Environmental Impact Statement for TVA's Integrated Resource Plan

TVA's Environmental & Energy Future

March 2011 | Volume 1

TVA

Document Type: EIS-Administrative Record
Index Field: Final Environmental Impact Statement
Project Name: Integrated Resource Plan
Project Number: 2009-19

Environmental Impact Statement **March 2011**

Proposed action: Integrated Resource Plan

Lead agency: Tennessee Valley Authority

For further information on the EIS, contact:

Charles P. Nicholson
National Environmental Policy Act Manager
Tennessee Valley Authority
400 W. Summit Hill Drive, WT 11D
Knoxville, Tennessee 37902

Phone: 865-632-3582

Fax: 865-632-3451

E-mail: IRP@tva.gov

For further information on the project, contact:

Randall E. Johnson
Integrated Resource Plan Project Manager
Tennessee Valley Authority
1101 Market St., EB 8D
Chattanooga, TN 47402

Phone: 423 751-3520

E-mail: rejohnson1@tva.gov

Abstract: The Tennessee Valley Authority (TVA) proposes to adopt a new Integrated Resource Plan (IRP) to determine how it will meet the electrical needs of its customers over the next 20 years and fulfill its mission of low-cost, reliable power, environment, and economic development. Planning process steps include: 1) determining the future need for power; 2) identifying potential supply-side options for generating power and demand-side options for reducing the need for power; 3) developing a range of planning strategies encompassing various approaches TVA can take on issues such as the amount of renewable generation, amount of demand-side reductions, and constraints on future coal-fired and nuclear generation; and 4) identifying a range of future conditions (scenarios) used in evaluating the strategies. Capacity expansion plans (portfolios) are then developed for each combination of strategies and scenarios, and these are evaluated for financial, risk, environmental, and economic criteria. A final suite of four alternative strategies, the Baseline Plan (No Action alternative), the Diversity-Focused, the Energy Efficiency-Demand Response and Renewables Focused, and the Recommended Planning Direction, is then evaluated in detail. Under all of these strategies, coal-fired generation decreases and reliance on renewable and demand-side resources increase. All strategies add varying amounts of new nuclear and natural gas-fueled generation. Emissions of air pollutants and the intensity of greenhouse gas emissions decrease under all strategies. Other environmental impacts vary across strategies and scenarios and for most resource areas are lowest for the Energy Efficiency-Demand Response and Renewables Focused Strategy. TVA's preferred strategy is the Recommended Planning Direction.

SUMMARY

INTRODUCTION

The Tennessee Valley Authority (TVA) has developed the Integrated Resource Plan (IRP) and associated programmatic environmental impact statement (EIS) to address the demand for power in the TVA service area, the resource options available for meeting that demand, and the potential environmental, economic, and operating impacts of these options. The IRP will serve as a roadmap for meeting the energy needs of TVA's customers over the next 20 years

The Tennessee Valley Authority (TVA) is the largest producer of public power in the United States. With a generating capacity of 37,000 megawatts, TVA provides wholesale power to 155 distributors and directly sells power to 56 large industrial and federal customers. TVA's power system serves nine million people in a seven-state, 80,000 square mile region (Figure 1).

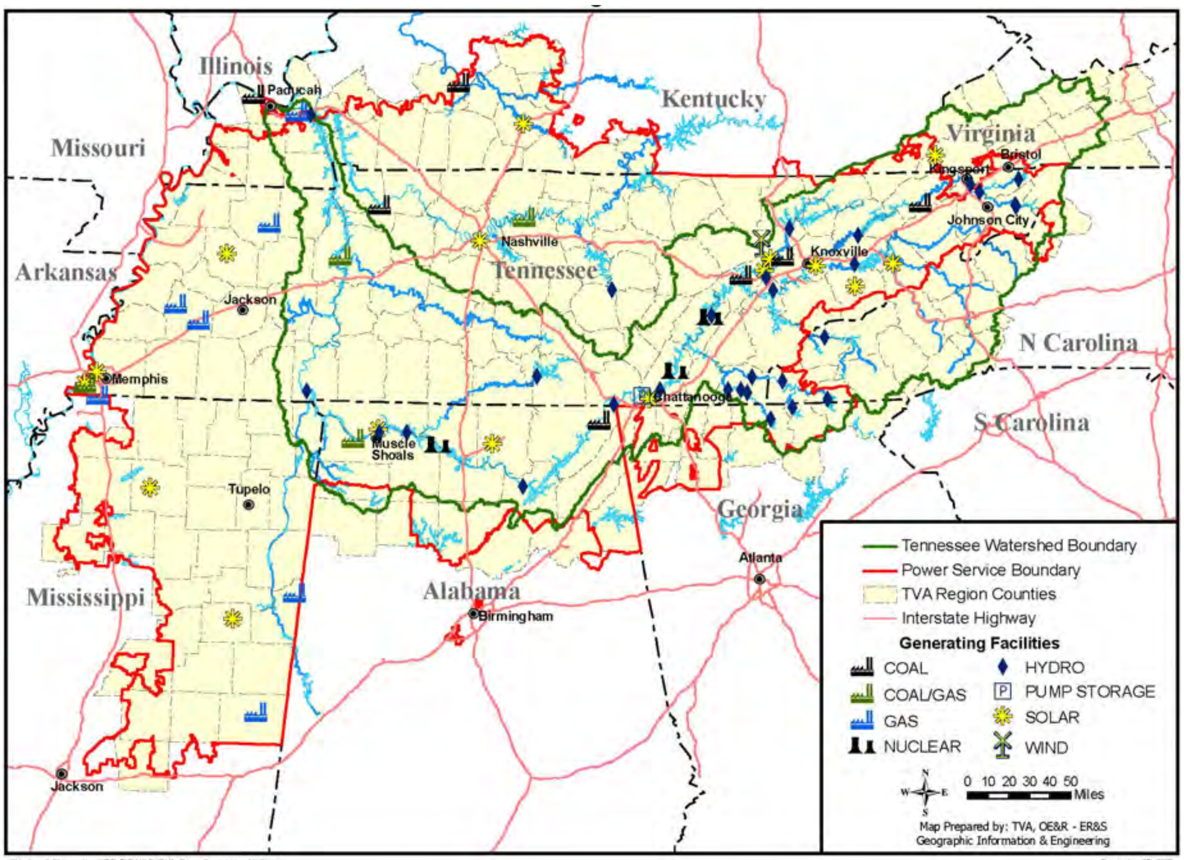

Figure 1. The TVA service area and generating facilities.

