Power to Memphis

OPTIONS FOR A RELIABLE, AFFORDABLE AND GREENER FUTURE

PREPARED FOR

Friends of the Earth

PREPARED BY
Jurgen Weiss
Judy Chang
Nicholas Powers
Kai van Horn

January 2019

THE Brattle GROUP

Notice

This report was prepared for Friends of the Earth, in accordance with The Brattle Group's engagement terms, and is intended to be read and used as a whole and not in parts. The report reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group's clients or other consultants.

Table of Contents

Executive Summary

The current contract between the Tennessee Valley Authority (TVA) and Memphis Light, Gas & Water ("MLGW"), Memphis' municipal utility and TVA's largest retail customer, provides that Memphis can end its contract by giving the TVA five years notice. Given the rapid and profound transformation of the electric power (and indeed the broader energy) industry, driven primarily by technological progress, changing consumer preferences and policy imperatives such as those related to the risks associated with climate change, this option creates a unique opportunity for the city of Memphis and its citizens to evaluate whether alternative power supply options could be more attractive than a continued contract with the TVA in the sense of being more affordable, more sustainable and/or less risky, while continuing to provide high levels of reliability.

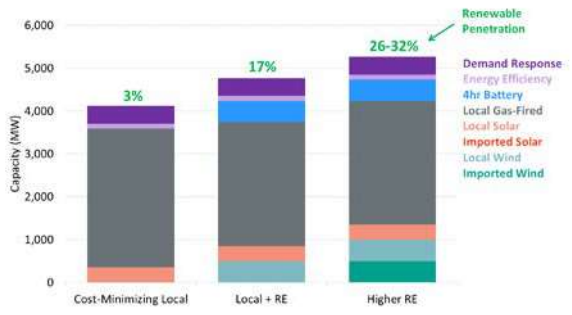
We evaluated a number of such alternatives, assuming that MLGW would provide notice to TVA in 2019 so that an alternative to the current power supply would need to be in place by and after 2024. Given that investments in electricity infrastructure tend to have long lives, we evaluated alternative power supply options for 2024 and for 2050, capturing short and longer-term opportunities to lower costs and take advantage of opportunities or policy imperatives to reduce GHG emissions. In particular, we examined whether Memphis could obtain a portfolio of power supply that reduces the cost of electricity supply to Memphis relative to current (and potential future) TVA rates, does not rely on immediate investments in new transmission to access non-TVA resources, and maximizes immediate opportunities to use renewable energy while setting the city onto a path towards potentially (near) 100% renewable power supply by 2050.

Using a detailed power system model to simulate the Memphis power supply, we find that several local supply resource portfolios combining natural gas and renewable energy, potentially with some imports of renewable energy over existing transmission from the West, would likely provide Memphis with reliable power supplies at a power supply cost substantially below current and projected TVA rates for 2024 and at emissions below those associated with the current and likely also TVA's projected future resource mix.

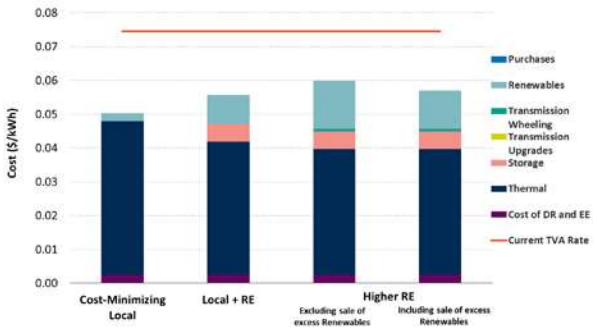
Indeed, we find that in 2024 electricity supply costs of the portfolios we evaluated could be as much as a third or $240-333 million per year lower than costs incurred by Memphis under the current TVA. These portfolios also meet Memphis' power supply needs with lower carbon dioxide emissions than those associated with the TVA's current power supply mix, and would put Memphis on a path towards potentially increasing the share of renewable energy over time to reach close to 100% renewable supply by 2050. Figure ES-1 shows the three different resource supply portfolios we evaluated for 2024 as well as three different resource supply portfolios for 2050, two of which achieve close to 100% renewable energy supply.

