The Least-Cost Resource Plan for Santee Cooper

A Path to Meet Santee Cooper's Customer Electricity Needs at the Lowest Cost and Risk

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EXECUTIVE SUMMARY

South Carolina's state-owned utility, Santee Cooper (the South Carolina Public Service Authority) is at a crossroads due to its large debt load and its reliance on an aging, expensive coal fleet. The South Carolina General Assembly has embarked on a process to evaluate options for the utility's future, including sale, management by a third party, or significant internal reform. A key question for any of these options is how Santee Cooper should generate electricity in the future.

This report addresses that question directly by evaluating the economics of several generation portfolios over the next 15 years. Using industry-standard methods, state-of-the-art simulation software, and the latest data on power production costs and grid capabilities, Synapse Energy Economics (Synapse) modeled scenarios to compare their relative cost and risks to ratepayers. The results show three central points.

First, Santee Cooper's aging coal units are very expensive, and continuing to run them will cost ratepayers hundreds of millions of dollars more than other options (with the exception of building several replacement gas plants, which would be the costliest option). This is because Santee Cooper's two coal plants, Winyah and Cross, are old, inefficient, and have rising fuel costs. In contrast, other cleaner forms of power generation have gotten much cheaper—so cheap that it now costs less to build *and* run replacement power sources than simply run old coal units. To save ratepayers money, Santee Cooper should pursue a reasonable schedule of coal plant retirements that preserves reliability and delivers cost savings as soon as possible.

Second, the least expensive pathway to meet power needs going forward is steady investment in renewable energy and energy efficiency (the "Clean Energy" scenario). Our modeling compared the economics of the full range of potential new power resources with one another to find the least expensive way to reliably serve Santee Cooper's projected power demand. Renewable power, for which prices have dropped dramatically over the past decade and are forecast to drop still further, outcompeted other resources on price. Compared to expanded gas scenarios that rely on 700 megawatts (MW) and 2,100 MW of new gas capacity (the "Gas Medium" and "Gas Major" scenarios), for example, the Clean Energy scenario would save $75 million and $596 million dollars, respectively. This assumes gas prices do not exceed expected price projections.

Third, the renewables portfolio is far less risky than other options. Santee Cooper's current predicament arose from large bets made on centralized power sources (nuclear and coal) that became uneconomic over time—leaving ratepayers with a heavy financial burden. Unlike new gas generation, renewable power has no fuel costs, and thus less vulnerability to fuel price volatility. Conversely, renewable power serves as a hedge against rising gas prices. If gas prices increase to $5–7/mmBtu, for example, the risks of heavy reliance on gas become daunting. To illustrate, the Gas Major scenario under such an increase would cost over $1 billion more than the Clean Energy scenario.

The renewable pathway also avoids large investments in centralized generation facilities—a risk exemplified by Santee Cooper's uneconomic coal units—allowing for a distributed and more modular buildout. Because renewable power can be deployed incrementally, "bet the farm" energy infrastructure risks like billion-dollar gas plants and pipelines can be avoided while maximizing future flexibility.

Notably, based purely on economics, optimization of the Santee Cooper system with unconstrained renewable solar and storage resources resulted in the buildout of a large amount of these resources to meet future capacity and energy. In fact, even in scenarios in which new gas generation resources are available, the model still chose additional solar and battery storage deployment as the most cost-effective resources to replace a substantial share of lost coal-fired generation capacity. According to the model, renewable power economically outcompetes new gas over time. This means that new gas facilities may become stranded assets—burdening ratepayers—before the end of their useful lives, as Winyah and Cross are today.

The utility industry-standard software that Synapse used is designed to maintain reliability levels at peak load plus a required reserve margin for all hours of the modeled years. Thus, all the scenarios modeled—including those deploying renewable power—would reliably maintain all levels of service and safety required to meet the needs of Santee Cooper's residential, commercial, and industrial customers. Imports into and exports out of the Santee Cooper system were modeled via existing electric transmission resources, subject to limits on those lines. For more information on regional transmission topology, see Appendix A.

This report concludes that the best course for Santee Cooper's future energy generation, regardless of who owns or runs it, is retiring uneconomic coal plants on a reasonable schedule and replacing that energy with clean renewable resources.[1] The clean energy approach saves $360 million compared to Santee Cooper's plan set forth in its 2018 Integrated Resource Plan (IRP). By contrast, including 700 MW of new gas in a resource portfolio costs ratepayers $75 million more than the Clean Energy scenario, while a portfolio with 2,100 MW of new combined cycle gas capacity would cost $599 million more than a clean energy plan under our reference gas prices. Indeed, the cost of the 2,100 MW gas portfolio would exceed the cost of Santee Cooper's coal-heavy Business as Usual plan and would cost ratepayers $1 billion more than the clean energy plan if gas prices were to rise.

[1] As Synapse was finalizing this report, newly appointed Santee Cooper CEO Mark Bonsall announced that the utility plans to retire the Winyah coal plant, build 1,000 MW of solar, 200 MW of battery storage, and 500 MW of new generation infrastructure fueled by fracked gas. While that proposal appears to recognize the economic advantages of renewable energy documented in this report, it would contain gas generation costs similar to our Gas Medium scenario but without the savings from near-term retirement of Santee Cooper's non-economic Cross coal units.

1. INTRODUCTION

On the heels of abandonment of V.C. Summer Units 2 and 3 in July 2017, the South Carolina General Assembly began evaluating the fate of Santee Cooper. The utility was a 45 percent partner in the failed $9 billion nuclear construction project. In December 2018, the South Carolina Public Service Authority Evaluation Committee sought expressions of interest from companies interested in owning or managing the utility. On February 2, 2019, the committee's consultant, ICF, issued a report analyzing the expressions of interest and indicative offers. After further legislative debate and inquiry, the General Assembly passed a joint resolution charging the South Carolina Department of Administration (DOA) with analyzing offers to buy, manage, or reform Santee Cooper.[2] The legislature asked bidders, as part of their offer, to describe how they plan to generate or import power to serve Santee Cooper customers.[3] DOA will present a "best in class" offer to the General Assembly in early 2020 in each category: sale, outside management, and internal reform.

The February 2, 2019 ICF report summarized non-binding, conceptual proposals from private generation companies and investor-owned utilities to buy or manage Santee Cooper. The ICF report indicated that new owners or managers would rely far less on Santee Cooper's existing coal units and turn instead to new gas-fired generation, solar energy, imports from existing generators in other states, and in one case, energy efficiency programs.[4]

These indicative bids reflect choices made and faced by utilities across the nation saddled with non-economic coal units. Over the past decade, utilities have largely relied upon gas generation when replacing aging baseload coal generation, in order to exploit low prices for fracked gas.[5]

A more recent pattern—driven by rapidly declining costs for solar, wind, and storage resources—shows economic competition favoring renewable power over coal and gas. This economic (rather than environmental) renewable energy procurement trend began in early 2018 when a Colorado utility sought bids from all sources of power and found that renewable energy combined with battery storage

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[2] South Carolina General Assembly, *Public Service Authority (Santee Cooper),* H. 4287. 123rd Session. (2019) https://www.scstatehouse.gov/sess123_2019-2020/bills/4287.htm.

[3] ICF International. 2019. *Evaluation of Responses to the Request for Expressions of Interest and Indicative Offers for Santee Cooper*, at 12, summarizing ICF's evaluation criteria for indicative bids to purchase Santee Cooper, including "Generation Portfolio Diversification" and "Feasibility."

[4] *Id.* at 6 (noting that "[s]ignificant cost savings appear to be available from changes to the supply resource mix if the Central Coordination Agreement implementation challenges can be resolved") and 28 (noting that only one bidder included significant energy efficiency resources).

[5] We note that there was a similar huge rush to build independently owned gas power plant capacity in the late 1990s and early 2000s when gas prices were low and gas generation was competitive. However, unexpectedly high gas prices in the mid-2000s made many plant owners go bankrupt and allowed utility companies to buy them inexpensively. It was largely this already-built stock of gas power plants that allowed gas generation to immediately outcompete coal when fracking again reduced gas prices at the end of the decade.

was the least-cost option.[6] At the end of 2018, Xcel Energy committed to a plan to voluntarily shift entirely to renewable energy.[7] A Northern Indiana Public Service Company all-source request for proposals during the same timeframe also led to a plan relying on cost-effective energy from renewable energy and storage.[8] Recently, a California utility announced plans to procure solar-plus-storage rather than gas peaking plants and Florida Power and Light announced that it will replace two gas units in Florida with the world's largest solar-powered battery.[9]

Each utility, however, is different in terms of cost and projected need. One function of this study is to explore through a neutral analysis whether following the decade-old trend towards gas or the more recent trend towards renewables plus storage and energy efficiency makes more sense for Santee Cooper ratepayers.

This analysis also helps illuminate issues raised by the General Assembly. The General Assembly's charge to the DOA requires a broad evaluation of the long-term costs and risks of proposed generation plans and what they mean for South Carolina and its ratepayers. Among other things, R113 requires DOA to consider the bidder's plans for generation, power purchases, and other resources over the next 20 years including, but not limited to, the "costs of additional infrastructure required to support any generating unit" (e.g., gas pipelines), transmission infrastructure, and fuel costs. Senators were particularly interested during their investigation to establish whether proposed plans are realistic and to consider transmission constraints, reliability requirements, and the time needed to build any necessary infrastructure.

In furtherance of that legislative direction, this report evaluates multiple options for meeting Santee Cooper's generation needs over the next 15 years. It draws on Synapse's expertise as a leading energy consultancy firm with experience in every state and most Canadian provinces. For this exercise, Synapse utilized the EnCompass capacity expansion and production cost model, licensed from Anchor Power Solutions. Input assumptions around loads and existing resources come from Santee Cooper's 2018 Integrated Resource Plan and S&P data. Renewable cost information and gas prices come from the U.S. Energy Information Administration (EIA). We provide further details on input assumptions in Appendix A.

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[6] *Utility Dive*. January 2018. "Xcel Solicitation Returns 'Incredible' Renewable Energy, Storage Bids." https://www.utilitydive.com/news/xcel-solicitation-returns-incredible-renewable-energy-storage-bids/514287/.

[7] *Greentech Media*. December 2018. "Xcel Energy Commits to 100% Carbon-Free Electricity by 2050." https://www.greentechmedia.com/articles/read/xcel-commits-to-100-carbon-free-electricity-by-20501#gs.tr0jdq.

[8] *Power Magazine*. November 2018. "Indiana Utility Will Close Coal Units, Transition to Renewables." https://www.powermag.com/indiana-utility-will-close-coal-units-transition-to-renewables/.

[9] *Utility Dive.* March 2019. "FPL Unveils Plans for Largest Solar-Powered Battery in the World." https://www.utilitydive.com/news/fpl-unveils-plans-for-largest-solar-powered-battery-in-the-world/551544/. See also, *Greentech Media.* September 2015. "NextEra on Storage: 'Post 2020, There May Never Be another Peaker Built in the US.'" https://www.greentechmedia.com/articles/read/nextera-on-storage-post-2020-there-may-never-be-another-peaker-built-in-t#gs.qsxqbp.

Turning to the several scenarios evaluated, first, Synapse examined a business as usual (BAU) scenario that assumes Santee Cooper continues to utilize its existing fleet coal, gas, nuclear, and renewable resources as set forth in Santee Cooper's 2018 IRP. We then evaluated two expanded gas options: the "Gas Medium" scenario builds 700 MW of combined cycle plant additions starting in 2025, while the "Gas Major" scenario builds 2,100 MW of gas capacity between 2025 and 2029.

The 700 MW and 2,100 MW capacity assumptions are not arbitrary. Gas combined cycle plants offered to the EnCompass model were sized at 700 MW each. The smaller buildout reflects the least-expensive gas plan determined by the modeling, with no constraint on adding renewable energy. The 2,100 MW gas plan reflects the same new gas build availability but limits solar to additions of 100 MW each year starting in 2025. This plan was added to more closely approximate plans indicated by expected bidders in the ICF process. Both plans assume a modest fuel adder to represent a generic gas pipeline service extension to support the resulting new combined cycle power plant(s).

We next examined a scenario that utilized new renewable energy, storage, and energy efficiency to meet Santee Cooper's demands in the face of retiring coal, adding no new gas. Finally, we evaluated each of these scenarios under both a reference gas price future and a high gas price future.

Our modeling revealed three central points:

First, the results show that continuing to operate Santee Cooper's existing coal units at Winyah and Cross would be very costly for ratepayers. This BAU scenario costs ratepayers more than $285 million on a present value basis relative to the Gas Medium portfolio, and $360 million more than the Clean Energy scenario. These numbers are even higher under the high gas price scenario: Ratepayers will pay an extra $596 million for continuing to run a coal-heavy portfolio, as compared to the Clean Energy scenario, and $539 million as compared to the Gas Medium scenario.

Second, the Clean Energy scenario is the least costly for ratepayers. If gas prices remain relatively low, as expected, the Clean Energy scenario saves ratepayers $75 million, as compared to the most competitive gas expansion scenario (Gas Medium). The Clean Energy scenario saves ratepayers $599 million compared to the Gas Major scenario.

Third, the Clean Energy scenario has the added benefit of avoiding future risks. Under the high gas prices, the Gas Major scenario will cost ratepayers over $1 billion dollars more than the Clean Energy plan, establishing the heightened risk of price increases corresponding with increasing gas reliance. The Clean Energy plan is also less risky because the renewable additions can be added in smaller increments as need arises, as opposed to investments in larger gas combined cycle units.

As ICF's report evaluating the bids for Santee Cooper pointed out, "… generation strategies relying on remote out of state power supplies may involve trade-offs between customer rates and price versus jobs, tax revenues to state, and economic development."[10] While this study did not include an analysis

[10] ICF. 2019. *Evaluation of Responses to the Request for Expressions of Interest and Indicative Offers for Santee Cooper*. Page 6.

of the economic impacts of the modeled scenarios, we note that more jobs and economic benefits would be kept in South Carolina with the construction of in-state generating capacity and increased energy efficiency under the Clean Energy scenario.

Below, we describe the modeled scenarios in more detail, including the input assumptions that differentiate those scenarios. Revenue requirements are presented for each of the modeled scenarios under reference gas prices as well as under a high gas price sensitivity. Likewise, capacity additions, modeled generation, and carbon dioxide (CO_2) emissions are presented for each scenario. Finally, more detail on input assumptions is presented in Appendix A.

2. Scenario Analysis

To conduct this study, Synapse used state-of-the-art, industry-standard capacity expansion and production cost software—the EnCompass model, licensed from Anchor Power Solutions—to examine several different energy provision scenarios in the Santee Cooper service territory over the 15-year period from 2019 to 2033.[11] EnCompass modeling produces an optimal, least-cost resource portfolio and generation mix, assuming a realistic coal retirement schedule, based on the detailed capacity expansion and electric system dispatch modeling of both Santee Cooper's service territory and the surrounding areas. The Encompass model combined information about Santee Cooper's existing and planned energy loads and capacity resources with projected data on generation costs to do three things: (1) build new resources when necessary; (2) simulate economic dispatch; and (3) calculate the total cost of the respective resource portfolio options.

Our modeling focused on four scenarios: (1) BAU (i.e., Santee Cooper's plan as set forth in its 2018 IRP); (2) Gas Medium (construction of 700 MW combined cycle gas capacity); (3) Gas Major (construction of 2100 MW combined cycle gas capacity); and (4) Clean Energy (renewables and efficiency). Each of these scenarios was modeled with reference gas prices and with higher gas prices, resulting in eight different modeled scenarios.

In the **BAU** scenario, the EnCompass model calculated the cost of Santee Cooper continuing to operate its existing resources, including coal units, through the analysis period as described in Santee Cooper's 2018 IRP. Synapse then used the model to calculate the cost of implementing each of the other three alternative energy futures—the Gas Major, Gas Medium, and Clean Energy.

In the **gas expansion** scenarios, the eight Winyah and Cross coal-fired units would be retired, and new generating capacity could be added in the form of gas, solar, wind, and battery storage. New gas generation capacity was available to the EnCompass model beginning in 2025 to accommodate the time needed for evaluation, regulatory approval, and construction of both the gas plant and necessary supporting pipeline infrastructure.

In the **Clean Energy** scenario, the replacement options to meet capacity and generation needs were limited to energy efficiency, renewable resources, and storage.

Synapse analyzed the impacts of each of these scenarios on Santee Cooper's revenue requirements (i.e., ultimate cost to ratepayers), annual capacity, annual and hourly energy mix, and CO_2 emissions.

Like other integrated resource planning software, the EnCompass model is designed to select and utilize the most cost-effective generating resources to reliably meet demand. Based purely on economics,

[11] Capacity and production cost models like EnCompass are used to simulate future utility operations under different scenarios to help determine the best strategy for minimizing costs and risks while meeting all relevant constraints such as reliability and transmission availability.

modeling of the Santee Cooper system resulted in the buildout of a large amount of renewable solar and storage resources to meet future capacity and energy needs when those resources were unconstrained. In fact, even if new gas generation resources were available, the model chooses additional solar and battery storage deployment as the most cost-effective resources to replace lost coal-fired generation capacity. This reflects the basic fact that renewable power is economically outcompeting new gas over time.

The economic cost of a utility's modeled future generation plans is expressed as the plan's "present value of revenue requirements" (PVRR)—that is, the amount of revenue that will need to be collected from ratepayers to pay for the plan over the course of the study period, discounted to present dollars. The PVRR for both the Clean Energy and Gas Medium scenarios are lower than for the coal dependent BAU scenario, while the Gas Major scenario is higher than the BAU scenario.

