ACHIEVING 100% CLEAN ELECTRICITY IN THE SOUTHEAST

ENACTING A FEDERAL CLEAN ELECTRICITY STANDARD

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ABOUT SACE

The Southern Alliance for Clean Energy is a nonprofit organization that promotes responsible and equitable energy choices to ensure clean, safe and healthy communities throughout the Southeast. As a leading voice for energy policy in our region, SACE is focused on transforming the way we produce and consume energy in the Southeast.

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INTRODUCTION

This report presents pathways four major Southeast utilities can take to get to 100% clean electricity under a federal Clean Electricity Standard (CES) policy. By pathway, we mean a combination of different resources that can be used to meet electricity demand, shift electricity demand, or reduce electricity demand. The method used here is designed to provide high-level pathways. Each utility needs to perform its own analysis, modeling, and evaluation to determine its optimal pathway to 100% clean electricity, but **these pathways show that not only is 100% clean electricity possible, there are options along the way. The key among all pathways is to start now.**

Clean or renewable electricity standards are already law in more than 30 states and territories, and have effectively driven low-cost power sector decarbonization while stimulating local economic development. This analysis assumes a generic CES at the federal level such that the Tennessee Valley Authority, a federal-owned public power utility, must reach 100% clean electricity by 2030 and all other utilities analyzed including NextEra, Duke Energy and Southern Company, must reach 100% clean electricity by 2035.

These pathways include only existing technologies that do not emit carbon dioxide (CO_2), and do not speculate on future technological improvements. Technological improvement will occur, and will make it easier to meet a CES. These pathways likely over-build to meet projected demand, leading to excess generation that is available for another use during most of the year. However, projected demand likely does not account for a high level of electrification. With additional policy support, electrification of buildings and transportation complements a CES to reduce overall CO_2 emissions.

Another important note about this analysis is what it is not: this is not a least-cost optimization and does not account for most transmission or distribution limitations. Least-cost optimization is often used as a part of utility resource planning. Since this is an exercise to explore the feasibility of these utilities meeting a CES, we used a simpler method.

CONTENTS

DEFINING A CLEAN ELECTRICITY STANDARD

A Clean Electricity Standard (CES) is a federal policy that defines when an entity must reach a certain penetration of clean energy resources. For purposes of this analysis, clean was defined as net zero-carbon, and the goal is a 100% CES by 2030 for the Tennessee Valley Authority and a 100% CES by 2035 for Southern Company, NextEra, and Duke Energy.

WHAT IS CLEAN?

Each CES policy defines what resources count toward the target. For our analysis purposes, clean resources included energy efficiency, solar, wind, energy storage, existing hydro, existing nuclear, and an other category that we left undefined. Fossil resources, which includes coal, gas, and oil, do not count toward the CES and were removed from a utility's resource mix. This analysis was too high-level to look at the potential for carbon capture or the use of hydrogen at existing fossil power plants.

SEVERAL PATHWAYS TO A CES

A CES policy does not define how a utility complies with the target. We explore two pathways utilities can take in this report: one focuses on distributed energy resources, and another replaces some of those distributed resources with large-scale resources.

COMMON THEMES ACROSS PATHWAYS EXPLORED

- A variety of clean energy resources is needed to meet a 100% CES.
- Action on clean energy resources must begin immediately and aggressively to get to zero carbon.

METHOD TO DEVELOP PATHWAYS TO 100% CLEAN ELECTRICITY

Start with the utility's current load forecast and resource plan for the target year. Remove all fossil resources. Leave solar, storage, wind, hydro, biomass, waste, other renewable resources, and nuclear.

↓

Identify assumptions for distributed energy resources (DER).

↓

Identify assumptions for transmission builds to connect to western wind, in-region wind potential both onshore and offshore.

↓

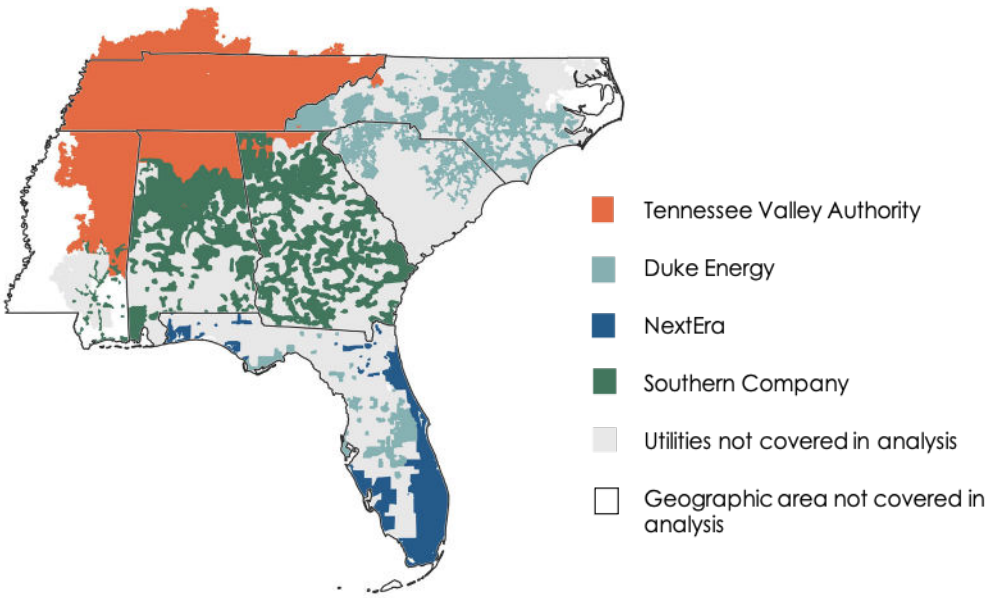
Fill remaining energy and reserve margin needs with large-scale solar and storage.

↓

Check each pathway against an actual hourly load shape from a peak day for winter and a peak day for summer. Ensure there is enough generation for each hour and also enough generation within that 24 hours to recharge battery storage.

See appendix for full description of method and assumptions.

ABOUT THE UTILITIES



TENNESSEE VALLEY AUTHORITY

Federally-owned **TVA** serves approximately 4.9 million customers in Tennessee and parts of six surrounding states: Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia.

SOUTHERN COMPANY

Alabama Power serves approximately 1.5 million homes, businesses, and industries across the southern two-thirds of Alabama.

Georgia Power serves approximately 2.6 million customers in all or parts of 155 of the state's 159 counties.

Mississippi Power serves approximately 190,000 customers within 23 counties in southeastern Mississippi.

NEXTERA

Florida Power & Light serves more than 5.6 million customers in southern and eastern Florida.

Gulf Power serves approximately 460,000 customers in the panhandle of Florida and will be consolidated into FPL after completion of the North Florida Resiliency Connection transmission line project in mid-2022. NextEra purchased Gulf from Southern Company in 2019.

DUKE ENERGY

Duke Energy Carolinas serves approximately 2.7 million customers in North and South Carolina.

Duke Energy Progress serves approximately 1.6 million customers in North and South Carolina.

Duke Energy Florida serves approximately 1.8 million customers in Florida.

Duke Energy also has utilities in Indiana, Ohio, and Kentucky that are not included here.


