2019 IRP Working Group

Meeting 11: February 28 – March 1, 2019


welcome

Safety Moment

Building Emergency Plan

Introductions

- Name
- Organization and Role

Agenda – Feb 28

11:30	Lunch	
12:30	Welcome Recap Meeting 10 and Where we are in process	Jo Anne Brian
1:00	Public Comment Period Plans	Amy
1:15	Draft Document Recap Details on EIS Environmental Metrics	Hunter / Ashley
1:45	Role /Purpose of Sensitivities in the 2019 IRP	Jane Elliott, Scott Jones, Roger Pierce
2:00	break	
2:15	Updated Base Case and Sensitivity results so far	Jane Elliott, Jones, Pierce
3:30	Group Break out	Group
5:00	Wrap Up day 1	Jo Anne / Brian
6:00	Group Dinner – Chop House Franklin Plaza	

Agenda – Mar 1

7:30	***Breakfast – at hotel for guests***	
8:30	**Welcome and Recap Day 1**	**Jo Anne / Brian**
9:00	**Review List of Sensitivities**	**Jane Elliott**
9:45	**Group Break Out – Sensitivities**	**Jo Anne and group**
10:45	**Break**	
11:00	**Individual Prioritization**	**Jo Anne and group**
11:30	**Recap Voting and IRPWG Recommendations on priorities** **Review next steps and adjourn.**	
12:00	**Lunch**	

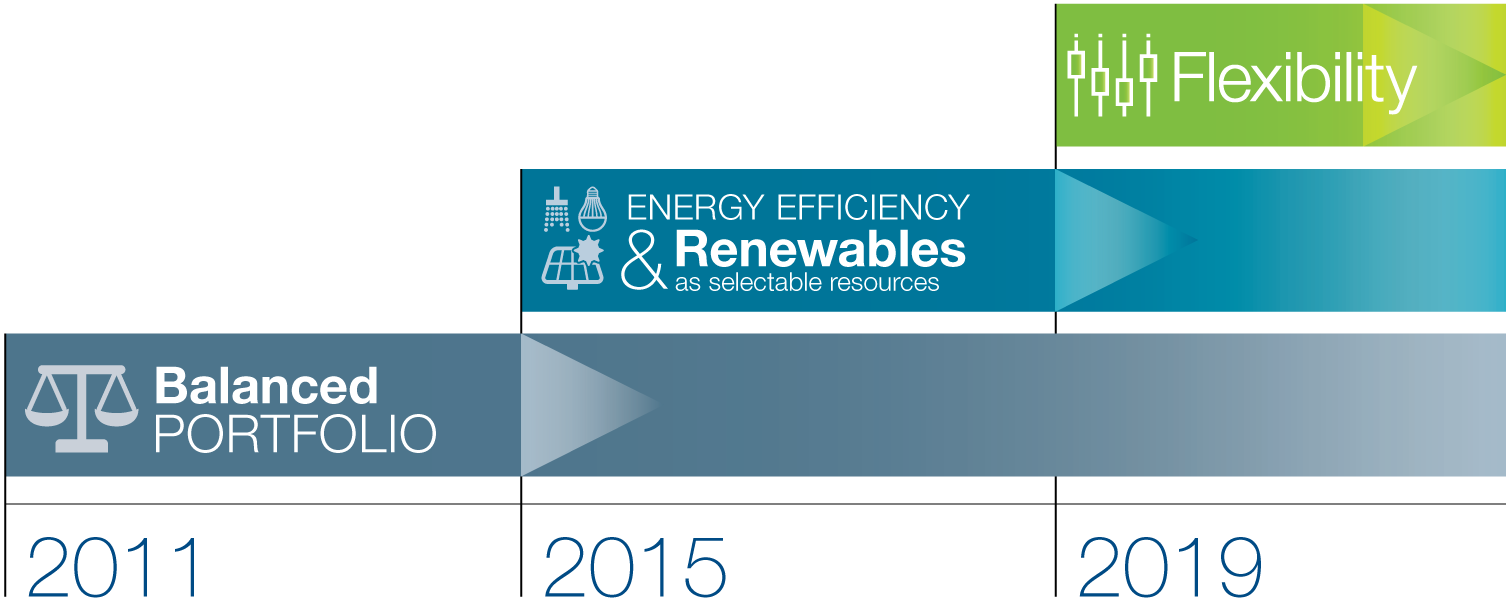
IRPWG Meeting 10 Recap

Brian Child

January Meeting Highlights

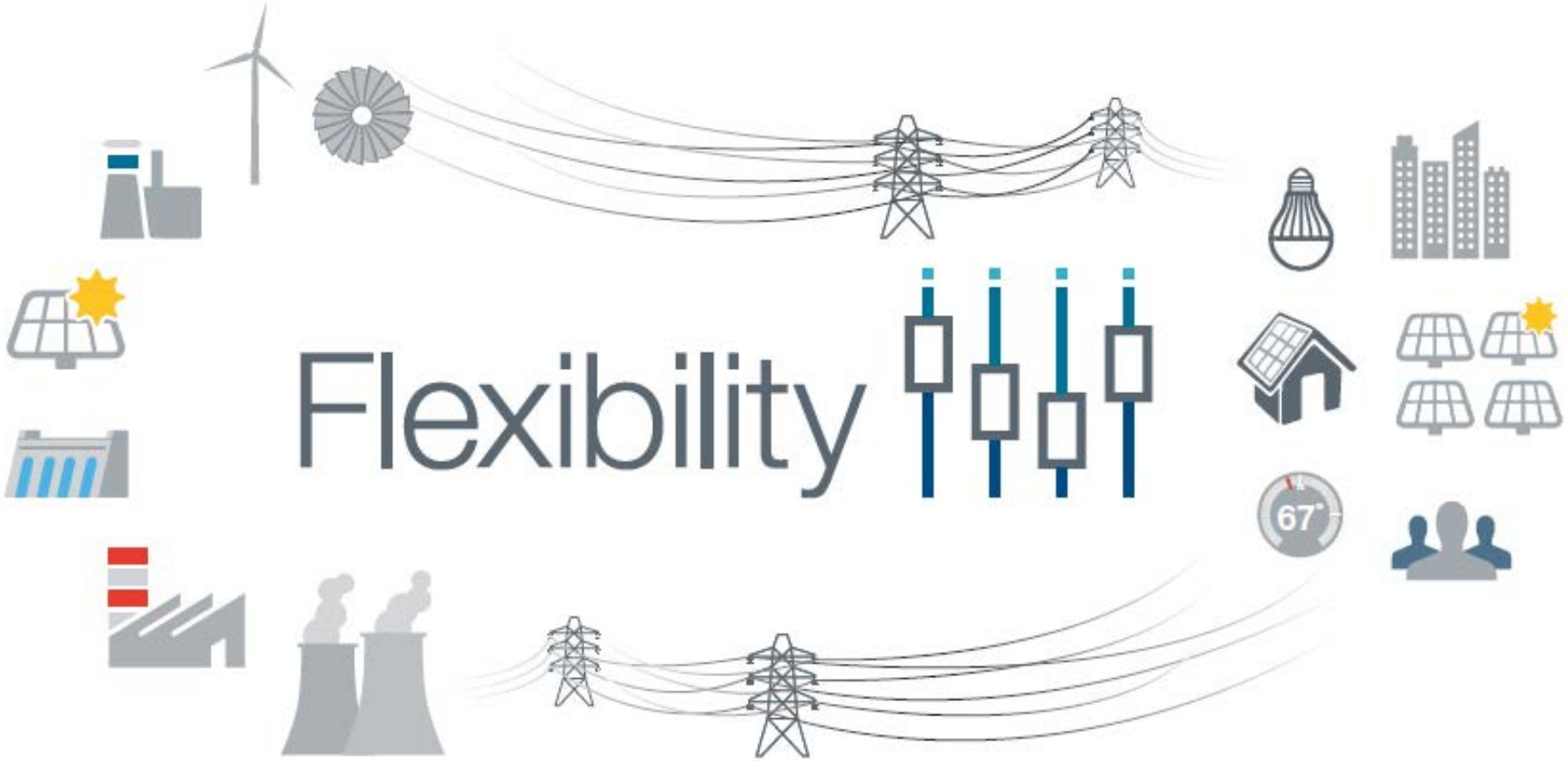
- Reviewed Final Results for the Draft
- Reviewed Metrics and Scorecards
- Next steps for Draft IRP and EIS

INTEGRATED Resource Plan 2019



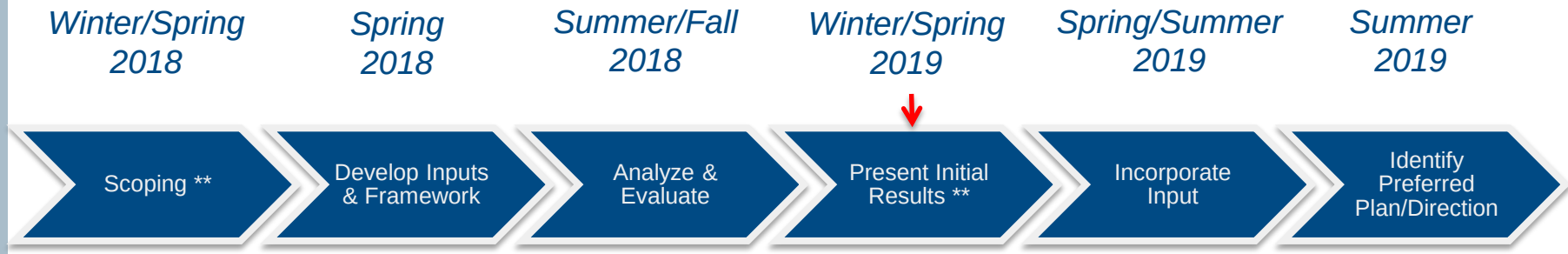
2019 IRP Focus Areas

- System flexibility
- Distributed Energy Resources
- Portfolio diversity


Flexibility
67

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)

IRP Working Group Meeting Objectives

February 28 – March 1	March 27 -28	May 12-13	June 25
• Updated Base Case • Sensitivities results so far • Discuss Sensitivities • Prioritize Sensitivities	• Sensitivity Results • Review public comment period • Early themes from public comments	• Final Sensitivity • Public Comments • Developing the Recommendation	• Final Recommendation

Public Comment Period Plans

Amy Henry

February 28, 2019

We Need Your Input!


February 19 – RERC Open House, Murfreesboro, TN


February 27 - Knoxville, TN


March 18 - Memphis, TN


March 19 – Huntsville, AL


March 20 - Chattanooga, TN


March 21 - Nashville, TN


March 26 - Bowling Green, KY

Meetings

5 p.m. to 6:30 p.m. local time

Can’t make it in-person?

- Listen to our webinar, taped live on February 26
- Visit our Interactive Report online at www.tva.com/irp

We'd like to hear from you!

The public comment period is open until April 8, 2019. Share your feedback with us online, in-person or by mail!

- Submit a comment form at tonight's public meeting
- View our interactive report and submit a comment online, visit **tva.com/irp**
- Listen to our webinar, taped live on February 26th
- Mail-in a comment form:

  Hunter Hydas
  IRP Project Manager
  Tennessee Valley Authority
  1101 Market Street, MR-3C
  Chattanooga, TN 37402

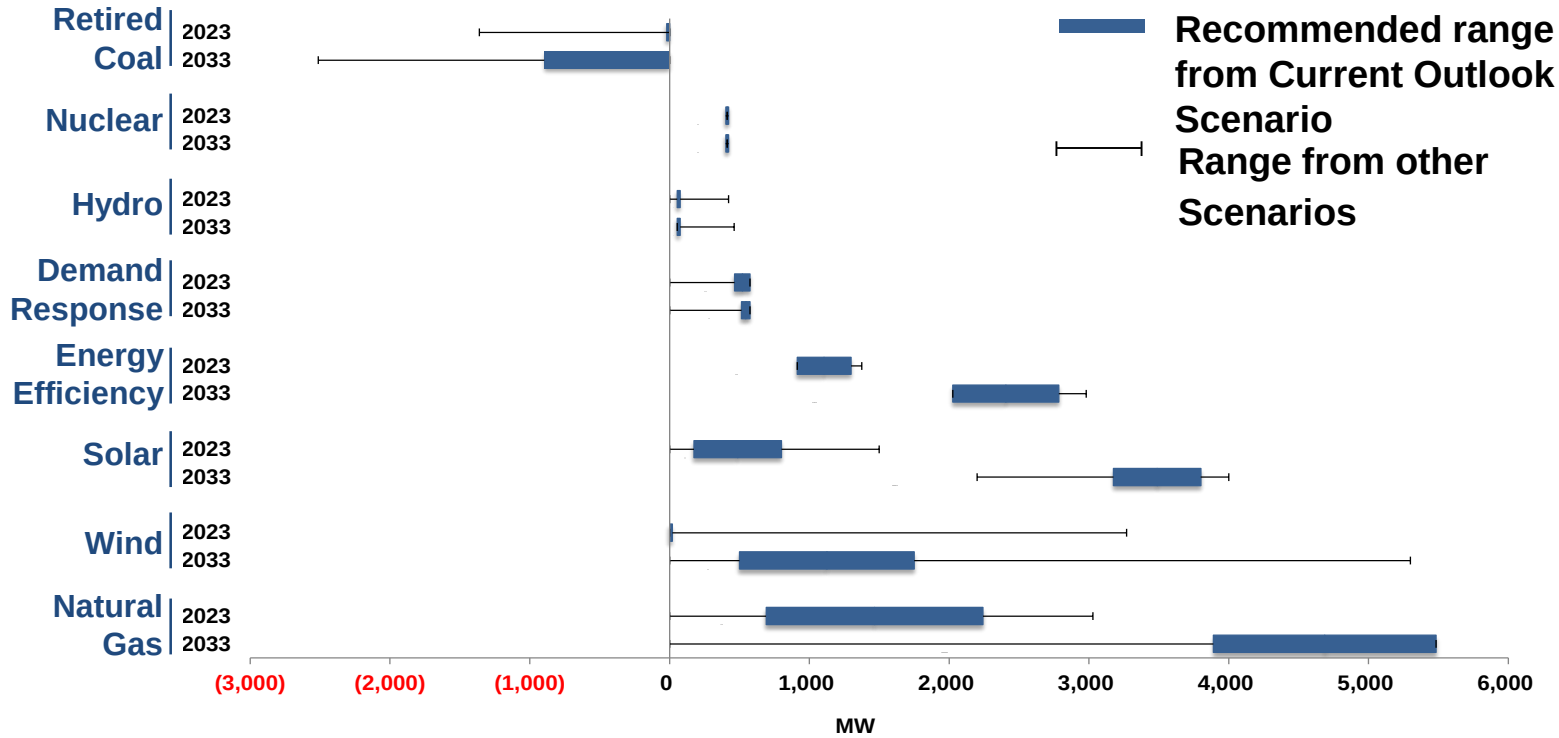
- Email us at: irp@tva.gov

Draft Document Recap

Hunter Hydas /

February 28, 2019

2015 IRP Recommendation



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

EIS Metrics

Ashley Pilakowski

February 28, 2019

DEIS Chapter 5. Anticipated Environmental Impacts

- Facility Siting and Review Processes
- Environmental Impacts of
  - Supply-Side Resource Options
  - Energy Efficiency and Demand Response Programs
  - Transmission Facility Construction and Operation
  - Alternative Strategies and Portfolios
- Potential Mitigation Measures
- Unavoidable Adverse Environmental Impacts

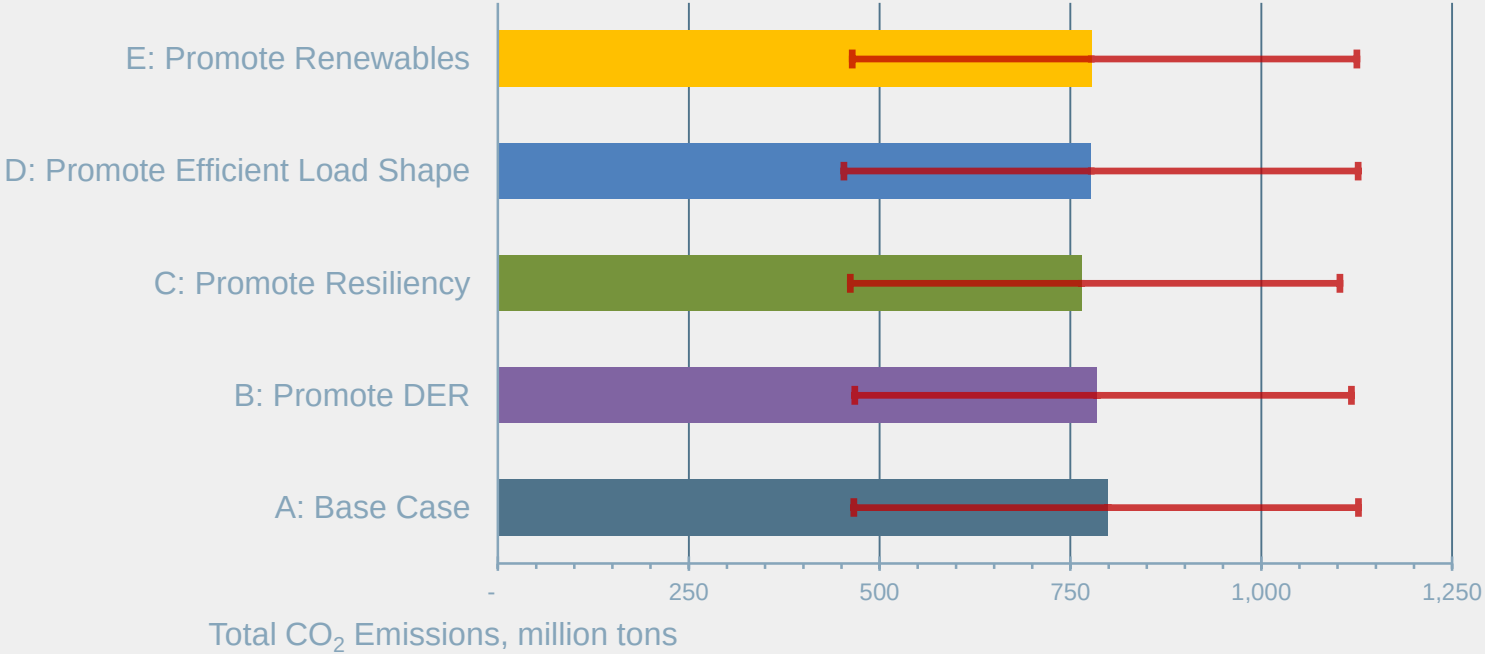
Environmental Impacts Quantified in EIS

- CO2 total emissions
- CO2 intensity
- **net CO2 emissions**
- SO2 emissions
- NOx emissions
- total water use
- total water consumption
- **water use by basin and source (surface, groundwater)**
- **water consumption by basin and source**
- land use – facility land requirements
- Coal Combustion Residual production
- coal consumption
- natural gas consumption
- uranium consumption
- spent nuclear fuel production
- change in per-capita income (REMI results)
- change in employment (REMI results)

* Underline = primary metrics used in Scorecard
***** **Bold** = new impacts included in 2019 IRP