However, the *least-cost* scenario is the Clean Energy scenario, which would require $360 million less revenue from ratepayers than the BAU plan, $75 million less than the Gas Medium plan, and $599 million less than the Gas Major plan. If gas prices increase to $5–$7/mmBtu, the Clean Energy plan also saves ratepayers money, costing $57 million less than a Gas Medium[12] plan and $1 billion less than a Gas Major plan. This means that the scenario based on adding all-renewable power to replace coal would result in the lowest electricity rates to Santee Cooper ratepayers over time.

Below we discuss the details of each of the four scenarios and related high gas price sensitivity scenarios.

Business as Usual Scenario:

The BAU scenario uses generation assumptions from Santee Cooper's 2018 IRP. Specifically, the BAU scenario assumes:

- Peak load and annual energy over years 2019 to 2033 from the 2018 IRP.
- No unit retirements: Santee Cooper's existing units, including the eight coal units at the Cross and Winyah plants, would continue operation through the duration of the analysis period.
- A capacity addition during the analysis period of 75 megawatts (MW) of solar at the Centerfield Cooper Solar Farm announced by Santee Cooper in April 2019[13] and an

[12] The difference in revenue requirements is less between the Clean Energy and Gas Medium plans under high gas prices because the model runs the more expensive combustion turbine units less when gas prices are higher. More efficient, less expensive combined cycle units run slightly more, leading to a smaller revenue requirement differential than under reference gas prices.

[13] Santee Cooper. April 2019. *Santee Cooper Adding 75 MW of Solar Energy to Generation Mix*. Available at: https://www.santeecooper.com/news/2019/04-24-19-Santee-Cooper-Adding-75-MW-of-Solar-Energy-to-Generation-Mix.aspx.

assumed trajectory of distributed solar additions throughout the planning period.[14] The EnCompass model was not allowed to build any other resources, given the IRP's conclusion that no other capacity additions are necessary to meet reserve requirements through 2033.

- Additional capital expenditures and variable operations and maintenance (O&M) costs associated with control technologies needed for compliance with Effluent Limitation Guidelines (ELGs) at Santee Cooper's coal-fired units.[15]
- A conservative CO_2 price of $5/ton (nominal) starting in 2025 and escalating at a rate of $3/ton each year, as utilized in Duke Energy's South Carolina 2018 IRPs.[16]

Three Alternative Generation Scenarios:

Synapse modeled three scenarios that retire all of Santee Cooper's coal-fired units in the 10-year period between 2019 and 2028 and add new capacity as needed. All three alternative scenarios use the following assumptions.

- Coal retirement schedule:[17]
  - Winyah 1 and 2: 12/31/2020
  - Winyah 3 and 4: 12/31/2022
  - Cross 2: 12/31/2023
  - Cross 1: 12/31/2026
  - Cross 3 and 4: 12/31/2028
- Renewable resource options offered to the EnCompass model for replacement capacity and energy included generic utility-scale solar, storage, wind, and paired solar-plus-storage resources.

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[14] This assumption is consistent with the trajectory developed by Horizons Energy as part of its National Database.

[15] 80 Fed. Reg. 67,838 (Nov. 3, 2015).

[16] When compared to the "social cost of carbon," this is a conservative assumption. See: US EPA. 2016. *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* Available at: https://archive.epa.gov/epa/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf. Under a discount rate of 3%, the authors calculate a social cost of carbon of $64/ton (2019$).

[17] The retirement schedule removes units in a sequence of lowest-to-highest capacity factor, i.e., removes the least-operated and costliest units first. We also considered avoidance of capital investments to comply with pending federal Effluent Limitation Guidelines (ELGs) where possible. Under the above retirement schedule, retirement of the Winyah units and Cross 2 would avoid the capital and variable O&M expenditures required under the ELGs, as the last day to demonstrate compliance is December 31, 2023. Cross 1, 3, and 4 were retired further out into the study period to ensure that a large capacity shortfall would not be incurred through simultaneous retirement of multiple units.

- Renewable costs based on the *2018 NREL Annual Technology Baseline (or ATB)*[18] or Lazard's *Levelized Cost of Storage Analysis.*[19]
- Construction costs for new combustion turbine and combined cycle technologies come from EIA's *Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019.*[20]
- A Reference Gas Price forecast that consists of NYMEX futures (short term) and annual average gas prices at Henry Hub from the AEO 2019 Reference case (long term). We also modeled a High Gas Price sensitivity for all three scenarios.

The three scenarios assume the same coal retirement schedule but differ in the type of replacement capacity offered to the EnCompass model. In the first alternative scenario, Gas Medium, new gas combined cycle and combustion turbines are offered to EnCompass as part of its resource optimization beginning in the year 2025, the soonest a plant and attendant infrastructure could potentially be proposed, approved, and constructed. No constraints were placed on the additions of renewable technologies in that scenario. In the Gas Major scenario, while new gas generators were offered to the EnCompass model in 2025, solar was limited to annual additions of 100 MW in and after 2025. The third scenario, Clean Energy, allows only renewable resources described above as replacement capacity, as well as increased energy efficiency. The additional efficiency was modeled as a supply-side resource that grows to 1 percent of sales in 2026 and is held at that 1 percent throughout the remainder of the analysis period.[21]

[18] National Renewable Energy Laboratory (NREL). 2018. *2018 Annual Technology Baseline*. Golden, CO: National Renewable Energy Laboratory. Available at: https://atb.nrel.gov/.

[19] Lazard. 2018. *Lazard's Levelized Cost of Storage Analysis: Version 4.0*. Available at: https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/.

[20] US Energy Information Administration (EIA). 2019. *Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019.* US Department of Energy. Available at: https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf.

[21] The 1% annual rate of energy efficiency (EE) savings is roughly equal to current EE program savings in the Duke Energy Carolinas territory and is approximately one half of the rate of energy savings implemented in Salt River Project territory by Santee Cooper's new management team.

3. Results – Reference Gas Prices

3.1. Resource Portfolio Costs

Revenue Requirements

Revenue requirements represent the overall costs to Santee Cooper of the four modeled energy scenarios, which are passed on to customers through electric rates. Revenue requirements are calculated as the sum of annual capital expenditures and production costs (fuel plus operation and maintenance) between 2019 and 2033, discounted to the present value using a discount rate of 7 percent. Revenue requirements are represented as "PVRR," and are shown in Table 1 below.

Table 1. Scenario revenue requirements, reference gas prices

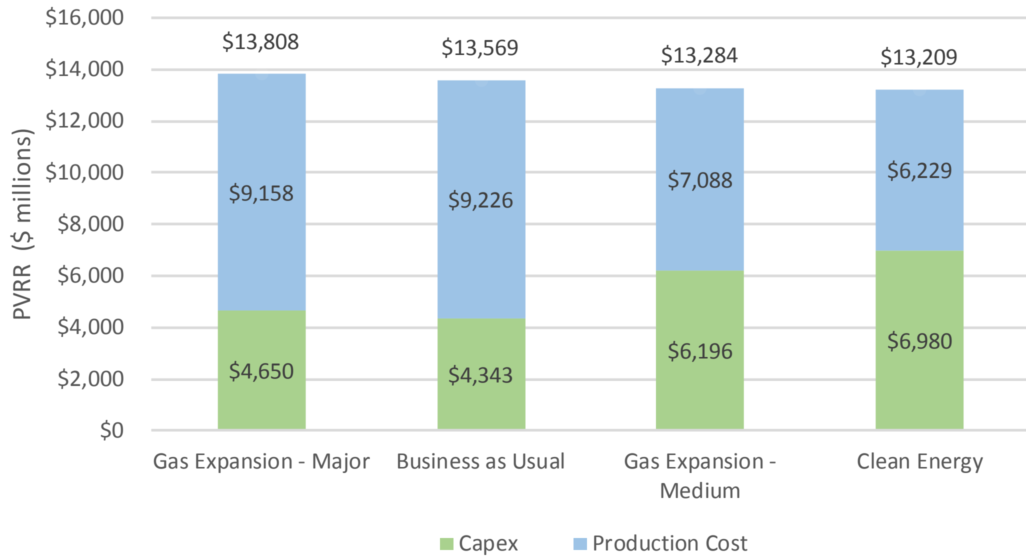
PVRR ($ millions)	Gas Major	BAU	Gas Medium	Clean Energy
Reference Gas	$13,808	$13,569	$13,284	$13,209
Costs/(Savings) compared to BAU	$239	-	($285)	($360)

The **highest** revenue requirement, or cost to ratepayers, is posed by the Gas Major scenario, which, with solar restricted, builds three new combined cycle units between 2025 and 2029 and would cost **$239 million more** than the BAU scenario. By contrast, the **lowest** revenue requirement, with the lowest costs to Santee Cooper ratepayers, is the Clean Energy plan, which over the study period would cost **$360 million less** than the BAU.[22] Compared to the Gas Major plan, the Clean Energy plan would save over a half-billion ($599 million) dollars.

Figure 1 shows the total revenue requirements for the four scenarios, broken down between capital expenditures and production costs (fuel plus O&M costs).

[22] Santee Cooper's own statement regarding planned changes to its future energy portfolio (*see supra* note 1) reflects its recognition that its BAU is not the most economic one.

Figure 1. Revenue requirements (M$ NPV, 2019-2033), reference gas prices



Capital expenditures in the BAU are lower than in any of the Retire/Replace scenarios, as they represent only the ongoing fixed costs necessary to maintain Santee Cooper's existing units and do not include capital expenditures on new generating capacity. The alternative scenarios, on the other hand, include increased capital spending on other generation resources—such as renewables and gas—and the Clean Energy scenario also includes program administration costs for energy efficiency. Production costs are higher in the BAU scenario due to the poor economics of the Santee Cooper coal units compared to the Gas Medium and Clean Energy scenarios. The fuel and O&M savings from the dispatch of low- and no-variable cost resources in these scenarios outweigh their increased capital spending, lowering the overall total revenue requirement. However, beginning in 2025, the Gas Major scenario replaces the retiring coal capacity in large part with new gas additions, which have higher production costs due to their fuel expenses and costs associated with emissions of CO_2.

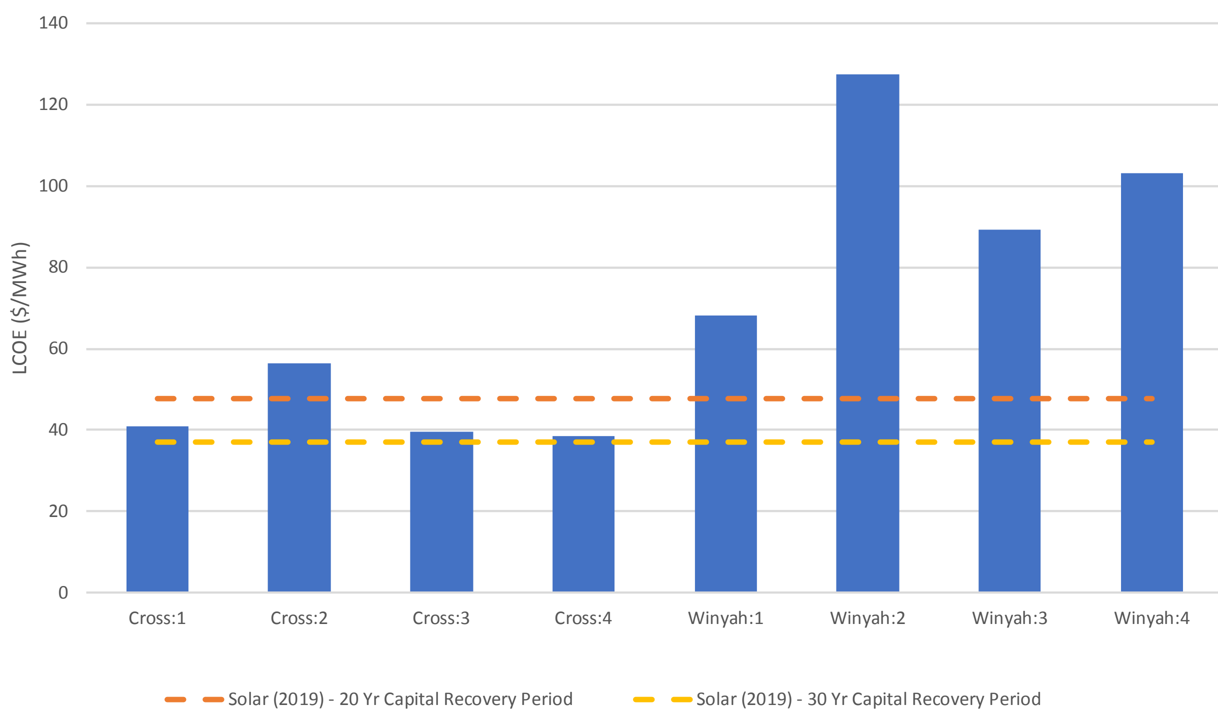
Levelized Cost Comparison

Revenue requirements of the Clean Energy scenario are lower than under the BAU because Santee Cooper's coal-fired units have higher levelized costs of energy (LCOE) than new solar capacity. LCOE is the average total cost to build and operate a generating resource over its lifetime divided by its total electricity output over the same period. Levelized costs allow for a consistent comparison of different types of generation sources.

Under the BAU scenario, the LCOE for Santee Cooper's existing coal units ranges from a low of $38/MWh at Cross 4 to a high of $106/MWh at Winyah 2. Built between 1975 and 1981, with summer rated capacities between 275 and 285 MW, the Winyah units are older and smaller than the four Cross units, which is reflected in their higher LCOE. Also shown in Figure 2 are two LCOE values for solar, which represent an online date and corresponding capital expenditures in 2019, with a capital recovery period of 20 or 30 years. NREL's ATB estimates that levelized costs for solar installations in 2019 range from

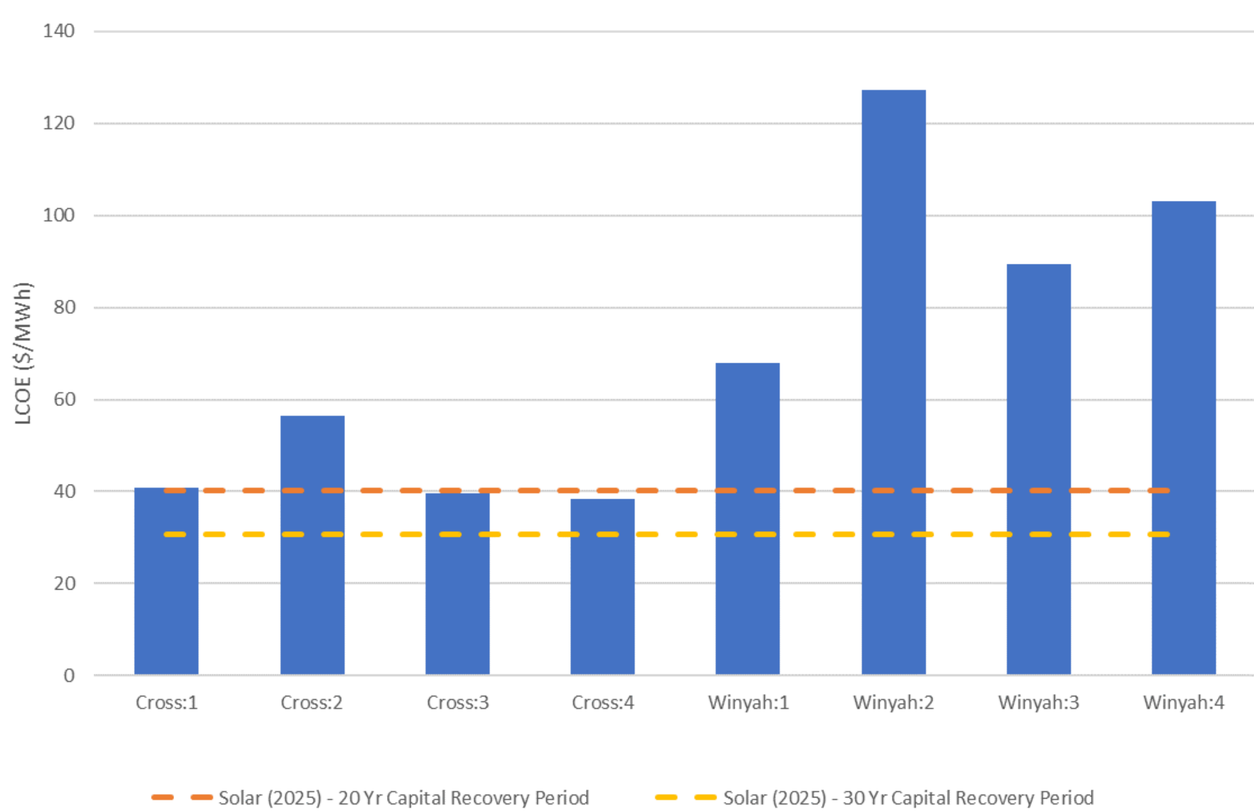
$37–$47/MWh. Depending on the capital recovery period, these levelized costs are lower than at least five of Santee Cooper's coal-fired units. If a longer capital recovery period is used, the LCOE for solar is lower than all eight units, as shown in Figure 2.

Figure 2. Levelized cost of energy, with solar costs reflecting online date of 2019 (2019$)



Capital costs for solar are expected to decline in the future, and thus solar capacity that comes online later is expected to have a lower LCOE than earlier installations. Similarly, capital investments recovered over a longer time period have lower LCOE values. Figure 3 shows the LCOE for Santee Cooper's coal units compared to solar resources installed in 2025. With a 30-year capital recovery period, the LCOE for solar is well below all of Santee Cooper's coal units. A 20-year capital recovery period again beats five of the eight units and is approximately equal to the remaining three units.

