The scenic beauty of the Tennessee Valley is an asset TVA works hard to preserve for future generations.

The Guntersville Dam in Marshall County, Ala., has a generating capacity of 140,400 kilowatts of electricity.

Draft Planning Scenarios and Strategies

Scenario
1 Economy Recovers Dramatically
2 Environmental Focus is a National Priority
3 Prolonged Economic Malaise
4 Game-Changing Technology
5 Energy Independence
6 Carbon Regulation Creates Economic Downturn
7 Reference Case: Spring 2010

Planning Strategy
A Limited Change in Current Resource Portfolio
B Baseline Plan Resource Portfolio
C Diversity Focused Resource Portfolio
D Nuclear Focused Resource Portfolio
E EEDR and Renewables Focused Resource Portfolio

7 Draft Study Results

This chapter describes the results and findings from the Draft IRP, published in September 2010. The Draft IRP studied five strategies in a total of six scenarios and one reference case scenario. As a result, 35 distinct 20-year portfolios or capacity expansion plans were created. These portfolios were scored and the results were evaluated as described in Chapter 6 – Resource Plan Development and Analysis. Results of this IRP are fully described in Chapter 8 – Final Study Results and Recommended Planning Direction

7.1 Analysis Results

7.1.1 Firm Requirements and Capacity Gap

Forecasted capacity needs for the range of scenarios considered were presented in Section 4.3 – Estimate Supply. Consistent with TVA's scenario planning approach, variations from the expected forecast were studied as well. These variations were grouped into scenarios that represented different plausible futures in which TVA may have to operate. The key components of each scenario were translated into a forecast of firm requirements (demand plus reserves), which was used to identify the resulting capacity gap and need for power, driving the selection of resources in the capacity planning model.

Figure 7-1 illustrates the firm requirements forecasts for the seven scenarios that were studied in the Draft IRP. Six of the seven scenarios were specifically designed for the IRP study and are discussed in Section 6.1 – Development of Scenarios and Strategies. The seventh scenario represented the spring 2010 market view and was considered the reference case for analysis in the Draft IRP.

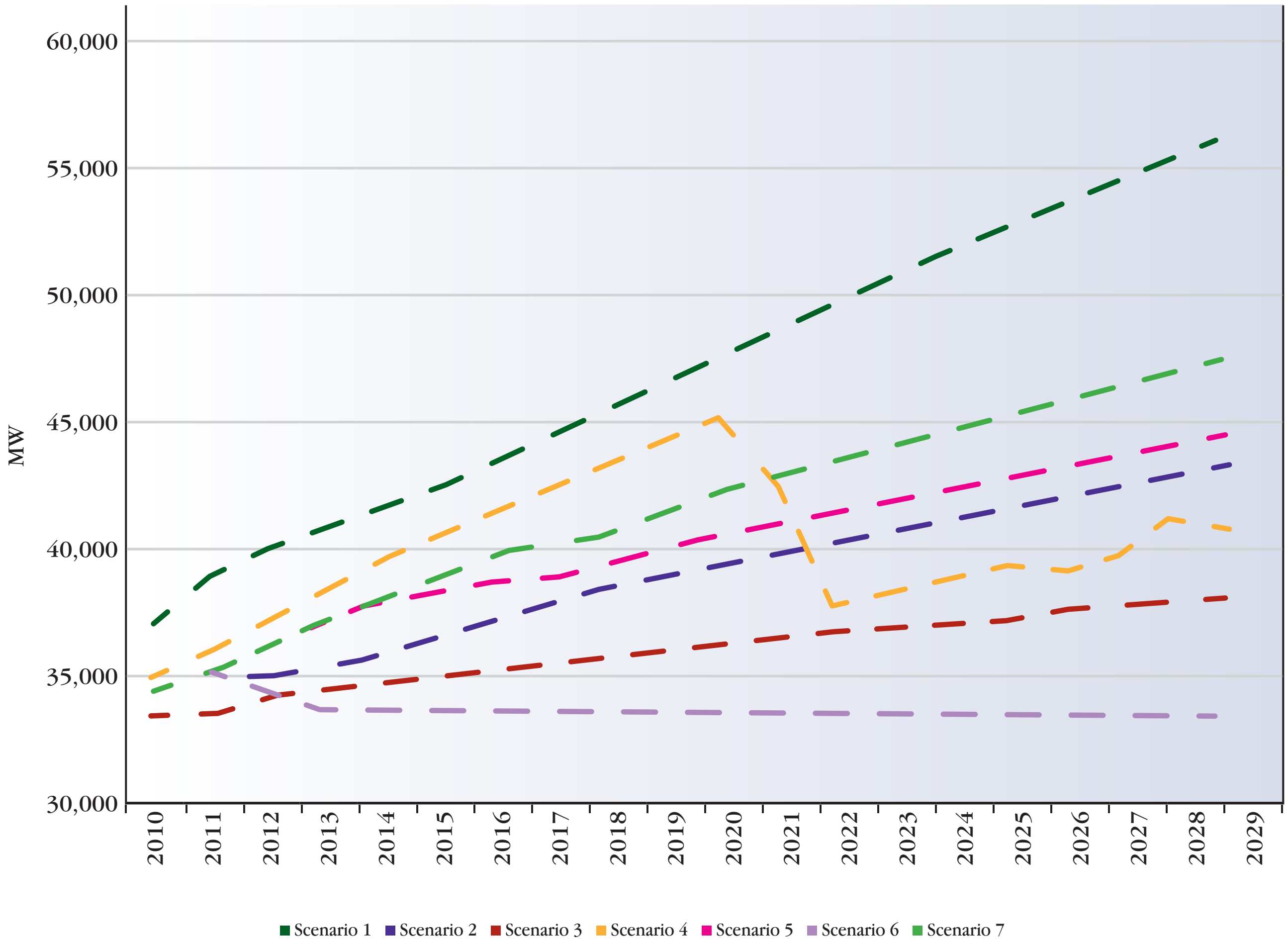

Figure 7-1 – Firm Requirements by Scenario

Firm requirements were greatest in Scenario 1 (highest load growth scenario) and lowest in Scenario 6 (flat to slightly negative load growth). The remaining scenarios fell within this range and generally displayed smooth but unique growth trends, with the exception of Scenario 4 (game-changing technology scenario). Firm requirements for Scenario 4 experienced a dramatic drop in load in 2021, reflecting that scenario's assumptions of rapid commercialization of alternative technologies displacing the need for traditional resources.

The shape of the firm requirements curves influenced the type and timing of resource additions in the strategies, especially in Scenario 4 where resource additions were reduced or eliminated in the latter years. The timing of additional resources was a function of the existing system capacity and the impact of the defined model inputs for each strategy.

Figure 7-2 summarizes the range of the capacity gaps at the end of the study period for the cases studied in the Draft IRP. The range of the capacity gaps in this figure is based on the minimum and maximum gaps found in the five planning strategies developed for the Draft IRP. The maximum gap represents the largest capacity gap and is based on Scenario 1. The minimum gap represents the smallest capacity gap or potentially a surplus of generation and is based on Scenario 6.

Strategy	Max Capacity Gap (MW)	Min Capacity Gap (MW)
A	18,000	(4,800)
B	20,000	(3,000)
C	17,000	(6,000)
D	19,000	(4,000)
E	18,000	(5,000)

Figure 7-2 – Range of Capacity Gaps by Strategy

This broad range of capacity gaps resulted in a wide range of expansion plans across the 35 portfolios developed in the Draft IRP.

