Drought Impacts on Electricity Generation in Texas: Challenges and Opportunities

Testimony of

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Droughts and other water extremes expose important vulnerabilities in the Texas power sector. However, by switching the fuel mix and implementing advanced cooling technologies, these vulnerabilities can be eliminated or mitigated. Furthermore, these investments will yield significant air quality co-benefits.

1. **The power sector is highly dependent on water**
    a. Power plants are responsible for nearly 40% of all water withdrawals annually
        i. Most of the withdrawn water is returned (but at a higher temperature)
        ii. A small portion of withdrawn water is evaporated
    b. Conventional power plants that use steam turbines (nuclear, coal, and natural gas boilers) with open-loop cooling withdraw 10-40 gallons of water per kWh
    c. The water intensity (defined by withdrawals) of power generation depends on the fuel type, generation technology, and cooling technology
    d. The water intensity of power plants in decreasing order:
        i. Nuclear (most water intensive)
        ii. Coal (conventional) & natural gas boilers
        iii. Coal (integrated gasification combined cycle)
        iv. Natural gas combined cycle
        v. Natural gas peaking turbines
        vi. Solar PV, wind (least water intensive)
2. **The power sector's water use introduces vulnerability to water extremes**
    a. *Freezes*: frozen water and instrumentation pipes can cause power plants to shut down (Texas 2011)
    b. *Heat waves*: thermal pollution limits can cause power plants to dial back their output when water temperatures are too high (France 2003)
    c. *Floods*: too much water can cause power plants to shut down because of safety concerns (Fukushima 2011)
    d. *Droughts*: scarcity might force power plants to dial back or turn off because cooling water isn't available for safe operation (SE USA 2008)

3. **Implementing advanced cooling technologies reduces drought vulnerability of the Texas power sector**

    a. Closed-loop cooling (via cooling towers) is less water intensive than open-loop

        i. Cooling towers are generally considered to be less impactful than open-loop cooling (because of lower water withdrawals and less entrainment of aquatic life)

    b. Dry-cooling is less water intensive than closed-loop

        i. Dry-cooling works like a car radiator

        ii. *Bad news*:

            1. Requires more capital up front

            2. Induces a parasitic efficiency loss at the power plant of ~1-5%

        iii. *Good news*: Makes the plant resilient against drought impacts

    c. Switching from open-loop to closed-loop spares significant volume of water withdrawals

    d. Switching from closed-loop to dry cooling spares even more water

    e. The economic value of drought resiliency from dry cooling roughly cancels out the costs of parasitic losses at some plants (not including the up-front costs of retrofitting)

        i. It's like paying a ~2% insurance premium to avoid the surprise costs of a house fire

4. **There Are Environmental Co-Benefits of Reducing Water**

    a. Power plants that are water-lean (Natural gas combined cycle, natural gas combustion turbines, solar PV and wind) also have low emissions

        i. These fuels are all abundant within Texas' borders

    b. Switching the fuel mix to cleaner fuels saves water AND reduces emissions

    c. Recent peer-reviewed scientific paper with MIT demonstrated that:

        i. Texas can reduce water use AND emissions dramatically by simply changing more from low-emitting sources (clean gas, and renewables) and less from high-emitting sources (coal and dirty gas) to

        ii. These reductions can be achieved through market mechanisms by putting a price on NOx emissions

            1. No need to pay hundreds of millions for scrubbers or wait years

2. Consistent with other tried & tested market schemes that were designed to address acid rain

3. Emissions of SOx, PM, Mercury and CO_2 also reduced

5. There are several policy options available:

a. The State could buy most of the water rights from power plant operators (which helps meet instream flow requirements), which gives operators the money they need to implement dry cooling retrofits

b. The State could provide low-interest loans to reduce the costs of retrofitting advanced cooling technologies

c. Looking forward, the state can (should?) include water availability in the permitting process

d. Looking forward, the state can (should?) require advanced cooling technologies

e. The State could push to put a price on NOx, thereby using efficient market mechanisms to reduce emissions and water withdrawals by power plants

6. In conclusion:

a. The risks of water scarcity to the power sector are real, severe, and expensive

b. There are solutions available:

i. Switch to a less water-intensive fuel mix

ii. Implement advanced cooling technologies

c. Reducing water use has environmental co-benefits of reduced emissions

d. There are several policy options available that reduce risks from drought

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