Figure ES-1: Evaluated Memphis Alternative Supply Portfolios[1]

2024

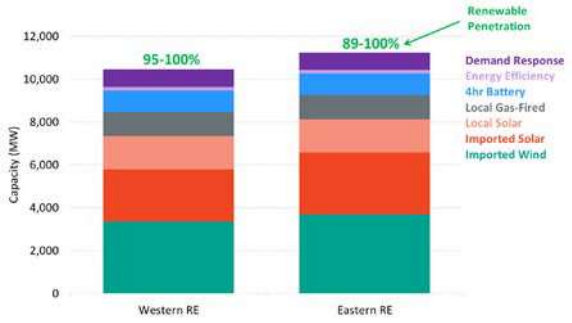


(a): Capacity in 2024 Alternative Supply Portfolios

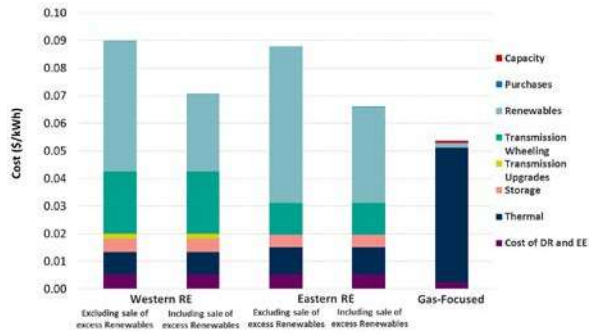


(b): Costs for 2024 Alternative Supply Portfolios

2050



(c): Capacity in 2050 Alternative Supply Portfolios



(d): Costs for 2050 Alternative Supply Portfolios

Our analysis indicates that by 2024 a local mix of gas-fired generation, solar PV, battery storage, energy efficiency and demand response would result in wholesale power supply costs substantially below the current TVA rate. Even adding more renewables both in Memphis and outside, but delivered over the assumed to be limited transmission connecting Memphis to MISO would likely still lead to substantially lower wholesale power supply costs compared to the costs incurred under the TVA's current Memphis rate. None of the near term options we evaluated require the construction of new transmission connections to other areas or the use of existing TVA transmission. This is not to say that cheaper power supply options could not be constructed if the use of the strong interconnection of Memphis with the TVA system could be used. Rather, it

[1] Renewable penetrations shown on the charts reflect the renewable generation as a percentage of annual load consumption.

illustrates the feasibility and potential economic attractiveness of alternative supply portfolios **even without the use of** existing TVA transmission infrastructure.

With either of the 2024 portfolios in place, Memphis would then have the option to move away from gas-fired generation towards a higher share of renewable energy resources over time, if economics or policy preferences would make doing so attractive. To indicate the potential impact of staying primarily with a natural gas based versus moving towards substantially more renewables over time, we also constructed three hypothetical 2050 portfolios. The first of these is essentially identical to the cost-minimizing 2024 portfolio. The other two would mostly or fully decarbonize Memphis' power supply by mid-century. Which of these portfolios is most attractive depends on a number of uncertain factors, including the evolution of gas prices and the cost of various renewables and storage technologies, but also local preferences and state and national energy policy. For example, the cost of a natural-gas portfolio does not assume that GHG emissions will be subjected to any restrictions by 2050. Consequently, the gas-based portfolio appears substantially less costly than a mostly renewable portfolio. However, a natural-gas focused portfolio would expose Memphis to potentially substantial risk related to changes gas prices and also to the possibility that over the coming decades some form of carbon pricing will further increase the cost of power generation with fossil fuels including natural gas. On the other hand, the costs of renewables-focused portfolios depend critically on the evolution of renewable (and storage) costs over time. The costs in Figure ES-1 above assume significant further cost reductions for these technologies. However, the costs of these technologies have been declining more rapidly than predicted and could decline more rapidly than we assume going forward. With a natural-gas focused portfolio in 2024, Memphis has the opportunity to learn about the pace of cost reductions for renewable and storage before deciding how to adjust its supply portfolio over time.