7.1.2 Expansion Plans

The amount and type of resource additions for the five planning strategies that were evaluated in the Draft IRP are consistent with the following assumptions that define each of the scenarios:

- The largest amount of resource additions occurred in Scenario 1
- Scenario 7, representing the Reference Case: Spring 2010, required an average amount of new resources over the study period
- Scenarios 3 and 6 had the least amount of resource additions
- Small amounts of new resources were added in Scenarios 2 and 5
- In Scenario 4, no resources were added after 2020, consistent with the dramatic drop in load beginning in 2021

The individual capacity expansion plans for each of the five planning strategies are presented in Appendix E – Draft IRP Phase Expansion Plan Listing, and are grouped by scenario. These plans reflect the contributions from the TVA Board of Directors' approved projects. In addition, the impacts of the defined model inputs, particularly the capacity associated with the renewable resource portfolios and the avoided capacity value from EEDR, are also included. Figure 7-3 illustrates the range of capacity additions by resource type across all the strategies.

Type	Minimum (MW)[1,2]	Maximum (MW)[1,3]
Nuclear	0	4,754 (4)
Combustion turbine	0	8,092 (11)
Combined cycle	0	6,700 (7)
IGCC	0	934 (2)
SCPC	0	800 (1)
Avoided capacity (EEDR)[4]	1,905	6,361
Renewables[4]	160	1,157
Pumped-storage[4]	0	850
Coal-fired capacity idled[4]	0	7,000

Notes:

1 – Values shown are for dependable capacity at the summer peak. Nameplate capacity of renewables range from 1,300 to 3,500 MW

2 – Minimums exclude Board-approved projects (WBN 2, JSFCC, and Lagoon Creek)

3 – Number of units shown in ( )

4 – Defined model input

Figure 7-3 – Capacity Additions by 2029

To provide a different view of the expansion plan results for the strategies evaluated in the Draft IRP, a set of histograms was developed that presents data on the frequency of selection of key resource types across the 35 portfolios. Figures 7-4 through 7-7 are plots that illustrate the number of portfolios and the specific number of nuclear, coal, combined cycle and combustion turbine units that may be added.

Nuclear capacity beyond Watts Bar Unit 2 was prominent in the analysis results, as illustrated in Figure 7-4. At least two nuclear units, and up to four, were added in 19 of the 28 possible portfolios, and the first nuclear unit was added between 2018 and 2022. Nuclear capacity was not added to portfolios in scenarios with nearly flat load growth. In one strategy, nuclear was not a permitted resource expansion option.

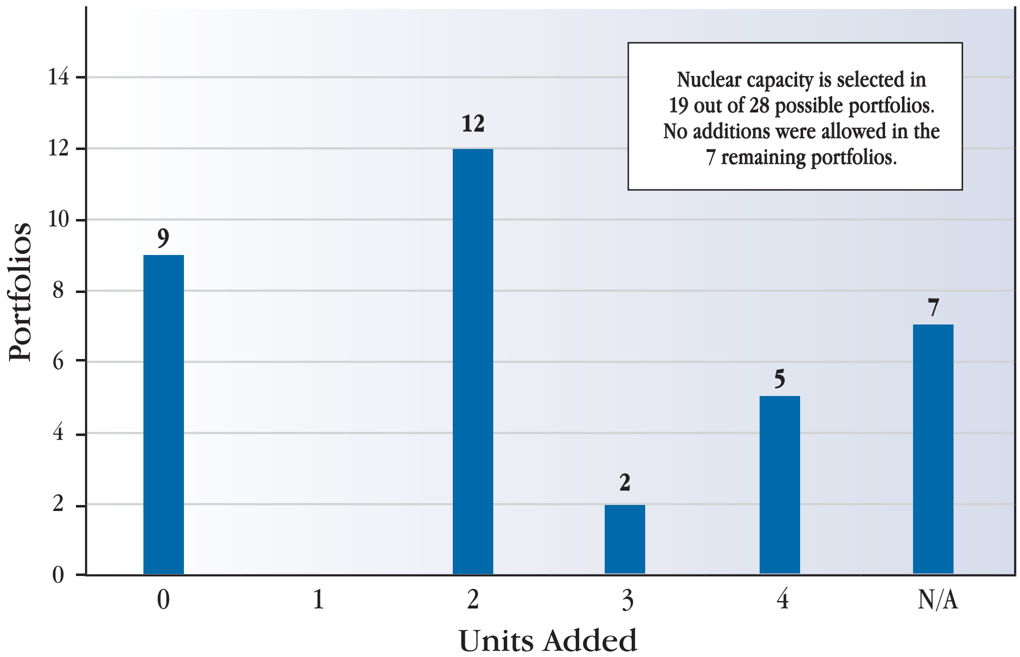

Figure 7-4 – Number of Nuclear Units Added

Coal capacity additions were very infrequent (Figure 7-5). Integrated gasification combined cycle (IGCC) units with carbon capture were selected only after 2025 and in just three of the 21 possible portfolios. Supercritical pulverized coal (SCPC) with carbon capture was added after 2035 and in only one of the 21 possible portfolios. Two strategies do not permit additional coal-fired units.

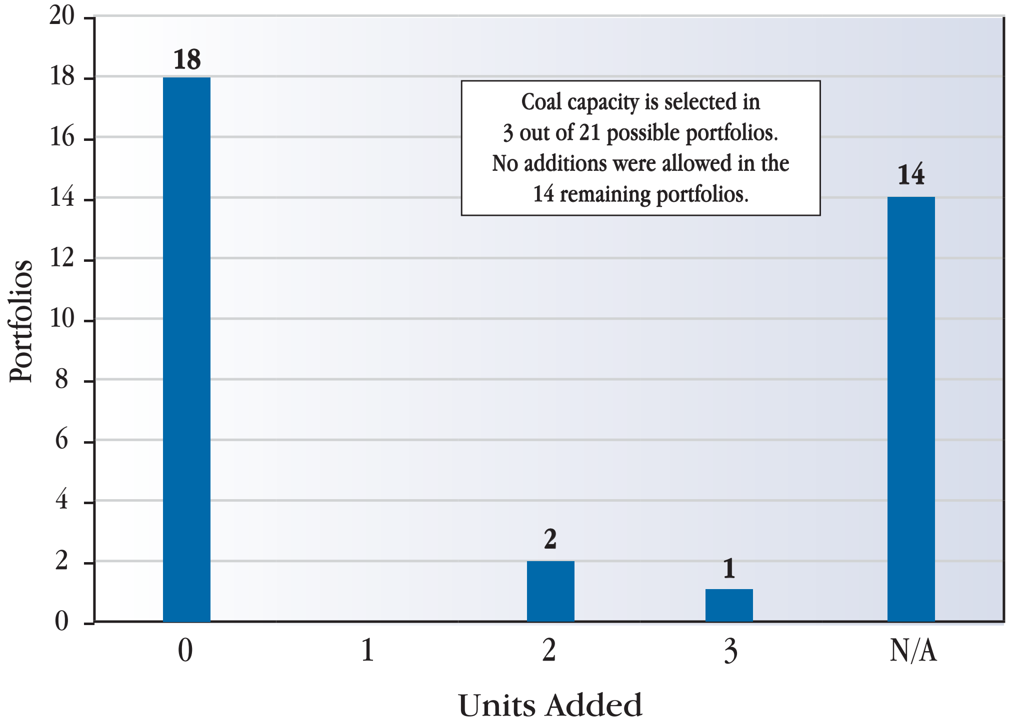

Figure 7-5 – Number of Coal Units Added

Additions of combined cycle capacity (including potential acquisitions of IPP projects) ranged from 0–7 units (0-6,700MW) as shown in Figure 7-6. Combined cycle capacity was selected in 15 of 28 possible portfolios.

