3

Portfolios

Highlights

- P3 Base, the Core Portfolio under Pathway 3, is the Companies' recommended portfolio for the Carolinas Resource Plan and informs the Execution Plan detailed in Chapter 4 (Execution Plan).
- P2 Base, the Core Portfolio under Pathway 2, requires 1,600 megawatts of offshore wind by 2033 and is projected to cost nearly $5 billion more than P3 Base. However, several Pathway 3 portfolios show value in offshore wind by the mid-to-late 2030s assuming high load growth or limited availability of other resource types, and nearly all include offshore wind by 2050.
- Significant increases to projected Carolinas' load growth from prior planning cycles, coupled with industry supply-chain constraints, labor shortages and other market headwinds make the resource additions required to support Pathway 1 unattainable.
- While the pace and scale of resource additions vary to some degree in the near-term, all Energy Transition Pathways and portfolios demonstrate the need for a significant addition of diverse resources to replace retiring coal assets and meet the needs of a rapidly growing economy in the Carolinas while maintaining or improving reliability and meeting customer expectations for increasingly clean energy.

This Chapter provides details on portfolio composition (resource decisions) and comparative evaluations across pathways and portfolios for Duke Energy Progress, LLC's ("DEP") and Duke Energy Carolinas, LLC's ("DEC" and, together with DEP, the "Companies") Carolinas Resource Plan (the "Plan" or "the Resource Plan"). As described in Chapter 2 (Methodology and Key Assumptions), the Companies have developed three Core Portfolios under three Energy Transition Pathways. Each Pathway, designed to prudently retire and replace 8,400 megawatts ("MW") of coal-fired generating capacity, often repurposing the existing site, with equally reliable resources to meet growing system needs, represents a different approach to the pace of the energy transition, one illustrating the extraordinary pace of resource additions needed to achieve a 70% reduction in carbon dioxide ("CO_2") emissions from 2005 levels ("Interim Target") by 2030, another by 2033 by leveraging offshore wind, and the third by 2035 when the first advanced nuclear units become commercially available. All three Pathways and their Core Portfolios (P1 Base, P2 Base and P3 Base) keep the Companies on the longer-term path to achieving carbon neutrality by 2050.

The second half of this Chapter is devoted to an evaluation of the Core Portfolios against the Companies' resource planning objectives for an orderly energy transition — maintain or improve reliability, compliance with laws and regulations, least cost planning and affordability, increasingly clean resource mix, resource diversity, accounting for executability and foreseeable conditions. This analysis is also informed by the results of the 13 Portfolio Variants and 10 Sensitivity Analysis Portfolios. It should be noted that the assumptions underlying all portfolios are founded on an expectation of constructive and timely regulatory outcomes (federal and state), supportive policies, and efficient siting and permitting processes and timely approvals during execution to enable the scope and scale of energy transition across the range of projections represented in the Plan. Additional detail regarding portfolio analytics and evaluation, including utility-specific detail, is presented in Appendix C (Quantitative Analysis).

Carolinas Resource Plan Pathways and Core Portfolios

As described in Chapter 2, the Companies identified three Energy Transition Pathways to inform the pace and execution approach to meeting projected load growth in the Carolinas. These Pathways demonstrate the need for a wide range of resource types including fuel-free renewables, advanced nuclear, energy storage, and hydrogen capable natural gas units to reliably meet growing customer needs while prudently retiring coal and advancing a system energy transition toward carbon neutrality by 2050.

The Companies developed three Core Portfolios (P1-P3) based on differences in availability (timing and quantity) of solar and battery storage, onshore wind, offshore wind, advanced nuclear, new pumped storage hydro and efficient hydrogen-capable natural gas resources. While specific variations in individual technology adoption rates and volumes between the Core Portfolios are discussed below, the overall need for a diverse mix of resources is consistent across the portfolios. Each resource type has unique operational characteristics, cost projections, supply-chain dependencies, geographic limitations and requirements, along with associated transmission and distribution grid dependencies. These differences result in relative benefits and risks that are unique to each resource type as discussed throughout the Carolinas Resource Plan and detailed in the various appendices of the Plan. Consideration of these individual benefits and risks for each resource type demonstrates that a prudent and orderly transition of the Carolinas' energy system will require a balanced approach across a number of different demand-side programs and supply-side resources as outlined in the subsequent portfolio discussion. The Companies' Pathways and Core Portfolios utilize least-cost planning to develop an all of the above energy transition strategy that maintains or improves system reliability, prudently manages risks and uncertainties, and ensures the Companies can meet the rapidly growing energy needs in the Carolinas. The results of this Core Portfolio modeling process are presented in Figure 3-1 below, illustrating model-selected resource additions through 2030, 2033, 2035 and 2038.

Figure 3-1: Incremental Resource Additions for Core Portfolios by 2030, 2033, 2035 and 2038

<table>
<tr><th>By January 1 2030</th><th>Grid Edge</th><th>Coal Retirements</th><th>Solar</th><th>Battery</th><th>CT</th><th>CC</th><th>Onshore Wind</th><th>Pumped Storage Hydro</th><th>Advanced Nuclear</th><th>Offshore Wind</th></tr>
<tr><td>P1 Base</td><td>EE at least 1% of eligible retail sales</td><td>(-7.1 GW)</td><td>6.6 GW</td><td>5.1 GW</td><td>1.7 GW</td><td>2.7 GW</td><td>0.3 GW</td><td></td><td></td><td>1.6 GW</td></tr>
<tr><td>P2 Base</td><td>IVVC growing to 96% (DEC) & 97% (DEP) circuits</td><td rowspan="2">(-2.2 GW)</td><td rowspan="2">4.1 GW</td><td>0.9 GW</td><td rowspan="2">2.1 GW</td><td rowspan="2">1.4 GW</td><td></td><td></td><td></td><td></td></tr>
<tr><td>P3 Base</td><td>Winter DR & CPP</td><td>0.7 GW</td><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>By January 1 2033</th><th>Grid Edge</th><th>Coal Retirements</th><th>Solar</th><th>Battery</th><th>CT</th><th>CC</th><th>Onshore Wind</th><th>Pumped Storage Hydro</th><th>Advanced Nuclear</th><th>Offshore Wind</th></tr>
<tr><td>P1 Base</td><td>EE at least 1% of eligible retail sales</td><td>(-7.1 GW)</td><td>13.4 GW</td><td rowspan="2">6.1 GW</td><td>2.6 GW</td><td>2.7 GW</td><td>1.5 GW</td><td></td><td></td><td>2.4 GW</td></tr>
<tr><td>P2 Base</td><td>IVVC growing to 96% (DEC) & 97% (DEP) circuits</td><td>(-6.2 GW)</td><td rowspan="2">8.8 GW</td><td rowspan="2">2.1 GW</td><td rowspan="2">4.1 GW</td><td rowspan="2">1.2 GW</td><td></td><td></td><td>1.6 GW</td></tr>
<tr><td>P3 Base</td><td>Winter DR & CPP</td><td>(-4.8 GW)</td><td>3.4 GW</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>By January 1 2035</th><th>Grid Edge</th><th>Coal Retirements</th><th>Solar</th><th>Battery</th><th>CT</th><th>CC</th><th>Onshore Wind</th><th>Pumped Storage Hydro</th><th>Advanced Nuclear</th><th>Offshore Wind</th></tr>
<tr><td>P1 Base</td><td>EE at least 1% of eligible retail sales</td><td>(-8.4 GW)</td><td>14.9 GW</td><td>6.1 GW</td><td>2.6 GW</td><td>2.7 GW</td><td>2.3 GW</td><td rowspan="3">1.7 GW</td><td rowspan="3">0.6 GW</td><td>2.4 GW</td></tr>
<tr><td>P2 Base</td><td>IVVC growing to 96% (DEC) & 97% (DEP) circuits</td><td rowspan="2">(-6.2 GW)</td><td>11.8 GW</td><td>6.7 GW</td><td rowspan="2">2.1 GW</td><td rowspan="2">4.1 GW</td><td>1.7 GW</td><td>1.6 GW</td></tr>
<tr><td>P3 Base</td><td>Winter DR & CPP</td><td>11.9 GW</td><td>4.3 GW</td><td>2.1 GW</td><td>0-1.6 GW</td></tr>
</table>

<table>
<tr><th>By January 1 2038</th><th>Grid Edge</th><th>Coal Retirements</th><th>Solar</th><th>Battery</th><th>CT</th><th>CC</th><th>Onshore Wind</th><th>Pumped Storage Hydro</th><th>Advanced Nuclear</th><th>Offshore Wind</th></tr>
<tr><td>P1 Base</td><td>EE at least 1% of eligible retail sales</td><td rowspan="3">(-8.4 GW)</td><td>15.8 GW</td><td>6.1 GW</td><td>2.6 GW</td><td>2.7 GW</td><td>2.3 GW</td><td rowspan="3">1.7 GW</td><td>3.0 GW</td><td>2.4 GW</td></tr>
<tr><td>P2 Base</td><td>IVVC growing to 96% (DEC) & 97% (DEP) circuits</td><td>14.1 GW</td><td>7.0 GW</td><td>2.1 GW</td><td rowspan="2">4.1 GW</td><td>2.1 GW</td><td rowspan="2">2.4 GW</td><td>1.6 GW</td></tr>
<tr><td>P3 Base</td><td>Winter DR & CPP</td><td>14.6 GW</td><td>6.0 GW</td><td>3.0 GW</td><td>2.3 GW</td><td>0-1.6 GW</td></tr>
</table>

Note 1 : Coal retirements are dependent on addition of resources shown. Note 2 : New Solar includes solar plus storage, excludes projects currently in advanced development. Note 3 : IVVC = Integrated Volt/VAR Control. Note 4 : CPP = Critical Peak Pricing. Note 5 : Battery includes batteries paired with solar. Note 6 : Offshore wind was not selected in P3 Base in the Base Planning Period; however, it may be an option depending on resource need and market conditions. Note 7 : Bad Creek II Pumped Storage Hydro is projected to come into service by mid-2033; for planning purposes, the modeling reflects this resource coming into all resource portfolios at beginning of year 2034.

Coal Unit Retirement Dates

Chapter 2 summarizes the coal unit retirement analysis methodology used in the Carolinas Resource Plan analysis, and Appendix F (Coal Retirement Analysis) provides additional detail. Table 3-5 below summarizes the results of that analysis by Pathway. The portfolio-specific results summaries following this section also include coal retirement results for each Core Portfolio individually. Coal retirement dates are the same for all portfolios under a single Pathway.

The results are similar across the three Pathways, and in all Pathways the Companies would cease burning coal by the end of 2035, retiring over 8,400 MW of coal capacity, representing approximately 20% of the winter capacity requirement for the combined system. Cliffside 6 would continue to run on 100% natural gas beyond 2035 and the Companies will evaluate opportunities to repurpose other former coal sites to host new generation and energy storage resources. Importantly, to ensure system reliability, coal retirements are dependent on an equivalent amount of equally reliable, replacement resources being placed into service. As a result, changes or delays to replacement generation in-service dates would affect the retirement dates shown in Table 3-1 below.

Table 3-1: Coal Unit Retirements (effective by January 1 of year shown)

Unit	Utility	Winter Capacity (MW)	Effective Year by Pathway (Jan 1)		
			Pathway 1	Pathway 2	Pathway 3
Allen 1[1]	DEC	167	2025	2025	2025
Allen 5[1]	DEC	259	2025	2025	2025
Belews Creek 1	DEC	1,110	2030	2036	2036
Belews Creek 2	DEC	1,110	2030	2036	2036
Cliffside 5	DEC	546	2029	2031	2031
Cliffside 6[2]	DEC	849	2049	2049	2049
Marshall 1	DEC	380	2029	2029	2029
Marshall 2	DEC	380	2029	2029	2029
Marshall 3	DEC	658	2034	2032	2032
Marshall 4	DEC	660	2034	2032	2032
Mayo 1	DEP	713	2029	2031	2031
Roxboro 1	DEP	380	2029	2029	2029
Roxboro 2	DEP	673	2029	2029	2029
Roxboro 3	DEP	698	2030	2033	2034
Roxboro 4	DEP	711	2030	2033	2034

Note 1: Allen Units 1 & 5 are planned to retire by December 31, 2024. Retirements were not included in the Coal Retirement Analysis due to near-term planned retirement dates.
Note 2: Cliffside 6 is assumed to continue operating on 100% on natural gas beyond 2035 and was not included in the coal retirement analysis for the Carolinas Resource Plan.