Whether or not such portfolios would reduce the cost relative to renewing a contract with TVA depends on many factors, including the evolution of TVA's own power supply mix. Over the time the TVA has been Memphis' power supplier, TVA rates have certainly not remained constant and, depending on the investment decisions made by the TVA and external factors such as natural gas prices, future TVA rates for Memphis could well increase in a way that makes even the renewables-focused 2050 portfolios very competitive with future TVA rates. Memphis may also be able to leverage its access to tax-advantaged financing to lower the cost of a renewable-focused portfolio it owns relative to the costs we have assumed in Figure ES-1 above. We note that access to tax advantaged financing would have a more important impact on a renewables-focused portfolio than a gas-focused portfolio since the share of capital expenditure is higher for the former, with the cost of the latter including a significant portion of fuel costs. Memphis would of course be in charge of its own future and would be able to pursue whatever lowest cost options it might choose, with the three 2050 portfolios we analyzed providing some insights as to the potential costs associated with some of those options.

Finally, to achieve a near 100% renewable power supply in 2050 <u>on average</u>, the renewables-focused portfolios produce "surplus" renewable electricity during times when production from these renewables exceeds the ability of Memphis to absorb all of it. The estimated cost of the renewables-focused 2050 portfolios depends significantly on the market value of this surplus

renewable electricity. The magnitude of this surplus depends on how well the production of renewable electricity is aligned with load (or can be aligned with added storage). Greater diversity in renewables profiles as well as load results in better alignment and reduces the amount of excess renewable generation. This highlights the importance (and value) of balancing renewable generation over a wider geographic footprint as the share of variable renewable resources in Memphis increases.

There could be other benefits of exploring power supply options other than a continuation of the current contract with the TVA, both in the short and in the longer run. Developing its own power supply would provide MLGW with an opportunity to consider the local economic development impacts of its supply portfolio, for example by emphasizing energy efficiency investments and/or the choice of local over more remote supply resources. Since renewable energy resources can be installed in relatively small increments, MLGW may also be able to make more incremental decisions, choosing how to build its long-term supply portfolio as it learns about the evolution of the relative costs of the various options available to it.

In sum, our analyses indicate that the option to end the current power supply contract with the TVA with a five-year notice provides Memphis and MLGW with opportunities to develop its own reliable power supply at potentially substantial cost savings over the current (and expected future) TVA rate. Doing so would give Memphis:

- Access to lower cost electricity;
- A choice to use its electricity supply to foster local economic development;
- The opportunity to take advantage of the very large and ongoing reductions in the cost of various new and renewable technologies;
- The ability to guide the city on a path towards a sustainable energy future.

F. Power System Optimizer (PSO)

The production simulations were carried out using PSO (Power Systems Optimizer), a state-of-the-art production cost simulation tool developed by Polaris Systems Optimization, Inc. Like other commercially available production simulation tools, PSO simulates least-cost security-constrained unit commitment and economic dispatch with the capability to capture a full nodal representation of the transmission system, similar to actual ISO operations. The model is designed to closely mimic market operations software and market outcomes in competitive energy and ancillary services markets.

PSO uses a unique chronological modeling approach that allows planners to capture the timing of decisions made by operators and information availability to operators at various decision points, as well as the impacts on operations of unforeseen changes in the system, such as generation/transmission outages or load/renewables forecast error, that may occur after some decision points have past and certain decisions are already "locked in." PSO also includes flexible and user-configurable representations of energy storage, ancillary service products, contracts and trading, and hydro resources, features which make it well-suited to the needs of renewable integration studies.