Blue Ridge Environmental Defense League
www.BREDL.org PO Box 88 Glendale Springs, North Carolina 28629 BREDL@skybest.com (336) 982-2691

February 13, 2020

Joseph Grist
Department of Environmental Quality
Central Office, 1111 E. Main Street, Suite 1400
Richmond, VA, 23219
Phone: 804-698-4031
E-mail: withdrawal.permitting@deq.virginia.gov

RE: Chickahominy Power, Groundwater Withdrawal Special Exception #GW0078700
Plant Location: 6721 Chambers Road, Charles City, VA 20203

Dear Mr. Grist, Mr. Paylor and Members of the Water Control Board:

On behalf of the Blue Ridge Environmental Defense League and our chapter members in Virginia, I write to request that you deny the special exception to the Groundwater Management Act requested by Chickahominy Power, LLC. The exception, if granted, would be contrary to the letter and purpose of the state's Ground Water Management Act of 1992. Further, the Chickahominy Power plant itself serves no practical purpose because, like other natural gas fired electric plants, it uses as much energy as it produces.

Special Exception is Contrary to the Purpose of the Groundwater Management Act

The proposed exception would be for water supply to a 1,600 megawatt natural gas fired combined cycle electric generating facility. Pursuant to VAC §62.1-267, DEQ plans to issue a Special Exception for a period of seven years for plant water withdrawal necessary for plant operation: start-up, evaporative cooling, boiler makeup and other non-potable needs. The regulation states: "The Board may issue a special exception to allow the withdrawal of ground water in the case of an unusual situation in which requiring the user to obtain a ground water withdrawal permit would be contrary to the intended purpose of the Act." The intent of the law at VAC §62.1-254 holds: "It is the purpose of this Act to recognize and declare that the right to reasonable control of all ground water resources within this Commonwealth belongs to the public and that in order to conserve, protect and beneficially utilize the ground water of this Commonwealth and to ensure the public welfare, safety and health, provision for management and control of ground water resources is essential." (Emphases added)

Pray, what is the "unusual situation" as required for a special exception for water resources belonging to the public, not a private entity? The Potomac Aquifer is in overall decline, a situation not likely to be reversed in seven years. There is no plausible justification offered in the DEQ's analysis.[1] In fact, if this and other natural gas-powered facilities are constructed, thereby contributing to greater greenhouse gas emissions, renewal of the aquifer becomes less likely.

---

[1] DRAFT Special Exception Issuance Fact Sheet—GW0078700, November 22, 2019

Natural Gas Power Plants Life Cycle Yields No Net Energy Gain

A complete analysis of natural gas power generation indicates that the energy consumed by gas extraction, transport, plant construction and operation outweigh the energy produced. Power plant operating inefficiency and natural gas production losses are the intractable problems at the basis of this analysis. The National Renewable Energy Laboratory concluded:

"[T]he life cycle efficiency is negative, indicating that more energy is consumed by the system than is produced in the form of electricity."[2]

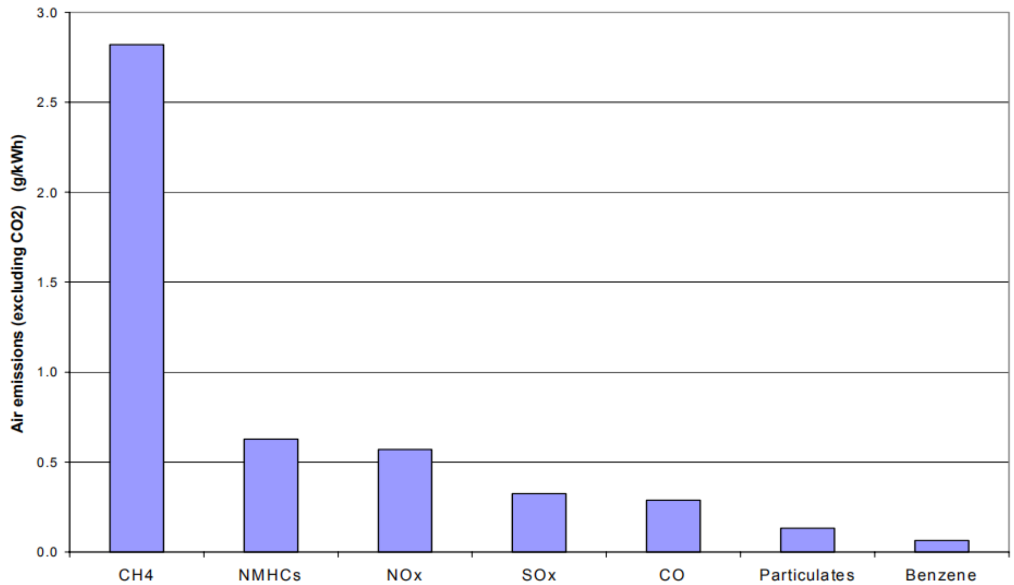
Most recent data indicate that electric power generation from utility-scale facilities in the United States totaled about 4,171 billion kilowatt-hours in 2018. Of this total, 35.2% was generated by combustion of natural gas.[3] The executive summary of the National Renewable Energy Laboratory's Life Cycle Assessment of natural gas powerplant analysis follows.