Figure 3. Levelized cost of energy, with solar costs reflecting solar online date of 2025 (2019$)



3.2. Electric System Modeling

EnCompass modeling produced an optimal, least-cost resource portfolio and generation mix based on the detailed capacity expansion and electric system dispatch modeling of both Santee Cooper's service territory and the surrounding areas. In this section we turn to the results of the EnCompass modeling with respect to the changing capacity mix and resulting electricity generation in the four modeled scenarios: BAU, Gas Medium, Gas Major, and Clean Energy.[23]

Capacity Mix in the Modeled Scenarios

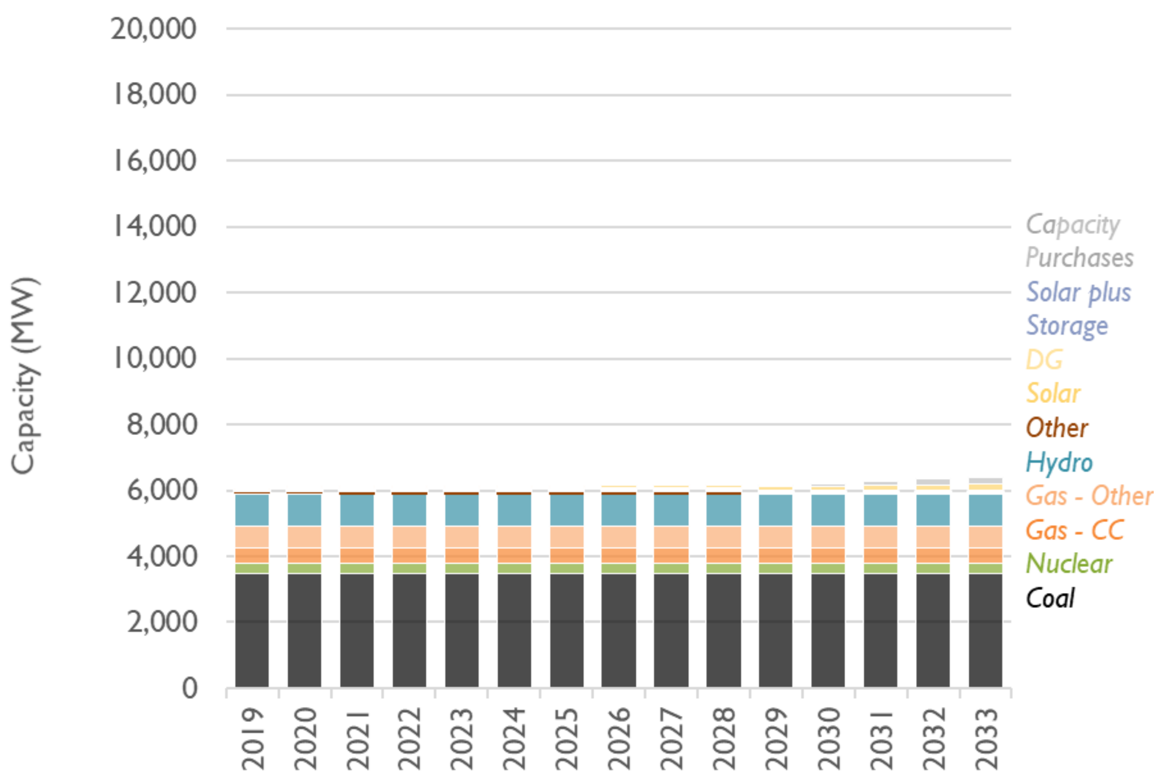
In its 2018 IRP, Santee Cooper states that it does not plan to add new generating capacity prior to 2033, as it already has enough capacity to meet projected peak load plus reserve requirements. The BAU

[23] Capacity is the maximum output of a generating unit at any point in time and is generally expressed in kilowatts (kW) or megawatts (MW). Generation is the amount of electricity that is produced over a specific time period and is generally expressed in kilowatt hours (kWh) or Megawatt hours (MWh).

scenario reflects the current resource mix with no new capacity retirements or replacements. The alternative scenarios (Gas Medium, Gas Major, and Clean Energy) adopt an accelerated retirement schedule for the Winyah and Cross coal units, which are non-economic, prior to 2029, and add new capacity as needed. Notably, when the model solved for the least-cost way to meet energy and capacity needs under the coal retirement scenarios, it selected clean energy resources such as utility-scale solar and paired solar-plus-storage even in the gas expansion scenarios. This selection reflects the increasing economic competitiveness of those resources.

The capacity mix in the BAU scenario is shown in Figure 4, and it reflects both the capacity owned by Santee Cooper and capacity purchased under power purchase agreements. Approximately 76 percent (4.6 GW) of Santee Cooper's installed capacity in 2019 is fossil fuel-powered thermal (coal- or gas-fired), 5 percent (322 MW) of capacity is nuclear, and the remaining 19 percent (~1 GW) comes from hydroelectric and renewable resources. The "Other" category represents a Santee Cooper contracted biomass facility of 74 MW that ends in 2028.

Figure 4. BAU scenario, Santee Cooper modeled capacity (nameplate), 2019 to 2033

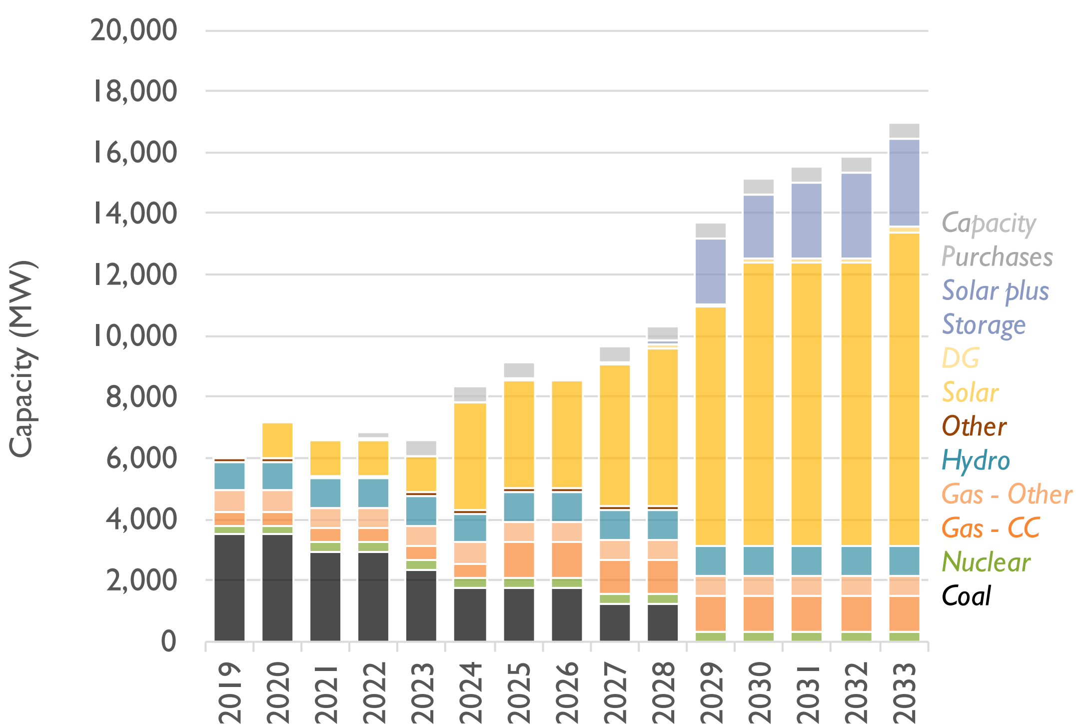


Note: Santee Cooper makes a capacity sale in 2019 and small capacity purchases during select years at the end of the analysis period, shown in light gray.

The BAU capacity portfolio stays relatively constant over the study period. However, in 2033 the proportion of fossil-fired resources declines slightly from 76 to 74 percent with the addition of assumed distributed generation (DG) solar resources. We based that assumption on a forecast from Horizons Energy, developer of the EnCompass National Database, and kept it consistent across all scenarios.

In the alternative Gas and Clean Energy scenarios, orderly retirement of Winyah and Cross units reduces coal capacity from 2019 through 2029. Figure 5 and Figure 6show the capacity mix that the model produced in the Gas Medium and Gas Major scenarios, respectively. In both scenarios, new gas combined cycle and combustion turbine resources were available beginning in 2025. In Gas Medium, the replacement renewable resources were unconstrained, meaning that there were no limits placed on either the annual or cumulative additions of renewable resources over the course of the study period, whereas in the Gas Major, new solar was constrained to 100 MW of new capacity per year.

Figure 5. Gas Medium scenario, Santee Cooper modeled capacity (nameplate), 2019 to 2033



Note: The "Gas-Other" category includes both combustion turbines and internal combustion units.

As shown in Figure 5, in the Gas Medium scenario, the model added one 702 MW gas combined cycle unit in 2025 and then selected no other additions of new gas capacity for the remainder of the study period. Instead, the model chose to meet any capacity and energy needs with new standalone solar capacity as well as paired solar-plus-storage resources. Based solely on economic selection by the model, renewable energy capacity is added to make up the bulk of Santee Cooper's resource portfolio by 2033 despite new gas capacity being available for selection.

In Gas Major, we placed limits on solar additions in order to model a resource portfolio that relies more heavily on new gas capacity for comparison purposes. Since new gas units are not available prior to 2025, EnCompass is allowed to select renewables as needed prior to 2025 for economic reasons and to avoid capacity shortages following the retirement of Santee Cooper's coal units. In 2025 and beyond, solar additions are limited to 100 MW per year. With the supply of cost-competitive solar limited, EnCompass added a first 702 MW combined cycle unit in 2025, a second 702 MW combined cycle unit in 2027, and a third like unit in 2029. While in the Gas Medium option, total gas capacity reaches 1.8 GW, or 11 percent of the total capacity mix in 2033, in the Gas Major scenario total gas capacity is 3.4 GW—almost a third of total capacity—by the end of the study period. Notably, the model added 1,500 MW of wind capacity in 2033 in this scenario. Under conditions where solar capacity is limited, the model added additional renewable capacity through the addition of wind in this final year rather than build new gas capacity, reflecting wind power being cost competitive when compared to new gas resources in the later years of analysis.

Figure 6. Gas Major scenario, Santee Cooper modeled capacity (nameplate), 2019 to 2033

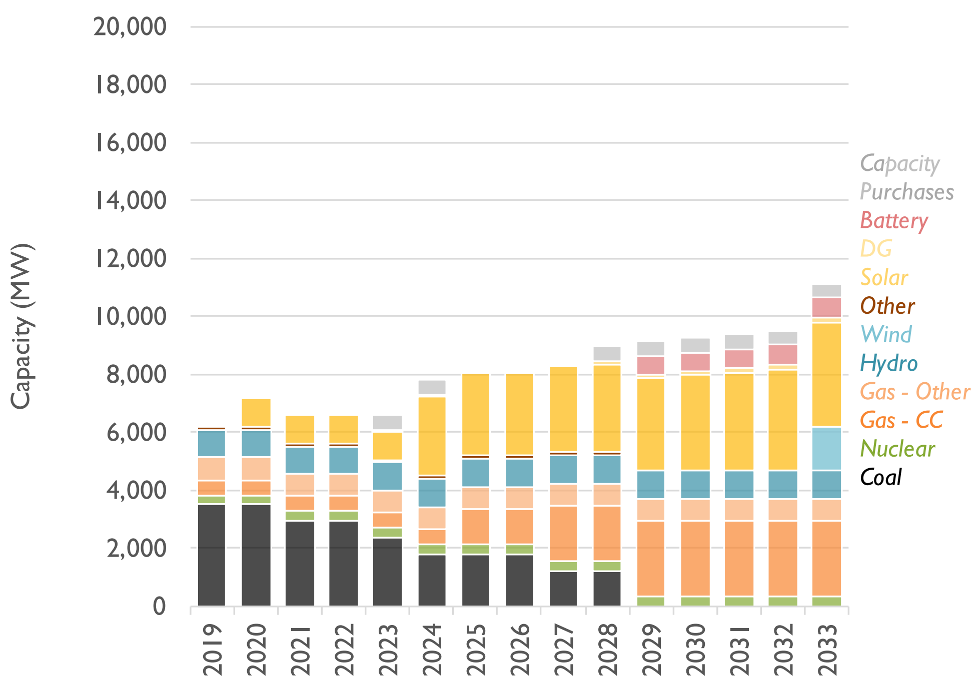
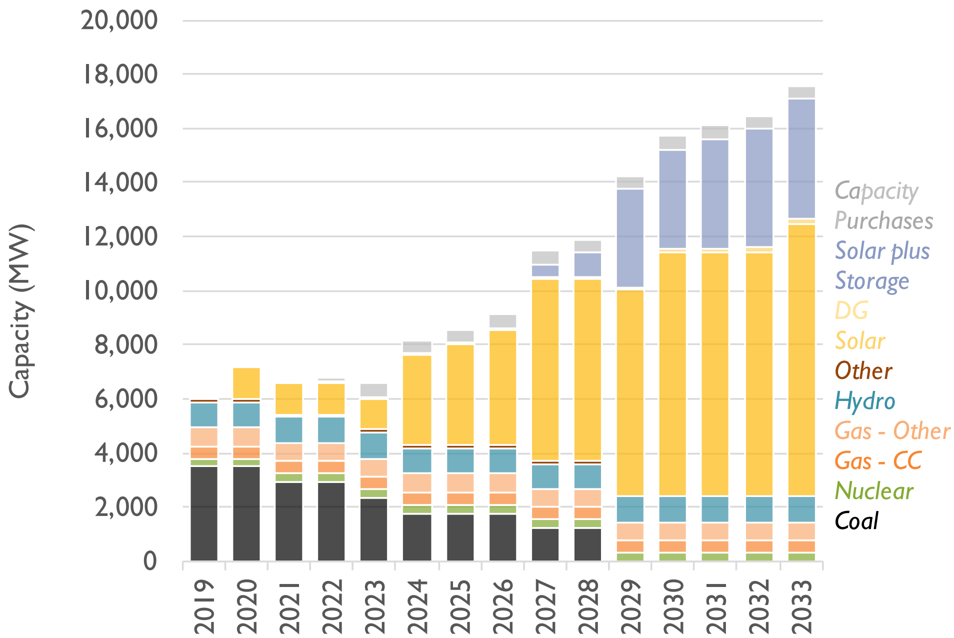


Figure 7 shows the resulting capacity mix under the Clean Energy scenario. In this scenario, EnCompass economically chose standalone solar resources through 2027, at which point the model also began to build paired solar-plus-storage resources. Batteries are charged only from the solar component of the paired resource and discharge during periods of peak demand. Total gas capacity in the Clean Energy scenario is 1.1 GW, which is approximately 7 percent of the total in 2033. Renewables—which include solar, solar-plus-storage, and existing hydro—make up 91 percent of total capacity, while nuclear and power purchase agreements for landfill gas make up the remaining 2 percent.

Figure 7. Clean Energy Scenario, Santee Cooper modeled capacity (nameplate), 2019 to 2033



Incremental and cumulative resource additions for each of the three Retire/Replace scenarios are shown in Table 2 and Table 3, respectively. In all three scenarios, the model added a large amount of solar in 2020, with the total amount dependent on the scenario. This solar capacity was added as replacement for the retiring Winyah 1 and 2 units and as a source of zero fuel cost generation. A second large amount of solar was added in 2024, following the retirements of Winyah 3 and 4 in 2022 and Cross 2 in 2023. Prior to 2025, solar additions in the Clean Energy scenario were slightly less than in Gas Medium, due in part to the increased energy efficiency present in the Clean Energy scenario. Notably, between 2019 and 2033, total solar installations in Gas Medium are only slightly less than in the Clean Energy scenario—12,080 MW compared to 12,900 MW—demonstrating that solar energy is an overwhelmingly economic replacement option for the retiring coal units, even when new gas capacity is available. The Clean Energy scenario does contain more than 500 additional MW of battery storage capacity as compared to the Gas Medium scenario. In the absence of the additional gas capacity, and due to the intermittent nature of solar, the model adds additional storage capacity so that it can call on this source of energy during hours when photovoltaic production is low or non-existent.

Table 2. Incremental resource additions in the Retire/Replace scenarios (MW)

	Gas Medium				Gas Major				Clean Energy			
Year	Gas	Solar	Battery	Wind	Gas	Solar	Battery	Wind	Gas	Solar	Battery	Wind
2019		40				40				40		
2020		1,060				850				1,030		
2021												
2022												
2023												
2024		2,330				1,790				2,170		
2025	702	50			702	100				400		
2026		1,090								540		
2027		630			702	100				2,770	152	
2028		3,940	40			100				280	140	
2029		1,440	672		702	100	668			2,680	912	
2030		240				100				1,450	32	
2031		220	120			100				240	116	
2032		1,040	112			100				220	112	
2033			12			100		1,500		1,080	32	

Table 3. Cumulative resource additions in the Retire/Replace scenarios (MW)

	Gas Medium				Gas Major				Clean Energy			
Year	Gas	Solar	Battery	Wind	Gas	Solar	Battery	Wind	Gas	Solar	Battery	Wind
2019		40				40				40		
2020		1,100				890				1,070		
2021		1,100				890				1,070		
2022		1,100				890				1,070		
2023		1,100				890				1,070		
2024		3,430				2,680				3,240		
2025	702	3,480			702	2,780				3,640		
2026	702	3,480			702	2,780				4,180		
2027	702	4,570			1,404	2,880				6,950	152	
2028	702	5,200	40		1,404	2,980				7,230	292	
2029	702	9,140	712		2,106	3,080	668			9,910	1,204	
2030	702	10,580	712		2,106	3,180	668			11,360	1,236	
2031	702	10,820	832		2,106	3,280	668			11,600	1,352	
2032	702	11,040	944		2,106	3,380	668			11,820	1,464	
2033	702	12,080	956		2,106	3,480	668	1,500		12,900	1,496	

Generation in the Modeled Scenarios

Figures 8 to 15 on the following pages provide more detail about the generation mix in each of the four scenarios. Two figures are provided for each scenario: an area chart showing the generation by fuel type for Santee Cooper's resources and a bar chart showing the imports and exports to and from Santee Cooper relative to generation and customer demand.

