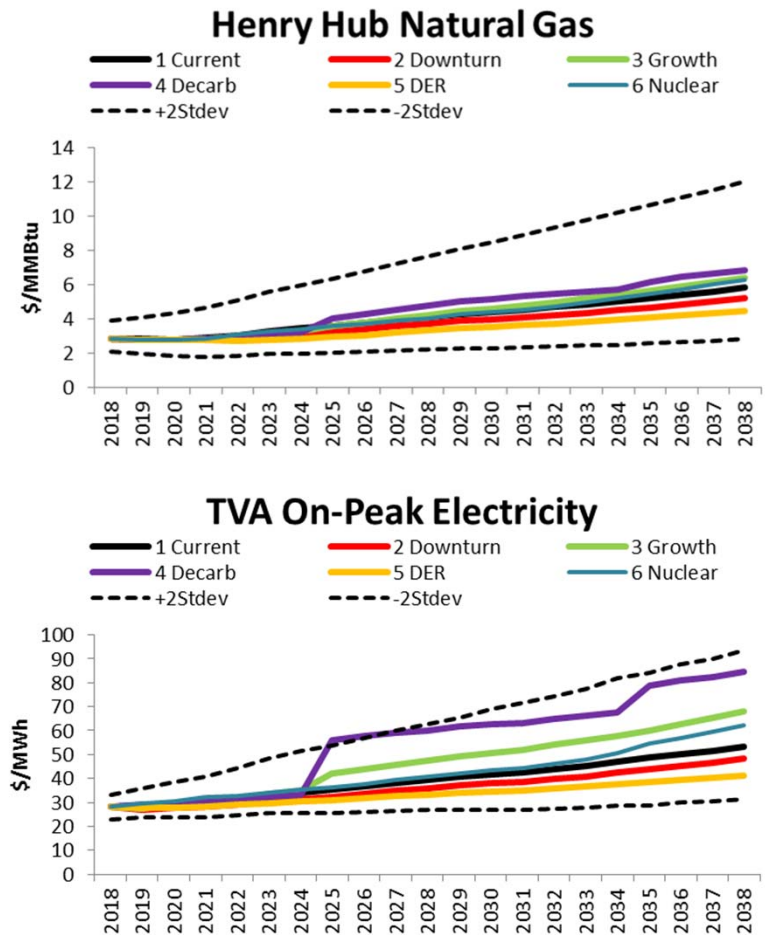


High and Low Gas Prices

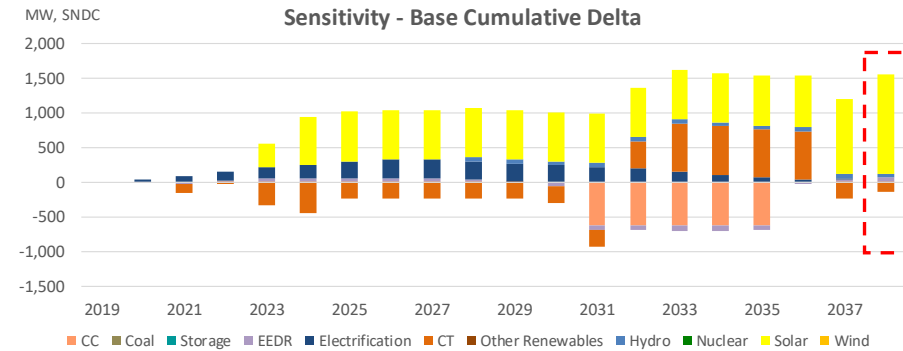
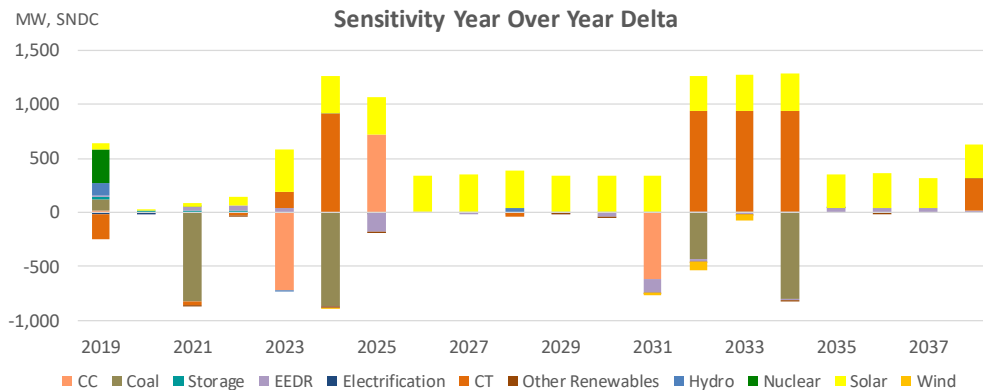
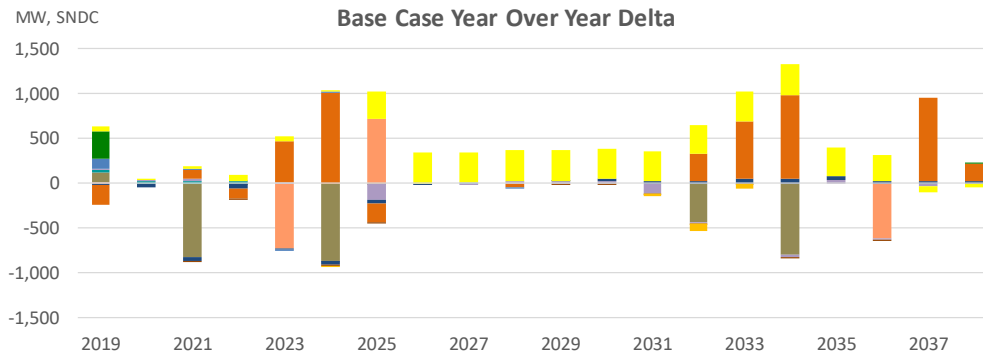
High & Low Gas Prices

Objective: Perform a sensitivity bounding case to evaluate the potential impact of high and low gas prices.

Approach: Assume additional sensitivities in which gas prices are two standard deviations below and two standard deviations above the fundamental forecast, then rerun models to derive impact on capacity expansion plan and metric results.

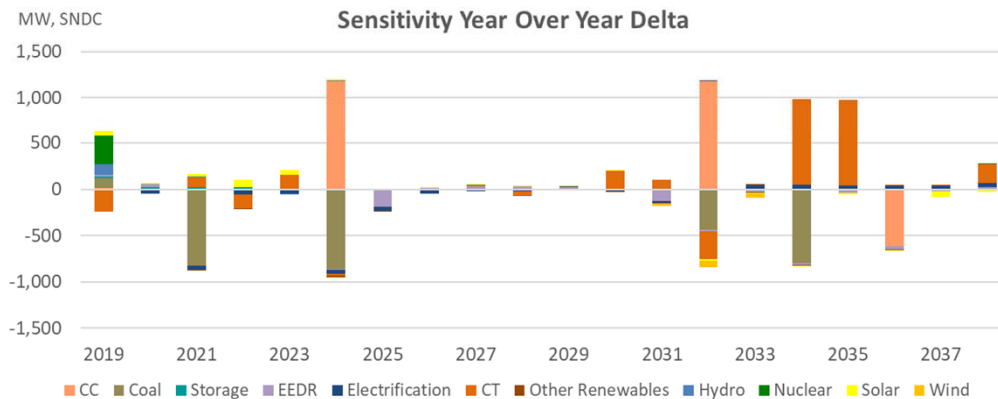
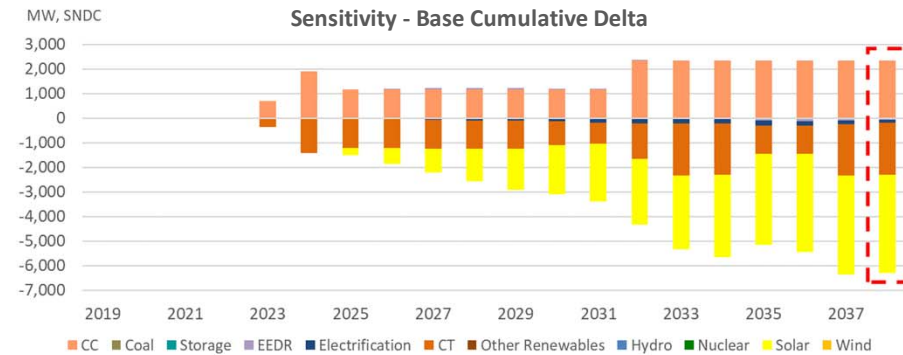
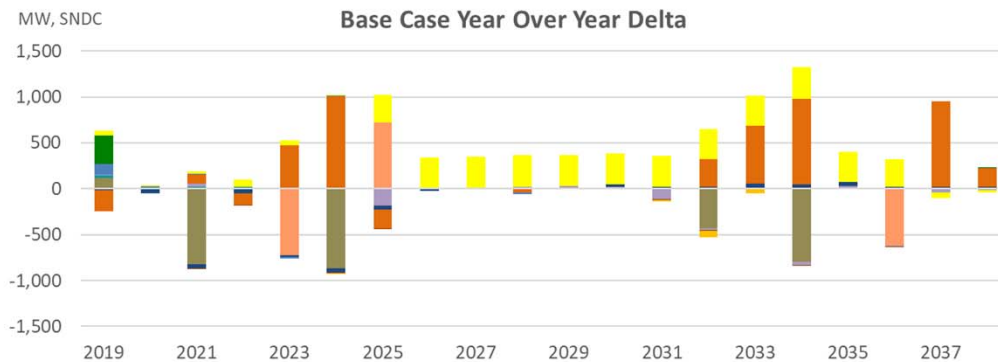


