

Low Cost
Renewable Energy
Options for the
Tennessee Valley Authority

Fall 2017



OVERVIEW

Renewable energy demand is growing. Renewable energy prices have plummeted over the past few years. Wind power prices have declined by 66%, and solar power prices by 85%, just since 2009. In many parts of the country, renewable energy is now cost competitive against traditional energy resources. Utilities like Southwestern Electric Power Company (Louisiana/Arkansas)¹ and MidAmerican (Iowa)² have both announced *multi-gigawatt wind power purchases* in the past year. Southern Power owns over 1,400 MW of wind power resources.³ North Carolina has the second highest level of solar power capacity in the country, with over 3,200 MW installed.⁴ Corporations and other non-utility buyers are finding innovative mechanisms to directly invest in renewable energy. These voluntary announcements are due to the low costs of renewable energy.

The Tennessee Valley Authority (TVA) has previously been a leader in purchasing renewable energy. In 2004, the Buffalo Mountain wind project in Tennessee became the south's first utility-scale wind farm, with TVA as its energy customer. In 2010, the TVA Board of Directors "authorized the purchase of as much as 2,000 MW of renewable and clean energy. TVA plans to have half of its power supply from clean and renewable energy sources by 2020."⁵ As part of that plan, TVA procured over 1,500 megawatts of wind power. In 2015, TVA completed a long-term planning process to identify future power generation resources and needs. In its Integrated Resource Plan (IRP), TVA stated that it would add "150 and 800 MW of large-scale solar by 2023, and between 3,150 and 3,800 MW of largescale solar by 2033...[and add]...between 500 and 1,750 MW by 2033, depending on pricing, performance, and integration costs. Given the variability of wind selections in the scenarios, evaluate accelerating wind deliveries into the first 10 years of the plan if operational characteristics and pricing result in lower-cost options."⁶

However, since 2015, TVA has not fulfilled their announced commitments or provided plans for achieving their goals. The newly appointed TVA board members will help steer the strategic direction of the organization, potentially with significant renewable energy procurement policies and plans. By setting clear goals, TVA can better promote its mission of to improve environmental stewardship, reliable power and economic development. Some recommendations include:

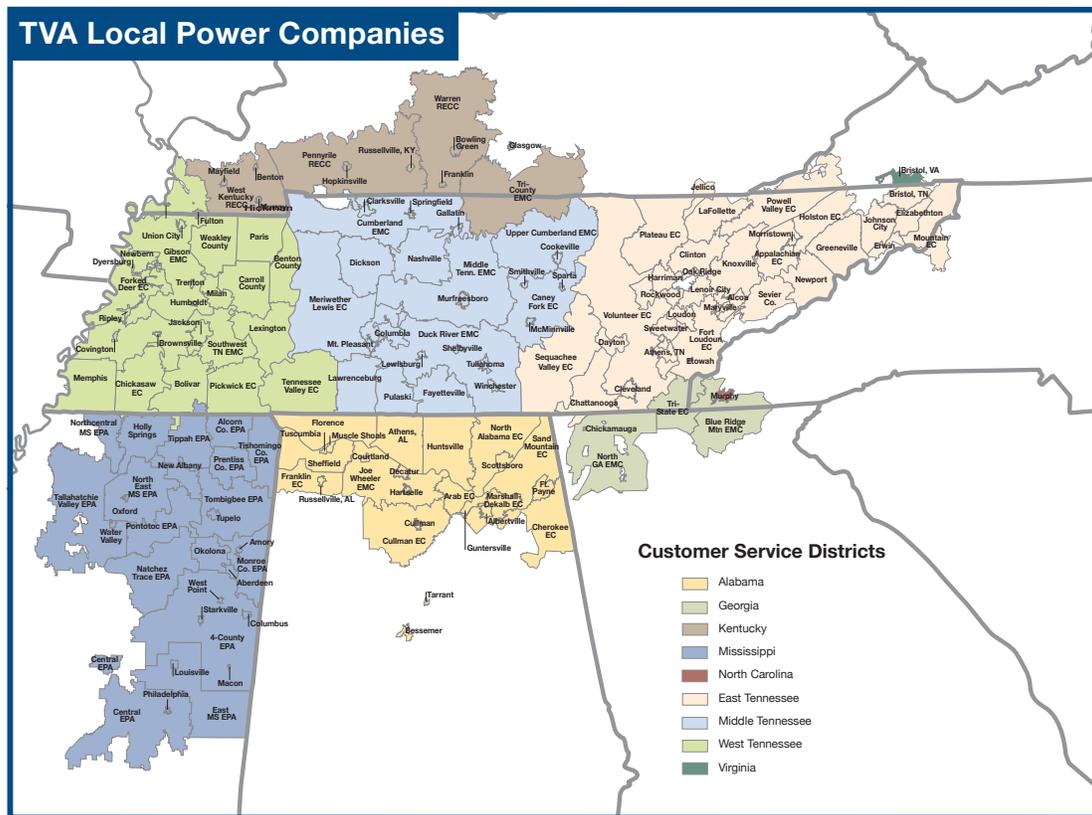
- Immediately direct TVA staff to fully implement the 2015 IRP's renewable energy goals.
- Set clear procedures for ongoing renewable energy procurement.
- Improve access to renewable energy procurement for large customers.
- Improve Integrated Resource Planning