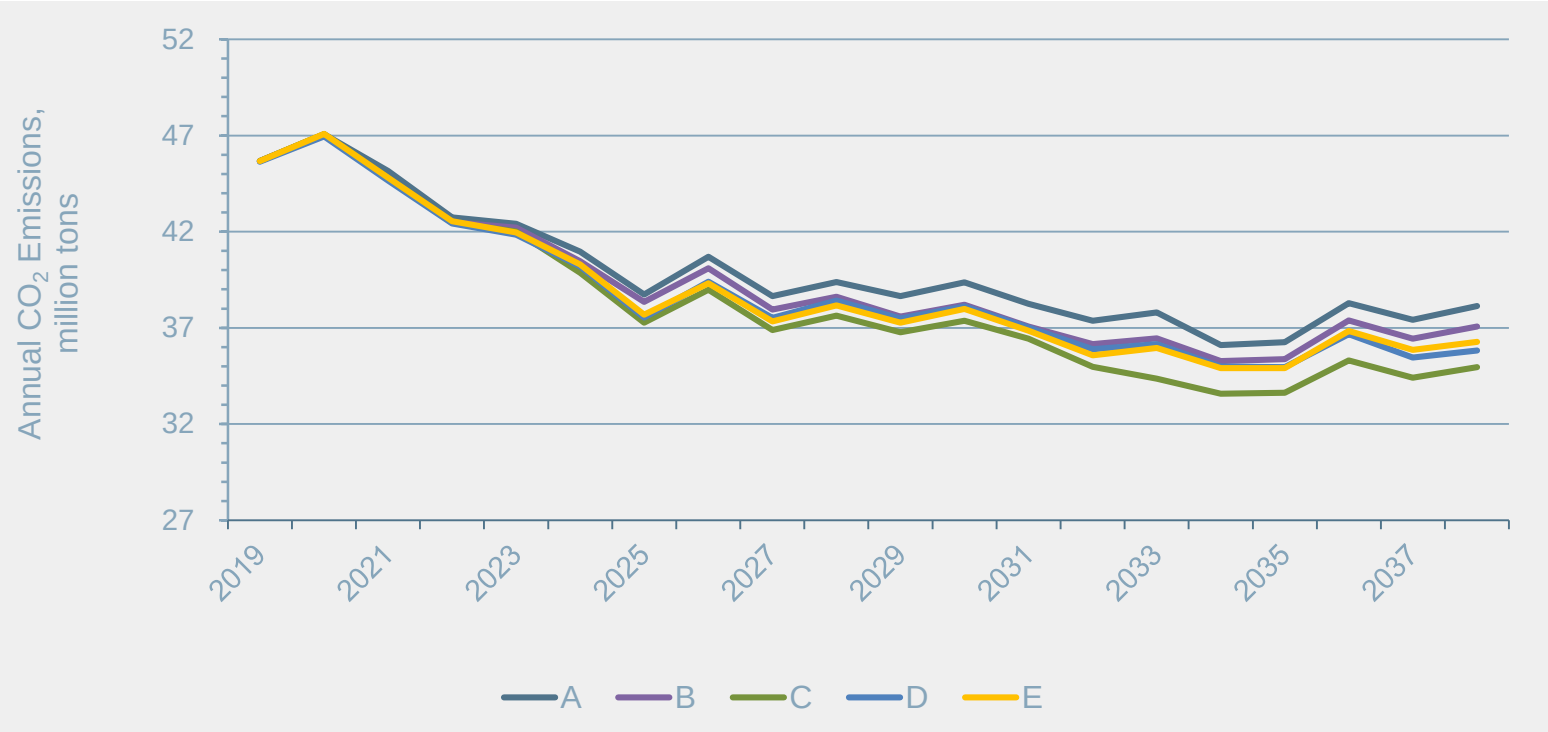
Anticipated Environmental Impacts

CO_2 Emissions by Alternative Strategy



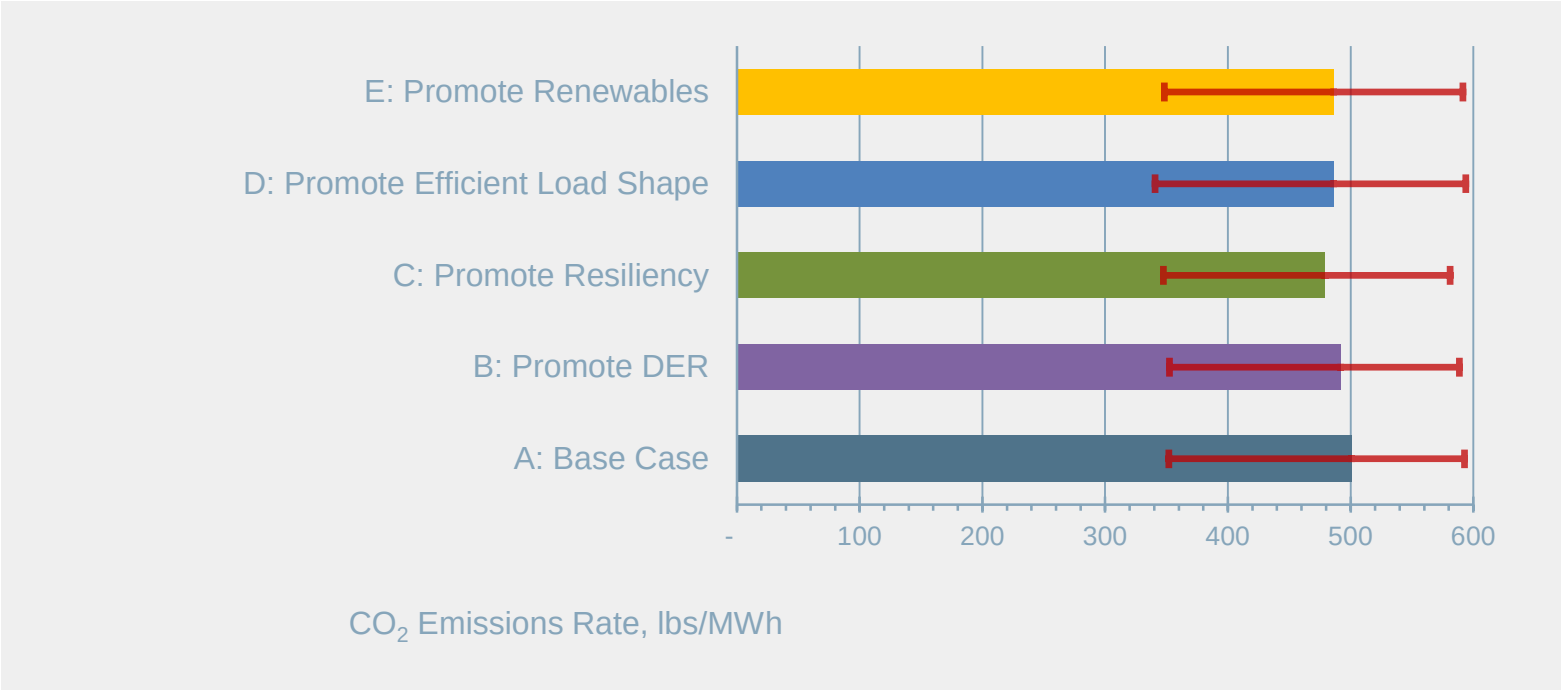
Anticipated Environmental Impacts

CO_2 Emissions by Alternative Strategy



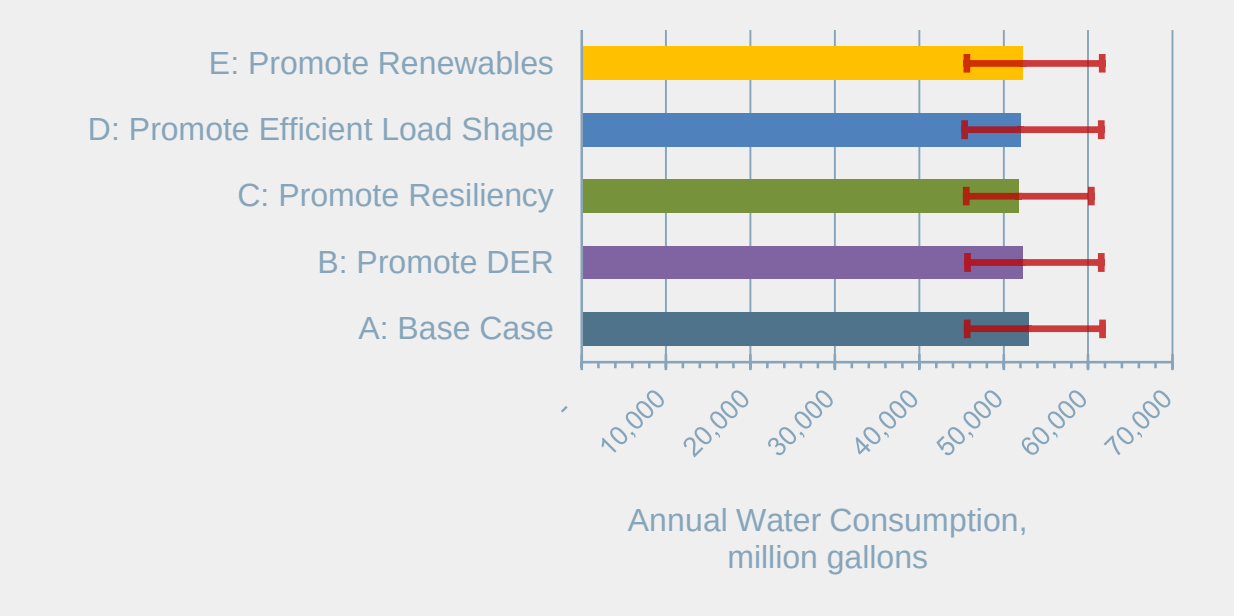
Anticipated Environmental Impacts

CO_2 Intensity by Alternative Strategy



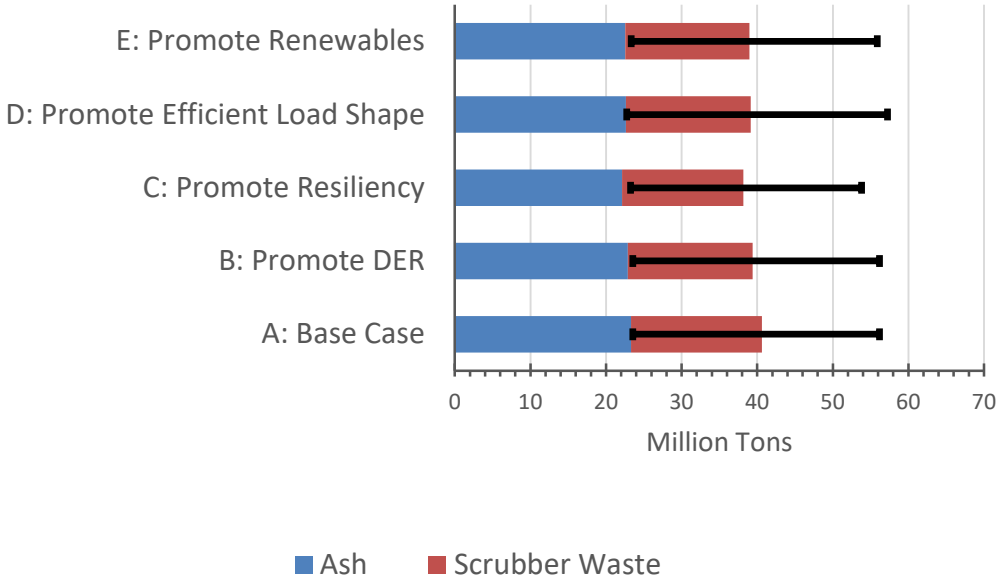
Anticipated Environmental Impacts

Water Consumption by Alternative Strategy



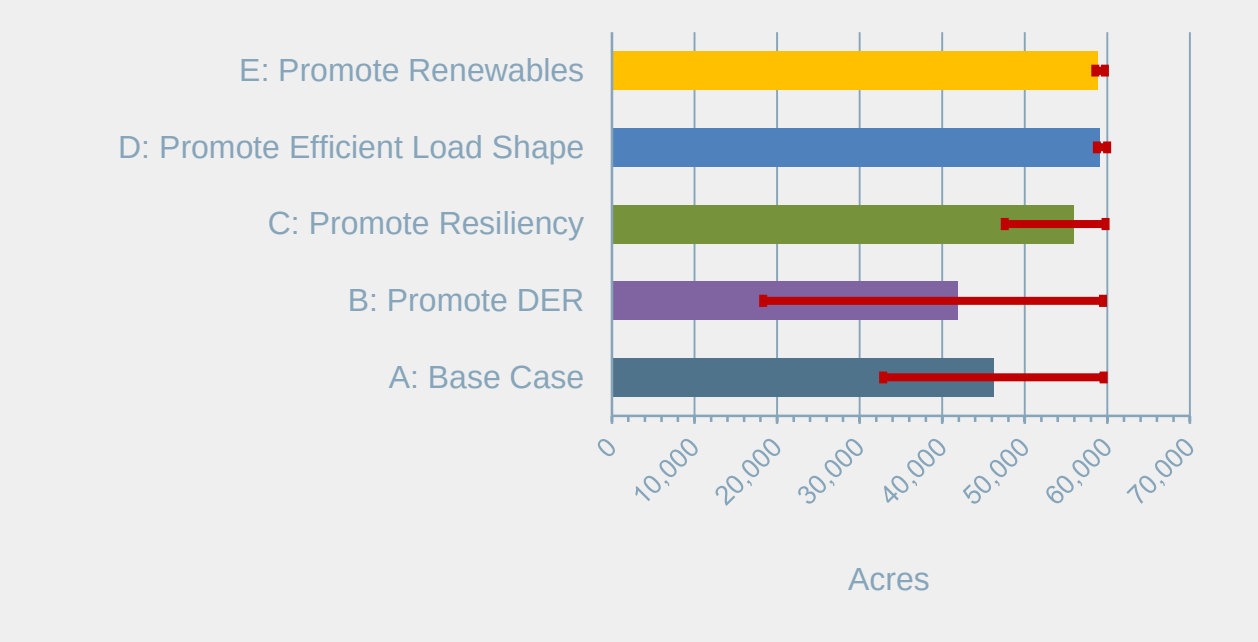
Anticipated Environmental Impacts

Coal Waste Production by Alternative Strategy



Anticipated Environmental Impacts

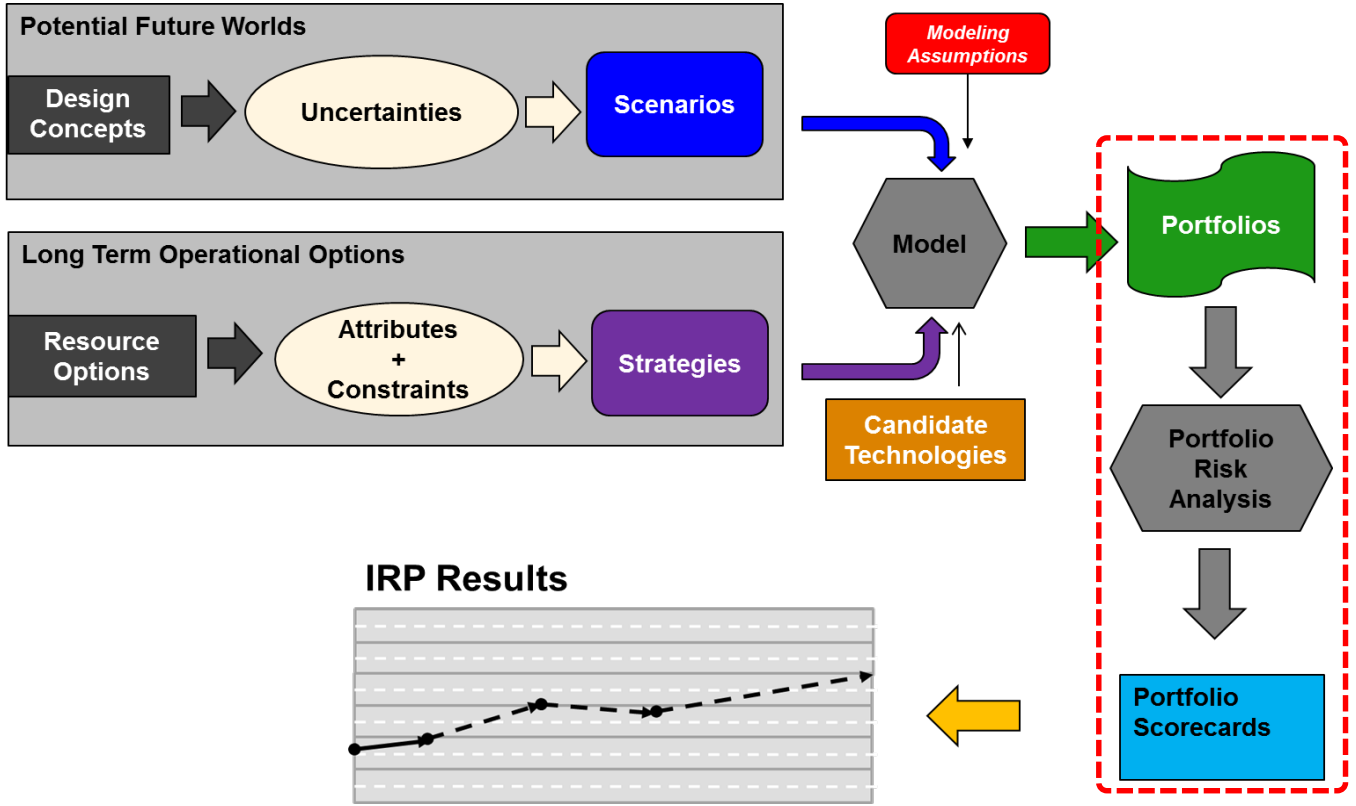
Land Requirements by Alternative Strategy



Additional IRP Analysis

Jane Elliott, Roger Pierce, Scott Jones
Resource Strategy

Sensitivity Analysis Informs Recommendation



The result of a strategy evaluated in a scenario

How uncertainty impacts the portfolio results

Standard metrics to compare portfolios

2019 IRP Scenarios and Strategies

Scenarios

1. *Current Outlook*
2. *Economic Downturn*
3. *Valley Load Growth*
4. *Decarbonization*
5. *Rapid DER Adoption*
6. *No Nuclear Extensions*

Strategies

A. *Base Case*
B. *Promote DER*
C. *Promote Resiliency*
D. *Promote Efficient Load Shape*
E. *Promote Renewables*

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

Additional Analysis for Today's Review

- Updated Base Case – updated cases reflecting TVA Board decision to retire Paradise 3 and Bull Run across all portfolios and metrics
- Gas CT Retirement Case – sensitivity bounding case assuming that all older Gas CTs are retired
- Integration Cost & Flexibility Benefit Case – sensitivity case removing all integration costs and flexibility benefits

Updated Base Case

Updated Base Case

Objective: Reflect the impact of TVA Board decision to retire Paradise 3 (PAF3) and Bull Run (BRF) fossil plants on IRP results.

Approach: Include PAF3 (2020) and BRF (2023) retirements as reductions in baseline firm supply, along with aligned cost estimates, in the full set of portfolio and scorecard results.

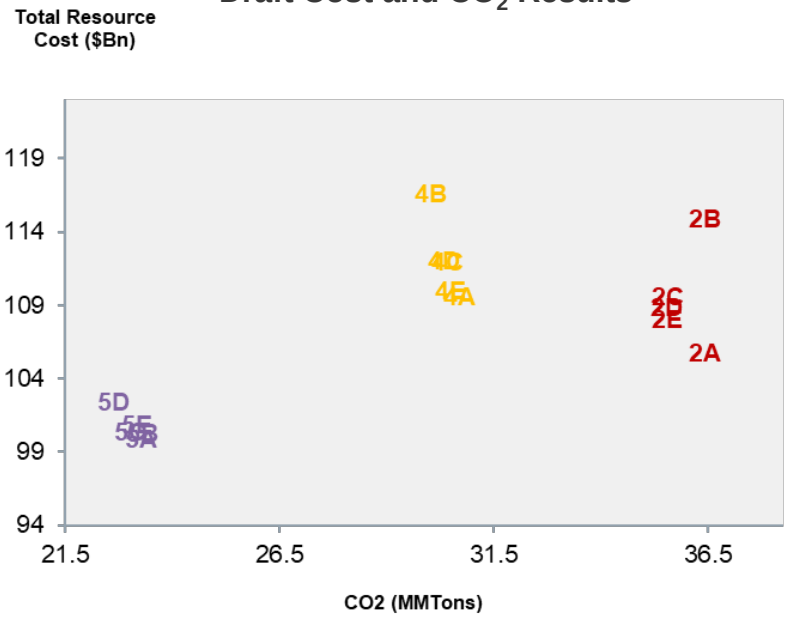
Updated Base Case: Lower Loads (Scenarios 2,4,5)

As both plants were selected for retirement in all lower load cases, reflecting the retirement decisions drives no change in capacity expansion plans for these cases.

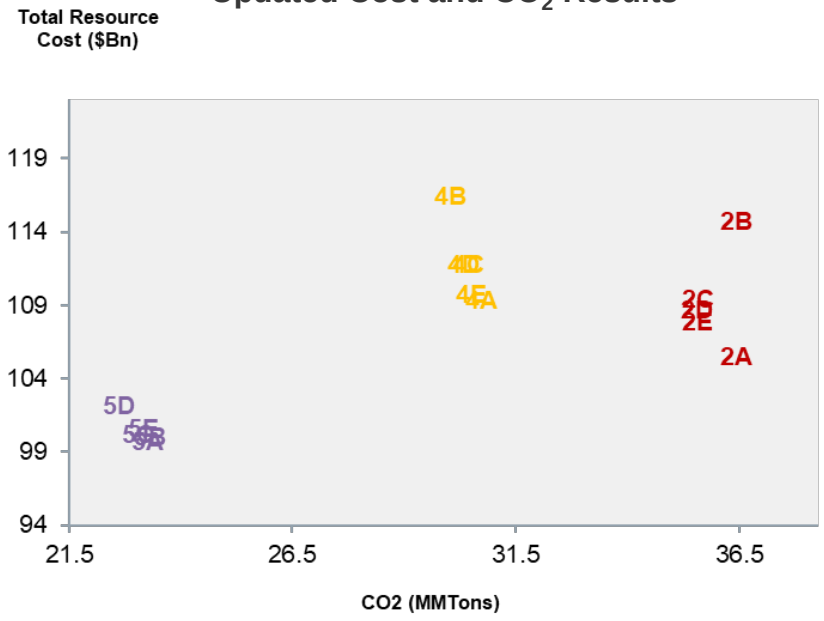
Updated Base Case: Lower Loads (Scenarios 2,4,5)

Cost estimates for PAF3 & BRF ongoing operation were updated after the Draft IRP base case was finalized. Aligning cost estimates drives a negligible change to results.

Draft Cost and CO_2 Results



Updated Cost and CO_2 Results



Updated Base Case: Economic Downturn (Scenario 2)

Updated 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
A: Base Case	105	71	106	1.00	113	36	489	51,136	1,865	41,245	1.37	56%	0.00%	0.00%
B: Promote DER	105	71	115	1.00	113	36	488	51,133	1,861	18,324	1.71	53%	0.00%	0.00%
C: Promote Resiliency	106	71	109	0.98	113	36	476	50,681	1,840	54,810	1.29	59%	0.00%	0.00%
D: Promote Efficient Load Shape	108	72	109	0.98	116	36	475	50,658	1,849	58,560	1.39	59%	-0.02%	-0.02%
E: Promote Renewables	106	71	108	0.98	113	36	476	50,694	1,840	58,464	1.18	59%	0.00%	0.00%

Delta from Draft 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
A: Base Case	-0.21	-0.14	-0.21	0.00	-0.24	0	0	0	0	0	0.00	0%	0.00%	0.00%
B: Promote DER	-0.21	-0.14	-0.21	0.00	-0.24	0	0	0	0	0	0.00	0%	0.00%	0.00%
C: Promote Resiliency	-0.21	-0.14	-0.21	0.00	-0.24	0	0	0	0	0	0.00	0%	0.00%	0.00%
D: Promote Efficient Load Shape	-0.21	-0.14	-0.21	0.00	-0.24	0	0	0	0	0	0.00	0%	0.00%	0.00%
E: Promote Renewables	-0.21	-0.14	-0.21	0.00	-0.24	0	0	0	0	0	0.00	0%	0.00%	0.00%

Updated Base Case: Decarbonization (Scenario 4)

Updated 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
A: Base Case	109	75	109	1.04	118	31	427	50,276	1,272	58,400	0.98	66%	0.00%	0.00%
B: Promote DER	109	75	116	1.03	118	30	418	48,706	1,271	58,400	0.98	66%	0.00%	0.00%
C: Promote Resiliency	109	75	112	1.04	118	30	423	48,765	1,264	58,464	1.04	66%	0.00%	0.00%
D: Promote Efficient Load Shape	111	76	112	1.02	120	30	422	48,627	1,235	58,560	1.15	66%	-0.02%	-0.02%
E: Promote Renewables	109	75	110	1.03	118	31	424	50,173	1,246	58,464	1.04	66%	0.00%	0.00%

Delta from Draft 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
A: Base Case	-0.21	-0.14	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
B: Promote DER	-0.21	-0.14	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
C: Promote Resiliency	-0.21	-0.14	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
D: Promote Efficient Load Shape	-0.21	-0.14	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
E: Promote Renewables	-0.21	-0.14	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%

Updated Base Case: Rapid DER Adoption (Scenario 5)

Updated Metric Results

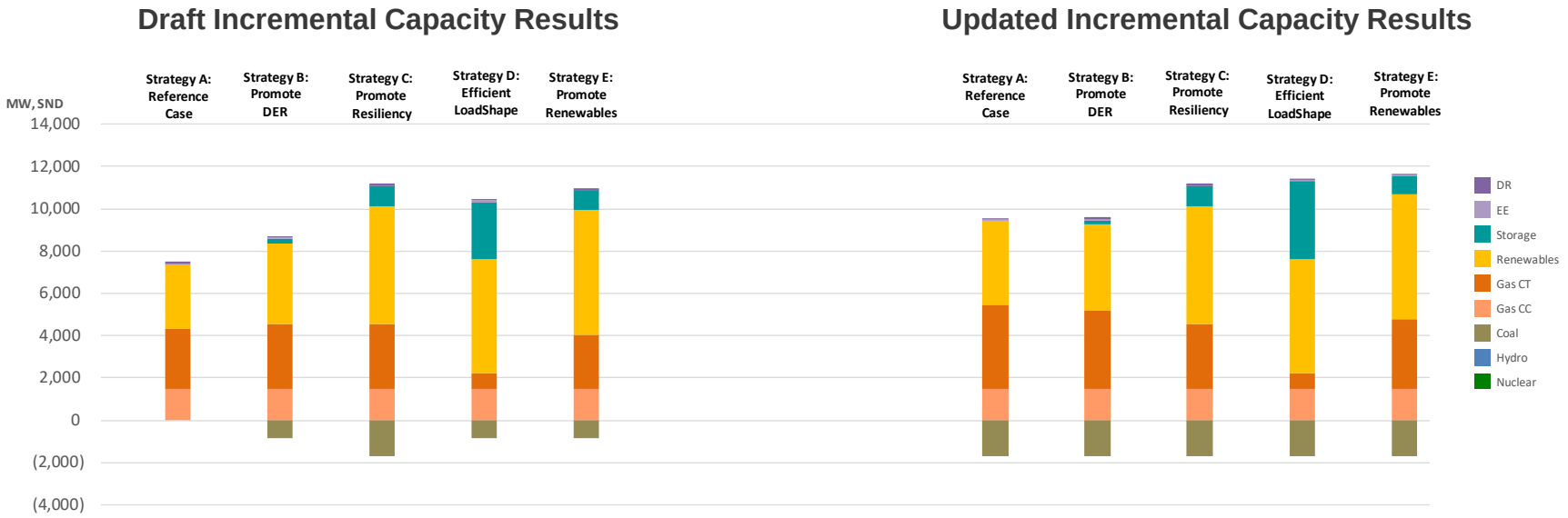
	PVRR ($Bn)	System Average Cost Years 1-20 ($/MWh)	Total Resource Cost ($Bn)	Risk/Benefit Ratio	Risk Exposure ($Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income	Percent Difference in Employment
A: Base Case	99	76	100	0.94	106	23	361	45,678	1,177	32,850	1.14	63%	0.00%	0.00%
B: Promote DER	99	76	100	0.94	106	23	361	45,697	1,176	32,850	1.14	63%	0.00%	0.00%
C: Promote Resiliency	100	76	100	0.94	106	23	356	45,563	1,162	47,502	1.02	66%	0.00%	0.00%
D: Promote Efficient Load Shape	101	77	102	0.93	108	23	350	45,383	1,137	58,560	1.13	69%	-0.02%	-0.02%
E: Promote Renewables	100	76	101	0.93	107	23	357	45,621	1,167	58,464	1.02	67%	-0.01%	-0.01%

Delta from Draft Metric Results

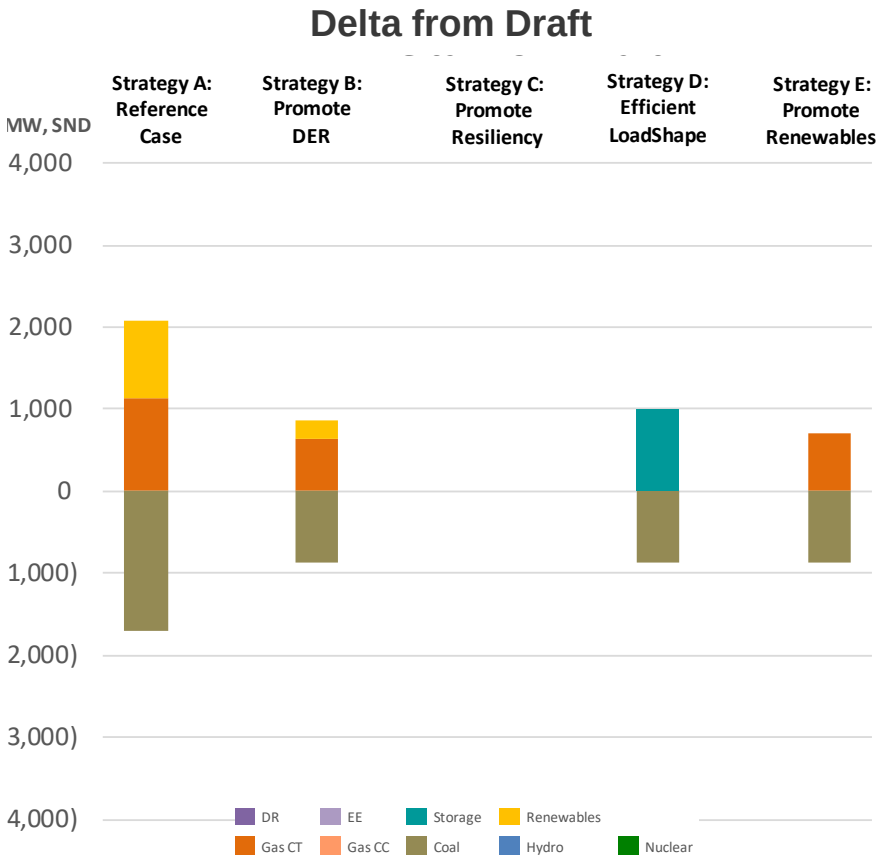
	PVRR ($Bn)	System Average Cost Years 1-20 ($/MWh)	Total Resource Cost ($Bn)	Risk/Benefit Ratio	Risk Exposure ($Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income	Percent Difference in Employment
A: Base Case	-0.21	-0.16	-0.21	0.00	-0.25	0	0	0	0	0	0.00	0%	0.00%	0.00%
B: Promote DER	-0.21	-0.16	-0.21	0.00	-0.25	0	0	0	0	0	0.00	0%	0.00%	0.00%
C: Promote Resiliency	-0.21	-0.16	-0.21	0.00	-0.25	0	0	0	0	0	0.00	0%	0.00%	0.00%
D: Promote Efficient Load Shape	-0.21	-0.16	-0.21	0.00	-0.25	0	0	0	0	0	0.00	0%	0.00%	0.00%
E: Promote Renewables	-0.21	-0.16	-0.21	0.00	-0.25	0	0	0	0	0	0.00	0%	0.00%	0.00%

Updated Base Case: Current Outlook (Scenario 1)

One or both plants were selected for retirement in the initial Current Outlook cases, aside from the draft Base Case where continued operation was assumed. In cases where both plants were not initially selected for retirement, reflecting retirement decisions drives additional solar and gas expansion later in the plan. Strategy D adds additional storage capacity due to promotion.



