

Problems in Paradise

Closing TVA's Aging Coal Unit is the Right Decision

Executive Summary

The decision by the Tennessee Valley Authority's board of directors to close the Paradise Unit 3 coal-burning power plant in 2020 made perfect sense: Economically, the aging facility simply could not compete with the utility's new combined cycle natural gas units and enhanced nuclear generation capacity. As Bill Johnson, the TVA CEO at the time, said in announcing the February 14, 2019 decision: "It is not about coal. This decision is about economics. It's about keeping rates as low as feasible."¹ That view was seconded by TVA's incoming CEO, Jeff Lyash, who said on April 12, 2019, that the closures had nothing "to do with a 'war on coal' or anything else. It has to do with deciding what's best for the Tennessee Valley."²



Indeed, the data clearly shows that keeping the Paradise plant open would not be in the best interests of TVA or its customers. It is a warning that potential outside investors who may now be considering a purchase should take to heart: The plant's economics do not stack up in today's competitive environment, as we will demonstrate in this research brief.

Among the many specific issues at the plant are:

¹ Associated Press (AP). [Trump-dominated board to close coal plant, despite his plea](#). February 14, 2019.

² AP. [New TVA head says board right on coal plant closures](#). April 12, 2019.

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- Its capital expenditures and non-capital production costs (that is, operations and maintenance expenses) topped \$76 per megawatt-hour (MWh) in TVA's 2018 fiscal year—well above the utility's system-wide wholesale rate.
 - Continued operation would require capital investments of more than \$200 million to repair and upgrade Unit 3's generation equipment.
 - The plant's performance during the past three years, as measured by its equivalent forced outage rate, has been significantly worse than comparable units in the U.S.³

TVA made the right decision in closing Paradise 3. Any effort to reverse course and keep the unit running (including at the behest of some prospective new owner) would necessarily imply significant and continual financial losses. Capital should be invested elsewhere, not wasted on an old, unneeded, uneconomical unit.

The Rationale Behind Closing Paradise 3

TVA's decision to close Paradise 3 was clearly correct in view of a number of economic considerations discussed further below.

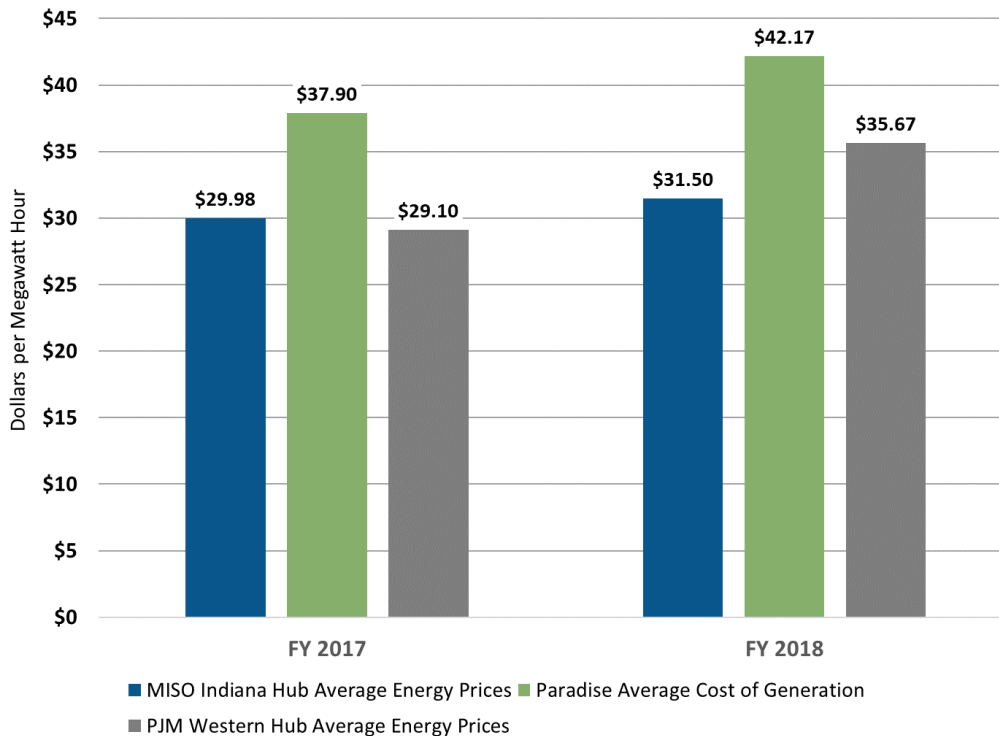
Going forward, any company considering purchasing and running Paradise 3 as an independent power producer would face seven serious risks to profitable operation of the plant.