TENNESSEE VALLEY AUTHORITY: HISTORY, REGION, AND TERRITORY

As a federal public power agency, the Tennessee Valley Authority (TVA) is unique among electric power providers. TVA was conceived during the President Franklin D. Roosevelt administration as an economic development agency for the Tennessee Valley region. The region was deeply affected by the Great Depression and lacked adequate power resources to support industry development or job creation. The Tennessee Valley Authority Act (TVA Act) was signed into law in 1933 and established TVA as a federally owned corporation with the powers of government. As a federally owned corporation, TVA’s Board of Directors is appointed by nomination from the President of the United States.

Board members have the responsibility to “establish broad strategies, goals and objectives; set long range plans and policies; and to ensure their implementation by TVA staff”.⁷ The actions of the Board have far reaching impacts: TVA’s service territory has grown throughout seven states, includes 16,200 miles of transmission lines, and the current customer base is over 9 million customers. The service territory established by the TVA Act is included below for context.

Figure 1: Map of Customer Service Districts and Local Power Companies for TVA territory



Perhaps most importantly, the TVA Act allows the utility “to exchange, buy or sell power with 14 neighboring electric utilities. This arrangement gives TVA the ability to purchase power when its generating capacity cannot meet demand or when purchasing power from a neighboring utility is more economical for TVA than generating it.” Buying power from outside the service territory allows TVA flexibility to find lowest cost power for its customers, including renewable energy development outside the territory.

TVA ELECTRIC GENERATION RESOURCES

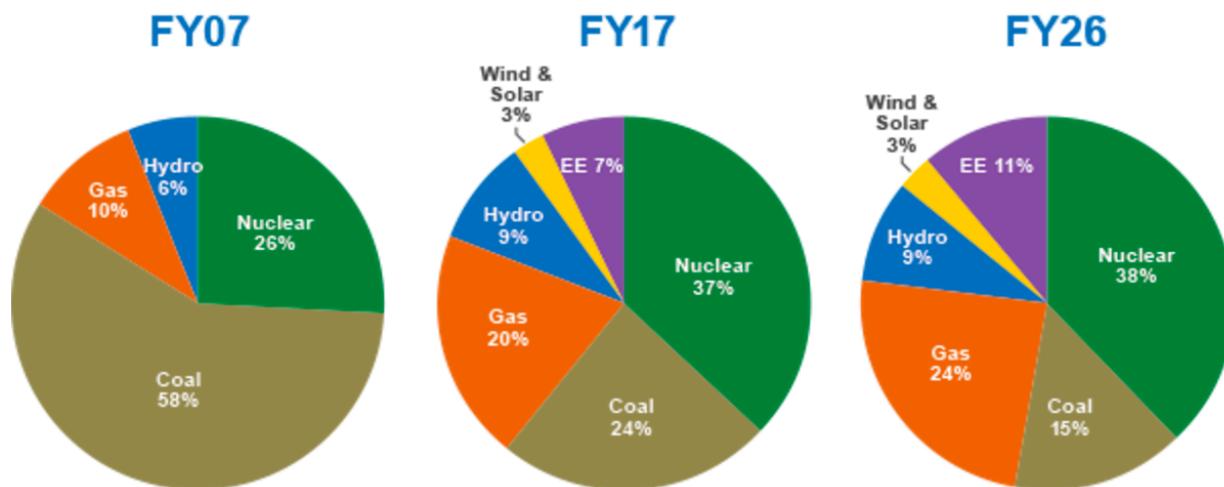
Meeting the electricity needs of TVA’s millions of customers requires a mix of many different power resources. The set of resources chosen is referred to as the utility’s *resource portfolio*. TVA re-evaluates its resource portfolio on a regular basis so that the company can adapt to changes in the power industry and any other outside circumstances.

TVA Renewable Energy

Hydropower: 4,655 MW
 Wind: 1,242 MW
 Solar: 221 MW
 Biomass: 64 MW

As of 2017, TVA’s resource generation portfolio relies predominantly on fossil fuels (coal and natural gas) and nuclear. The renewable energy portion of the mix includes biomass, hydroelectric, wind, and solar. Based on recent presentations by TVA, it appears the organization has no plans to add significant quantities of new renewable energy generation resources for the next decade, despite previous announcements and plans to do so.

Figure 2: TVA Generation Mix by Resource



Source: TVA 2016⁸

CURRENT RENEWABLES ENERGY RESOURCES

For the renewable energy portion of the portfolio, TVA relies primarily on Power Purchase Agreements (PPAs) with private developers. As a public entity, TVA is not eligible to directly take advantage of federal tax credits such as the Investment Tax Credit (ITC, for solar projects) or Production Tax Credit (PTC, for wind projects). However, by entering a PPA with private renewable energy developers, TVA is able to buy the power generated by the wind or solar farm at fixed rates for the duration of a typical 20+ year contract at reduced cost.