High Gas Prices



- By 2038, an additional ~1,400 MW of solar and ~55 MW of new hydro replace a small amount of CT capacity
- Electrification programs are reduced and CC capacity is swapped for CT builds earlier in the plan
- Gas is a significant component of total generation, so the avoided energy cost for alternate resources is higher in this sensitivity

Low Gas Prices



- By 2038, ~4 GW of solar and ~2 GW of CT capacity is replaced with CC capacity
- However, this sensitivity does not take into account customer demand for renewables and clean energy that would likely create a floor for renewable additions



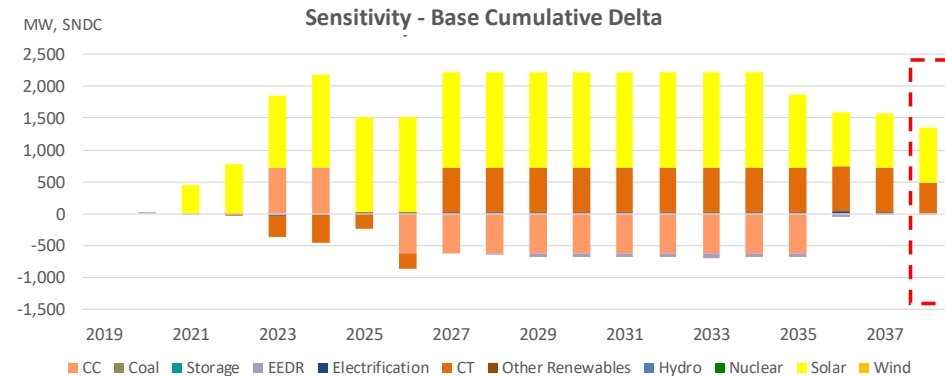
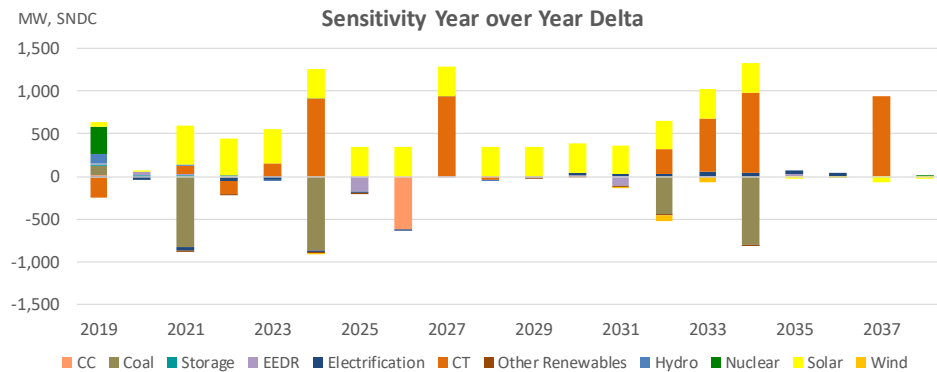
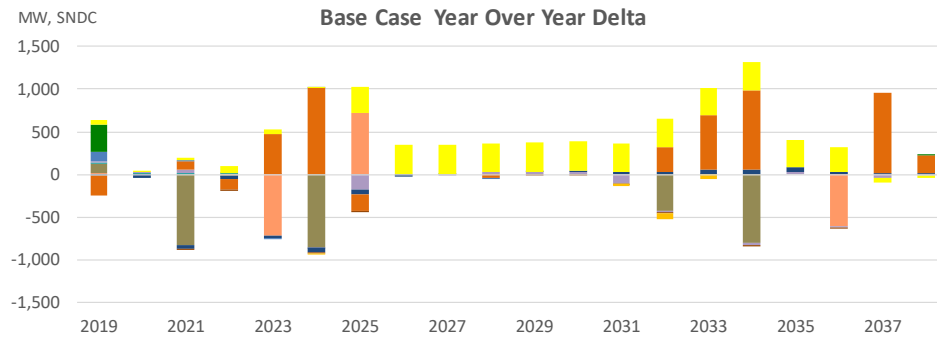
Solar Acceleration and Annual Caps

Accelerated Solar

Objective: Perform a sensitivity case to evaluate the impact of accelerating solar builds to align with the potential timing of customer demand for renewables.

Approach: Reflect recent Facebook and Google solar signings of ~700 MW total scheduled to come online by 2021 and assume 500 MW per year accelerated solar additions thereafter until economic solar additions pick up in the mid-2020s, then rerun models to derive impact on capacity expansion plan and metric results

Accelerated Solar



- Accelerating solar additions primarily has the effect of bringing the economic solar additions forward, resulting in an additional ~800 MW of solar by 2038 which is less than the total accelerated amounts
- Total nameplate MW of solar is below 10,000 MW in the both cases

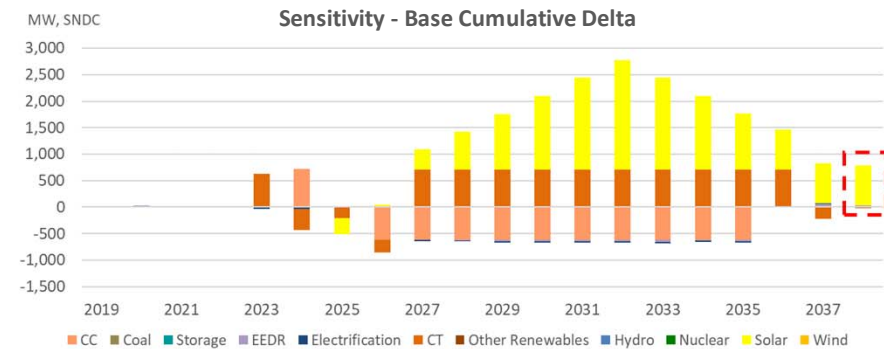
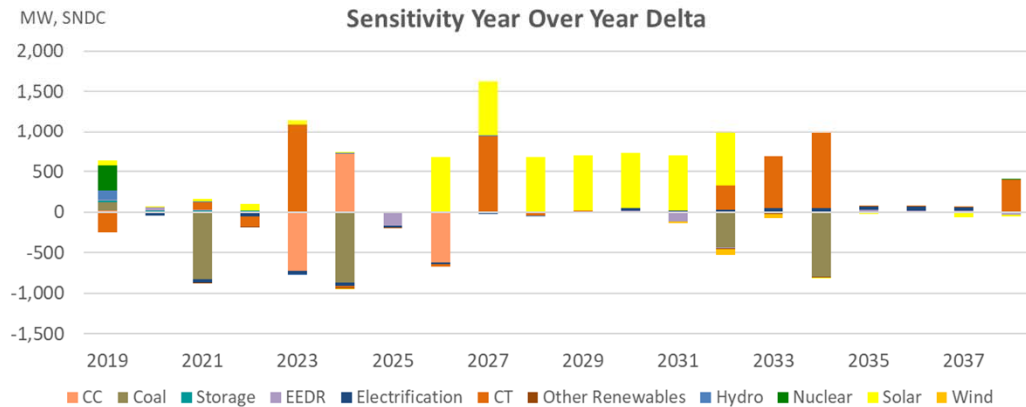
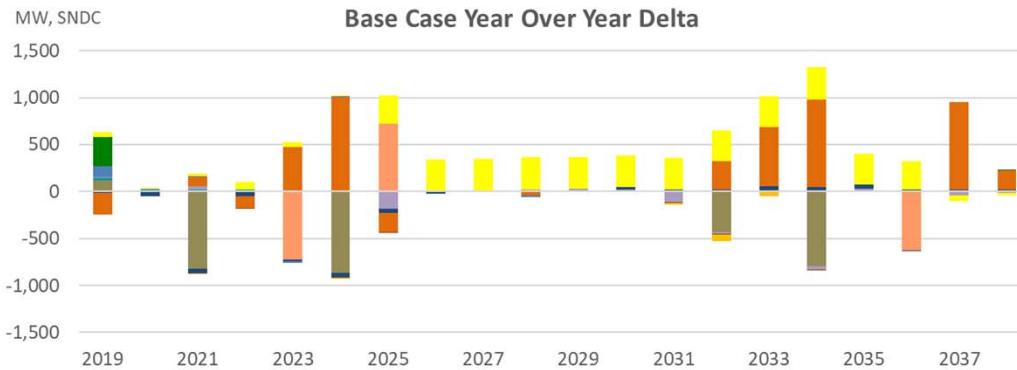
Double Annual Solar Cap

Objective: Perform a sensitivity case to evaluate the potential impact of increasing the annual cap on solar additions.

