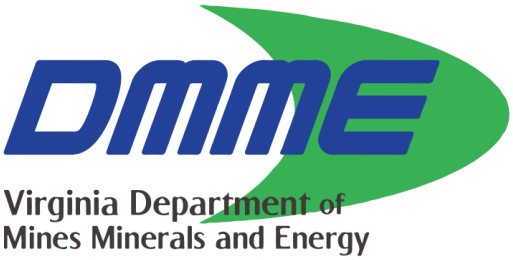

Combined Heat and Power Technology: A Roadmap for Virginia

Virginia Department of Mines, Minerals and Energy – November 2020

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About the Report

Project Team

- The Division of Energy within the Virginia Department of Mines, Minerals and Energy (DMME)
- U.S. Department of Energy CHP Technology Assistance Partnership (DOE)
- Environmental Protection Agency CHP Partnership (EPA)
- Combined Heat and Power Alliance

Background

The 2018 Virginia Energy Plan (VEP) recommended that the Commonwealth achieve 750 MW of additional combined heat and power (CHP) technology by 2030. It directed DMME to develop a roadmap to achieve this level of deployment through utility-sponsored programs, public buildings and the private market. To achieve the directive this roadmap report was created in a collaborative effort with officials from the DOE and EPA. The purpose of the report is to provide a background on CHP technology, and to consider how increasing investment in this technology could support public policy strategies for energy efficiency, emergency preparedness and resiliency. The report also examines the status of CHP policy in Virginia, and barriers that would prevent further development of this technology. The report concludes with recommendations to achieve the CHP goals laid out in the 2018 Virginia Energy Plan.

Introduction

All forms of energy generation incur some energy waste in the form of heat discharged into the atmosphere.[i] Combined Heat and Power (CHP) systems can capture economic quantities of such waste heat that would be lost with traditional electricity generation and redirect it for practical facility needs such as the production of steam, hot water, hot air, refrigeration, or chilled water. More specifically, CHP is the simultaneous generation of electricity and thermal energy from a single fuel source.[ii] A slightly different form of CHP is Waste Heat to Power (WHP), which is the process of capturing heat discarded by an existing industrial process and using that heat to generate power.[iii] CHP systems are often paired with mission critical facilities that require substantial thermal loads, such as hospitals, military installations, and emergency management centers. This technology has existed for decades and, when properly designed and applied, it can provide significant efficiency, environmental, economic, and reliability benefits.[iv]

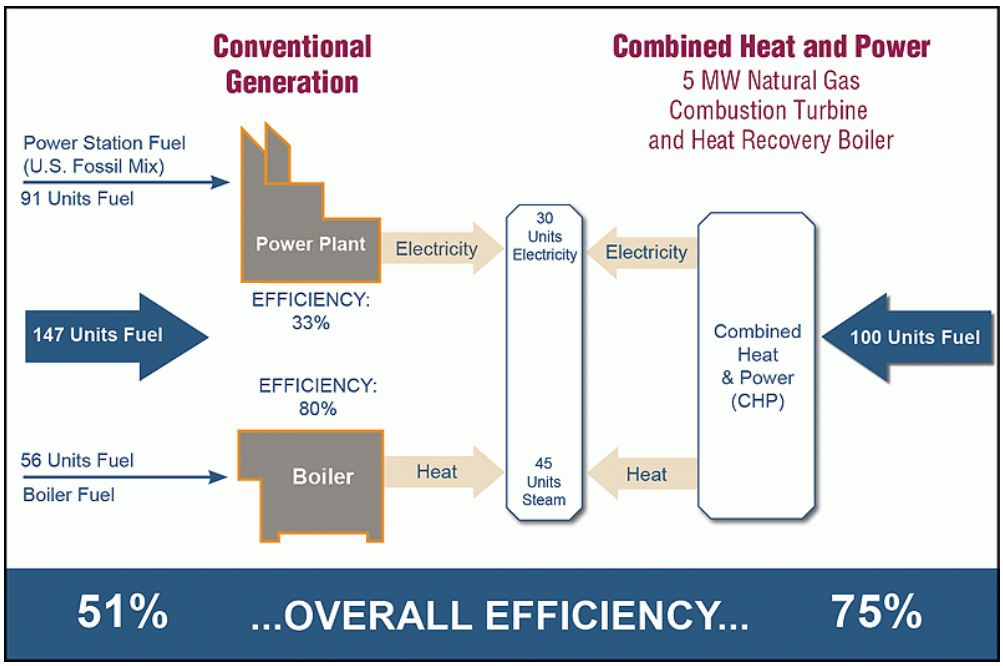

Figure 1 source: U.S. EPA CHP Partnership image https://www.epa.gov/chp/chp-benefits

The average efficiency of fossil-fueled power plants in the United States is just 33 percent.[v] Energy efficiency can be dramatically improved by utilizing CHP systems that can achieve efficiencies of 60 to 80 percent for producing electricity and thermal energy.[vi] This means that CHP has a significant advantage when compared with more conventional separate heat (i.e. boilers/furnaces) and power generation (i.e. Central utility plants). Furthermore, the nature of CHP as an onsite resource improves power reliability and resiliency for power outages and disruptions associated with severe weather events.