Although renewable energy PPAs would be cost-effective for customers, the current portfolio shows a low level of investment in renewable energy relative to its size. Investments in large-scale solar are particularly lagging. TVA has acknowledged that solar is one of *“the most abundant and easily deployable renewable resources.”*

TVA’s interest in solar power is currently limited to a handful of small-scale solar facilities, and one fairly large utility-scale project. Plans to expand solar capacity by partnering directly with the local power companies (LPCs) were announced in May 2017. TVA awarded 10 MW of solar capacity to seven LPCs who applied through TVA’s Distributed Solar Solutions (DSS) pilot program. Contracts were awarded to seven LPCs for solar projects ranging from 50 kW to 2 MW in size each.

TVA currently purchases energy from one “In-Valley” wind project in Tennessee via PPA. The Buffalo Mountain Wind Farm began operation in 2004 in Anderson County, Tennessee with a 27 MW nameplate capacity. The rest of TVA’s wind energy resources are made up of PPA contracts for 1,215 MW from wind farms outside the TVA service territory. Wind farm development companies have agreed to wheel energy into TVA from states outside the TVA footprint including Illinois, Iowa and Kansas. When the wind power contracts reach their expiration date (usually up to 20 years after initial operation), TVA has the option to either extend or replace them with comparable wind contracts. TVA routinely evaluates these and other types of wind energy in their resource planning process, known as Integrated Resource Planning.

INTEGRATED RESOURCE PLANNING

IRPs are planning tools for a utility to evaluate different resource options and develop formal plans to meet future energy needs. The portfolio selected in the IRP process represents the best combination of resource pricing, timeline, reliability, and environmental impacts. Utilities across the country follow this process, which is routinely updated and repeated.

The advantage of anticipating different scenarios is that it allows the utility to respond to quickly changing market conditions. Ultimately, the process ends with selecting a portfolio that offers the best combination of benefits to utility customers. The scoping process can start years before the actual portfolio is selected, but the development of the portfolio analysis is outlined in *Figure 3*:

In 2015, TVA completed an IRP. TVA also files a supplemental environmental impact statement (EIS) alongside its IRP, as part of the federal National Environmental Policy Act review process. TVA describes the process in the following manner:

“The purpose of the IRP and EIS processes is to evaluate TVA’s current energy resource portfolio and alternative future portfolios of energy resource options at a least system-wide cost to meet the future electrical energy needs of the TVA region while taking into account TVA’s mission of energy, environmental stewardship and economic development.”

The core function of the IRP is not only to evaluate the financial and environmental impacts, but also to enable review and participation from the public. Utilities typically maintain transparency in the process by collecting public comments at multiple milestones, holding public meetings, and issuing news releases and meeting notices. During the last cycle, TVA received over one thousand public comments. Given that such an impactful process happens in the public eye, *approving an IRP is, by far, one of the most important responsibilities that TVA board members have.* The TVA Board of Directors is responsible for approving the company’s IRP.

OUTCOMES FROM TVA'S 2015 IRP

The IRP evaluates both different planning strategies and scenarios. *Planning strategies* reflect the different resource choices the utilities can make, i.e. differing amounts of renewables vs. fossil fuels. In 2015 TVA evaluated five planning strategies: A) a reference plan, B) meeting an emissions target, C) focusing on long-term, market supplied resources, D) maximizing energy efficiency, E) maximizing renewables, and a baseline scenario assuming no changes. *Scenarios* reflect different sets of future conditions such as economic stability, availability of resources, or environmental regulations. Five different scenarios are assumed to exist: 1) the current outlook, 2) a stagnant economy, 3) a growth economy, 4) a de-carbonized future, and 5) a distributed marketplace.

Combinations of these strategies and scenarios are evaluated and chosen for a portfolio. The advantage of anticipating different scenarios is that it allows the utility to respond to quickly changing market conditions. Below is an illustration of the varying amounts of renewables for Strategy A in multiple scenarios:

Figure 3: IRP Process, as defined in TVA's 2015 IRP

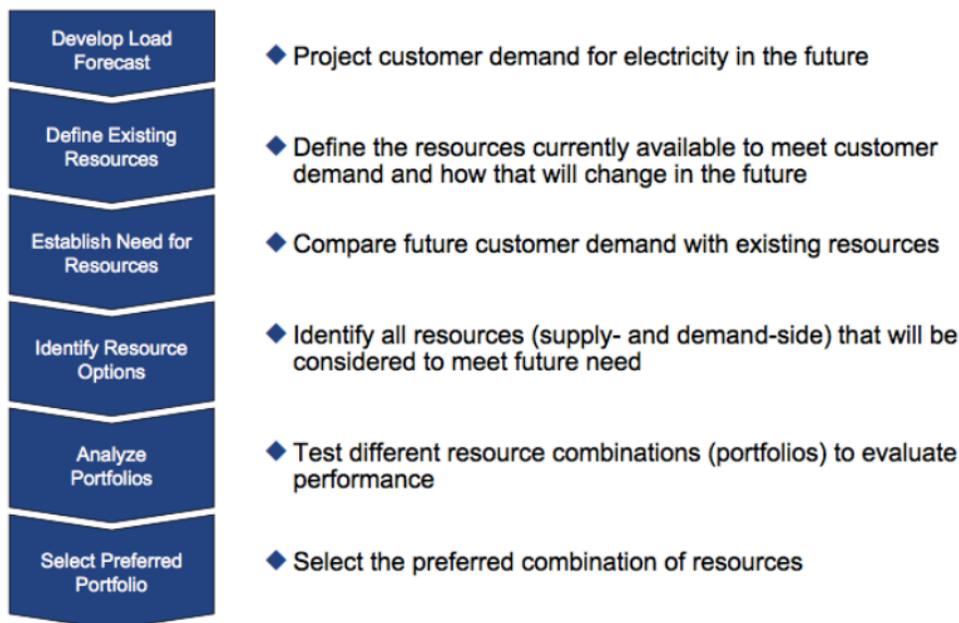
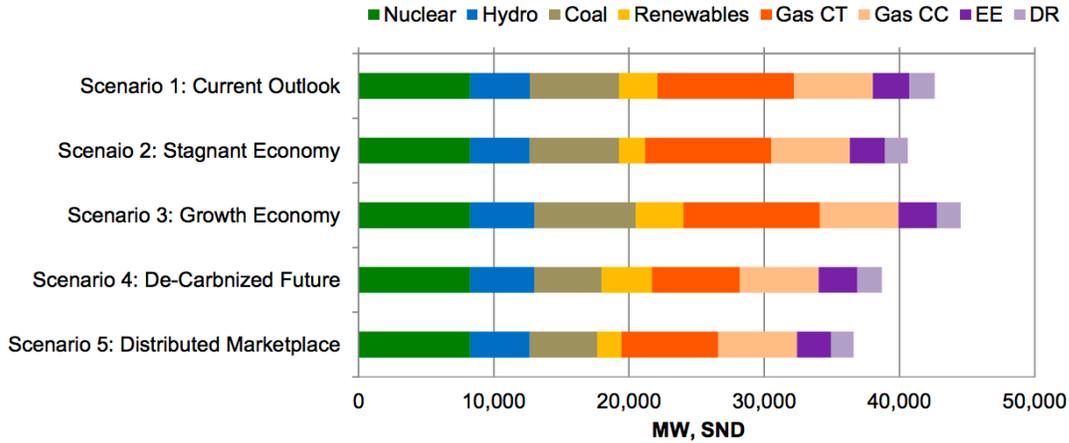


Figure 4: Analysis of Strategy A against multiple scenarios

Strategy A: The Reference Plan Capacity by 2033



*The nameplate capacity for the renewables category is as follows: Scenario 1: 5,050 MW, Scenario 2: 2,400 MW, Scenario 3: 7,500 MW, Scenario 4: 9,200 MW, Scenario 5: 2,200 MW.

IRP Outcomes

Wind Energy

The final outcome of the IRP called for between 500 and 1,750 MW of additional wind energy by 2033. The amount from this range ultimately added to TVA’s portfolio is “dependent on pricing, performance, and integration costs.” The timeline is also variable, with these additions possibly occurring in the near-term: “lowering costs and providing a higher guaranteed net dependable capacity for HVDC wind results in selection as early as 2020.”

Solar Energy

TVA made a substantial commitment to large-scale solar, with the final IRP stating that they would add “between 150 and 800 MW of large-scale solar by 2023, and between 3,150 and 3,800 MW of large-scale solar by 2033. The trajectory and timing of solar additions will be highly dependent on pricing, performance and integration costs.” The sensitivities modeled assumed that utility-scale solar tracking would be selected as early as 2020.

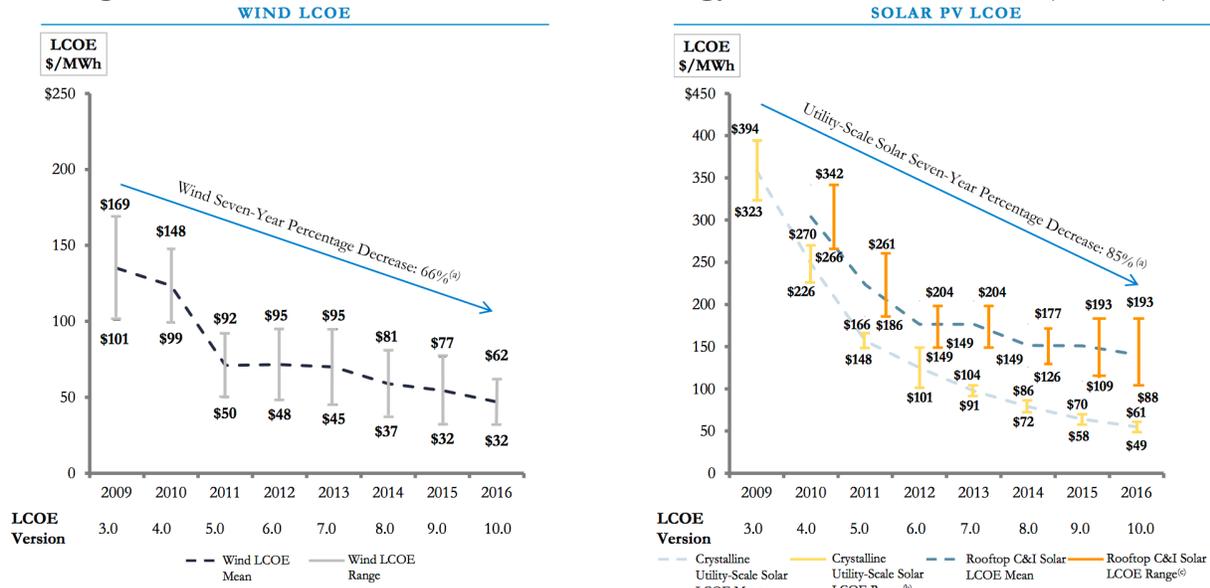
Subsequent Renewable Energy Action and Request for Information (RFI)