Purpose and Need

Like other utilities, TVA develops power supply plans. This planning process includes forecasting the demand for power and developing capacity resource plans. In the mid-1990s, TVA developed a comprehensive integrated resource plan with extensive public involvement. This process was completed with issuance of the Energy Vision 2020 IRP/Final EIS (EV2020) in 1995 (TVA 1995) and the associated Record of Decision in 1996. Based on the extensive evaluation, TVA adopted a flexible portfolio of supply- and demand-side energy resource options to meet the growing demand for electricity in the region, prepare for industry deregulation, and achieve the goals of the TVA Act and other congressional directives. The adopted portfolio has subsequently been amended by Records of Decision for various implementing actions. When completed, the new IRP and EIS will replace EV2020.

The purpose of this study is to evaluate TVA's current portfolio and alternative future portfolios of energy resource options to meet the future electrical energy needs of the TVA region and achieve a sustainable future. Energy resource options include the means by which TVA generates or purchases electricity, transmits that electricity to customers, and influences the end use of that electricity through energy efficiency and demand response programs. As part of the integrated resource planning process, TVA has evaluated the future demand for electricity by its customers, characterized potential supply- and demand-side options for meeting future demand, and assembled these options into planning strategies and portfolios. TVA then evaluated the strategies for several criteria including capital and fuel costs, risk, reliability, compliance with existing and anticipated future regulations, environmental impacts, and flexibility in adapting to changing future conditions. Following the public review of the Draft IRP and EIS, TVA conducted further evaluations, including the development of a new strategy, addressed the public comments, and has issued this Final EIS and the Final IRP These reports identify TVA's preferred alternative strategy, which will be submitted to the TVA Board of Directors for approval.

Public Participation

TVA conducted public scoping for the IRP and associated EIS in June 2009 with the publication of the Notice of Intent in the Federal Register. TVA simultaneously issued news releases, posted notice on the project website, and sent letters about the project to numerous state and federal agency offices and Indian tribal representatives. During the 60-day scoping period, TVA held public scoping meetings at seven locations across the TVA region. About 200 people attended these meetings.

TVA received over 1,000 individual comments during the scoping period. These included oral and written comments submitted at the scoping meetings, comments submitted through the TVA website, letters, and comments submitted by email. About 845 people completed at least part of a scoping questionnaire. Comments were also received from nine offices of four federal agencies and from 20 state agencies representing six of the seven TVA region states.

Scoping comments addressed a wide range of issues, including the integrated resource planning process, preferences for various types of power generation, support for increased energy efficiency and demand response efforts, and the environmental impacts of TVA's power generation, fuel acquisition, and power transmission operations. Comments on these issues are briefly summarized below; a more detailed discussion of the scoping comments is available in the IRP EIS Scoping Report issued in October, 2009.

To gain additional input, TVA established a Stakeholder Review Group that has regularly met throughout the development of the IRP. The Stakeholder Review Group is composed of 16 members representing state agencies, the Department of Energy, distributors of TVA power, industrial groups, academia, and non-governmental organizations. TVA has also held quarterly public briefings to educate the general public on the IRP planning process and to present results of major planning steps. Participants could attend these meeting in person or by web conference.

The Draft IRP and EIS were issued to the public on September 15, 2010 and the notice of their availability was published in the *Federal Register* on September 24, 2010. This initiated a 45-day public comment period. The comment period was later extended to 52 days and closed on November 15, 2010. During the comment period, TVA held five public meetings to describe the project and to accept comments on the Draft IRP and EIS. TVA staff presented an overview of the planning process and draft results. Attendees then had the opportunity to make oral comments and ask questions about the project. A panel of TVA staff responded to the questions. Stakeholders could also participate in the meetings via webinar and TVA responded to comments and questions submitted by webinar participants in the same manner as those from in-person attendees.

TVA received 501 comment submissions, which included letters, form letters, emails, oral statements, and submissions through the project website. These were carefully reviewed and synthesized into about 370 individual comments. These comments and TVA's responses to them are provided in Volume 2 of the Final EIS. As a result of the comments, TVA made several changes to the Final IRP and EIS. TVA also considered the comments during the development of Recommended Planning Direction alternative that has been added to the Final IRP and EIS.

TVA'S RESOURCE PLANNING PROCESS

TVA chose to employ a scenario planning approach in the IRP. The major steps in this approach include identifying the future need for power, developing scenarios and strategies, determining potential supply-side and demand-side resource options, developing portfolios associated with the strategies, and ranking the strategies and portfolios.

Need for Power

The need for additional power is based on forecasts of the demand for power over the next 20 years and the ability of TVA's existing facilities to meet the forecast demand. Demand forecasts are based on mathematical models that link electricity sales to the price of electricity, the price of natural gas, growth in economic activity, and other factors for the residential, commercial, and industrial sectors. The results are forecasts of peak load (the maximum amount of power used at a given point in time) and net system energy (the amount of power used over a specified time period). Forecasts are developed for baseline conditions (Reference Case: Spring 2010 scenario) and high- and low-demand scenarios (Figure 2).