Approach: Double the annual solar cap to 1,000 MW and remove the cumulative cap on solar additions, then rerun models to derive impact on capacity expansion plan and metric results

Note: There are limitations on the timing of other resource additions, such as how many new builds can be planned for a given year, to reflect the practicality of when we have knowledge of the need and other project management considerations.

Double Annual Solar Cap



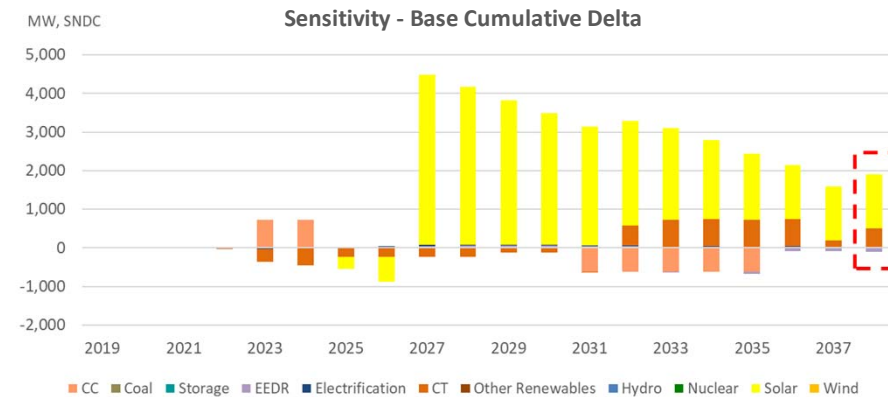
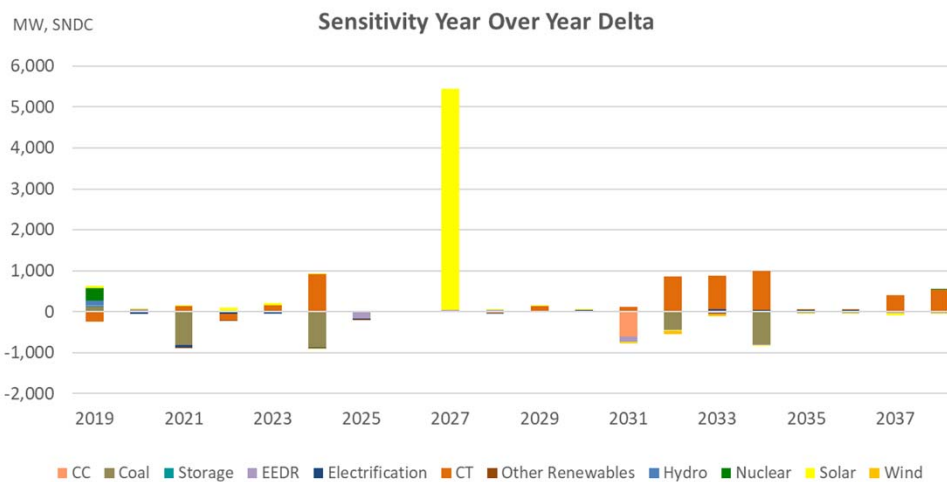
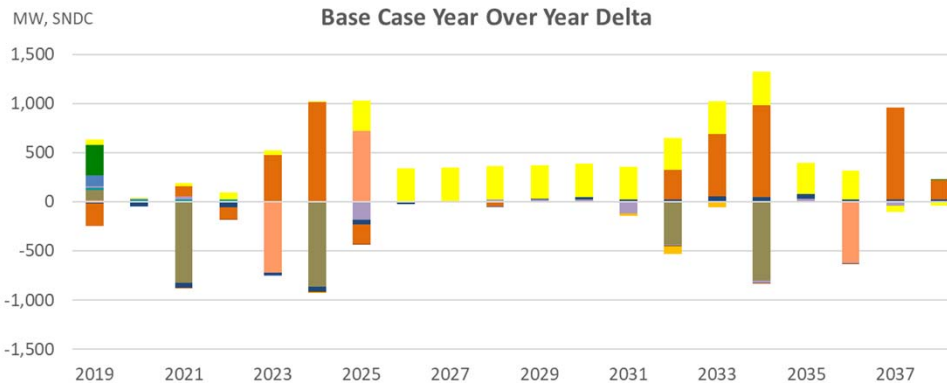
- In this case, solar capacity is accelerated due to favorable pricing in the mid to late 2020s
- By 2038, ~750 MW of additional solar capacity is added

No Annual Solar Cap

Objective: Perform a sensitivity case to evaluate the potential impact of removing annual solar limits.

Approach: Remove the annual and cumulative cap on solar additions, then rerun models to derive impact on capacity expansion plan and metric results.

No Annual Solar Cap



- By 2038, ~1,300 MW of additional solar capacity is added
- In practicality, it is unrealistic to have perfect foresight of the “optimal year” and to manage additions of this magnitude in a single year



Breakeven Analysis: Wind, Storage, CHP & SMR Capital Costs

Breakeven Analysis

- Objective: Perform a breakeven analysis for resources that were promoted but not selected based on economics. These resources include:
- Wind
 - Battery Storage
 - Combined Heat & Power
 - Small Modular Reactors
- Approach: Force each resource into the expansion plan at zero cost in the first year available to determine PVRR impacts from displaced energy and capacity, then derive the levelized breakeven cost or value of that resource.

Breakeven Analysis

Resource	Online Year	Lifespan	MW	Levelized Breakeven*	IRP Assumption*
Wind	2023	20	200	\$27/MWh	\$83/MWh
Battery Storage	2023	20	200	\$62/MWh	\$241/MWh
SMR 600 MW SMR 720 MW (Post-IRP)	2028	40	600	\$46-53/MWh \$44-53/MWh	\$125/MWh \$109/MWh

- TVA IRP wind assumptions reflect PTC expiration and no decreasing technology curve, resulting in costs that are triple the breakeven; TVA will continue to monitor wind costs for changing economics
- Battery storage is a higher value resource, but costs are still triple the breakeven value; TVA will continue to monitor rapidly evolving battery storage costs for improving economics
- SMR investment is capital intensive and more than double the breakeven value; refinements in design improve costs, but cost and risk sharing are essential to close the gap

2019 IRP Sensitivities

Today

- ✓ Older Gas CT retirements
- ✓ Integration cost and flexibility benefit
- ✓ High and low gas prices (two standard deviations)
- ✓ Solar acceleration and caps
- ✓ Breakeven analysis for storage, wind, CHP and SMR capital costs