Results Summary

The Companies developed the Carolinas Resource Plan portfolios by first assuming aggressive development of Grid Edge resources in all portfolios to "shrink the challenge" and then optimizing supply-side resource additions to reliably serve growing load and replace retiring coal generation with a diverse mix of increasingly clean resources. Notably, given the increase in projected customer demand for energy, all portfolios show an increase in overall resource needs relative to prior resource plans. Furthermore, the resource mixes for the three Core Portfolios, in terms of both capacity and energy, largely converge by 2050. That convergence begins for the combined Carolinas system by the end of the 15-year Base Planning Period in 2038 as illustrated in Figure 3-2 through Table 3-3 below. Importantly, however, each Pathway requires a different pace, scope, and scale of near-term development activities across varying technologies to achieve the Interim Target. For example, Pathway 1 requires an average of 2,200 MW of solar to be placed in service each year from 2027 to 2029 and 1,600 MW of offshore wind by the beginning of 2030, while Pathway 2 requires completion of a more feasible 1,350 MW of solar per year from 2027 to 2029 and requires 1,600 MW of offshore wind by 2033, which would necessitate commitment in the near-term. Offshore wind remains an important option for Pathway 3 in the mid-2030s, but the more measured pace of transition allows additional time to check and adjust the Plan with respect to this major investment.

Figure 3-2: Modeled Energy Mix by Core Portfolio, Combined Carolinas System

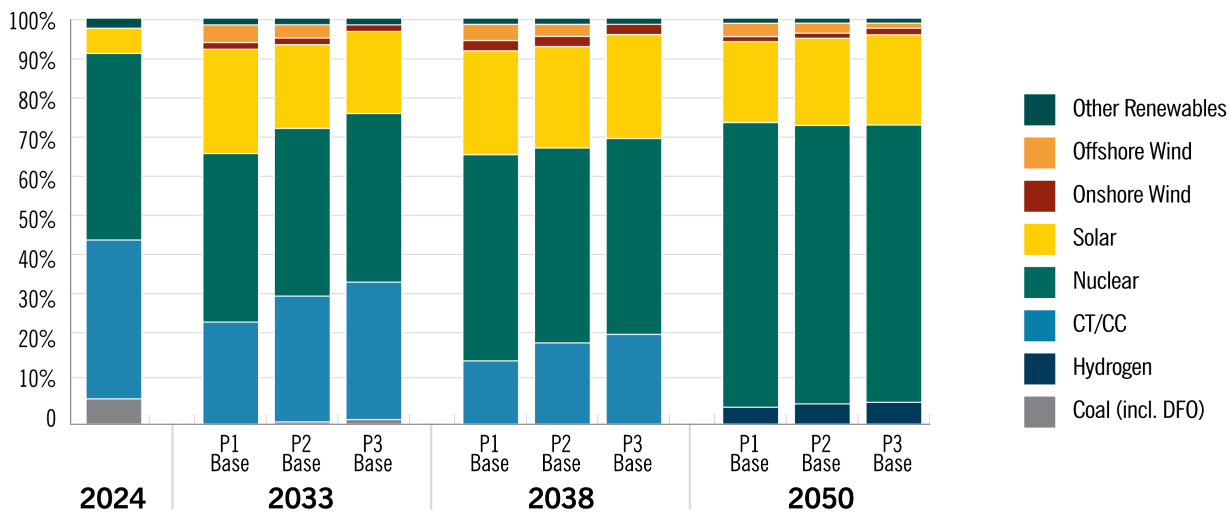


Table 3-2: Modeled Energy Mix by Core Portfolio, Combined Carolinas System

Resource Type	2024	2033			2038			2050		
		P1 Base	P2 Base	P3 Base	P1 Base	P2 Base	P3 Base	P1 Base	P2 Base	P3 Base
Grid Edge	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Renewables	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Offshore Wind	0%	5%	3%	0%	4%	3%	0%	3%	2%	1%
Onshore Wind	0%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Solar	6%	26%	21%	20%	26%	25%	25%	20%	21%	22%
Nuclear	46%	41%	41%	41%	51%	48%	48%	70%	68%	68%
Gas	39%	25%	31%	34%	16%	20%	22%	0%	0%	0%
Hydrogen	0%	0%	0%	0%	0%	0%	0%	4%	5%	5%
Coal	6%	0%	0%	1%	0%	0%	0%	0%	0%	0%

Note: Columns may not sum to 100% due to rounding.

Figure 3-3: Nameplate Capacity Mix by Core Portfolio, Combined Carolinas System (beginning-of-year basis)

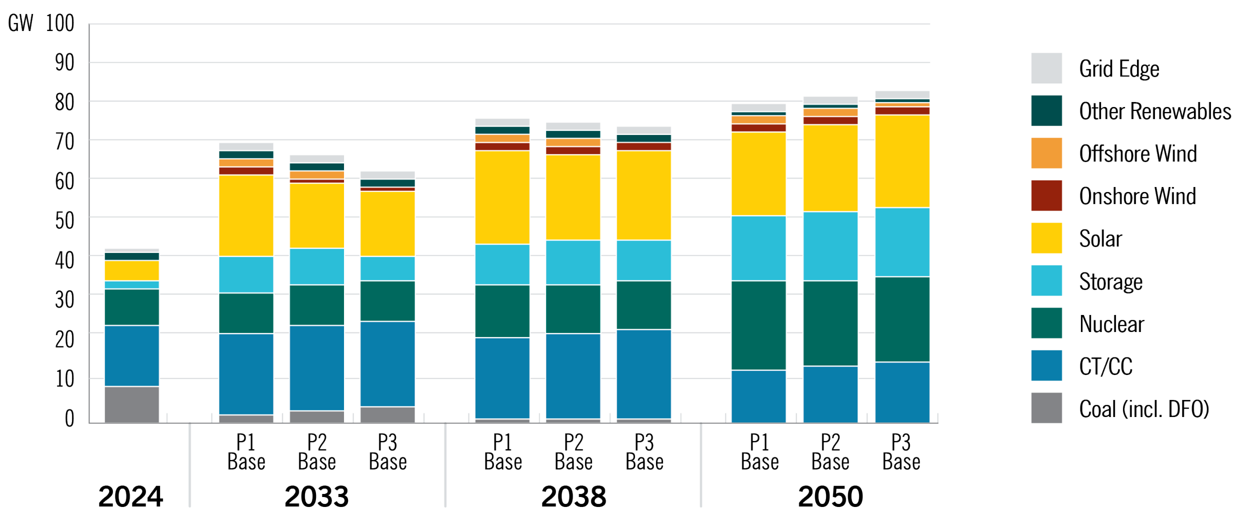


Table 3-3: Nameplate Capacity Mix by Core Portfolio, Combined Carolinas System (percentages, beginning-of-year basis)

Resource Type	2024	2033			2038			2050		
		P1 Base	P2 Base	P3 Base	P1 Base	P2 Base	P3 Base	P1 Base	P2 Base	P3 Base
Grid Edge	2%	2%	3%	3%	2%	2%	2%	2%	2%	2%
Other Ren.	4%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Off. Wind	0%	4%	2%	0%	3%	2%	0%	3%	2%	1%
On. Wind	0%	2%	2%	2%	3%	3%	3%	3%	3%	3%
Solar	11%	30%	25%	26%	30%	29%	30%	26%	26%	28%
Storage	6%	13%	14%	10%	14%	15%	14%	20%	21%	20%
Nuclear	22%	14%	15%	16%	17%	16%	17%	27%	26%	26%
CC / CT	34%	29%	33%	34%	27%	29%	30%	16%	18%	18%
Coal (incl. DFO)	21%	3%	5%	7%	1%	1%	1%	0%	0%	0%

Note: Columns may not sum to 100% due to rounding.
Note: Dual fuel optionality ("DFO")

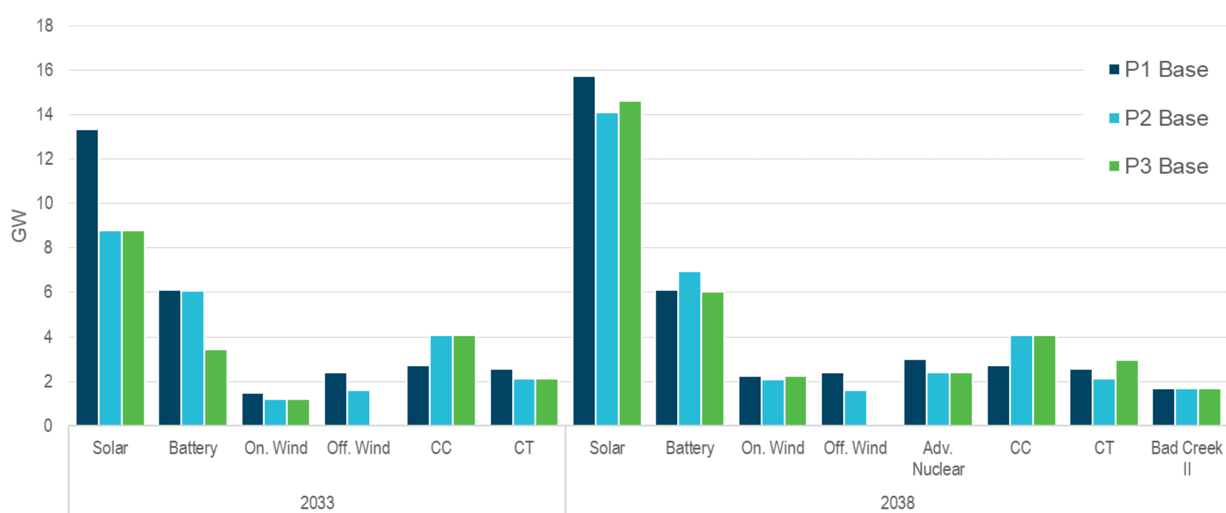
As indicated above, all Core Portfolios begin to converge by the end of the Base Planning Period and result in very similar energy and capacity mixes over the long-term. By 2050, all portfolios call for substantial additions of solar, both stand-alone and paired with energy storage (20,600 MW to 22,800 MW total installed, representing nearly 30% of system nameplate capacity in P3 Base), as well as the introduction of wind energy into the Carolinas energy mix, along with significant amounts of both battery energy storage and pumped storage hydro to help meet customer peak demand needs while also managing energy variability by aligning generation with load.

In addition to significantly expanding renewable capacity, all portfolios also continue to rely heavily on nuclear energy as well as other baseload and dispatchable resources to provide capacity and to ensure power supply reliability for customers every hour of every day, through all types of weather. Although advanced nuclear makes up a relatively small portion of the incremental capacity additions prior to 2038, nuclear is fundamental to the energy transition and over two-thirds of the Companies' energy mix and over a quarter of the capacity mix by 2050 is obtained from nuclear resources in all Core Portfolios. Hydrogen-capable combustion turbines ("CT") and combined cycle ("CC") generators also remain key parts of the Companies' dispatchable, load-following fleets; however, their operations will shift over time. CCs in particular will run fewer hours over time but will continue to provide increasingly important system flexibility and critical reliability services to meet customers' needs into the future and under all weather conditions. This change in operations is particularly important as remaining coal units are retired and the system becomes increasingly dependent on intermittent renewable resources and limited-duration storage technologies. Finally, the limited number of CTs and CCs added in the portfolios will have the ability to blend carbon-free hydrogen as a fuel source as that fuel becomes commercially available with a full transition to hydrogen by 2050.

Despite differing paces of resource additions in the late 2020s and early 2030s, the convergence that results in such similar resource mixes by 2050 is observable across all Core Portfolios by 2038. By the end of 2035, coal fuel is entirely phased out with the modeled retirement of Belews Creek and transition of Cliffside 6 to 100% natural gas. Vital additional long-duration energy storage capacity is online by that time following completion of the second powerhouse at the Bad Creek pumped storage hydro facility.