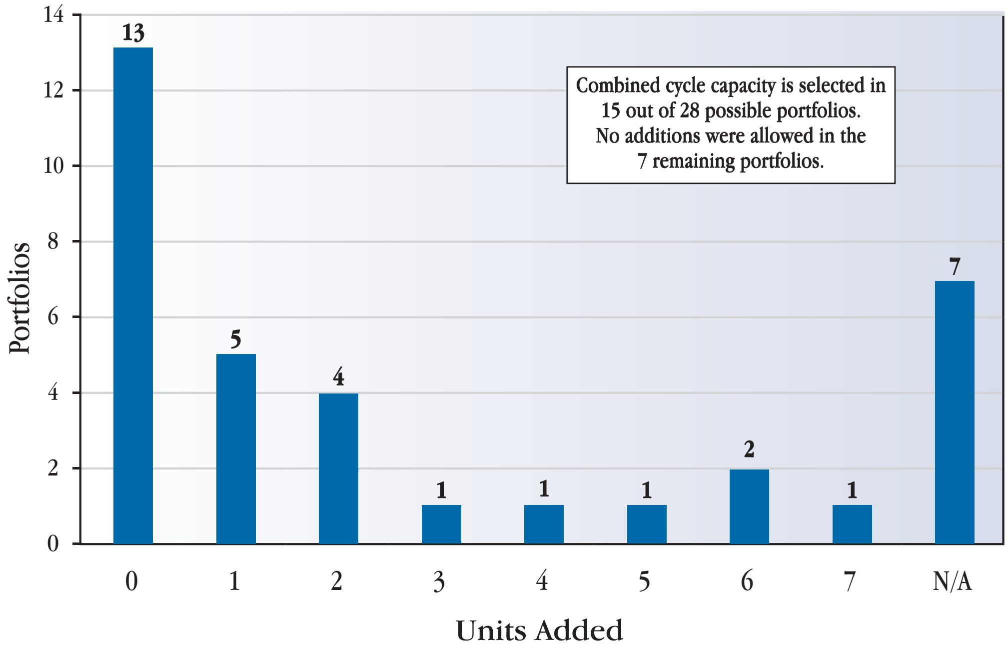

Figure 7-6 – Number of Combined Cycle Units Added

As illustrated in Figure 7-7, combustion turbine capacity additions ranged from 0–11 units (0-8,000 MW) and the majority of portfolios that selected combustion turbine capacity added just a single unit. Natural gas capacity (CT/CC) was not selected for portfolios in scenarios with nearly flat load growth or scenarios with the largest avoided capacity from EEDR.

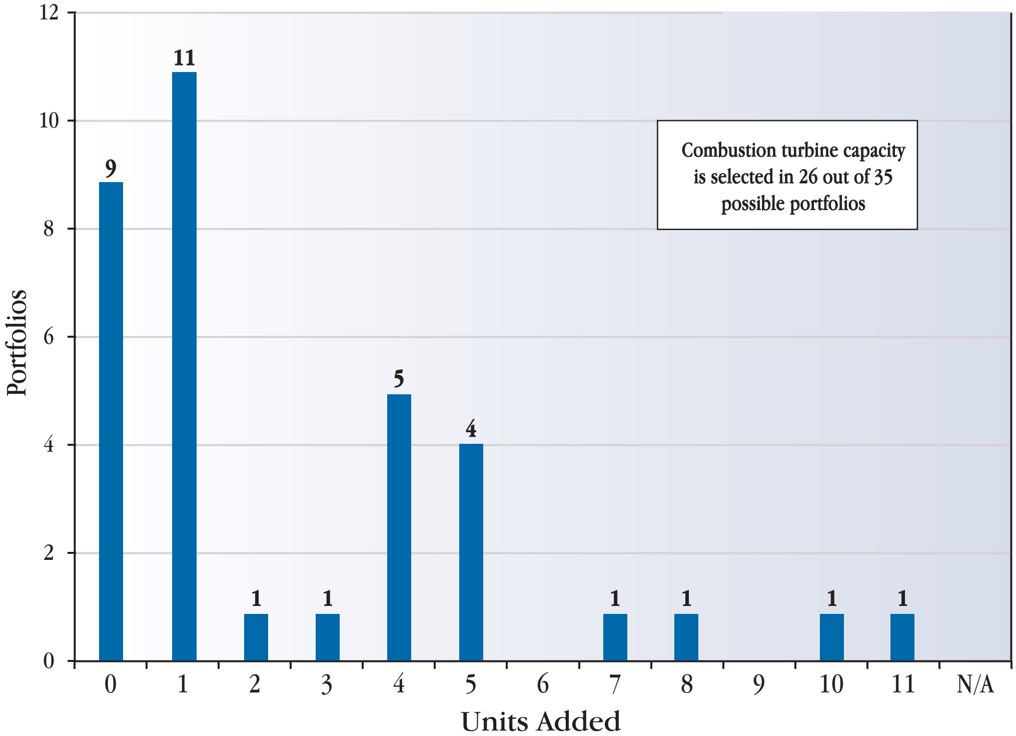

Figure 7-7 – Number of Combustion Turbine Units Added

7.1.3 System Energy Mix

Figure 7-8 lists the minimum and maximum percentage contributions to total energy production by type in 2029 from the 35 portfolios produced in the Draft IRP. Values represent the highest and lowest percentages for each type and are not from a single portfolio; therefore, they do not add to 100 percent.

Type	Minimum	Maximum
Combined Cycle	0%	13%
Combustion Turbine	0%	3%
Nuclear	27%	47%
Coal	24%	47%
Renewables	2%	8%
EEDR (savings)	2%	11%

Figure 7-8 – Range of Energy Production by Type in 2025

Nuclear and coal had the greatest swings in percentage contribution to total energy. In the majority of scenario and strategy planning combinations, nuclear overtook coal to produce the greatest percentage of total energy. Strategy A is the exception with coal remaining the largest energy producer in that strategy.

7.1.4 Plan Cost and Risk

A comparison of the expected value of PVRR by scenario for the strategies evaluated in the Draft IRP is illustrated in Figure 7-9. Scenario 1 resulted in the highest value for PVRR, while the lowest PVRR values were found in Scenario 6. Within each scenario, Strategy D generally produced the highest cost portfolios due to the larger amount of coal-fired capacity idled that must be replaced by new resources. Strategy A resulted in the set of portfolios with the next highest cost, caused by retaining a higher level of coal-fired capacity compared to other strategies, exposing it to more significant CO_2 compliance costs. Strategy C produced the lowest PVRR values in six of the seven scenarios. However, Strategy C was near the middle of the pack on short-term rate impacts which are discussed in the next section.