Next Meeting

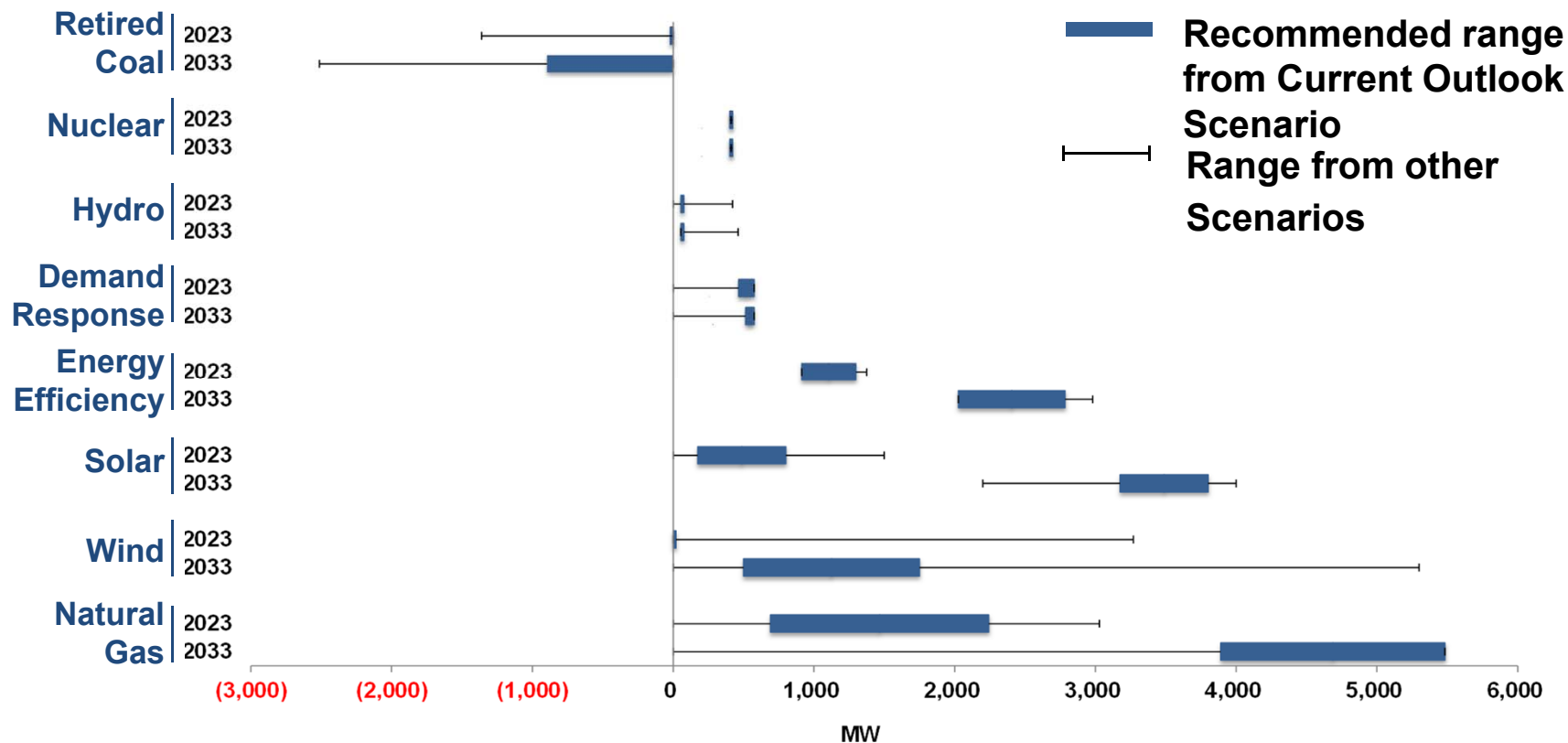
- More stringent carbon penalty (Double decarbonization scenario)
- Increasing ongoing operating costs for coal plants
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- Increased EE and DR market depth



Developing the Recommendation

Hunter Hydas

2015 IRP Recommendation



MWs are incremental additions from 2014 forward. Board-approved coal retirements and natural gas additions as of August 2015 are excluded.

Considerations for Developing Recommendation

- Draft IRP portfolio results and scorecards
- Tradeoff considerations
- Public comments
- Sensitivity results

Preliminary Feedback from IRPWG

- Box and whisker format
- Extremes from sensitivities
- Two 10-year periods vs. 20-year

Next Steps

- Received public comments through April 8 and will be developing responses in the coming weeks
- Continue work to run prioritized sensitivities and review at upcoming meetings
- Input from the IRPWG at May Meeting towards forming the recommendation
- Review balance of sensitivities and recommendation at June RERC meeting



Finalizing the IRP and Environmental Impact Statement

Hunter Hydas / Matthew Higdon

April 18, 2019

The Final IRP and EIS

- Final IRP will have additional chapters on:
 - Sensitivity Results and Discussion
 - The Recommendation
 - Implementation Challenges and Next Steps
- Final EIS will include:
 - Updated analyses incorporating the sensitivity results and the recommendation
 - A discussion of the public outreach and review process
 - Public comments and TVA responses







Q&A / RERC Discussion

RERC Discussion Questions

- 1. What key points are most interesting to you from the public comment topics?**
- 2. What should TVA consider as it creates a final recommendation for the 2019 IRP?**





RERC Discussion (cont'd)

RERC Discussion Questions

- 1. What key points are most interesting to you from the public comment topics?**
- 2. What should TVA consider as it creates a final recommendation for the 2019 IRP?**