In summary, the primary factor differentiating the Energy Transition Pathways is the pace of energy transition and timing, scope and scale of new resource additions. The pace at which the transition is pursued directly affects the required resource additions, the cost of transition and the reliability challenges associated with operational integration of substantial levels of variable energy and energy-limited resources. The aggressiveness of the timetable is also closely linked to the likelihood that a plan can be executed by the target date at costs consistent with plan modeling assumptions. Figure 3-4 below depicts supply-side resource additions required under each portfolio by 2033 and by 2038, illustrating the differences in resource additions over the Base Planning Period.

Figure 3-4: Nameplate Model-Selected Supply-Side Resource Additions by Technology and Core Portfolio by 2033 and 2038, Combined Carolinas System (GW, beginning-of-year basis)



Planning Across Energy Transition Pathways

As described in Chapter 2, the Companies framed the Carolinas Resource Plan around the analysis of three Energy Transition Pathways that maintain or improve system reliability, prudently manage risks and uncertainties, and ensure the Companies can meet the energy needs of customers while evaluating different paces for the continuing energy transition to achieve carbon neutrality. This section presents a summary of the results of that analysis.

Energy Transition Pathway 1 is modeled to reach the Interim Target by 2030 and carbon neutrality by 2050. However, reaching the Interim Target by 2030 is not possible using the Companies' already aggressive base case assumptions for new resource availability as discussed in Chapter 2. To enable the capacity expansion model to solve, the Companies found it necessary to substantially increase assumed resource availability for modeling purposes, as explained in Chapter 2 and detailed in Appendix C. For this reason, analytical results for the Pathway 1 portfolios show new resources added to the Companies' electric systems at a rate that considerably exceeds Duke Energy's expectations for what will be available and possible to connect without jeopardizing system reliability. By the beginning of 2030, P1 Base includes approximately 9,600 MW of solar (including approximately 3,000 MW currently in advanced development), 1,600 MW of offshore wind, two advanced-class, hydrogen capable combined-cycle generators, and over 5,000 MW of battery energy storage. Because Pathway 1 requires resource additions in excess of even the Companies' "high resource availability" case, the Companies did not evaluate Portfolios Variants on resource availability or gas supply for Pathway 1.

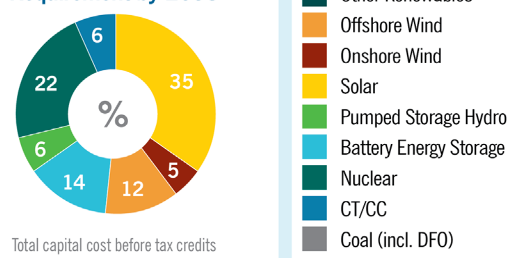
As a part of Energy Transition Pathway 1, the Companies also evaluated the potential conversion of Belews Creek units to 100% operation on natural gas. This Portfolio Variant assumes Belews Creek is converted to operate exclusively on natural gas beginning in 2030 to help meet the Interim Target and extending the life of the asset through 2040 as a bridge to a time when the Companies could bring fully hydrogen-fired CT or CC generating units online. This would be an alternative to investing in new natural gas generating units now and then later incurring costs to convert those units to a zero-carbon fuel source. Ultimately, the assumed conversion did not improve overall portfolio economics and the Companies determined that the project is not cost justified as further discussed in Appendix C. Figure 3-5 below presents a summary of Core Portfolio P1 Base, including projected total cost in Present Value Revenue Requirements ("PVRR") through 2038 and 2050 as well as estimated bill impacts in 2033 and 2038 — a breakdown of the total capital that would be required to execute Portfolio P1 Base in the Base Planning Period by resource type, views of the changing capacity and energy mix modeled under this Pathway, as well as coal retirements by year.

Figure 3-5: P1 Base Summary

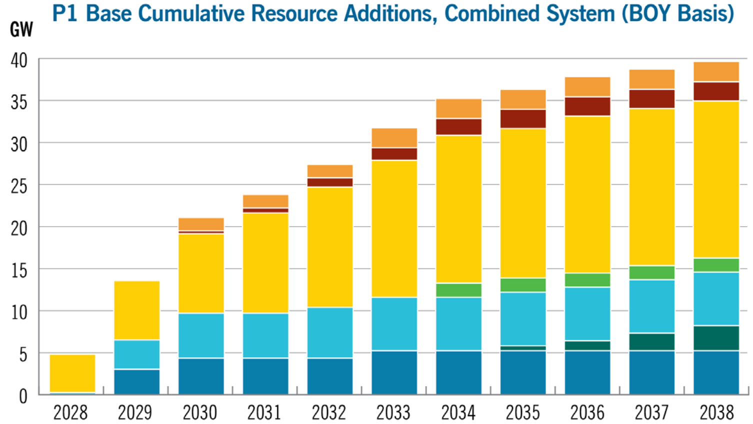
P1 Base Summary

P1 Base		2038	2050
PVRR ($B)	Combined System	$76	$139
	DEP PVRR	$34	$62
	DEC PVRR	$42	$77
		2033	2038
BILL IMPACT	Combined System CAGR	4.5%	3.2%
	DEP CAGR	5.6%	3.2%
	DEC CAGR	3.3%	3.2%
	Year in which 70% target is met	2030	

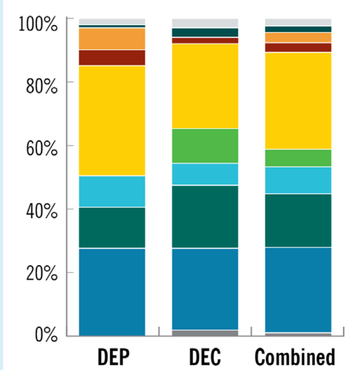
Percentage of Total Capital Requirement by 2038



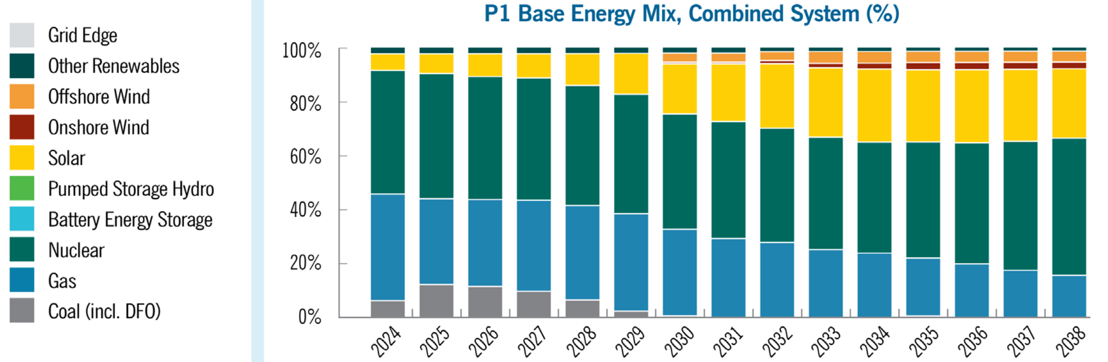
P1 Base Cumulative Resource Additions, Combined System (BOY Basis)



P1 Base Capacity Mix, BOY 2038 (%)



P1 Base Energy Mix, Combined System (%)



P1 Coal Retirements by Year (MW, effective by January 1 of year shown)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
DEP						1,766	1,409						
DEC		426*				1,306	2,220				1,318		
TOTAL		**426***				**3,072**	**3,629**				**1,318**		

*Allen Units 1 & 5 are planned to retire by December 31, 2024.

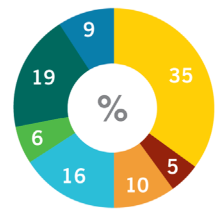
Energy Transition Pathway 2 is modeled to reach the Interim Target by 2033 and carbon neutrality by 2050. Achievement of the Interim Target along this Pathway is enabled by model selection of offshore wind as soon as it is reasonably available. All Pathway 2 portfolios require 800 MW of offshore wind by the beginning of 2032 and another 800 MW by the beginning of 2033, for a total of 1,600 MW by 2033. In addition to offshore wind, achieving the Interim Target by 2033 requires solar and onshore wind additions at or near (in the case of solar) the limits of what the Companies' estimate could be available in every year until 2033. All Pathway 2 portfolios also include three new advanced-class, hydrogen-capable CCs by 2032 and at least seven small modular reactors ("SMR") by 2038, the end of the Base Planning Period. Figure 3-6 below provides a summary of P2 Base as the Core Portfolio for Pathway 2.

Figure 3-6: P2 Base Summary

P2 Base Summary

P2 Base		2038	2050
PVRR ($B)	Combined System	$69	$124
	DEP PVRR	$28	$53
	DEC PVRR	$40	$71
		2033	2038
BILL IMPACT	Combined System CAGR	3.7%	2.7%
	DEP CAGR	4.9%	2.7%
	DEC CAGR	2.6%	2.6%
	Year in which 70% target is met	2033	

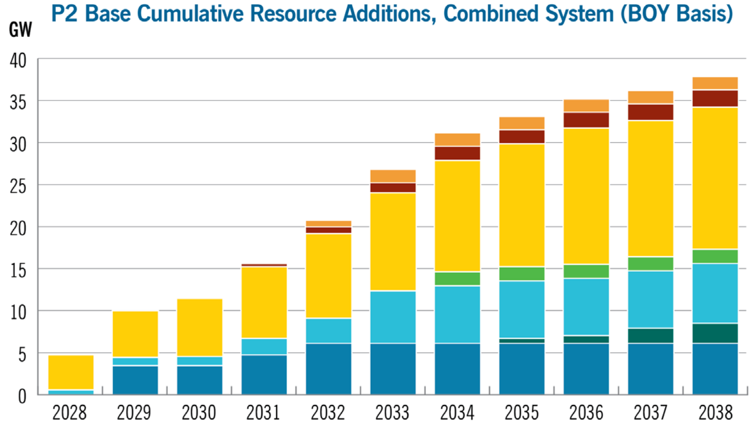
Percentage of Total Capital Requirement by 2038



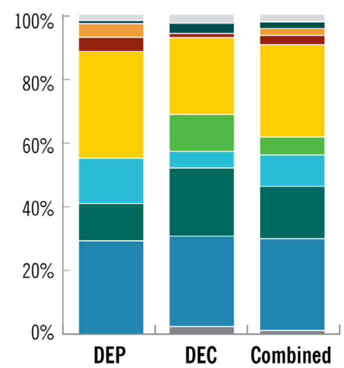
Total capital cost before tax credits

- Grid Edge
- Other Renewables
- Offshore Wind
- Onshore Wind
- Solar
- Pumped Storage Hydro
- Battery Energy Storage
- Nuclear
- CT/CC
- Coal (incl. DFO)

P2 Base Cumulative Resource Additions, Combined System (BOY Basis)

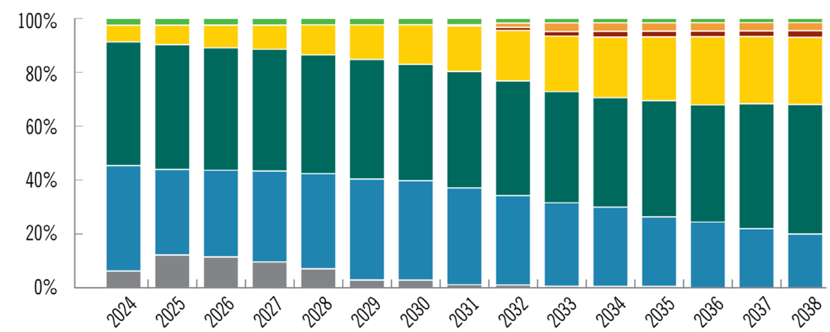


P2 Base Capacity Mix, BOY 2038 (%)



- Grid Edge
- Other Renewables
- Offshore Wind
- Onshore Wind
- Solar
- Pumped Storage Hydro
- Battery Energy Storage
- Nuclear
- Gas
- Coal (incl. DFO)

P2 Base Energy Mix, Combined System (%)



P2 Coal Retirements by Year (MW, effective by January 1 of year shown)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
DEP						1,053		713		1,409			
DEC		426*				760		546	1,318				2,220
TOTAL		426*				1,813		1,259	1,318	1,409			2,220

*Allen Units 1 & 5 are planned to retire by December 31, 2024.