Risk #1: Paradise Power is Uncompetitive

The cost of generating power at Paradise 3 has been high in recent years—significantly higher than it would have cost any party to buy the same energy in MISO or PJM, the two organized markets in which Paradise 3 would compete if it were operated as an independent entity.

³ TVA. [Generation and Financial Information on Paradise Fossil Unit 3](#). December 2018.

Figure 1: FY2017-FY2018 Paradise 3 Non-Capital Production Costs vs. MISO and PJM Energy Market Prices⁴



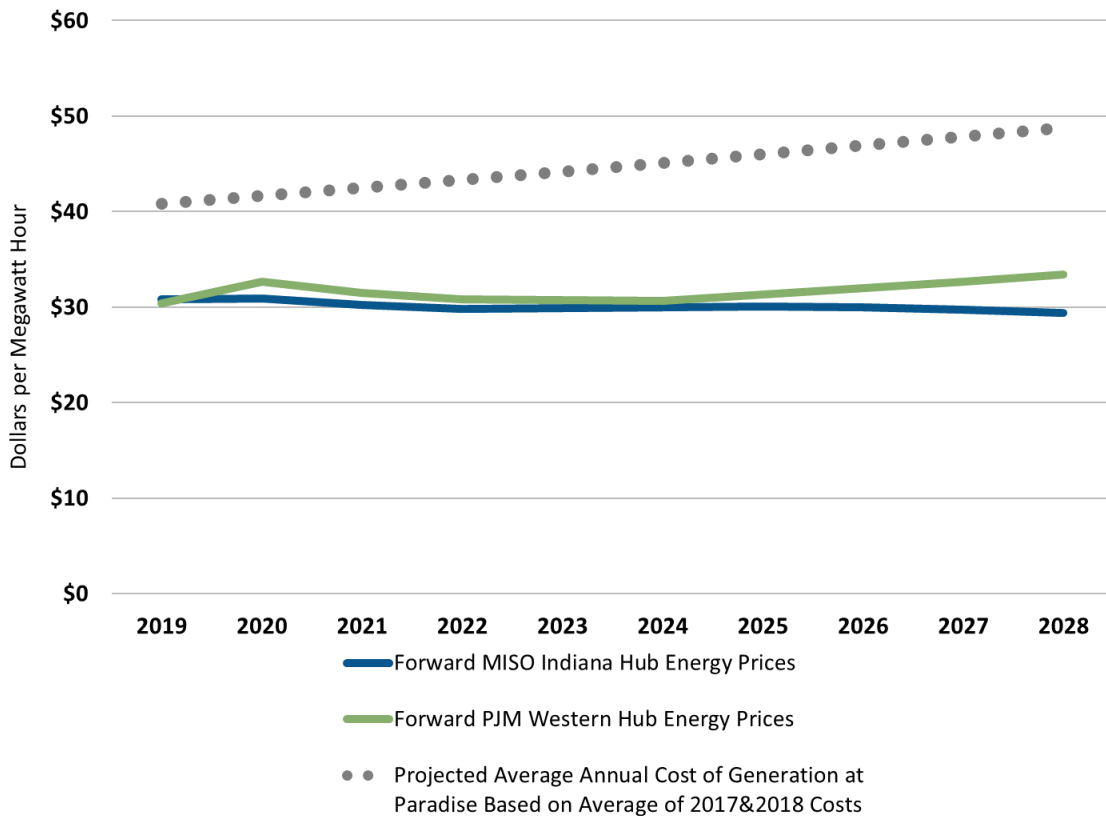
Sources: MISO and PJM energy market prices downloaded from S&P Global Market Intelligence. Paradise 3 generation costs from TVA, Dec. 2018, *Generation and Financial Information on Paradise Fossil Unit 3*.

Barring a dramatic reversal in the relative cost of producing power at Paradise 3—meaning sharp reductions in those costs—the cost of generating power at the plant will certainly continue to be much higher than the market prices at which potential customers could buy the same energy at MISO or PJM hubs. If it were possible to reduce the cost of generating power at Paradise 3 to make the unit competitive, it could be expected that TVA, one of the nation's most-experienced coal plant operators, would make all reasonable efforts to do so. It is just not possible, however.