Updated Base Case: Current Outlook (Scenario 1)



Strategy A

- BRF and PAF capacity replaced by solar and CT

Strategy B

- BRF capacity replaced by CT and solar

Strategy C

- No change

Strategy D

- BRF capacity replaced by incented storage

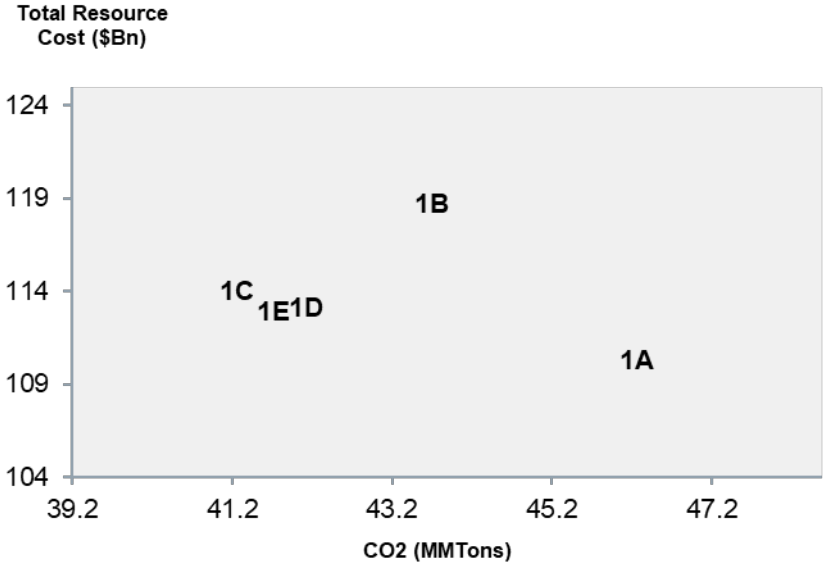
Strategy E

- BRF capacity replaced by CT

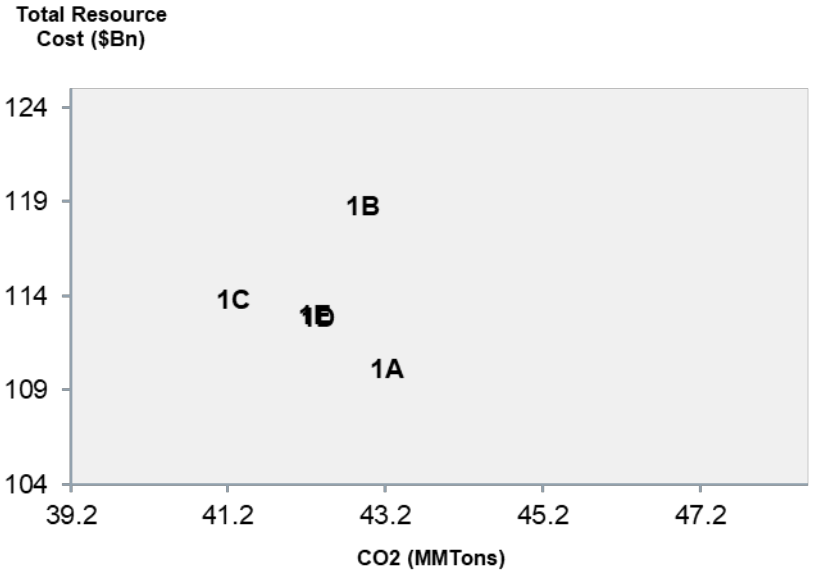
Updated Base Case: Current Outlook (Scenario 1)

Retiring both plants in all Current Outlook cases results in similar costs and lower carbon emissions, due to the nature of replacement resources selected later in the plan.

Draft Cost and CO_2 Results



Updated Cost and CO_2 Results



Updated Base Case: Current Outlook (Scenario 1)

Updated 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
A: Base Case	110	70	110	1.06	119	43	541	54,053	2,269	43,365	1.98	50%	0.00%	0.00%
B: Promote DER	110	70	119	1.05	119	43	537	53,958	2,256	33,145	1.97	50%	0.00%	0.00%
C: Promote Resiliency	111	71	114	1.06	120	41	516	53,101	2,197	55,058	1.56	53%	-0.01%	-0.01%
D: Promote Efficient Load Shape	112	72	113	1.02	121	42	531	53,746	2,229	59,034	1.60	53%	-0.01%	-0.01%
E: Promote Renewables	111	71	113	1.04	120	42	529	53,720	2,227	58,759	1.65	53%	0.00%	0.00%

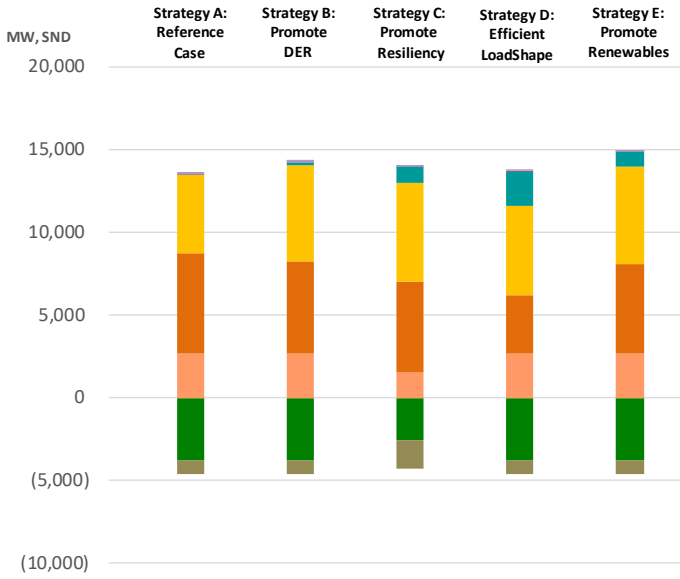
Delta from Draft Metric Results

	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
A: Base Case	-0.24	-0.08	-0.19	0.01	-0.17	-3	-38	-2,501	-358	10,294	-0.08	2%	0.00%	0.00%
B: Promote DER	0.09	0.05	0.09	0.00	0.10	-1	-10	-278	-22	2,629	0.03	0%	0.00%	0.00%
C: Promote Resiliency	-0.21	-0.13	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
D: Promote Efficient Load Shape	-0.26	0.05	-0.26	0.00	-0.38	0	5	20	-23	240	0.17	0%	0.00%	0.00%
E: Promote Renewables	0.05	-0.06	0.05	0.00	-0.05	1	6	81	-5	74	0.16	0%	0.00%	0.00%

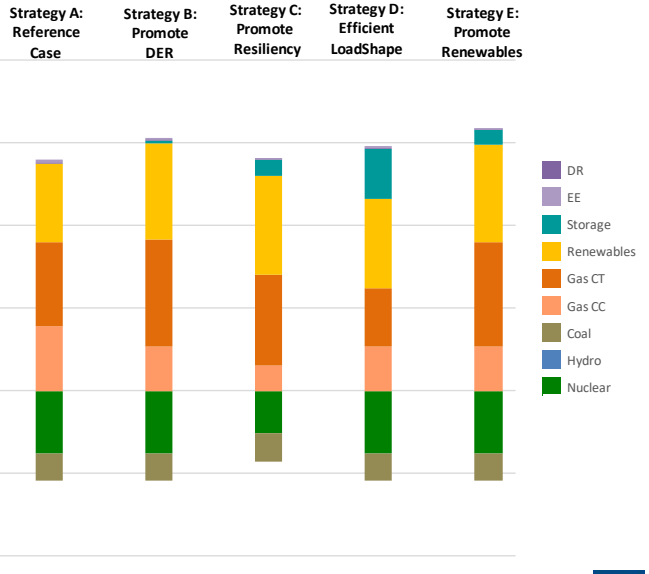
Updated Base Case: No Nuclear Extensions (Scenario 6)

PAF3 was selected for retirement in all No Nuclear Extensions cases, and BRF was selected in Strategy C. Reflecting retirement decisions in all cases drives additional gas expansion later in the plan, except for in Strategy D where additional storage capacity is added due to promotion.

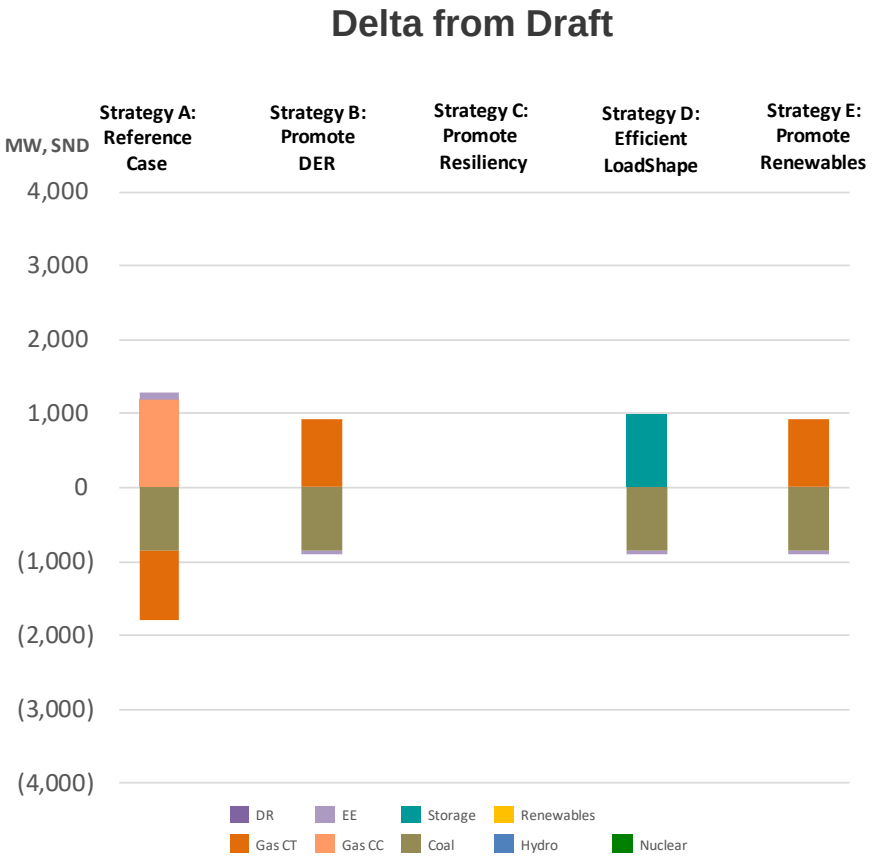
Draft Incremental Capacity Results



Updated Incremental Capacity Results



Updated Base Case: No Nuclear Extensions (Scenario 6)



Strategy A

- BRF capacity and previously selected CT capacity replaced by CC

Strategy B

- BRF capacity replaced by CT

Strategy C

- No change

Strategy D

- BRF capacity replaced by incented storage

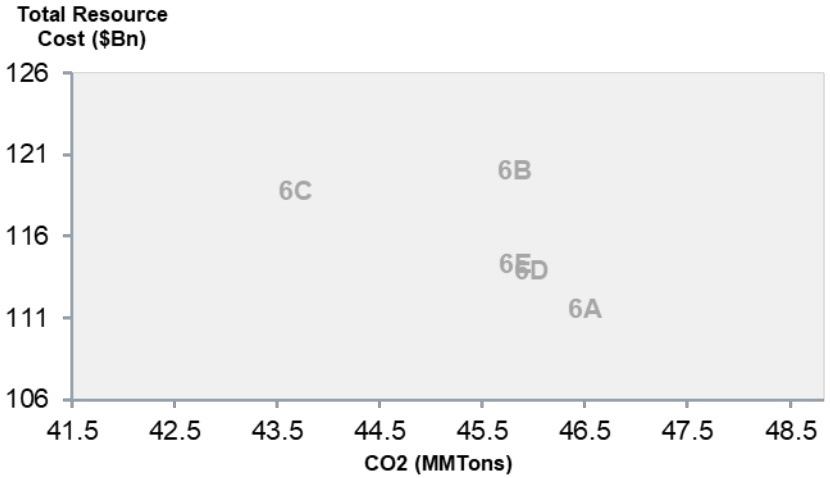
Strategy E

- BRF capacity replaced by CT

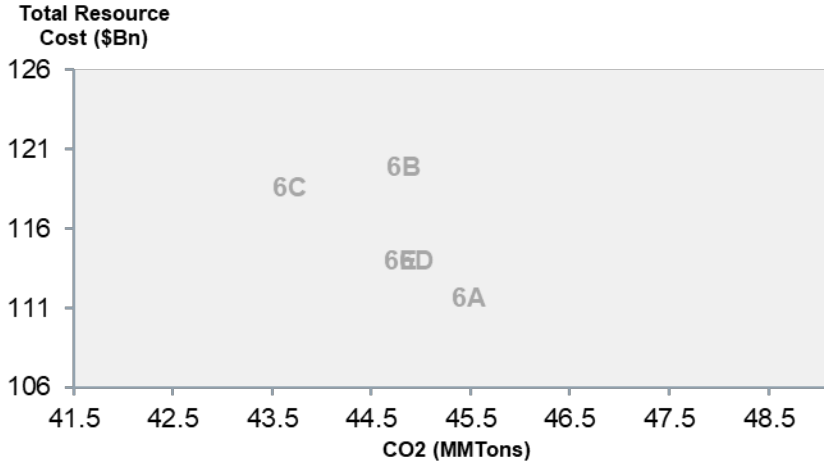
Updated Base Case: No Nuclear Extensions (Scenario 6)

Retiring both plants in all No Nuclear Extensions cases results in similar costs and lower carbon emissions, due to the nature of replacement resources selected later in the plan.

Draft Cost and CO_2 Results



Updated Cost and CO_2 Results



Updated Base Case: No Nuclear Extensions (Scenario 6)

Updated Metric Results

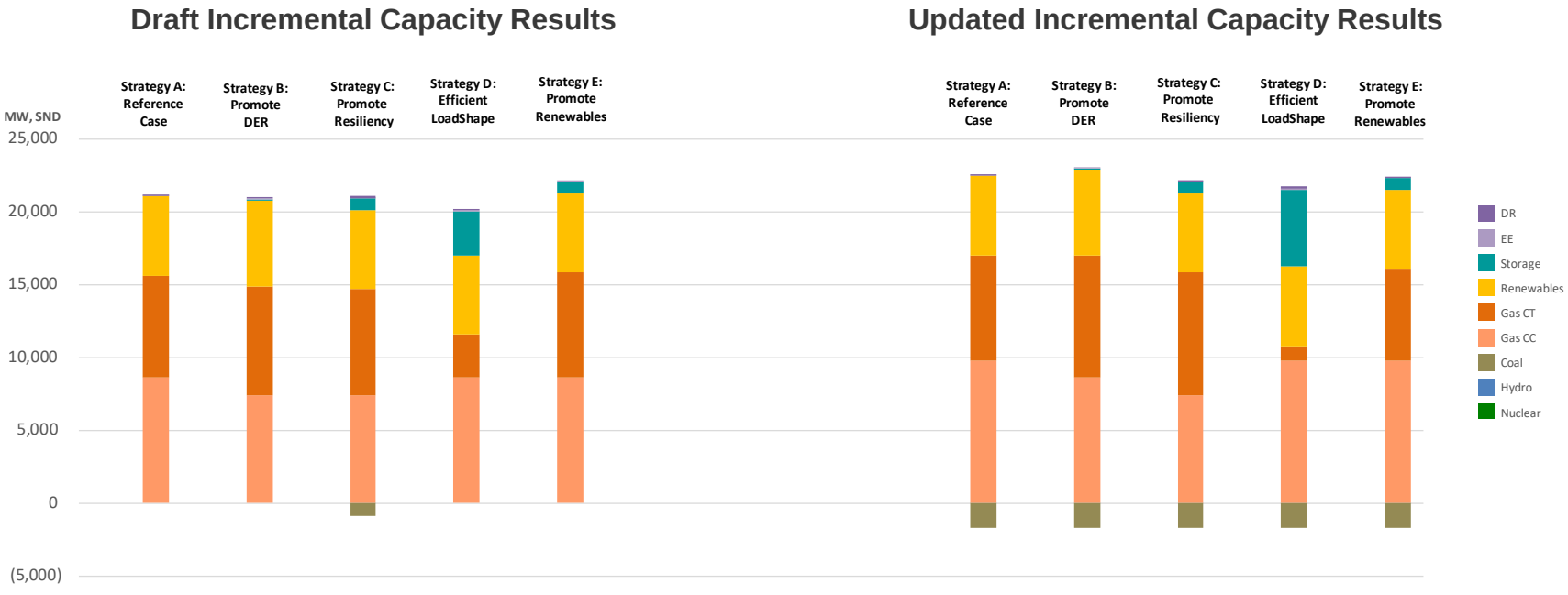
	PVRR ($Bn)	System Average Cost Years 1-20 ($/MWh)	Total Resource Cost ($Bn)	Risk/Benefit Ratio	Risk Exposure ($Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income	Percent Difference in Employment
A: Base Case	111	71	112	1.08	121	46	570	51,895	2,371	51,730	2.22	32%	0.00%	0.00%
B: Promote DER	111	71	120	1.07	121	45	561	51,637	2,354	51,710	2.03	34%	0.00%	0.00%
C: Promote Resiliency	116	74	119	1.07	125	44	546	52,183	2,302	59,711	1.83	40%	-0.03%	-0.03%
D: Promote Efficient Load Shape	113	72	114	1.06	123	45	563	51,684	2,367	59,189	1.92	34%	-0.01%	-0.01%
E: Promote Renewables	112	71	114	1.07	121	45	560	51,624	2,352	59,074	2.07	34%	0.00%	0.00%

Delta from Draft Metric Results

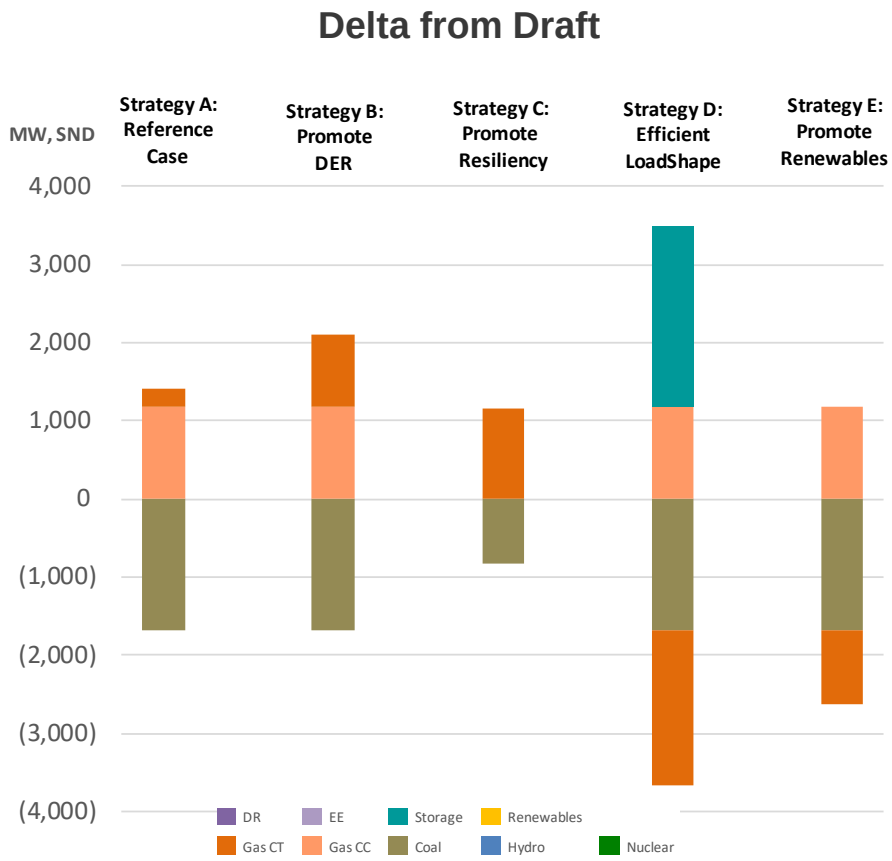
	PVRR ($Bn)	System Average Cost Years 1-20 ($/MWh)	Total Resource Cost ($Bn)	Risk/Benefit Ratio	Risk Exposure ($Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income	Percent Difference in Employment
A: Base Case	0.05	0.03	0.05	0.00	0.06	-1	-13	-347	-68	20	0.02	0%	0.00%	0.00%
B: Promote DER	-0.14	-0.09	-0.14	0.00	-0.12	-1	-12	-319	-66	74	0.10	0%	0.00%	0.00%
C: Promote Resiliency	-0.21	-0.13	-0.21	0.00	-0.23	0	0	0	0	0	0.00	0%	0.00%	0.00%
D: Promote Efficient Load Shape	0.11	0.16	0.11	0.00	0.16	-1	-12	-227	-46	240	0.09	0%	0.00%	0.00%
E: Promote Renewables	-0.25	-0.09	-0.24	0.00	-0.25	-1	-12	-355	-57	74	0.10	0%	0.00%	0.00%

Updated Base Case: Valley Load Growth (Scenario 3)

BRF was selected for retirement in one of the Valley Load Growth cases. Reflecting the retirement decisions in all cases drives additional solar, gas, and storage later in the plan.