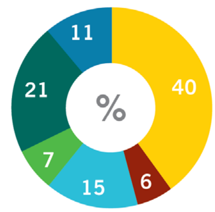
Energy Transition Pathway 3 is modeled to reach the Interim Target by 2035 and carbon neutrality by 2050. Achievement of the Interim Target along this Pathway is enabled by model selection of advanced nuclear generation. All Pathway 3 portfolios, except for the Portfolio Variant developed to evaluate a delay in the commercialization of advanced nuclear technology, include two SMRs by the beginning of 2035 and a total of at least seven SMRs by 2038. The capacity expansion model did not select offshore wind in the 2030s in the Core Portfolio for Pathway 3, P3 Base, however offshore wind was selected in several Portfolio Variants demonstrating the value offshore wind can provide in the mid-2030s under varying market conditions described below to reduce exposure to fuel availability and prices while providing carbon reductions. Figure 3-7 below provides a summary of P3 Base as the Core Portfolio for Pathway 3.

Figure 3-7: P3 Base Summary

P3 Base Summary

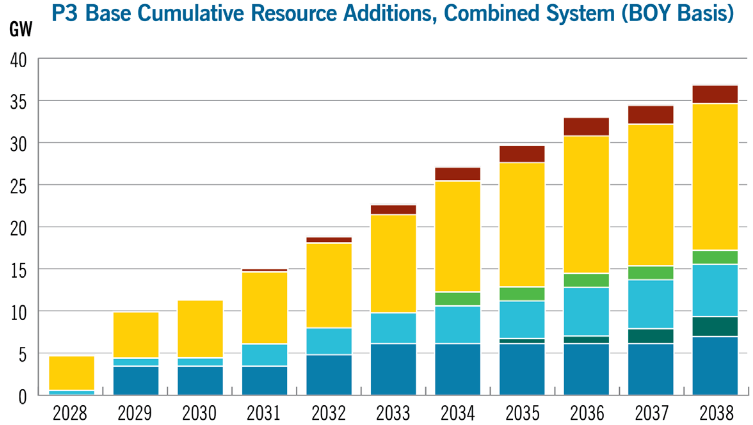
P3 Base		2038	2050
PVRR ($B)	Combined System	$66	$119
	DEP PVRR	$26	$48
	DEC PVRR	$40	$71
		2033	2038
BILL IMPACT	Combined System CAGR	2.8%	2.6%
	DEP CAGR	3.0%	2.2%
	DEC CAGR	2.6%	2.9%
Year in which 70% target is met		2035	

Percentage of Total Capital Requirement by 2038

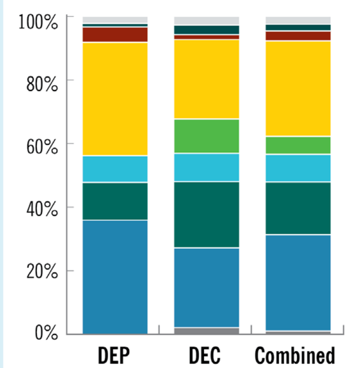


Total capital cost before tax credits

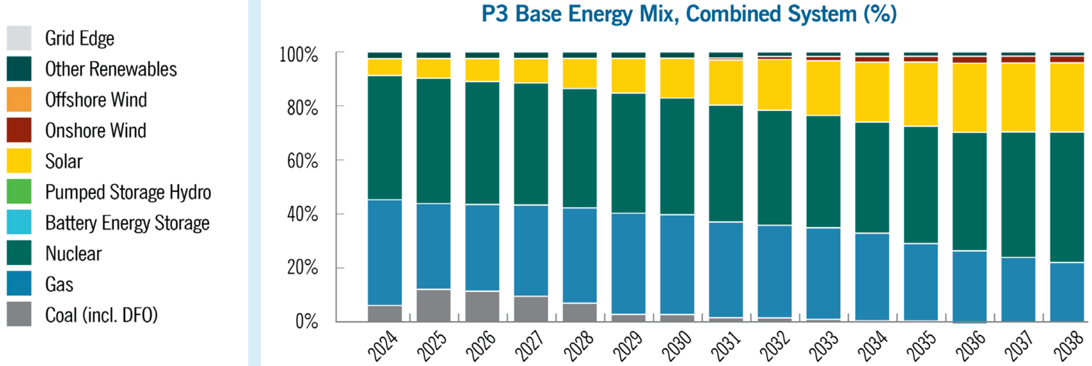
P3 Base Cumulative Resource Additions, Combined System (BOY Basis)



P3 Base Capacity Mix, BOY 2038 (%)



P3 Base Energy Mix, Combined System (%)



P3 Coal Retirements by Year (MW, effective by January 1 of year shown)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
DEP						1,053		713			1,409		
DEC		426*				760		546	1,318				2,220
TOTAL		**426***				**1,813**		**1,259**	**1,318**		**1,409**		**2,220**

*Allen Units 1 & 5 are planned to retire by December 31, 2024.

Exploring Portfolio Variants

The portfolio variants explore potential alternative assumptions for resource availability and gas supply. These factors, the pace at which new resources can be procured and connected to the system, and the sources of natural gas available in the Carolinas, will affect the pace and cost at which the Companies can continue to execute an orderly energy transition. A summary of the key insights from the analysis of Portfolio Variants is presented here. Appendix C provides additional detail on modeling methods and results.

Resource Availability

One of the primary risks to successful Plan execution is the risk that new resources cannot be added to the system at the pace envisioned in the Core Portfolios. Market challenges in one or more of several areas, including but not limited to supply of materials and capital equipment, labor availability, siting and permitting, and regulatory approvals can affect resource availability. To evaluate the potential impacts of this possibility, the Companies developed six Portfolio Variants testing how low solar availability, low onshore wind availability and limited gas availability would affect the resource mix in Pathway 2 and Pathway 3. In addition, the Companies developed a seventh Portfolio Variant in which SMRs are not available for model selection until 2037. This delayed SMRs variant was tested in Pathway 3. No resource availability variants were tested in Pathway 1 because the P1 Base portfolio already represents an “extra high” resource availability case and the consequence of not achieving those extra high levels of resource deployment is effectively represented by Pathways 2 and 3. The following key insights may be drawn from the resource availability variants:

- **Wind is an important component of the energy transition.** The Companies created the low onshore wind variants by limiting annual onshore wind additions to 150 MW/yr. compared to up to 450 MW/yr. in the Core Portfolios. Lowering the pace of available onshore wind additions reduces the total capacity of onshore wind that can be online by the Interim Target date but does not change the cumulative amount selected in DEP (1,650 MW). In the “Low Onshore Wind” Portfolio Variant for Pathway 3, the model selects 800 MW of offshore wind by 2034, adding approximately $500 million to PVRR through 2050. The model also selected an additional 800 MW of offshore wind by 2034 in the “Low Onshore Wind” variant for Pathway 2, as well as an additional 1,900 MW of batteries by 2033, increasing PVRR through 2050 by $2.8 billion. The low solar variants, which the Companies created by limiting annual solar additions to 1,350 MW/year, compared to 1,575 MW/year in the Core Portfolios, yielded similar results. The model selected 800 MW of offshore wind in 2034 in both Pathway 2 (in addition to the 1,600 MW in the P2 Base by 2033) and Pathway 3. Pathway 2 and Pathway 3 PVRRs increased by approximately $1.8 billion and $300 million, respectively, through 2050. These results underscore the importance of a diverse resource mix, highlighting the value of adding wind, which can generate energy overnight and on winter mornings, to complement a solar-rich system.

- **Offshore wind would be needed to provide energy and support system reliability in a future with tighter constraints on gas supply.** The Companies created the constrained gas supply variants by limiting the number of CT units available for model selection to the two Marshall Advanced CTs already planned. If future gas supply were to be constrained beyond the limits assumed in the Core Portfolios, it would be necessary to prioritize highly efficient advanced class CCs over simple-cycle turbines. In the more constrained gas supply Portfolio Variant for Pathway 3, the model accelerated deployment of the third CC from 2033 to 2031, added 800 MW of offshore wind in 2034, and selected an additional 1,000 MW of battery capacity to support system reliability prior to the CC addition in 2031. PVRR through 2050 increased by $1.1 billion compared to P3 Base. In Pathway 2, limited gas supply resulted in the acceleration of battery deployment from the mid to the early 2030s to support reliability, increasing PVRR through 2050 by only about $300 million. Despite the smaller change, the PVRR for "P2-Limited Gas" remained approximately $4 billion greater than the PVRR for "P3-Limited Gas" through 2050.

- **Advanced nuclear or offshore wind is required to achieve the Interim Target by 2035.** In the Portfolio Variant for Pathway 3 in which SMRs are not available for model selection until 2037, the model adds 1,600 MW of offshore wind by 2035 to achieve the target. The target is still met in 2035, but the total Carolinas PVRR to 2050 is increased by $6.7 billion over P3 Base. Advanced nuclear resources are selected when they become available in 2037.

- **Offshore wind could be added in the mid-to-late 2030s to increase resource diversity and support continued transition with limited impact on PVRR.** The Companies developed a Portfolio Variant in which the model was required to select a minimum of 1,600 MW of offshore wind by 2038. In this case, the model added 800 MW each in 2037 and 2038 and selected one fewer SMR (two instead of three) in 2037. The resulting change in PVRR through 2050 was less than $800 million. Assuming near-term challenges for the offshore wind industry are resolved, maintaining optionality for offshore wind in the mid-to-late 2030s also provides important system diversity in renewable technologies to offset the potential limited availability of other resource types, as illustrated above in the discussions of the "Low Onshore Wind", "Low Solar" and "Limited Gas" Portfolio Variants.

Finally, in addition to the low resource availability variants described above, the Companies developed two Portfolio Variants, one for Pathway 2 and one for Pathway 3, in which future resource availability was assumed to be higher than the already aggressive resource additions modeled in the Core Portfolios. In these cases, the Companies raised the amount of available solar to 1,800 MW/yr., increased the cumulative amount of available onshore wind to 4,500 MW, increased the amount of offshore wind that could be connected in a single year to 1,600 MW, increased CC availability to a total of four units, and increased the total number of advanced nuclear units that could be added to the portfolio. In these variants, the model accelerated solar resource additions prior to the Interim Target date in each Pathway but slightly reduced the total amount of solar selected overall. Additional onshore wind was selected in both Pathways. In Pathway 3, the increased renewables and storage were enough to eliminate the third CC, however the model selected a CT in 2031 to make up for the lost capacity. For both Pathways, the model responded to the more aggressive assumptions for advanced nuclear by selecting the first SMR in 2034, the first year in which it was available for the high resource availability variants.

Natural Gas Supply

As explained in Chapter 2, the Companies developed Portfolio Variants for Pathway 2 and Pathway 3 to evaluate the potential effects of successful completion of the Mountain Valley Pipeline ("MVP"). In the Portfolio Variants that assume MVP completion prior to the first CC coming online by the beginning of 2029, the PVRRs for Pathway 2 and Pathway 3 decrease relative to the Core Portfolio by $1.5 billion and $1.7 billion, respectively, through 2038, and by $2.5 billion and $2.6 billion, respectively, through 2050. This result is similar to that for the low fuel price Sensitivity Analysis Portfolio described below. As discussed previously, and in Chapter 4 (Execution Plan), it will be important to monitor future market conditions for these alternative renewable and storage options in order to check and adjust the plan as appropriate.

Insights from Portfolio Sensitivity Analysis

As described in Chapter 2, the Companies developed 10 Sensitivity Analysis Portfolios to further evaluate the sensitivity of resource selection and portfolio cost outcomes in Pathway 3 to changes in certain additional input variables. The Sensitivity Analysis Portfolios were created for Pathway 3 because it has the most flexibility with respect to resource additions to achieve the Interim Target and therefore can provide the most useful insights for this analysis. A summary of the key findings from the portfolio sensitivity analysis is presented here. Appendix C provides additional detail on modeling methods and results.

Resource Cost

With considerable uncertainty around the future costs for all resource types, the Companies tested the sensitivity of resource selection to future price environments both higher and lower than anticipated in the base case forecasts used to develop the Core Portfolios. As expected, higher prices cause resource additions to be deferred to the extent possible, while lower prices cause additions to be accelerated. In the high resource capital cost case, PVRR through 2050 increased by $10.8 billion. Cumulative resource additions decline by approximately 1,400 MW through 2035 (less than 5% of cumulative additions to that point), the Interim Target year, but cannot drop below the level required to meet the target reliably. In the low resource capital cost case, PVRR through 2050 decreases by $10.1 billion. The model selects one fewer CT and 150 fewer MW of onshore wind, adding instead 600 MW each of battery energy storage and solar by 2038, as well as an additional SMR, reflecting the steeper cost decline curves for those resources in the low capital cost case relative to the base case. The significant PVRR changes caused by higher and lower resource capital cost assumptions are an indicator of the degree to which the Plan is exposed to fluctuations in market conditions due to the need to add resources at a deliberate pace to meet growing customer demand while continuing the energy transition.