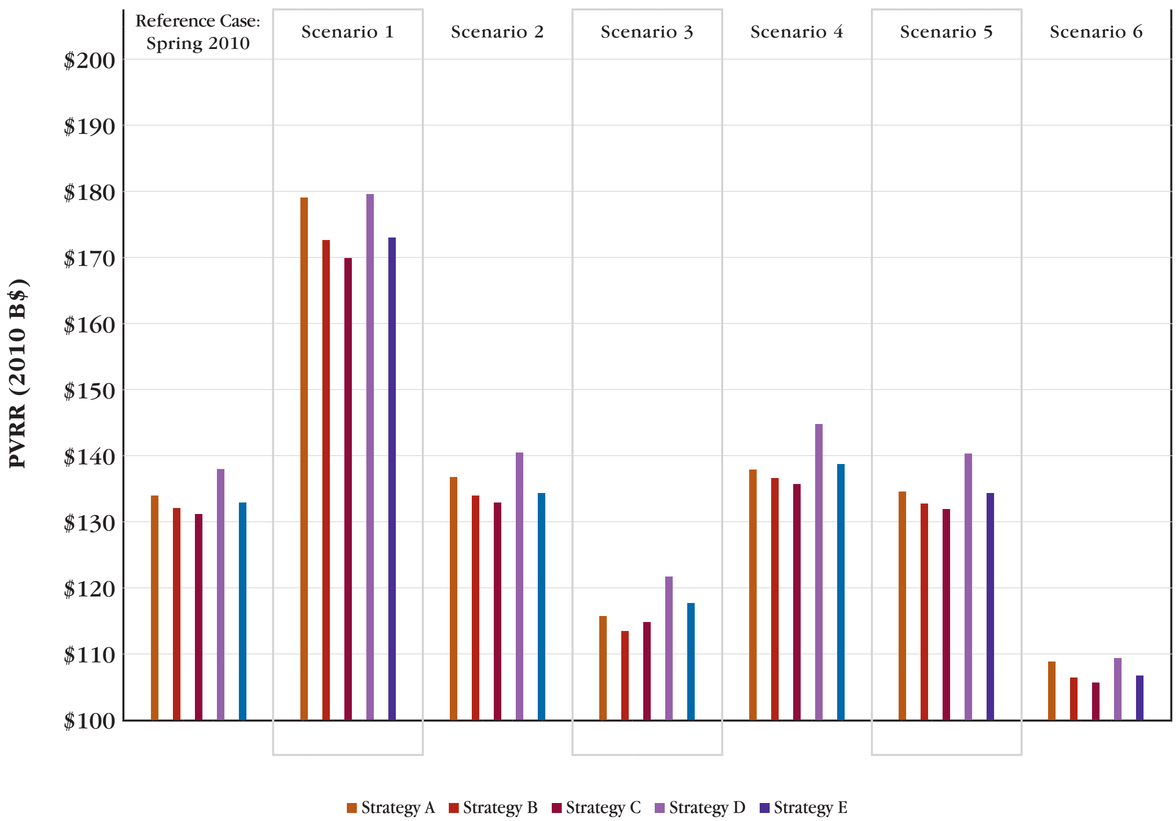

Figure 7-9 – Expected Value of PVRR by Scenario

Figure 7-10 presents the short-term rate impacts (average system costs) by scenario. The strategy with the highest expected value of short-term rates was Strategy D because this strategy had the most new capacity additions in the 2011–2018 timeframe. Strategy A produced the lowest short-term rate values in five of the seven scenarios because no new capacity was added to any portfolios within that strategy. However, Scenarios 3 and 6 included higher CO_2 compliance costs, which drove up the cost of the coal-heavy portfolios in Strategy A (in those scenarios). Strategy A's exclusive reliance on the market to serve load growth also has greater risk as shown in the discussion of risk metrics in the next section.

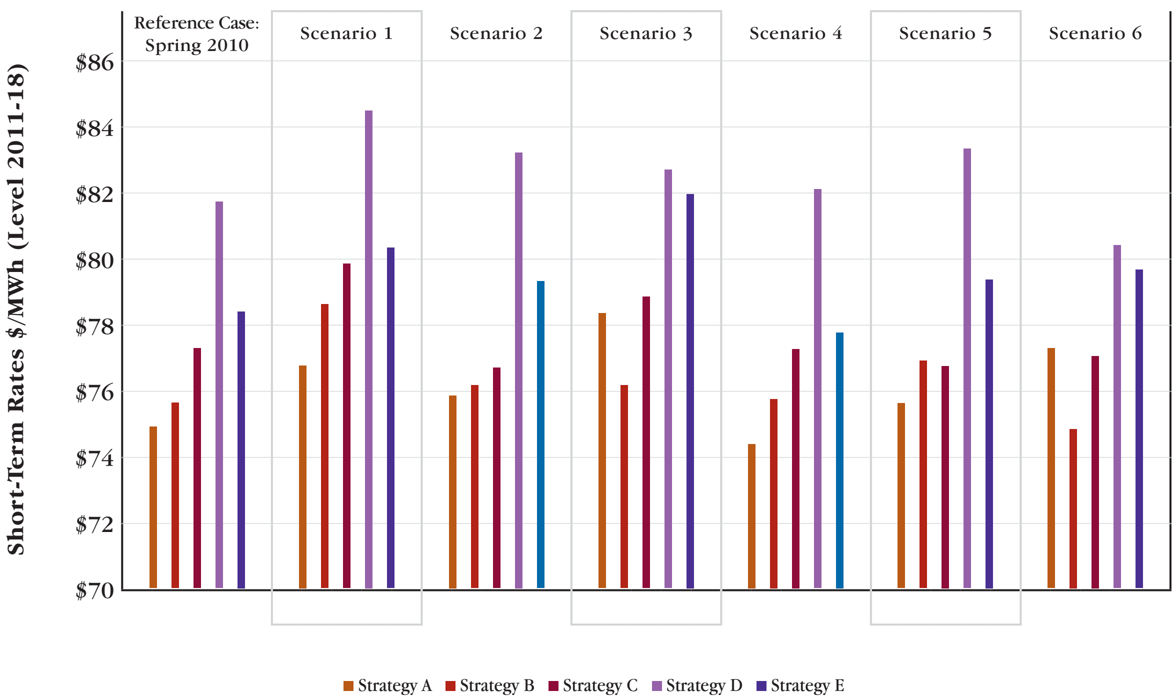

Figure 7-10 – Expected Values for Short-Term Rates by Scenario

Figures 7-11 and 7-12 compare the two risk metrics for the planning strategies. Lower ratios indicated less risky portfolios based on the probability distributions of the portfolio PVRR values. The relative relationship across the scenarios for both the risk ratio and the risk/benefit ratio were consistent. The highest values occurred in Scenario 1, the risk ratio was lowest in Scenario 3 and the risk/benefit ratio was lowest in Scenario 6.

In both cases, these low values were caused by much lower load forecasts in those scenarios, which resulted in lower PVRR values with more narrow probability distributions. Strategy A had the highest risk profile in five of the seven scenarios, which was caused by the retention of coal-fired capacity. Strategy C was the least risky strategy in six of the seven scenarios due to its generally balanced resource mix.

