May 21, 2019

Dear Ohio Energy & Natural Resources Committee,

I present this testimony on behalf of Don't Waste Michigan in Opposition to HB 6. Many Don't Waste Michigan members live and recreate on Lake Erie. Most of these persons also drink from Lake Erie. In the Summer of 2014 there were particularly extreme toxic algal blooms. Much of southeatern Michigan and northeastern Ohio drinking water supply was interrupted because the water quality resulting from toxic algal blooms.

The extreme rainfall this Spring will result in massive nutrient runoff. Major algal blooms are now predicted. Thermal Pollution is a major driver / contributor to algal blooms. The Davis-Besse and Perry nuclear plants are both huge contributors to thermal pollution driving and exasperating algal blooms.

As the Sierra Club has pointed out this is particularly problematic in the shallow Western Basin. In addition vast quantities of steam emitted not only warm the air, but also have a marked greenhouse effect. Fish and other aquatic life are killed by heat and mechanics when water is sucked in for cooling.

These two massive thermal polluters will have extreme environmental costs, which could result in the death of Lake Erie.

Please enter the attached "Thermal Water Pollution from Nuclear Power Plants" report into the record.

Thank you

Michael J. Keegan

Co-Chair Don't Waste Michigan, Monroe, Michigan 48161

http://large.stanford.edu/courses/2019/ph241/clark1/

Thermal Water Pollution from Nuclear Power Plants

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Introduction

Water in the Nuclear Heating Process

The most common argument for the use of nuclear power over power from conventional fossil fuels is the diminished environmental impact that nuclear power promises. While nuclear fission reactions do not directly produce greenhouse gases like fossil fuel combustion, power plants affect the environment in a myriad of ways. In order to elucidate a clearer environmental impact comparison between all power generation methods, including renewables, less obvious environmental effects must be adequately assessed. For example, both nuclear and fossil fuel plants produce significant thermal pollution to bodies of water. Thermal water pollution is the degradation of water quality due to a change in ambient water temperature.

Water is the thread that connects the entire nuclear power process. There are two distinct water streams used, process water and cooling water. Process water travels through a pump to the reaction chamber, containing the nuclear fuel rods, where the water is heated and vaporized to pressurized steam, reaching temperatures of roughly 315°C. The steam then passes through multiple turbines, which turn generators that makes electricity. Finally, the steam is condensed, cooled, and sent back to the reaction chamber. In the second stream, cooling water travels from a natural reservoir to cool process water in the condenser. It then travels to a cooling tower, back into the reservoir, or both. Process water is reused in the generation process, but the cooling water is discharged back into a lake, river, or ocean, as seen in Fig. 1, at a temperature typically around 30-40°C. [1-3] Fortunately, one favorable aspect of this process is that the radioactive water that contacts nuclear fuel rods is not released to the environment, because process water operates on a closed loop.

Since steam-based energy production is based on the Rankine Cycle, maximum power generation is determined by the temperature difference between the steam in the generator and the water in the cooling chamber. However, there is still extra thermal energy from the reactor vessel in the liquid-vapor mixture at the exhaust of the low pressure turbines that is not usable. This is because, as the steam loses thermal energy to mechanical work, the rise in moisture content would damage further turbines. Therefore, cooling the process water as much as possible is desirable to the power plant to maintain high energy efficiency, which raises the temperature of cooling water. In response, most state regulations set a hard limit on cooling water maximum temperature, usually around the 30-40°C mentioned above, regardless of season or ambient cooling water inlet temperature.

The thermal energy efficiency of a conventional thermal power plant is 30% to 48%, while typical nuclear power plants have thermal efficiencies around 30%, the low end of the spectrum. This is because most nuclear power stations must operate below the temperatures and pressures that fossil fuel plants do in order to provide more conservative safety margins within the systems that remove heat from the nuclear fuel rods. [3] The remainder of the energy is mostly contained in cooling water and released to the environment. While nuclear power's thermal pollution per usable energy produced is only slightly more than other thermal power generation technologies, nuclear power releases a higher percentage of its wastewater as liquid effluent streams instead of vapor. This is because coal and natural gas plants discharge much higher wastewater temperatures, 128.4°C and 91.1°C, respectively. [3] Therefore, nuclear power plants have a more direct, intense environmental impact on local water sources, while other plants have a less intense, but broader environmental impact.

Nuclear Power Plant Water Usage

Thermal power plants require enormous amounts of water. The United States Geological Survey (USGS) estimated on a national level that 41% of all freshwater withdrawals in the United States in 2005 were for thermoelectric power operations, primarily for cooling needs. [4] About 60 percent of American nuclear power systems use recirculating cooling, and the remainder use cheaper once-through cooling. The median nuclear recirculating cooling system uses 1,101 gal/MWh, while the median once-through cooling system uses 44,350 gal/MWh. In comparison, the median recirculating and once-through water withdrawal values for natural gas plants are 255 gal/MWh and 11,380 gal/MWh, and the median values for coal plants are 1,005 gal/MWh and 36,350 gal/MWh. [4]

Effects on Water Quality and Aquatic Ecosystems

Multiple issues occur concurrently when heated water is released to an aquatic ecosystem. The most immediate change is a decrease in dissolved oxygen levels and rise in pH. Warm water cannot hold as much dissolved oxygen as cold water, and organic matter decomposes faster in warmer temperatures. The increase in decomposed aqueous nutrient concentrations causes eutrophication, most commonly realized as algae blooms, which block sunlight for underlying aquatic plants. The abundance of algae is an easy food source for aerobic microbes that soar in population and further deplete the dissolved oxygen. Low oxygen levels create hypoxic dead zones that cannot support most aquatic organisms. [5,6]

Additionally, rapidly heated water accelerates the metabolism of cold blooded aquatic animals like fish, causing malnutrition due to insufficient food sources. Since the environment usually becomes more inhospitable to the area's aquatic fauna, many species leave while more vulnerable species may die, changing the biodiversity of both the original and invaded locations. These effects are especially dramatic near coral reefs, the home of over 2 million aquatic species and roughly 25% of all marine life. [7] Vast coral bleaching (coral death) has been observed near coastal power plants that release heated water into the ocean. [1]

Extent of Power Plant Thermal Pollution

Recent research suggests that the duration and range of thermal pollution is higher than commonly believed. A study of Lake Stechlin in Germany found that industrial thermal pollution in temperate lakes during winter is stored in the deep water column until the next winter, whereas heat added in the summer dissipates relatively rapidly into the atmosphere. [8] Accordingly, this pollution can have lasting effects on deep water biogeochemical cycles, not just surface water or water directly near power plants. Due to discharge from two nuclear power plants, the Danube River in Romania exhibits a thermal plume current that extends up to 6km downstream, where temperature changes up to 1.5°C between plume and non-plume areas can still be measured. [9] Furthermore, a study of 128 power plants lining the Mississippi River

Watershed showed that thermal pollution is extensive enough to significantly impair the energy efficiency of downstream plants, since downstream plants indirectly use warmed effluent upstream water for their own cooling processes. [10] The impact of thermal pollution can be felt by both the ecosystem and human populations far beyond the point of release. Such communities would benefit from the knowledge and regulation of pollution that is not directly their fault, and governments should consider these broader chain reactions when making policy decisions.

Conclusions

The world's environments are much more interconnected than most realize. This review shows that less obvious ramifications of power generation, such as thermal water pollution, can be remarkably influential. The whole story around each option should be given due diligence before making conclusions about the future's energy landscape.

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