Going forward, the gap is likely to grow even more pronounced. Forward prices in both MISO and PJM are essentially flat through 2028, while recent performance at Paradise 3 indicates that its production costs are likely to increase, as Figure 2 indicates.

⁴ TVA's fiscal year runs October 1-September 30. For example, FY2018 ran from October 1, 2017-September 30, 2018.

Figure 2: Projected Future Paradise 3 Production Costs vs. Forward Energy Market Prices at MISO Indiana and PJM Western Hubs



Sources: Forward MISO and PJM energy prices as of April 5, 2019 from OTC Global Holdings, downloaded from S&P Global Market Intelligence. Projected Paradise 3 generation costs based on escalating average of 2017 & 2018 costs by 2 percent annually. TVA, December 2018, *Generation and Financial Information on Paradise Fossil Unit 3*.

Risk #2: Significant Capital Investment would be Needed to Maintain Paradise 3

Given the plant's age, rising capital expenditures for major maintenance projects are to be expected. But the past couple of years have been particularly troublesome for Paradise 3, contributing significantly to TVA's decision to close the plant. These costs are outlined in Table 1 below.

Table 1: Paradise Capital Expenditure Estimates (in millions)

	Non- Environmental	Environmental Compliance	Total Capex
FY 2017	56	38	94
FY2018	25	70	95
FY 2019-2023	216	212	428
Average FY2019-23	54	53	107

Source: TVA, December 2018, *Generation and Financial Information on Paradise Fossil Unit 3*.

Two things are of particular importance regarding these capital investments. First, they are not factored into the plant's non-capital production costs shown above in Figures 1 and 2. In other words, Paradise 3's power generation is even less competitive than Figures 1 and 2 indicate.

Second, these estimated capital expenditures are non-negotiable items, dealing with the guts of Unit 3's power generation equipment.

TVA attempted to address some of the issues at Paradise 3 in 2017, taking the unit offline in September that year for a lengthy reconditioning and maintenance overhaul. At the time, Jeff Montgomery, the acting plant manager, said the goal of the work was to "set this plant up for long-term sustainability in our fleet."⁵

That goal has been elusive. On Jan. 10, 2018, after generating just 5,385MWh of electricity following its return to service, the unit tripped offline when the high-pressure turbine rotor locked.⁶ The problem kept the unit offline until Jan. 30 and cost TVA more than \$12 million just for replacement power.

The unit was brought back online and generated power throughout the year, but there clearly are still problems, as outlined in the company's environmental assessment (EA) and other documents analyzing the impact of shutting down the plant.

In the EA, TVA wrote:

"Moreover, PAF Unit 3 has experienced deterioration in its material condition resulting in reliability challenges and need for large investments. Further, an emergent steam turbine rotor issue would require significant expenditures as the rotor must be replaced."⁷ (Emphasis added.)

Other parts identified as needing repair include the "boiler, turbine, generator, condenser, induction fan, and balance of plant projects."⁸ With that sizable a list of necessary repairs, it is entirely possible that the TVA's estimate is understated,

⁵ TVA. *Paradise Redux*. October 2, 2017.

⁶ TVA *Generation and Financial Information on Paradise Fossil Unit 3*. December 2018.

⁷ TVA. *Final Environmental Assessment on Paradise Unit 3 Retirement*, p. 2. February 2019.

⁸ TVA. *Generation and Financial Information on Paradise Fossil Unit 3*. December 2018.

particularly given the age of the plant and the likelihood that other problems will be uncovered once repairs are started.

Risk #3: Paradise also will Require Substantial Environmental Compliance Expenditures

Keeping Paradise 3 in operation also would require significant capital expenditures “to support compliance with the USEPA’s Coal Combustion Residual (CCR) and Effluent Limitation Guidelines [ELG] rules,” TVA wrote in its environmental assessment of the unit’s closure.⁹

Specifically, TVA projects that environmental spending at Paradise 3 would total \$212 million from FY2019 through FY2023.¹⁰

Those costs should serve as a bright red warning flag for anyone thinking about buying the plant and selling power into the increasingly competitive marketplace. Natural gas prices have been stable and are expected to remain low well into the future, a development that will give efficient natural gas combined cycle (NGCC) capacity a significant competitive advantage over coal. In addition, the price of renewable energy, particularly zero-fuel-cost wind and solar, continues to fall, pushing higher cost resources, particularly older coal units, down the dispatch curve.