CHP generators have traditionally been a customer-owned resource, meaning the electricity produced onsite is used as an alternative to utility provided power. Therefore, CHP has often been viewed by utilities as a competitor. This competition helps to explain why CHP has not reached its full implementation potential both in Virginia and nationwide. However, like the energy industry at large, this is changing. Duke Energy and others are now actively evaluating and incorporating CHP into their resource planning.[vii] Additionally, Virginia's Grid Transformation and Security Act of 2018 directed Dominion Energy to consider in its next Integrated Resource Plan (IRP) the deployment of 200 MW of CHP or WHP by 2024.

In addition to energy efficiency and resiliency benefits, CHP systems offer considerable emissions benefits. The majority of CHP systems today use natural gas as the primary fuel source, but by capturing and utilizing heat that would otherwise be wasted, CHP systems require less fuel to produce the same amount of energy. Therefore, because less fuel is combusted, greenhouse gas (GHG) emissions are reduced.[viii] While renewable energy resources are by far the fastest growing capacity resources, there can still be challenges with the intermittent nature of these resources, and CHP can support that intermittency by providing an energy efficient and resilient source of flexible power.

The Opportunity for CHP in Virginia

According to data provided by the U.S. Department of Energy, Virginia currently has 49 CHP installations with a capacity of 1,619 MW.[ix] However, Virginia's estimated technical potential for additional capacity is 4,308 MW across 7,291 potential existing sites, with the majority of that potential consisting of commercial and institutional facilities (see figure 2).[x] This data indicates that there is a substantial opportunity to expand this energy efficient technology throughout the Commonwealth in a way that would also yield resiliency benefits for critical facilities.

Sector:	Current Installations	Current Capacity (MW)	Potential Sites	Potential Capacity (MW)
Industrial	25	1,248	951	1,703
Commercial/Institutional	22	131	6,329	2,540
WHP CHP	-	-	11	65
Other	2	240	-	-
Total:	49	1,619	7,291	4,308

Figure 2 source: Virginia specific data from the DOE CHP Installation Database (as of April 2020) and DOE's Combined Heat and Power (CHP) Technical Potential in the United States Report

The commercial/institutional portion of the table above mainly consists of facilities associated with military, colleges/universities, government buildings, hospitals/healthcare, schools, retail, hotels, multi-family buildings, and other facilities. Given that there is significant potential for CHP expansion in this sector, it is pragmatic to consider CHP as a resiliency and emergency preparedness resource. As an onsite generation resource, CHP systems can be designed to "island" from the grid in the event of a grid disruption. This feature means that CHP generators can provide uninterrupted power and thermal energy service to critical infrastructure facilities that are particularly vulnerable to grid disruptions. CHP systems would allow these facilities to remain functional in the event of a disaster, and for non-critical loads to resume functionality as quickly as possible.[xi]

Emergency preparedness is a core function of state government. As natural disasters such as tornadoes, hurricanes, and flooding become more frequent it will be important to ensure that key facilities across Virginia are protected from disruptions to the electric grid. In this effort, CHP can be a practical technique to enhance public safety and security as well as a supplementary tool to accomplish state carbon reduction and net zero carbon goals.

Environmental Implications

While the resiliency benefits of CHP are substantial there are also environmental benefits. Although over half of CHP systems in the U.S. use natural gas for fuel, they use less of it to produce the same amount of energy as traditional generation. Furthermore, CHP systems are more versatile than traditional

generation methods. For example, they can be scaled for large utility-scale projects, as well as smaller units of 25-500 kilowatts in capacity that could be used in homes and other buildings.[xii] They can be outfitted to utilize renewable biomass or biogas which are cleaner alternatives to fossil fuels.

Biomethane, sometimes referred to as "renewable natural gas," is produced from existing waste streams and a variety of sustainable biomass sources, including animal waste, landfills, crop residuals and food waste. Once processed, it is interchangeable with traditional pipeline-quality natural gas and fully compatible with the U.S. pipeline infrastructure. A recent example of biomethane's potential was shown by Smithfield Foods' and Dominion Energy's announcement to double their investment in biomethane projects across the U.S. to $500 million through 2028.[xiii] The additional investment will expand their biomethane joint venture beyond its initial projects in North Carolina, Virginia and Utah, to pursue new projects across the country, including in Arizona and California.