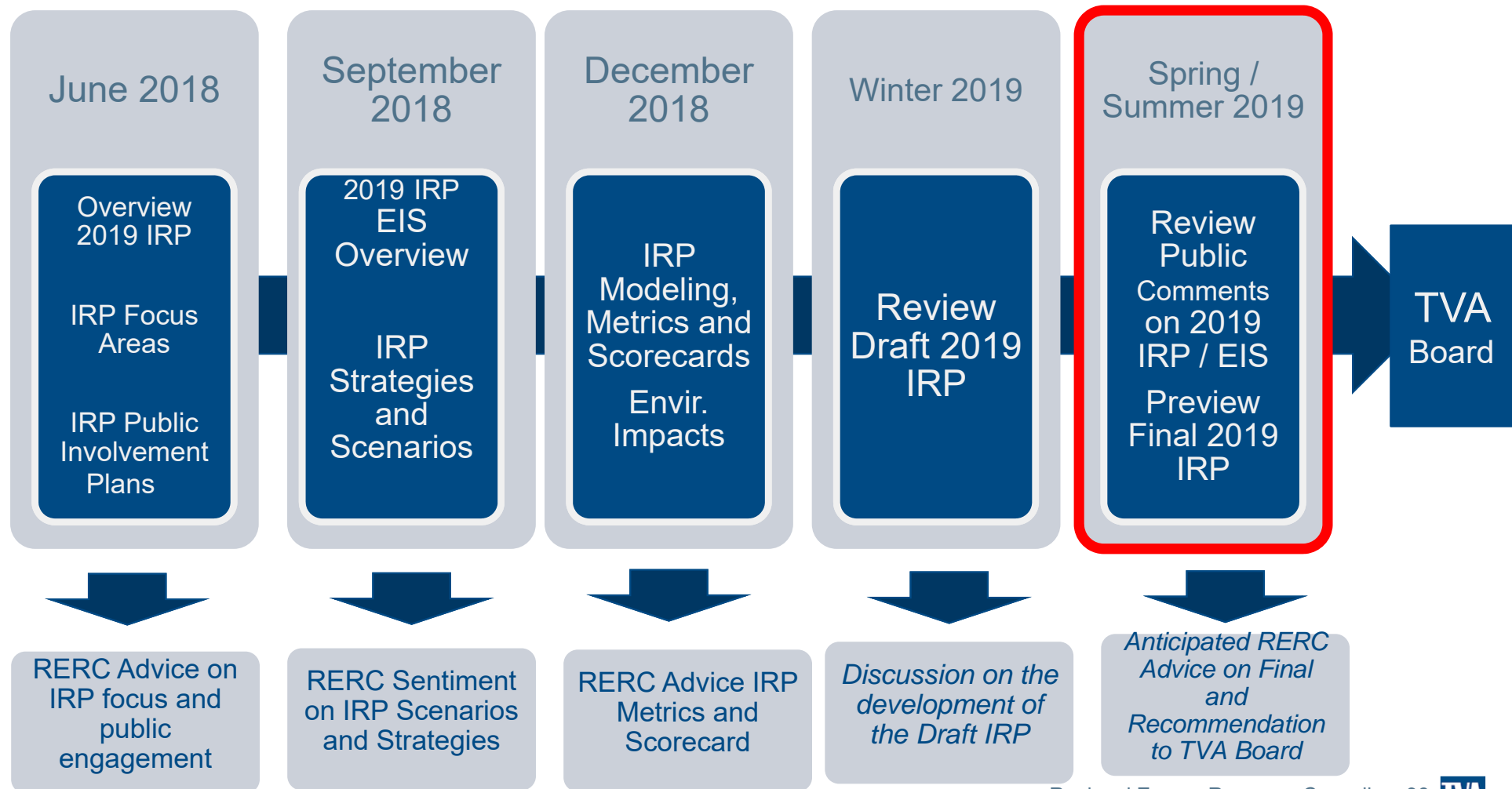
IRP Next Steps

Hunter Hydas- Project Manager, 2019 IRP

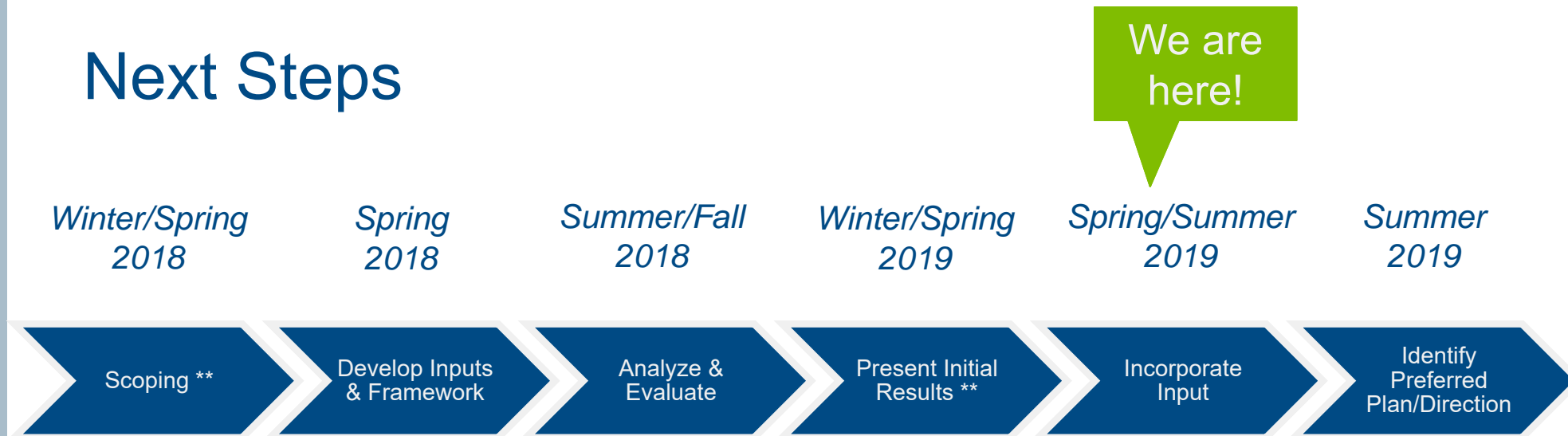
Developing the Final IRP and EIS

- Evaluate and address comments received
- Run sensitivities in model
- Analyze and develop preliminary recommendations
- Continue working with the IRP Working Group and RERC to develop final IRP

RERC Review and Input to 2019 IRP



Next Steps



(** indicates timing of Valley-wide public meetings)

Key Tasks/Milestones in this study timeline include:

- Establish stakeholder group and hold first meeting (Feb 2018)
- System modeling (June - December 2018)
- Publish draft EIS and IRP (Feb 2019)
- Complete public meetings (March 2019)
- Board approval and final publication of EIS and IRP (expected Summer 2019)



Wrap Up and Adjourn

Future RERC Tentative Meeting Dates

- June 26-27, 2019, Chattanooga, Tennessee
 - Review final IRP results and recommendation
 - RERC advice to TVA Board on 2019 IRP
- Term 3 of the RERC concludes July 30, 2019
- Thank you for your service!





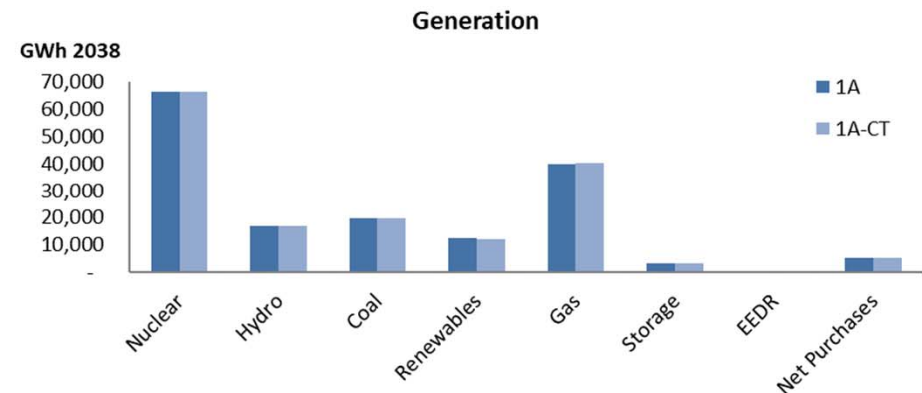
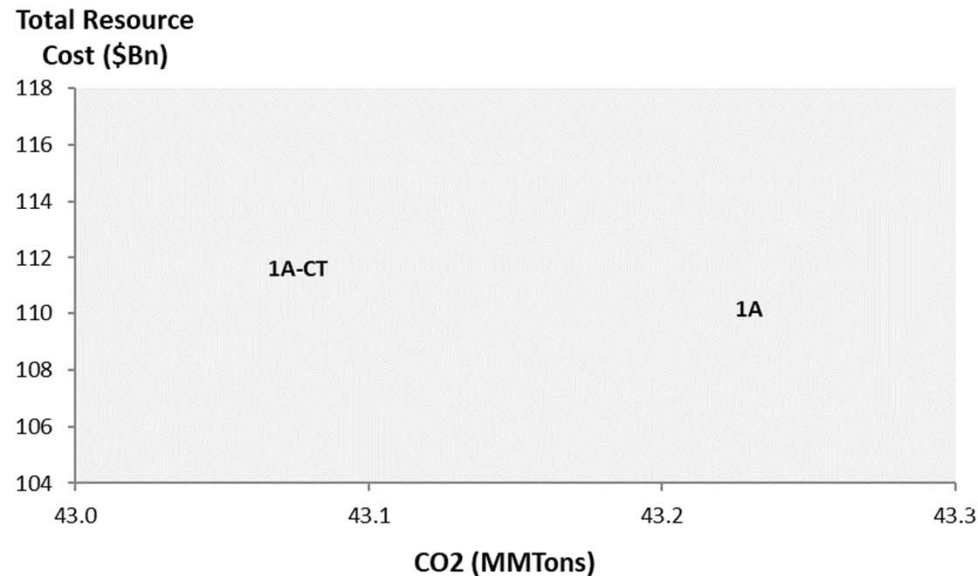
Thank you and please travel safely!



Appendix

Gas CT Retirement

Retiring older Gas CTs results in similar costs and carbon emissions, as older, higher maintenance CTs are replaced with newer, lower maintenance CTs. Generation largely remains the same.



Gas CT Retirement

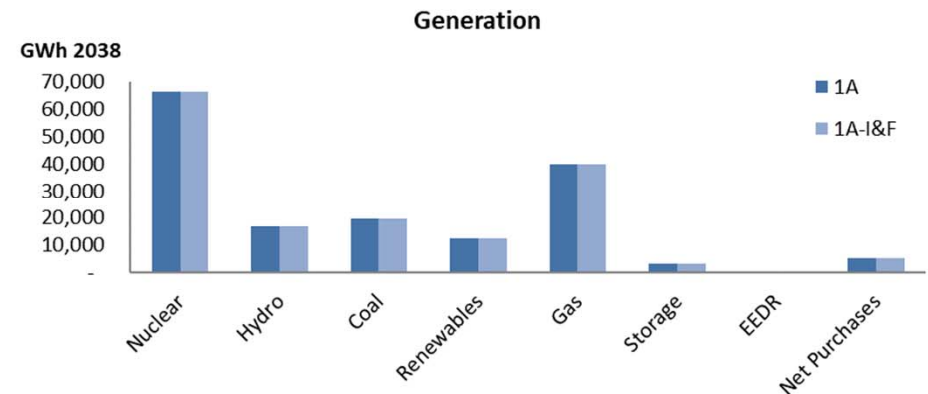
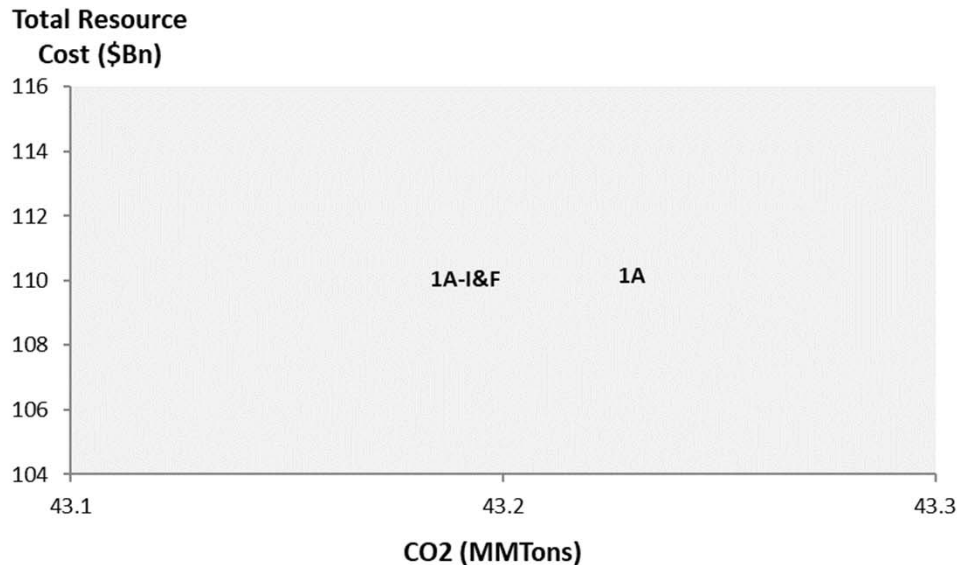
Sensitivity Metric Results

	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
Gas CT Retirement Case	111	71	112	1.06	120	43	539	54,001	2,259	43,221	2.07	50%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	1.44	0.98	1.45	0.00	1.43	0	-1	-0,052	-10	-144	0.09	0%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

Integration Cost & Flexibility Benefit Case

As removing integration costs and flexibility benefits has minor impact on capacity expansion plans, impacts on metric results overall from hourly models are also minor. However, it is important to understand integration costs and flexibility benefits in specific asset evaluations.