Fuel Commodity Price

Fuel price forecasts are an important factor influencing the model economics of fuel-burning resources relative to renewables supported by energy storage. The Companies developed portfolios to evaluate potential changes to resource selection that may occur if natural gas commodity prices were forecasted to be above or below the base case forecast. Increasing natural gas prices above the base forecast resulted in little change to resource selection relative to P3 Base by either 2033 or 2038, reflecting the critical role of efficient, dispatchable, hydrogen-capable gas resources in supporting reliability while meeting growing customer needs. Using a lower gas price forecast, on the other hand, yielded a portfolio similar to the Portfolio Variant that assumed MVP completion with accelerated CC deployment leading to the displacement of some solar and batteries in favor of offshore wind.

High and Low Load Growth Cases

Future load growth may trend higher or lower than the base case forecast for a variety of reasons. The high load growth portfolio is of particular interest given recent trends of large businesses adding or expanding operations and employment in the Companies' service territories and the potential for those trends to persist in the coming months and years. In the portfolio developed to test the sensitivity of resource selection to higher load, the model has limited options for additional generation because most resources are needed in volumes at or near their expected maximum availability even in P3 Base until the late 2030s. This portfolio shows the acceleration of a CC from 2033 to 2031 for a total of three CCs needed by the start of 2032 and includes 1,600 MW of offshore wind by 2034. Additional solar (when available), batteries and CTs are also needed to reliably serve the higher load.

For the low load portfolio, the model selects lower amounts of most resources and defers deployment of the first CC to 2031, adding an additional CT to maintain adequate capacity in 2029 and another in 2031. The third CC is deferred from 2033 to 2034.

Energy Efficiency and Demand Response

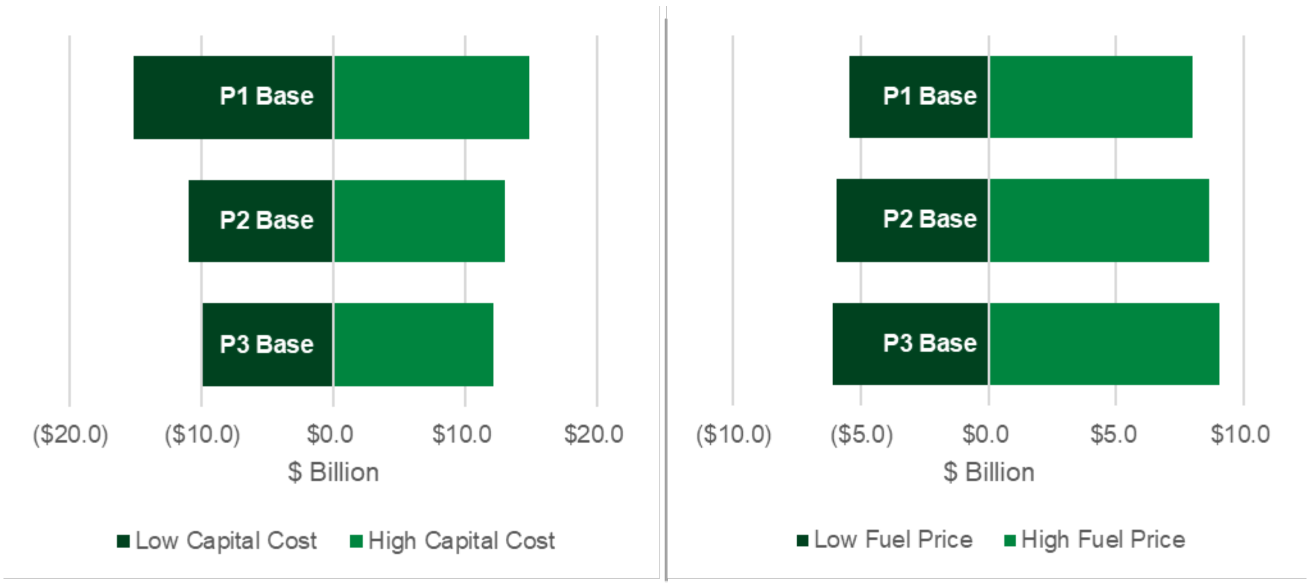
In many respects, sensitivity analysis testing high and low levels of utility energy efficiency ("UEE") savings is similar to sensitivity analysis testing high and low load. In both cases, the effect is to adjust the net load that the capacity expansion model builds a resource portfolio to serve. The Companies' approach to planning for net load is described in Chapter 2. The Sensitivity Analysis Portfolio developed assuming higher savings from UEE includes lower amounts of solar, batteries and onshore wind than are present in P3 Base. The Sensitivity Analysis Portfolio developed assuming lower savings from UEE translates to higher net load that must be served by supply-side resources and the capacity expansion model selects a single 800 MW block of offshore wind in 2034 to meet that additional need. The additional offshore wind meets the need and offsets the need for other resources in that timeframe, reducing the amount of solar, batteries and CTs added by 2038.

The high and low demand response ("DR") cases yielded no material changes in portfolio composition, reflecting the fact that the variance between the base case and alternate forecasts still accounts for a small percentage of peak load.

Insights from Performance Sensitivity Analysis

The performance sensitivity analysis, as explained in Chapter 2, evaluates the robustness of portfolio cost, measured using PVRR, with respect to changes in resource costs and fuel prices. Portfolios that show relatively larger changes in PVRR are relatively more sensitive to the input variable that is changed, which implies greater exposure to risk related to that input variable. Figure 3-8 below illustrates the changes in Core Portfolio PVRRs in response to changes in resource capital cost and fuel price forecasts.

Figure 3-8: PVRR Changes Through 2050 in Response to Changes in Capital Cost and Fuel Price Forecasts by Core Portfolio, Combined Carolinas System ($B)



P1 Base, which requires far more rapid capital investment than P2 Base or P3 Base, is the most exposed (to the upside and downside) to changes in the price environment for capital equipment. Similarly, P3 Base, which requires slightly higher fuel burn that the other Core Portfolios, is the most exposed to changes in fuel prices.

In addition to the single variable sensitivity analysis, the Companies also conducted performance sensitivity analysis on combinations of the high and low forecasts for resource capital costs and fuel prices. Table 3-4 below shows the PVRR through 2038 across these 27 cases. In each sensitivity case, P3 Base has the lowest PVRR of the three.

Table 3-4: PVRR through 2038 Across Resource Capital and Fuel Price Performance Sensitivities, Combined Carolinas System ($B)

Case	P1 Base	P2 Base	P3 Base
Base Capital/High Fuel	$82	$75	$73
Base Capital/Base Fuel	$76	$69	$66
Base Capital/Low Fuel	$71	$64	$61
Low Capital/High Fuel	$75	$71	$70
Low Capital/Base Fuel	$69	$65	$63
Low Capital/Low Fuel	$65	$60	$58
High Capital/High Fuel	$84	$77	$74
High Capital/Base Fuel	$78	$70	$68
High Capital/Low Fuel	$73	$65	$62

Put another way, P3 Base minimizes the maximum customer exposure to cost increase. Table 3-5 below presents the “regrets” for each case, defined as the difference between the PVRR for a given portfolio in each case and the minimum portfolio PVRR for that same case. As Table 3-5 shows, P3 Base has the lowest maximum regret across the cases. This is referred to as “minimax regrets” analysis.

Table 3-5: PVRR Regret through 2038 Across Resource Capital and Fuel Price Performance Sensitivities, Combined Carolinas System ($B)

Case	P1 Base	P2 Base	P3 Base
Base Capital/High Fuel	$9.3	$2.2	$0.0
Base Capital/Base Fuel	$10.0	$2.5	$0.0
Base Capital/Low Fuel	$10.4	$2.6	$0.0
Low Capital/High Fuel	$5.8	$1.5	$0.0
Low Capital/Base Fuel	$6.5	$1.8	$0.0
Low Capital/Low Fuel	$6.9	$1.9	$0.0
High Capital/High Fuel	$9.4	$2.3	$0.0
High Capital/Base Fuel	$10.1	$2.6	$0.0
High Capital/Low Fuel	$10.5	$2.7	$0.0

The minimax regret analysis described above stresses market variables without consideration of future re-optimization for the portfolios in response to changing market conditions. This means that the analysis does not account for the “check and adjust” approach that is a vital part of the iterative resource planning process.

Supplemental Portfolios

In addition to the portfolios described in the preceding sections, the Companies developed additional portfolios to provide general insights on additional topics. As explained in Chapter 2, these are included for informational purposes and do not reflect the core planning assumptions of the Plan.

No Carbon Constraints Portfolio

As required by the Public Service Commission of South Carolina,[1] the Companies modeled Supplemental Portfolios without any CO_2 reduction constraints (Base Case and a Portfolio Variant). While the Companies performed an informational "No Carbon Constraints" modeling exercise, it is not an executable Pathway as it does not comply with applicable laws and requirements. Additionally, this portfolio lacks resource diversity as a core planning objective called for in both states' Integrated Resource Plan rules and would result in customer exposure to gas availability, price volatility as well as proposed and future regulatory compliance risks. Furthermore, executing on a resource plan with no specified CO_2 emission reduction target would require the Companies to violate state law that applies to their dual-state operations. For these reasons, this informational portfolio cannot be the most reasonable and prudent means of meeting the Companies' resource planning requirements. The results for this portfolio show lower levels of renewables and energy storage selected by the model throughout the planning period relative to P3 Base, but PVRR differs by less than $1 billion on a system-wide basis through 2038. Relative to the "no carbon constraints" analysis, P3 Base provides considerably more resource diversification and better shields customers from risks related to future fuel supply, price volatility and future federal regulatory actions, demonstrating the reasonableness and prudence of Pathway 3. Appendix C includes additional detail on this analysis.

Proposed Environmental Protection Agency Regulations

In May 2023, the United States Environmental Protection Agency ("EPA") published a suite of proposals under Clean Air Act ("CAA") section 111 ("EPA CAA Section 111 Proposed Rule") that would regulate CO_2 emissions from fossil fuel-fired power plants. These regulations address greenhouse gas emissions from existing coal plants and from new and existing natural gas plants. The Companies recognize the significance and potential impacts of these proposed rules, as well as the complex and lengthy period ahead as the proposed regulations are carefully considered. At the time of this filing, the Companies just recently submitted their comments on the proposed rules to the EPA.[2]

[1] Order No. 2023-189 at 8-9, Docket Nos. 2019-224-E, 2019-225-E, 2021-8-E, and 2023-10-E (Mar. 22, 2023).

[2] Comments of Duke Energy, EPA New Source Performance Standards For Greenhouse Gas Emissions From New, Modified, And Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines For Greenhouse Gas Emissions From Existing Fossil Fuel-Fired Electric Generating Units; And Repeal Of The Affordable Clean Energy Rule, Docket ID No. EPA-HQ-OAR-2023-0072, 88 Fed. Reg. 33,240 (May 23, 2023), submitted on regulations.gov, Aug. 8, 2023.

The Companies did not include these newly proposed rules in base planning assumptions, as these rules are still being interpreted, clarified, and commented on and may change prior to being finalized. However, given the potential broad implications of this rule, the Companies did evaluate performance of the Core Portfolios against the proposed rules for existing coal and Supplemental Portfolios around the proposed rules for natural gas units to help inform the Commissions, noting that these sensitivities have considerable uncertainty regarding how the rules will be finalized as well as future hydrogen production and infrastructure costs and timing (detailed assumptions and results in Appendix C).

The EPA CAA Section 111 Proposed Rule would impose CO_2 emission limitations on new natural gas-based (CCs/CTs) electric generating units ("EGUs") with the standard varying by capacity factor. For the first time, the EPA also establishes standards in several phases, known as Phases 1, 2 and 3, with more stringent standards coming into effect over time. These standards are discussed in more detail in Appendix K (Natural Gas, Low-Carbon Fuels and Hydrogen).