CUSTOMER-ORIENTED PATHWAY TO 100% CLEAN ELECTRICITY

DISTRIBUTED ENERGY RESOURCES-FOCUSED CES

Distributed Energy Resources (DERs) are dispersed throughout the electric grid, usually small in size, and can be on the customer side of the meter. Common examples include residential, commercial, and industrial energy efficiency measures, customer-sited solar, often on rooftops, and demand response. These pathways, called our DER-focused CES pathways, include the highest assumed penetration of these distributed technologies in this analysis.

DISTRIBUTED ENERGY RESOURCES (DER) CONTRIBUTION

The table shows the percent of annual energy needs that is met by energy efficiency and distributed solar resources. Because this analysis did not model every day in the year, we only show the percent of energy from these two resources because they were not curtailed.

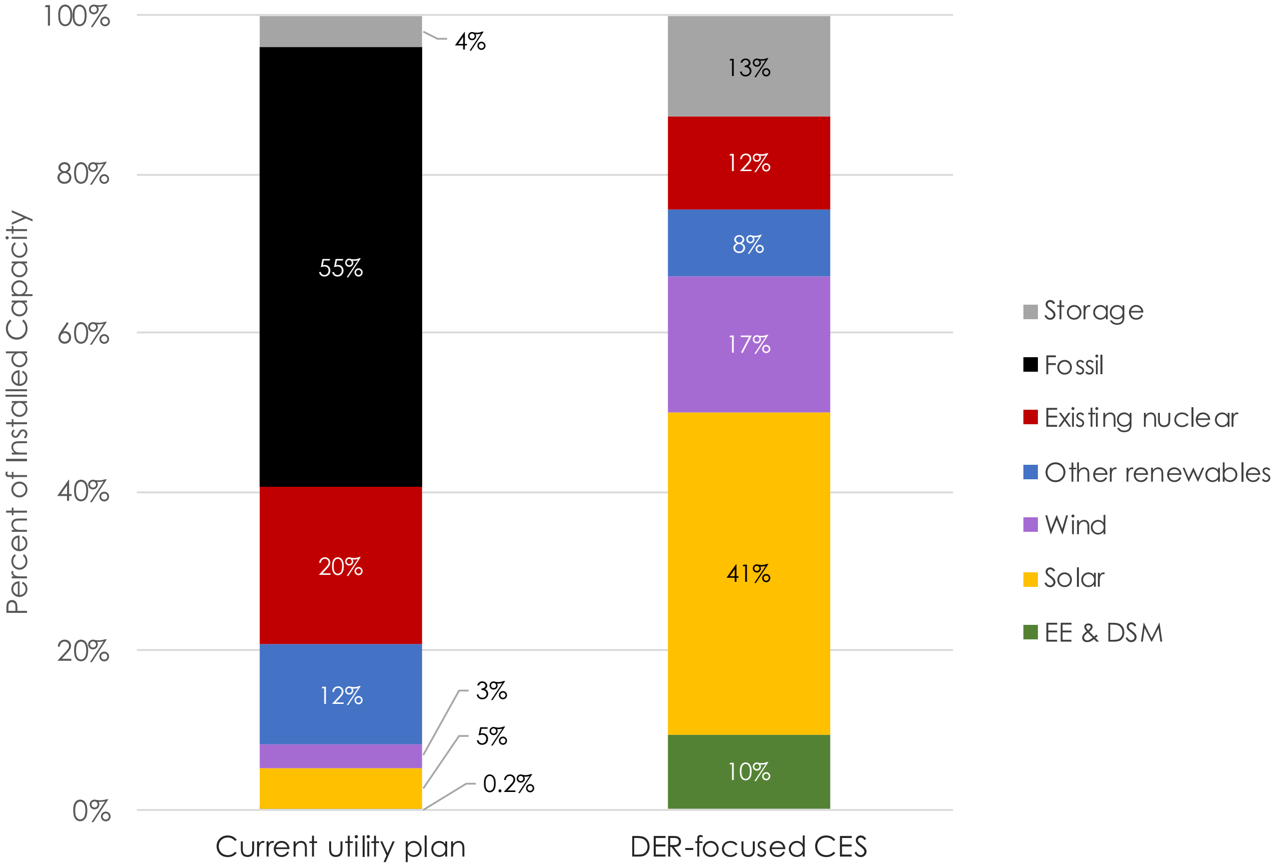
TVA has lower levels of distributed resources because it achieves 100% clean electricity in 2030, five years before the rest of the sector. These programs are assumed to build-up over time, and TVA currently has low levels of penetrations of both of these DERs, so lower levels of penetration are achieved by 2030.

UTILITY		PERCENT OF 2030 ENERGY FROM ENERGY EFFICIENCY	PERCENT OF 2030 ENERGY FROM DISTRIBUTED SOLAR	TOTAL PERCENT OF 2030 ENERGY FROM DERS
TENNESSEE VALLEY AUTHORITY		9%	5%	14%

UTILITY		PERCENT OF 2035 ENERGY FROM ENERGY EFFICIENCY	PERCENT OF 2035 ENERGY FROM DISTRIBUTED SOLAR	TOTAL PERCENT OF 2035 ENERGY FROM DERS
SOUTHERN COMPANY	Alabama Power	21%	10%	31%
	Georgia Power	21%	9%	30%
	Mississippi Power	21%	9%	30%
NEXTERA		20%	14%	34%
DUKE ENERGY	Duke Energy Carolinas	21%	8%	29%
	Duke Energy Progress	21%	9%	30%
	Duke Energy Florida	20%	14%	34%

TENNESSEE VALLEY AUTHORITY

TVA DER-FOCUSED CES IN 2030



Note: The current utility plans include generating resources, energy efficiency (but not demand response), and distributed solar from the utilities' latest resource plans and those that have been reported to the Energy Information Administration (EIA).

Because TVA is strategically located, has a high amount of traditional and pumped hydro resources that can help it integrate high levels of wind and solar, and is directly controlled by the federal government, we crafted a pathway for TVA to get to 100% clean electricity five years earlier than the rest of the sector.