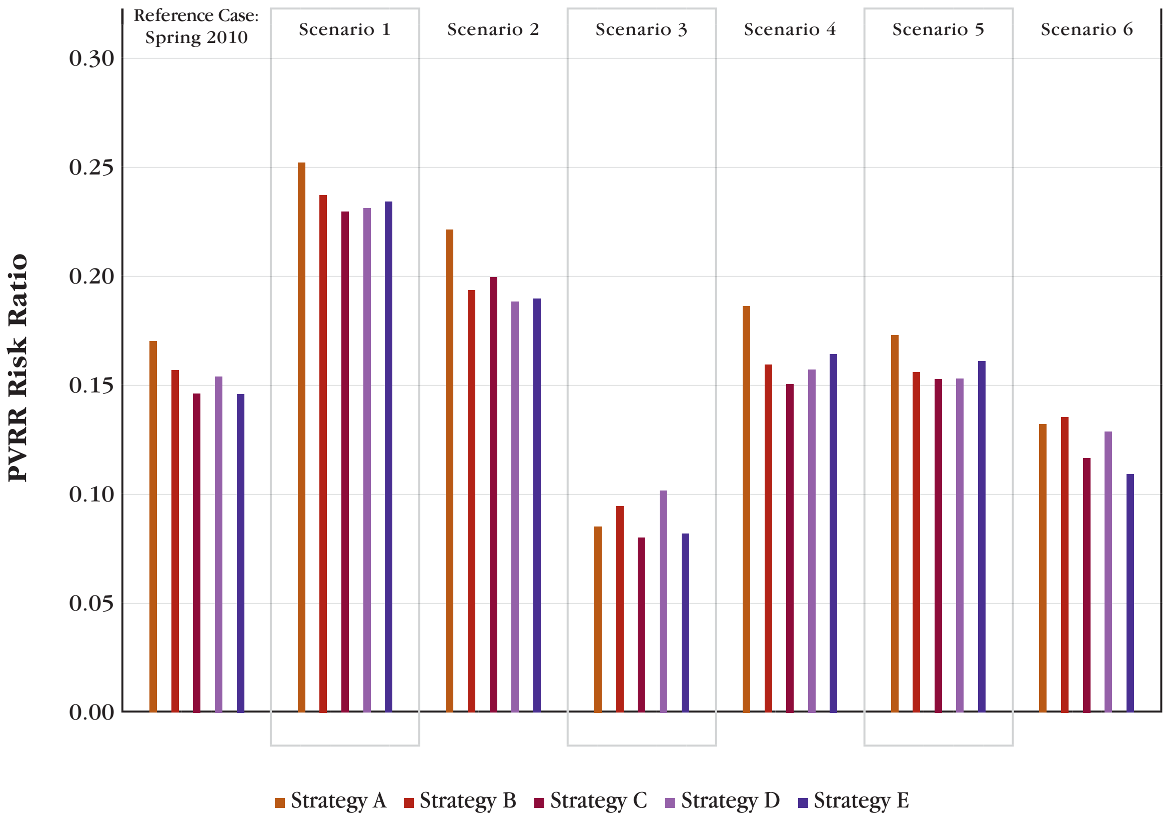

Figure 7-11 – PVRR Risk Ratio by Scenario

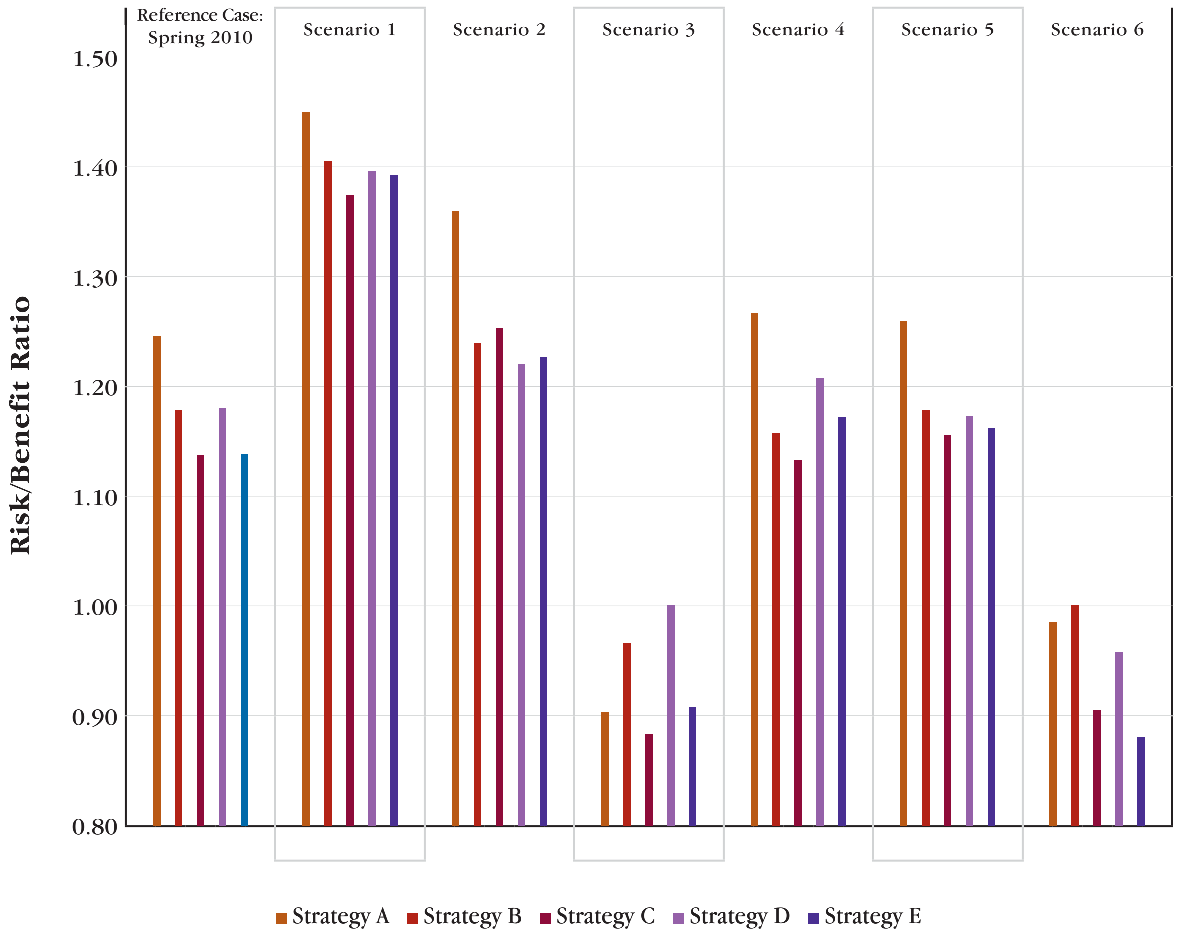

Figure 7-12 – PVRR Risk/Benefit by Scenario

7.2 Selection Process

The process that was used to rank and identify the preferred planning strategies was discussed in Chapter 6 – Resource Plan Development and Analysis. That process involved the following four steps:

1. Planning strategies were scored (based on cost and risk metrics) and ranked
2. Strategic metrics were added to the ranking metrics to complete the scorecard for the top ranked strategies
3. Selected strategies were released for public comment in the Draft IRP and the associated EIS
4. Sensitivity analyses were done as a result of public comments

The ranking of each strategy was based on the expected values of the cost and risk metrics generated by the stochastic analysis, which is described in Chapter 6 – Resource Plan Development and Analysis. The expected values were translated into a score, and the scores across all seven scenarios were combined to produce a total strategy score. Strategies were ranked based on total score from highest to lowest. A subset of strategies was selected for further consideration based on scores and other strategic considerations such as potential environmental impacts.

7.2.1 Scorecard Results

Scorecards were generated by translating the expected values from the modeling results into a standardized score that was summed across the scenarios for each planning strategy. Figure 7-13 summarizes the average expected values of PVRR, short-term rates, risk/benefit and risk computed for the five planning strategies in each of the seven scenarios.