EPA also proposed standards for existing natural gas-based EGUs, which are those that commenced construction or reconstruction before May 23, 2023 and are above 300 MW with a capacity factor above 50%. EPA proposed Phase 2 and 3 emission limitation standards for these units, which are the same as the proposed standards for new natural gas-based EGUs.

The Companies modeled potential approaches to compliance with the EPA CAA Section 111 Proposed Rule. The Companies observed that the Core Portfolios were generally in line with the existing coal and Phase 1 standards for new and existing natural gas units. For Phases 2 and 3, the Companies modeled two scenarios with respect to the proposed requirements for applicable new and existing gas resources: 1) limiting the capacity factors of new natural gas units to operate in intermediate or low load and ensuring that existing units operate below the applicability criteria for this proposal; and 2) utilizing hydrogen co-firing to achieve the emission limitation standards for new and existing natural gas units by assuming access to sufficient hydrogen fuel at 30% of total fuel volume by 2032 and 96% of total fuel volume by 2038. Both approaches were modeled under Pathway 3.

In the first case, the model required significant incremental and accelerated resources to meet forecasted customer energy needs, requiring 1,600 MW of offshore wind by 2032 and a fourth CC by 2035, both of which exceed assumed resource availability for Pathway 2 and Pathway 3. In addition to exceeding base case resource availability, the capacity limitation case added $3.9 billion to PVRR through 2050 relative to P3 Base.

For the second case, the Companies assumed a clean hydrogen fuel market at a price that trends toward the Department of Energy's 2021 Hydrogen Shot goal of $1/kg ($7.44/MMBtu) by 2030. Additional government incentives, such as the regional hydrogen hub program, may aid in achieving this target or continue to drive the hydrogen market pricing downward. In this case, because the CC units were able to run unconstrained on a blend of gas and hydrogen, model resource selection was quite similar to P3 Base (and consistent with Pathway 3 resource availability assumptions), with some solar capacity eliminated from the portfolio based on the energy coming from the hydrogen co-fired CCs reducing the CO_2 emissions of the system. PVRR through 2050 increased by approximately $11.4 billion relative to P3 Base.

Portfolio Comparison and Evaluation

The following sections provide a comparative summary of results across portfolios followed by an evaluation of portfolio performance and trade-offs with respect to the planning objectives outlined in Chapter 2. The evaluation criteria discussed in this section are developed largely from those planning objectives.

Table 3-6 below provides definitions of the metrics used in portfolio comparison and evaluation, and Table 3-7 below illustrates cost, reliability, risk assessment and pace of energy transition across the three Core Portfolios, providing a high-level summary of relative portfolio trade-offs. The Companies then provide a more detailed comparative evaluation of the portfolios after the summary tables below.

Table 3-6: Metrics Used to Evaluate Portfolio Performance

Metric	Definition	Role in Evaluation
Portfolio Cost		
Average Monthly Residential Bill impact for a Household Using 1,000 kilowatt-hours ("kWh")	Expected change in monthly bill due to resource plan activities by year specified, relative to present	Provides snapshot of resource plan related cost impacts at specified future points in time
Present Value of Revenue Requirement ("PVRR") Through 2038, 2050	Forecasted incremental revenue requirement for the Plan over full analysis period, discounted back to present	Provides estimate of total portfolio cost over analysis period in present value terms
Increasingly Clean Resource Mix		
CO_2 Intensity	Pounds of CO_2 emitted per megawatt-hour ("MWh") of energy generated across the combined Carolinas system	Allows comparison of pace at which resource mix gets cleaner on a per unit of energy basis.
Year in which 70% Interim Target Achieved	Year by which CO_2 emissions are reduced by 70% relative to 2005 baseline	Allows comparison of pace at which resource mix gets cleaner
Reliability & Flexibility		
95th Percentile Expected Net Load Ramp (MW/hr.)	95th percentile of forecasted daily maximum increase (ramp) in net load ramp (total load less wind and solar generation) averaged across 43 sample weather years used in loss-of-load expectation ("LOLE") analysis	Indicates flexibility expected to be required of dispatchable energy resources in specified future years to back stand renewable resources and follow net load ramp needs on the system.
Average CC Starts per Unit per Year	Number of times each CC unit is expected to be shut down and restarted, averaged across all CC units, as predicted in production cost model results	Provides indication of expected reliance on CC cycling to accommodate increased deployment of non-dispatchable resources. Starts may be clustered in certain months
Energy Transition Risk Assessment		
Cumulative Nameplate MW Additions of Resources with Limited Operational History in the Carolinas	Cumulative additions of onshore wind, offshore wind, batteries, and advanced nuclear by year specified	Provides indication of required pace of transition to resource types with limited operational track record in the Carolinas
Cumulative Nameplate MW Additions, Combined Carolinas System	Nameplate MW required in each portfolio by year specified	Indicates scale and pace of infrastructure siting, permitting, and construction required under each Core Portfolio
Cumulative Nameplate MW Additions as % of Current Combined Carolinas System	Nameplate MW required by year specified, as percentage of total nameplate MW serving customers today, including contracted generation	Illustrates the magnitude of infrastructure requirements in the context of the existing system
Cumulative Capital Dollar Requirement, Combined Carolinas System	Total nominal capital dollars, including financing costs, required to execute portfolio by year specified	Indicates scale and pace of capital investment required under each Core Portfolio

Table 3-7: Summary of Portfolio Results

Carolinas Resource Plan Portfolios	P1 Base		P2 Base		P3 Base	
DEC/DEP Combined System Resources [MW] start of year (2033 | 2038)						
Total Contribution from Grid Edge & Customer Programs[1]	2,087	2,536	2,087	2,536	2,087	2,536
Incremental System Solar (excl. ~3,000 MW in dev.)	13,350	15,750	8,775	14,100	8,775	14,625
Incremental Onshore Wind	1,500	2,250	1,200	2,100	1,200	2,250
Incremental Offshore Wind	2,400	2,400	1,600	1,600	0	0
Incremental Advanced Nuclear Capacity	0	3,000	0	2,400	0	2,400
Incremental Energy Storage[2]	6,374	8,054	6,314	8,894	3,694	7,954
Incremental Gas (CC)[3]	2,720	2,720	4,080	4,080	4,080	4,080
Incremental Gas (CT)[3]	2,550	2,550	2,125	2,125	2,125	2,975
Remaining Coal Capacity[4]	2,162	0	3,064	0	4,473	0
Total Coal Retirements [MW] by End of 2035[4]	8,445		8,445		8,445	
Portfolio Cost						
Average Monthly Residential Bill Impact for a Household Using 1000kWh (DEP/DEC Combined System) [$/month] 2033|2038[5]	$60	$70	$48	$56	$35	$55
Average Monthly Residential Bill Impact for a Household Using 1000kWh (DEP) [$/month] 2033|2038[5]	$86	$77	$72	$63	$41	$48
Average Monthly Residential Bill Impact for a Household Using 1000kWh (DEC) [$/month] 2033|2038[5]	$41	$65	$32	$51	$30	$59
Present Value Revenue Requirement ("PVRR") (DEP/DEC Combined System) through 2038|2050 [$B]	$76	$139	$69	$124	$66	$119
PVRR (DEP) [$B] through 2038|2050	$34	$62	$28	$53	$26	$48
PVRR (DEC) [$B] through 2038|2050	$42	$77	$40	$71	$40	$71
Increasingly Clean Resource Mix (2033 | 2038)						
CO_2 Intensity (DEP/DEC Combined) [lbs./MWh]	217	131	267	163	313	182
Year in which 70% CO_2 Reduction Achieved	2030		2033		2035	
Reliability & Flexibility (2033 | 2038)						
95th Percentile Expected Net Load Ramp (MW/hour)	12,122	13,581	9,206	12,553	9,201	12,880
Average CC Starts per Unit per Year	86	90	39	64	60	81
Energy Transition Risk Assessment (2033 | 2038)						
Cumulative Nameplate MW Additions of Resources with Limited Operational History in the Carolinas[6]	10,274	15,704	9,114	14,994	4,894	12,604
Cumulative Nameplate MW Additions, Combined Carolinas System[7]	31,907	39,737	27,107	38,312	22,887	37,297
Cumulative Nameplate MW Additions as % of Current Combined Carolinas System	73%	91%	62%	88%	53%	86%
Cumulative Capital Dollar Requirement, Combined Carolinas System [$B]	$85	$130	$59	$101	$44	$92
Overall Pathway Risk Related to Cost, Reliability, and Plan Execution	●		◕		◑	

Note 1: Includes winter peak impact of load modifiers (utility-sponsored energy efficiency, behind-the-meter solar, critical peak pricing), integrated Volt-VAR control ("IVVC") and demand response programs.

Note 2: Includes stand-alone, paired, PSH.

Note 3: New natural gas facilities will be capable of burning zero-carbon hydrogen in the future; hydrogen blending assumed to begin in 2035.

Note 4: Cliffside 6 continues to operate on 100% natural gas.

Note 5: Average retail rate impact across all customer classes applied to representative residential bill.

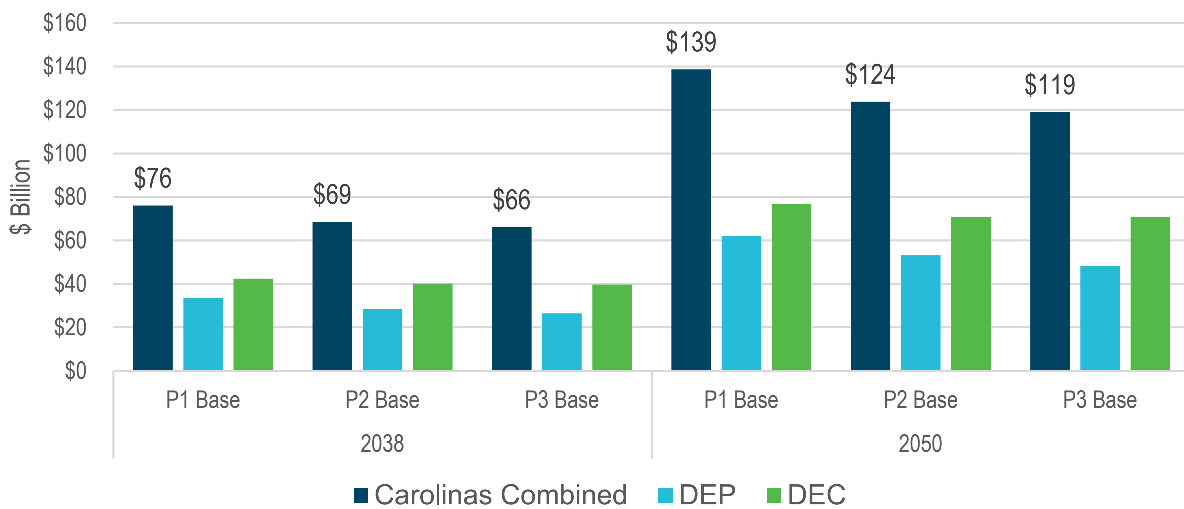
Note 6: Includes onshore wind, offshore wind, battery energy storage and advanced nuclear.

Note 7: Includes solar and battery projects currently in advanced development.

Portfolio Evaluation: Cost and Affordability

Figure 3-9 below shows the total cost of each portfolio through 2038 and 2050 expressed as the PVRR. The costs shown are associated with incremental resource additions and retirements contemplated in each portfolio. Cost characteristics and forecasts vary by resource type, so both the timing and amount of incremental resource additions influence total portfolio cost. Discounting in the PVRR calculation further amplifies the impact of the timing of new investments on the overall cost evaluation.