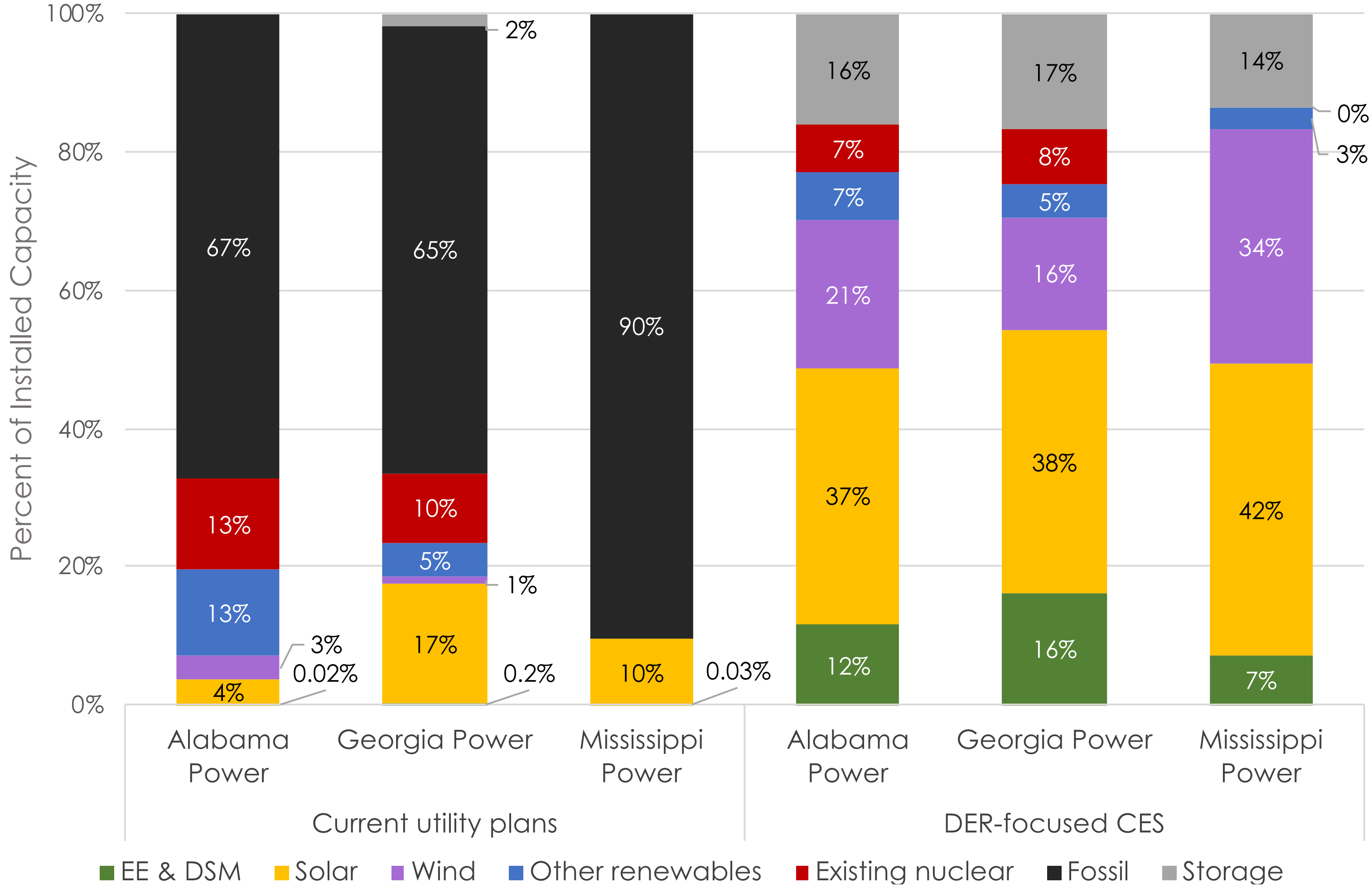
This pathway shows that TVA can reach 100% clean electricity by 2030 with an investment in distributed energy resources (DERs) like energy efficiency, demand response, and distributed solar. These DERs take time to build up, so the sooner TVA starts to invest in them, and the more TVA can build each one up each year, the easier it will be for the utility to meet this CES target.

TVA has some of the best onshore wind resources in the Southeast. Building out some wind resources within the TVA region and expanding transmission to increase the ability to import wind from western states can complement TVA's build-out of DERs, large-scale solar, local wind, and storage to achieve 100% clean electricity in 2030.

Similar to other utilities, storage is used in the CES pathway to meet winter reserve margins, and is not fully used even on peak days. Thus the amount of storage proposed in this pathway for TVA is there "just in case" of equipment failures or outages during peak events. As generation and storage resources are more distributed throughout the grid, the grid becomes more resilient overall.

SOUTHERN COMPANY

SOUTHERN COMPANY DER-FOCUSED CES IN 2035



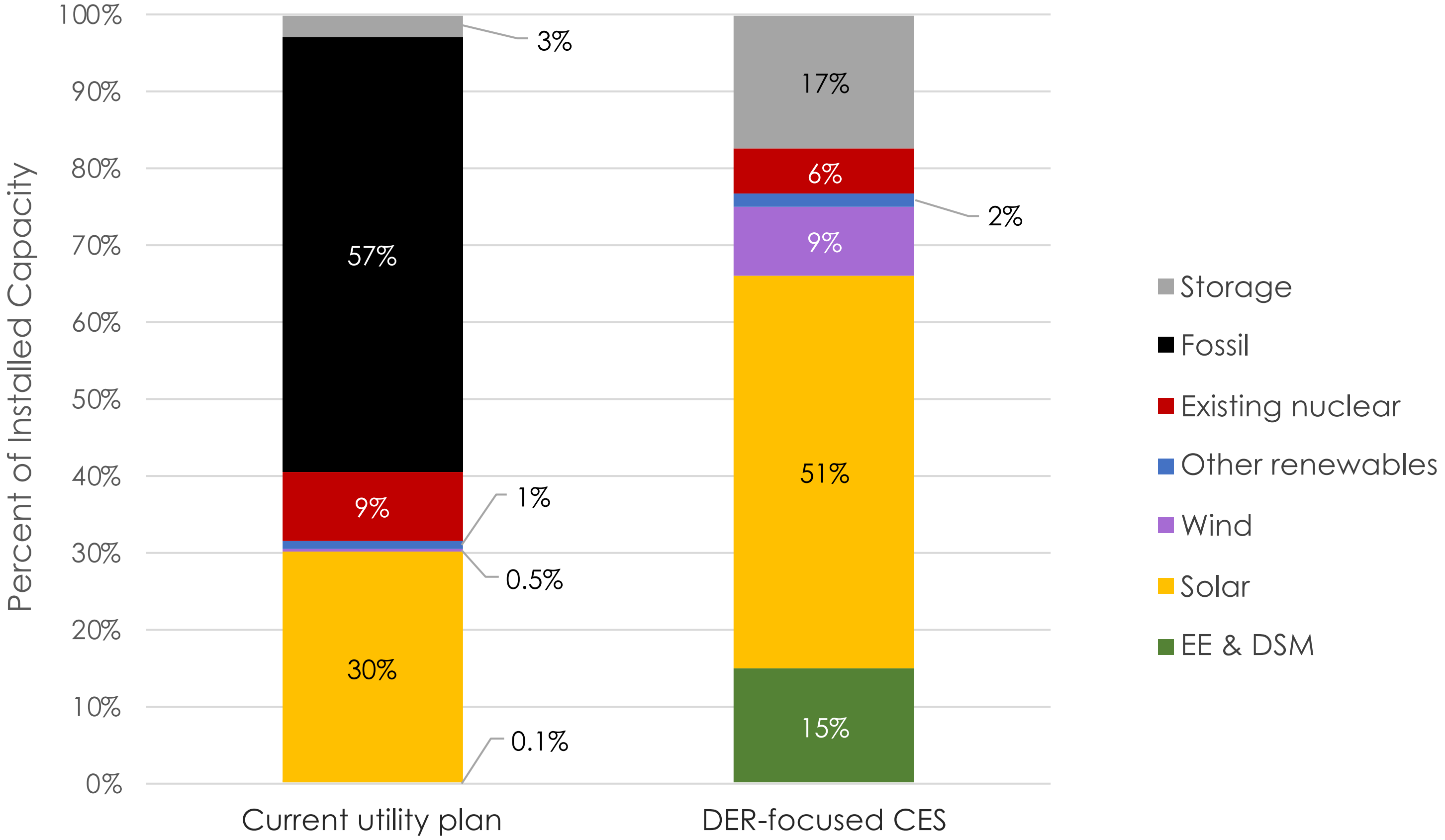
Southern Company's three operating utilities are currently expected to continue to rely heavily on fossil generation through 2035 in the absence of policy.