Integration Cost & Flexibility Benefit Case

Sensitivity Metric Results

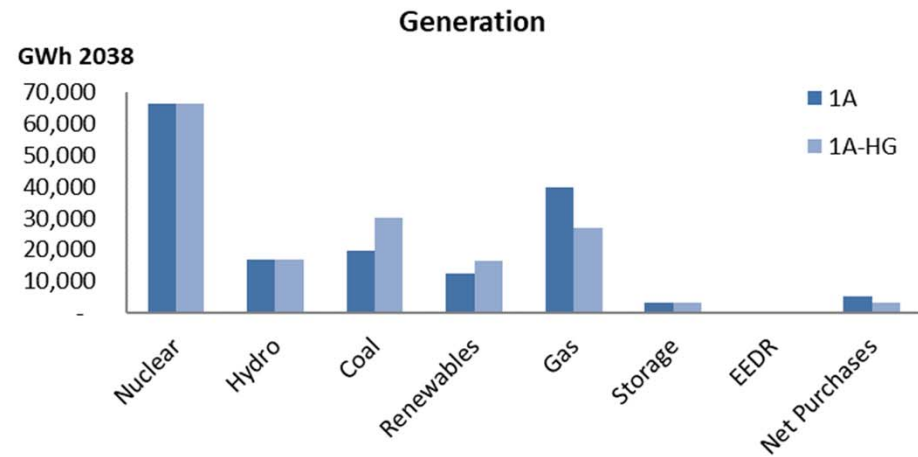
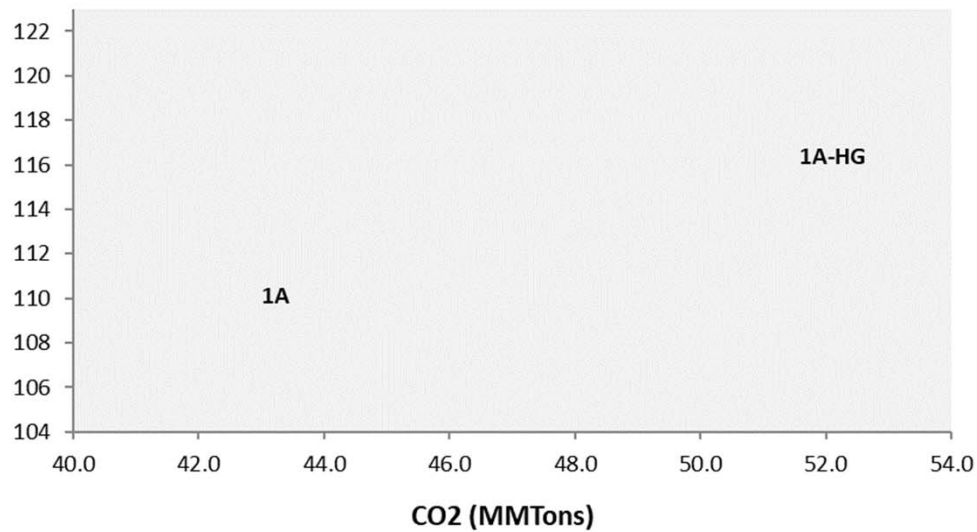
	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
Integration Cost & Flexibility Benefit Case	110	70	110	1.06	119	43	541	54,037	2,267	43,365	1.97	50%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	-0.10	-0.02	-0.10	0.00	-0.11	0	0	-0,016	-2	0	-0.01	0%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

High Gas Prices

High gas prices drive increased renewables capacity and coal generation along with lower gas capacity factors, resulting in higher carbon emissions overall.

Total Resource
Cost (\$Bn)



High Gas Prices

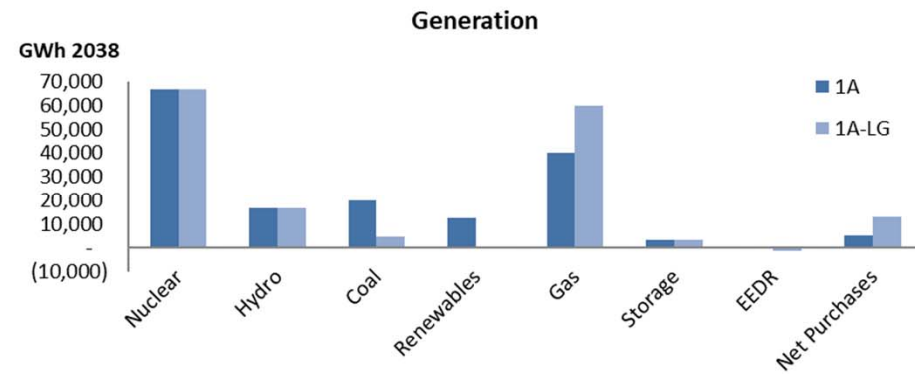
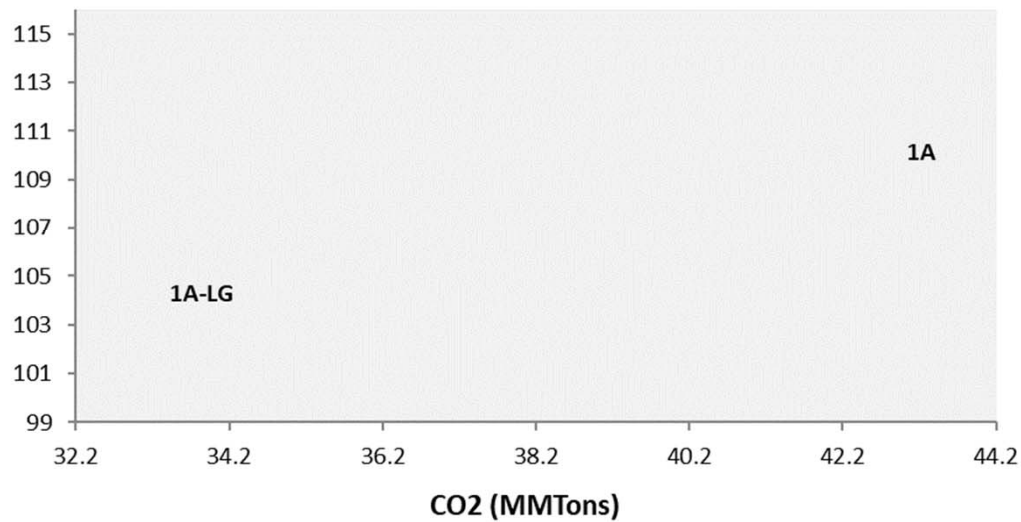
Sensitivity Metric Results

	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
High Gas Prices	116	75	116	1.10	128	52	658	56,902	3,296	58,695	1.70	53%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	6.27	4.66	6.25	0.03	8.88	9	117	2,849	1,028	15,330	-0.28	3%	0.00%	0.00%

Low Gas Prices

Low gas prices drive lower renewable capacity along with increased gas generation and lower coal capacity factors, resulting in lower carbon emissions overall.