While the BAU scenario brings relatively few changes to the capacity mix over time, we do see one very important change in the generation mix due primarily to the poor economics of Santee Cooper's coal plants as compared to other energy resources. In Figure 8 and Figure 9, representing the BAU, energy imports begin to make up a growing percentage of Santee Cooper's generation mix in 2024, rising to approximately one-third of total generation in 2033. This is due to a combination of factors, including increasing demand, expiring power purchase agreements, a decline in generation from gas peaking units, and most importantly a decline in coal generation of approximately 5,000 gigawatt hours (GWh) between 2019 and 2033. This decline in coal generation is driven by the availability of less expensive energy from gas and renewable resources in the neighboring regions, making it cheaper for Santee Cooper to import energy from its neighbors than to run its own coal-fired power plants. In the absence of these imports, system generation costs would rise as Santee Cooper's own units are forced to generate more costly electricity to meet demand.

Figure 8. BAU scenario, modeled generation, 2019 to 2033

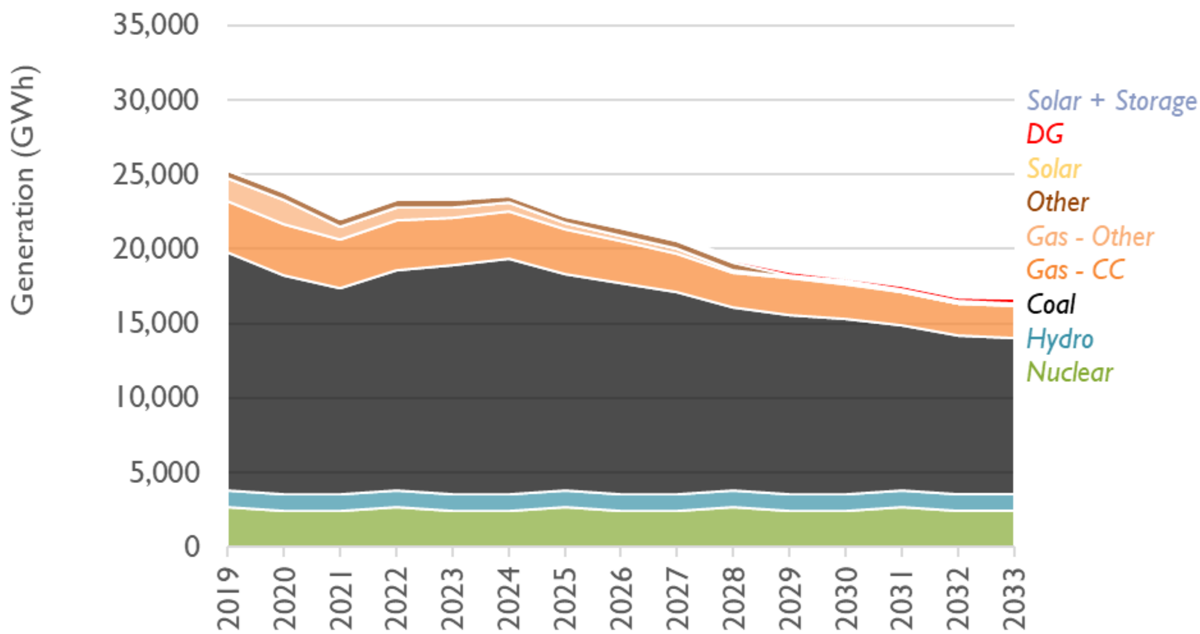
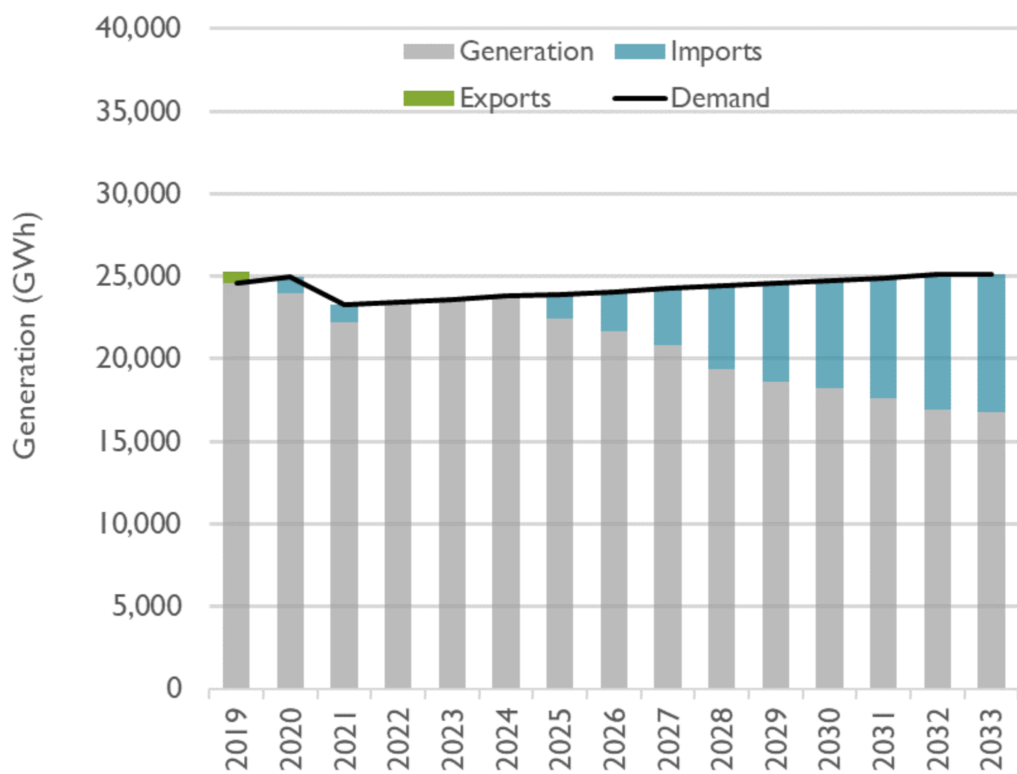


Figure 9. BAU scenario, modeled imports/exports and generation, 2019 to 2033



In the alternative non-BAU scenarios, non-economic coal generation declines more quickly between 2019 through 2028 as units retire. Figure 10 through Figure 13 show generation and imports/exports in the Gas Medium and Gas Major scenarios, respectively. In both scenarios, Santee Cooper turns from a net importer (in the BAU) to a net exporter of energy to the remainder of the SERC-East balancing authority. Standalone solar generation (yellow) or solar-plus-storage generation (lavender) are a large part of the generation mix as can been seen in both Figure 10 and Figure 12.[24] Excess generation beyond what is needed to meet Santee Cooper's own energy requirements—either to meet demand or to refill storage capacity—is exported to neighboring utilities in the region. The level of imports and exports for each of the scenarios relative to the total generation and demand are shown in Figure 11 and Figure 13. Generation that exceeds total demand and is not exported to neighboring regions goes toward charging battery resources in Santee Cooper's service territory.

[24] The lavender "Solar + Storage" section (not visible in the BAU scenario) represents both components of the paired solar-plus-battery resources—generation from the solar resource and discharge from the battery. Generation from the solar component can be used to charge the battery component or can flow to the grid.

Figure 10. Gas Medium scenario, modeled generation, 2019 to 2033

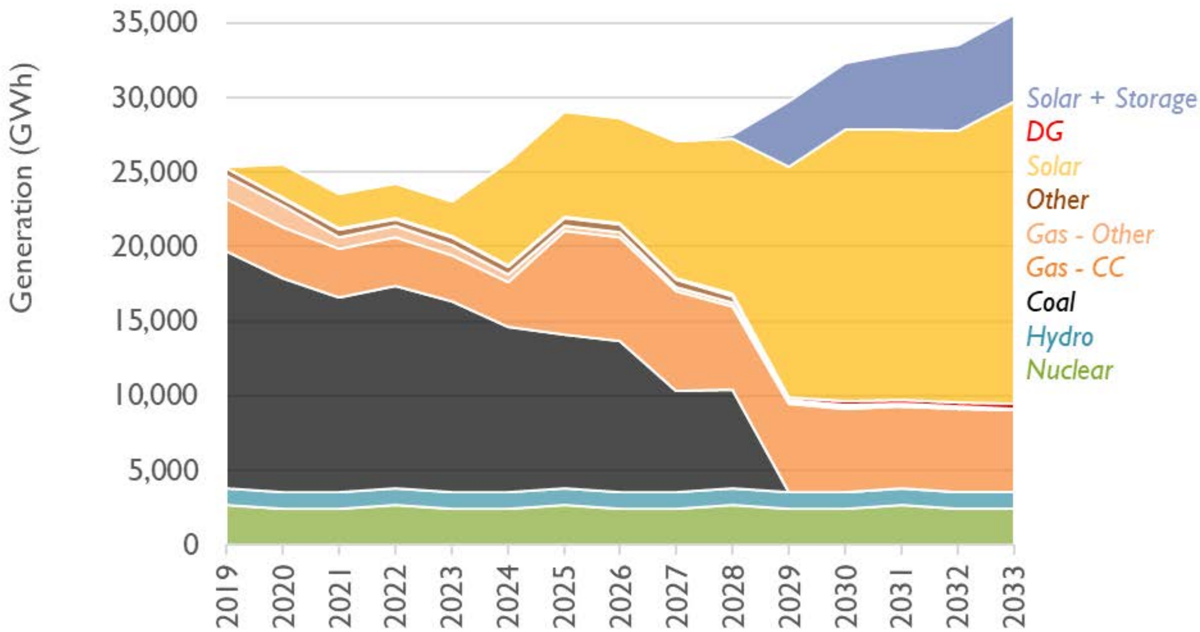


Figure 11. Gas Medium scenario, modeled imports/exports and generation, 2019 to 2033

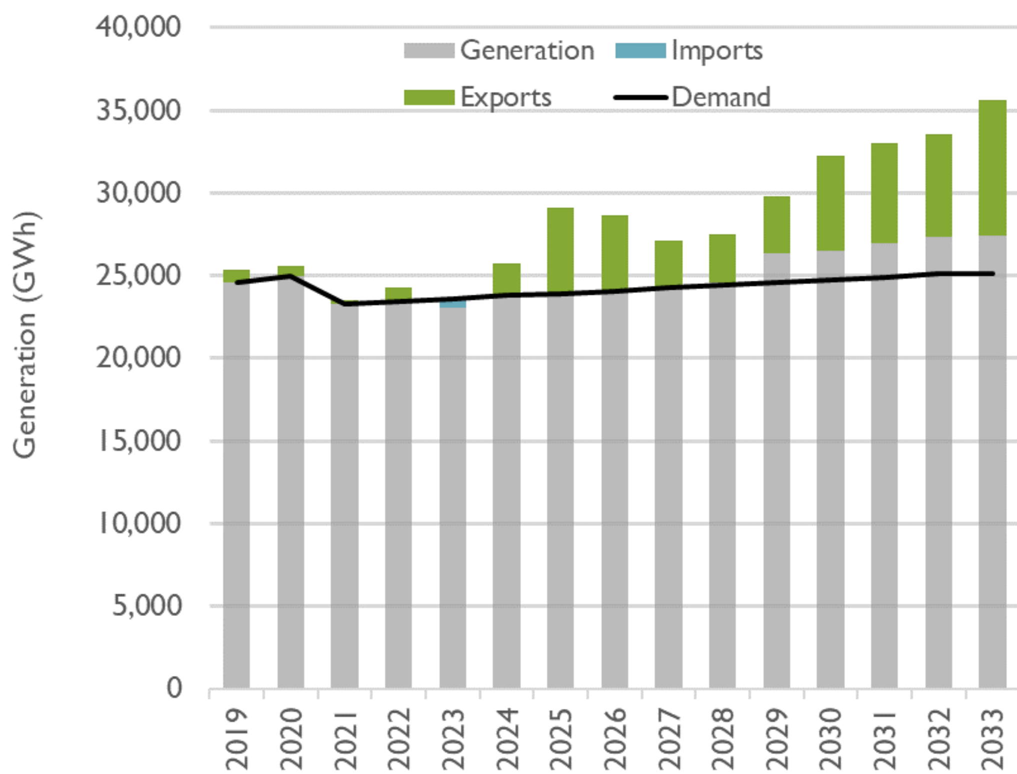


Figure 12. Gas Major scenario, modeled generation, 2019 to 2033

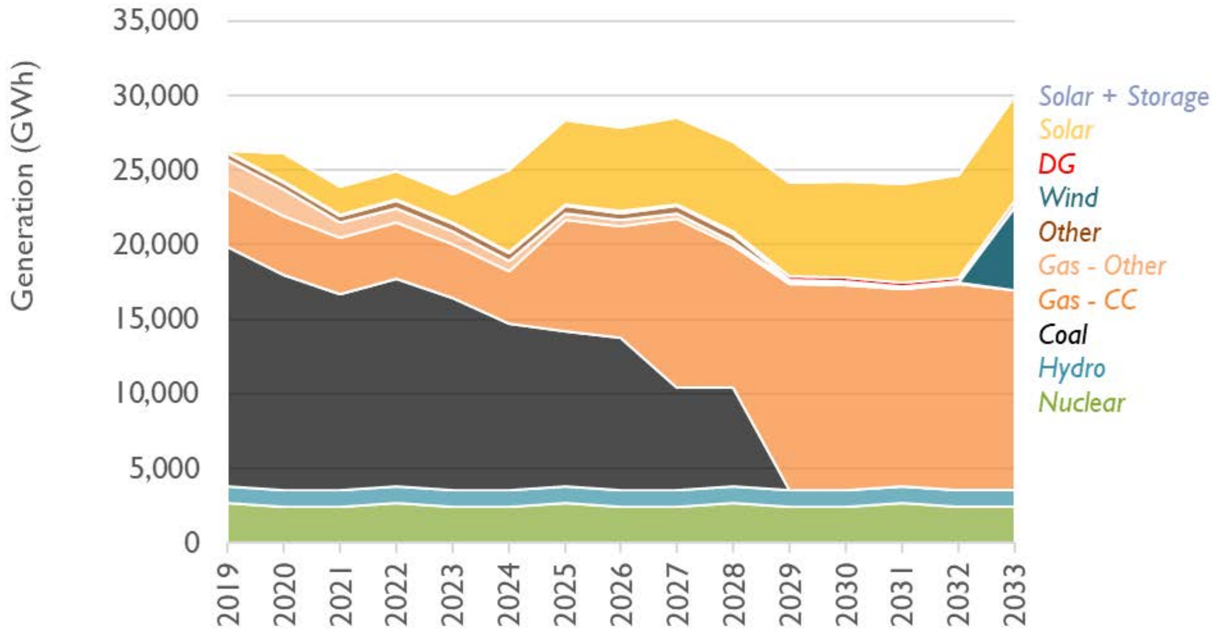
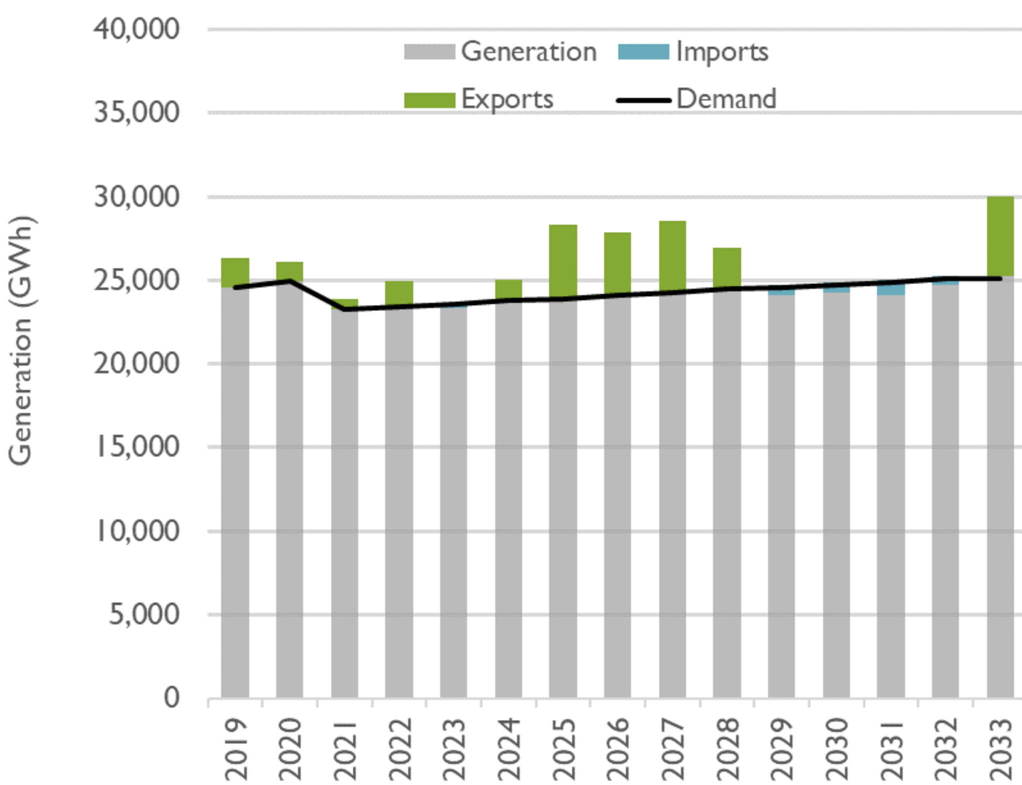


Figure 13. Gas Major scenario, modeled imports/ exports and generation, 2019 to 2033



The Clean Energy scenario has lower annual energy demand than any of the other modeled scenarios due to additional energy efficiency. It also shows more energy generation coming from paired solar-plus-storage resources and slightly less from standalone solar compared to the Gas Medium scenario. Exports in this scenario are higher than in the Gas Major scenario but lower than in the Gas Medium scenario. Those results are shown below in Figure 14.