For each utility, the winter peak shape drives the need for resources to achieve 100% clean electricity by 2035, though there is relatively little excess generation during peak summer days. This indicates that the CES pathway resources are needed for both peak seasons. The renewables and storage built to meet summer and winter peaks is projected to be enough to meet load during a typical spring day, meaning it is likely that Southern Company utilities could operate some or all nuclear generation only in the winter and summer, and mothball the plants during the spring and fall.

In addition to the DERs that make up the base of this pathway to 100% clean electricity, each utility adds large-scale renewable generation, primarily solar supplemented by onshore local and western wind, and storage to meet energy and reserve margin needs.

NEXTERA

NEXTERA (FPL & GULF) DER-FOCUSED CES IN 2035



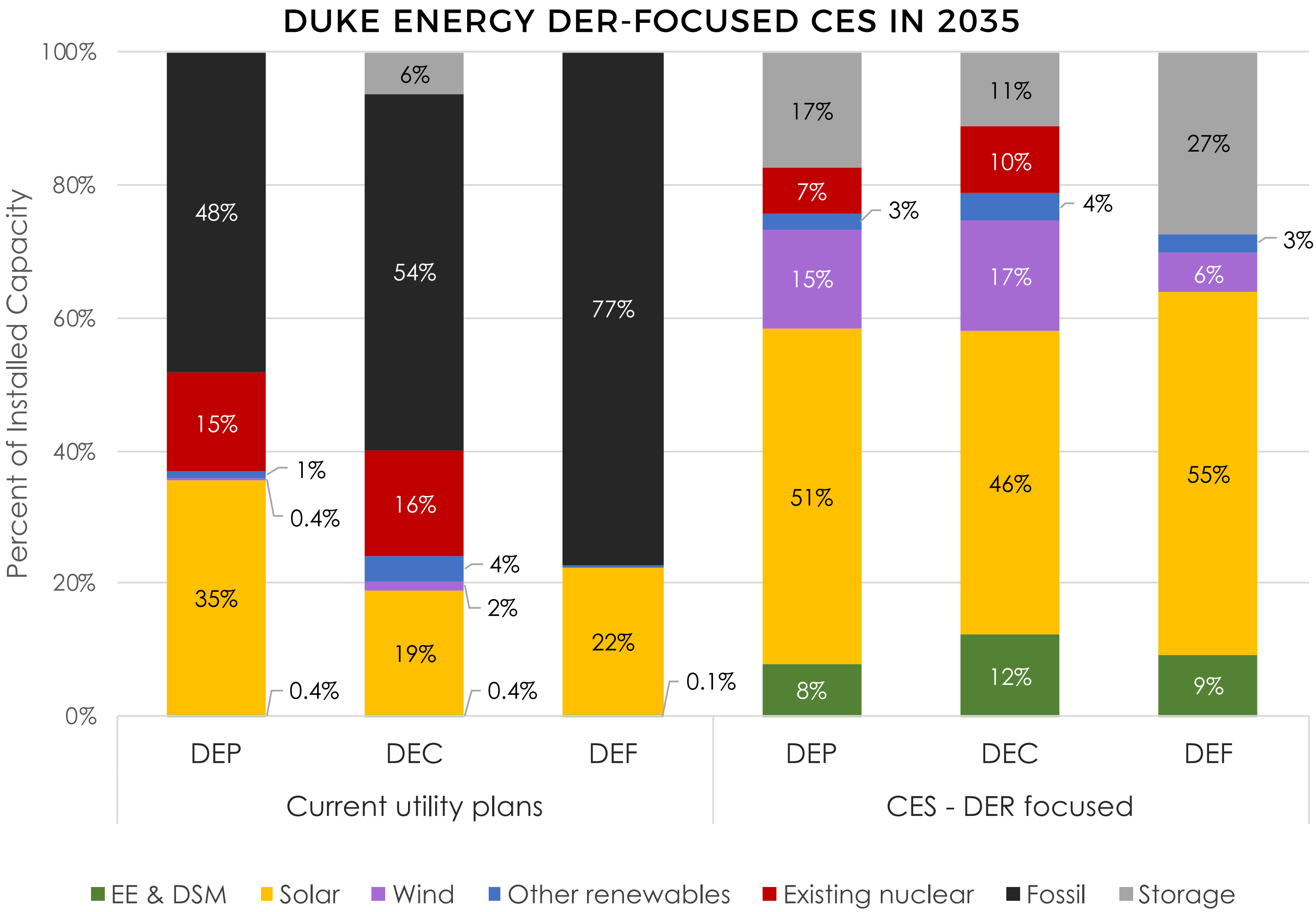
NextEra plans to integrate Gulf Power into FPL by 2022, so for purposes of these analyses they were treated as one utility. Despite being a summer peaking utility, the winter peak drives the amount of resources needed to serve the system with 100% clean electricity because of the lower generation from solar in the winter months. That means that on summer peak days there is projected to be some excess generation above what is used to charge the needed storage.

To achieve 100% clean electricity by 2035 the combined FPL implements aggressive energy efficiency and distributed solar programs and retires all fossil resources, which are primarily gas.

With solar and storage resources spread throughout the state under this CES pathway, the grid would be far less reliant on importing fuel from outside of the state. Not only will this allow more of the funds customers spend on their electric bills to remain in-state, but it also is more resilient than relying on an extended supply chain for power. The clean resources needed to meet summer and winter peaks generate enough energy in the spring and fall to be able to shut down several or all nuclear units for the season.

It is expected that the storage resources in the CES pathway are in various forms, such as electric school buses and other fleets that can be resources to get power to places with outages in the aftermath of extreme weather events like hurricanes.

DUKE ENERGY



Each of Duke's operating utilities has a unique set of existing and projected new resources to meet a DER-focused CES policy. **Duke Energy Carolinas (DEC)** and **Duke Energy Progress (DEP)** both have existing nuclear, and are assumed to build both onshore and offshore wind within their service territories to achieve 100% clean electricity by 2035. It is notable that current utility plans show DEP and DEC having approximately the same amount of large-scale solar in 2035, despite DEC being a larger utility.

Duke Energy Florida (DEF) does not have nuclear capacity and does not build onshore wind in its territory, instead relying more on solar, storage, and offshore wind to achieve 100% clean electricity by 2035. DEF is the smallest of the three utilities, with annual energy demand and peak loads that are slightly lower than those of DEP.

Duke's Florida utility is not projected to have the same level of wind build-out as its Carolinas utilities, and so relies more on solar and storage to fill the gaps between the distributed energy resources and the demand for electricity.