> Natural gas accounts for 22% of all of the energy consumed in the United States. It is used for steam and heat production in industrial processes, residential and commercial heating, and electric power generation. Currently, 15% of utility and non-utility power is produced from natural gas, while the U.S. Department of Energy's Energy Information Administration projects that 33% of the electricity generated in 2020 will be from natural gas-fired power plants (U.S. DOE, December 1998, p.5). Because of its importance in the power mix in the United States, a life cycle assessment (LCA) on electricity generation via a natural gas combined-cycle (NGCC) system has been performed. In the near future, this study will be compared with LCAs for other electricity generation systems previously performed by NREL: biomass gasification combined-cycle, coal-fired power production, biomass cofiring in a coal-fired power plant, and direct-fired biomass power generation (Mann and Spath, 1997; Spath and Mann, 1999; Mann and Spath, 2000; and Spath and Mann, 2000). This will give a picture of the environmental benefits and drawbacks of these various power generation technologies.
>
> Since upstream processes can be significantly polluting, the application of LCA methodologies is important for gaining an understanding of the total environmental impact of a process. The system evaluated in this study was divided into the following process steps: construction and decommissioning of the power plant, construction of the natural gas pipeline, natural gas production and distribution, ammonia production and distribution for NOx removal, and power plant operation.

[2] National Renewable Energy Laboratory, *Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System*. Spath PL and Mann MK, NREL/TP-570-27715, Sept. 2000.
[3] US Energy Information Administration, "U.S. electricity generation by source, amount, and share of total in 2018," accessed 2/12/2020 at https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

The size of the NGCC power plant is 505 MW. The plant configuration consists of two gas turbines, a three pressure heat recovery steam generator, and a condensing reheat steam turbine. To minimize the plant's NOx emissions, the power plant incorporates selective catalytic reduction (SCR) with water injection. Additionally, the base case of this LCA assumes that 1.4% of the gross natural gas that is extracted is lost to the atmosphere as fugitive emissions (Harrison et al, 1997).

This study found that CO2 accounts for 99 wt% of all air emissions. Methane is emitted in the next highest quantity, 74% of which are fugitive emissions from natural gas production and distribution. Following CO2 and CH4, the next highest air emissions, in order of decreasing amount, include non-methane hydrocarbons (NMHCs), NOx, SOx, CO, particulates, and benzene.



The contributions from three greenhouse gases, CO2, CH4, and N2O, are considered in the assessment of the global warming potential (GWP) of the system. According to the Intergovernmental Panel on Climate Change (IPCC) the cumulative capacities of CH4 and N2O to contribute to the warming of the atmosphere are 21 and 310 times higher than CO2, respectively, for a 100 year time frame (Houghton, et al, 1996). The GWP for this system is 499.1 g CO2-equivalent/kWh. The following table contains the emission rates for the different greenhouse gases and their contribution to the total GWP.

Emissions of Greenhouse Gases and Contribution to GWP

	Emission amount (g/kWh)	Percent of greenhouse gases in this table (%)	GWP relative to CO_2 (100 year IPCC values)	GWP value (g CO_2-equivalent /kWh)	Percent contribution to GWP (%)
CO_2	439.7	99.4	1	439.7	88.1
CH_4	2.8	0.6	21	59.2	11.9
N_2O	0.00073	0.0002	310	0.2	0.04

The GWP of the system can also be divided among the different system operations. The table below shows the contribution of each subsystem to the overall GWP of the system. The power plant CO2 emissions contribute the most to the GWP at 64%. Because of the natural gas lost to the atmosphere, the natural gas production and distribution subsystem is responsible for nearly all of the remainder of the system's GWP.

GWP Contribution For Each System Component

Process step	GWP value (g CO_2-equivalent /kWh)	Percent contribution to GWP (%)
Power plant operation	372.2	74.6
Natural gas production & distribution	124.5	24.9
Construction & decommissioning	2.0	0.4
Ammonia production & distribution	0.4	0.1
Total	499.1	100.0

Note: The construction and decommissioning subsystem includes power plant construction and decommissioning as well as construction of the natural gas pipeline.

The power plant efficiency for this NGCC system is 48.8% (higher heating value (HHV) basis). This is defined as the energy to the grid divided by the energy in the natural gas feedstock to the power plant. Four other types of efficiencies/energy ratios were defined to study the energy budget of the system.