Total Resource
Cost (\$Bn)



Low Gas Prices

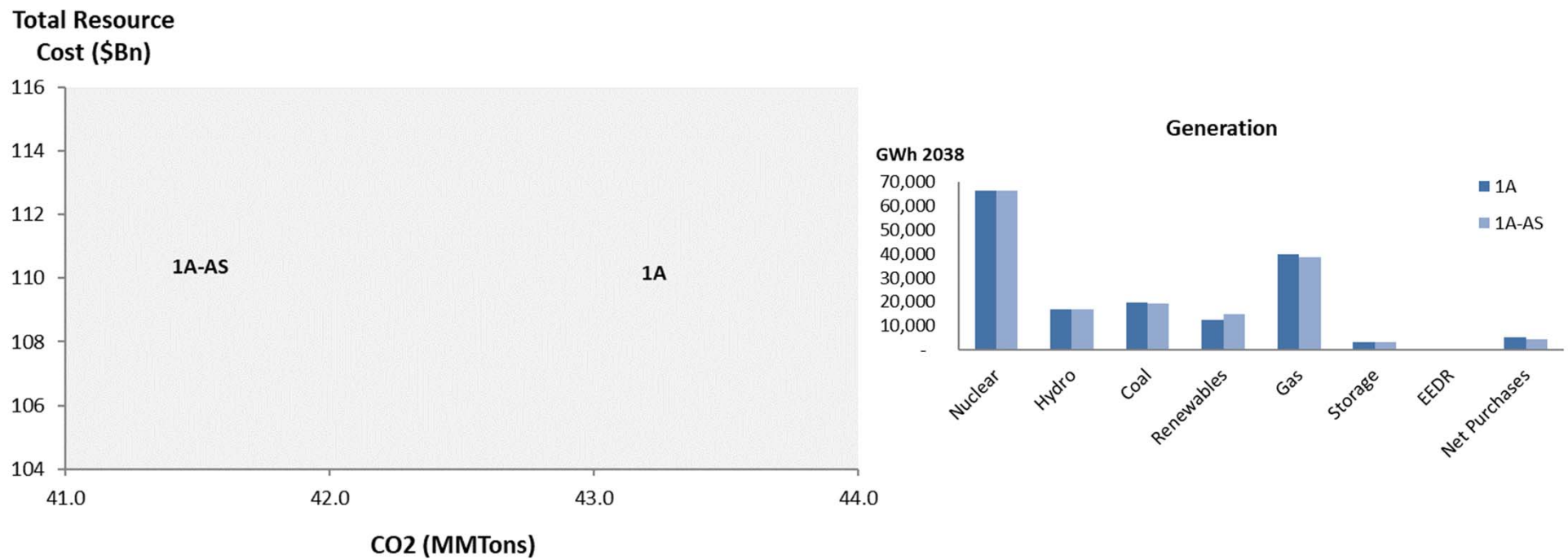
Sensitivity Metric Results

	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
Low Gas Prices	104	66	104	1.02	111	34	421	50,314	952	335	2.06	41%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	-5.87	-4.00	-5.85	-0.04	-7.72	-9	-120	-3,739	-1,316	-43,030	0.08	-9%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

Accelerated Solar

Given the overall impact on solar additions, renewable generation slightly displaces gas generation and leads to a reduction in carbon emissions.



Accelerated Solar

Sensitivity Metric Results

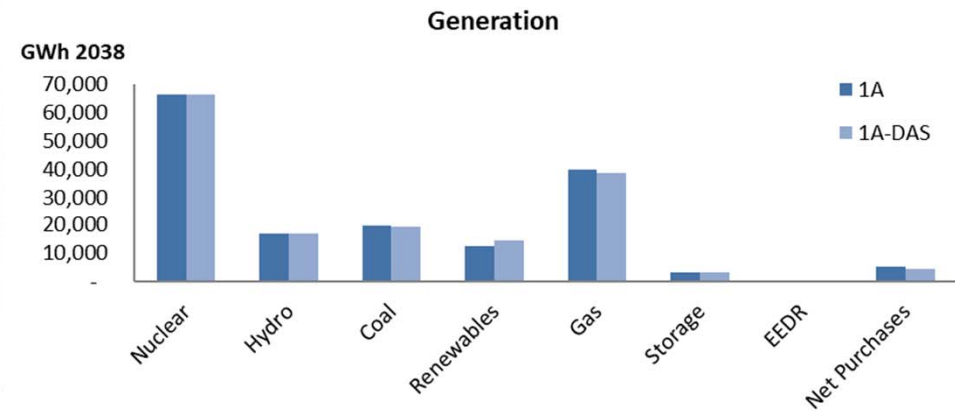
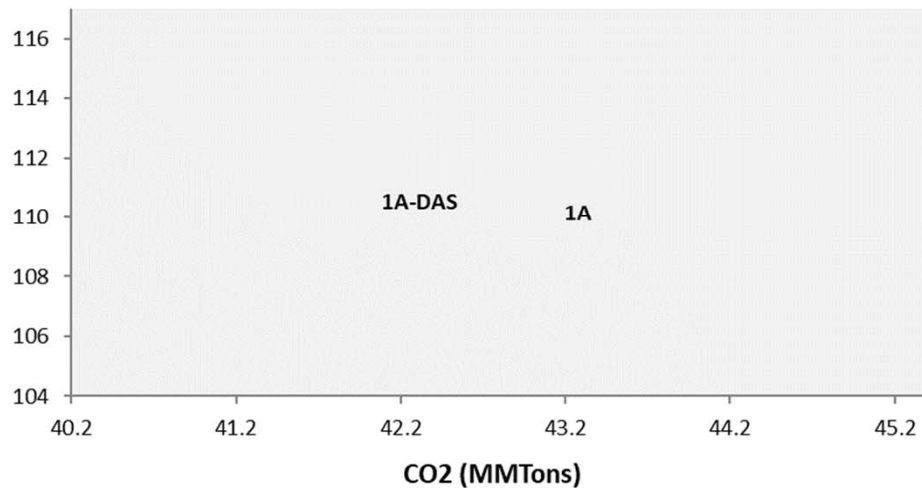
	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
Accelerated Solar	110	70	110	1.04	119	42	520	53,408	2,191	52,564	1.88	51%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	0.22	0.19	0.22	-0.03	-0.04	-2	-21	-645	-78	9,199	-0.10	2%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

Double Annual Solar Cap

Doubling the annual solar cap results in similar costs and lower carbon emissions, as renewable generation slightly displaces gas generation.

Total Resource
Cost (\$Bn)



Double Annual Solar Cap

Sensitivity Metric Results

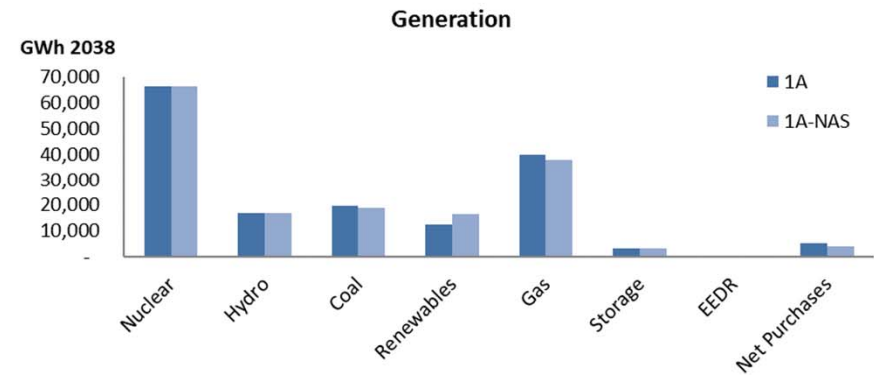
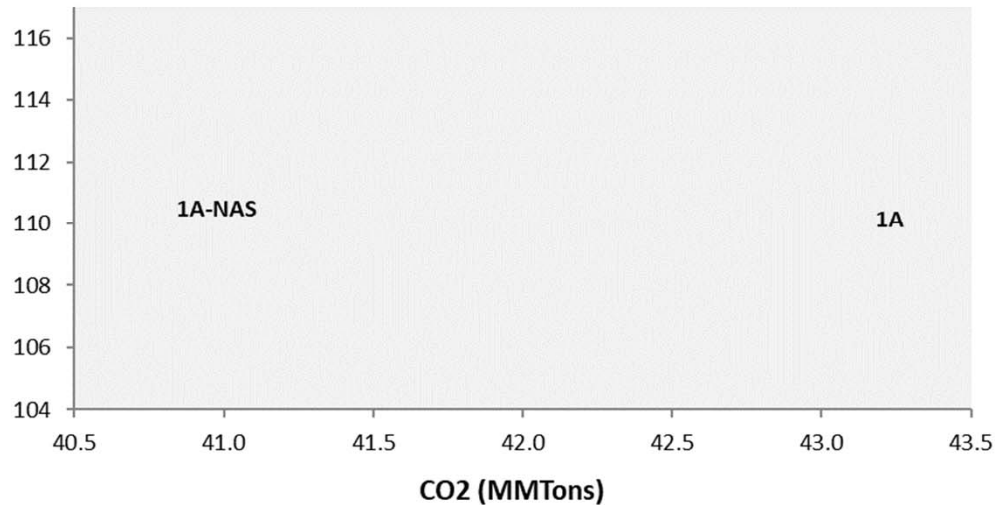
	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
Double Annual Solar Cap	110	70	111	1.05	119	42	528	53,703	2,228	51,395	1.83	51%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	0.37	0.20	0.38	-0.01	0.25	-1	-12	-350	-41	8,030	-0.14	1%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

No Annual Solar Cap

No annual solar cap results in additional solar capacity that further displaces some fossil generation and results in lower carbon emissions.