KEYS TO 100% CLEAN ELECTRICITY WITH A DER FOCUS

Aggressive and consistent investments in energy efficiency, demand response, and distributed solar for all customers (residential, commercial, and industrial) starting in 2022 to ensure that programs have time to ramp up as the utility moves to 100% clean electricity no later than 2035.

Utility-scale solar and storage additions go above and beyond current utility plans.

Even though moderate levels of western wind and offshore wind are assumed, transmission to western wind and offshore wind projects will need to be started immediately to ensure they are available by 2030 or 2035.

A moderate level of local wind will require a mindset shift for Southeast utilities, which have long assumed lower wind speeds in the region make local wind unattainable.

Each utility relies at least somewhat on expanding additional renewable technologies, which could be landfill gas, biomass, geothermal, expansions to existing hydro, or any combination of projects depending on the local resources. These are assumed to be dispatchable, and first to be curtailed.

This scenario keeps all existing nuclear units online even if that requires an extension to the current license. However, because of the expansion of renewables and storage, many nuclear units may be able to be operated seasonally, meaning they would turn off in the spring and fall.

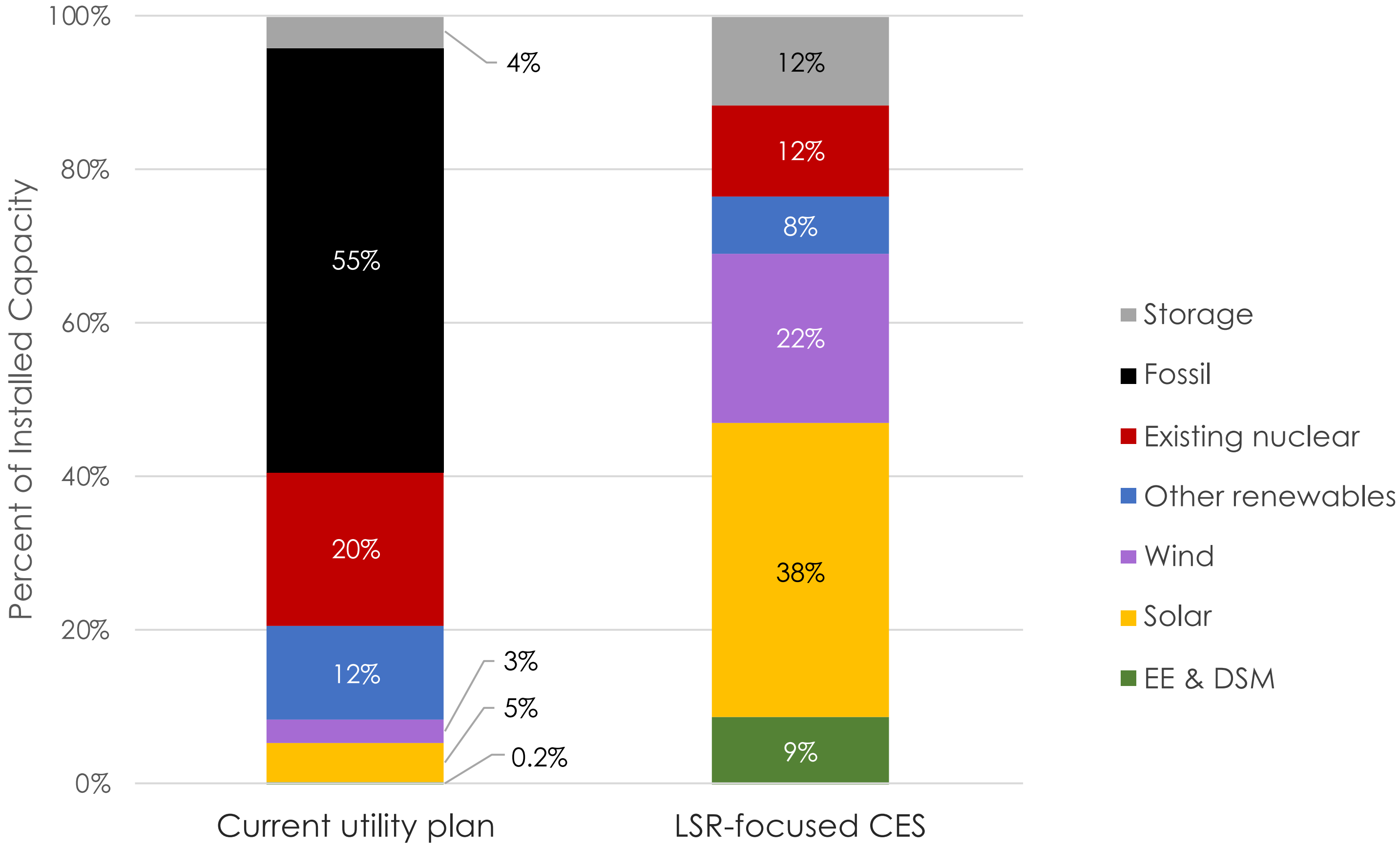
MODERATE DISTRIBUTED RESOURCE PATHWAY TO 100% CLEAN ELECTRICITY

LARGE-SCALE RENEWABLE RESOURCES-FOCUSED CES

Large-scale renewables (LSR) make up the difference in these pathways to 100% clean electricity, which assume DER penetration levels are lower than in the DER-focused CES pathways but still higher than current utility plans. These LSR projects can include large-scale solar and wind, onshore and off-shore, built within the region.