Figure 14. Clean Energy scenario, modeled generation, 2019 to 2033

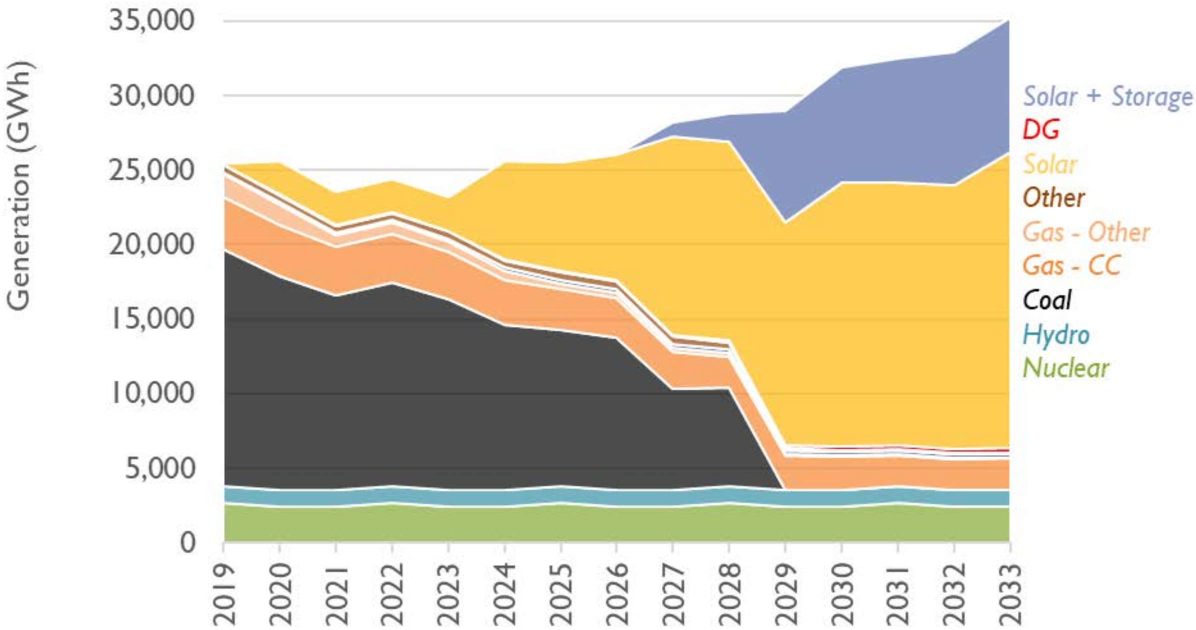
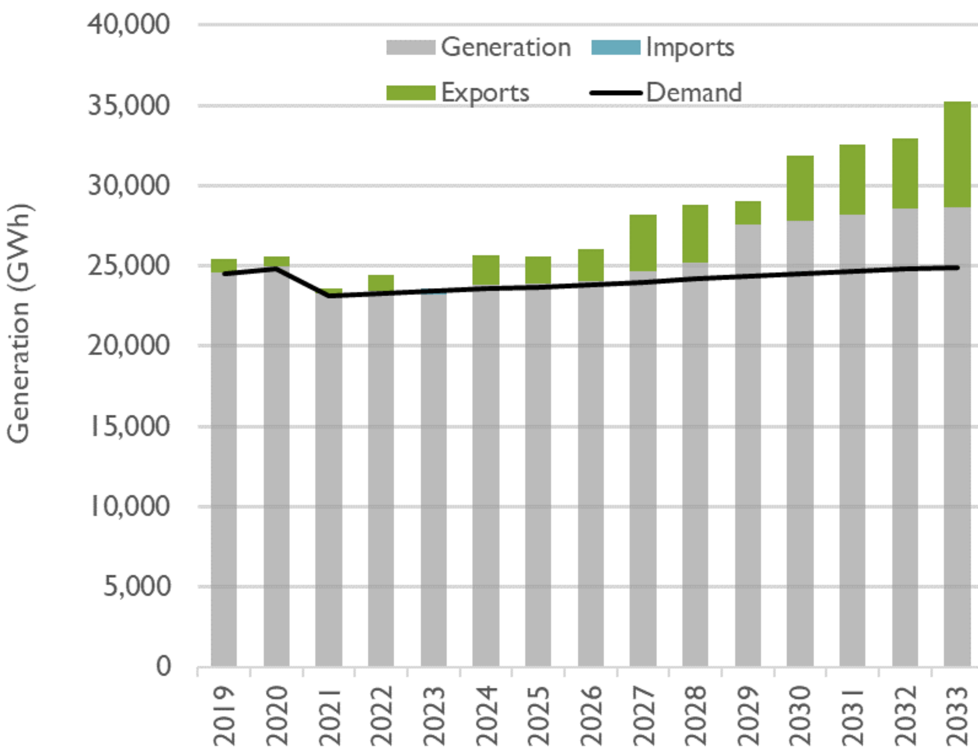


Figure 15. Clean Energy scenario, modeled imports/exports and generation, 2019 to 2033



All three of these alternative scenarios contain a higher percentage of renewable generation than what Santee Cooper has planned for in its IRP. The Gas Major scenario, which has renewable supplies limited to 100 MW annual additions, shows the least amount of generation coming from renewables at just under 50 percent in 2033. When renewables are unconstrained, by contrast, the model economically selects more renewable capacity over the analysis period. Renewables make up most of the generation mix in both the Gas Medium and Clean Energy plans by 2033, as shown in Table 4 below.

Table 4. Percentage of renewable energy generation by scenario and year

Year	Gas Medium	Gas Major	Clean Energy
2025	30%	24%	36%
2030	75%	35%	85%
2033	78%	48%	87%

Note: Energy imports, exports and energy efficiency were not included in the percentage calculation.

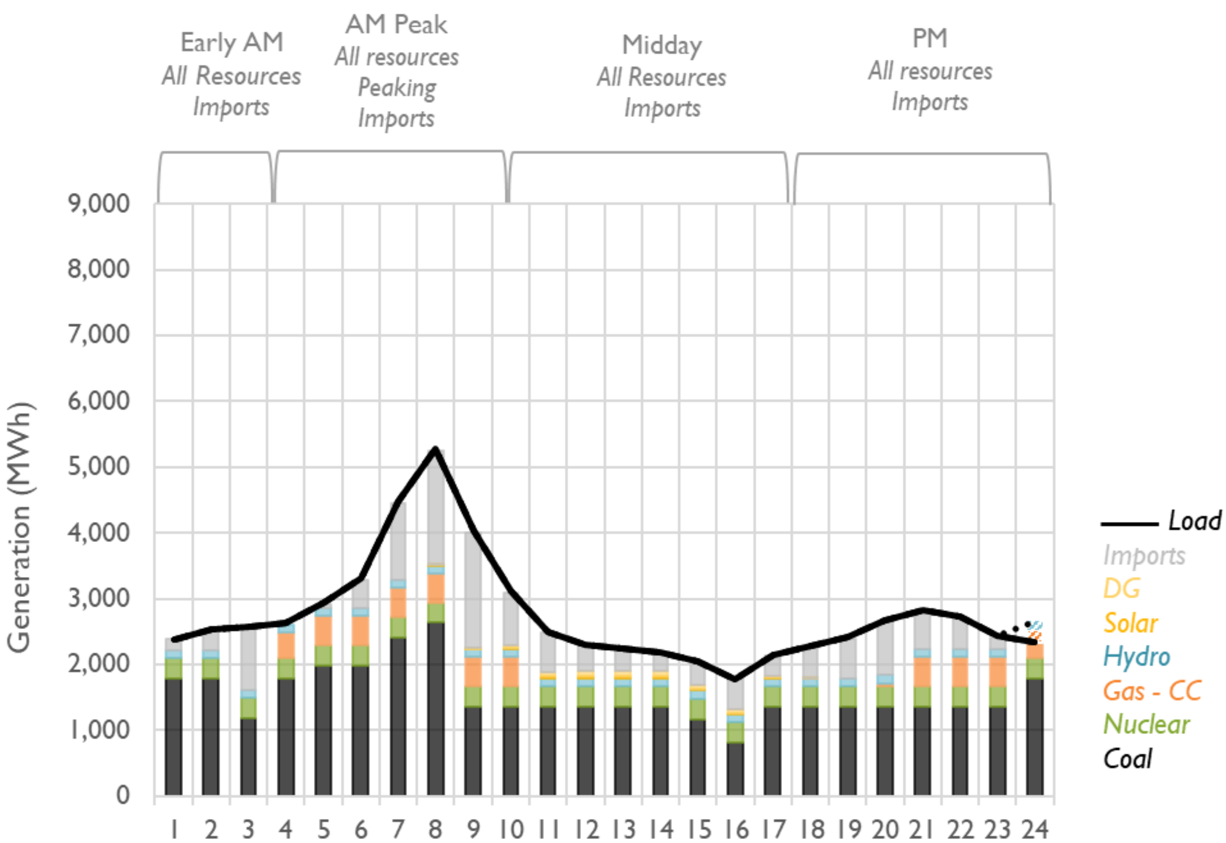
3.3. Operational Aspects of Alternative Scenarios – Peaking Hours

As higher renewable energy scenarios are adopted around the country, they may challenge traditional expectations of utility operations. Below, we discuss how the Encompass model balances renewable energy production, storage, and demand on an hourly basis during key periods of the year. The Clean Energy portfolio successfully generates, stores, and dispatches renewable energy through the Santee Cooper region. In addition, it imports and exports energy from and to its utility neighbors, and it meets customer peak demands (and regional demand) under all conditions, including morning winter peaks.

In considering peak demand hours, it is important to understand that, while systems like Santee Cooper's may experience relatively few highest peak demand hours on winter mornings, they will experience many more "near peak" hours over the course of long hot summer afternoons. For example, the peak hour in our model occurs in January. When a threshold of 80 percent of this peak is applied to all hours in the year, the month of January has 53 hours during which load is above this threshold. The month of July, in contrast, has 151 hours above this threshold, while August has 75 hours that are above the threshold. Both winter and summer peaks are considered below.

Figure 16 shows energy generation and load in the BAU on January 1, 2032, a representative winter peak day. Customer load is represented by the solid black line. Each of the solid colored bars represents generation of the specific resources. Imports are represented by the solid gray bars. As shown in Figure 16, the BAU scenario relies primarily on coal generation and energy imports in all hours of the day, with the exception of Hour 23 (11:00 pm), in which coal ramps up to displace the imports and produce net exports. Gas generation contributes to the early morning peak and shoulder hours as well as the tail end of the evening peak.

Figure 16. BAU scenario, sample winter peak generation by fuel type, January 1, 2032



We present hourly generation in the Clean Energy scenario for two different years in the analysis period. Figure 17 presents hourly generation in 2025 when Cross 1, 3, and 4 are still in operation, while Figure 18 shows hourly generation in 2032 after all coal has been retired. Figure 17 below shows hourly energy generation and load in the Clean Energy scenario on January 1, 2025, a representative winter peak day demonstrating the impacts of partial coal retirement. Again, the solid black line represents the load over the day and the solid gray area represents energy imports. The hatched-colored bars above the solid black line and below the dotted line represents energy exports.

Figure 17. Clean Energy scenario, sample winter peak generation by fuel type, January 1, 2025

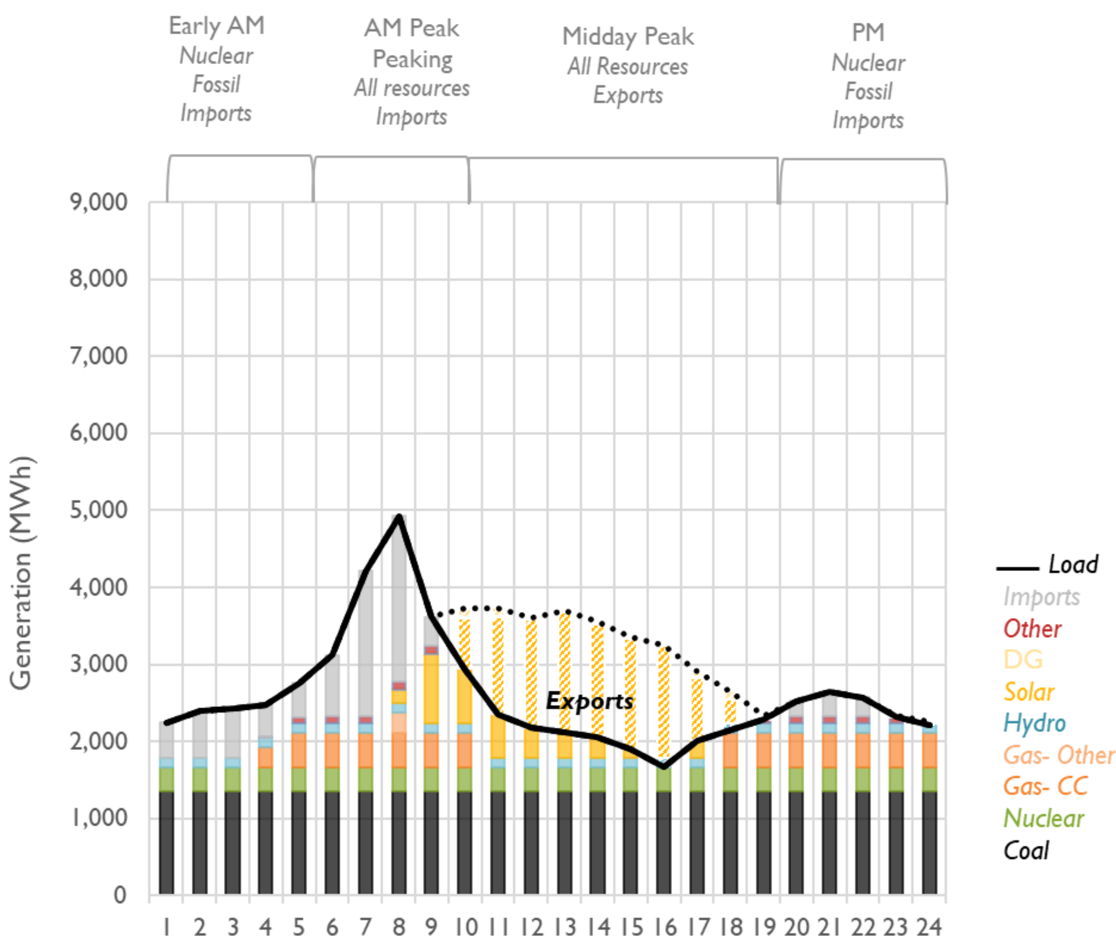
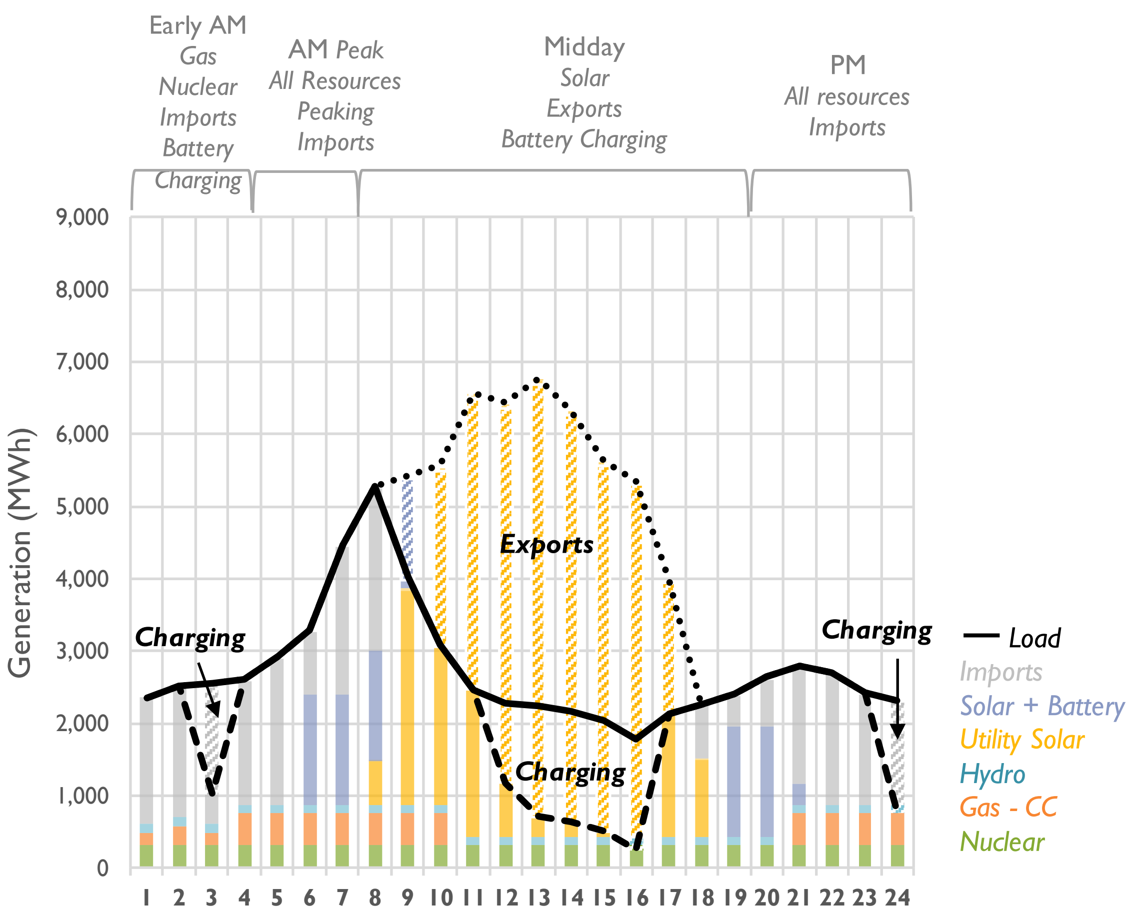


Figure 18 shows the Clean Energy portfolio on January 1, 2032, a representative day after all coal units have been retired. The figure is more complex because it reflects increased amounts of storage resources in the later years of the analysis period and captures interactions between the solar resources and the batteries. Energy imports are represented in solid gray bars below the black load line. Exports are represented in the cross-hatched colored area above the black line. Cross-hatched areas under the black line and above the dashed line show times when storage resources are charging, either via imported energy (cross-hatched gray bars) or via Santee Cooper's solar resources (cross-hatched gold bars). Solar generation does triple duty by providing energy to customers, charging the system's storage devices, and exporting energy for sale throughout the day.