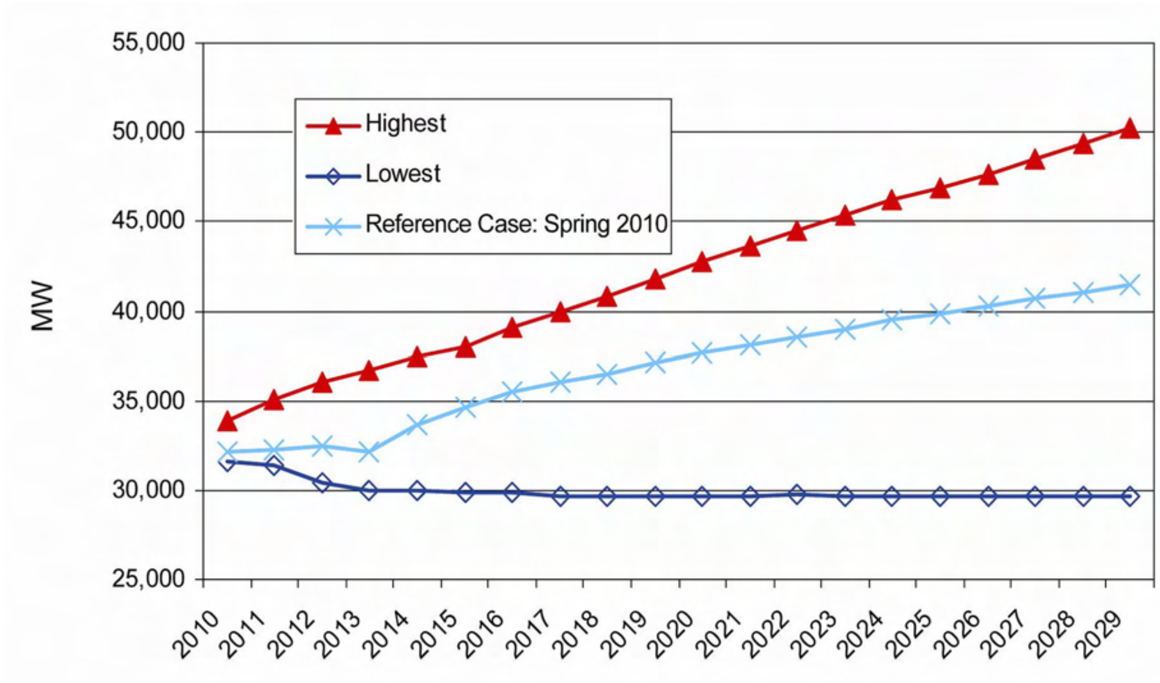

Figure 2. Peak load forecast through 2029 in megawatts (MW) for the IRP Baseline, high- and low-growth scenarios.

The next step in determining the need for power is to assess TVA's current generating mix and how the existing resources will change over the next 20 years. The largest components of TVA's 2010 energy resources, which total about 37,200 megawatts in capacity, are coal-fired and nuclear facilities (Figure 3). The major changes to this over the next few years are the addition of the 880-megawatt John Sevier combined cycle plant in 2012 and 1,180-megawatt Watts Bar Nuclear Plant Unit 2 in 2013, and the expiration of several power purchase agreements for combined-cycle generation.

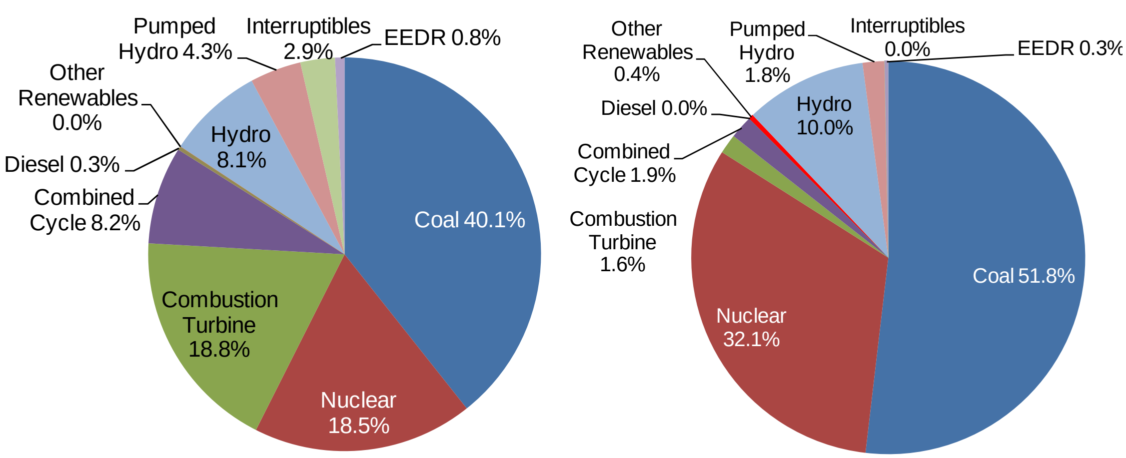

Figure 3. 2010 baseline portfolio firm capacity (left) and generation (right).

The last step in determining the need for additional power is to compare the existing energy resource portfolio with the forecasted need for power. The differences define the capacity gap (Figure 4) and the energy gap. The capacity gap includes a 15 percent reserve margin necessary to meet reliability standards.