TENNESSEE VALLEY AUTHORITY

TVA LSR-FOCUSED CES IN 2030



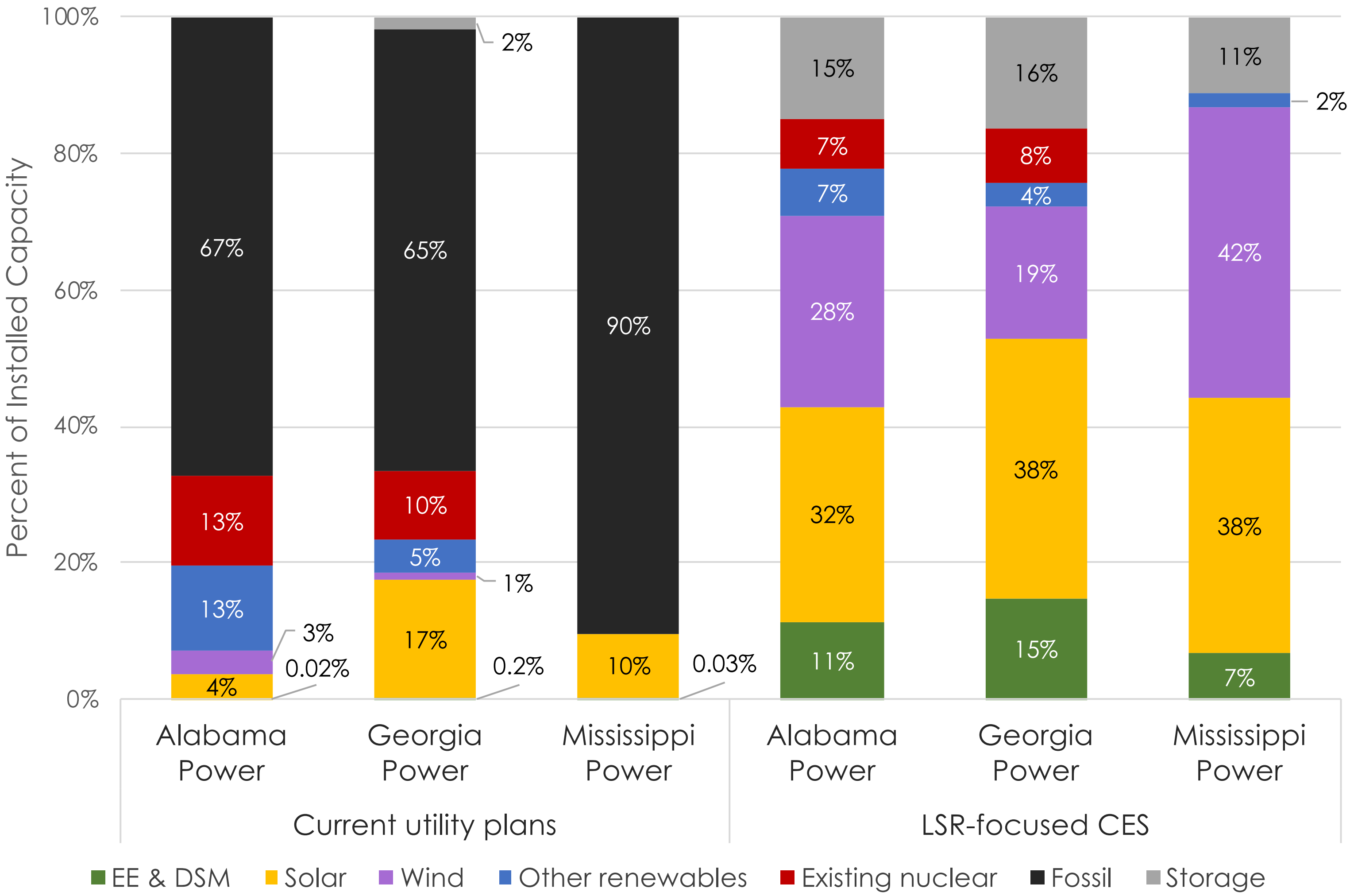
TVA's existing hydro and nuclear resources help it achieve 100% clean electricity by 2030 even with lower penetrations of DERs, though it would require a near doubling of the wind developed within the TVA service territory. An increase in the transmission to bring western wind into the TVA service territory would provide this same complementary renewable resource to TVA's build-out of solar, but we project it would be difficult to expand transmission beyond what is already assumed to be built by 2030 because of the long lead time needed for electric transmission projects.

With the additional wind resources TVA is able to rely less on other renewables and slightly less on storage compared to the DER-focused pathway.

Because the winter reserve margin and winter peak day drive the need for resources, TVA experiences excess generation even on peak summer days. During the sample spring day, just as in the DER-focused pathway, renewable resources are enough to allow TVA to take even its substantial existing nuclear fleet offline for the season.

SOUTHERN COMPANY

SOUTHERN COMPANY LSR-FOCUSED CES IN 2035



With a lower penetration of DERs in this pathway to achieve 100% clean electricity by 2035 there is a greater need for more large-scale resources. However, this pathway still assumes a greater investment in DERs like energy efficiency and distributed solar than the utility's current plan.

The winter reserve margin requirement and winter peak day both drive the need for resources, with most Southern utilities experiencing at least some excess generation on peak summer days under this pathway.

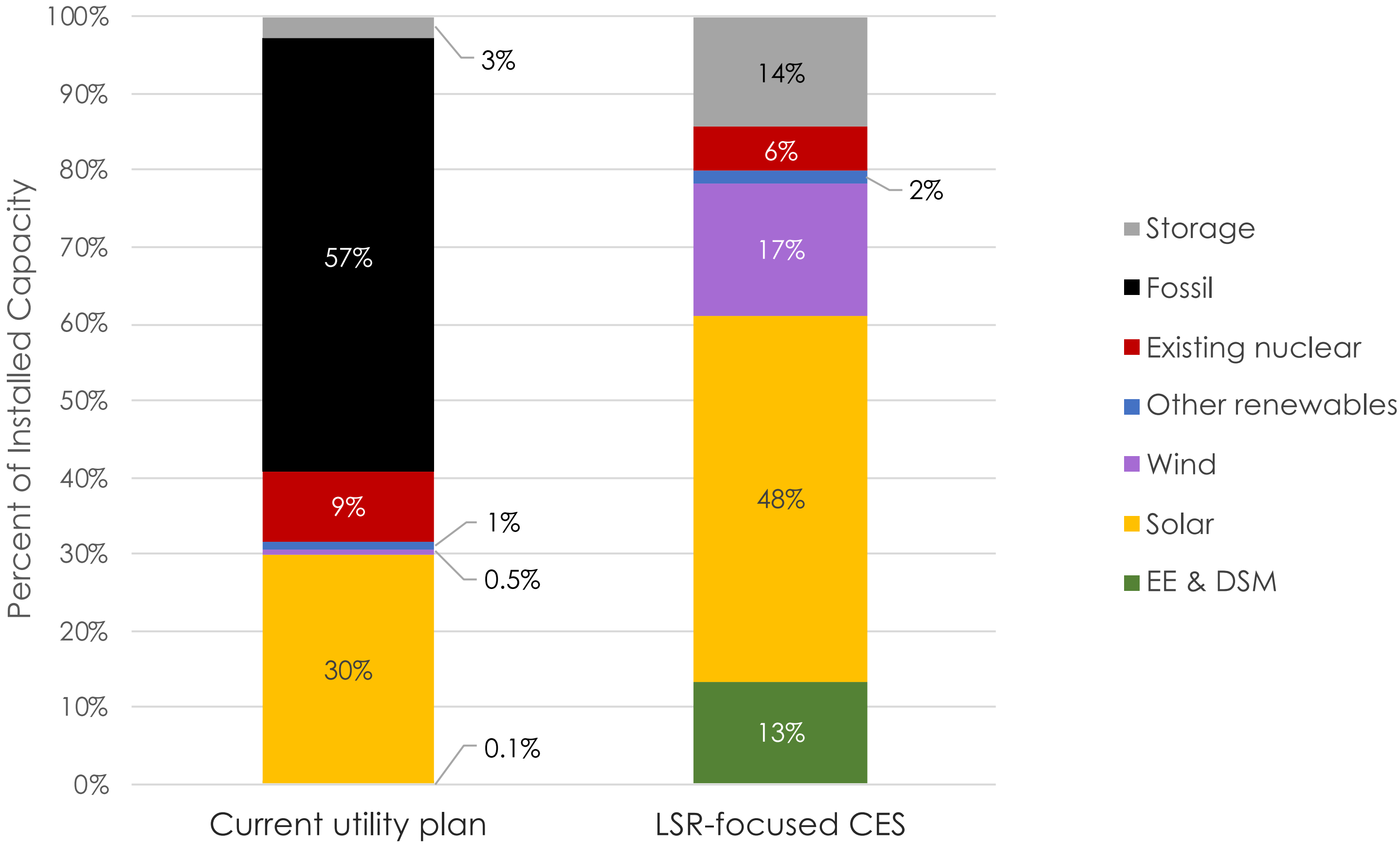
Compared to the DER-focused pathway, **Alabama Power** sees the greatest increase in wind, so relies less on large-scale solar and storage under this pathway. Alabama Power has nearly zero excess generation on the sample peak summer day, indicating that under this LSR-focused pathway it is both the winter and summer peaks that are driving the need for resources.