Figure 18. Clean Energy scenario, sample winter peak generation by fuel type, January 1, 2032

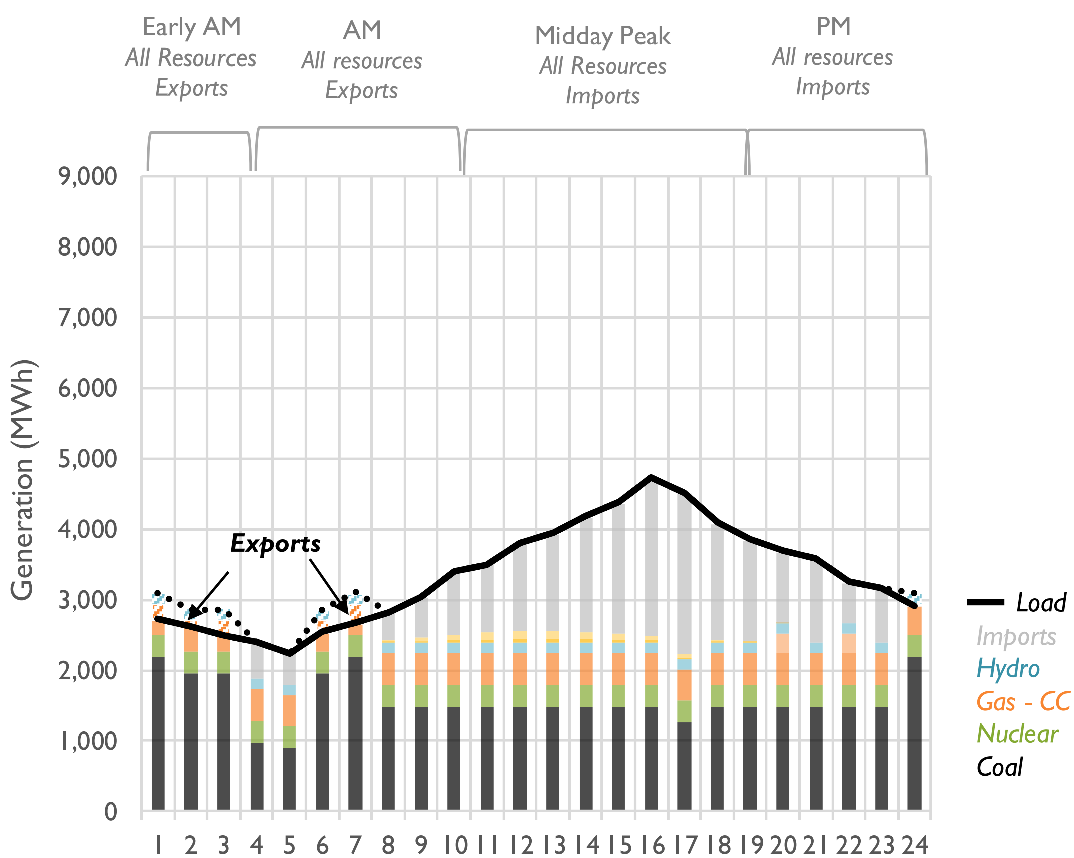


The Clean Energy scenario relies on renewable resources, nuclear generation, gas, and some level of energy imports to meet demand in peak morning hours and then exports energy during the midday demand trough. In this scenario, the renewable energy is approximately 86 percent of the total energy generated in Santee Cooper in calendar year 2032. This scenario uses a mix of storage, hydroelectric, and some solar generation to meet the hourly peaks. Modest amounts of battery storage capacity with four-hour duration are charged in the early morning from energy imports prior to the morning peak and then are charged in the midday load-trough hours from system solar generation. This charging pattern allows the batteries to discharge during morning hours to meet the morning peak and evening hours to help meet the evening peak. During the 9 am hour, batteries are discharging both to meet Santee Cooper load and to export energy to neighboring utilities.

Discussions around the sale of Santee Cooper have highlighted the importance of imports into and from the utility's service territory, as some bidders rely in large part on capacity and energy imports to meet projected future demand. Imports play an important role during winter peaking hours in our Clean Energy scenario, with exports of similar importance during the hours with peak solar output. These imports and exports are able to occur on existing transmission lines and do not require the addition of transmission lines. Appendix A gives more information on our assumed model topology.

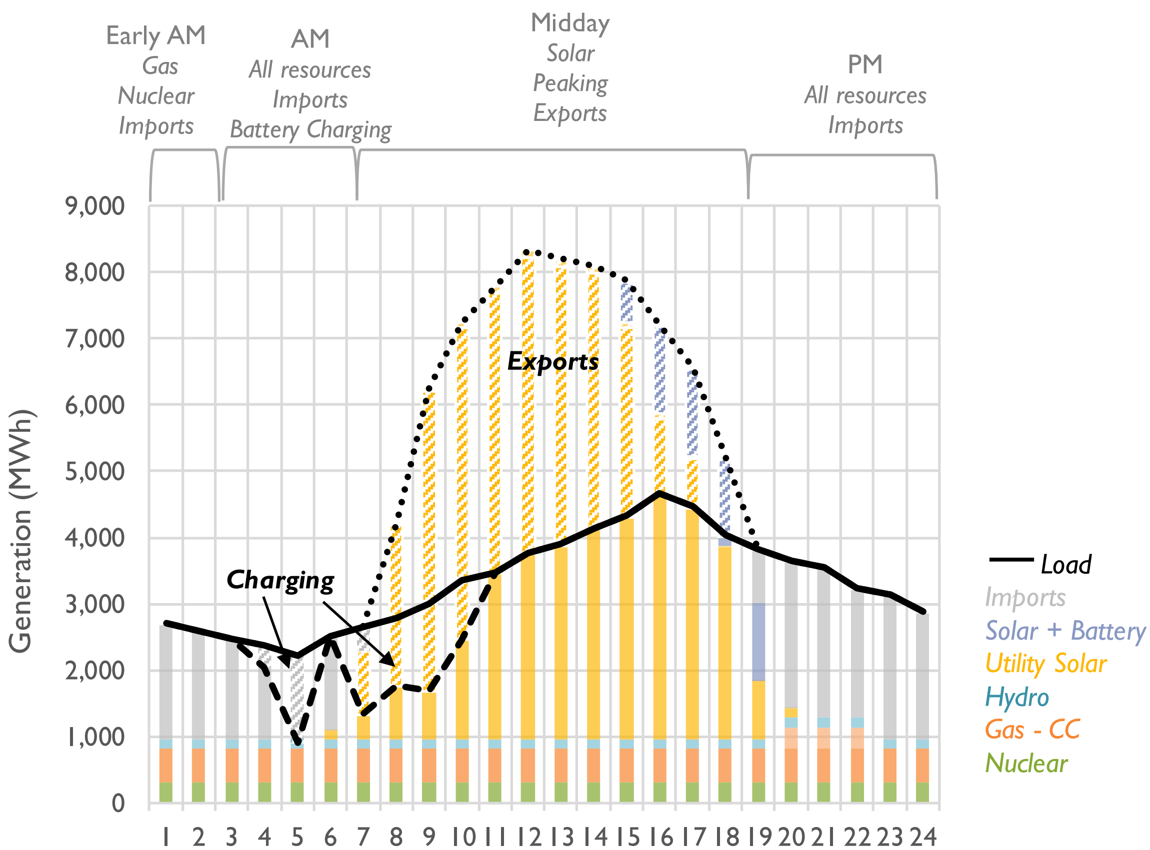
Figure 19 and Figure 20 show energy generation on July 1, 2032—a representative summer peak day—for the BAU and Clean Energy scenarios.

Figure 19. BAU scenario, sample summer peak generation by fuel type, July 1, 2032



In contrast to the winter months, the daily peak in the summer occurs during the early evening. In the BAU scenario, coal, nuclear, gas, and hydro generate throughout the day, with coal ramping up from 5 am to 7 am and staying relatively constant from 8 am to 11 pm. Imports rise to meet the 4 pm peak and then ramp steadily down.

Figure 20. Clean Energy scenario, sample summer peak generation by fuel type, July 1, 2032



In the Clean Energy scenario, battery storage capacity is charged in the early morning between 3 am and 7 am from energy imports, and from 6 am to 11 am from solar,[25] allowing the batteries to discharge during evening hours between 6 pm and 8 pm. Like the winter peak profile, the Clean Energy scenario relies on nuclear generation, gas, and some level of energy imports to meet demand in the early morning and late evening. From approximately 7 am until 7 pm, solar generation meets a sizable portion of Santee Cooper's customer demand and also goes toward a substantial volume of exports to neighboring utilities. Regional economics of generating units affect the behavior of battery storage from hour to hour in this analysis. Batteries discharge during the summer peak between the hours of 3 pm and 6 pm, primarily for the purposes of energy exports, which are the highest valued use of stored

[25] Note that at 7 am, batteries are charging from both imports and solar.

generation. Generation from storage to meet Santee Cooper's load occurs at 6 pm and 7 pm. If the generation mix in neighboring utility territories were to look different, generation from battery storage could instead displace a portion of the imports that occur in the early morning or late evening hours.

3.4. Carbon Dioxide Emissions

Finally, as expected based on the substantial difference in carbon-free capacity and generation between the BAU and the Gas Medium and Clean Energy scenarios, the CO_2 emissions in the latter scenarios are much lower than in the BAU scenario. The retirement of the Winyah units and the Cross 2 unit by the end of 2023 leads to a reduction in annual CO_2 emissions of almost 6 million tons by 2024. By contrast, the Gas Major scenario has emissions that are higher than in the BAU prior to 2023 due to the lower volume of solar additions in the early years in that scenario. While all scenarios see an overall emissions decline, the emissions decline in the BAU scenario is driven by decreasing operation of uneconomic coal units due to displacement by lower-priced energy imports (the cost of purchasing energy in the market is lower than the cost of running the coal plants). Nonetheless, the BAU scenario continues to emit almost 12.5 million tons of CO_2 in 2033, while the Gas Major emits just over 5 million tons, Gas Medium emits almost 2.3 million tons, and the Clean Energy scenario emits just under 1 million tons. Figure 21 depicts this widening gap.

Figure 21. Annual Santee Cooper CO_2 emissions by scenario

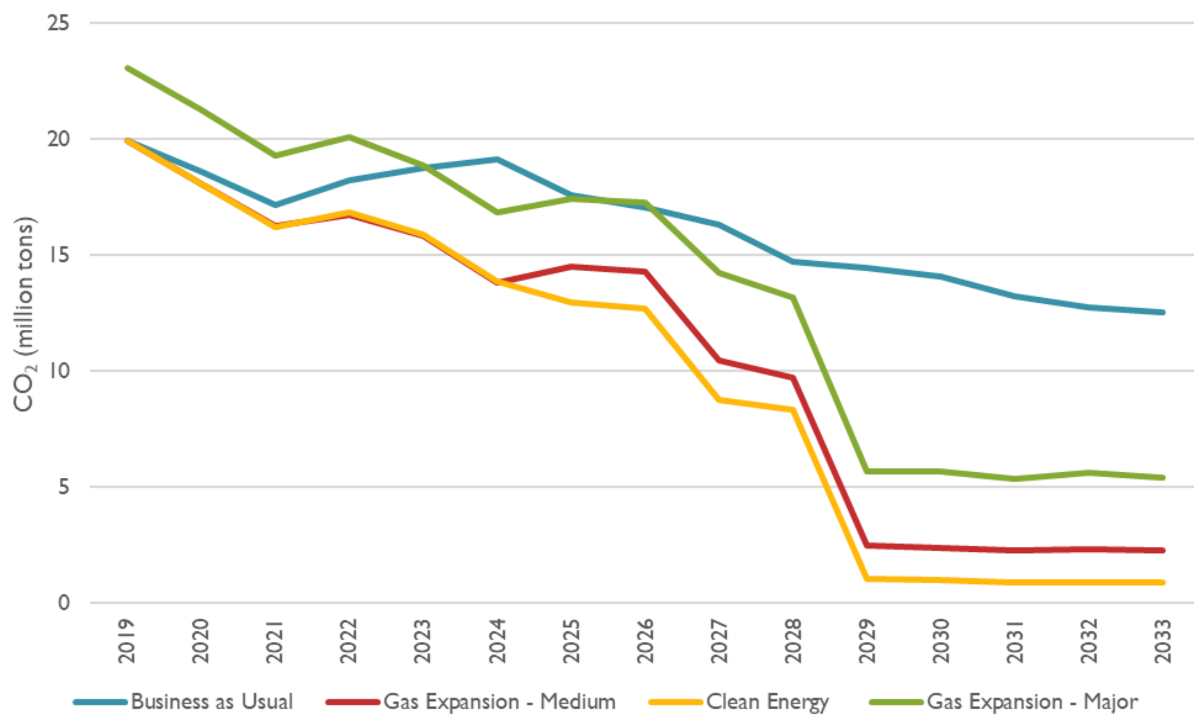


Figure 21 depicts the carbon emissions over the course of the study period between 2019 and 2033. We highlight the fact here that the Gas Medium scenario includes only one 702 MW CC plant as a replacement resource and relies on a much greater volume of renewable resources, which is why the emissions in this scenario are closer to—although considerably higher than—emissions in the Clean Energy scenario. The Gas Major scenario, which includes a more substantial gas buildout and limits renewable deployment, has emissions that are more than double the Gas Medium scenario.

The numbers do not include emissions associated with imports of energy from neighbors, nor do they account for emissions displaced due to exports to neighbors. This analysis includes a CO_2 price forecast from Duke Energy's 2018 IRPs. This forecast is a conservative one, and a higher CO_2 price trajectory will increase the costs of the more fossil-intensive resource portfolios. It is also important to understand that other emissions associated with the extraction and transportation of the additional gas in these scenarios have not been accounted for in the estimates shown in Figure 21. If included, these emissions would make them higher still than the Clean Energy plan. Finally, the results depicted are for the timeframe of the study only. However, once installed, gas units will continue to emit CO_2 over the operating life of the asset.

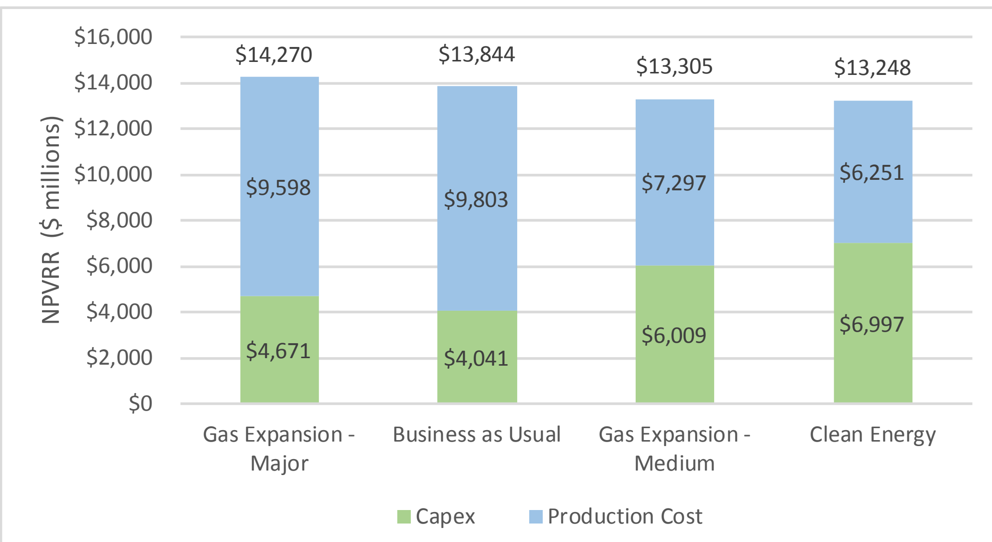
4. Results – High Gas Price Sensitivity

Prior to the technology development that allowed for greater volumes of shale gas extraction, gas prices were historically quite volatile. Gas prices are a result of both supply and demand, and if gas becomes a preferred source of fuel for many end-uses, including heating and electricity, the risk exists that gas prices will increase more than expected over the analysis period. To test this price risk, Synapse examined a High Gas Price sensitivity, fixing the capacity builds in each of the three scenarios in order to examine the effect of higher gas prices on system generation and costs.

4.1. Resource Portfolio Costs

Revenue requirements of scenarios with increased reliance on gas respond directly to variations in gas prices. In Figure 22, the revenue requirements for the four modeled scenarios are compared under the High Gas Price sensitivity. Ratepayers save even more from a Clean Energy option under a high gas price future, with the Clean Energy scenario costing $596 million less than the BAU scenario and over a billion dollars less than the Gas Major scenario.

Figure 22. Revenue requirements (M$ NPV 2019-2033), high gas prices



As shown in Table 5, under reference gas prices, the Clean Energy plan saves customers $360 million compared to BAU as Santee Cooper's coal-fired generators are retired and energy efficiency and renewable are used, while as mentioned above higher gas prices yield a savings of $596 million.