Updated Base Case: Valley Load Growth (Scenario 3)



Strategy A

- PAF and BRF capacity replaced by CC

Strategy B

- PAF and BRF capacity replaced CC and CT

Strategy C

- BRF capacity replaced by CT

Strategy D

- PAF, BRF, and previously selected CT capacity replaced by incented storage and CC

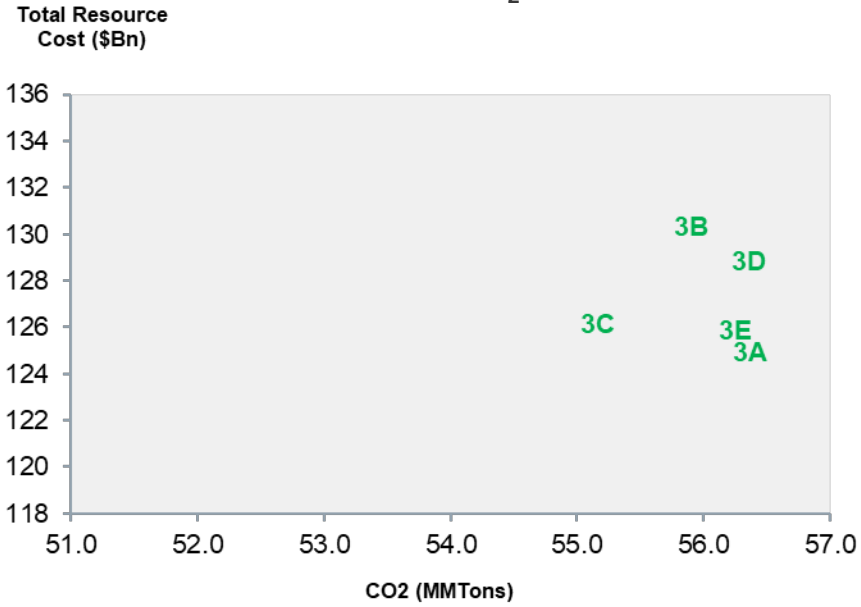
Strategy E

- PAF, BRF, and previously selected CT capacity replaced CC

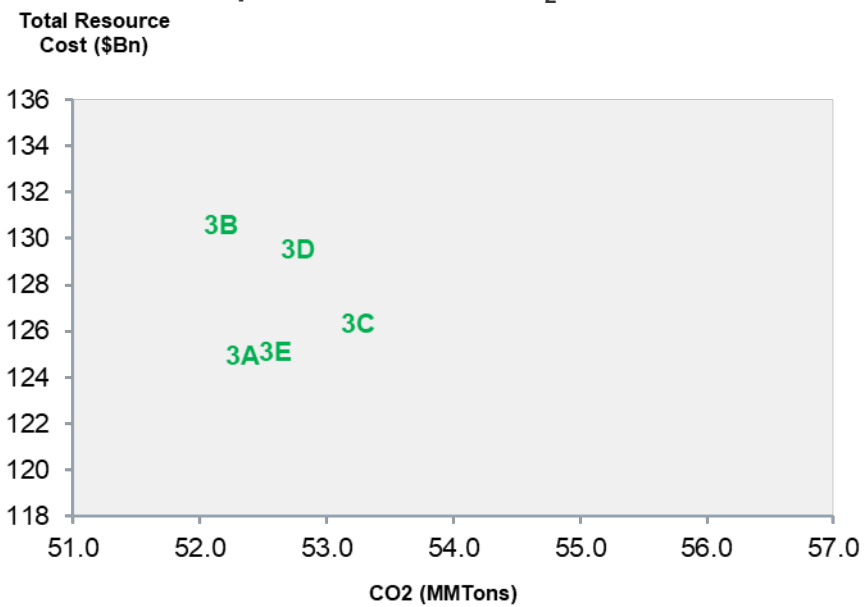
Updated Base Case: Valley Load Growth (Scenario 3)

Retiring both plants in all Valley Load Growth cases results in similar costs and lower carbon emissions, due to the nature of replacement resources selected later in the plan.

Draft Cost and CO_2 Results



Updated Cost and CO_2 Results



Updated Base Case: Valley Load Growth (Scenario 3)

Updated Metric Results

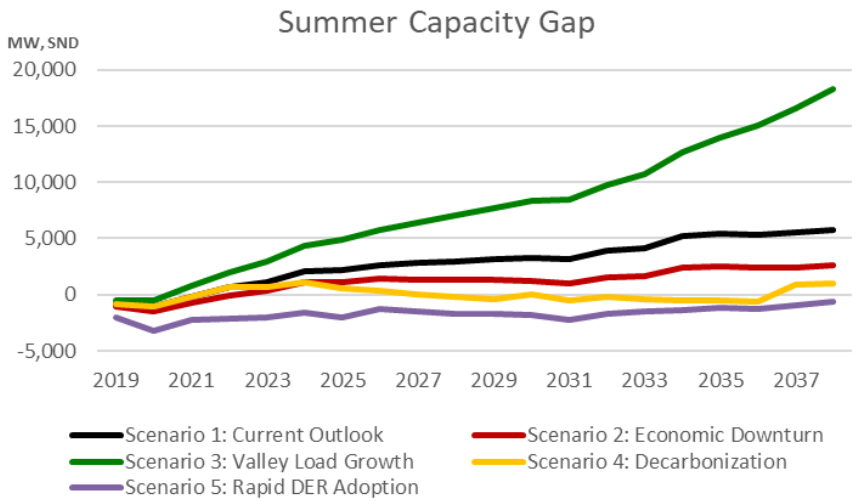
	PVRR ($Bn)	System Average Cost Years 1-20 ($/MWh)	Total Resource Cost ($Bn)	Risk/Benefit Ratio	Risk Exposure ($Bn)	CO2 (MMTons)	CO2 Intensity (lbs/MWh)	Water Consumption (MMGallons)	Waste (MMTons)	Land Use (Acres)	Flexible Resource Coverage Ratio	Flexibility Turn Down Factor (2038)	Percent Difference in Per Capita Income	Percent Difference in Employment
A: Base Case	125	70	125	1.06	137	52	552	58,823	2,283	59,647	2.17	36%	0.00%	0.00%
B: Promote DER	124	70	131	1.06	137	52	550	58,675	2,318	59,627	2.11	36%	0.01%	0.01%
C: Promote Resiliency	126	71	126	1.06	138	53	561	57,456	2,363	59,679	2.09	36%	-0.01%	-0.01%
D: Promote Efficient Load Shape	129	73	130	1.04	142	53	557	58,999	2,386	60,091	1.79	36%	-0.04%	-0.04%
E: Promote Renewables	125	70	125	1.06	137	53	556	58,843	2,350	59,637	2.15	36%	-0.01%	-0.01%

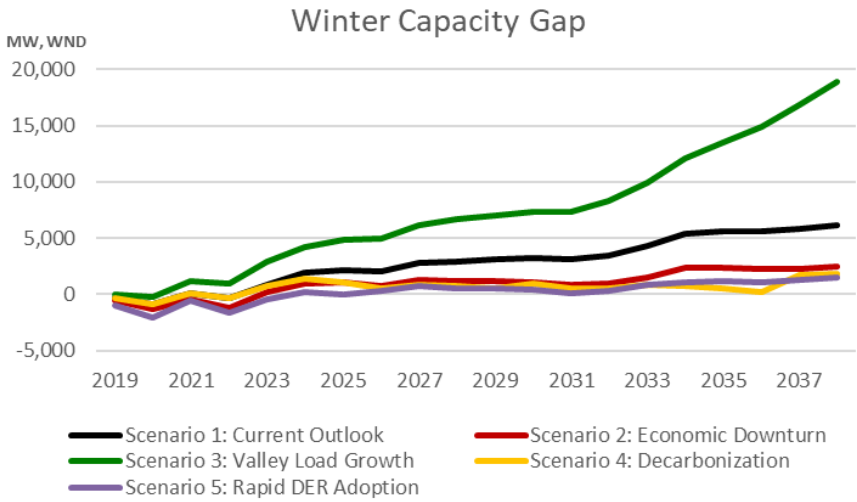
Delta from Draft Metric Results

	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
A: Base Case	-0.03	-0.01	-0.03	0.00	0.15	-4	-43	-2,891	-527	94	0.11	0%	0.00%	0.00%
B: Promote DER	0.24	0.10	0.26	0.00	0.44	-4	-40	-2,871	-491	168	0.16	0%	0.00%	0.00%
C: Promote Resiliency	0.19	0.05	0.19	0.00	0.42	-2	-21	-2,937	-328	99	0.09	0%	0.00%	0.00%
D: Promote Efficient Load Shape	0.70	0.29	0.70	0.00	1.10	-4	-39	-2,563	-476	506	0.07	0%	0.00%	0.00%
E: Promote Renewables	-0.72	-0.23	-0.73	0.00	-0.57	-4	-37	-2,842	-444	20	0.01	0%	0.00%	0.00%

Summary of Portfolio Results with Updated Base Case

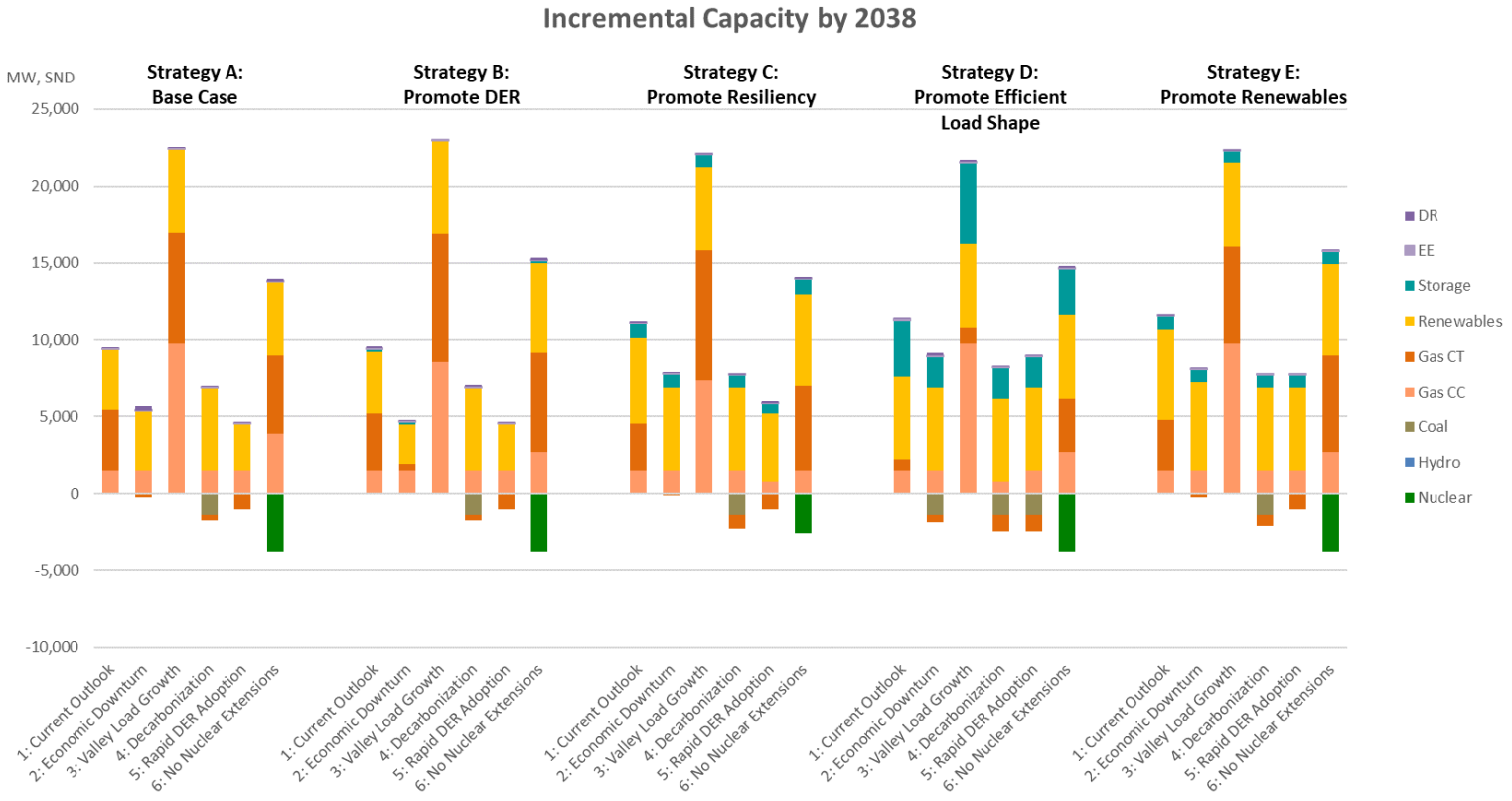
Scenario Capacity Gaps





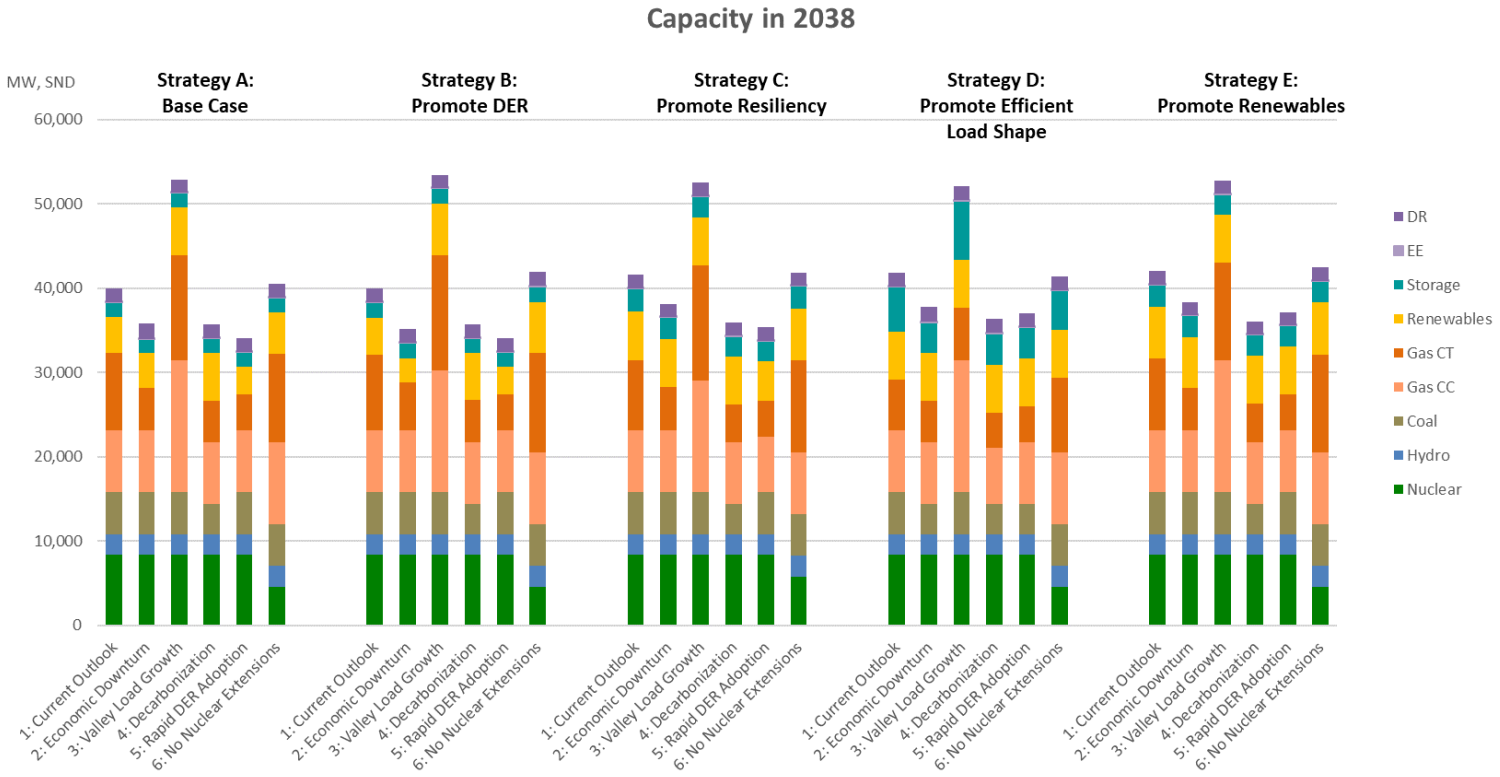
Scenario 6 is the same as the Current Outlook

Incremental Capacity by 2038



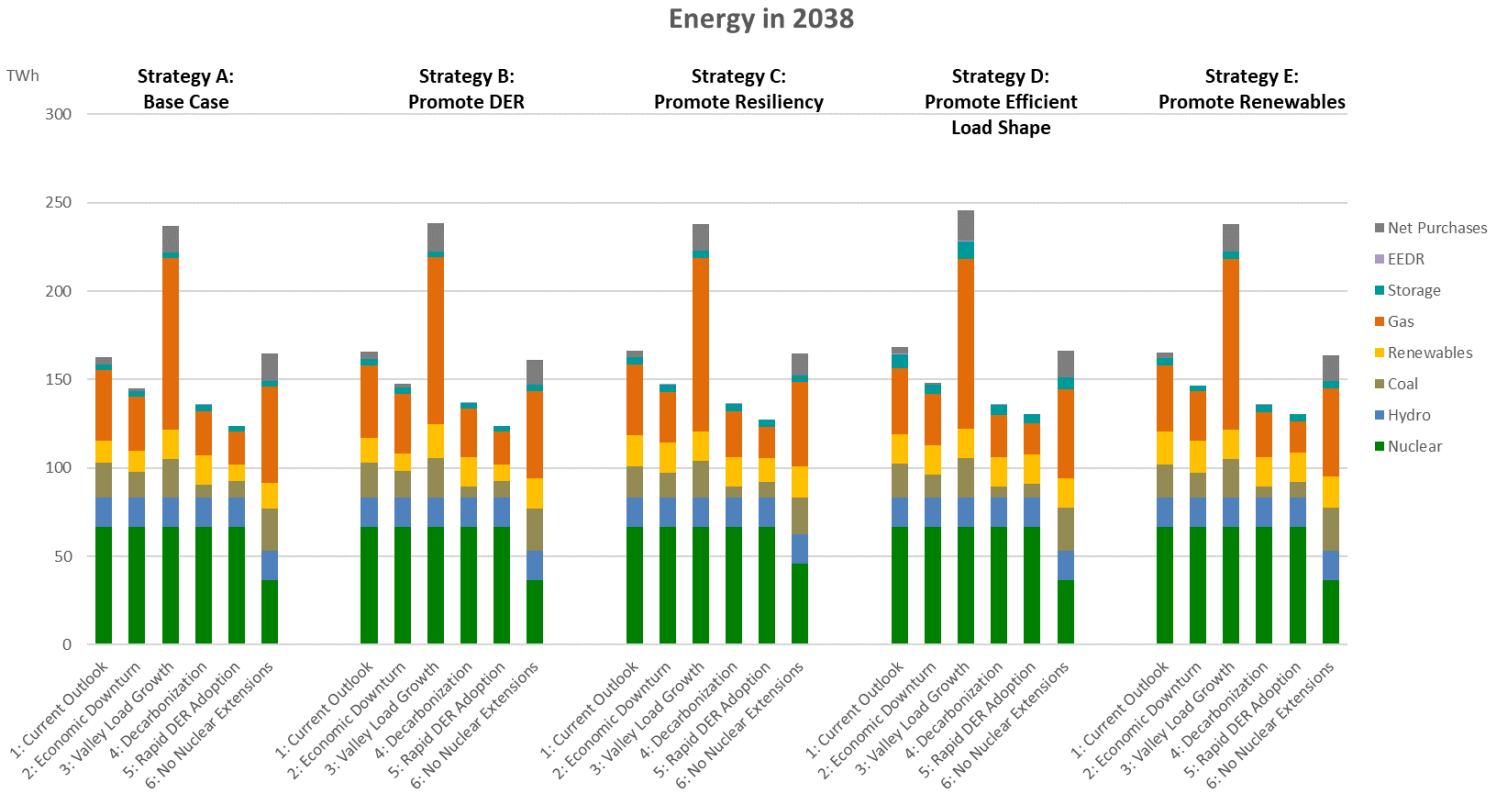
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Capacity in 2038



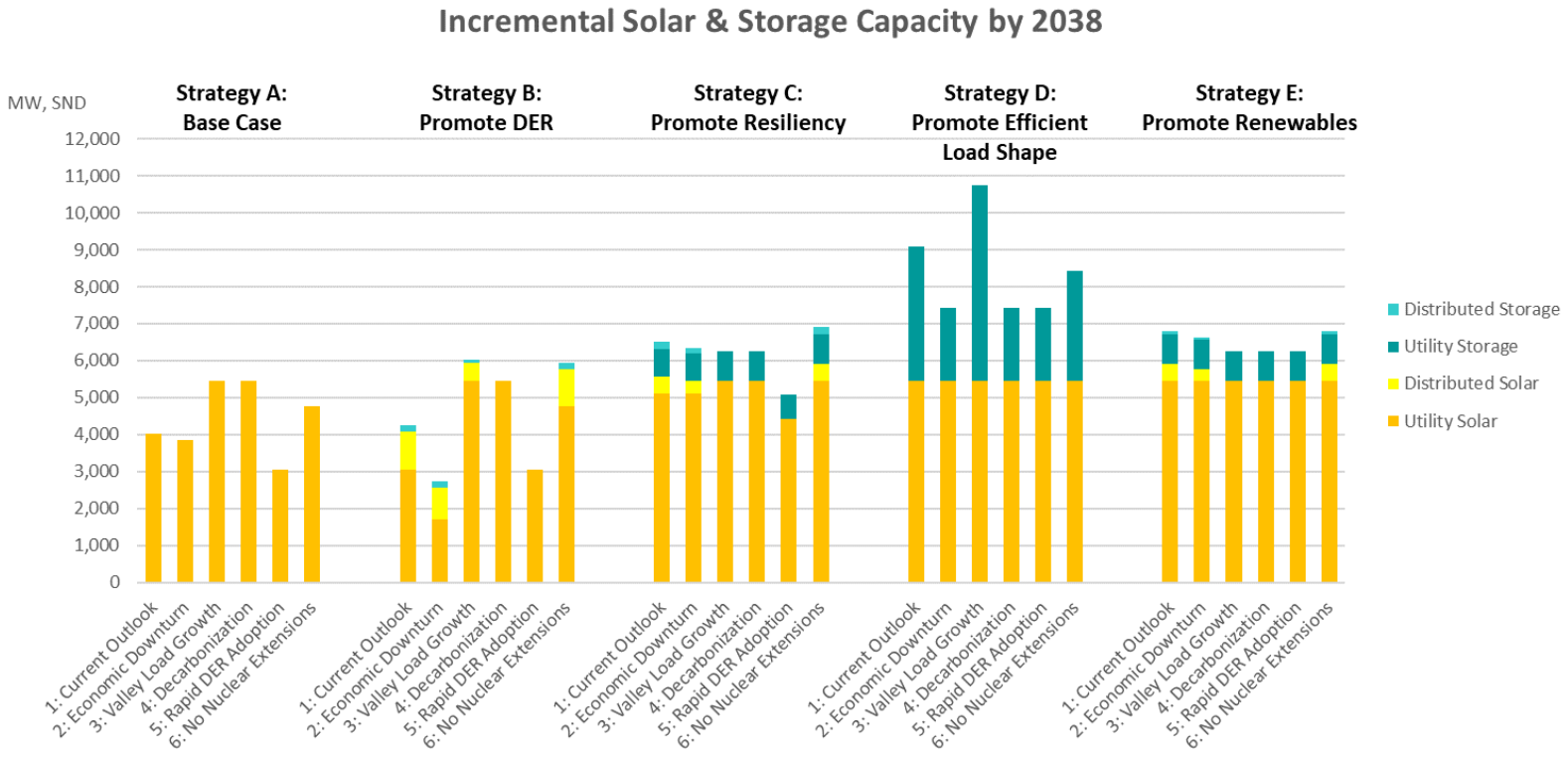
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Energy in 2038