		Scenarios							
	Strategy	1	2	3	4	5	6	7	**Average**
Average of PVRR (2010 B $)	A	180	137	116	138	135	109	134	**136**
	B	179	136	114	137	133	107	133	**134**
	C	175	133	114	135	131	105	130	**132**
	D	181	137	115	138	134	103	132	**134**
	E	174	131	115	136	131	104	130	**132**
Average of ST Rates (level 2011-18)	A	76.82	75.92	78.42	74.47	75.75	77.31	74.97	**76.24**
	B	82.49	77.49	76.22	75.88	77.04	74.91	75.72	**77.11**
	C	83.57	74.60	77.40	76.00	75.64	75.55	75.94	**76.96**
	D	84.83	79.54	75.24	75.98	76.80	72.70	75.13	**77.17**
	E	78.91	75.94	78.23	74.78	76.01	75.90	75.14	**76.42**
Average of Risk/Benefit	A	1.45	1.36	0.91	1.27	1.26	0.99	1.25	**1.21**
	B	1.43	1.24	0.97	1.16	1.18	1.00	1.18	**1.17**
	C	1.41	1.29	0.89	1.14	1.16	0.91	1.14	**1.14**
	D	1.45	1.26	1.06	1.25	1.20	1.00	1.23	**1.21**
	E	1.42	1.24	0.93	1.19	1.18	0.90	1.15	**1.15**
Average of Risk	A	0.25	0.22	0.09	0.19	0.19	0.13	0.17	**0.18**
	B	0.23	0.19	0.10	0.16	0.17	0.14	0.16	**0.16**
	C	0.23	0.20	0.08	0.15	0.17	0.12	0.15	**0.16**
	D	0.23	0.19	0.11	0.17	0.18	0.14	0.16	**0.17**
	E	0.24	0.20	0.08	0.17	0.17	0.11	0.15	**0.16**

Figure 7-13 – Ranking Metrics Worksheet

After applying the methodology for translating actual values into color-coded scores, which is described in Chapter 6 – Resource Plan Development and Analysis, a scorecard was produced for each of the five planning strategies. In Figure 7-14, planning Strategy A was used to demonstrate how scores were computed and then summed to produce the total ranking score.

	Ranking Metrics				
Scenarios	PVRR	Short-Term Rate Impact	Risk/Benefit	Risk	Ranking Metric Score
1	93.87	100.00	95.07	91.26	94.82
2	95.76	99.25	90.32	85.74	93.61
3	98.28	95.78	98.39	94.38	96.84
4	97.49	100.00	88.75	77.41	92.42
5	97.09	99.85	91.73	87.21	94.81
6	94.14	93.66	90.08	80.82	90.51
7	96.74	100.00	90.59	85.43	94.15
				Total Ranking Metric Score:	657.15

Total Ranking Metric Score=Sum of Ranking Metrics Scores for all seven scenarios

Ranking Metric Score=65%*(65%*PVRR + 35%*ST Rate) + 35%*(35%*Risk/Benefit + 65%*Risk)
=65%*(65%*97.09 + 35%*99.85) + 35%*(35%*91.73 + 65%*87.21)=94.81

Legend

Better

Figure 7-14 – Planning Strategy A – Limited Change in Current Resource Portfolio

Scorecards for the remaining four strategies are shown in Figures 7-15, 7-16, 7-17 and 7-18.

	Ranking Metrics				
Scenarios	PVRR	Short-Term Rate Impact	Risk/ Benefit	Risk	Total Plan Score
1	97.71	97.59	98.40	97.34	97.68
2	97.76	98.85	100.00	99.98	98.79
3	99.61	98.70	91.37	83.79	94.79
4	98.38	98.11	98.25	93.79	97.26
5	98.44	98.14	98.61	98.94	98.51
6	96.55	96.96	88.56	78.46	91.55
7	98.01	99.01	96.50	94.26	97.20
				Total Ranking Metric Score:	**675.78**

Legend

Better

Figure 7-15 – Planning Strategy B – Baseline Plan Resource Portfolio

	Ranking Metrics				
Scenarios	PVRR	Short-Term Rate Impact	Risk/ Benefit	Risk	Total Plan Score
1	100.00	97.48	100.00	100.00	99.43
2	99.58	100.00	96.20	96.17	98.49
3	100.00	97.13	100.00	100.00	99.35
4	100.00	97.94	100.00	100.00	99.53
5	100.00	100.00	100.00	100.00	100.00
6	98.59	96.09	98.19	93.22	96.75
7	100.00	98.71	100.00	100.00	99.71
				Total Ranking Metric Score:	**693.25**

Legend

Better

Figure 7-16 – Planning Strategy C – Diversity Focused Resource Portfolio

	Ranking Metrics				
Scenarios	PVRR	Short-Term Rate Impact	Risk/ Benefit	Risk	Total Plan Score
1	97.40	97.54	96.41	96.81	97.18
2	97.90	98.51	99.04	98.90	98.40
3	99.41	100.00	81.31	69.12	90.43
4	97.40	97.97	90.14	92.05	95.42
5	97.86	98.47	96.57	92.60	96.64
6	100.00	100.00	89.16	78.46	93.77
7	98.56	99.79	92.15	91.33	96.41
				Total Ranking Metric Score:	668.26

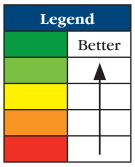

Figure 7-17 – Planning Strategy D – Nuclear Focused Resource Portfolio

	Ranking Metrics				
Scenarios	PVRR	Short-Term Rate Impact	Risk/ Benefit	Risk	Total Plan Score
1	99.43	99.21	97.82	96.78	98.58
2	100.00	99.22	99.79	100.00	99.80
3	99.15	96.03	95.91	97.73	97.72
4	99.45	99.58	95.32	89.57	96.73
5	99.83	99.50	98.87	99.47	99.56
6	99.16	95.61	100.00	100.00	98.64
7	99.68	99.77	98.98	98.96	99.45
				Total Ranking Metric Score:	690.47

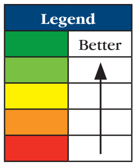

Figure 7-18 – Planning Strategy E – EEDR and Renewables Focused Resource Portfolio

The scores assigned to each strategy and the associated color coding was done within a given scenario. To properly interpret the scoring for each strategy, the values for each individual ranking metric in all five strategies were compared within a particular scenario.

7.2.2 Ranking of Strategies

Detailed descriptions of strategies were introduced in Chapter 6 – Resource Plan Development and Analysis. Figure 7-19 shows the rank order of the five planning strategies evaluated in the Draft IRP based on the total ranking metrics scores. The total strategy scores range from 657 to 693 out of a possible 700 points.

Rank	Planning Strategy	Preliminary Observations
1	C	• Performs the best against PVRR and risk metrics • Near the median for short-term rates
2	E	• Near the median for short-term rates • Performs near the best for PVRR
3	B	• Ranks near the median for PVRR, short-term rates and risk
4	D	• Ranks below the median for PVRR, rates and risk
5	A	• Performs the worst on PVRR and risk • Ranks the best for short-term rates in some scenarios

Figure 7-19 – Planning Strategy Ranking Order

A key element of a “no-regrets” strategy is that a portfolio performs relatively well in most scenarios, not just the reference case scenario. Using the initial planning results, Strategy C was the top-ranked planning strategy on the basis of the total ranking metric score. However, the separation between the scores of Strategies C and E was not statistically significant. Strategy C represented an attempt to define a balanced approach to the resource mix and performed best in five of the seven scenarios based on total plan score, performed second best in another and third in just one scenario. The ranking metrics implied that Strategy C was the most robust in many possible futures. Strategy C was the top performer for PVRR and for both risk metrics. It performed reasonably well on short-term rates, but it was not the best strategy in that category.