Energy Efficiency and Energy Ratio Definitions

Life cycle efficiency (%) (a)	External energy efficiency (%) (b)	Net energy ratio (c)	External energy ratio (d)
$=\frac{Eg-Eu-En}{En}$	$=\frac{Eg-Eu}{En}$	$=\frac{Eg}{Eff}$	$=\frac{Eg}{Eff-En}$

where: Eg = electric energy delivered to the utility grid
Eu = energy consumed by all upstream processes required to operate power plant
En = energy contained in the natural gas fed to the power plant
Eff = fossil fuel energy consumed within the system (e)

(a) Includes the energy consumed by all of the processes.
(b) Excludes the heating value of the natural gas feedstock from the life cycle efficiency formula.
(c) Illustrates how much energy is produced for each unit of fossil fuel energy consumed.
(d) Excludes the energy of the natural gas to the power plant.
(e) Includes the natural gas fed to the power plant since this resource is consumed within the boundaries of the system.

The net energy ratio is a more accurate measure of the net energy yield from the system than the external energy ratio because it accounts for all of the fossil energy inputs. The following table contains the resulting efficiencies and energy ratios for the NGCC system. All efficiencies are given on a LHV basis.

Efficiencies and Energy Ratio Results (LHV basis)

System	Life cycle efficiency (%)	External energy efficiency (%)	Net energy ratio	External energy ratio
Natural gas combined-cycle	-70.1%	29.9%	0.4	2.2

Because natural gas is not a renewable resource, the life cycle efficiency is negative, indicating that more energy is consumed by the system than is produced in the form of electricity (i.e., if the feedstock were renewable then the life cycle efficiency and external energy efficiency would be the same). Additionally, the net energy ratio in the table above shows that for every MJ of fossil energy consumed 0.4 MJ of electricity are produced. Excluding the consumption of the natural gas feedstock, the external energy efficiency and the external energy ratio indicate that upstream processes are large consumers of energy. Disregarding the energy in the natural gas feedstock, 98% of the total energy is consumed in the production and distribution of natural gas. This subsystem can be further broken up into natural gas extraction, separation and dehydration, sweetening, and pipeline transport. Of these operations, the natural gas extraction and transport steps consume the most energy. Drilling requires electricity, which is supplied by diesel combustion engines; the pipeline compressors move the natural gas using a combination of grid electricity and natural gas.

In terms of resource consumption, natural gas is used at the highest rate, accounting for nearly 98 wt% of the total resources. This is followed by coal at 1.0 wt%, iron ore plus scrap at 0.7 wt%, oil at 0.4 wt%, and limestone at 0.4 wt%. Practically all of the iron and limestone are used in the construction of the power plant and pipeline, while the production and distribution of the natural gas consumes the vast majority of the coal and oil. Also, the resource requirements associated with pipeline construction are greater than those due to power plant construction. The total amount of water pollutants was found to be extremely small (0.01 g/kWh) compared to the other emissions. The main water emissions are oils and dissolved matter, making up 80 wt% of the total water emissions. The oils come primarily from natural gas production and distribution, while the dissolved matter is produced from the material manufacturing steps involved in pipeline and power plant construction.

In terms of solid waste, 94 wt% percent of the system's total comes from the natural gas production and distribution block. A large percentage of the waste, 65% of the total, comes from pipeline transport. Although the majority of the pipeline compressors are driven by reciprocating engines and turbines which are fueled by the natural gas, there are some electrical machines and electrical requirements at the compressor stations. Since most of the electricity in the U.S. is generated from coal-fired power plants, the majority of the waste will be in the form of coal ash and flue gas clean-up waste. The second largest waste source is natural gas extraction (29% of the total waste). The only waste stream from the power plant itself will be a small amount of spent catalyst which is generated every one to five years from the SCR unit.

A sensitivity analysis on this system determined that changes in two parameters, power plant efficiency and natural gas losses, have the largest effect on the results. Although NGCC is currently the most efficient technology available for large-scale electricity production, any increases in efficiency will reduce resulting environmental stressors throughout the system. Reducing natural gas losses during production and distribution increases the net energy balance and lowers the GWP.

Conclusion

Based on our analysis and the findings published by the National Renewable Energy Laboratory, we submit that the Chickahominy Power application is not in accord with Groundwater Management Act of Virginia. Further, the Chickahominy Power plant would be of benefit to the groundwater, to air quality, to the energy supply, to greenhouse gas reductions and to the people of Virginia only by shutting down before it opens.

Respectfully submitted,

Louis A. Zeller, Executive Director

CC: Senator Lionell Spruill Sr., (757) 424-2178 or district05@senate.virginia.gov
Senator Thomas Norment Jr., (757) 259-7810 or district03@senate.virginia.gov
Senator Stephen Newman (804) 698-7523 or district23@senate.virginia.gov
Senator Louise Lucas (804) 698-7518 or district18@senate.virginia.gov
Senator David Marsden (804) 698-7537 or district37@senate.virginia.gov