Total Resource
Cost (\$Bn)



No Annual Solar Cap

Sensitivity Metric Results

	PVRR (\$Bn)	System Average Cost Years 1-20 (\$/MWh)	Total Resource Cost (\$Bn)	Risk/Benefit Ratio	Risk Exposure (\$Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income*	Percent Difference in Employment*
No Annual Solar Cap	110	70	111	1.03	119	41	513	53,237	2,181	245,696	1.77	52%	0.00%	0.00%
Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
Delta from Base Case	0.32	0.25	0.33	-0.03	-0.01	-2	-28	-816	-88	202,331	-0.21	3%	0.00%	0.00%

**Economic analysis was not re-run for sensitivities*

Regional Energy Resource Council Bylaws and Operating Procedures

Section I: Purpose

The purpose of the Regional Energy Resource Council (the Council) is to provide advice and recommendations on TVA's energy resource activities and the priorities among competing objectives and values. TVA's energy resource activities include constructing and operating various supply-side resources, including fossil-fueled power plants, nuclear plants, hydroelectric dams, and renewable resources; the development and management of demand-side resources, including energy efficiency; the design, construction, and operation of power delivery systems; and the integration of all of these energy resources into plans for meeting future demands for electricity in the TVA region.

Section II: Authority

The Council is a discretionary advisory committee established under the authority of the Tennessee Valley Authority (TVA) in accordance with the provisions of the Federal Advisory Committee Act (FACA), as amended, 5 U.S.C., App. 2.

Section III: Membership and Appointment

Members of the Council are appointed by the TVA Board of Directors, or its designee, in accordance with the Council's charter and as more specifically described in TVA's Membership Balance Plan. Members serve as representatives of the group, organization, or other entity identified by TVA in making the appointment. Alternate members are not permitted to represent those individuals appointed to the Council.

Membership on the Council includes the responsibility to attend Council meetings personally. In exceptional circumstances, a member may participate in a meeting of the Council (at which the member is entitled to vote) by means of conference telephone, audio/video transmission or similar communications equipment if (1) the member makes a request to the Chair to participate by means of conference telephone, audio/video transmission, or similar communications equipment, and (2) the Chair approves the member's request to participate by such means. If the Chair approves a member's request, then the communications equipment must be such that all persons participating in the meeting can simultaneously communicate on a real-time basis with all other participants, and participation in a meeting pursuant to this bylaw shall constitute presence in person at such meeting.

Section IV: Meeting Procedures

The Council will meet approximately twice annually, or more often if needed to carry out its duties. Meetings will be called by the Designated Federal Officer (DFO) in consultation with the Chair of the Council (the Chair), in accordance with the following considerations:

A. Agenda. The DFO will prepare and approve the agenda for all meetings, following consultation with the Chair. TVA will distribute the agenda to the Council members prior to each meeting and will publish an outline of the agenda with notice of the meeting in the Federal Register. Items for the agenda may be submitted to the DFO and/or the Chair by any member of the Council. Items may also be suggested by non-members, including

members of the public. In each meeting, the Council may choose to address the issues submitted by the DFO for the Council's consideration, or the Council may recommend consideration of other issues.

B. Minutes and Records. The DFO will ensure that minutes are prepared of each meeting and will make such minutes available to Council members. Minutes may be taken in the form of a full transcript. Minutes of open meetings are typically available on the TVA web site (<http://www.tva.gov/lerc/>) and will otherwise be made available to the public upon request. Minutes of closed meetings also will be available to the public upon request, subject to the withholding of matters about which public disclosure would be harmful to the interests of the Government, industry, or others, and which are exempt from disclosure under the Freedom of Information Act. The minutes will include a record of the persons present (including the names of Council members, names of TVA staff, and names of members of the public from whom written or oral presentations were made), a complete and accurate description of the matters discussed and conclusions reached, and copies of all reports received, issued, or approved by the Council.

All documents, reports, or other materials prepared by or for the Council constitute official government records and must be maintained in accordance with applicable federal law and TVA policies and procedures.

C. Quorum. ~~Eleven voting members shall constitute a quorum for the conduct of business.~~ A majority of the members of the Council constitutes a quorum; provided, however, that if any vacancies exist on the Council by reason of death, resignation, or otherwise, a majority of the remaining members (but in no case less than eight members) shall constitute a forum.

D. Adjournment. Meetings may be adjourned by the Chair upon approval by a majority of Council members present or by the DFO.

E. Open Meetings. Unless otherwise determined in advance by the DFO, all meetings of the Council will be open to the public. All materials brought before, or presented to, the Council during the conduct of an open meeting, including the minutes of the proceedings of an open meeting, will be available to the public for review or copying.

Members of the public may attend any meeting or portion of a meeting that is not closed to the public and may, at the determination of the Chair, offer oral comment at such meeting. The Chair may decide in advance to exclude oral public comment during a meeting, in which case the meeting announcement published in the Federal Register will note that oral comment from the public is excluded and will invite written comment as an alternative. Members of the public may submit written statements to the Council at any time.

Once an open meeting has begun, it will not be closed for any reason.

F. Closed Meetings. Meetings of the Council will be closed only in limited circumstances and in accordance with applicable law. In addition, requests for closed meetings must be approved by TVA's Office of the General Counsel in advance of the meeting.

Where the DFO has determined in advance that discussions during a Council meeting will involve matters about which public disclosure would be harmful to the interest of Government, industry, or others, an advance notice of a closed meeting, citing the applicable exemptions of the Government in Sunshine Act, will be published in the Federal

Register. The notice may announce the closing of all or a portion of a meeting. If, during the course of an open meeting, matters inappropriate for public disclosure arise during discussions, the Chair will order such discussion to cease, and the DFO, after consultation with the Chair, may schedule a closed session to consider those matters.

G. Preparatory or Administrative Meetings. Two or more members of the Council may convene, without public notice of such meeting and in a setting not open to the public, solely to engage in preparatory work and/or administrative work, as described in the regulations implementing FACA.

Section V: Voting

When a decision or recommendation of the Council is required, the Chair may call for a vote, or any members of the Council may make a motion for a vote. No second after a proper motion will be required to bring any issue to vote.

Any recommendation by the Council to TVA shall require an affirmative vote of at least a simple majority of the total Council membership present on that date. Each Council member shall be provided the opportunity to include minority or dissenting views to accompany recommendations by the Council to TVA.

Section VI: Role of Council Officials

Chair: The Chair works with the DFO to establish priorities and identify issues which must be addressed by the Council and serves as the focal point for the Council's membership. The Chair chairs all meetings of the Council unless the DFO has been directed to do so by the TVA Board of Directors or its designee.

Designated Federal Officer: The DFO serves as TVA's agent for all matters related to the Council's activities. The DFO must perform (as required by law) or assure the performance of the following duties and activities: (1) approve and call all meetings of the Council or any subcommittees; (2) prepare and approve meeting agendas following consultation with the Chair; (3) submit current issues for the Council's consideration following consultation with the Chair; (4) attend all meetings; (5) notify Council members of the time and place for each meeting; (6) ensure that proper public notice is given of meetings; (7) ensure that detailed minutes are taken at all meetings, including those of subcommittees and other subgroups and working groups; (8) maintain records of all meetings, including those of subcommittees and other subgroups and working groups; (9) maintain official Council records and file all papers and submissions prepared for or by the Council, including those items generated by subcommittees and other subgroups and working groups; (10) attend to official correspondence; (11) act as the Council's agent to collect, validate, and pay all vouchers for pre-approved expenditures; (12) prepare and handle such reports about the operation of the Council as may be required or desirable; (13) ensure that adequate facilities are provided for Council meetings and other needs; (14) provide adequate staff support to the Council; (15) adjourn meetings when the DFO determines it is in the public interest to do so; and (16) chair meetings when directed to do so by the TVA Board of Directors or its designee.

Section VII: Expenses and Reimbursement

Expenses related to the operation of the Council will be borne by TVA. Each member of the Council may be allowed reimbursement for travel and subsistence expenses which are incurred in connection with the attending of Council meetings or otherwise incurred while engaged in the performance of Council duties and approved by TVA. Such reimbursements shall be subject to and computed and paid in accordance with federal travel regulations and TVA policies and procedures.

Expenses of any kind must be approved in advance by the DFO.

Approved by Designated Federal Officer

Date