Georgia Power sees an increase in both wind and large-scale solar compared to the DER-focused pathway. It also adds some offshore wind, which reduces the need for storage. Excess generation during a summer peak day is very small but non-zero.

Mississippi Power increases wind and large-scale solar compared to its DER-focused pathway to achieve 100% clean electricity.

NEXTERA

NEXTERA (FPL & GULF) LSR-FOCUSED CES IN 2035



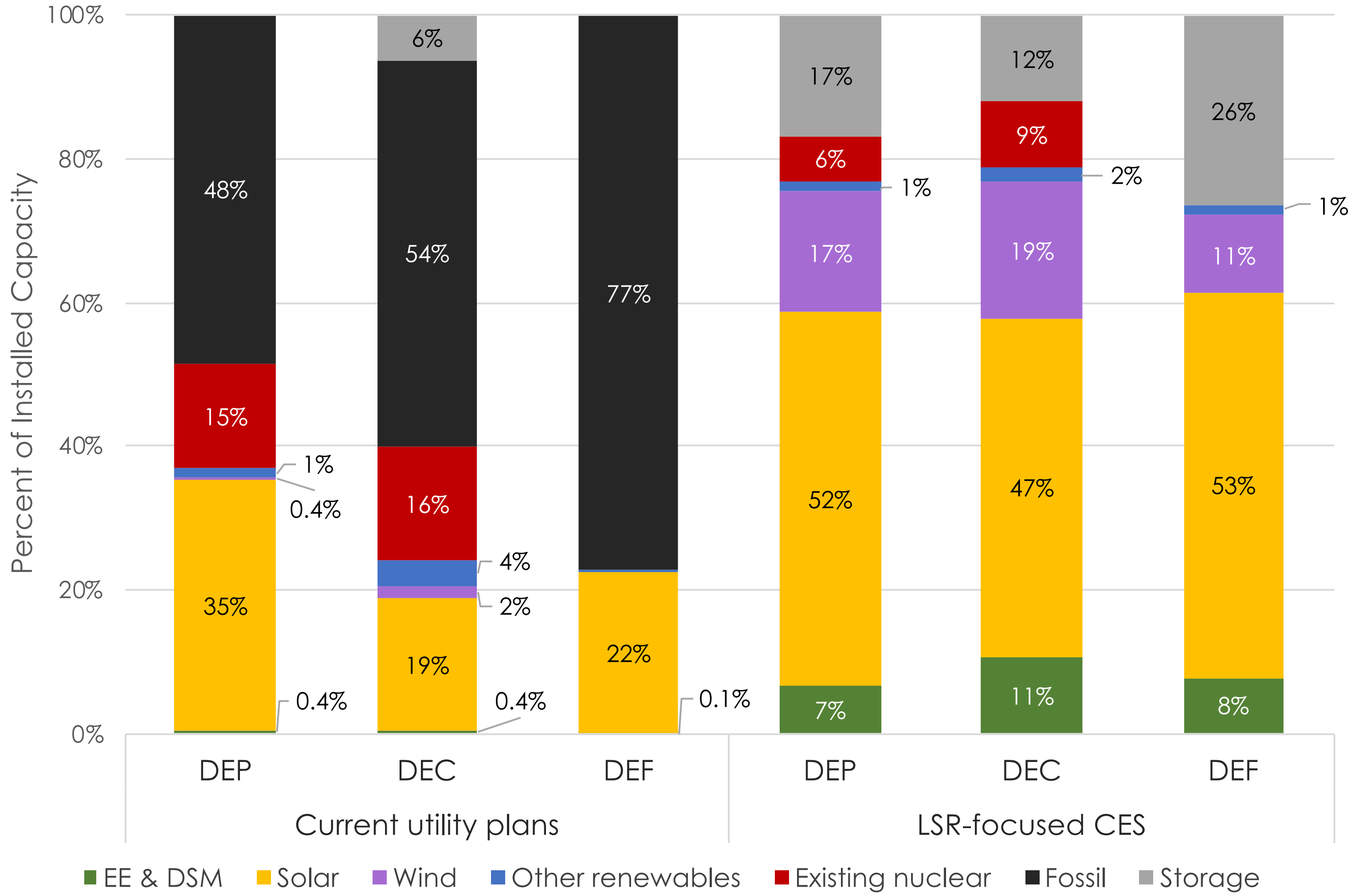
The combined FPL builds slightly more large-scale solar and significantly more total wind in this pathway to 100% clean electricity compared to the DER-focused pathway. There is even a small amount (under 400 MW) of onshore wind assumed to be built in or connected directly to NextEra's service territories in Florida in this pathway.

The resource needs in this pathway are driven by both summer and winter peak shapes, with very little excess generation during the sample summer peak day and no excess generation during the sample winter peak day.

The increase in wind, and its complementary shape to solar, allows the utility to build slightly less storage to meet reserve margin targets than was needed in the DER-focused pathway.

DUKE ENERGY

DUKE ENERGY LSR-FOCUSED CES IN 2035



Duke's utilities still rely heavily on solar and storage resources in this pathway, but a larger portion of the solar is in the large-scale category instead of distributed solar.

Duke Energy Progress sees an increase in large-scale solar, both onshore and offshore wind, and slightly more storage, while the need for other renewables decreases compared to the DER-focused pathway.

Duke Energy Carolinas also sees an increase in large-scale solar and wind compared to the DER-focused pathway, and requires less from the other renewables category and slightly less storage.

Duke Energy Florida sees the largest increase in offshore wind compared to the DER-focused pathway This is balanced with less other renewables and more storage.

KEYS TO 100% CLEAN ELECTRICITY WITH A LSR FOCUS

DERs still play a fundamental role in achieving 100% clean electricity with a focus on large-scale renewable resources. Any reduction in load or peak from DERs reduces the need for large-scale renewables to be built. An aggressive and sustained investment in DERs is important in any pathway to 100% clean electricity.

The LSR-focused pathways rely more on the build out of large projects. These include both generating projects, such as wind and solar farms, but also projects that are traditionally difficult to build in the U.S. like electric transmission and offshore wind.

One key to getting these projects built in time to meet a CES is to start early and to streamline the siting and permitting process without sacrificing necessary environmental reviews.