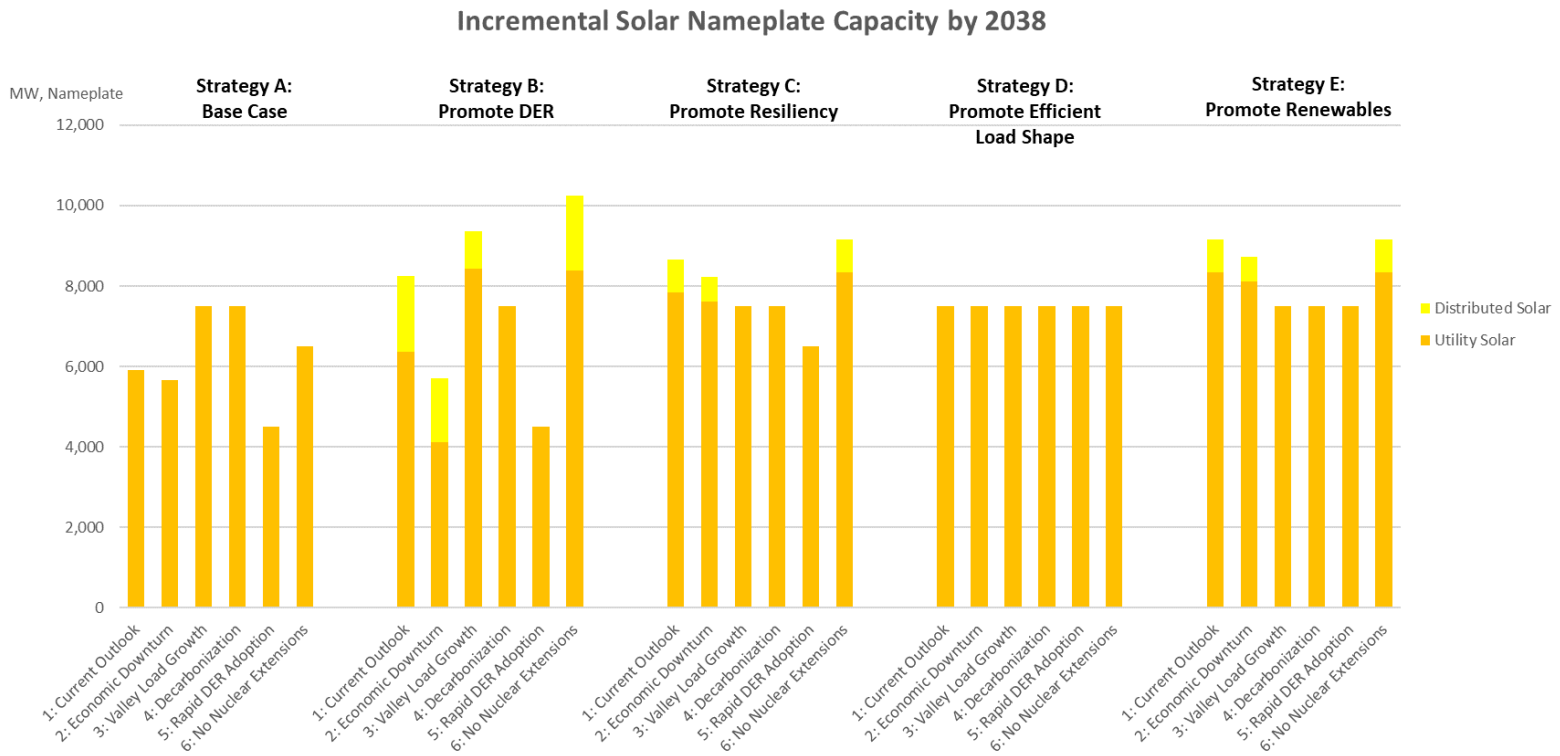
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental Solar & Storage by 2038



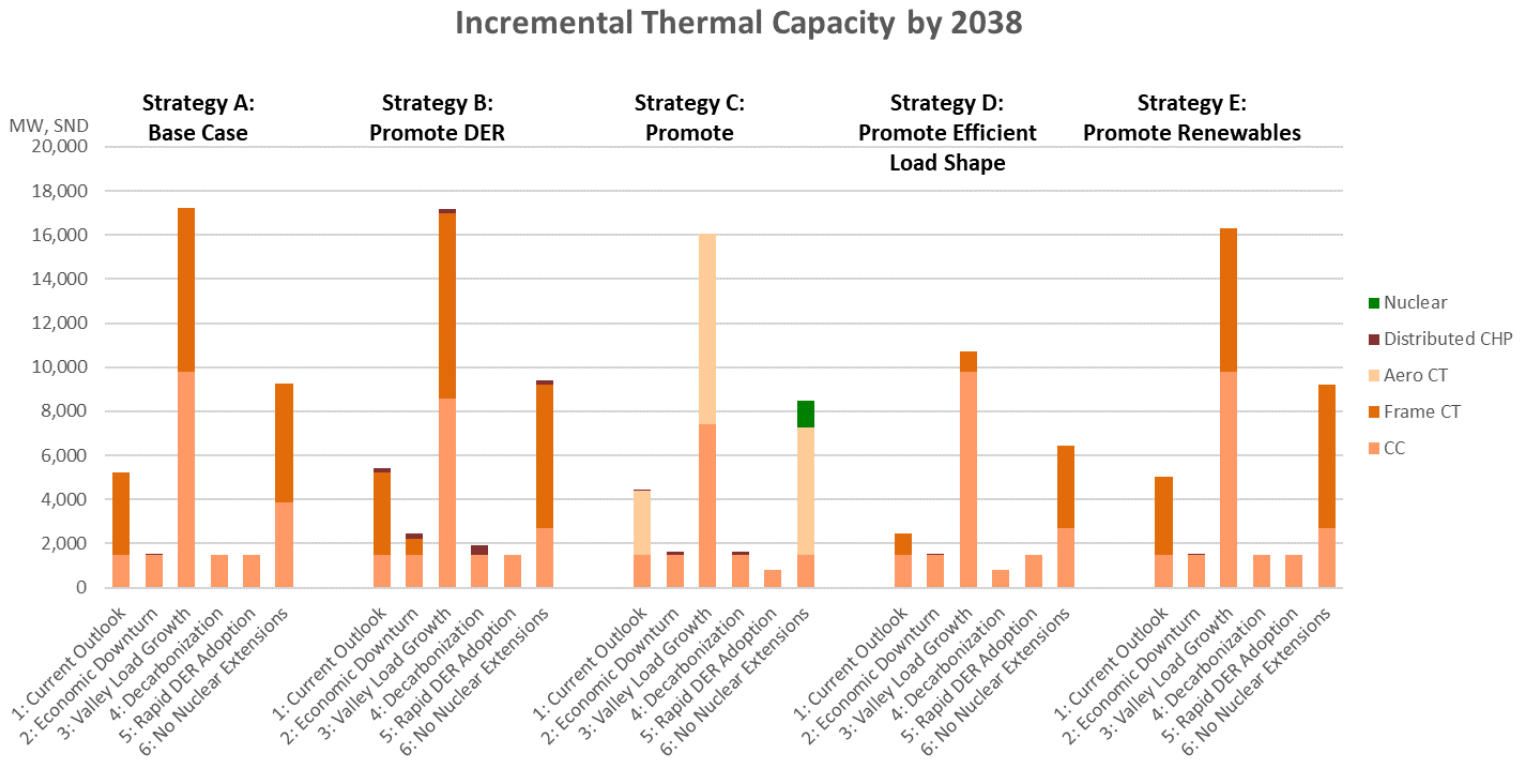
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental Solar Nameplate by 2038



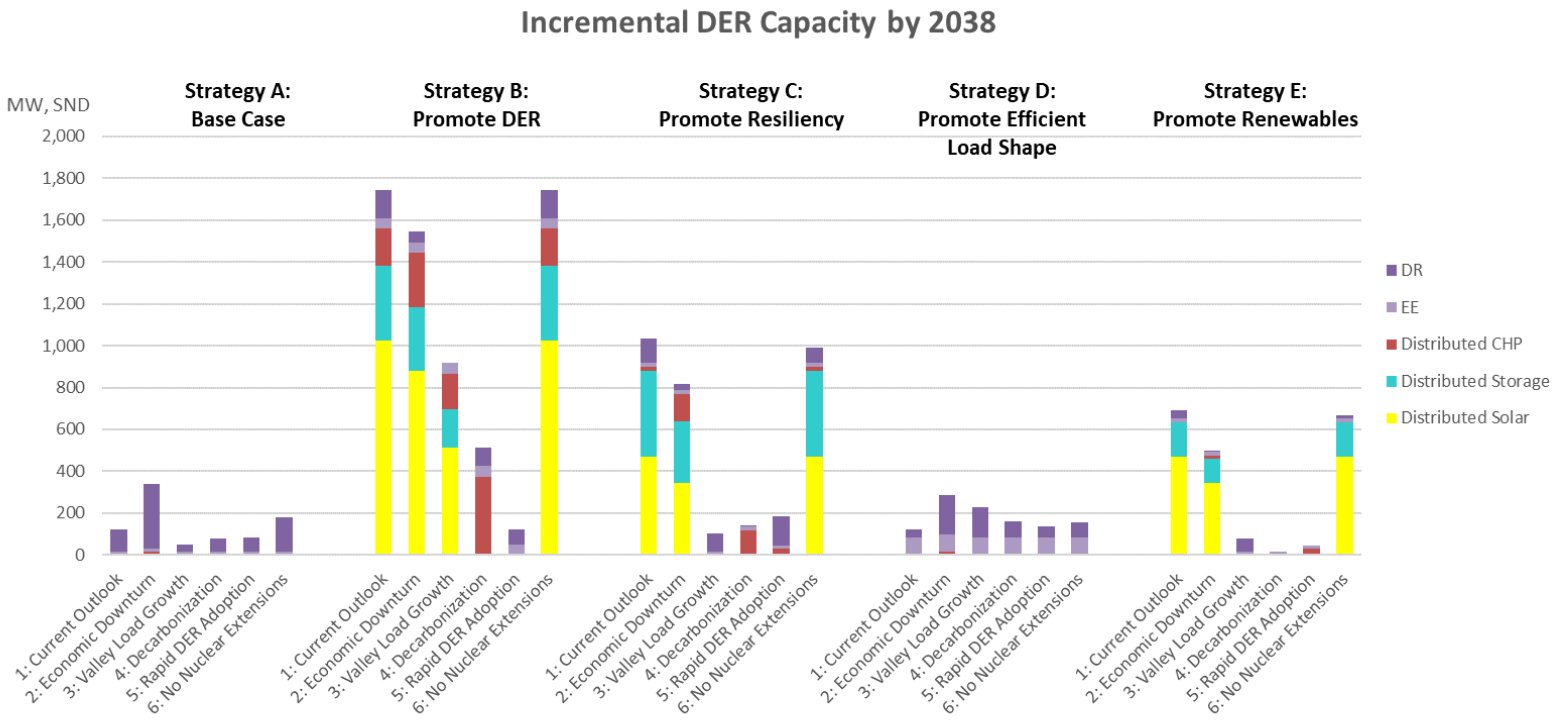
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental Thermal Capacity by 2038



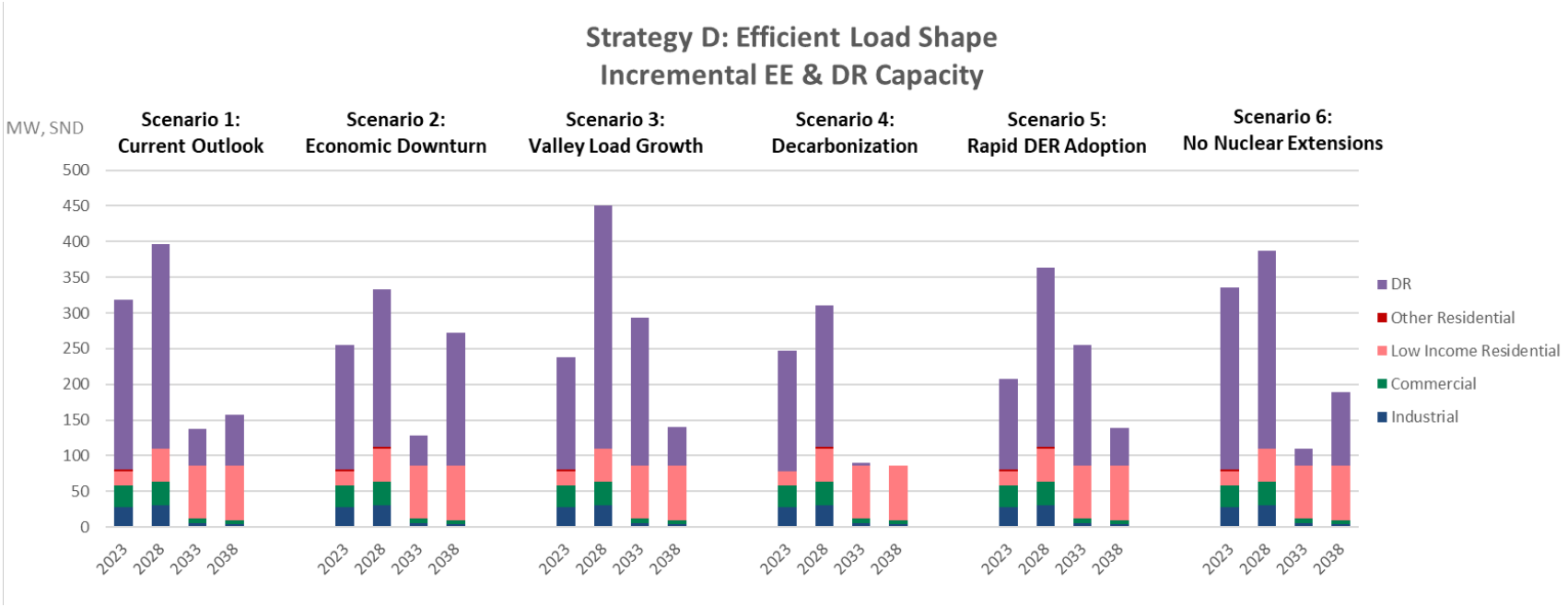
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental DER Capacity by 2038



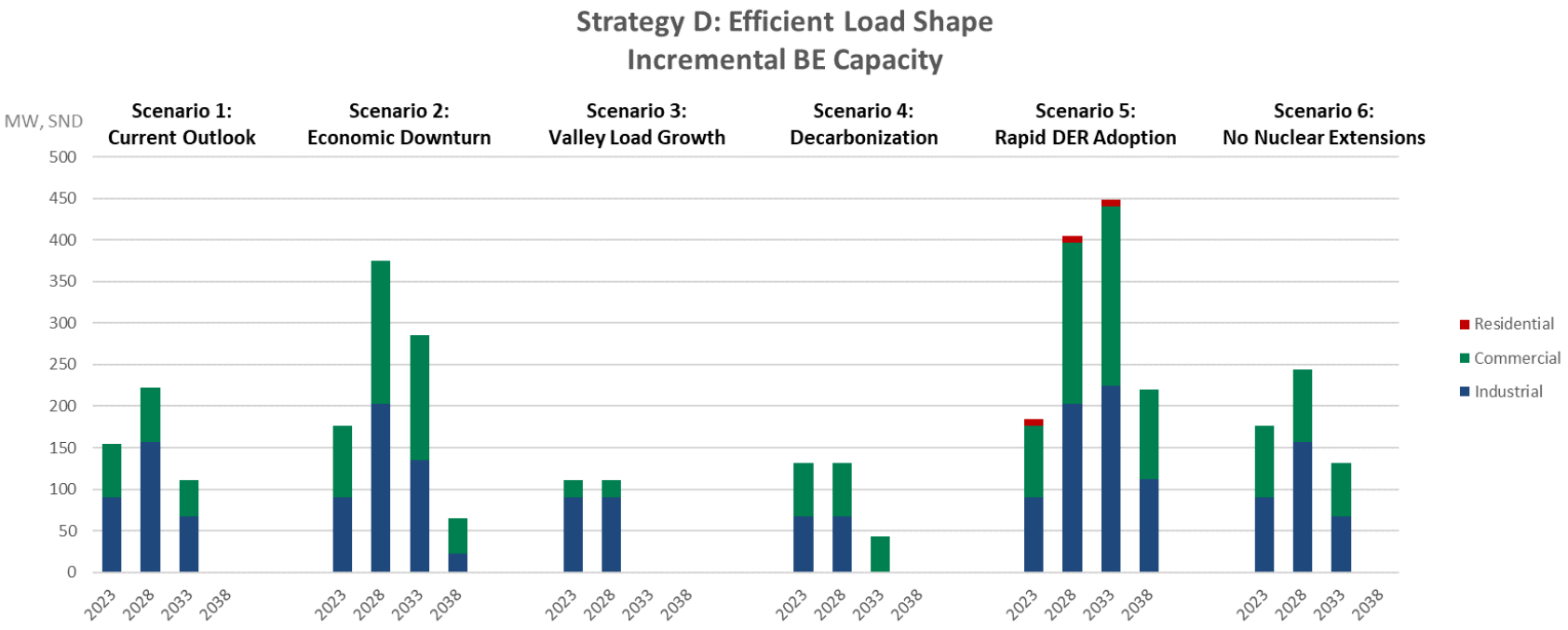
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental EE & DR in Strategy D



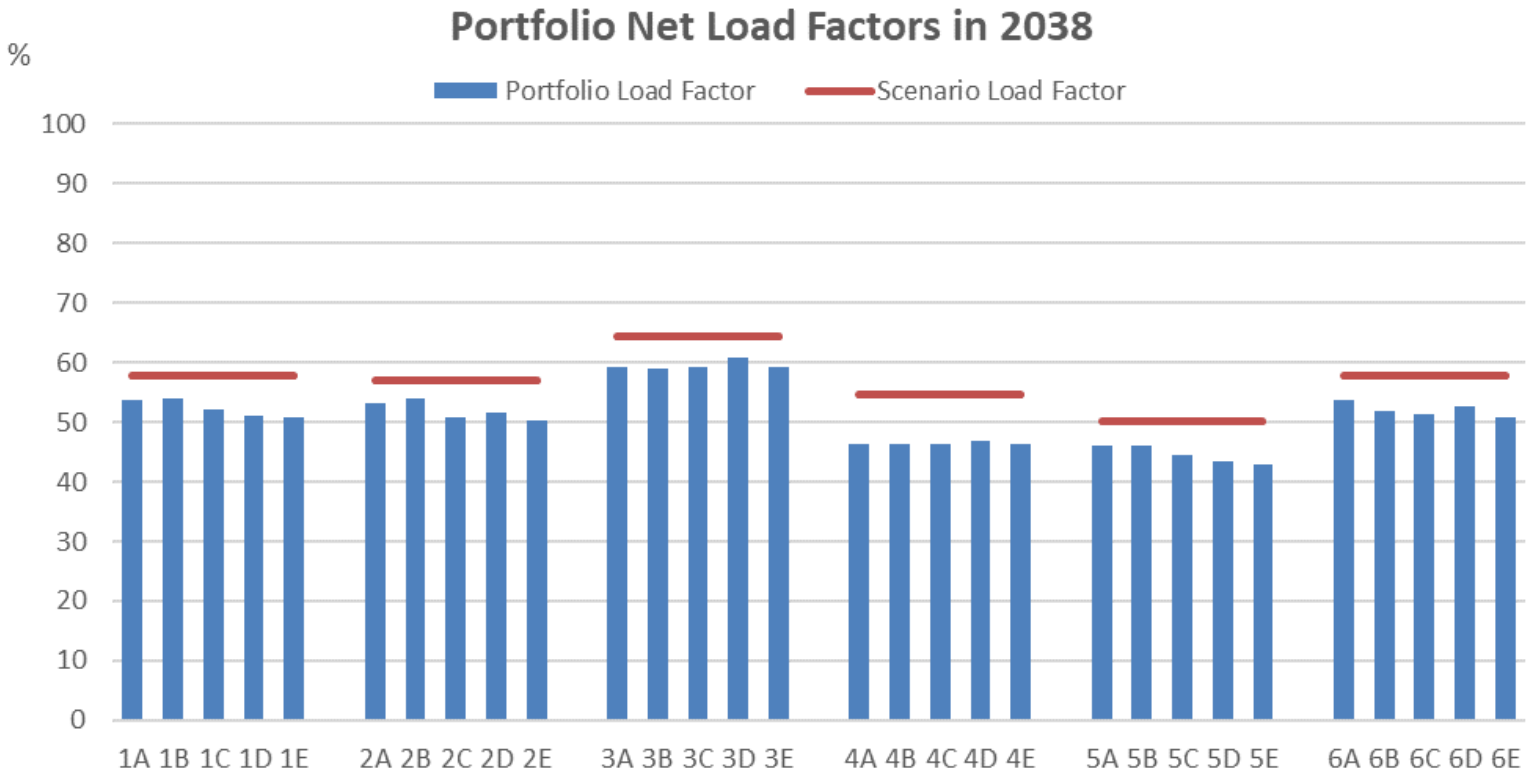
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Incremental BE in Strategy D



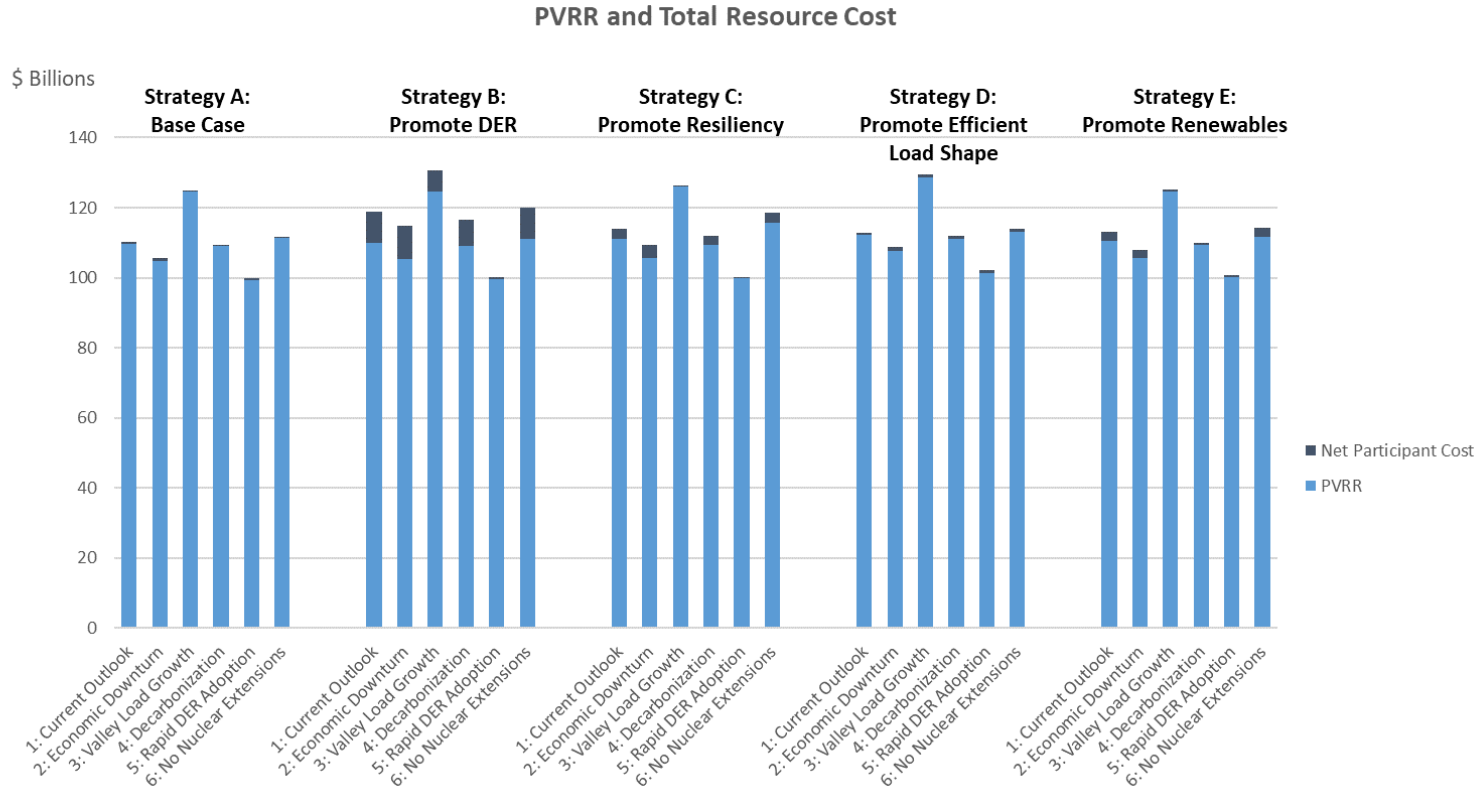
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Portfolio Net Load Factors in 2038