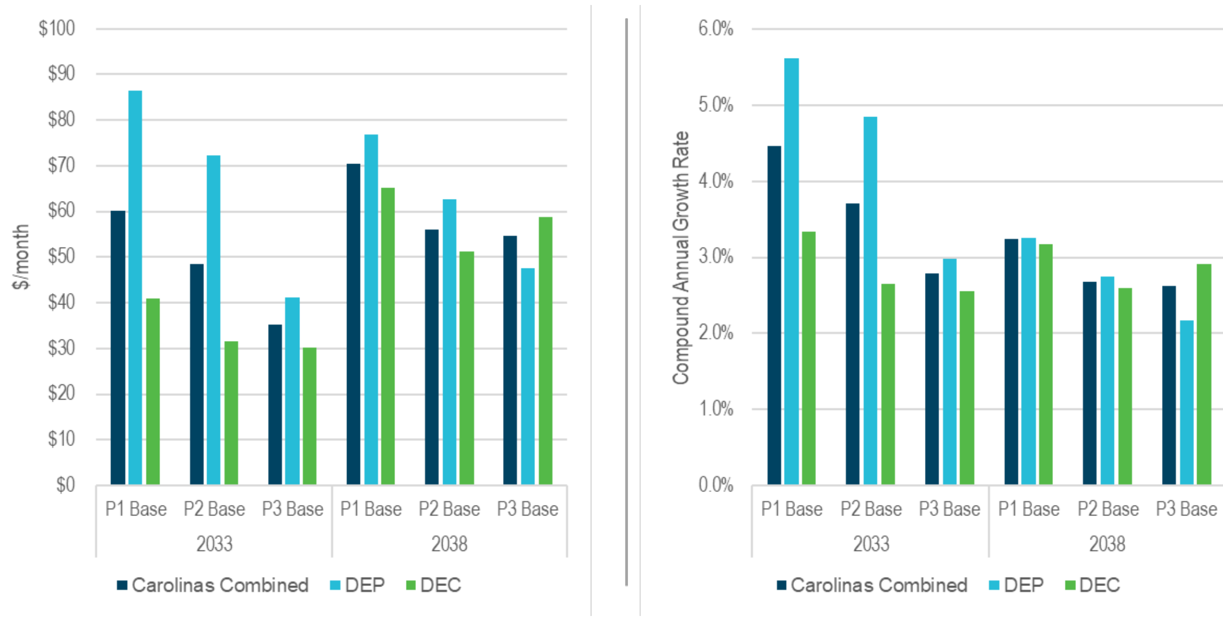
Figure 3-9: PVRR by Portfolio, Calculated through 2038 and 2050



The extraordinarily aggressive pace of energy transition contemplated in Pathway 1 is reflected in the high cost of P1 Base relative to the other portfolios. To procure and deploy new resources in the unprecedented volumes required for P1 Base, particularly by 2030 (1,600 MW of offshore wind, approximately 9,600 MW of solar, approximately 5,300 MW of batteries, 300 MW of onshore wind, 2 CC and 4 CTs), the Companies would expect to incur costs well above those captured in the generic unit cost forecasts used in the resource planning analysis. As a proxy for these unknown market conditions, the Companies added a 20% cost risk premium to the capital costs for the scope, scale and pace of resource additions in P1 Base for the purposes of this comparison. Even this adjustment may be conservative. The Carolinas combined PVRR for P1 Base assuming no adjustment for market depth for materials and labor is $71 billion through 2038 and $127 billion through 2050.

The overall resource mixes identified as needed in P2 Base and P3 Base are very similar by 2038, with the primary difference being the inclusion in P2 Base of 1,600 MW of offshore wind by 2033. The offshore wind and the much more accelerated battery deployment in the early 2030s result in a $2.5 billion increase over P3 Base through the end of the Base Planning Period and a $4.8 billion PVRR increase over P3 Base through 2050 on a combined system basis. This additional cost is particularly apparent in the forecasted customer bill impacts, with a 38% greater expected bill increase by 2033 under P2 Base than P3 Base as the offshore wind and additional battery capacity get added to base rates. The forecasted compound annual growth rate ("CAGR") for P2 Base approaches 4% through 2033, compared to the more measured CAGR, below 3%, for P3 Base that is closer to the rate of general inflation. Bill impact snapshots by Portfolio are shown below in Figure 3-10.

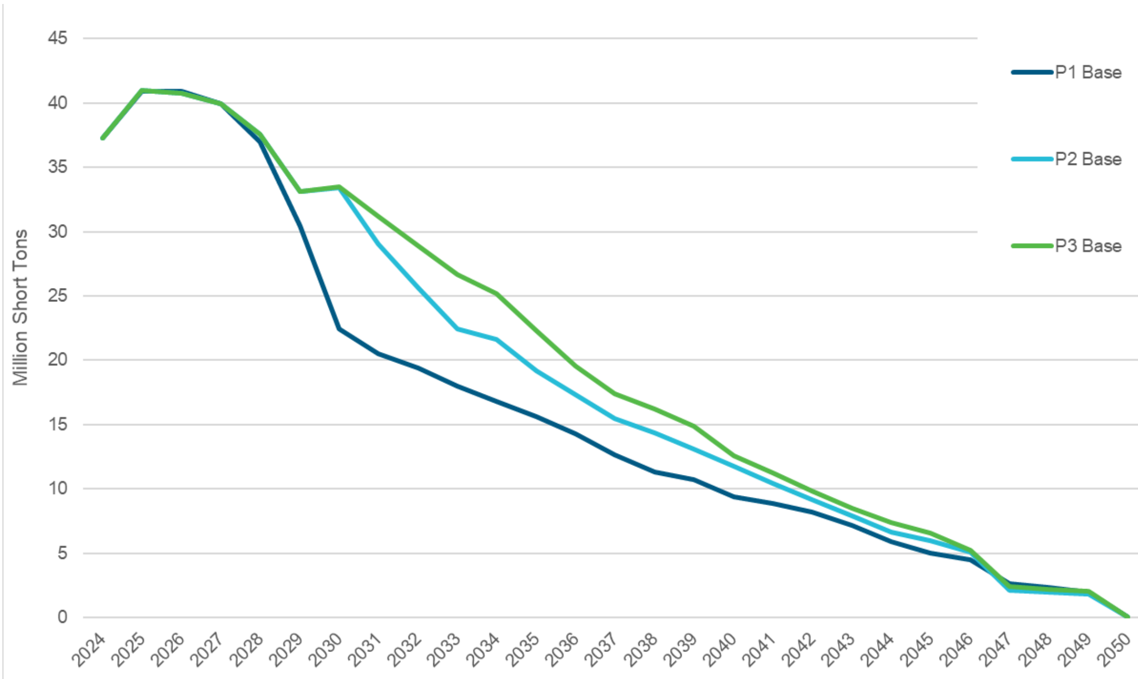
Figure 3-10: Bill Impact Snapshots by Portfolio, 2033 and 2038



Portfolio Evaluation: Increasingly Clean Resource Mix

CO_2 emissions are correlated with other factors related to the cleanliness of the resource mix and are used as a representative indicator in the Plan. As discussed in Chapter 2 and earlier in this Chapter, all Energy Transition Pathways lead to carbon neutrality by 2050, but each does so at a different pace, and the three reach the Interim Target in different years. Figure 3-11 below shows the forecasted annual CO_2 emissions for each Core Portfolio through 2050.

Figure 3-11: Annual CO_2 Emissions by Core Portfolio, Combined Carolinas System

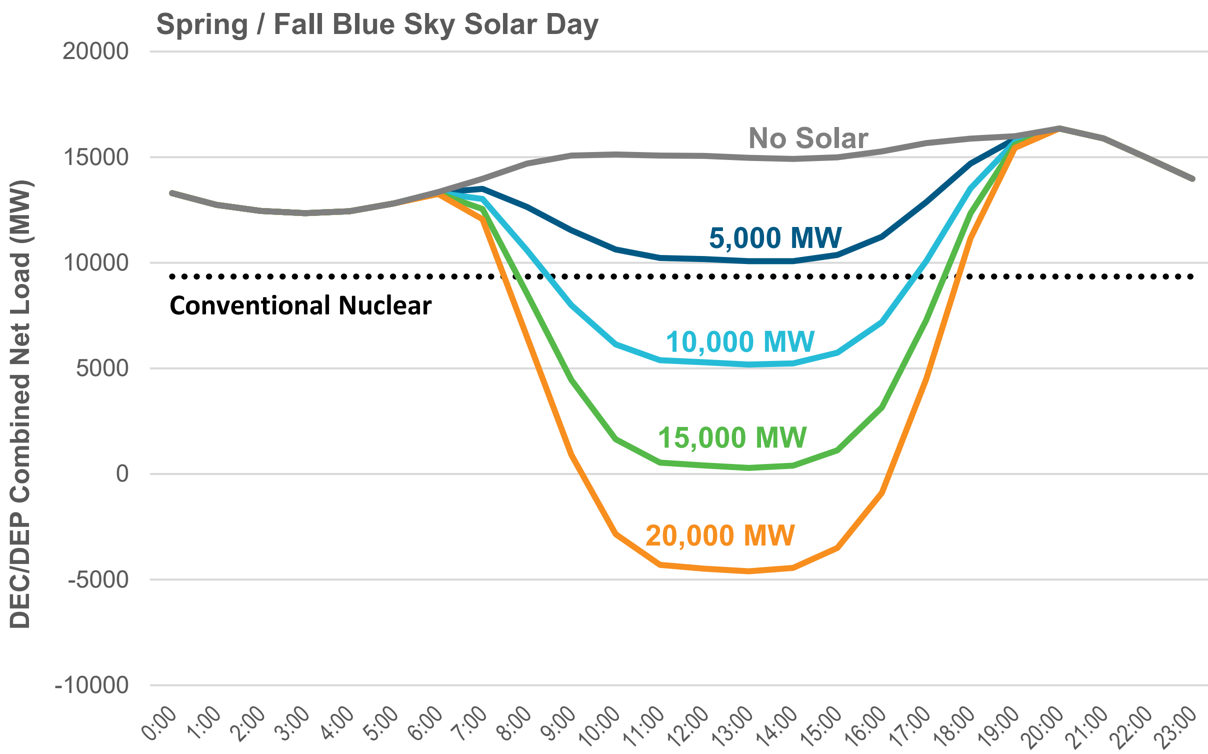


Portfolio Evaluation: Reliability and Flexibility

Ensuring reliability during the energy transition will be an ongoing process of operational integration, learning and adjustment. A detailed discussion of system reliability and the measures that will be taken to ensure that reliability is maintained or improved is presented in Appendix M (Reliability and Operational Resilience). The portfolio comparison presented in Figure 3-13 further below is based on flexibility metrics that illustrates the differences across portfolios with respect to the reliability and flexibility challenges presented by the energy transition.

As intermittent renewable energy becomes an increasingly large share of generation capacity, the remaining electricity demand that must be met by dispatchable sources — that is, the electric load net of renewable energy contributions, commonly referred to as “net load” — will change in timing, shape and magnitude in ways that will place new stresses on the power system. Given the day-night (diurnal) pattern of output, high levels of solar can become increasingly difficult to manage, with two key challenges that must be met in future portfolios — accommodating very low (or even negative) net loads at midday and managing the associated increasingly rapid decreases and increases in net load as the sun rises and sets. Figure 3-12 below illustrates potential net load profiles on a sunny, mild spring day with several levels of installed solar capacity.

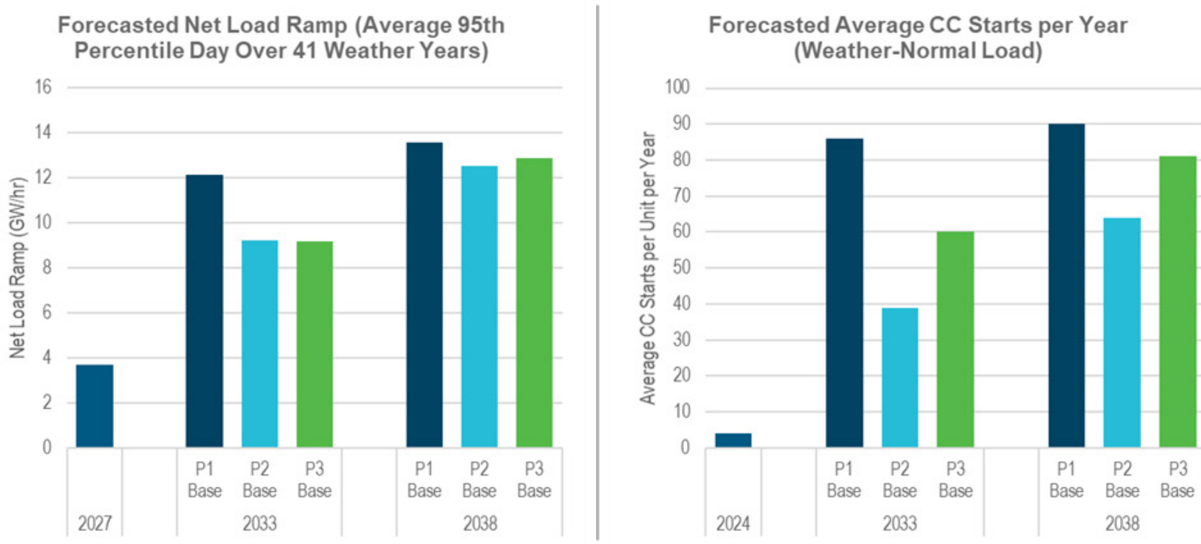
Figure 3-12: Spring Low Net Load Examples with Different Levels of Installed Solar Capacity



The flexibility demands of a system with significantly increased amounts of intermittent resources will require a new operational approach for the Companies' CC units in particular. Historically, the Companies' CC fleets have been designed and operated specifically for baseload operations and have faced a limited need to cycle given the flexibility of the remaining generators. As the energy transition progresses, the CC fleet will need to cycle on a more frequent basis. This operational approach will be new to the Companies' fleet and is likely to require changes to operations and maintenance practices and investments and upgrades to increase unit flexibility. The process of re-starting the majority (and in some seasons, entirety) of the Companies' CC fleets within a few hours has not been tested, and coordination among all units and stages will be a challenge to precisely match the rapid increases in net load into the evening hours.