Virginia already has several CHP sites that utilize biogas paired with CHP systems, and it should focus on the most efficient CHP systems to benefit the Commonwealth's emission reduction goals.

Hydrogen powered CHP has also shown promise as an alternative fuel source. Most CHP prime mover manufacturers are developing and, in some cases field-testing, CHP systems capable of operating on 100% hydrogen. However, hydrogen does not exist in a natural state, and must be reformed by catalysis from a source material such as water or methane. This process could be fueled by excess renewable electricity sources during periods of low demand, where these resources might otherwise be curtailed.

These developments create a pathway for CHP systems to significantly reduce carbon emissions in the near-term and show an economical clean energy solution for the future.

Current Status of CHP Policy in Virginia

In 2020, the General Assembly passed and Governor Northam signed the Virginia Clean Economy Act (VCEA). This omnibus legislation brought sweeping changes to Virginia's energy and utility policy, as well as potential opportunities for the development of utility owned CHP. The VCEA created an Energy Efficiency Resource Standard (EERS) that requires Dominion Energy to reduce energy consumption by 5 percent (against a 2019 baseline) by 2025 and Appalachian Power by 2 percent. The bill provides that the utilities can invest in new CHP and WHP facilities to reach these energy efficiency goals under certain conditions. More specifically, the EERS language requires the utilities to implement energy efficiency programs and measures to achieve specific "total annual energy savings." Below is the definition of "total annual energy savings" included in the legislation:

> *"Total annual energy savings" means (i) the total combined kilowatt-hour savings achieved by electric utility energy efficiency and demand response programs and measures installed in that program year, as well as savings still being achieved by measures and programs implemented in prior years, or (ii) savings attributable to newly installed **combined heat and power** facilities, including **waste heat-to-power** facilities, and any associated reduction in transmission line losses, provided that biomass is not a fuel and the total efficiency, including the use of thermal*

> *energy, for eligible combined heat and power facilitates must meet or exceed 65 percent and have a nameplate capacity rating of less than 25 megawatts.*

The VCEA creates incentives for utility-owned CHP by including CHP as a potential option to satisfy the EERS goals. The intent of this provision is to move utility ownership of CHP forward and build on previous CHP policy enacted in the 2018 Virginia Energy Plan. Additionally, the Grid Transformation and Security Act (GTSA) directed Dominion Energy to consider the deployment of 200 MW of CHP or WHP technology by 2024 in its next Integrated Resource Plan. On May 1, 2020, Dominion Energy filed its 2020 IRP with the Virginia State Corporation Commission (SCC). The IRP included a section on CHP within section *5.5 Future Supply-Side Generation Resources*. The section mainly explains CHP and WHP as a technology and makes the following statement:

> *The Company will continue to track this technology and its associated economics based on site and fuel resource availability.*[xiv]

As stated in previous sections, CHP has traditionally been viewed as a customer-owned resource. Utility-owned CHP is a fairly new concept, but given Virginia's primarily regulated electric market and the incentives created by the VCEA, utilities may see ownership as a feasible path forward. As Dominion Energy continues to modernize their service operations, they should pursue the 200 MW of CHP outlined in the GTSA by partnering with potential "host customers" to build smaller, highly efficient CHP installations. Distributed energy resources are likely to make up an ever increasing share of Virginia's energy system going forward, and by deploying CHP as a customer-sited resource it would enhance local reliability and supplement company energy efficiency goals.

A key policy goal of the VCEA was to codify Governor Northam's recently announced plans to move toward a carbon free energy economy. On September 17, 2019 Governor Northam announced Executive Order 43 (EO43), which set a goal for 30% of Virginia's electricity to be produced by renewables by 2030, and 100% to be generated by carbon-free sources by 2050. The VCEA accelerates the latter goal by requiring Dominion Energy to be carbon free by 2045. The development of CHP systems should occur in alignment with the goals of the VCEA.

Barriers to CHP Expansion

This section will focus on the general challenges that have traditionally prevented further CHP expansion nationally and the specific barriers at play in Virginia. Effective policy can overcome many of the barriers, however, the principal challenge for CHP on a state by state basis is the economic and financial realities of the various electricity markets across the country.[xv] The economic viability of CHP is inextricably linked to the cost of electricity and natural gas, which vary from state to state.[xvi] Therefore, if a state has electricity rates that are below the national average it can be challenging to justify the upfront cost of CHP, which is high when compared to other energy efficiency measures. Additionally, the most typical payback range for an investment in a CHP system is approximately four to six years which is too long for most facility managers or other decision makers.[xvii]

Virginia faces many of the traditional challenges to CHP deployment, which has resulted in the number of CHP installations in Virginia to lag behind several of the mid-Atlantic and Northeastern states.[xviii] The American Council for an Energy-Efficient Economy (ACEEE) evaluates each state's favorability for CHP with their *State Energy Efficiency Scorecard*. In the 2019 scorecard Virginia received a rank of 29 among the other 50 states for CHP favorability. The primary reason for the low score is that Virginia is regarded as an unfavorable CHP market because of economic and public policy reasons.