Risk #4: Paradise 3 No Longer Operates Reliably

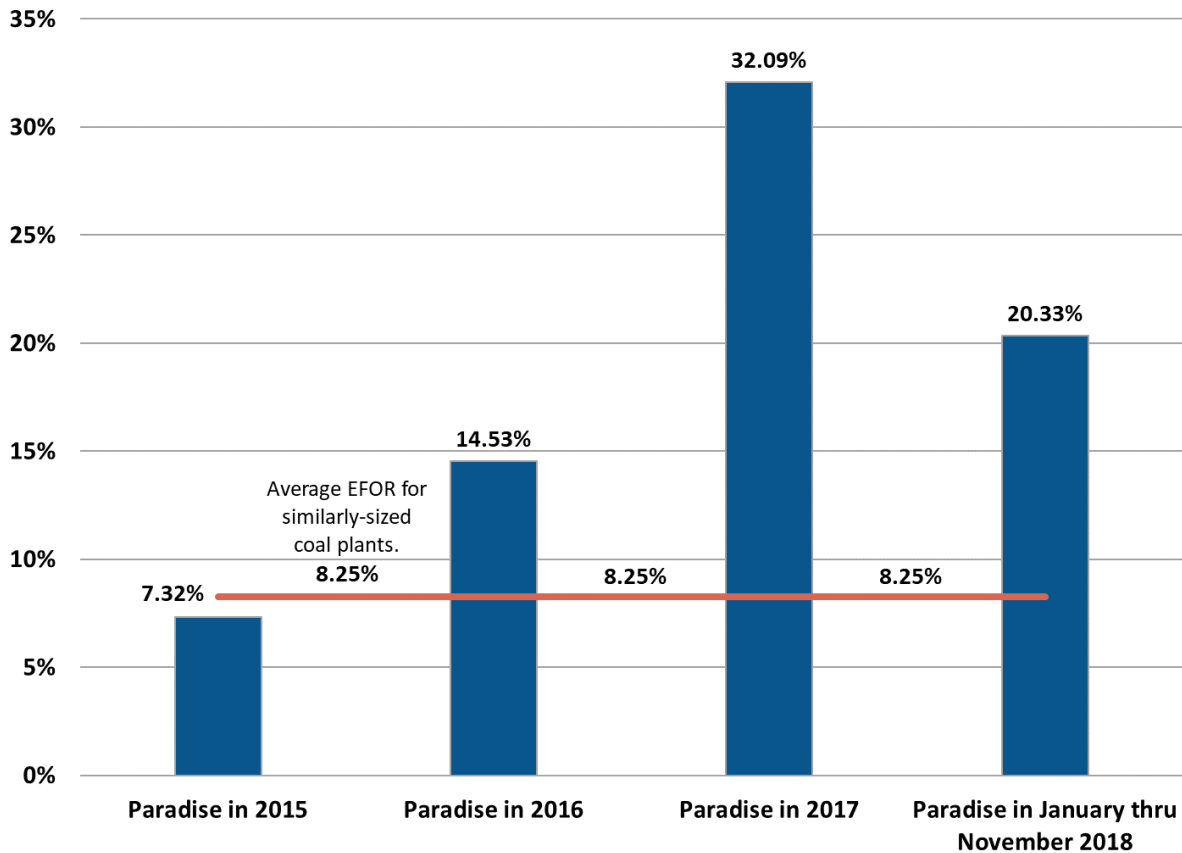
An outside purchaser might be tempted to skimp or delay some of these needed repairs, but that would be a recipe for disaster while trying to compete in the market. Paradise 3’s problems have resulted in a significant increase in the past three years in the plant’s equivalent forced outage rate (EFOR)—a key industry reliability metric that measures how much a plant is forced entirely or partially out of service due to unplanned outages or deratings. The average rate for a unit of comparable size is about 8.25%, a level that Paradise 3 beat in 2015. But it has been a different story since: The unit’s EFOR for the succeeding three years was 14.53%, 32.09%, and just over 20% (through November 2018), respectively.¹¹

⁹ TVA. *Final Environmental Assessment on Paradise Unit 3 Retirement*, p. 8. February 2019.

¹⁰ TVA. *Generation and Financial Information on Paradise Fossil Unit 3*. December 2018.

¹¹ *Ibid.*

Figure 3: Equivalent Forced Outage Rate at Paradise vs. Comparable Coal Plants



Sources: North American Electric Reliability Corporation's (NERC) Generating Availability System (GADS) Generating Unit Statistical Brochure for 2013-2017 and TVA, December 2018 Generation and Financial Information on Paradise Fossil Unit 3.