TVA made a major commitment to renewable energy development in the 2015 IRP, but has made little to no progress towards fulfilling that commitment. In May 2016, TVA issued a short, three-page Request for Information (RFI) to collect information from developers on renewable energy projects. Typically, an RFI is used to evaluate candidates to receive potential future RFPs since an RFP may or may not be publically posted. The RFI stipulates that the proposed arrangement would be a ‘sell-all’ Power Purchase Agreement (PPA) for 20-25 years, with a commercial operation date no later than December 31, 2020. It has been over one full calendar year since the RFI submission deadline passed, but there is still little information available on the outcomes of the RFI. It is still unknown how many developers responded, what range of pricing options were offered to TVA, or if there are any plans to initiate an RFP that would result in a selection of renewable energy resources.

RENEWABLE ENERGY REVIEW

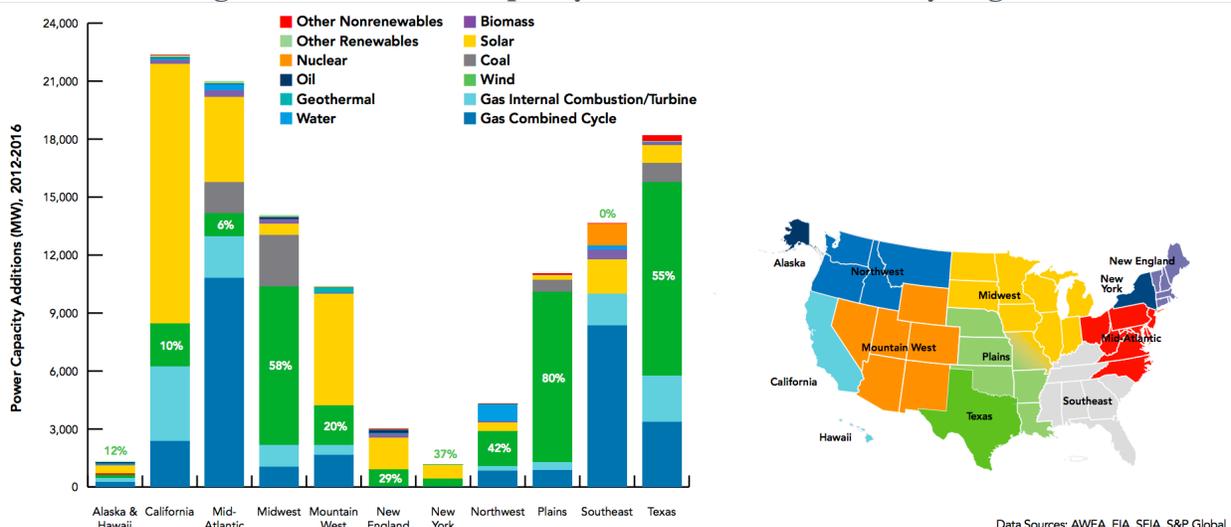
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Figure 5: Unsubsidized Levelized Cost of Energy for Wind/Solar Power (\$/MWh)



Source: Lazard Associates 2016¹³

Figure 6: U.S. Power Capacity Additions 2012 to 2016, by Region



Source: AWEA 2017¹⁴

Solar Power Opportunities

Solar photovoltaic (PV) panels have improved dramatically in performance, as well as price, over the past few years. Generally, panels can be arranged as a “fixed tilt” project, or with a “tracking” system that follows the path of the sun in order to increase output. Both opportunities have unique benefits and costs that are necessary to consider.