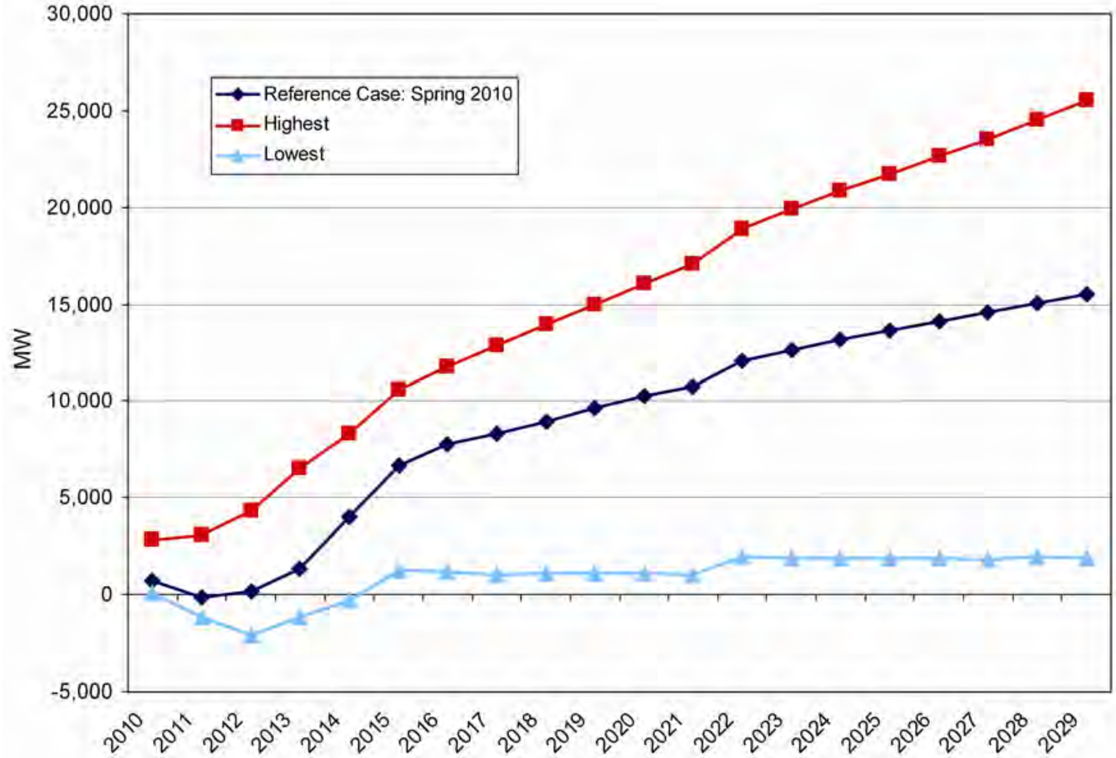

Figure 4. Capacity gap (in megawatts) for the IRP Baseline and high- and low-growth scenarios.

Scenario Development

TVA developed a set of scenarios used in evaluating the performance of the resource strategies against potential future conditions. These conditions (uncertainties) address a range of economic, financial, regulatory, and legislative conditions, as well as social trends and adoption of technological innovations. Six unique scenarios were developed and are summarized in the following table. Two additional scenarios reflect TVA's Spring 2010 and Fall 2010 planning approaches.

Strategy Development

Five distinct planning strategies were developed and analyzed in the draft IRP and EIS, and a sixth strategy was added during the development of the final IRP and EIS. These strategies describe a broad range of business options that TVA could adopt. Their attributes are assumed to be within TVA's control, and include the amounts of energy efficiency and demand response (EEDR); renewable energy, energy storage, nuclear capacity, and natural gas-fired capacity additions; coal plant shutdowns; limitations on the technology and timing of coal-fired capacity additions; reliance on purchased power; and the required transmission infrastructure. The attributes of the six planning strategies are described in a table below.

Key Characteristics of the Scenarios

Scenario	Key Characteristics
1 - Economy Recovers Dramatically	• Economy recovers stronger than expected and creates high demand for electricity • Carbon legislation and renewable electricity standards are passed • Demand for commodity and construction resources increases • Electricity prices are moderated by increased gas supply
2 - Environmental Focus is a National Priority	• Mitigation of climate change effects becomes a national priority • The cost of CO_2 allowances, gas and electricity increase significantly • Industry focus turns to nuclear, renewables, conservation and gas to meet demand
3 - Prolonged Economic Malaise	• Prolonged, stagnant economy results in low to negative load growth and delayed expansion of new generation • Federal climate change legislation is delayed due to concerns of adding further pressure to the economy
4 - Game-changing Technology	• Strong economy with high demand for electricity and commodities • High price levels and concerns about the environment incentivize conservation • Game-changing technology results in an abrupt decrease in load served after strong growth
5 - Reduce Dependence on Foreign Energy Sources	• The U.S. focuses on reducing its dependence on non-North American fuel sources • Supply of natural gas is constrained and prices for gas and electricity rise • Energy efficiency and renewable energy move to the forefronts as an objective of achieving energy independence
6 - Carbon Regulation Creates Economic Downturn	• Federal climate change legislation is passed and implemented quickly • High prices for gas and CO_2 allowances increase electricity prices significantly • U.S. based energy-intensive industry is non-competitive in global markets and leads to an economic downturn

Attributes of the Six Planning Strategies

Attributes	Planning Strategies: 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	R - Recommended Planning Direction
EEDR	1,940 MW & 4,725 annual GWh reductions by 2020	2,100 MW & 5,900 annual GWh reductions by 2020	3,500 MW & 11,400 annual GWh reductions by 2020	4,000 MW & 8,900 annual GWh reductions by 2020	5,900 MW & 14,400 GWh annual reductions by 2020	2,100-3,500 MW & 4,700-14,400 GWh annual reductions by 2020[1]
Renewable Additions	1,300 & 4,500 GWh competitive renewable resources or PPAs by 2020	Same as Strategy A	2,500 MW & 8,500 GWh competitive renewable resources or PPAs by 2020	Same as Strategy C	3,500 MW & 12,000 GWh competitive renewable resources or PPAs by 2020	1,500-3,500 MW competitive renewable resources or PPAs by 2020[2]
Coal Capacity Idled	No reductions	2,000 MW total reductions by 2017	3,000 MW total reductions by 2017	7,000 MW total reductions by 2017	5,000 MW total reductions by 2017	2,400-4,700 MW total reductions by 2017[3]
Energy Storage	No new additions	Same as Strategy A	Add one pumped storage unit	Same as Strategy C	Same as Strategy A	Same as Strategy C
Nuclear	No new additions after WBN2	First unit online no earlier than 2018 Units at least 2 years apart	Same as Strategy B	Same as Strategy B	First unit online no earlier than 2020 Units at least 2 years apart Limited to 3 units	Same as Strategy B
Coal	No new additions	New coal units are outfitted with CCS First unit online no earlier than 2025	Same as Strategy B	Same as Strategy B	No new additions	Same as Strategy B
Gas-Fired Supply (Self-Build)	No new additions	Meet remaining supply needs with gas-fired units	Same as Strategy B	Same as Strategy B	Same as Strategy B	Same as Strategy B

Attributes of the Six Planning Strategies (Continued)

Attributes	Planning Strategies					
	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	R - Recommended Planning Direction
Market Purchases	No limit on market purchases beyond current contracts and contract extensions	Purchases beyond current contracts and contract extensions limited to 900 MW	Same as Strategy B	Same as Strategy B	Same as Strategy B	Same as Strategy B
Transmission	Potentially higher level of transmission investment to support market purchases Transmission expansion (if needed) may have impact on resource timing and availability	Complete upgrades to support new supply resources	Increase transmission investment to support new supply resources and ensure system reliability Pursue inter-regional projects to transmit renewable energy	Same as Strategy C	Potentially higher level of transmission investment to support renewable purchases Transmission expansion (if needed) may have impact on resource timing and availability	Same as Strategy C