The second best planning strategy, based on total ranking metric score, was Strategy E. As with Strategy C, this strategy represented an expanded commitment to cleaner resource options, especially pertaining to EEDR and renewable energy options. The strategy performed well in all four of the ranking metrics and performed best in two of the seven scenarios based on total plan score, resulting in a total strategy score that was very close to Strategy C.

The third best planning strategy was Strategy B. This strategy represented a “business-as-usual” approach that did not significantly deviate from existing portfolio mixes over the long term. This strategy performed reasonably well with scores in the four ranking metrics that were in the mid range for each metric, but did not rank first in any of the scenarios.

Strategy B was retained for further analysis in this IRP as a baseline strategy for impact analysis.

Strategies A and D were in the lower tier of the total strategy scores and did not represent options that offer preferable planning approaches. These two strategies represented approaches that tended to define the boundary conditions within which the other strategy results could be placed. Strategy A was an approach that included retention of all existing coal-fired capacity, with a high level of clean air capital and maintenance spending and heavy reliance on the market. The scorecard for this strategy showed it to be the worst performer in most metrics for most of the scenarios, except for the short-term rate metric where it performed quite well. Strategy D was characterized by the largest level of coal-fired capacity idled which called for the most new capacity additions. This resulted in poor strategy scores across the scenarios, although this strategy outperformed Strategy A.

7.2.3 Sensitivity Cases

In addition to the initial 35 portfolios developed from the five planning strategies, TVA also performed certain sensitivity analyses. These analyses focused on key assumptions within those strategies based on review of the scorecard results. In the Draft IRP, the sensitivity analyses consisted of four cases involving Strategies C and E (the top-ranked strategies based on the results to date). The characteristics of these sensitivity cases are described in Figure 7-20.

Sensitivity Description	Basis for Selection
C1 – Strategy C with pumped-storage hydro removed	Test for improvement in short-term rate impacts by removing defined model input for pumped-storage hydro unit
C2 – Same as Sensitivity C1 with no capacity additions prior to 2018	Test for improvements in short-term rate impacts by defining near-term capacity additions. Modeled after Strategy A, which performs the best on rates
E1 – Strategy E with greater (7,000 MW) coal-fired idling (same as Strategy D)	Test to see if largest values for EEDR, renewables, and coal unit idling significantly improve the PVRR and short-term rate impacts of Strategy E
E2 – Strategy E with lower (2,500 MW) renewable portfolio (same as Strategy C)	Improve PVRR and short-term rates by using the lower renewable portfolio applied in Strategy C

Figure 7-20 – Sensitivity Characteristics

When these sensitivity cases were evaluated using the same ranking metrics applied to the original five planning strategies, a new rank order of strategies was established, as shown in Figure 7-21. The scores now range from 655 to 689.

Rank	Planning Strategy
1	C1 – Strategy C without pumped-storage hydro
2	C – Diversity Focused Resource Portfolio
3	C2 – same as C1 with no capacity additions prior to 2018
4	E – EEDR and Renewables Focused Resource Portfolio
5	E2 – Strategy E with greater coal unit idling
6	E1 – Strategy E with lower renewable portfolio
7	B – Baseline Plan Resource Portfolio
8	D – Nuclear Focused Resource Portfolio
9	A – Limited Change in Current Resource Portfolio

Figure 7-21 – Rank Order of Strategies

Sensitivity C1 was a slight improvement over planning Strategy C and now has the highest-ranking metric score among the options considered in the Draft IRP. Sensitivity C2 was slightly lower than Strategy C. As components changed, the stability of Strategy C represented a noteworthy quality. Sensitivities E1 and E2 did not improve the results as compared to Strategy E and were removed from further consideration for the final IRP.

7.2.4 Other Strategic Considerations

In addition to the metrics used to establish the rank order of the planning strategies, TVA included strategic metrics in the fully populated scorecard. These strategic metrics included environmental and regional economic impact measures that recognize other aspects of TVA's mission. These strategic metrics are fully discussed in Chapter 6 – Resource Plan Development and Analysis. Note that for the economic impact measures, all of the IRP strategies were analyzed only for Scenarios 1 and 6 – the scenarios that defined the upper and lower range of strategy impacts within the scenario range.

Figure 7-22 shows the strategic metrics for each of the five planning strategies.

Planning Strategy A

	Strategic Metrics				
	Environmental Stewardship			Economic Impact	
Scenarios	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	○	◑	◑	0.1%	0.1%
2	○	◔	◔		
3	○	○	○		
4	○	◔	◑		
5	○	◔	◔		
6	○	○	◔	-0.4%	-0.4%
7	○	◔	◑		

Planning Strategy D

	Strategic Metrics				
	Environmental Stewardship			Economic Impact	
Scenarios	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	●	◕	●	1.2%	1.0%
2	●	◕	●		
3	●	●	●		
4	●	◕	●		
5	●	●	●		
6	◕	●	●	-0.1%	-0.2%
7	●	●	●		

Planning Strategy B

	Strategic Metrics				
	Environmental Stewardship			Economic Impact	
Scenarios	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	◔	○	○	1.0%	0.8%
2	◔	○	○		
3	◔	◔	◔		
4	◔	○	○		
5	◔	○	○		
6	◔	◔	○	-0.3%	-0.3%
7	◔	○	○		

Planning Strategy E

	Strategic Metrics				
	Environmental Stewardship			Economic Impact	
Scenarios	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	◕	●	◕	0.8%	0.6%
2	◕	●	◕		
3	◕	◕	◕		
4	◑	●	◕		
5	◕	◕	◕		
6	●	◕	◕	0.3%	0.2%
7	◕	◕	◕		

Planning Strategy C

	Strategic Metrics				
	Environmental Stewardship			Economic Impact	
Scenarios	CO_2 Footprint	Water	Waste	Total Employment	Growth in Personal Income
1	◑	◔	◔	0.9%	0.6%
2	◑	◑	◑		
3	◑	◑	◑		
4	◕	◑	◔		
5	◑	◑	◑		
6	◑	◑	◑	0.2%	0.1%
7	◑	◑	◔		

Legend	
●	Better
◕	↑
◑	
◔	
○	

Figure 7-22 – Strategic Metrics for Five Planning Strategies

Results of the CO_2 metric showed that Strategy D had the best performance (lowest emissions), followed by Strategies E, C, B and A. Each strategy showed a declining rate of emissions and the variance between each strategy was quite low since all coal-fired units that will remain in service are assumed to receive environmental controls. With that being said, all five strategies will be fully compliant with applicable air emissions regulations.

Results of the water metric indicated that Strategy D had the best performance, followed by Strategies E, C, A and B. Results of the waste metric show Strategy D had the best performance, followed by Strategies E, C, A and B. Additional information on all environmental metrics calculations can be found in Appendix A – Method for Computing Environmental Impact Metrics.

Based on the Draft IRP results, planning Strategies D and E had the best relative performance across the environmental metrics. Strategy C was average to slightly above average, and Strategies A and B had the lowest relative performance.

For the economic impact metrics, Strategy A was the worst performer. Strategies B, C, D and E had comparable results, within a few tenths of a percentage difference from the impacts computed for the reference portfolio (Strategy B in Scenario 7). Strategies C and E had very similar impacts, performing above the reference portfolio in the long term under both Scenarios 1 and 6.