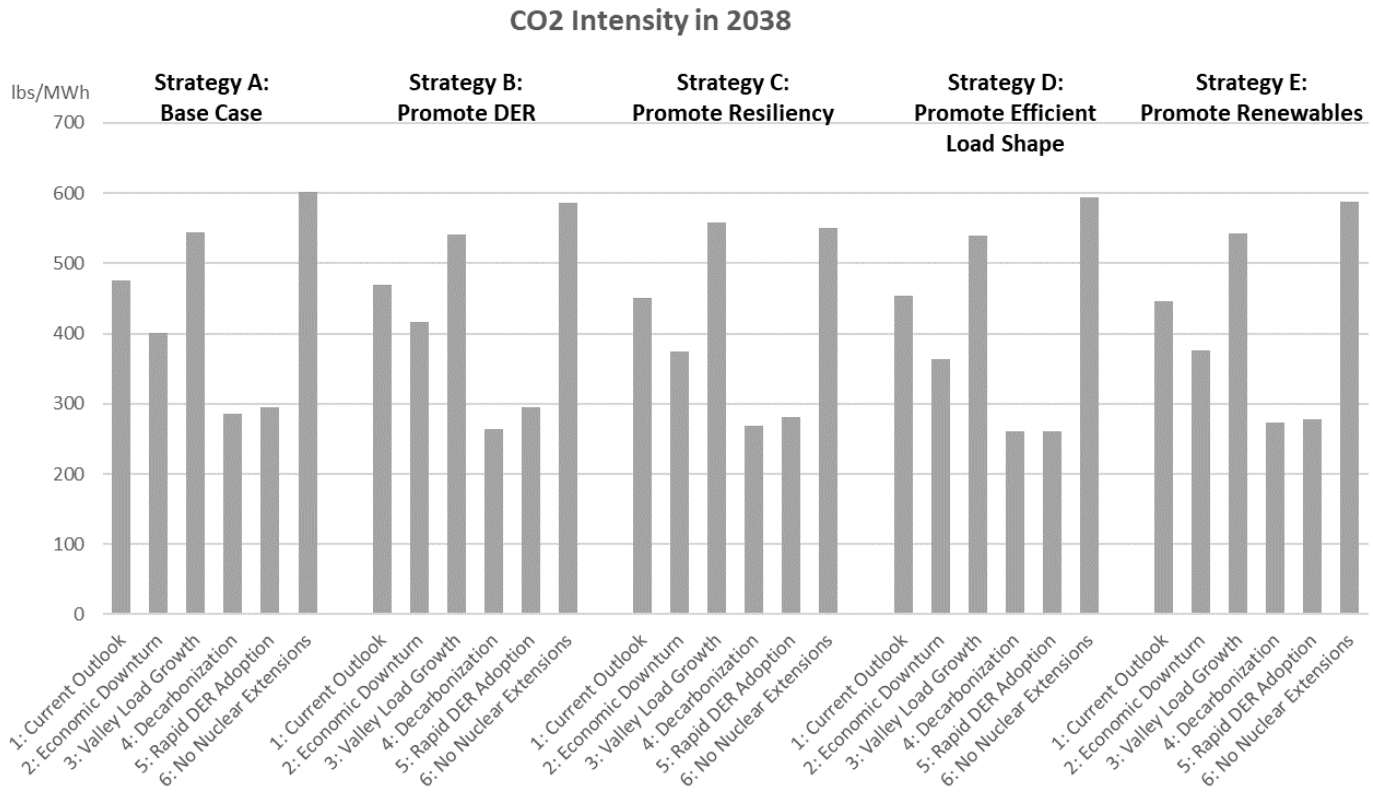
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

PVRR and Total Resource Cost in 2038



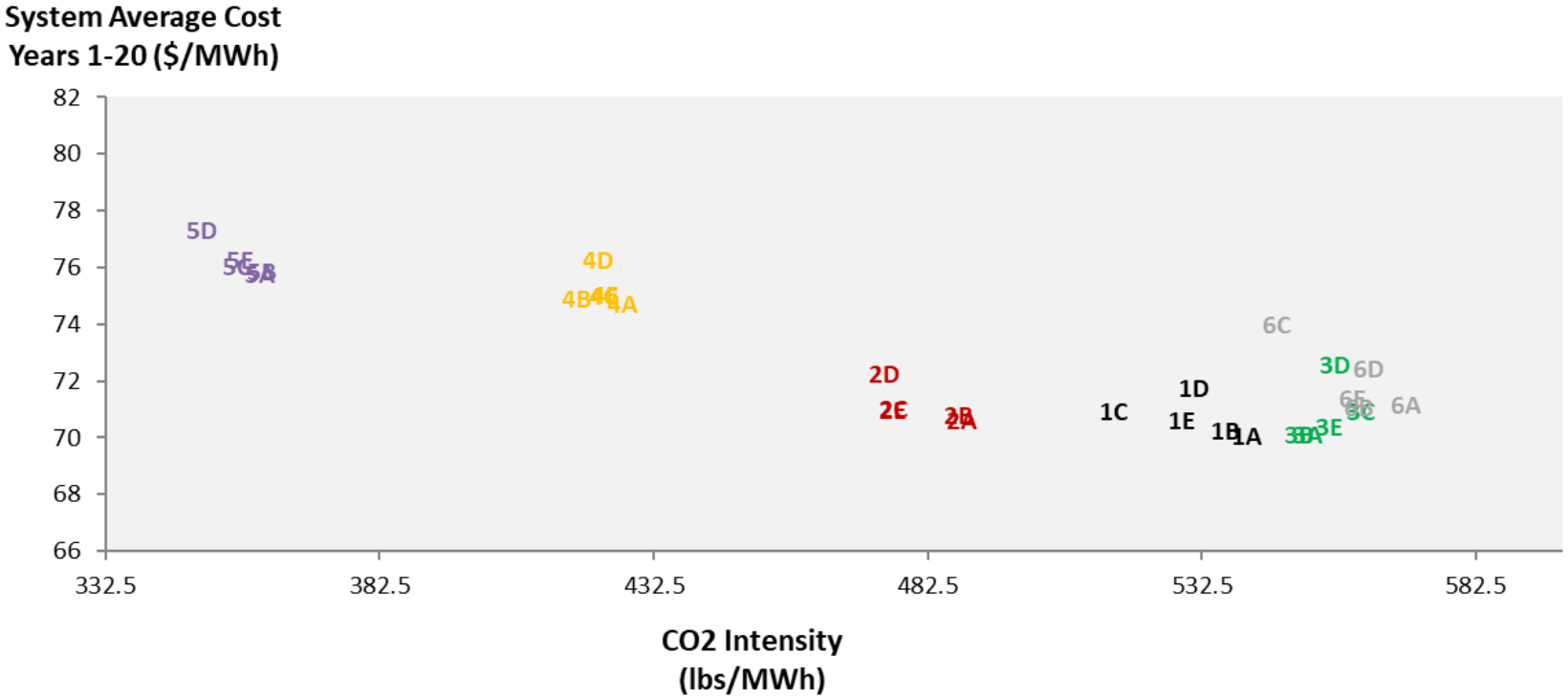
Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

CO2 Intensity in 2038



Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Portfolio Cost and CO2 Tradeoff



Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Cost Metrics Summary

Scorecard Metric	Current Outlook	Economic Downturn	Valley Load Growth	De-Carbonization	Rapid DER Adoption	No Nuclear Extensions	Average Result	Average Rank
PVRR ($Bn)								
Base Case	$ 109.7	$ 104.9	$ 124.5	$ 108.9	$ 99.3	$ 111.2	$ 109.8	1.3
Promote DER	$ 110.0	$ 105.2	$ 124.5	$ 109.0	$ 99.5	$ 111.1	$ 109.9	1.7
Promote Resiliency	$ 111.0	$ 105.6	$ 125.9	$ 109.2	$ 99.8	$ 115.8	$ 111.2	3.8
Promote Efficient Load Shape	$ 112.1	$ 107.6	$ 128.8	$ 111.0	$ 101.4	$ 113.2	$ 112.3	4.8
Promote Renewables	$ 110.6	$ 105.5	$ 124.7	$ 109.4	$ 100.2	$ 111.7	$ 110.4	3.3
System Average Cost Years 1-20 ($/MWh)								
Base Case	$ 70.1	$ 70.6	$ 70.1	$ 74.7	$ 75.8	$ 71.2	$ 72.1	1.2
Promote DER	$ 70.2	$ 70.8	$ 70.1	$ 74.9	$ 75.9	$ 71.1	$ 72.2	1.8
Promote Resiliency	$ 70.9	$ 71.0	$ 70.9	$ 75.0	$ 76.1	$ 74.0	$ 73.0	3.8
Promote Efficient Load Shape	$ 71.8	$ 72.3	$ 72.6	$ 76.3	$ 77.3	$ 72.4	$ 73.8	4.8
Promote Renewables	$ 70.6	$ 71.0	$ 70.4	$ 75.0	$ 76.3	$ 71.4	$ 72.4	3.3
Total Resource Cost ($Bn)								
Base Case	$ 110.2	$ 105.6	$ 125.0	$ 109.4	$ 99.7	$ 111.7	$ 110.3	1.0
Promote DER	$ 118.9	$ 114.8	$ 130.6	$ 116.5	$ 100.1	$ 120.0	$ 116.8	4.5
Promote Resiliency	$ 113.9	$ 109.4	$ 126.4	$ 111.8	$ 100.2	$ 118.6	$ 113.4	3.5
Promote Efficient Load Shape	$ 112.9	$ 108.7	$ 129.6	$ 111.9	$ 102.2	$ 114.1	$ 113.2	3.3
Promote Renewables	$ 113.0	$ 107.9	$ 125.2	$ 109.8	$ 100.7	$ 114.1	$ 111.8	2.7

Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Risk Metrics Summary

Scorecard Metric	Current Outlook	Economic Downturn	Valley Load Growth	De-Carbonization	Rapid DER Adoption	No Nuclear Extensions	Average Result	Average Rank
Risk/Benefit Ratio								
Base Case	1.06	1.00	1.06	1.04	0.94	1.08	1.03	4.5
Promote DER	1.05	1.00	1.06	1.03	0.94	1.07	1.03	3.3
Promote Resiliency	1.06	0.98	1.06	1.04	0.94	1.07	1.02	3.7
Promote Efficient Load Shape	1.02	0.98	1.04	1.02	0.93	1.06	1.01	1.0
Promote Renewables	1.04	0.98	1.06	1.03	0.93	1.07	1.02	2.5
Risk Exposure ($Bn)								
Base Case	$ 118.7	$ 112.6	$ 136.7	$ 118.0	$ 105.5	$ 120.8	$ 118.7	1.5
Promote DER	$ 119.0	$ 113.0	$ 136.7	$ 118.0	$ 105.8	$ 120.6	$ 118.8	1.5
Promote Resiliency	$ 120.1	$ 113.3	$ 138.2	$ 118.3	$ 106.1	$ 125.1	$ 120.2	3.8
Promote Efficient Load Shape	$ 121.2	$ 115.6	$ 141.6	$ 120.2	$ 107.9	$ 122.8	$ 121.6	4.8
Promote Renewables	$ 119.6	$ 113.3	$ 136.9	$ 118.4	$ 106.6	$ 121.2	$ 119.3	3.3

Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Environmental Metrics Summary

Scorecard Metric	Current Outlook	Economic Downturn	Valley Load Growth	De-Carbonization	Rapid DER Adoption	No Nuclear Extensions	Average Result	Average Rank
CO2 (MMTons)								
Base Case	43.2	36.5	52.3	30.8	23.3	45.5	38.6	4.2
Promote DER	42.9	36.5	52.2	30.1	23.4	44.9	38.3	3.2
Promote Resiliency	41.3	35.6	53.3	30.5	23.1	43.7	37.9	2.5
Promote Efficient Load Shape	42.4	35.6	52.8	30.4	22.7	45.0	38.1	2.5
Promote Renewables	42.3	35.6	52.6	30.5	23.2	44.8	38.2	2.7
Water Consumption (MMGallons)								
Base Case	54,053	51,136	58,823	50,276	45,678	51,895	51,977	4.3
Promote DER	53,958	51,133	58,675	48,706	45,697	51,637	51,634	3.2
Promote Resiliency	53,101	50,681	57,456	48,765	45,563	52,183	51,291	2.3
Promote Efficient Load Shape	53,746	50,658	58,999	48,627	45,383	51,684	51,516	2.3
Promote Renewables	53,720	50,694	58,843	50,173	45,621	51,624	51,779	2.8
CO2 Intensity (lbs/MWh)								
Base Case	541	489	552	427	361	570	490	4.3
Promote DER	537	488	550	418	361	561	486	3.0
Promote Resiliency	516	476	561	423	356	546	480	2.5
Promote Efficient Load Shape	531	475	557	422	350	563	483	2.5
Promote Renewables	529	476	556	424	357	560	483	2.7
Waste (MMTons)								
Base Case	2,269	1,865	2,283	1,272	1,177	2,371	1,873	4.3
Promote DER	2,256	1,861	2,318	1,271	1,176	2,354	1,873	3.5
Promote Resiliency	2,197	1,840	2,363	1,264	1,162	2,302	1,855	2.2
Promote Efficient Load Shape	2,229	1,849	2,386	1,235	1,137	2,367	1,867	2.8
Promote Renewables	2,227	1,840	2,350	1,246	1,167	2,352	1,864	2.2
Land Use (Acres)								
Base Case	43,365	41,245	59,647	58,400	32,850	51,730	47,873	1.8
Promote DER	33,145	18,324	59,627	58,400	32,850	51,710	42,343	1.0
Promote Resiliency	55,058	54,810	59,679	58,464	47,502	59,711	55,871	3.5
Promote Efficient Load Shape	59,034	58,560	60,091	58,560	58,560	59,189	58,999	4.8
Promote Renewables	58,759	58,464	59,637	58,464	58,464	59,074	58,810	3.3

Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Operational Flexibility Metrics Summary

Scorecard Metric	Current Outlook	Economic Downturn	Valley Load Growth	De-Carbonization	Rapid DER Adoption	No Nuclear Extensions	Average Result	Average Rank
Flexible Resource Coverage Ratio								
Base Case	1.98	1.37	2.17	0.98	1.14	2.22	1.64	2.0
Promote DER	1.97	1.71	2.11	0.98	1.14	2.03	1.66	2.5
Promote Resiliency	1.56	1.29	2.09	1.04	1.02	1.83	1.47	4.2
Promote Efficient Load Shape	1.60	1.39	1.79	1.15	1.13	1.92	1.49	3.2
Promote Renewables	1.65	1.18	2.15	1.04	1.02	2.07	1.52	3.0
Flexibility Turn Down Factor (2038)								
Base Case	0.50	0.56	0.36	0.66	0.63	0.32	0.51	1.5
Promote DER	0.50	0.53	0.36	0.66	0.63	0.34	0.50	2.7
Promote Resiliency	0.53	0.59	0.36	0.66	0.66	0.40	0.53	3.3
Promote Efficient Load Shape	0.53	0.59	0.36	0.66	0.69	0.34	0.53	3.8
Promote Renewables	0.53	0.59	0.36	0.66	0.67	0.34	0.53	3.7

Results updated based on 2/14/2019 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Valley Economics Metrics Summary

Scorecard Metric	Current Outlook	Economic Downturn	Valley Load Growth	De-Carbonization	Rapid DER Adoption	No Nuclear Extensions	Average Result	Average Rank
Percent Difference in Per Capita Income								
Base Case	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	1.7
Promote DER	0.002%	-0.002%	0.006%	0.002%	-0.001%	0.003%	0.002%	1.3
Promote Resiliency	-0.006%	-0.004%	-0.011%	-0.002%	-0.003%	-0.027%	-0.009%	4.0
Promote Efficient Load Shape	-0.014%	-0.020%	-0.042%	-0.016%	-0.019%	-0.011%	-0.020%	4.8
Promote Renewables	-0.003%	-0.002%	-0.007%	-0.002%	-0.010%	-0.002%	-0.004%	3.2
Percent Difference in Employment								
Base Case	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	1.7
Promote DER	0.002%	-0.002%	0.006%	0.002%	-0.001%	0.003%	0.002%	1.3
Promote Resiliency	-0.006%	-0.004%	-0.011%	-0.002%	-0.003%	-0.027%	-0.009%	4.0
Promote Efficient Load Shape	-0.014%	-0.020%	-0.042%	-0.016%	-0.019%	-0.011%	-0.020%	4.8
Promote Renewables	-0.003%	-0.002%	-0.007%	-0.002%	-0.010%	-0.002%	-0.004%	3.2

Economic results are rounded to the thousandths decimal place.
Results updated based on 2/14/19 TVA Board decision to retire Bull Run and Paradise 3 fossil plants.

Updated Base Case – Summary of Impacts

Objective: Reflect the impact of Board decision to retire Paradise 3 (PAF3) and Bull Run (BRF) fossil plants on IRP results.

Approach: Include PAF3 (2020) and BRF (2023) retirements as reductions in baseline firm supply, along with aligned cost estimates, in the full set of portfolio and scorecard results.

Impact:
Lower Load Scenarios – no impact
Current Outlook – similar costs and lower carbon emissions
No Nuclear Extensions – similar costs and lower carbon emissions
Valley Load Growth – similar costs and lower carbon emissions

Updated Base Case Discussion

What are your observations about the updated Base Case and its impact on results?

Gas CT Retirement Case

Gas CT Retirement Case

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

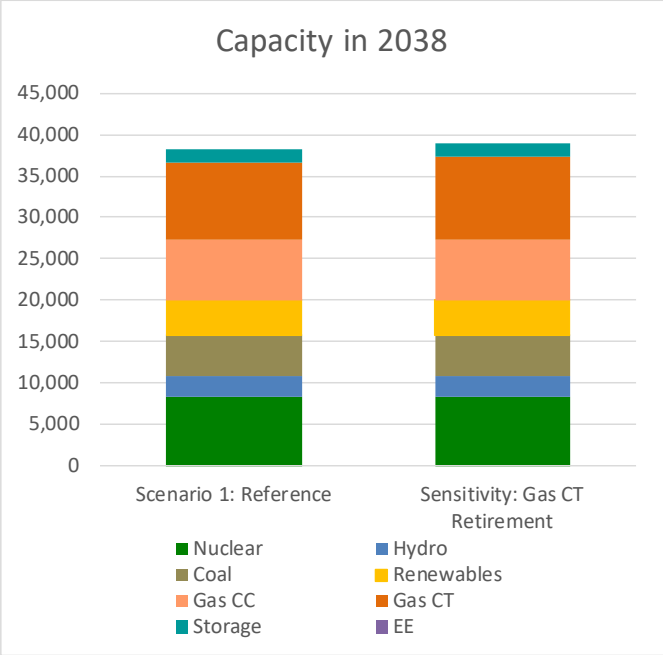
Approach: Assume all Gas CTs older than 40 years are retired at the earliest possible date (2020), then rerun models to derive impact on capacity expansion plan and metric results.

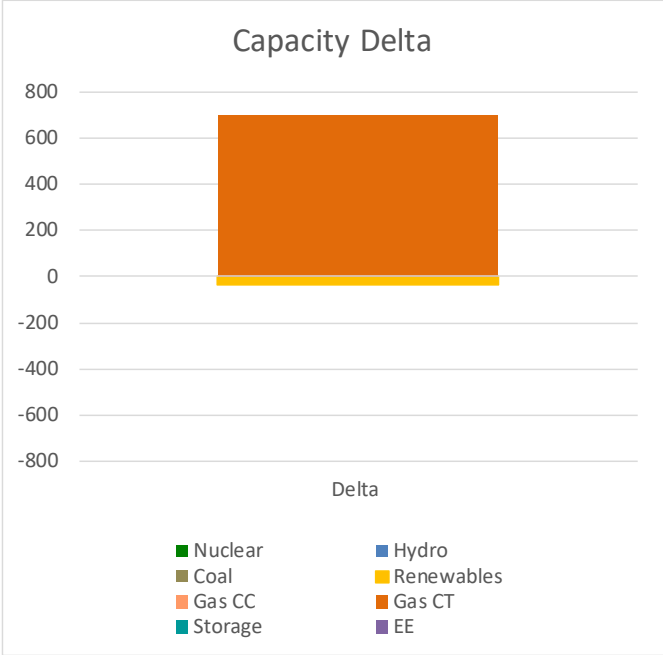
Gas CTs older than 40 years include:

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

Gas CT Retirement Case

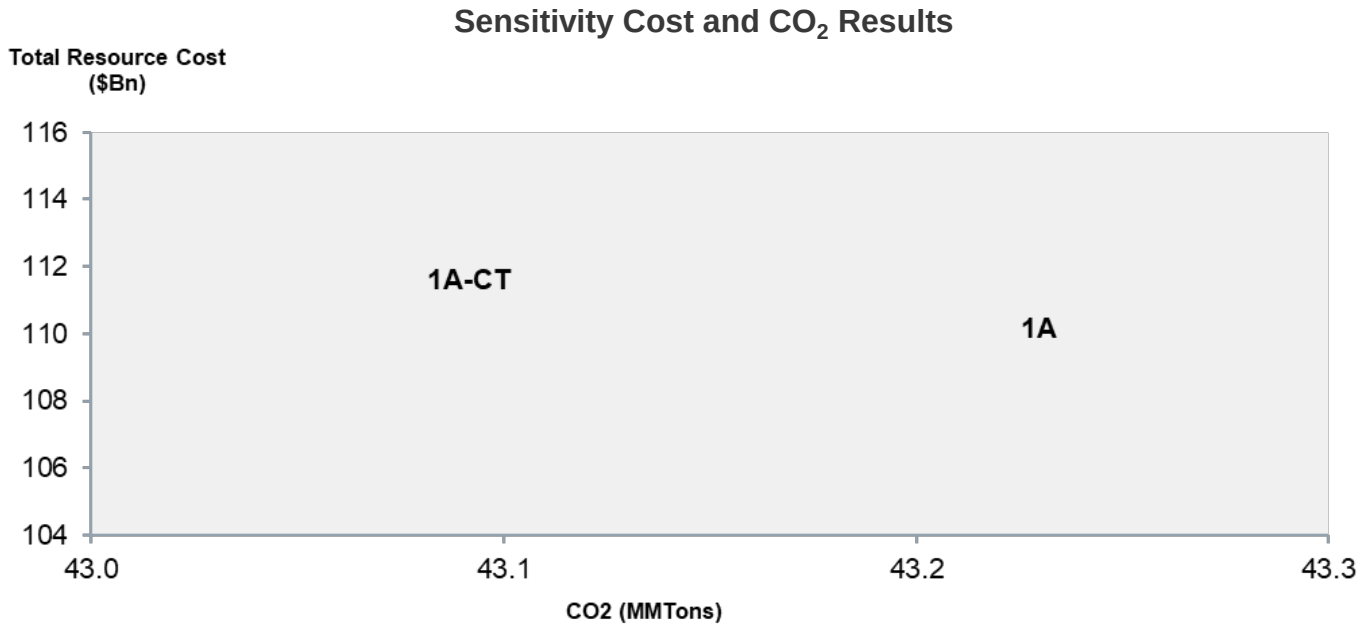
Sensitivity bounding case retiring all older Gas CTs at the earliest possible date (2020) drives replacement of capacity with new Gas CTs to meet peaking needs and winter reserve margins. By 2038 there is an additional ~700 MW of gas CT due to a slightly different timing of CT builds.