[1]Assumed 3,627 MW reduction by 2020 in portfolios
[2]Assumed 1,854 MW by 2020 in portfolios
[3]Assumed 4,000 MW reductions by 2017 in portfolios

Portfolio Development

Potential 20-year resource plans or portfolios were developed for each combination of a planning strategy and scenario. A major input to the portfolio development is the definition of the supply-side and demand-side energy resource options that can become components of the portfolios. These options include existing and potential future TVA generating facilities and existing and potential future power purchase agreements. They were evaluated according to their technological maturity, commercial availability, availability to TVA either within the TVA region or importable through market purchases, economics, and ability to contribute to TVA objectives of reducing emissions of air pollutants, including greenhouse gases. In addition to TVA's existing generating facilities, resource options evaluated include advanced coal plants with carbon capture and sequestration, natural gas-fueled combustion turbine and combined cycle plants, completion of the two Bellefonte Nuclear Plant units, construction of new nuclear units at Bellefonte or on an undetermined site, pumped hydro and compressed air energy storage plants, wind, solar photo-voltaic, and biomass generation, and combinations of demand-response programs.

The portfolios are developed with a capacity planning model that finds the "optimum" combination of resource options to meet projected demand/energy requirements over the 20-year planning period. An optimized portfolio has the lowest net Present Value of

Revenue Requirements while meeting energy balance, reserve, operational, environmental, and other requirements. The portfolios are then evaluated using an hourly production costing program to determine detailed revenue requirements and short-term rates. Additional metrics developed to rank the portfolios include financial risk, CO_2 emissions, water impact (thermal cooling requirements), waste handling costs, and changes in total employment and personal income. These metrics were used to compare the planning strategies and their associated portfolios and eliminate those that performed poorly or duplicated other portfolios.

ALTERNATIVE STRATEGIES

The two strategies ranked highest for the cost and risk factors are Strategy C - Diversity Focused Resource Portfolio, and Strategy E - EEDR and Renewables Focused Resource Portfolio. Strategy B - Baseline Plan Resource Portfolio ranked in the middle of the range and Strategy D - Nuclear Focused Resource Portfolio and Strategy A - Limited Change Resource Portfolio rank lowest. Strategies D and E had the best (i.e., lowest) scores for the environmental metrics and strategies A and B had the worst scores. Strategy C was in the middle of the range. Strategy A performed poorly due to the continued operation of all TVA coal plants and the likely reliance on natural gas for most future capacity additions through power purchase agreements. The other four strategies all had reductions in coal capacity and, under most scenarios, nuclear capacity additions; these factors resulted in their lower CO_2 emissions. The ranking of the strategies by the two economic development metrics was similar. Strategies B and D performed similarly and had greatest increases in total employment and personal income under the high-growth scenario. Strategies C and E also performed similarly and were in the middle of the range. Strategy A consistently ranked lowest.

Based on these rankings, TVA eliminated strategies A and D from further consideration. The retained Strategy B (Baseline Plan) is a continuation of TVA's current planning strategy and this represents the No Action Alternative. In order to better evaluate the retained strategies B, C, and E, the individual scenario-specific portfolios that comprise each strategy were examined more closely.

Within strategies B, C, and E, the portfolios and resulting capacity expansion plans tended to be similar for the paired scenarios 1 (Economy Recovers Dramatically) and 4 (Game-Changing Technology), for scenarios 2 (Environmental Focus is a National Priority) and 5 (Energy Independence), and for scenarios 3 (Prolonged Economic Malaise) and 6 (Carbon Legislation Creates Economic Downturn). The Scenario 7 (IRP Baseline Case) portfolios tended to be relatively unique. Based on the results of this examination, the portfolios associated with scenarios 1, 2, 3, and 7 were retained for further consideration. Portfolios were also developed for the fall 2010 baseline Scenario 8 (Great Recession Impact Recovery) and for Strategy R. Characteristics of the resulting No Action Alternative (Strategy B) and the three Action Alternatives (strategies C, E, and R) are listed in the following tables.

The No Action Alternative - Strategy B - Baseline Plan Resource Portfolio

Year	Defined Model Inputs			Capacity Additions by Scenario				
	EEDR[1]	Renew-ables[2]	Coal Idling[3]	SC1	SC2	SC3	SC7	SC8
2010	229	35	-	PPAs & Acquisitions				
2011	385	48	(226)					
2012	384	137	(226)	CC - 880	CC - 880	CC - 880	CC - 880	CC - 880
2013	610	155	(935)	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180
2014	1,363	155	(935)	CT - 621 CT - 828 GL CT - 170				
2015	1,496	160	(2,415)	CT - 828 CC - 910	GL CT - 170[4]		CT - 621, GL CT - 170	GL CT - 170
2016	1,622	160	(2,415)	CT - 828			CT - 621	MKT
2017	1,751	160	(2,415)	CT - 828			CT - 828	MKT
2018	1,881	160	(2,415)	BLN1 - 1,250			BLN1 - 1,250	BLN1 - 1,250
2019	2,012	160	(2,415)	CT - 828	BLN1 - 1,250			MKT
2020	2,124	160	(2,415)	BLN2 - 1,250			BLN2 - 1,250	BLN2 - 1,250
2021	2,216	160	(2,415)	CC - 910	BLN2 - 1,250			
2022	2,294	160	(2,415)	CT - 828, CC - 910			CC - 910	CC - 910
2023	2,362	160	(2,415)	CT - 828			CT - 828	CT - 621
2024	2,429	160	(2,415)	BLN3 - 1,117				CT - 828
2025	2,470	160	(2,415)	IGCC - 490	BLN3 - 1,117		CT - 828	
2026	2,495	160	(2,415)	BLN4 - 1,117				CT - 828
2027	2,509	160	(2,415)	CT - 828	BLN4 - 1,117		CT - 828	
2028	2,516	160	(2,415)	CC - 910		CT - 828		CT - 828
2029	2,520	160	(2,415)	IGCC - 490, CT - 621	CT - 621		CC - 910	CT - 621 MW

[1]Peak load impact in MW
[2]Firm capacity at the summer peak
[3]Cumulative capacity of coal units to be idled
[4]Upgrade of Gleason CT plant from 360 to 530 MW