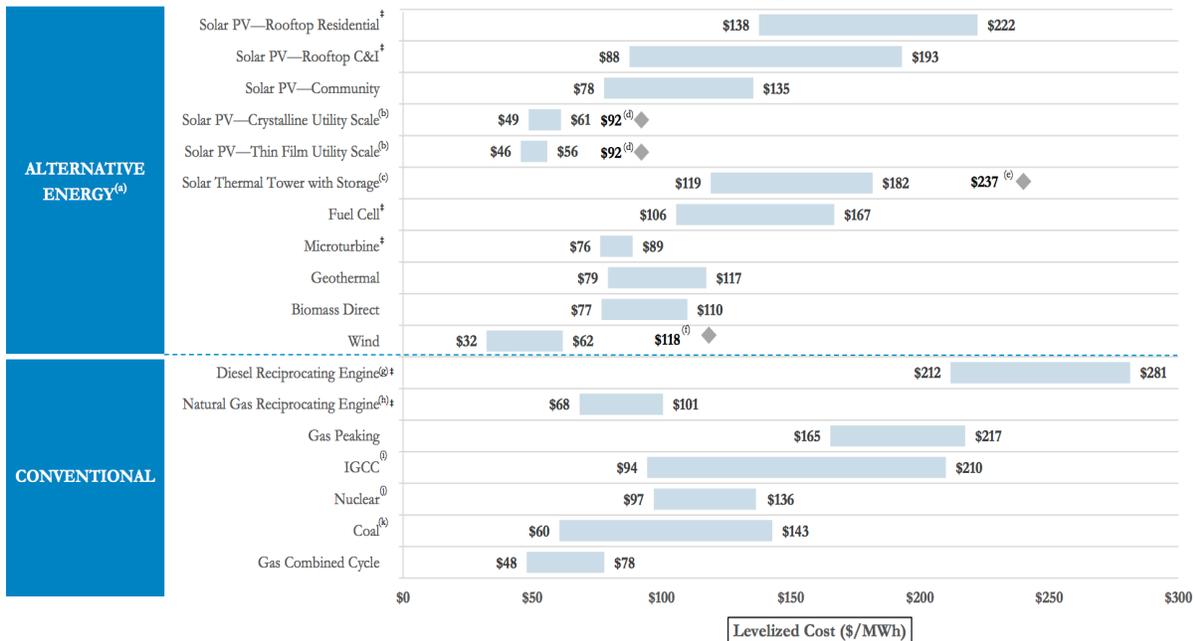
Wind Power Opportunities

TVA could utilize existing transmission to connect to projects from outside the region, such as those from the Midcontinent Independent System Operator (MISO) and the Southwest Power Pool (SPP). The power from a wind or solar project outside the region would be delivered to the TVA system. MISO and SPP wind energy resources are fairly reflective of TVA’s current renewable energy PPAs.

Newly planned HVDC transmission projects are purpose-built for wheeling in wind energy to the Southeast, including the western edge of the TVA service area. These HVDC projects include those currently under construction by transmission developers such as Clean Line Energy Partners and Pattern Energy. These could connect up to 6,000 MW of wind power alone.

Renewable energy resources within the TVA footprint are considered “In-Valley” energy resources. These In-Valley resources are generally characterized as having higher installation costs and lower capacity factors compared to other wind energy resources, yet offer a number of co-benefits such job creation from the supply chain (local manufacturers, installers, technicians, etc.).

Figure 7: Wind and Solar Power Are Low-Cost Unsubsidized Levelized Cost of Energy Comparison