This recent performance, TVA pointed out, puts Paradise 3 "in the bottom quartile of the U.S. coal fleet for forced outage occurrences."

A competitive generator cannot afford to be in that quartile and stay in business. In other words, the capital expenditures outlined above would not be optional, they would be mandatory. And it is reasonable to expect that substantially more capital expenditures will be needed as the plant ages.

Risk #5: Paradise is Likely to Experience Higher Operating Costs and Declining Performance as it Continues to Age

Paradise Unit 3 went into service in February 1970, meaning it is currently 49 years old, and it will be 53 years old when it is retired by TVA in 2023.

Older plants, on average, tend to cost more to operate and maintain and are less reliable. For example, analyses by the U.S. Department of Energy's Argonne National

Laboratory and the National Energy Technology Laboratory have found that coal plant heat rates increase with plant age, while plant availability declines.¹² Heat rate is a measure of a power plant's efficiency in generating electricity, and plants tend to become less efficient as they age. Plant availability measures the percentage of possible operating hours in which a plant was actually available to generate power, and plants tend to become less available to generate power as they age, in part because they tend to experience more unanticipated problems that require more frequent shutdowns and unplanned outages. At the same time, older plants tend to cost more to maintain, as equipment and components degrade or fail and must be repaired or replaced.

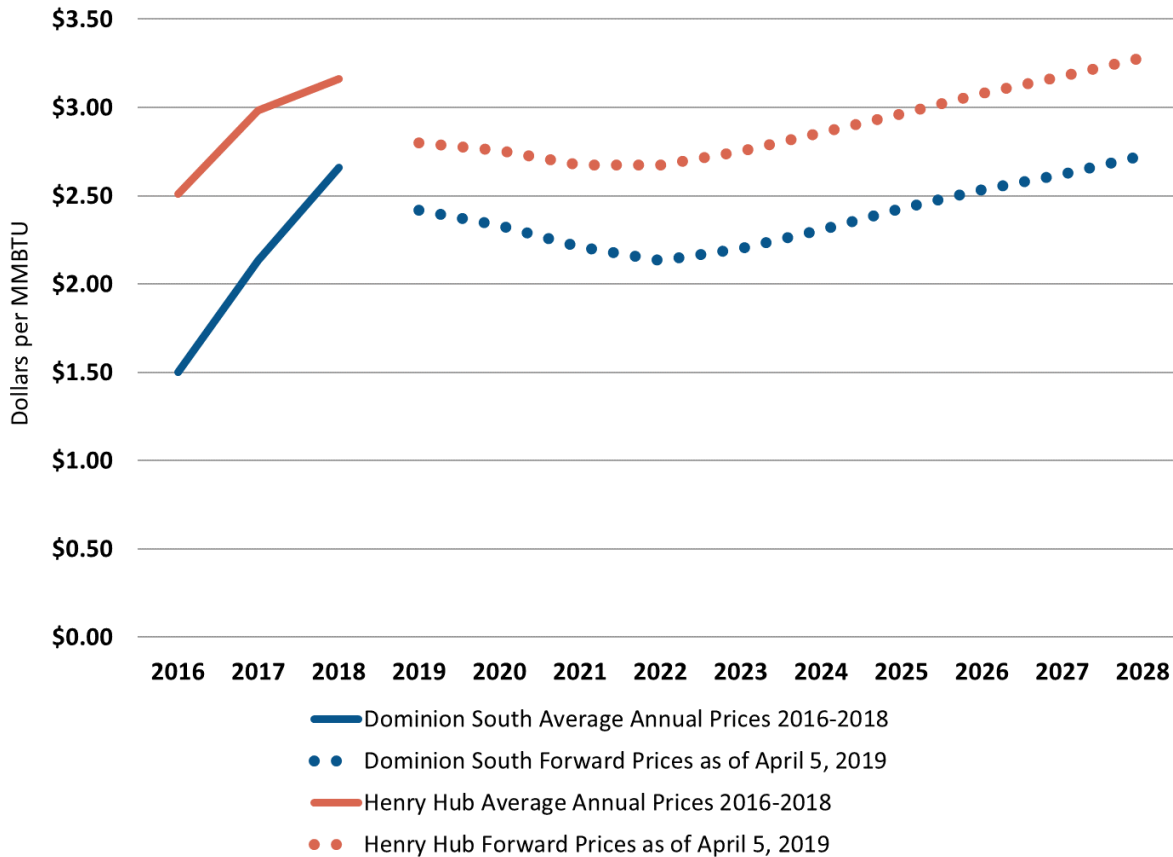
In other words, any new owner of Paradise 3 could expect increasingly unreliable operation from the plant and increasingly more expensive production costs and capital needs as it ages.