Action Alternative - Strategy C - Diversity Focused Resource Portfolio

Year	Defined Model Inputs			Capacity Additions by Scenario				
	EEDR[1]	Renew-ables[2]	Coal Idling[3]	SC1	SC2	SC3	SC7	SC8
2010	298	35	-	PPAs & Acquisitions				
2011	389	48	(226)					
2012	770	146	(226)	CC - 880	CC - 880	CC - 880	CC - 880	CC - 880
2013	1,334	286	(935)	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180
2014	1,596	442	(935)	CT - 621				
2015	2,069	515	(3,252)	CT - 828, GL CT 170[4], CC - 910			CT - 621, GL CT - 170	GL CT - 170
2016	2,537	528	(3,252)	CT - 828				
2017	2,828	715	(3,252)					
2018	3,116	768	(3,252)	BLN 1 - 1,250			BLN1 - 1,250	
2019	3,395	822	(3,252)					
2020	3,627	883	(3,252)	BLN2 - 1,250, PSH - 850	PSH - 850	PSH - 850	BLN2 - 1,250, PSH - 850	PSH - 850
2021	3,817	896	(3,252)	CT - 828				
2022	3,985	911	(3,252)	CC - 910	BLN1 - 1,250			BLN1 - 1,250
2023	4,143	922	(3,252)	CC - 910				
2024	4,295	935	(3,252)	BLN3 - 1,117	BLN2 - 1,250			BLN2 - 1,250
2025	4,412	942	(3,252)	IGCC - 490			CT - 828	
2026	4,502	947	(3,252)	BLN4 - 1,117				
2027	4,561	948	(3,252)	CT - 828			CC - 910	
2028	4,602	953	(3,252)	CT - 828				CT - 621 MW
2029	4,638	954	(3,252)	IGCC - 490, CT - 621	BLN3 - 1,117		CT - 621	CT - 828

[1]Peak load impact in MW
[2]Firm capacity at the summer peak
[3]Cumulative capacity of coal units to be idled
[4]Upgrade of Gleason CT plant from 360 to 530 MW

Action Alternative - Strategy E - EEDR and Renewables Focused Resource Portfolio

Year	Defined Model Inputs			Capacity Additions by Scenario				
	EEDR[1]	Renew-ables[2]	Coal Idling[3]	SC1	SC2	SC3	SC7	SC8
2010	34	35	-	PPAs & Acquisitions				
2011	181	48	(226)					
2012	1,136	178	(226)	CC - 880	CC - 880	CC - 880	CC - 880	CC - 880
2013	1,664	314	(935)	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180
2014	2,431	493	(935)					
2015	3,479	580	(4,730)	GL CT - 170[4], CT - 621, CC (2) - 910			CT - 621, GL CT - 170	GL CT - 170
2016	3,843	616	(4,730)	CT - 828				
2017	4,183	846	(4,730)					
2018	4,504	921	(4,730)	CT - 828			CC - 910	
2019	4,811	994	(4,730)	CC - 910				
2020	5,074	1,060	(4,730)	CC - 910				
2021	5,353	1,074	(4,730)	CT - 621				
2022	5,460	1,094	(4,730)	BLN1 - 1,250	BLN1 - 1,250		BLN1 - 1,250	BLN1 - 1,250
2023	5,599	1,107	(4,730)	CT - 828				
2024	5,739	1,124	(4,730)	BLN2 - 1,250	BLN2 - 1,250		BLN2 - 1,250	BLN2 - 1,250
2025	5,815	1,133	(4,730)	CT - 828				
2026	5,893	1,142	(4,730)	CT - 828			CT - 828	CT - 621
2027	5,961	1,145	(4,730)	CT - 828				
2028	6,009	1,154	(4,730)	BLN3 - 1,117			CT - 621	CT - 621
2029	6,043	1,157	(4,730)	CT - 828			CT - 621	CT - 621

[1]Peak load impact (MW)
[2]Firm capacity at the summer peak (MW)
[3]Cumulative capacity (MW) of coal units to be idled
[4]Upgrade of Gleason CT plant from 360 to 530 MW

Action Alternative - Strategy R - Recommended Planning Direction

Year	Defined Model Inputs			Capacity Additions by Scenario				
	EEDR[1]	Renew-ables[2]	Coal Idling[3]	SC1	SC2	SC3	SC7	SC8
2010	298	39	-	PPAs & Acquisitions				
2011	389	53	(226)					
2012	770	168	(226)	CC - 880	CC - 880	CC - 880	CC - 880	CC - 880
2013	1,334	309	(935)	WBN2 - 1,180, PPAs	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180	WBN2 - 1,180
2014	1,596	465	(935)	CT - 828				
2015	2,069	538	(4,002)	GL CT - 170[4], CT - 621, CC - 910, PPAs			GL CT - 170, PPAs	GL CT- 170, PPAs
2016	2,537	551	(4,002)	CT - 828			MKT	
2017	2,828	738	(4,002)	MKT			MKT	
2018	3,116	791	(4,002)	BLN1 - 1,250	BLN1 - 1,250		BLN1 - 1,250	
2019	3,395	845	(4,002)	MKT			MKT	MKT
2020	3,627	906	(4,002)	BLN2 - 1,250, PSH - 850	BLN2 - 1,250, PSH - 850	PSH - 850	BLN2 - 1,250, PSH - 850	BLN1 - 1,250, PSH - 850
2021	3,817	919	(4,002)	CC - 910				
2022	3,985	934	(4,002)	CC - 910, MKT				BLN2 - 1,250
2023	4,123	945	(4,002)	CT - 828, MKT			CT - 828	
2024	4,295	958	(4,002)	BLN3 - 1,117				
2025	4,412	965	(4,002)	IGCC - 490, MKT			CT - 621	
2026	4,412	970	(4,002)	BLN4 - 1,117			MKT	CT - 828
2027	4,561	970	(4,002)	CT - 828			CT - 828	MKT
2028	4,602	971	(4,002)	CT - 828			MKT	CT - 828
2029	4,638	977	(4,002)	CT - 828, IGCC - 490	CT - 828		CT - 828	CT - 621

[1]Peak load impact (MW)

[2]Firm capacity at the summer peak (MW)

[3]Cumulative capacity (MW) of coal units to be idled

[4]Upgrade of Gleason CT plant from 360 to 530 MW

Key to the preceding tables:

EEDR - Energy Efficiency and Demand Response, expressed as peak load impact in MW
Renewables - firm capacity at the summer peak in MW
Coal Idled - cumulative value of coal capacity idled in MW.
PPA - power purchase agreement
CC - natural gas-fired combined cycle plant
WBN2 - Watts Bar Nuclear Plant Unit 2
CT - natural gas-fired combustion turbine plant
GL CT - upgrade of the TVA Gleason CT plant from 360 to 530 MW
BLN - Bellefonte Nuclear Plant. BLN1 and BLN2 are partially constructed units, and BLN3 and BLN4 are new units.
PSH - pumped storage hydro plant
IGCC - coal-fueled integrated gasification combined cycle plant with carbon capture and sequestration

The preferred alternative strategy is Strategy R - Recommended Planning Direction. This strategy has the highest total ranking metric score of the four alternative strategies, indicating that it performs well across the range of range of scenarios. It performs best in six of the eight tested scenarios for total plan cost (PVRR) and best in five of the eight scenarios for the risk/benefit ratio metric. Based on the strategic metrics, it is the second best performing strategy, behind Strategy E. This is primarily due to the differences in the environmental stewardship metrics; the differences in the economic impact metrics among the four strategies are negligible. Across the full range of environmental resources, Strategy E would result in the lowest level of potential environmental impacts, followed by Strategies R, C, and B.

AFFECTED ENVIRONMENT

The primary study area, hereinafter called the TVA region, is the combined TVA power service area and the Tennessee River watershed. This area comprises 202 counties and approximately 59 million acres. In addition to the Tennessee River watershed, it covers parts of the Cumberland, Mississippi, Green, and Ohio Rivers where TVA power plants are located. For some resources such as air quality and climate change, the assessment area extends beyond the TVA region. For some socioeconomic resources, the study area consists of the 170 counties where TVA is a major provider of electric power and Muhlenberg County, Kentucky, where the TVA Paradise Fossil Plant is located.

Climate and Greenhouse Gas Emissions - The TVA region has a generally mild climate. Both annual average temperature and precipitation vary from year to year and neither shows significant long-term increasing or decreasing trends. Wind speeds are generally light with higher speeds in winter and spring and lower speeds in summer and fall. Across the TVA region, the potential for wind generation is likely to be no more than about 1,300 MW of capacity and 3,400 gigawatt-hours (GWh) of annual generation. The potential for solar photovoltaic generation is moderate relative to the rest of the U.S.

In 2008, direct CO_2 emissions from the generation of power marketed by TVA (from both TVA-owned facilities and facilities owned by others) totaled approximately 99.9 million metric tons. The CO_2 emission rate (expressed in terms of tons emitted per GWh) in recent years has been around 690 tons/GWh, somewhat below the average for large electrical utilities in the central and eastern United States.

Air Quality - Air quality in the TVA region is generally good and has steadily improved over the last 30 years. There are currently no areas in the TVA region (non-attainment areas) that do not meet air quality standards for carbon monoxide, lead, nitrogen dioxide, sulfur dioxide (SO_2), ozone, and larger particulate matter (PM_{10}). A few counties in the eastern half of the region are designated as non-attainment for fine particulate matter ($PM_{2.5}$). Portions of the TVA region are expected to be designated as non-attainment for a recent, more stringent SO_2 standard and for ozone after an anticipated more stringent ozone standard is implemented.

The burning of coal is a major source of SO_2 emissions, a contributor to acid deposition, regional haze, and fine particulate concentrations. TVA has equipped about half of its coal-fired generating capacity with scrubbers to control SO_2 emissions and burns low-sulfur coal at its other coal units. These measures have resulted in an 85 percent decrease in TVA's SO2 emissions since 1974 and further reductions are anticipated. These measures have been a major factor in the 63 percent reduction in SO_2 concentrations in the TVA region since 1979. Nitrogen oxides (NOx) are a highly reactive group of gases that include nitrogen dioxide and contribute to ozone, fine particulates, regional haze, acid deposition, and nitrogen saturation. TVA has reduced its NOx emissions by 68 percent since 1993 and currently emits 11 percent of man-made regional NOx emissions. Regional nitrogen dioxide concentrations have declined by 41 percent since 1979 and by 54 percent since peaking in 1988. Regional ozone concentrations vary greatly from year to year due to meteorological conditions and have decreased by 11 percent since 1978. The reductions in air pollutants from TVA facilities have contributed to regional improvements in visibility.

Water Resources - Power generation affects water resources by discharging treated liquid wastes, by using water directly to generate electricity in hydroelectric plants, and by using water to produce steam and cool plants. Water quality across the TVA region is generally good. TVA's coal-fired and most nuclear plants predominantly operate with open-cycle cooling, where large volumes of water are withdrawn from a river or reservoir, circulated through the plant, and discharged back to the river or reservoir. The combined-cycle plants and Watts Bar Nuclear Plants use closed-cycle cooling, where a smaller quantity of cooling water is withdrawn and evaporated in cooling towers. Water sources for the combined-cycle plants include groundwater, surface waters, and reclaimed wastewater.

Land Resources - The TVA region encompasses nine ecoregions and its land resources are diverse. They include large numbers of plant communities, diverse wildlife populations, and a variety of endangered and threatened species. The TVA power system affects land resources through site selection for power plants, transmission lines, fuel procurement, air emissions, radioactive waste management and solid waste management. TVA's existing power plant reservations, excluding the hydroelectric plants associated with multi-purpose reservoirs, occupy about 24,000 acres. The actual area disturbed by facility construction and operation totals about 17,400 acres.

Wastes - In recent years the TVA coal plants have produced about 3.9 million tons of ash and slag and about 2.4 million tons of scrubber waste per year. About 40 percent of these coal combustion wastes are marketed for beneficial use. The remainder is stored at or near the plant sites. TVA uses both dry and wet storage for these wastes and is in the process of converting to only dry storage. The TVA nuclear plants produce a total of about 650 tons of high-level radioactive waste and about 614 tons of low-level radioactive waste per year. The high-level waste, almost all spent fuel, is stored on the plant sites. The low-level waste is either shipped to an off-site processor or stored at the Sequoyah site, depending on the type of waste.