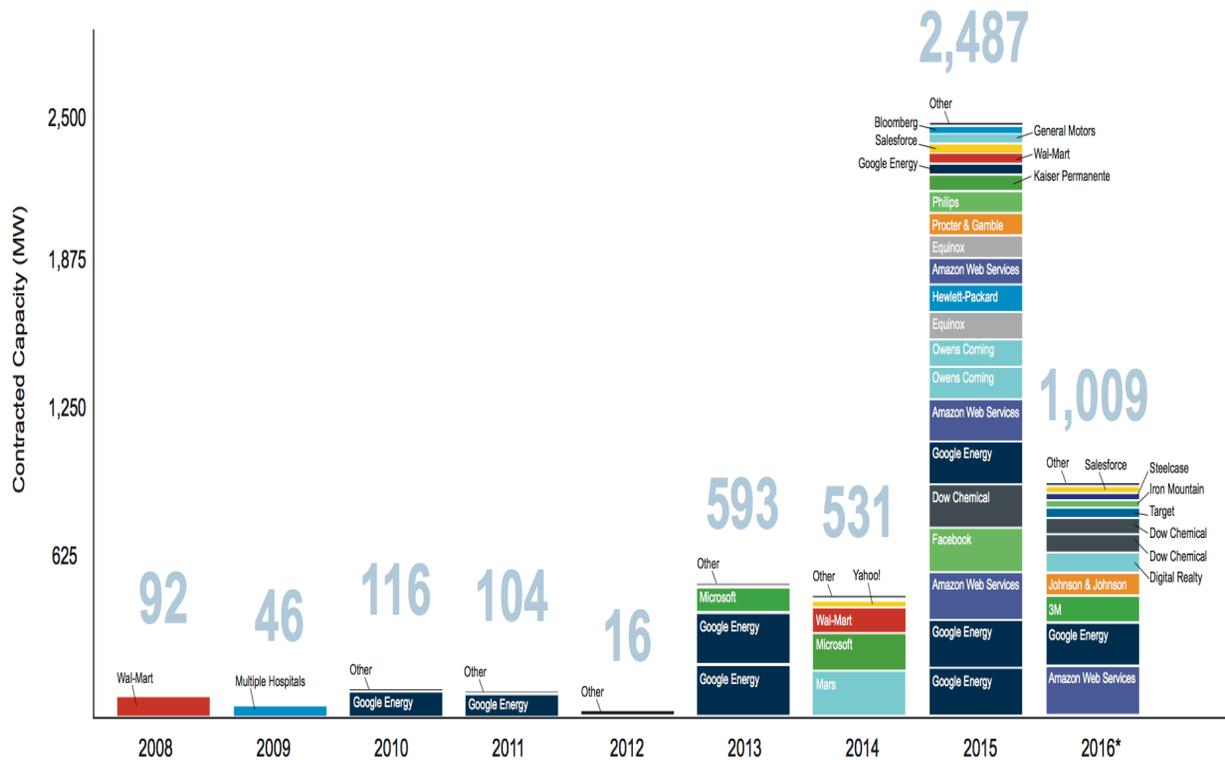


Source: Lazard Associates 2016¹⁵

BUSINESSES DEMAND RENEWABLE ENERGY

Corporations are increasingly voluntarily purchasing renewable energy, where possible with innovative efforts, such as TVA’s work to attract a Google datacenter to Alabama.¹⁶ Like many companies, Google plans to receive 100% of its electricity from renewable energy resources.¹⁷ Businesses are actively seeking locations for new facilities that can access significant quantities of low-cost renewable energy resources. As large commercial customer demand increases for renewable energy, utilities need to adapt in order to serve these customers, or risk losing significant economic development benefits.

Figure 8: Corporate Renewable Energy Demand is Increasing



Source: AWEA 2017¹⁸

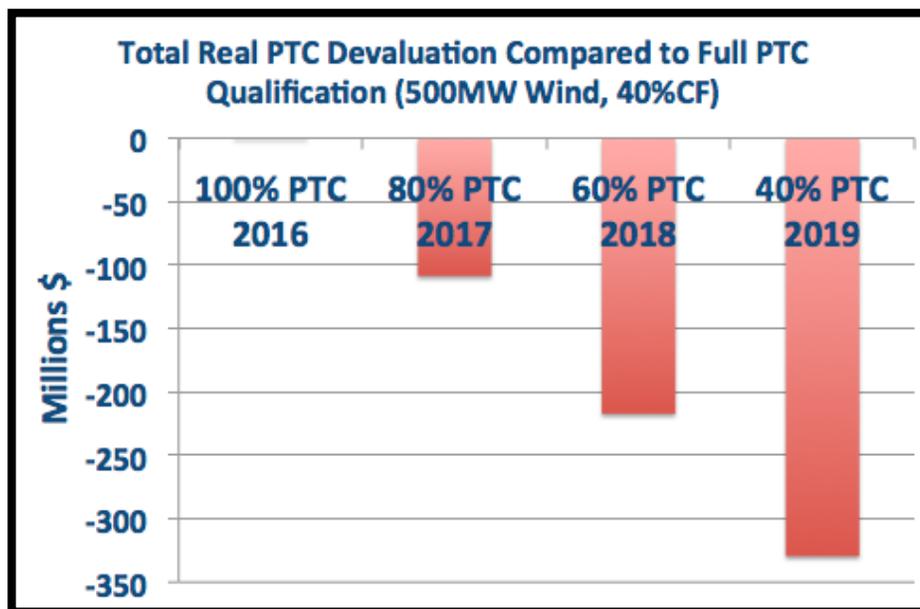
BUY WIND AND SOLAR SOONER RATHER THAN LATER

In December 2015, the United States Congress passed a long-term extension of the federal Production Tax Credit (PTC) for wind energy with a phase-out starting in 2016 and ending by 2020. The legislation also extended the federal Investment Tax Credit (ITC) for solar power projects, which declines from 30% value to 26% in 2020, 22% in 2021, and 10% thereafter. This extension is a prime opportunity that has created a distinct, urgent timeframe for the TVA Board of Directors to take action. Recent reports indicate that prices are now so low that many utilities are finding that it makes sense to reach beyond their “needs” and “requirements” to begin locking in fuel savings for customers *now*. Given the extension of the tax credits, there is now a renewed need for the TVA board to develop a strong renewable energy procurement policy - *soon*.

TVA planning activities towards should be directed towards actively searching for renewable energy developments. TVA is one of many companies that stand to benefit from the extension of the ITC and PTC. Unlike other companies, TVA has not released an RFP in several years, nor has it approved a renewable energy policy as part of their resource acquisition strategy. A variety of southern electric utilities have announced wind and solar request for proposals (RFPs) this year, including many on a voluntary basis. Companies with a renewable energy policy have a competitive edge since their internal guidelines allow them to move quickly in the procurement process.

Timing is a key factor in the procurement process since the most cost-effective PPA prices will be in the near-term before the tax credits phase-out. The PTC declines annually in value by 20% until the credits phase out completely for wind energy projects starting construction in 2020. By delaying procurement of renewable energy resources, utilities risk losing hundreds of millions of dollars.

Figure 8. Expedited Wind Energy Purchasing Preserves Tax Credit Value



RECOMMENDATIONS

The newly appointed TVA board members will help steer the strategic direction of the organization, potentially with significant renewable energy procurement policies and plans. By setting clear goals, TVA can better promote its mission of to improve environmental stewardship, reliable power and economic development.