Table 5. Comparison of revenue requirements, reference gas and high gas

PVRR ($ millions)	Gas Major	BAU	Gas Medium	Clean Energy
Reference Gas Price	$13,808	$13,569	$13,284	$13,209
Costs/(Savings) compared to BAU	$239	-	($285)	($360)
High Gas Price	$14,270	$13,844	$13,305	$13,248
Costs/(Savings) compared to BAU	$426	-	($539)	($596)

4.2. Electric Sector Modeling

Capacity in each of the High Gas Price scenarios was fixed and is thus unchanged from the Reference Gas Price scenarios. We show generation mix in this section for each of the modeled scenarios. Figure 23 and Figure 24 show generation and imports/exports, respectively, in the BAU scenario under high gas prices.

Figure 23. BAU scenario, modeled generation, 2019 to 2033, high gas prices

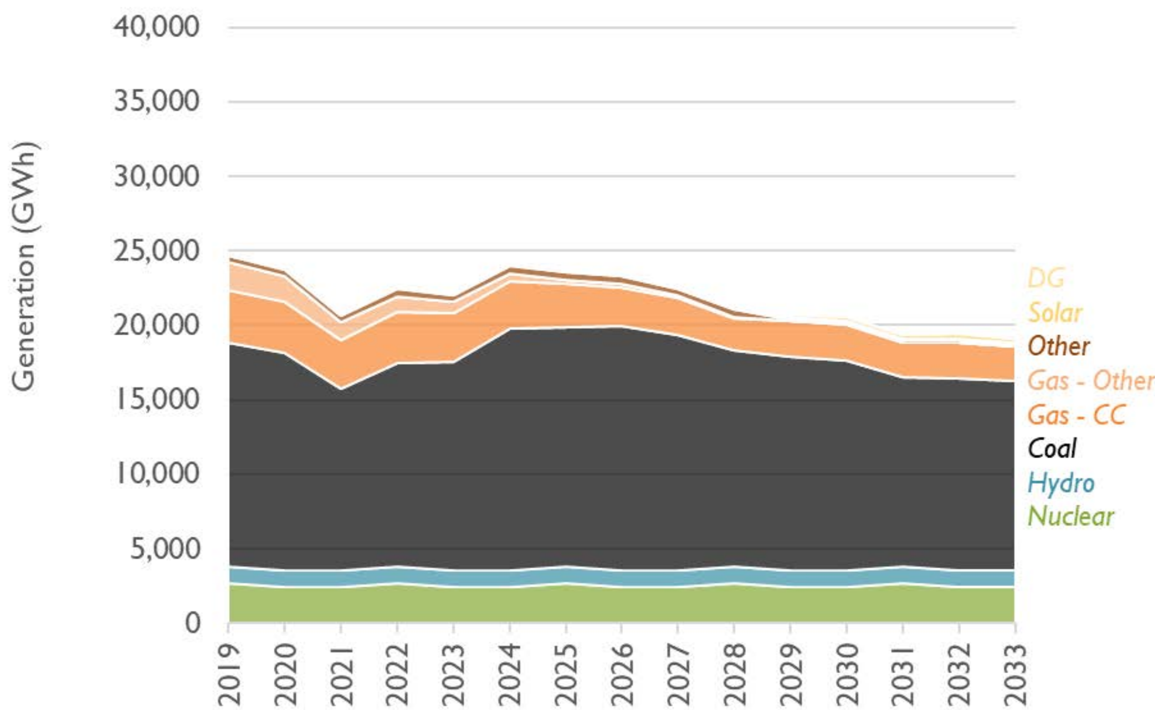
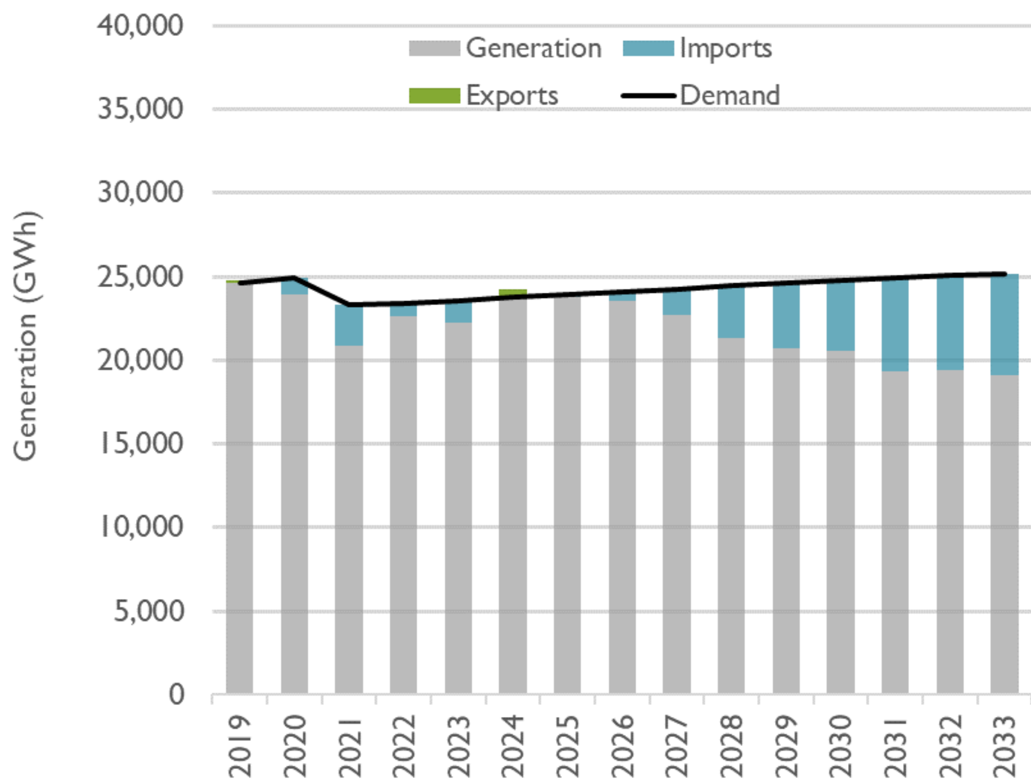


Figure 24. BAU scenario, modeled imports/ exports and generation, 2019 to 2033, high gas prices



Under the BAU scenario, high gas prices have the primary effect of displacing a portion of the imports that were present under Reference gas prices, likely from gas generators in neighboring regions. Santee Cooper's coal units generate approximately 2,200 GWh more than under Reference gas prices in order to make up for the decline in imported energy. Generation in the Gas Medium and Gas Major scenarios is shown in Figure 25 and Figure 27, while imports/exports are shown in Figure 26 and Figure 28.

Figure 25. Gas Medium scenario, modeled generation, 2019 to 2033, high gas prices

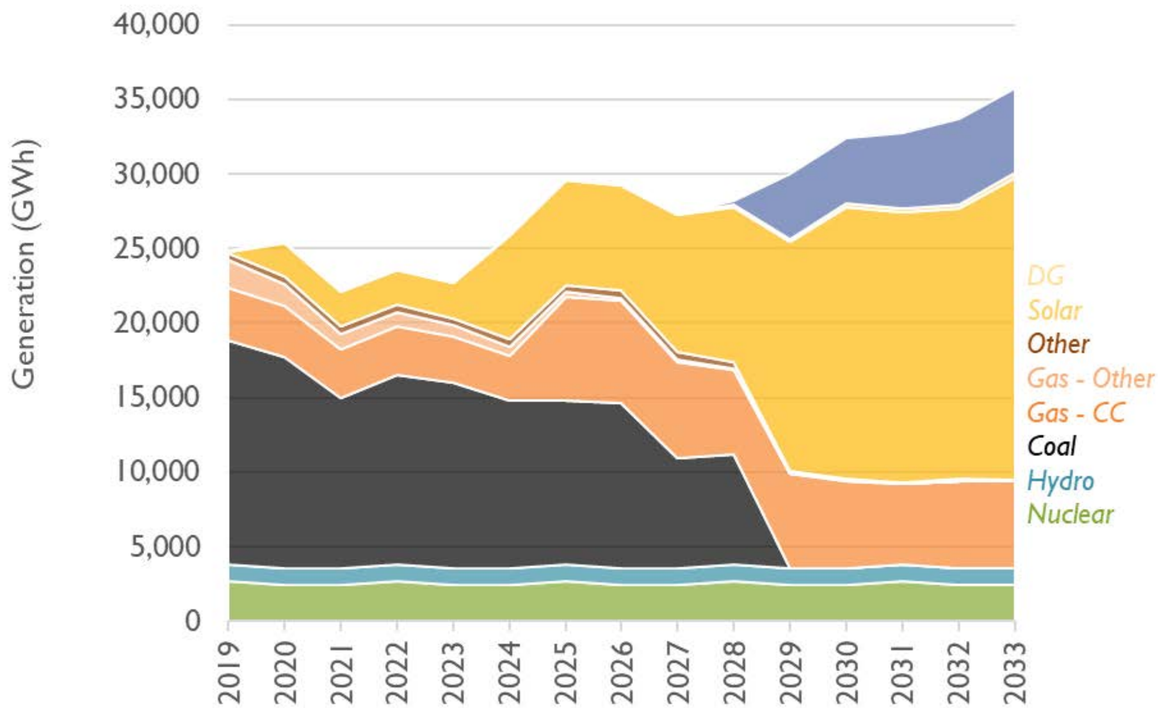
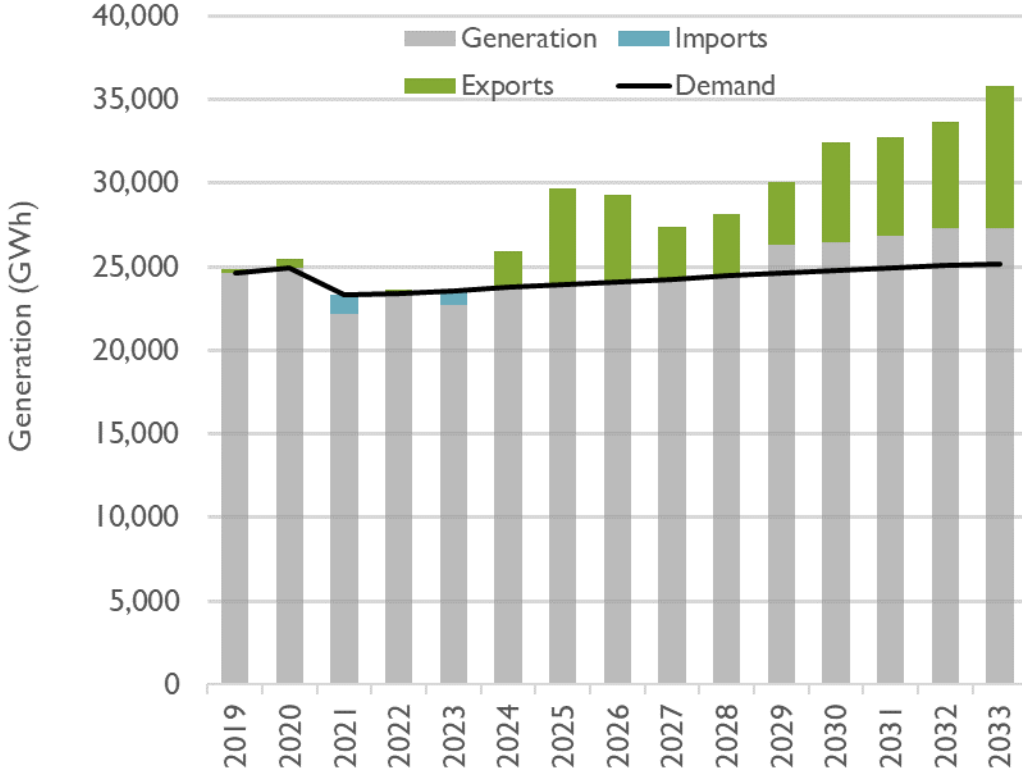


Figure 26. Gas Medium scenario, modeled imports/ exports and generation, 2019 to 2033, high gas prices



In the Gas Medium scenario, gas peaking units operate less with higher gas prices due to their higher heat rates and less efficient operation; however, generation from the combined cycle units varies according to year, with less generation in certain years and more generation in other years. Exports increase slightly. Given the penetration of renewable energy in Santee Cooper's service territory under the Gas Medium scenario, it becomes more efficient for the utility to generate slightly more from its combined cycle units in order to export additional energy in instances of high gas prices.

Figure 27 shows overall generation from gas declines slightly in the Gas Major scenario. Once Santee Cooper's coal fleet retires, the other generators that remain on the system—hydro, nuclear, and solar—have relatively constant generation relative to capacity. Their capacity is fixed in the High Gas sensitivity model runs, meaning that the model cannot add new renewables in response to high gas prices. Given this fixed capacity of low- and no-variable cost resources, gas generation has a minimal response in instances of high gas prices. Revenue requirements of scenarios that rely on gas show a more dramatic response to the price increase.

Figure 27. Gas Major scenario, modeled generation, 2019 to 2033, high gas prices

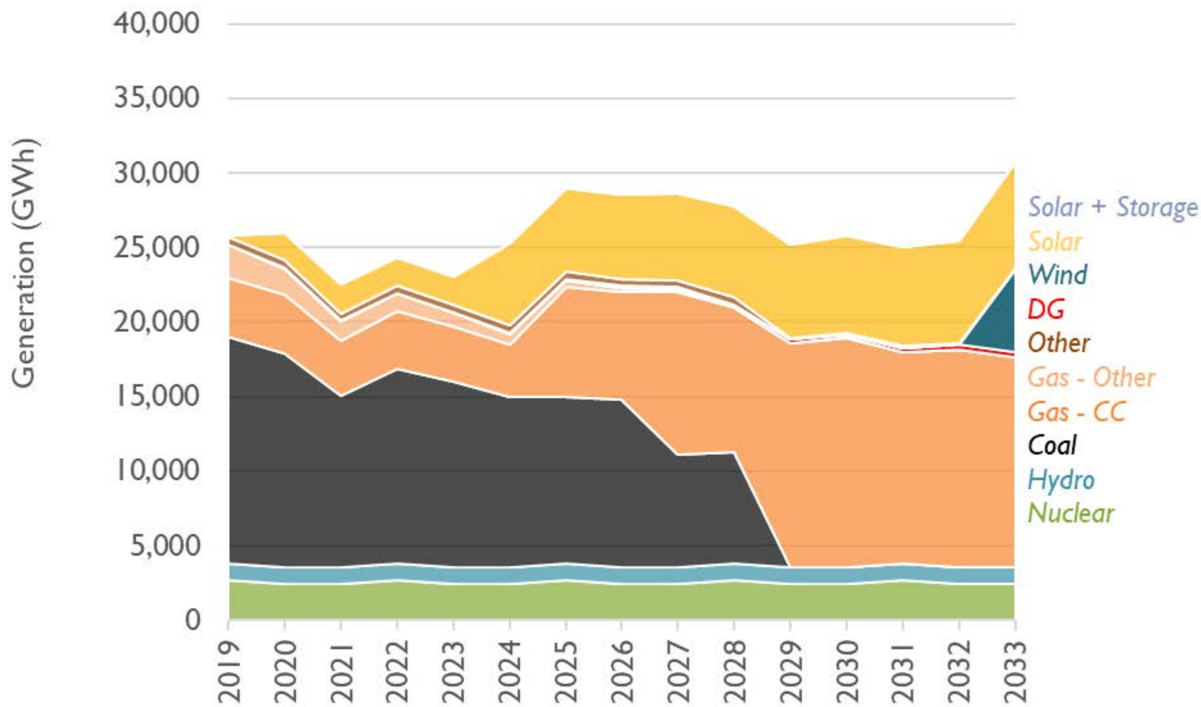
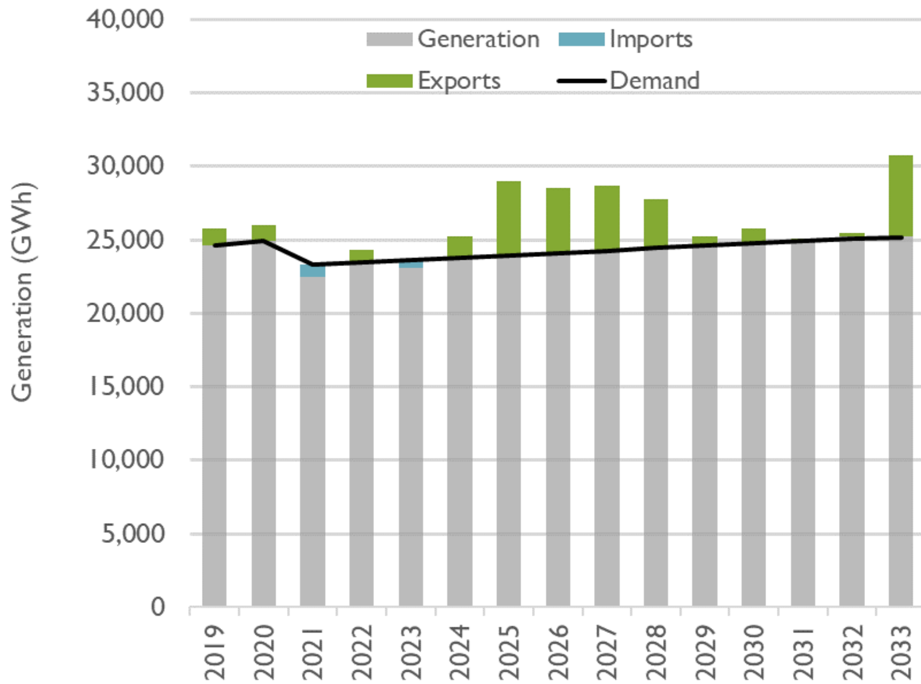


Figure 28. Gas Major scenario, modeled imports/ exports and generation, 2019 to 2033, high gas prices



The Clean Energy scenario, shown in Figure 29, has a small amount of gas generation and demonstrates little generation variation under high gas prices.