However, recent policies such as the GTSA and VCEA have improved Virginia's favorability. Virginia, as a regulated utility state, should continue to pursue utility-owned CHP as the primary mechanism to achieve the 750 MW VEP goal and the VCEA's energy efficiency goals. In Virginia's current electric market it will be harder for rate payers to justify the upfront cost of a CHP investment. Although if a facility is in a situation where a boiler is reaching the end of life, and a new source of thermal power generation is needed, it would be more prudent for the facility to procure a CHP system.

How CHP Can Enhance Energy Equity

CHP systems paired with multi-family buildings that house low-income families can expand energy equality. Multi-family buildings can be attractive for CHP systems because such facilities often have significant energy costs, concurrent electricity and thermal energy demands, and power reliability and resiliency needs.[xix] Multi-family buildings and their residents can benefit from CHP systems in much the same ways as industrial and mission critical facilities.

Nearly 40 million people live in multi-family rental housing in the United States, and these type of properties are significantly more likely to be energy inefficient than single-family, owner-occupied homes. This results in higher energy cost burdens for renters.[xx] Additionally, multi-family housing for low-income households have been historically underserved by energy efficiency programs.[xxi] To address these inequities, properly applied CHP systems could improve the quality of life for low income multi-family facility residents by increasing energy efficiency and power reliability.[xxii]

CHP for multi-family housing has been successful in the northeastern region of the United States.[xxiii] However, in Virginia this practice is untested. Outreach may be needed to identify potential multi-family CHP candidates, and connect them with the proper channels to assess their property for a CHP system. Doing so would support Virginia's energy policy goals as well as create opportunities to address energy equity.

Conclusion

CHP technology has existed since the creation of the modern electrical grid.[xxiv] It is important to understand the benefits of and barriers to CHP and take the necessary steps to advance this technology because reliability and resiliency are critical to ensuring public safety and security. The energy landscape

in Virginia is changing as renewables continue to play a much greater role in electricity generation than ever before. As renewable energy grows rapidly, addressing intermittency issues will become more important, and currently energy storage technology alone cannot ameliorate these concerns. CHP has demonstrated that it is an economically viable, flexible and efficient tool for grid stability. Additionally, CHP can significantly reduce carbon emissions in the near-term and can support the pathway to a zero-carbon energy solution for the future.

Virginia should take an all of the above approach to reduce emissions and adapt to extreme events such as infectious disease outbreaks, hurricanes, tornadoes and flooding as they become more frequent, and the best way to do that is to embrace more decentralized, local forms of generation. A more distributed energy system means more reliability and resiliency for Virginia's citizens, and this report has described how CHP can and should play a critical role to mitigate power outage risks, decrease carbon emissions, and support the integration of renewable energy.

Recommendations

DMME offers the following recommendations to meet the 750MW goal established in the 2018 Virginia Energy Plan:

- Encourage electric utilities to seek partnerships and proposals from CHP developers and potential customers through either a Request for Information (RFI) or Request for Proposal (RFP) process. Inviting such proposals from the marketplace will identify viable project opportunities and provide utilities with accurate data points that could be further evaluated in integrated resource planning models. Virginia utilities can build on similar efforts by other regulated utilities such as Duke Energy and Florida Public Utilities. Utilities should consider giving priority to projects which enhance grid resilience, reduce customer costs, and reduce emissions.
- Conduct a stakeholder engagement process to raise awareness and create opportunities for collaboration. The stakeholder engagement process should promote the utility owned CHP incentives outlined in the Virginia Clean Economy Act.
- Conduct a geospatial study of specific CHP project candidates throughout the Commonwealth.
- Examine current regulatory practices to facilitate utility-owned CHP systems at customer sites. More specifically, it is recommended that the State Corporation Commission (SCC) review IRP rules to ensure they reflect current priorities related to CHP deployment. If needed, the SCC should consider revising rules to ensure inclusion of CHP or issuing guidance that clarifies how CHP should be treated in the IRP process.
- Lead by example – the Commonwealth should examine its own facilities and consider efficient CHP systems where appropriate.
- Consider incentives to support the additional costs of resilient CHP systems applied to critical infrastructure.
- Develop a program to promote the use of digesters in agriculture and wastewater treatment facilities to minimize waste and potentially fuel onsite CHP systems. The Commonwealth should

promote CHP as an important efficiency and resilience resource for attracting new businesses to the Commonwealth.

- Financial support for CHP generators should be considered as a component of relevant disaster relief funding.
- Conduct outreach to multi-family facility owners and managers to identify potential candidates for CHP installations that would expand energy equity.

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