Risk #6: Paradise 3 Faces Rising Competition from Renewables and Natural Gas

Natural gas prices in the region (including Ohio, Kentucky, Tennessee and Indiana) are low, and are expected to remain that way for the foreseeable future. By keeping energy market prices low, this would continue to undermine the profitability of Paradise 3 by reducing fuel costs for the natural gas plants with which it would compete.

¹² See e.g.: U.S. Department of Energy. [Staff Report to the Secretary on Electricity Markets and Reliability](#), at page 155. August 2017.

Figure 4: Natural Gas Futures Prices at the Dominion South and Henry Hub Trading Locations



Sources: Natural Gas Prices downloaded from S&P Global Market Intelligence.

In the nearby PJM market alone, 11,500MW of new gas-fired capacity (most of which was efficient, low-cost combined cycle units)¹³ came online in 2018, and another 3,453MW of natural gas combined cycle capacity is expected online this year.¹⁴ All of this capacity, fueled by low-cost natural gas, will easily undercut any reasonable power production prices from Paradise 3.

Equally threatening is the continued development of renewable energy generation resources in the region, particularly zero-fuel-cost wind and solar. For example, there are eight wind projects totalling almost 1,400MW of capacity in the MISO development queue in eastern Missouri alone, only some 200 miles from Paradise. To the north in Indiana, both Vectren in the south and NIPSCO in the northern part of the state are moving forward with plans to retire coal plants and build natural gas and renewable capacity to replace that generation. The prices NIPSCO received from renewable energy developers in its latest request for proposals were low enough to

¹³ FERC. *State of the Markets Report 2018*, at slide 13. April 2019.

¹⁴ S&P Global Market Intelligence. *ISO Outlook 2019: PJM looks at net gain of 6,200 W of generating capacity*. February 15, 2019.

convince the utility to phase out its coal generation entirely by 2028. And TVA itself is also moving ahead with plans for new solar capacity, all of which will undercut any production for Paradise 3.

Risk #7: Lack of Demand Growth Undercuts Need for Paradise 3

Paradise 3 was commissioned in 1970 and has a net summer capacity of 971 megawatts (MW). Like other coal-fired units of its size and age, it was designed to run more or less continuously, providing baseload power to the TVA system. The utility no longer needs that power: Since 2010, TVA has brought more than 3,800MW of natural gas combined cycle NGCC generation online, completed the 1,164MW second unit at the Watts Bar nuclear plant and is in the process of adding 465MW of capacity to the three-unit Browns Ferry nuclear facility. All this new capacity competes head-on against Paradise 3, and it does so at lower cost.

As TVA's former CEO Bill Johnson noted in explaining the board's closure vote: "TVA has more than enough capacity to meet the load without Paradise and Bull Run."¹⁵

In the company's 2018 fiscal year (which ended Sept. 30, 2018 in keeping with its status as a federally-owned entity), it sold just over 160 billion kilowatt-hours of electricity, down from the utility's all-time peak of about 180 billion kWh in FY2008 just before the onset of the Great Recession. Since then, a shift away from industrial load and more efficient technologies has pushed demand down—and TVA expects it to stay there. In the draft of its latest long-term planning document, TVA's reference case projects no growth in energy demand through 2038.

The new generation resources and the lack of demand growth is bad news for Paradise 3 (and the Bull Run coal-burning plant that the TVA board also voted to close at its February 2019 meeting). The plants "do not fit current and likely future portfolio needs," Johnson said. "The only way these plants are able to do their intended function is if our baseload power demand would double, but I think our load is likely to continue to decline. These plants are relatively old, and both have outlived their design life. We can retire these plants without any impact on the reliability or resilience of our system."¹⁶

Conclusion

Individually any of these risks would undermine the economics of buying and maintaining Paradise Unit 3, but together they clearly demonstrate that continuing to operate the plant would be economic folly. Cleaner, cheaper and more reliable power generation options are readily available and should be used. After decades of service, it is time to retire Paradise 3.

¹⁵ Times Free Press. [Divided TVA board votes to shut down Paradise, Bull Run fossil plants despite appeals by Trump, Senate Majority leader for delay](#). February 14, 2019.

¹⁶ Ibid.

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