Gas CT Retirement Case

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



Gas CT Retirement 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
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%

Integration Cost & Flexibility Benefit Case

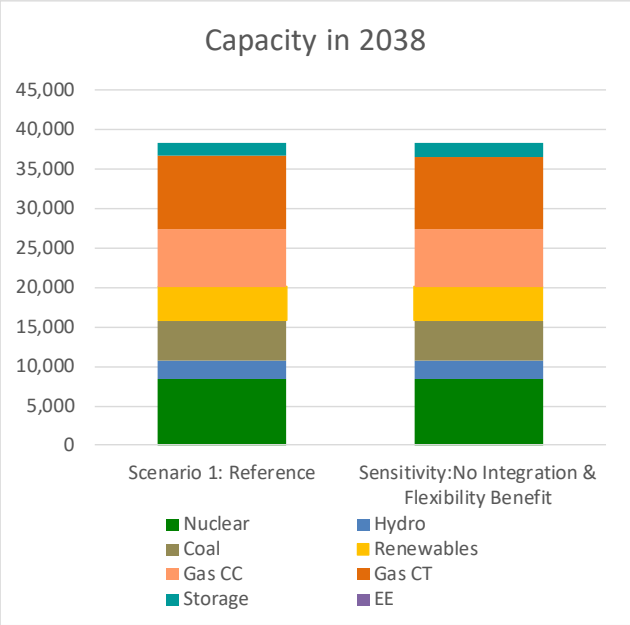
Integration Cost & Flexibility Benefit Case

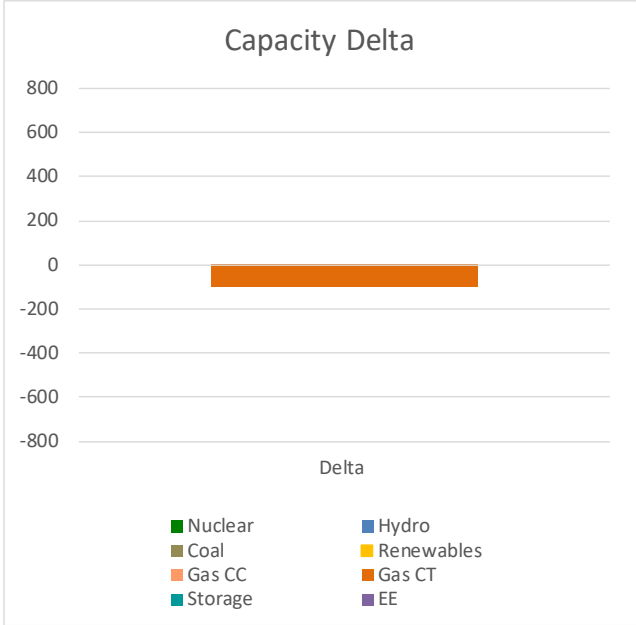
Objective: Perform a sensitivity case to evaluate the impact of removing integration costs and flexibility benefits on IRP results.

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

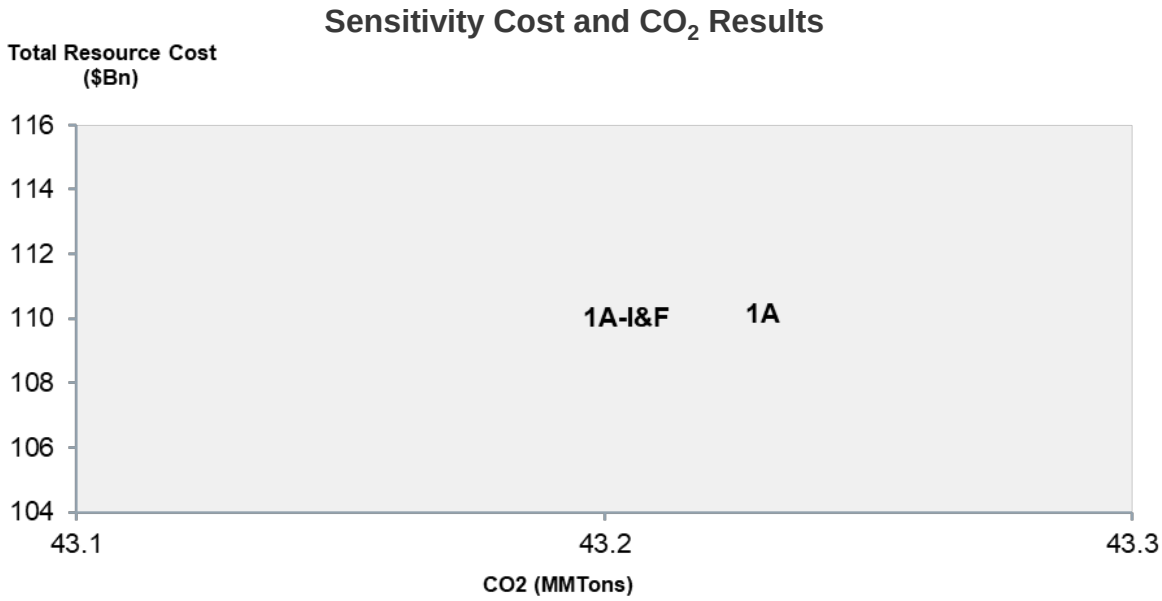
Sensitivity case removing integration costs and flexibility benefits results in minor changes to capacity expansion plans. Integration costs and flexibility benefits have more impact on specific asset or deal evaluations.





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.

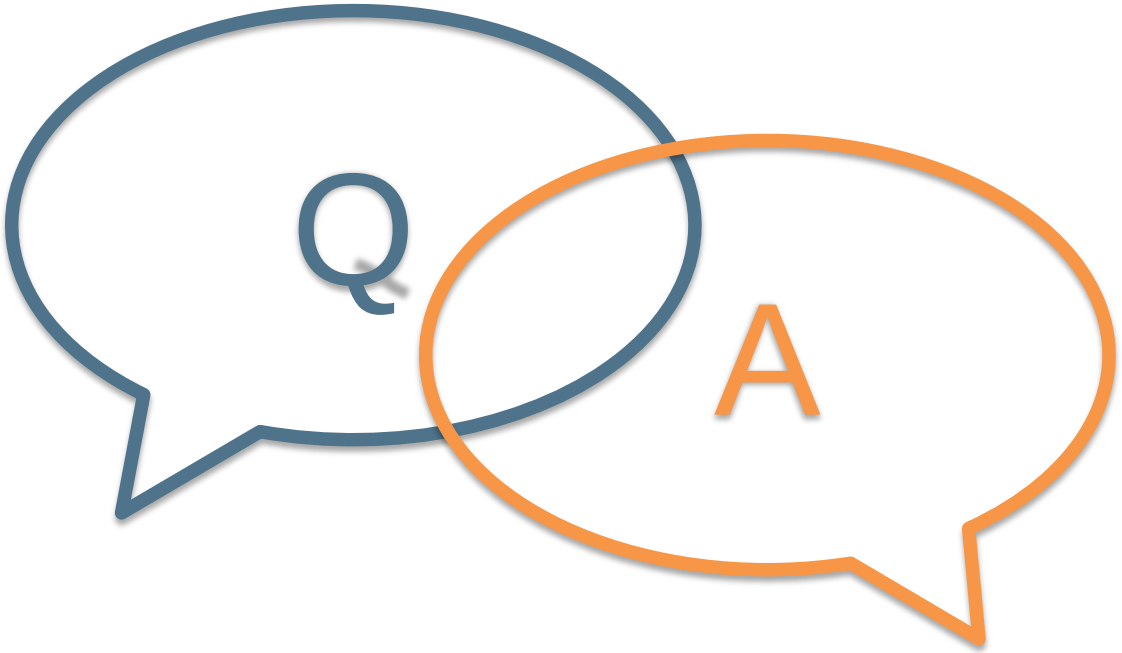


Integration Cost & Flexibility Benefit Case

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%

Questions about Sensitivity Results?



Other Potential Sensitivities

Jane Elliott
Resource Strategy

Current List of Potential Sensitivities

- ✓ Older Gas CT retirements
- ✓ Integration cost and flexibility benefit
- High and low gas prices (2 standard deviations)
- Storage, wind and SMR capital costs (breakeven analysis)
- Increased EE and DR market depth
- Accelerated solar to meet customer demand
- Increasing ongoing operating costs for coal plants

Public comments will inform additional areas meriting further analysis.

Previous List of Potential Sensitivities

Green	Addressed?
Yellow	Still needed?
Red	Not needed?

Current Outlook & Valley Growth / Base Case

- Retire Paradise 3 (2020) and Bull Run (2023)

Current Outlook / Base Case:

- Enforce promoted resources individually at moderate and high levels *
- Enforce distributed scale solar at same penetration as utility scale solar
- Accelerate pace of utility scale solar additions *
- Remove integration cost and flexibility benefit *
- Model high and low natural gas and power prices *
- Model higher ongoing costs for aging coal units

Current Outlook / Promote DER:

- Promote utility scale storage to moderate and high levels *
- Promote distributed storage to high level *

Current Outlook / Promote Renewables:

- Promote utility scale storage to high level *

** Included based on IRPWG feedback*

Group Breakout:
Other Potential Sensitivities

Breakout Questions

1. From the list of previous sensitivities, do you agree the sensitivities in green are being covered? Do we still need any of the sensitivities in yellow and red?

2. Are we missing anything important? If so, what would you add and why?

Review of Potential Sensitivities

Jane Elliott
Resource Strategy

Revised List of Potential Sensitivities

- List to be developed during IRPWG meeting based on input on potential additional sensitivities from the group breakout session

Public comments will inform additional areas meriting further analysis.

Group Breakout: Sensitivity Discussion

Breakout Questions

1. What insights does each sensitivity help provide?

2. How might each sensitivity help inform the recommendation?

Prioritization Activity

Jo Anne Lavender and IRPWG

Prioritization Activity

1. Consider the potential sensitivities and the value each one helps provide.

2. Identify your Top 5 additional sensitivities to run by placing a sticker on each one.

3. Recap voting results and finalize prioritized list of additional sensitivities.

Next Steps

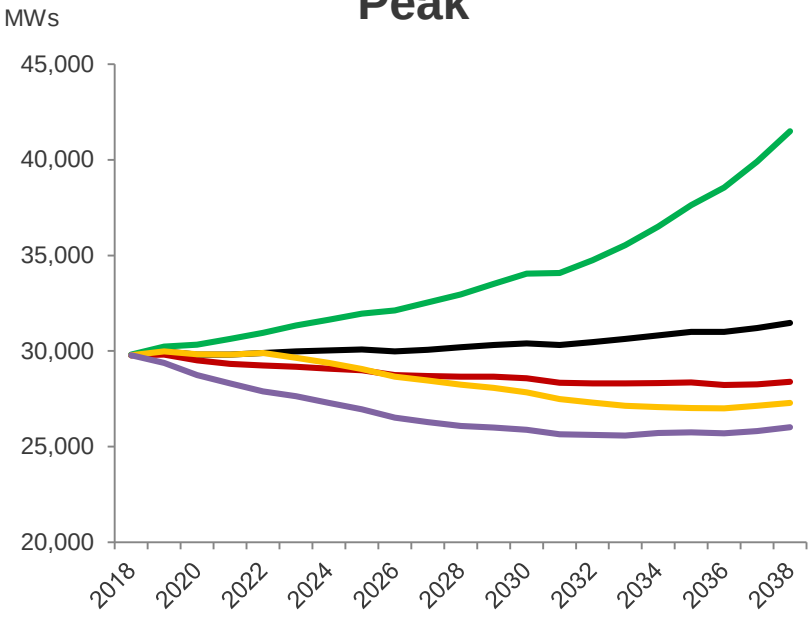
Next Steps

- Receive public comments through April 8 and consider additional sensitivities
- Run prioritized sensitivities and review at upcoming meetings
- Develop recommendation in May IRPWG meeting

Appendix:
Key Planning Assumptions

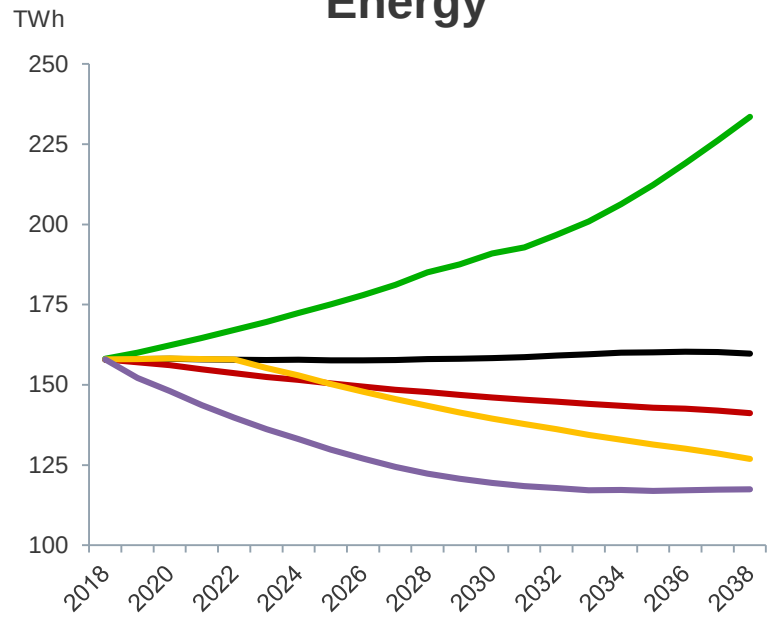
Scenario Forecasts: Load Outlook

Peak



	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	0.3%	-0.2%	1.7%	-0.4%	-0.7%	0.3%

Energy

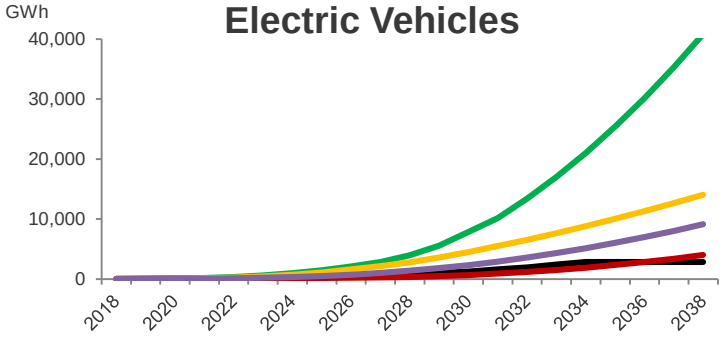


	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	0.0%	-0.5%	2.0%	-1.1%	-1.5%	0.0%

Note: Forecast for Scenario 6 Nuclear same as Scenario 1 Current Outlook

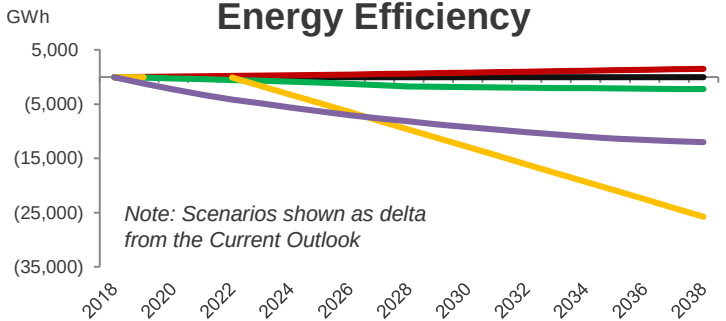
Scenario Forecasts: Behind the Meter Impacts

Electric Vehicles



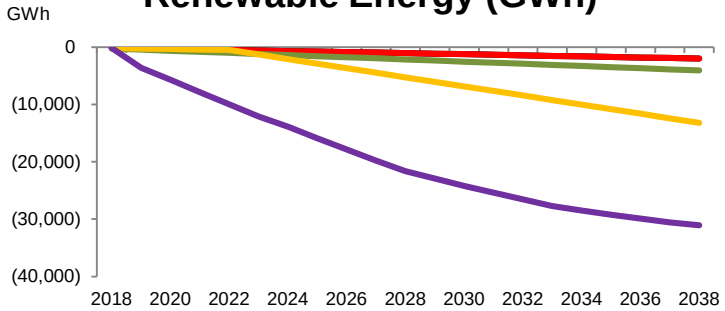
	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	27%	29%	43%	37%	34%	27%

Energy Efficiency



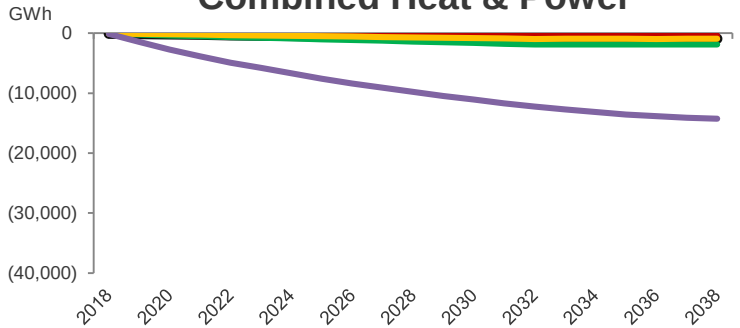
	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	N/A	44%	-47%	-66%	-60%	N/A

Renewable Energy (GWh)



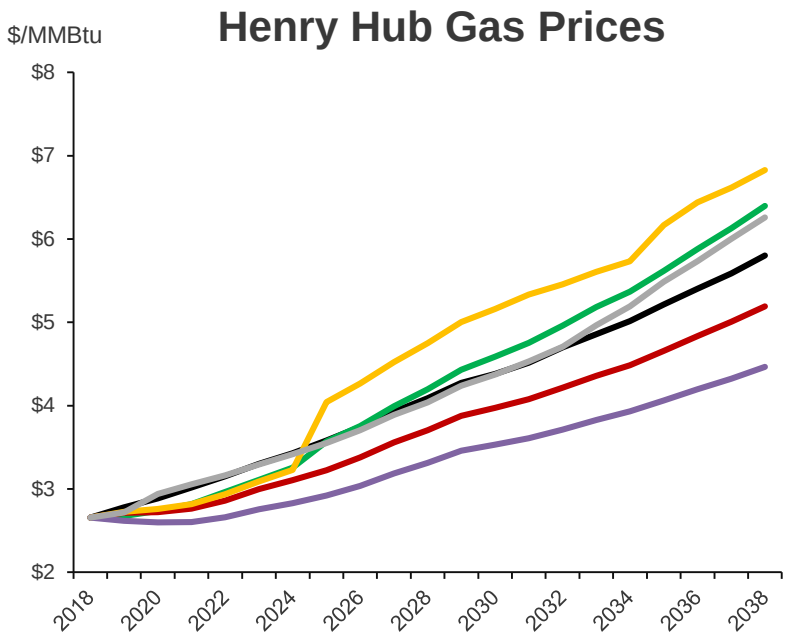
	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	-14%	-14%	-15%	-25%	-32%	-14%

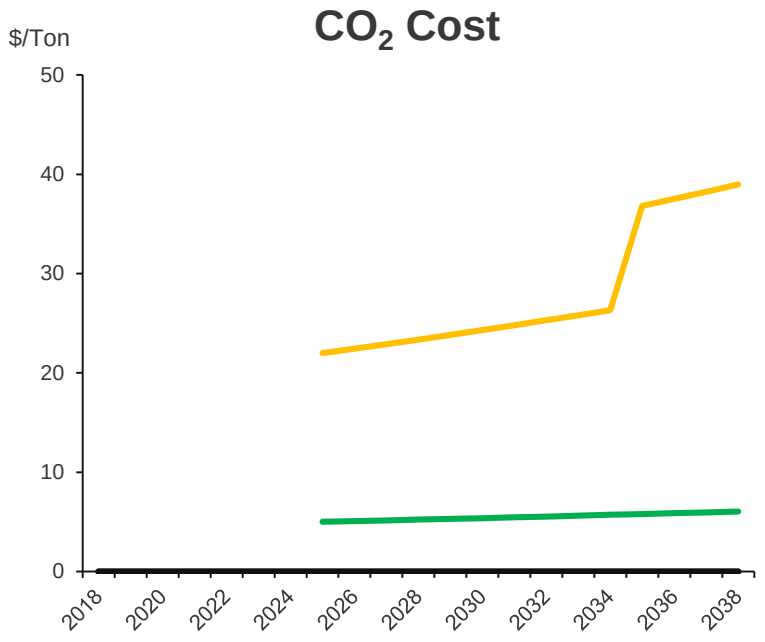
Combined Heat & Power



	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	-14%	-9%	-19%	-14%	-27%	-9%

Scenario Forecasts: Gas and Carbon Prices

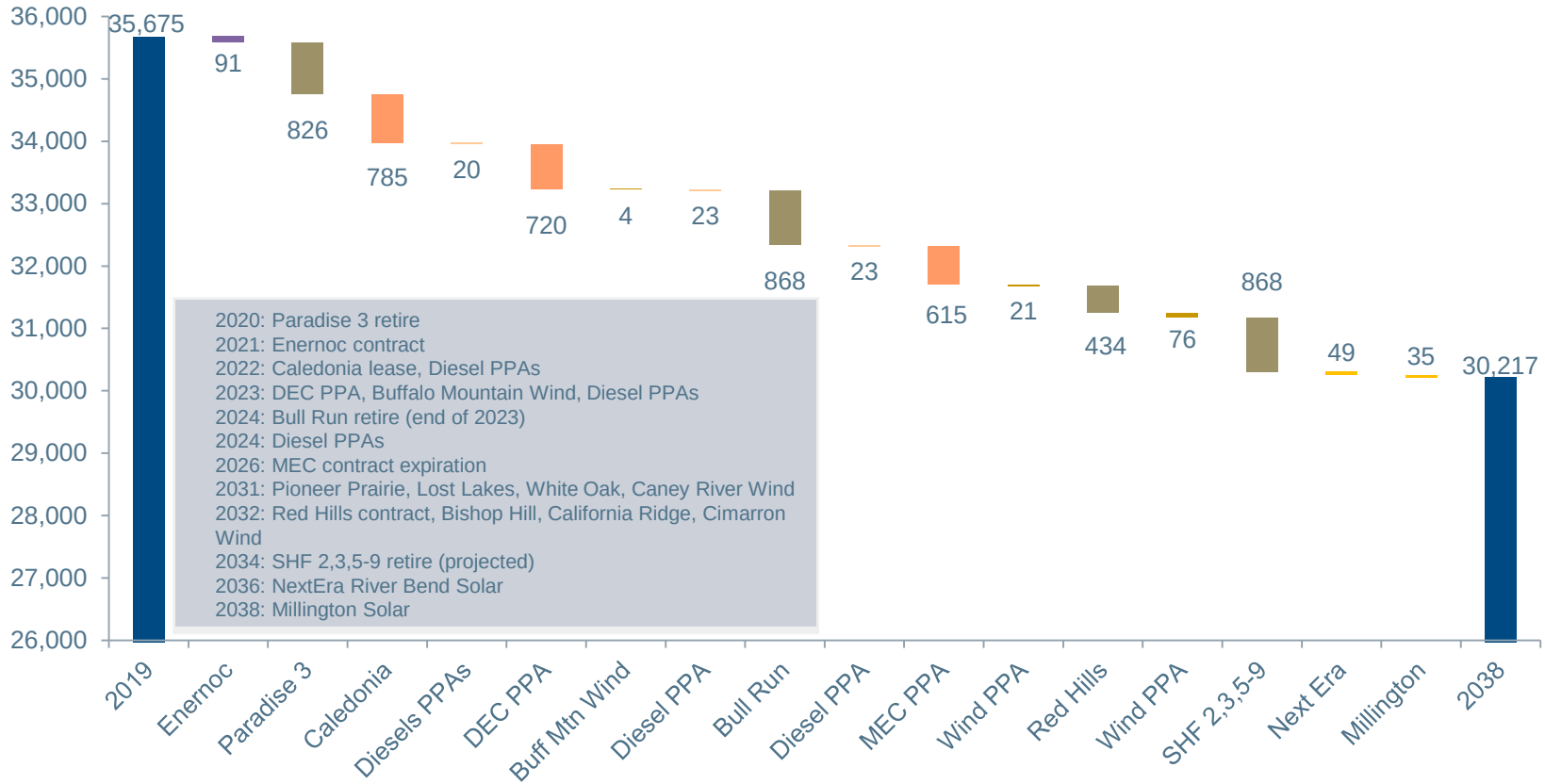




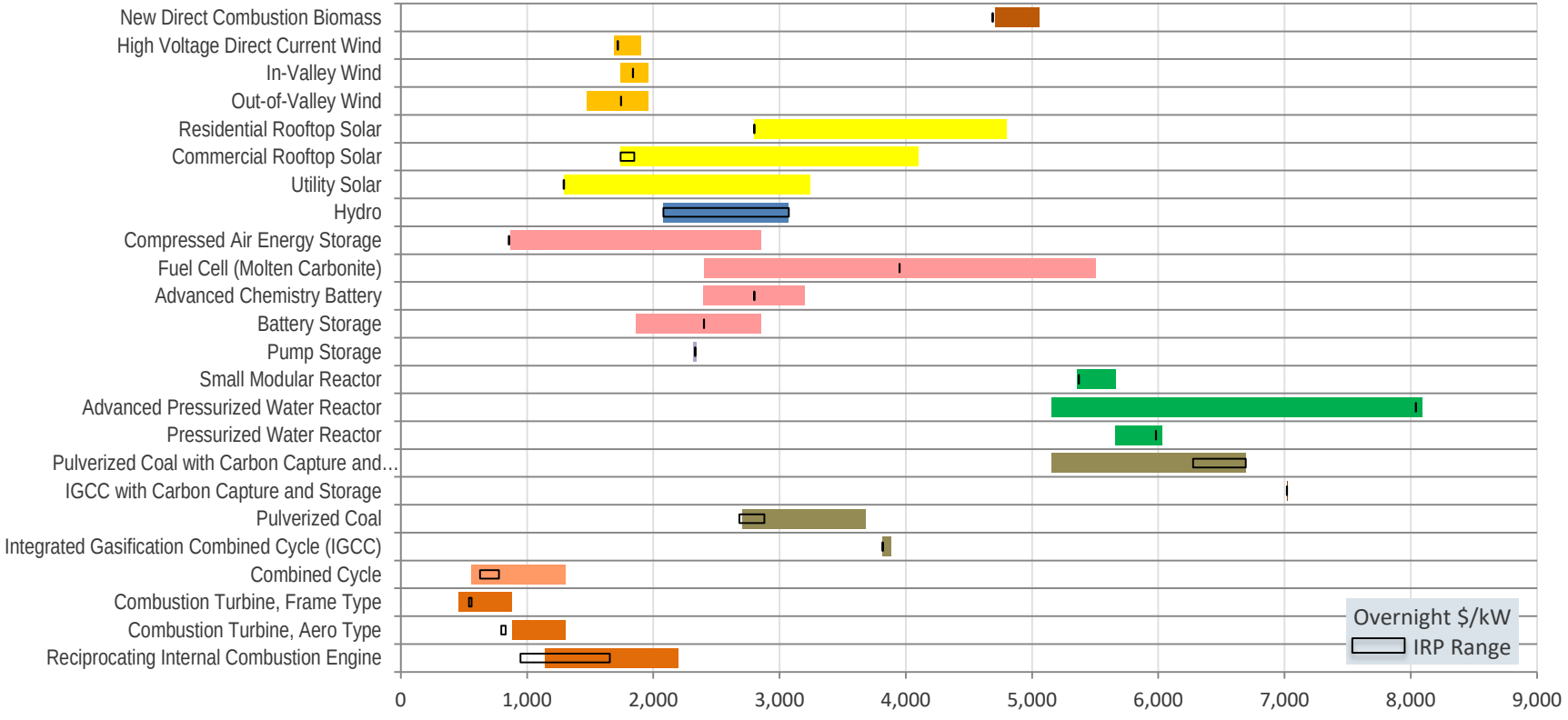
	Current	Downturn	Growth	Decarb	DER	Nuclear
CAGR	3.9%	3.4%	4.5%	4.8%	2.6%	4.4%