Figure 29. Clean Energy scenario, modeled generation, 2019 to 2033, high gas prices

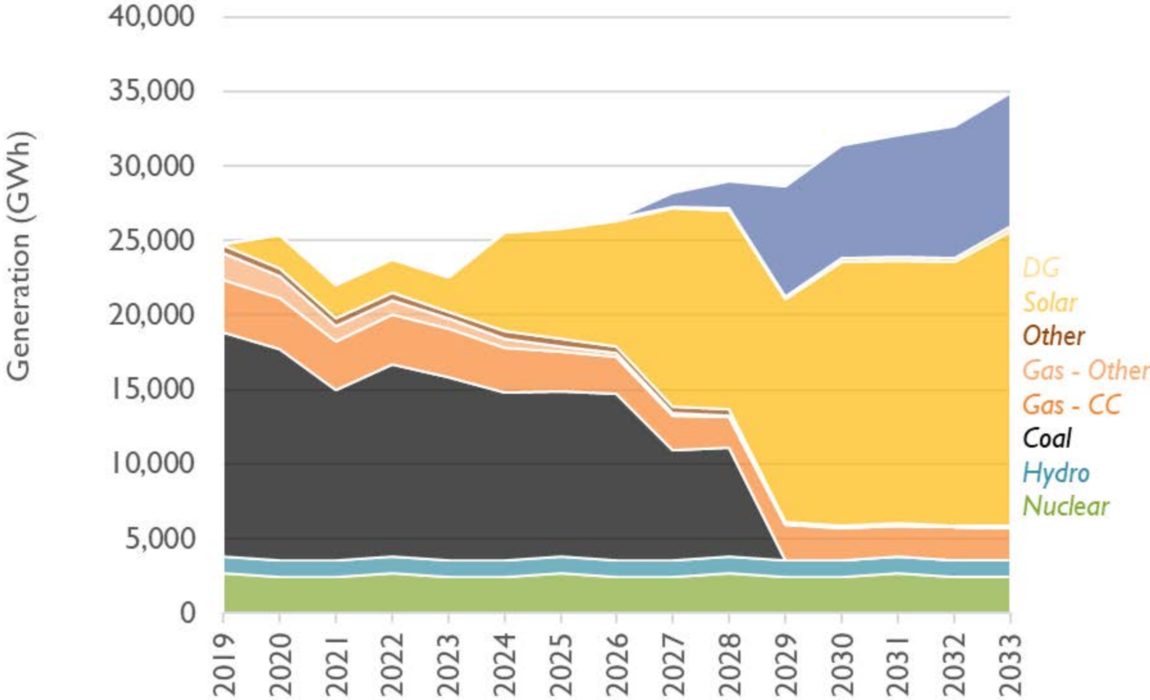
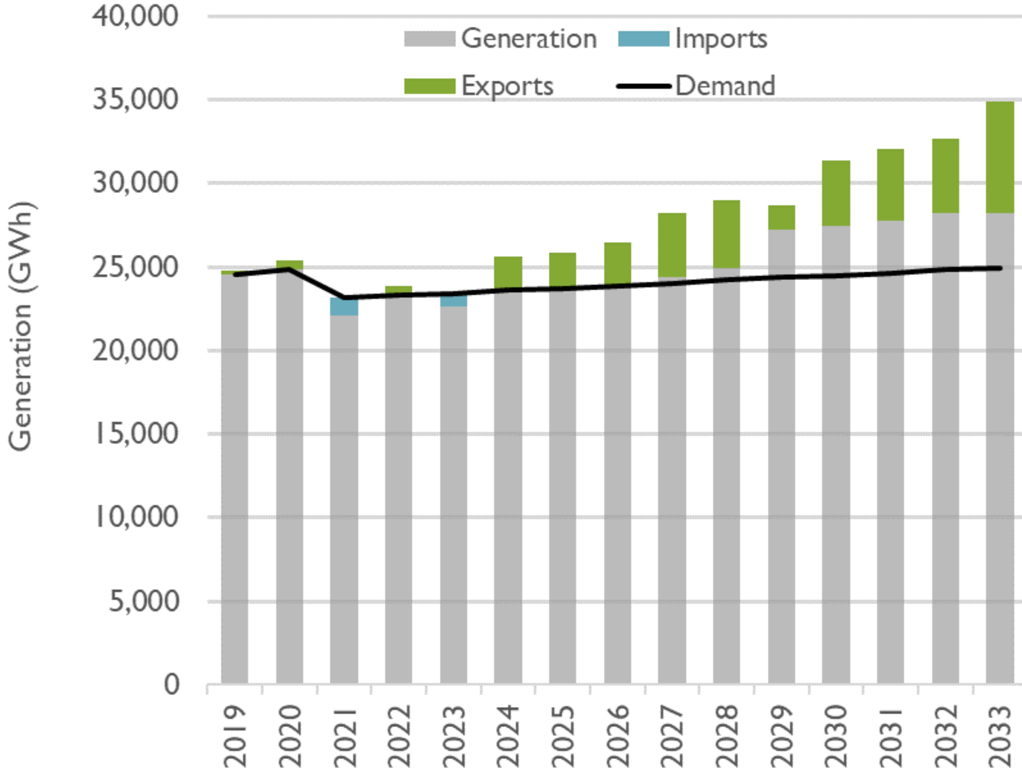


Figure 30. Clean Energy scenario, modeled imports/ exports and generation, 2019 to 2033, high gas prices



5. Conclusions

Our analysis demonstrates that Santee Cooper's existing coal fleet is quite costly to operate and that retirement of the Winyah and Cross units makes economic sense for the utility's ratepayers. Further, the three alternative resource portfolios modeled here demonstrate that the lower revenue requirements associated with the Clean Energy scenario result in the greatest benefit to ratepayers in the form of lower electric rates. The increased energy efficiency in the Clean Energy scenario also means that consumers use less energy, resulting in lower electric bills.

By comparison, both gas expansion scenarios have higher revenue requirements than the Clean Energy scenario, and greater risk. Note that this analysis is conservative in that our gas scenarios assume a modest, generic gas pipeline service extension to support the resulting new combined cycle power plant(s) at a small cost, in the form of a delivery adder applied to the fuel burned at the new units. We did not include the capital costs or risks associated with any new major interstate gas transmission infrastructure.

The gas expansion resource portfolios also present future risks from gas price increases and CO_2 emissions pricing. Either or both of these factors would increase the cost of operating gas-fired resources. The combined cycle units added in these scenarios operate for a maximum of eight years during the analysis period, while those added later than 2025 operate for even fewer years within the modeled scenarios. As a practical matter, however, combined cycle units have useful lives of at least 30 years. Increases in gas prices or more stringent regulations on CO_2 could increase the operating costs of new and existing gas-fired generators, such that it becomes more uneconomical for them to generate and increasing the risk that they might become stranded assets. Santee Cooper would then find itself in a similar position to that in which it is now—as the owner of assets that are uneconomical to operate and lead to higher customer costs, as compared to cleaner options. A portfolio that consists largely of renewable and storage resources would be immune to such risk.

As a matter of economics, Santee Cooper should not rely on existing coal or new gas capacity as part of its future energy strategy. Instead, energy efficiency and solar and storage resources would provide the necessary capacity and energy at least cost and least risk. The Clean Energy scenario results in the lowest revenue requirement and results in the highest benefit to South Carolina ratepayers.

Appendix A. Technical Appendix

Synapse used EnCompass to model resource choice impacts in Santee Cooper's service territory in South Carolina. Developed by Anchor Power Solutions, EnCompass is a single, fully integrated power system platform that provides an enterprise solution for utility-scale generation planning and operations analysis. EnCompass is an optimization model that covers all facets of power system planning, including:

- Short-term scheduling, including detailed unit commitment and economic dispatch, with modeling of load shaping and shifting capabilities;
- Mid-term energy budgeting analysis, including maintenance scheduling and risk analysis;
- Long-term integrated resource planning, including capital project optimization, economic generating unit retirements, and environmental compliance; and
- Market price forecasting for energy, ancillary services, capacity, and environmental programs.

Synapse used the EnCompass National Database created by Horizons Energy to model the Santee Cooper service territory. Horizons Energy has benchmarked dispatch and prices resulting from its comprehensive dataset to actual, historical data across all modeling zones. More information on EnCompass and the Horizons dataset is available at www.anchor-power.com.

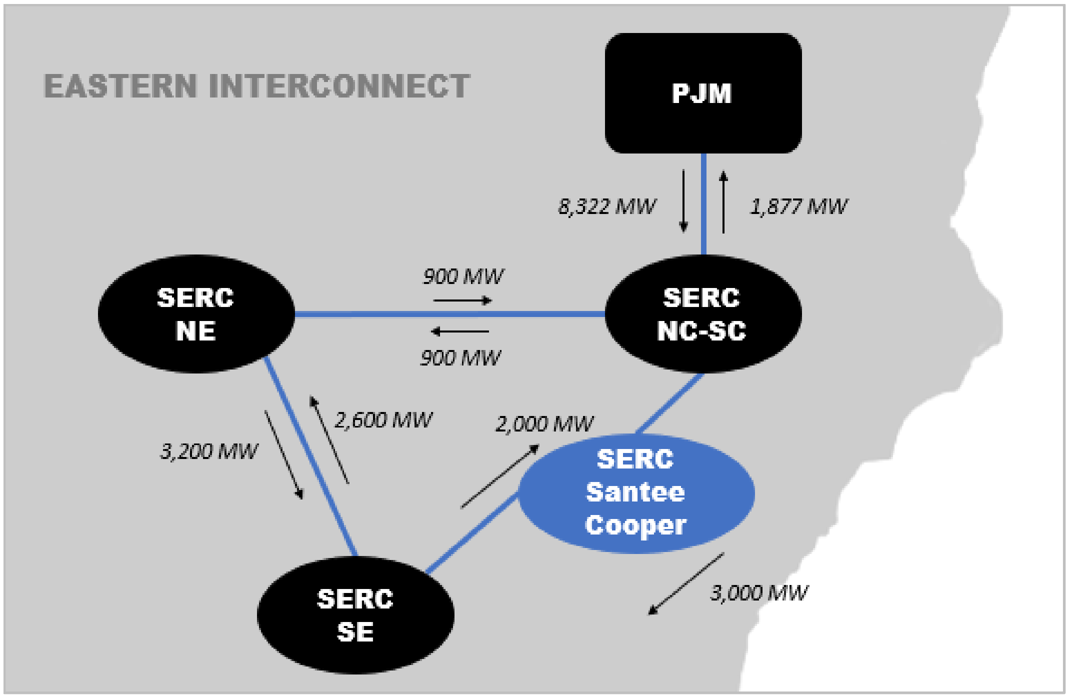
Topology and Transmission

Synapse modeled two detailed areas with full unit-level operational granularity: the Santee Cooper service territory and the remaining SERC-East region comprised of North Carolina and South Carolina. Additionally, we modeled external contract regions representing the remaining SERC and PJM balancing areas. We relied on transmission assumptions from the EnCompass National Database, displayed in Figure 31 below. These transmission limits into and out of Santee Cooper were based on the Eastern Interconnection Planning Collaborative (EIPC) MRN-NEEM Model from 2011.[26]

Energy transfers between SERC NC-SC and the Rest-of-SERC and PJM regions are subject to a per MWh tariff. Capacity transfers into and out of Santee Cooper's service territory were limited to 500 MW to alleviate concerns about an overreliance on imports to meet capacity and reserve requirements. Energy from the PJM and Rest-of-SERC regions are priced at recent historical energy prices and escalated throughout the period.

[26] See: https://eipconline.com/

Figure 31. Santee Cooper modeling topology and energy transfer capabilities



Peak Load and Annual Energy

Synapse relied on annual energy and peak load as defined in the 2018 Santee Cooper IRP and the NERC Long-term Reliability Assessment for the SERC-NC-SC region. We utilized FERC Form 714 hourly load shapes from 2017 for both Santee Cooper and SERC NC-SC.

Fuel Prices

For the Reference gas price forecast, Synapse relied on NYMEX futures for monthly Henry Hub gas prices through December 2021. Between 2022 and 2024, Synapse used a blend of NYMEX futures and the annual average prices projected for Henry Hub in the AEO 2019 Reference case. For all years after 2024, Synapse used the Henry Hub AEO 2019 Reference case price projections. We then applied trends in average monthly prices observed in the NYMEX futures to this longer-term gas price to develop long-term monthly trends. Delivery price adders for Zone 5 are sourced from the EnCompass National Database.

For the High Gas Price forecast, we relied on the same NYMEX futures for monthly Henry Hub gas prices through December 2021. Between 2022 and 2024, Synapse used a blend of NYMEX futures and the annual average prices projected for Henry Hub in the AEO 2019 Low oil and gas resource and technology case. For all years after 2024, Synapse used the Henry Hub AEO 2019 Low oil and gas resource and technology case price projections. We then applied trends in the average monthly prices observed in the NYMEX futures to the longer-term gas price to develop long-term monthly trends.

Coal prices for Santee Cooper's coal units were escalated from prices taken from S&P Global data for 2017, while coal prices for existing units in the remainder of SERC-East are sourced from the EnCompass National Database. Gas and coal price forecasts are shown in Figure 32 and Figure 33 below.

Figure 32. Henry Hub gas price forecast – reference and high gas

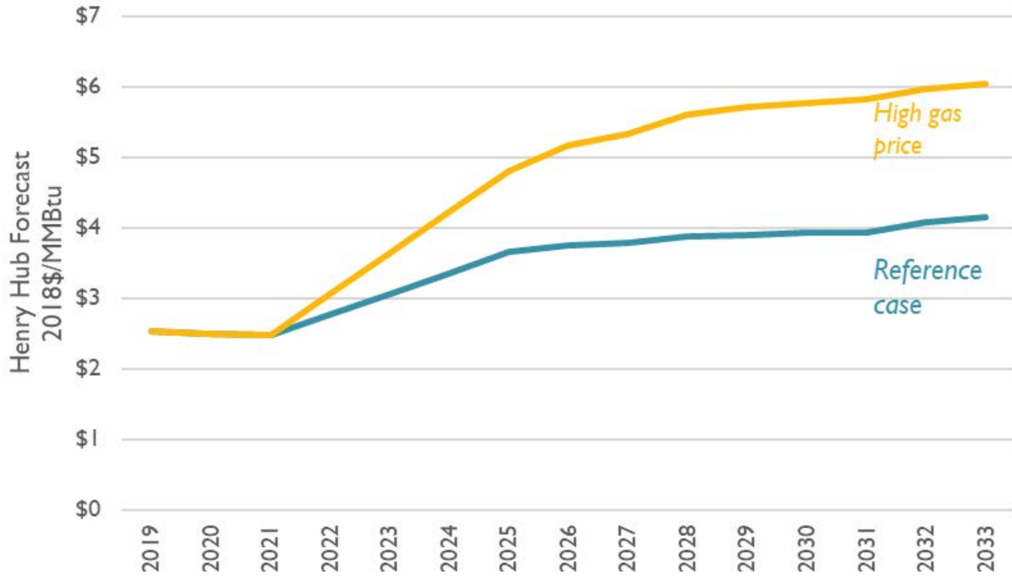
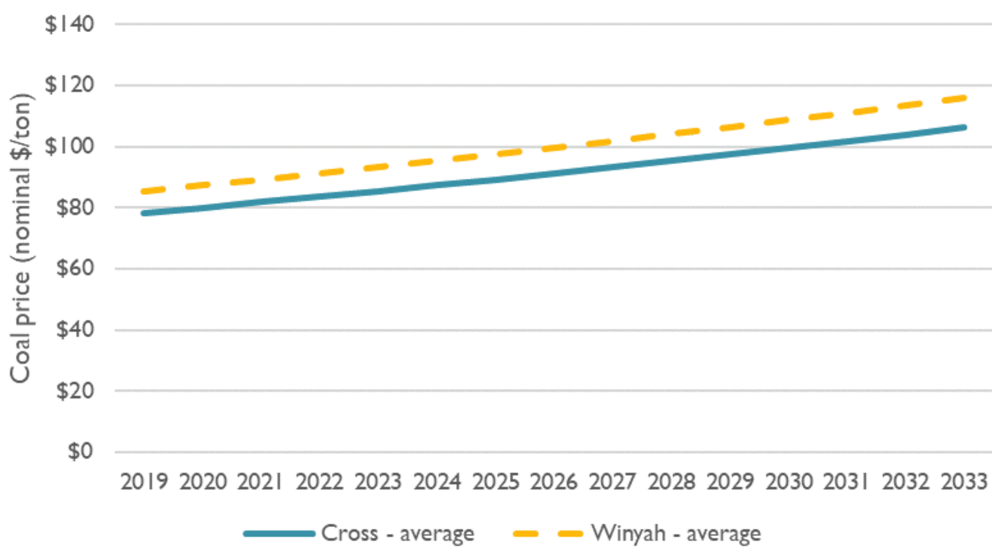


Figure 33. Coal price forecast – average fuel costs at Cross and Winyah



Alternative Scenario Projects

For the alternative scenarios, Synapse allowed the model to select from four generic project options in South Carolina. They include onshore wind, utility-scale battery, utility-scale solar, and a paired "solar-plus-storage" resource, which is a combined utility-scale battery and solar project. For these projects Synapse uses NREL's Advanced Technology Baseline projections and Lazard's Levelized Cost of Storage 2018 report to define cost and operational parameters.

Gas Infrastructure

In order to account for the new pipeline capacity cost that would be necessary to build additional gas-fired combined cycle units, a conservative adder of $0.30/MMBtu in fuel expense was added to the fuel consumed at the new combined cycle units constructed in the gas expansion scenarios.

Energy Efficiency

Additional energy efficiency is included in the Clean Energy scenario. Annual energy savings rises to 1 percent of sales in 2026 and that 1 percent is maintained throughout the remainder of the analysis period. Program administration costs for energy efficiency are from the *2016 Duke Energy North Carolina DSM Market Potential Study* and the *2016 Duke Energy South Carolina DSM Market Potential Study*, both done by Nexant Consulting.