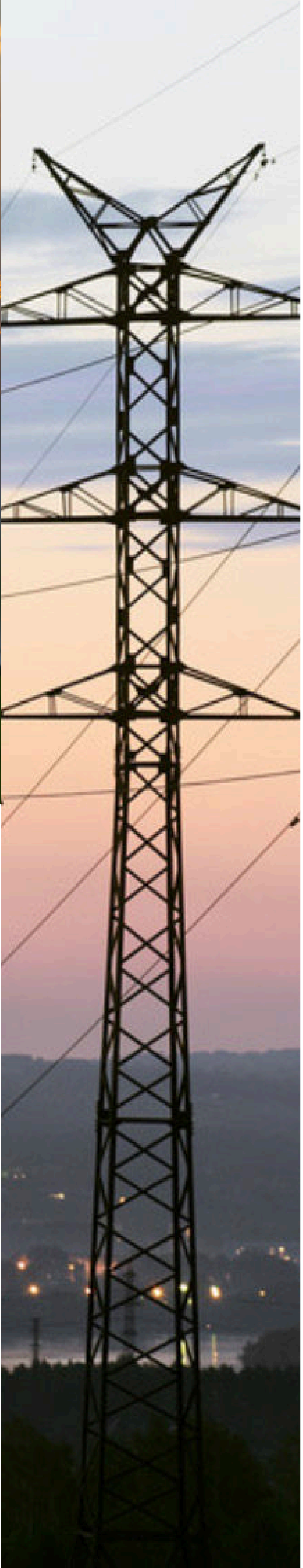
It is important that we get these projects done quickly, but it is even more important that we do not invest in more energy infrastructure that harms frontline communities, historical or cultural sites, or biodiversity.

Innovation in large-scale renewable and energy storage technologies would be expected to reduce the overall amount or resources needed in these pathways, shift what kinds of resources are needed, and make it both easier and more cost-effective to achieve 100% clean electricity.

While the technologies exist today, it is important to focus on both building out today's technologies and investing in research and development to improve technologies in the future.

ADDITIONAL PATHWAYS TO 100% CLEAN ELECTRICITY

The distributed energy resources-focused and large-scale renewable-focused pathways described above are two of many potential pathways to get electric utilities to 100% clean electricity under a CES policy. On the following pages we describe some of the additional pathways we explored and how they compare to the pathways described above.



COMPARISONS OF ADDITIONAL PATHWAYS

LEAVE SOME GAS FOR RESERVE MARGINS ONLY

Instead of overbuilding energy storage to meet reserve margins, gas combustion turbine (CT) plants, which are already rarely used, could be left in a state such that they can be called on in case of emergencies. To simulate this example we left the gas CT plants online during the reserve margin calculations, and only added enough storage to meet the hourly load profiles of the peak days. Under this setup and the DER-focused pathway assumptions the region would need approximately 8 GW less of energy storage (or 15% less) to achieve 100% clean electricity.

NO OFFSHORE WIND PATHWAY

The DER-focused pathway was tested to see what changes would be needed if no offshore wind is built within the Southeast. This primarily impacted the utilities in the Carolinas and Florida.

Without offshore wind, significantly more large-scale solar and some more storage is needed to meet peak load and reserve margin targets.

In the Carolinas it is possible that some of these large-scale solar projects could instead be additional onshore wind development. Because of their location within the region it is unlikely these utilities could cost-effectively scale up contracts with western wind to replace the offshore wind unless the Southeast were to form an RTO-like market and eliminate the addition of transmission charges for each utility that power has to pass through.

NO NUCLEAR EXTENSIONS PATHWAY

The DER-focused pathway was tested to see what changes would be needed if existing nuclear units retire when their current license expires instead of having it renewed. This impacted three operating utilities under our assumptions: Georgia Power, Duke Energy Carolinas, and Duke Energy Progress. TVA has three nuclear units at Browns Ferry that are operating under licenses that expire between 2030 and 2035. Because we applied a 100% by 2030 CES to TVA, we did not examine a case in which these Browns Ferry units retire.

Without these nuclear units online more large-scale solar and other renewable generation are required to be installed in Georgia Power, DEC, and DEP to achieve 100% clean electricity by 2035. Another way to offset these potential retirements, which wasn't explored in this analysis, would be to further develop DERs to achieve higher levels of penetration and thus offset more of the energy and capacity projected to be provided by the nuclear units.

CONCLUSIONS

The pathways presented here are not meant to be a roadmap for how each utility should comply with a CES policy, but show that compliance with a CES is feasibly by all four of these utility companies, that there are options when figuring out how to comply with a CES, and **the most important thing we can do to get to 100% clean electricity is start right away**.

MARKETS AND INNOVATION MAKE 100% CLEAN ELECTRICITY EASIER

As indicated by the fact that fewer new resources were needed to achieve 100% clean electricity for a combined FPL and Gulf Power, it would be easier for the region as a whole to meet a 100% CES if it were easier for utilities to share resources. The most common way for this to happen today is through formation of a wholesale electricity market where transmission planning and resource adequacy is done for the region as a whole and not for each individual utility.

These pathways show we can get to 100% clean electricity using technologies available today, but we should not settle for that. It is important that we take immediate steps to transform the electricity grid using today's technologies while simultaneously investing in research and development that can lead to improvements of existing clean electricity technologies and commercialization of new clean electricity technologies. This should not be a question of either deployment or research, both are needed.

ELECTRIFICATION AMPLIFIES CLEAN ELECTRICITY'S IMPACT

A Clean Electricity Standard is one part of a larger decarbonization strategy. Electrification of direct fossil use, particularly in buildings and transportation, is another decarbonization strategy that goes hand-in-hand with a CES. As our electricity gets cleaner, so do new appliances, cars, and trucks that run on electricity instead of fossil fuels.

INVESTMENT RISKS

It is clear from this exercise that we are not at risk of investing too much in energy efficiency, solar, and wind. Utilities should be building and buying as much of these resources as they can over the next five years and beyond. Scaling up is critical not only to build up clean electricity resources and retire fossil resources, but also to build up the clean energy workforce needed to deploy these resources at scale and to increase utilities' operating experience with these resources. Current plans fall well below what is needed to achieve 100% clean electricity by 2030 or 2035, and often include investments in new fossil infrastructure. It is time to shift utilities' incentives and regulatory structure so we can clean up the grid in a swift and equitable manner.

CONCLUSIONS

MORE ANALYSIS NEEDED

More analysis by independent parties and the utilities themselves is needed to determine a near-term plan that gets us on track to decarbonize the electricity sector by 2035. This has not been a focus of utility resource plans to-date. Future resource planning is the tool for utilities to determine how to get to 100% clean electricity, and the absence of serious decarbonization within resource planning pushes back the feasibility of getting to 100% electricity in the timeframe needed to avoid the worst impacts of climate change. Each utility needs to perform its own analysis, modeling, and evaluation to determine its optimal near-term plan and long-term pathway to 100% clean electricity.

CLEAN ELECTRICITY STANDARD POLICY COMES FIRST

One thing this report does not consider is how a CES policy comes to be. While many states across the country, and one (North Carolina) in the Southeast, have either Clean Energy Standards or Renewable Portfolio Standards, as of the writing of this report there is no federal Clean Electricity Standard on the books. A 100% CES by 2035 has been proposed by President Biden. There have also been several CES policies introduced by various members of the 116th and 117th Congresses. We hope that policymakers, utilities, regulators, and citizens in the Southeast will take away from this report that a federal CES is feasible and can accelerate the transformation to a clean, equitable, and healthy energy sector in the Southeast and across the country.

Please view the appendices for information on method, assumptions, capacity by type for all pathways, and hourly profile charts.