Note: Forecast for Scenarios 2 Downturn, 5 DER and 6 Nuclear same as Scenario 1 Current Outlook

Planned Reductions in Firm Capacity



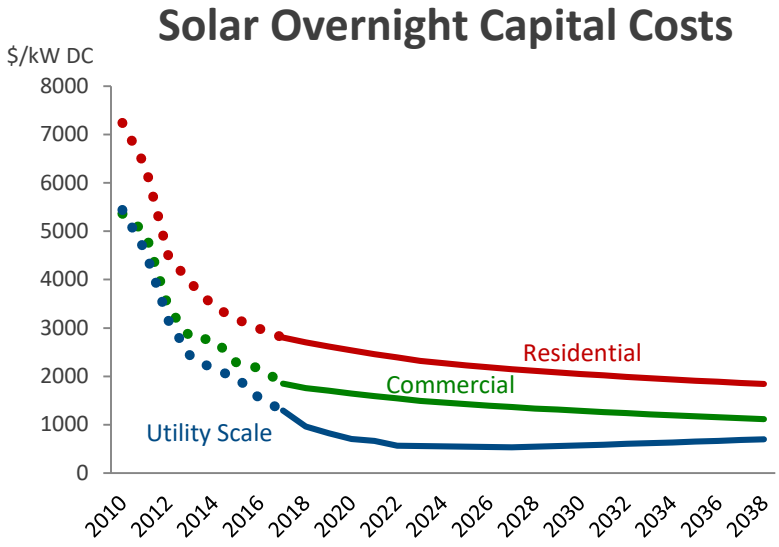
Resource Options and Cost Assumptions ($/kW)

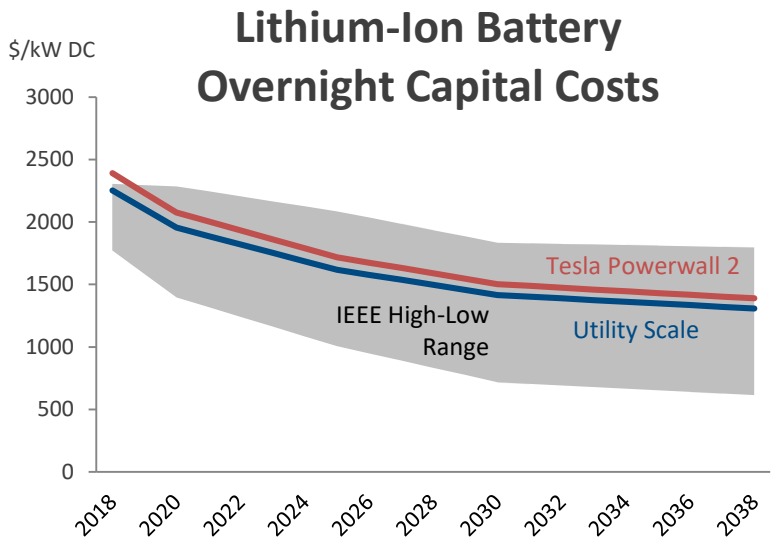


Colored bars reflect benchmark ranges and black outlines represent TVA assumptions;
TVA assumptions outside of benchmark ranges are based on actual costs of TVA projects or vendor quotes.

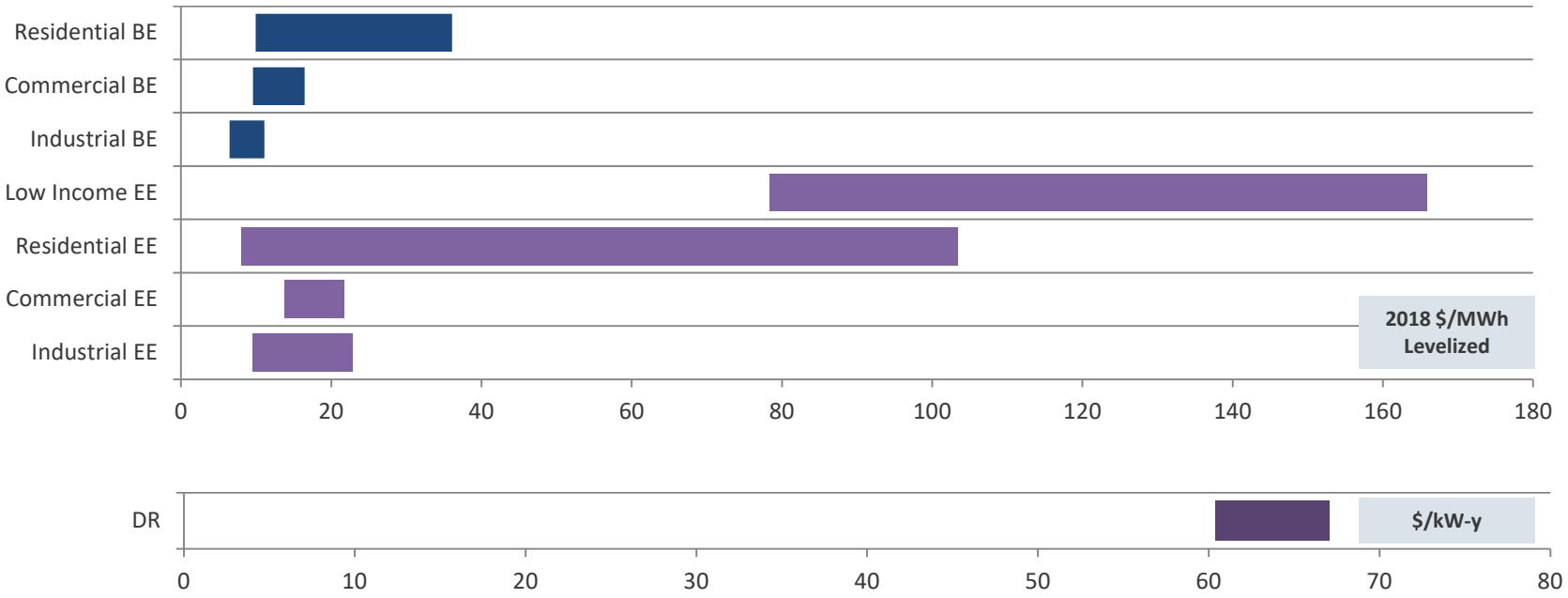
Escalation Assumptions

While most resource costs will escalate with inflation, costs for resources that are still rapidly evolving may escalate differently, and escalation rates can vary by scenario.





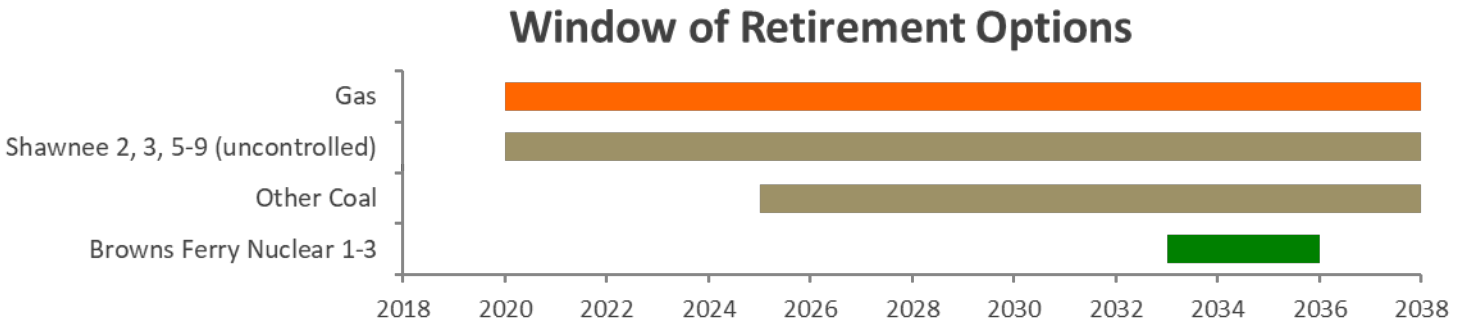
Programmatic DER Options & Cost Assumptions



BE = Beneficial Electrification
EE = Energy Efficiency
DR = Demand Response

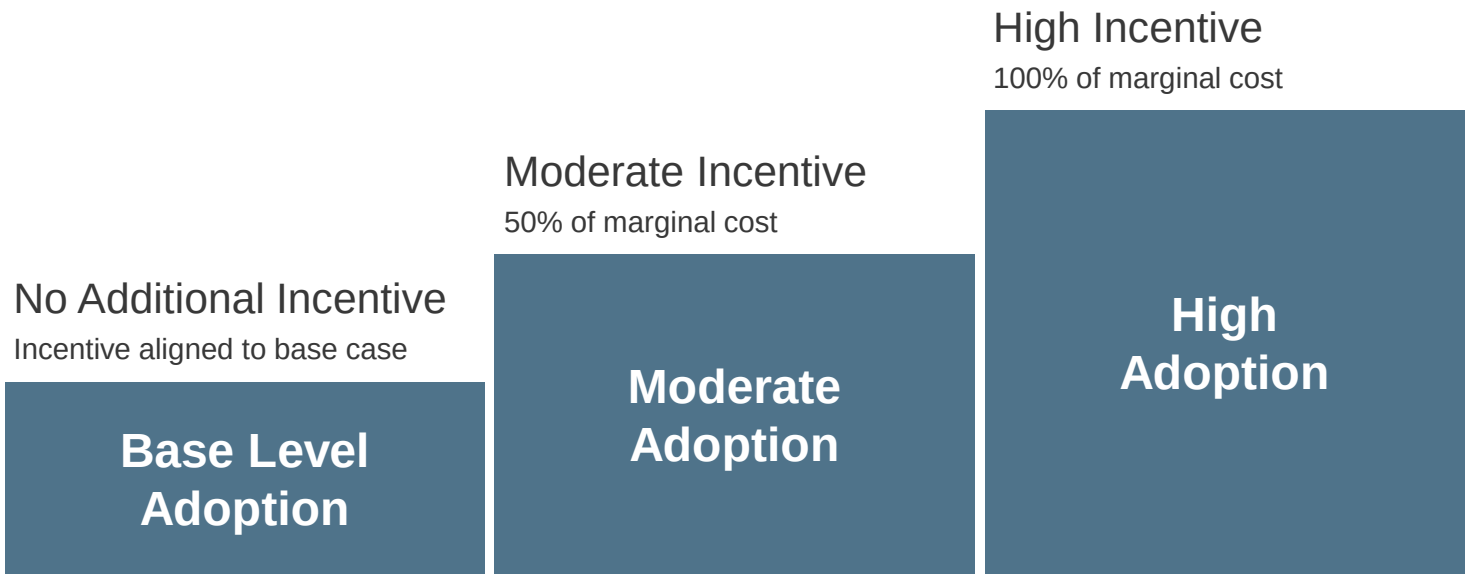
Retirement Options

Total costs can be reduced in low load scenarios or when replacement resources are more economic than the ongoing costs of existing resources. It is important that accurate ongoing costs, demolition/closure costs, and transmission upgrades required to retire resources are considered against the cost of new resources.



Strategies Promote Resources Using Incentives

Strategies provide incentives to promote adoption of certain resources, with consideration of potential, adoption curve, and reserve margin.



Strategy Design Matrix

Strategy	Distributed Resources & Electrification						Utility Scale Resources					
	Distributed Solar	Distributed Storage	Combined Heat & Power	Energy Efficiency	Demand Response	Beneficial Electrification	Solar	Wind	Biomass & Biogas	Storage	Aero CTs & Recip Engines	Small Modular Reactors
Base Case	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Promote DER	High	Moderate	High	Moderate	Moderate	Base	Base	Base	Base	Base	Base	Base
Promote Resiliency	Moderate	High	Moderate	Base	Moderate	Base	Base	Base	Base	Moderate	Moderate	Moderate
Promote Efficient Load Shape	Base	Moderate	Base	High	High	Moderate	Base	Base	Base	High	Base	Base
Promote Renewables	Moderate	Moderate	Base	Base	Base	Base	Moderate	Moderate	Moderate	Moderate	Base	Base

Low Income Energy Efficiency is promoted in the following manner across the strategies:

- Pilot continuation (Base, Resiliency, Renewables)
- Pilot expanded valley-wide (DER)
- Pilot expanded valley-wide and incentives increased (Efficient Load Shape)

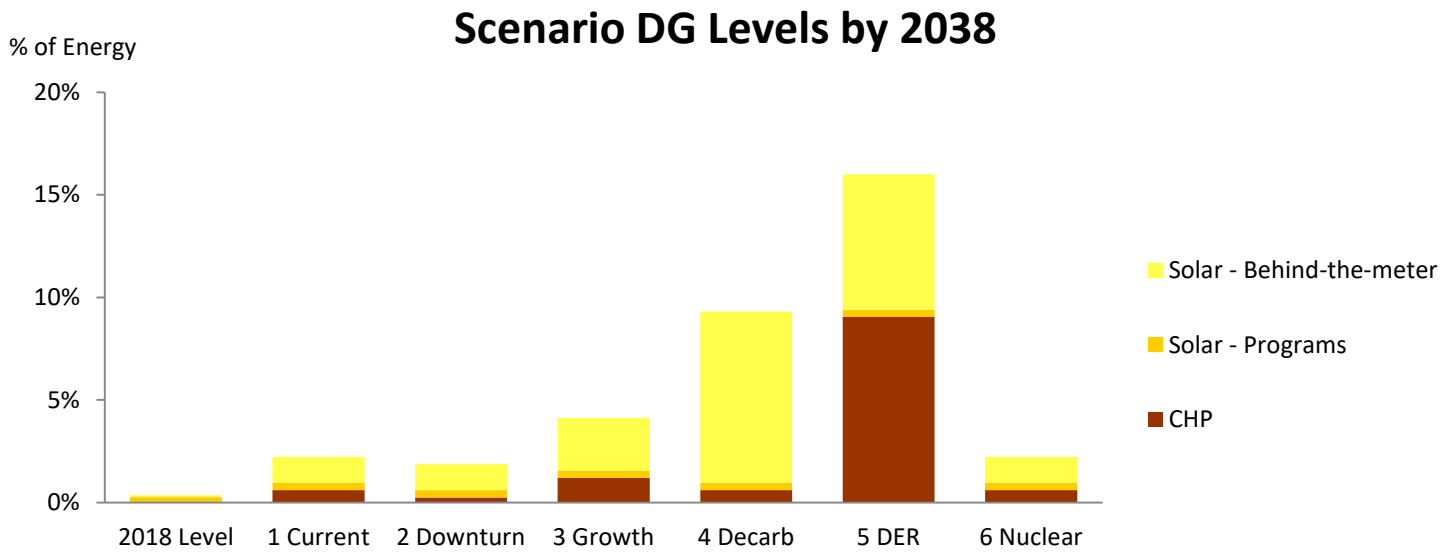
Distributed Resource Modeling Methodology

Distributed resource adoption at a base, moderate, or high level of incentives will be enforced in the model according to strategy design, prior to optimizing the balance of resources for a portfolio. The individual steps in this process are described below.

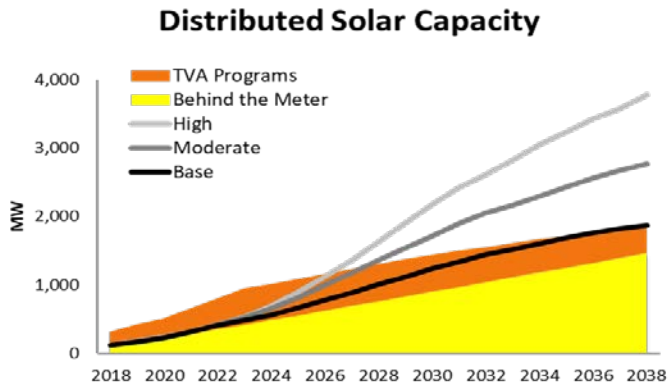
This approach for modeling distributed generation allows TVA to gain insights into the impact that distributed resources could have on the TVA system under a variety of different future states.

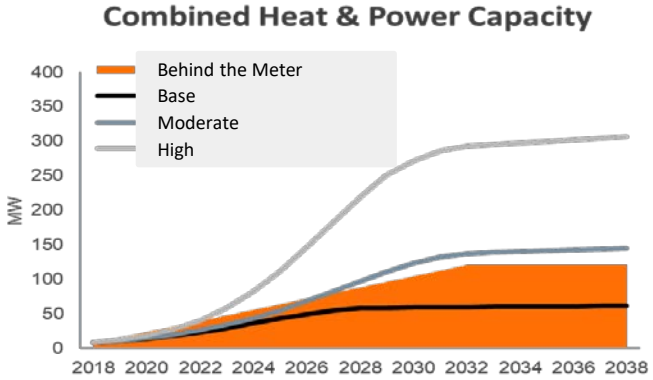
Distributed Generation Adoption Levels by Scenario

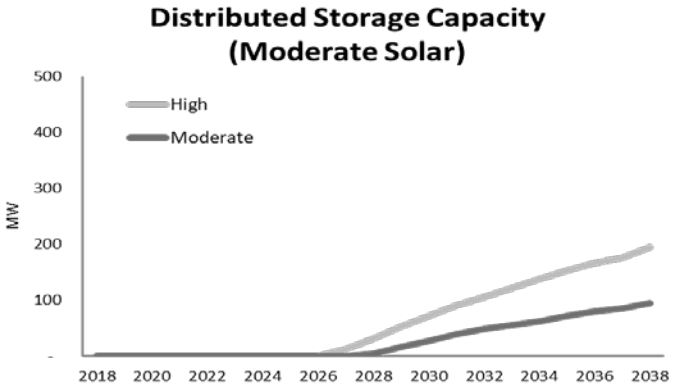
Each scenario has unique assumptions for DG penetration prior to portfolio optimization to fill the capacity gap for each strategy. In scenarios that have high DG penetration, there may be little or no opportunity to incent additional DG adoption.

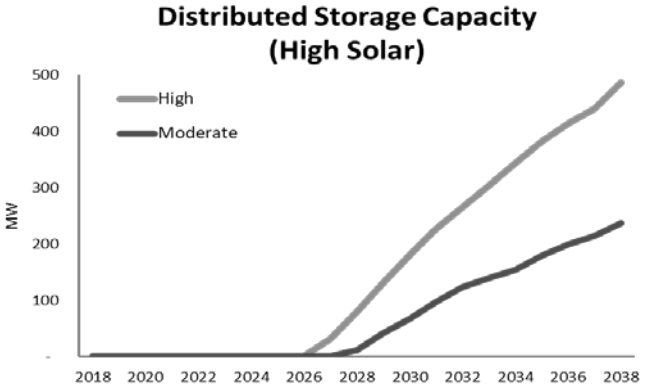


Adoption Curve Examples (Current Outlook)



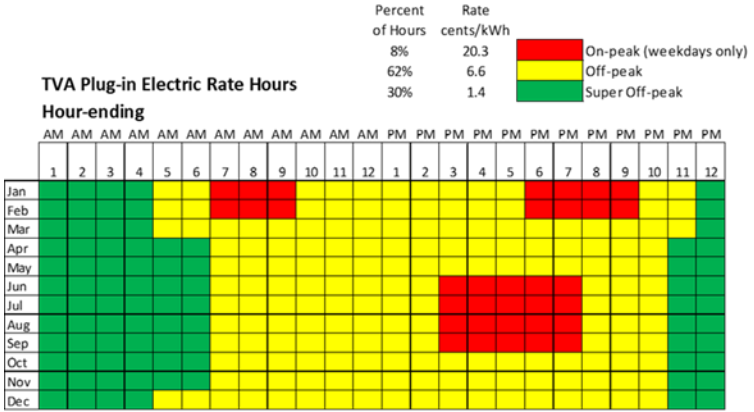




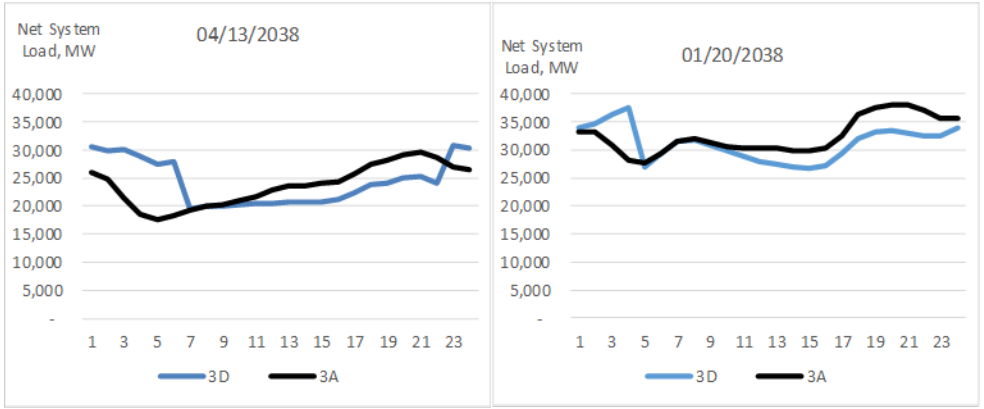


EV & Battery Charging Rate Structure (Strategy D)

Strategy D promotes an efficient load shape through a time of use rate structure applied to electric vehicle and battery usage across the scenarios. For Strategy D portfolio optimization, an alternate load shape is used applying this structure.



Note: Based upon Georgia Power's Plug-in Electric Program



Effects of rate structure are most pronounced in scenario 3

Considering Uncertainty in Resource Planning

While scenarios explore step changes in possible futures, stochastic analysis evaluates risk of uncertainty around key planning assumptions for each portfolio.

Variability occurs within each scenario and strategy combination, driven by:

- Weather
- Market conditions
- Energy usage patterns
- Unit performance
- Operating costs
- Capital costs

Monte Carlo simulation allows for a better understanding of portfolio performance by testing the variability of key assumptions and expressing portfolio results as a range around an expected case.