Immediately direct TVA staff to fully implement its 2015 IRP.

TVA's 2015 IRP identified up to 1,750 megawatts of wind energy and 800 MW of solar power capacity purchases; however, to date, no significant purchases or announcements have been made. Because of the impending phase-out of the federal production tax credit for wind, and investment tax credit for solar, it is important to sign power purchase agreements quickly.

Set clear procedures for ongoing renewable energy procurement.

TVA lacks a clear policy or process for procuring renewable energy as a long-term goal. Previously, TVA announced plans to purchase up to 2,000 MW of renewable resources; however, the utility has fallen short of that goal.

Improve access to renewable energy procurement for large customers.

As mentioned previously, businesses and corporations are interested in procuring significant quantities of renewable energy. TVA should begin to evaluate opportunities to provide renewable energy resources to their customers, such as green tariff programs.

Improve Integrated Resource Planning

It is unclear when TVA will begin its next IRP. TVA began its 2015 IRP process in earnest in 2013, suggesting an approximately two-year process. Given that timeframe, the earliest TVA could complete its next IRP would likely be mid-2019 – beyond key deadlines for the federal PTC/ITC for wind and solar power. Some utilities have clearly outlined schedules and processes for IRP development and stakeholder engagement. TVA needs to set clear goals, schedules and processes for its next IRP.

¹ Clean Technica (July 27, 2017). USA's Largest & World's Second-Largest Onshore Wind Farm (2 Gigawatt Farm) To Be Built In Oklahoma. [<https://cleantechnica.com/2017/07/27/invenenergy-ge-team-2-gw-worlds-second-largest-us-largest-onshore-wind-farm/>]

² Greentech Media (August 31, 2016). New \$3.6B Project in Iowa Could Be One of Many 'Mega' Wind Orders [<https://www.greentechmedia.com/articles/read/iowas-new-3.6b-wind-project-could-be-one-of-many-mega-wind-orders>]

³ Southern Power (January 2017). Southern Power Projects - Wind. [<https://www.southerncompany.com/our-companies/southern-power/projects.html>]

⁴ Solar Energy Industries Association (2017). North Carolina Solar. [<http://www.seia.org/state-solar-policy/north-carolina>]

⁵ Federal Register (February 4, 2010). "Environmental Assessment or Environmental Impact Statement for Purchase of Renewable Energy From CPV Ashley Wind Power Project in North Dakota," Notice by the Tennessee Valley Authority. [<https://www.federalregister.gov/documents/2010/02/04/2010-2377/environmental-assessment-or-environmental-impact-statement-for-purchase-of-renewable-energy-from-cpv>]

⁶ Tennessee Valley Authority (2015). Integrated Resource Plan. [https://www.tva.gov/file_source/TVA/Site%20Content/Environment/Environmental%20Stewardship/IRP/Documents/2015_irp.pdf]

⁷ Tennessee Valley Authority. Board of Directors. [<https://www.tva.gov/About-TVA/Our-Leadership/Board-of-Directors>]

⁸ Tennessee Valley Authority (September 2016). [<https://www.tva.gov/Newsroom/TVA-Invests-in-a-Greener-Future>]

⁹ Clean Technica (July 27, 2017). USA's Largest & World's Second-Largest Onshore Wind Farm (2 Gigawatt Farm) To Be Built In Oklahoma. [<https://cleantechnica.com/2017/07/27/invenenergy-ge-team-2-gw-worlds-second-largest-us-largest-onshore-wind-farm/>]

¹⁰ Greentech Media (August 31, 2016). New \$3.6B Project in Iowa Could Be One of Many 'Mega' Wind Orders [<https://www.greentechmedia.com/articles/read/iowas-new-3.6b-wind-project-could-be-one-of-many-mega-wind-orders>]

¹¹ Southern Power (January 2017). Southern Power Projects - Wind. [<https://www.southerncompany.com/our-companies/southern-power/projects.html>]

¹² Solar Energy Industries Association (2017). North Carolina Solar. [<http://www.seia.org/state-solar-policy/north-carolina>]

¹³ Lazard Associates (2016). Lazard's Levelized Cost of Energy Analysis - Version 10.0. [<https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf>]

¹⁴ American Wind Energy Association (2017). U.S. Wind Industry Annual Market Report.

¹⁵ Lazard Associates (December 2016). Lazard's Levelized Cost of Energy Analysis. [<https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf>]

¹⁶ Tennessee Valley Authority (June 24, 2015). Google Chooses TVA Site for Next Data Center. [<https://www.tva.gov/Newsroom/Press-Releases/Google-Chooses-TVA-Site-for-Next-Data-Center>]

¹⁷ Google (December 2016). Achieving our 100% Renewable Energy Purchasing Goal and Going Beyond. [<https://static.googleusercontent.com/media/www.google.com/en//green/pdf/achieving-100-renewable-energy-purchasing-goal.pdf>]

¹⁸ American Wind Energy Association (2017). Evolution of the Corporate wind PPA: Market Insights.