ANTICIPATED ENVIRONMENTAL IMPACTS

The environmental impacts of the resource option vary depending on the type of option. EEDR measures may result in the production of some solid waste but reduce the air emissions and other impacts associated with generating electricity. Among the various types of generating facilities, coal-fired plants have the greatest environmental impacts. A major cause of these impacts is the emission of air pollutants; TVA has substantially reduced these impacts over the years and will continue to further reduce them.

Air Quality - All four alternative strategies will result in significant long-term reductions in total emissions of SO_2, NOx, and mercury. The trends in emissions of these air pollutants are similar with decreases of about 60 percent between 2010 and 2015. Factors contributing to these decreases include the continued installation of emission controls necessary to comply with the Clean Air Act, including the anticipated requirements for use of maximum achievable control technology to reduce emissions of hazardous air pollutants, and reduced coal-fired generation due to the coal capacity idled and the increase in nuclear and natural gas generation. The decreases in emissions are greatest under Strategy E and least under Strategy B. Under all of these alternative strategies, there will likely be a substantial beneficial cumulative impact on regional air quality.

Greenhouse Gas Emissions and Climate Change - Total direct CO_2 emissions under the alternative strategies are highest under Strategy B and lowest under Strategy E. Compared to TVA's recent annual average direct CO_2 emissions of around 100 million tons, all of the strategies result in a decrease in CO_2 emissions. For most scenarios other than Scenario 1, and especially under strategies C, E, and R, the decrease is marked and significant. The CO_2 intensity of TVA's power generation, around 700 tons/GWh in recent years, significantly decreases under all of the alternative strategies. For both total direct CO_2 emissions and CO_2 intensity, the reductions are greatest under Strategy E and least under Strategy B.

The long-term increase in temperature forecast for the TVA region by many climate researchers would likely increase the overall demand for electricity. It would also increase the temperature of surface waters used for cooling fossil and nuclear plants. This can reduce the efficiency of the generating plants and may require reductions in power generation or increased use of cooling towers (if available) to remain in compliance with permit requirements. The installation of increased cooling capacity at coal and nuclear plants may be necessary in the future.

Water Resources - Potential impacts to water quality, with the exception of thermal discharges, are generally greater from coal-fired generation than from other types of generation due to the various liquid waste streams from coal-fired plants and the potentially adverse water quality impacts from coal mining and processing. The overall potential for water quality impacts would decrease under all alternative scenarios, with the greatest decrease under Strategy E. Under all alternative strategies, TVA would continue to meet water quality standards through compliance with National Pollutant Discharge Elimination System permit requirements.

All of the alternative scenarios would increase both the volume of water used and the volume of water consumed (evaporated) for cooling generating plants. The increases in water use are relatively small. In contrast, the increases in water consumption are large (up to 560 percent) because all future plants requiring cooling water are anticipated to use closed-cycle cooling. TVA would carefully assess the potential impacts of water use and water consumption during the planning process for any new generating facility.

Fuel Consumption - The major fuels used for generating electricity would continue to be coal, enriched uranium, and natural gas in all of the alternative strategies. The proportion of generation from coal, as well as the quantity of coal consumed, declines in the future as coal units are idled and, except for an advanced coal plant proposed under the highest growth scenarios in Strategies B, C, and R, no additional coal plants would be built. The consumption of nuclear fuel increases with the startup of Watts Bar Nuclear Plant Unit 2 in 2013 under all of the alternative strategies and continues to increase with up to four additional nuclear units are added under Scenarios 1, 2, 7, and 8. Natural gas consumption increases under all of the alternative strategies. Under all strategies, it remains fairly constant for Scenario 3, and increases by about 50 percent for Scenarios 2 and 7. The increase in gas consumption for Scenario 1, which has the highest electrical demand, ranges from about 270 percent under Strategy B to 350 percent under Strategy E. Overall natural gas consumption is greatest under Strategy E and least under Strategy C. Much of the increase is anticipated to provide intermediate generation and will likely displace some coal-fired generation. The consumption of biomass fuels increases under all alternative strategies and is greatest under Strategy E, which has the most biomass-fueled generation. Accurately forecasting this increase in the quantity of biomass fuels is difficult without knowing the types of biomass fuels and the types of new dedicated biomass generating facilities deployed during the planning period. All of the fuel life-cycles have associated environmental impacts that are probably greatest for coal-fired plants.

Solid Waste - The largest amounts of solid waste produced by the alternative strategies are coal ash and scrubber waste. The production of ash decreases under the alternative strategies by about 19 to 42 percent as a result of the coal capacity idled. The production of scrubber sludge increases from an average of about 30 percent for the Strategy E scenarios to about 58 percent for the Strategy B scenarios. The increases are due to the continued operation of coal plants that are presently equipped with scrubbers and the anticipated installation of scrubbers on unscrubbed plants that continue operating. The trends in production of high- and low-level radioactive waste are similar to the trends in the use of nuclear fuel described above. TVA would continue to store high-level waste (predominantly spent fuel) at the nuclear plants until a long-term disposal facility is operating.

Land Resources - The potential for a facility to impact vegetation, wildlife, endangered and threatened species, historic properties, and other land resources increases as the facility's land requirements increase. The alternative strategies require between about 4,530 and 8,130 acres for new generating facilities. These land requirements only include those for the generating facility footprints and associated access roads. Wind and ground-mounted solar photovoltaic generation plants have large facility land requirements relative to the amount of energy generated. With its large amount of renewable generation, Strategy E has the largest facility land requirements and Strategy B, with the least amount of renewable generation, has the lowest land requirements. Life-cycle land requirements, which include the fuel cycle as well as lands affected by a facility - but not necessarily physically altered, such as the area surrounding wind turbines - are also greatest for

Strategy E and least for Strategy B. Because of the present uncertainty over long-term disposition of spent nuclear fuel, it was not included in the comparison of life-cycle land requirements. Had it been included, nuclear life-cycle land requirements would have increased.

Socioeconomics - Socioeconomic impacts were analyzed by comparing the changes in forecast total employment and personal income of the alternative strategies to those of the baseline plan. The changes are all small and mostly beneficial. Strategies C, E, and R had somewhat greater beneficial impacts than Strategy B.