Along with the strategic metrics, innovations that enable the utilization of key technologies in the planning strategies have been identified and summarized in Figure 7-23. The figure shows which of the five planning strategies would be impacted by each of the innovations in the future.

Technology Innovation	Description	A	B	C	D	E
Smart Grid Technologies	Advancements in this area are necessary to fully realize the EEDR benefits included in certain planning strategies		X	X	X	X
Transmission Design & Infrastructure	Improvements in transmission system devices to manage power flows and advancement in dc line technologies will be needed to facilitate power transfers and the import of additional wind-sourced power			X	X	X
Advanced Energy Storage	More research is needed to improve the design of pumped-storage hydro (PSH) and identify new storage technologies that might offer advantages similar PSH			X	X	X
Small Modular Nuclear Reactors	This technology may offer some flexibility for siting and operating nuclear capacity in those strategies that include a reliance on new nuclear capacity later in the planning period		X	X	X	X
Advanced Emission Controls for Coal-Fired Units	To enable full use of coal-fired resources, advances in emission controls (especially carbon capture and sequestration) are needed to achieve a more balanced long-term generation portfolio	X	X	X		

Figure 7-23 – Technology Innovation Matrix

TVA will closely monitor and possibly invest in these and other technology innovations during the planning period. The particular technology innovations that are necessary to implement the Recommended Planning Direction will likely shift as more information becomes available about each technology area and as power supply needs change.

In addition to the PVRR risk metrics discussed in Chapter 6 – Resource Plan Development and Analysis, there are other risks that were considered when evaluating the merits of alternative strategies. The financial risk measures included in the ranking metrics portion of the planning strategy scorecard may have indirectly accounted for some of these risks, but only in part. Examples of these broader, more difficult to quantify, risk considerations include:

- The ability of EEDR programs to stimulate distributor and customer participation and the programs' ability to deliver forecasted energy savings and demand reductions. The planning strategies with higher EEDR targets have a greater exposure to these risks
- The availability and deliverability of natural gas. There is finite capacity in the existing natural gas infrastructure. Risks of being limited by deliverability and availability will likely increase as natural gas generation capacity is increased
- The ability to achieve schedule targets for licensing/permitting, developing and constructing new generation capacity. Risks of meeting schedule targets will likely increase as the number and complexity of construction projects increase. In addition, projects with more extensive licensing/permitting requirements will likely have greater exposure to schedule risk
- The timely build-out of transmission infrastructure to support future resources. This is a particular concern with projects that may require transmission expansion outside of the TVA system, such as power purchase agreements for wind energy. Risks will likely increase as the amount of construction required increases and if that construction is undertaken by entities other than TVA
- Legislative and regulatory risks that could strand certain investments in coal-fired assets by, for example, applying a more stringent regulatory framework around coal-fired assets, or by mandating certain other types of generation, including renewables, that could crowd out existing sources of generation
- Game-changing technologies, either on the supply or demand side, that could either dramatically increase (i.e., new sources of demand) the need for electricity or dramatically decrease (i.e., distributed generation) the need for electricity in the long term

The list above is not intended to be exhaustive. It provides examples of other strategic components that TVA considered when it identified the preferred planning strategies in the Draft IRP as well as the Recommended Planning Direction in the final IRP. In addition, the analysis results and public input were considered. TVA encouraged those commenting on the Draft IRP to provide information about and share their views on these other risks.

7.3 Preferred Planning Strategies

Based on the Draft IRP results, TVA retained the top three ranked planning strategies for further analysis for the final IRP (Chapter 8 – Final Study Results and Recommended Planning Direction). Strategies C, E and B were retained from the Draft IRP to be subjected to additional analysis and sensitivity testing in an effort to determine improved combinations of planning components.

Illustrative portfolios (20-year resource plans) were identified as part of the evaluation. In the Draft IRP, a broad set of portfolios were identified that corresponded to the three planning strategies that were retained in the Draft IRP.

Four representative resource portfolios were selected from planning Strategies C, E and B. The 12 implementing portfolios for the Draft IRP are shown in Figure 7-24. These portfolios described a relatively broad set of resource plan options that were subjected to additional analysis before completing the final IRP. Portfolios produced in Scenario 1 represented the largest amount of new resource additions, while those produced in Scenario 3 represented the least amount of new resources that could be added over the planning period.

Year	Planning Strategy C				Planning Strategy E				Planning Strategy B			
	SC 1	SC 2	SC 3	SC 7	SC 1	SC 2	SC 3	SC 7	SC 1	SC 2	SC 3	SC 7
2010	PPAs & Acq				PPAs & Acq				PPAs & Acq			
2011												
2012	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC	JSF CC
2013	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2	WBN2
2014	CTa								CTa CT GL CT Ref			
2015	CT GL CT Ref CC			GL CT Ref CC	GL CT Ref CTa CC (2)			GL CT Ref CC	CT CC	GL CT Ref		GL CT Ref CTa MKT
2016	CT			MKT	CT			MKT	CT			CT MKT
2017	MKT			MKT				MKT	CT			CTa MKT
2018	BLN1			BLN1	CT			CC	BLN1			BLN1
2019	MKT				CC				CT	BLN1		
2020	BLN2 PSH	PSH	PSH	BLN2 PSH	CC			MKT	BLN2			BLN2
2021	CT				CTa			MKT	CC	BLN2		
2022	CC MKT	BLN1			BLN1 MKT	BLN1		BLN1 MKT	CT CC			CC
2023	CC MKT				CT MKT			MKT	CT			CT
2024	NUC	BLN2		MKT	BLN2	BLN2		BLN2	NUC MKT			
2025	IGCC			CT	CT				IGCC	NUC		CT
2026	NUC			MKT	CT			CT	NUC		MKT	MKT
2027	CT			CC	CT				CT	NUC	MKT	CT
2028	CT				NUC			CTa	CC		MKT	MKT
2029	IGCC CTa	NUC		CTa	CT			CTa	IGCC CTa	CTa	CTa MKT	CC

Defined Model Inputs	
Coal-fired capacity idled	3,252 MW by 2015
Renewable firm capacity	953 MW by 2029
	8,791 GWh by 2029
EEDR	4,638 MW by 2029
	14,032 GWh by 2029

Defined Model Inputs	
Coal-fired capacity idled	4,730 MW by 2015
Renewable firm capacity	1,157 MW by 2029
	12,251 GWh by 2029
EEDR	6,043 MW by 2029
	16,455 GWh by 2029

Defined Model Inputs	
Coal-fired capacity idled	2,415 MW by 2015
Renewable firm capacity	160 MW by 2029
	4,231 GWh by 2029
EEDR	2,520 MW by 2029
	7,276 GWh by 2029

Key:

PPAs & Acq = purchased power agreements, including potential acquisition of third-party-owned projects (primarily combined cycle technology)

JSF CC = the combined cycle unit to be sited at the John Sevier plant (TVA Board of Directors' approved project, currently under development)

WBN2 = Watts Bar Unit 2 (TVA Board of Directors' approved project, currently under development)

GL CT Ref = the proposed refurbishment of the existing Gleason CT units

CC = combined cycle

CT/CTa = combustion turbines

PSH = pumped-storage hydro

BLN1/BLN2 = Bellefonte Units 1 & 2

NUC = nuclear unit

IGCC = integrated gasification combined cycle (coal technology)

MKT = Purchased Power

Figure 7-24 – Implementing Portfolios (Initial Phase)