Each portfolio across the Carolinas Resource Plan Pathways calls for substantial additions of new renewable energy capacity to continue the orderly energy transition while maintaining or improving reliability. Figure 3-13 below illustrates expected CC starts and net load ramps for each of the Core Portfolios, as representative of the Energy Transition Pathways, 2033 and 2038.

Figure 3-13: Forecasted CC Starts and Net Load Ramp by Portfolio, Combined Carolinas System



The greater net load ramp and CC starts associated with the dramatic adoption of new renewable energy resources by 2033 required for Pathway 1, represented by P1 Base, will create additional flexibility challenges and operational risk relative to Pathways 2 and 3, represented by P2 Base and P3 Base, respectively. Even P2 Base and P3 Base represent significant changes from the present. The increases in both system hourly ramping requirements and projected CC starts point directly to the need to replace aging coal units with energy storage and flexible CT and CC capacity, as the existing coal fleet lacks the flexibility to respond to the system ramp rates or stop and start requirements shown above. Compared to coal units, new natural gas CCs have 60% lower carbon intensity, much faster start-ups and shutdowns, much wider operating range, much faster ramp rates and higher reliability. New CTs will provide even faster startups, with fast ramping up and down to complement weather-dependent renewables, ensuring operational flexibility and reliability needs can be met when solar and wind have limited availability. In contrast to battery storage, CTs can run for days or weeks when needed to maintain reliability during extreme weather events. New CC and CT units will also have the ability to blend 30% to 50% zero-carbon hydrogen, with retrofits available in the 2030s to allow 100% hydrogen as the hydrogen supply becomes available.

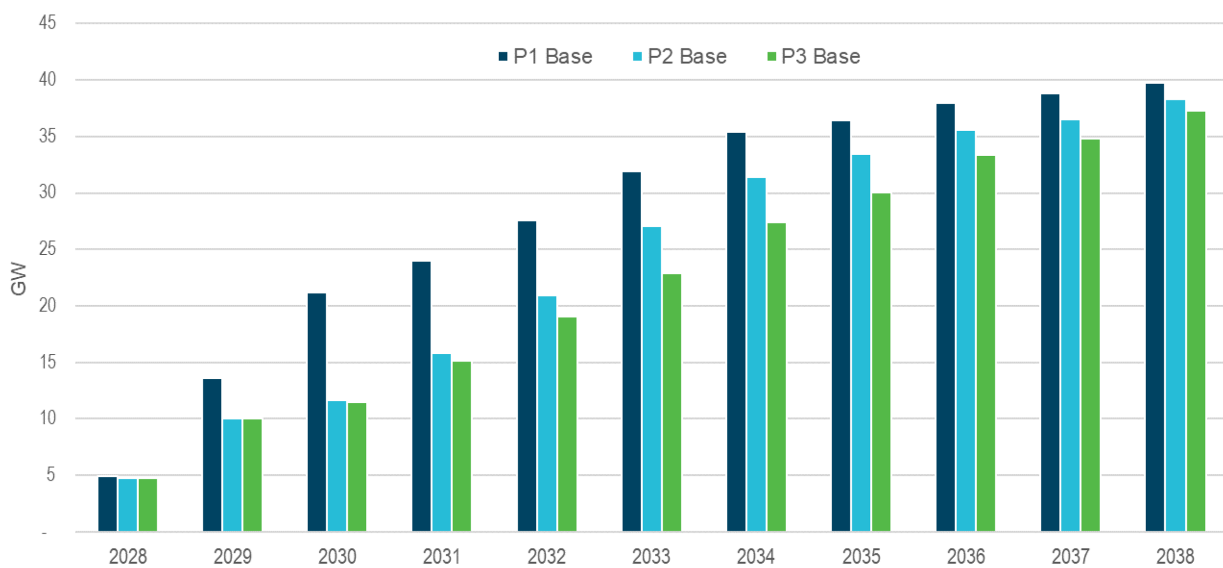
Achieving an orderly and reliable transition of the energy system must balance and coordinate the pace of intermittent renewable resource additions, coal retirements and adoption of dispatchable storage and hydrogen-capable gas resources on the system. If these varying resource changes to the system over time are not made at the appropriate interrelated and coordinated pace, the ensuing outcome would likely be system reliability events and inordinate levels of solar curtailments.

Portfolio Evaluation: Balancing Risks for a Changing Energy Landscape

The Companies developed the Energy Transition Pathways to inform the pace of and optimal execution approach to the Carolinas' energy transition. Prudently retiring and replacing 8,400 MW of coal-fired generating capacity with equally reliable resources to meet growing system needs will require the addition to the Companies' system of substantial amounts of new resource capacity during the Base Planning Period.

Each Energy Transition Pathway requires an "all of the above" approach to new resource deployment, but the three vary in the pace at which resources must be deployed to achieve projected CO_2 emission reductions. Deployment of new resources is contingent upon a variety of factors including supply chain, siting and permitting, labor supply, regulatory approvals, transmission planning and interconnection and fuel supply, as discussed in Chapter 4 and the supply-side resource-specific appendices. Deploying new resources in significant volumes at an unprecedented pace exacerbates exposure to each of these potential risks, thereby affecting the likelihood of successful Plan execution at the cost and in the timeframe envisioned. Figure 3-14 below presents a snapshot of supply-side capacity resource additions required under each Core Portfolio as an indication of the pace of new resource adoption and the associated risk to successful plan execution.

Figure 3-14: Cumulative Supply-Side Resource Additions by 2038, Combined Carolinas System (beginning-of-year basis)



As Figure 3-14 above shows, Pathway 1, represented by P1 Base, requires an unprecedented and highly aggressive pace of new supply-side resource acquisition and deployment prior to the beginning of 2030, with cumulative resource additions exceeding 20,000 MW by 2030, an amount equal to nearly half of the Companies' entire combined Carolinas' system today. On a project basis, P1 Base would require completion and interconnection of approximately 40 to 50 major generation projects per year (based on generic unit sizes) from 2027 to 2029, of which two 1,360 MW CCs (1,720 MW total) and 1,600 MW of offshore wind are only three. Even with prudent planning, constructive regulatory oversight, and highly efficient execution, integrating this level of new capacity into the system over a three-year period while retiring 7,100 MW of coal units by 2030 as envisioned under Pathway 1 is likely infeasible and substantially questions whether system reliability can be maintained or improved for customers during this period of significant transition.

Pathway 2 and Pathway 3, represented by P2 Base and P3 Base, require more measured but still ambitious resource additions over the Base Planning Period, adding over 38,000 MW and 36,000 MW of new nameplate capacity, respectively by 2038. Pathway 2, to achieve the Interim Target by 2033, requires more rapid deployment of new resources in the early 2030s than does Pathway 3. Pathway 2 requires 1,600 MW of offshore wind by 2033 in addition to all the resources required for Pathway 3. On a project basis, P2 Base requires the completion and interconnection of approximately 30 to 40 major generation projects per year (based on generic unit sizes) from 2030 to 2032, including approximately 50 major projects in 2032, of which 1,600 MW of offshore wind is only one. P3 Base requires a more measured but still challenging 25 to 30 projects per year over the same period. As discussed in more depth in Chapter 4, a more compressed timetable paired with significant development activities across multiple technologies carries increased risk that adverse conditions outside of the Companies' direct control could jeopardize achievement of the Interim Target date on the timeline modeled. These execution risks could manifest in any one of several areas, including but not limited to, supply chain delays, skilled labor shortages, external contractor availability limitations, extended state and federal permitting processes, legal challenges, etc.

Summary of Portfolio Evaluation

As the results of the Carolinas Resource Plan analysis demonstrate, an "all of the above" approach is required to prudently retire and replace 8,400 MW of coal-fired generating capacity with equally reliable resources to meet growing system needs. All three Energy Transition Pathways require the deployment of a diverse range of resources, including grid-edge resources and customer programs, renewables, energy storage, advanced nuclear and hydrogen-capable gas.

The key differentiator across the Pathways is the pace of transition, in terms of the relative cost and risks related to cost volatility, reliability and overall, the market's ability to deliver successful Plan execution. Pathway 1, which from a planning perspective, reaches the Interim Target by 2030, would require resource additions at a pace, scope and scale outside of the realm of reasonable and prudent utility planning and execution. Planning to achieve Pathway 1 could also conflict with the Companies' requirement to add new and replacement resources at a rate which does not negatively impact the adequacy or reliability of the existing grid across the Carolinas in accordance with North American Electric Reliability Corporation reliability standards. Pathway 2 is designed to achieve the Interim Target by 2033, resulting in 5% less CO_2 on a cumulative basis through 2050 relative to Pathway 3. However, this more rapid pace of energy transition requires trade-offs in terms of increased cost and risk to Plan execution. P2 Base, the Core Portfolio under Pathway 2, is projected to cost approximately $5 billion more than P3 Base, the Core Portfolio under Pathway 3 by 2050. In the near term, the customer bill impact of executing P2 Base versus P3 Base is also significant, with a bill CAGR approaching 4% through 2033 on a combined Carolinas basis. Ultimately, the primary factor differentiating the costs and risks of Pathway 2 and Pathway 3, is Pathway 2's accelerated reliance on 1,600 MW of offshore wind in 2033 to achieve the Interim Target, supported by significantly accelerated deployment of battery energy storage resources. P3 Base, which itself requires completing approximately 25 to 30 major generation projects each year from 2030 to 2035, represents the most prudent approach, reasonably balancing the pace of energy transition with need to serve growing customer needs reliably and cost-effectively in the Carolinas.

Careful consideration of these trade-offs is essential to determining prudent next steps as the Companies begin executing the Carolinas Resource Plan. As discussed in more detail in Chapter 4, the Companies recommend planning for execution aligned with Pathway 3 and have developed and are proposing for approval near-term actions through 2026 that are informed by the P3 Base portfolio. Near-term execution activities outlined in Chapter 4 represent substantial and immediate progress implementing an array of demand-side customer programs and supply-side technologies, while prudently pursuing limited near-term activities related to the potential development of offshore wind.

To ensure the Companies continue to prudently plan to reliably transition their systems on the most reasonable, least-cost path for customers, the Companies will monitor rapidly changing market dynamics such as the potential for completion of MVP as well as use both execution-informed resource costs in the Carolinas as well as trends and experience in the industry to inform future resource plans. Most notably, the Companies believe the range of results across Pathway 3 portfolios supports continued consideration of offshore wind as a potentially needed resource in the mid- to late 2030s, particularly if there is additional load growth, if there are significant shortfalls in the deployment of other zero-carbon resources, or less contribution to load reduction from Grid Edge and customer programs.

Recognizing that resource planning is an iterative process, both Commissions will have a further opportunity to “check and adjust” in the future as policies evolve, new technological developments occur, and more refined information becomes known. Over the next few years, timelines and costs assumed in the modeling will either be validated or challenged by the real-world execution path and such information will be used to refine strategies and improve benefits for customers in future plans.