Water-driven Constraints and Adaptations in Coal-fired Power Plants

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Introduction

- Water is a critical resource in the energy industry: 41% of total U.S. water withdrawals are used for thermoelectric power plant operations.
- Changing water conditions are putting plants at risk for drought, flood, and/or discharge permitting.
- To evaluate future risks, it is important to understand nuances of individual plants in their design, operational policies, and contingency planning. Such information is not broadly available.

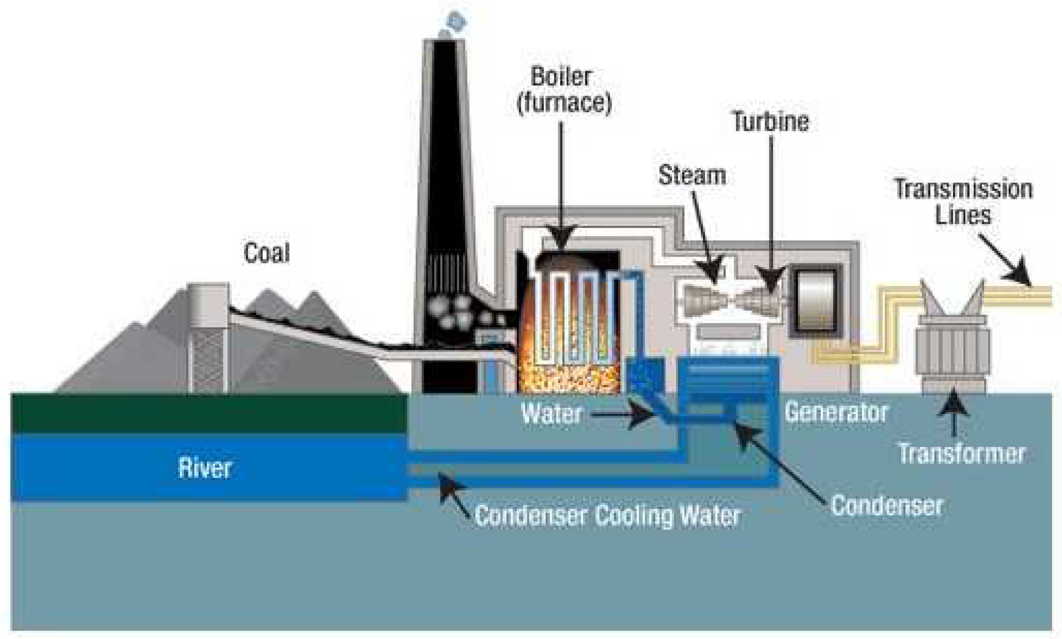

Figure 1. Schematic of a thermoelectric, coal-fired power plant. Source: University of Maryland [1]

Study Objective: Characterize where individual power plants get their water, potential restrictions on its use or discharge, and any contingency plans they have developed to deal with water limitations.

Hypothesis

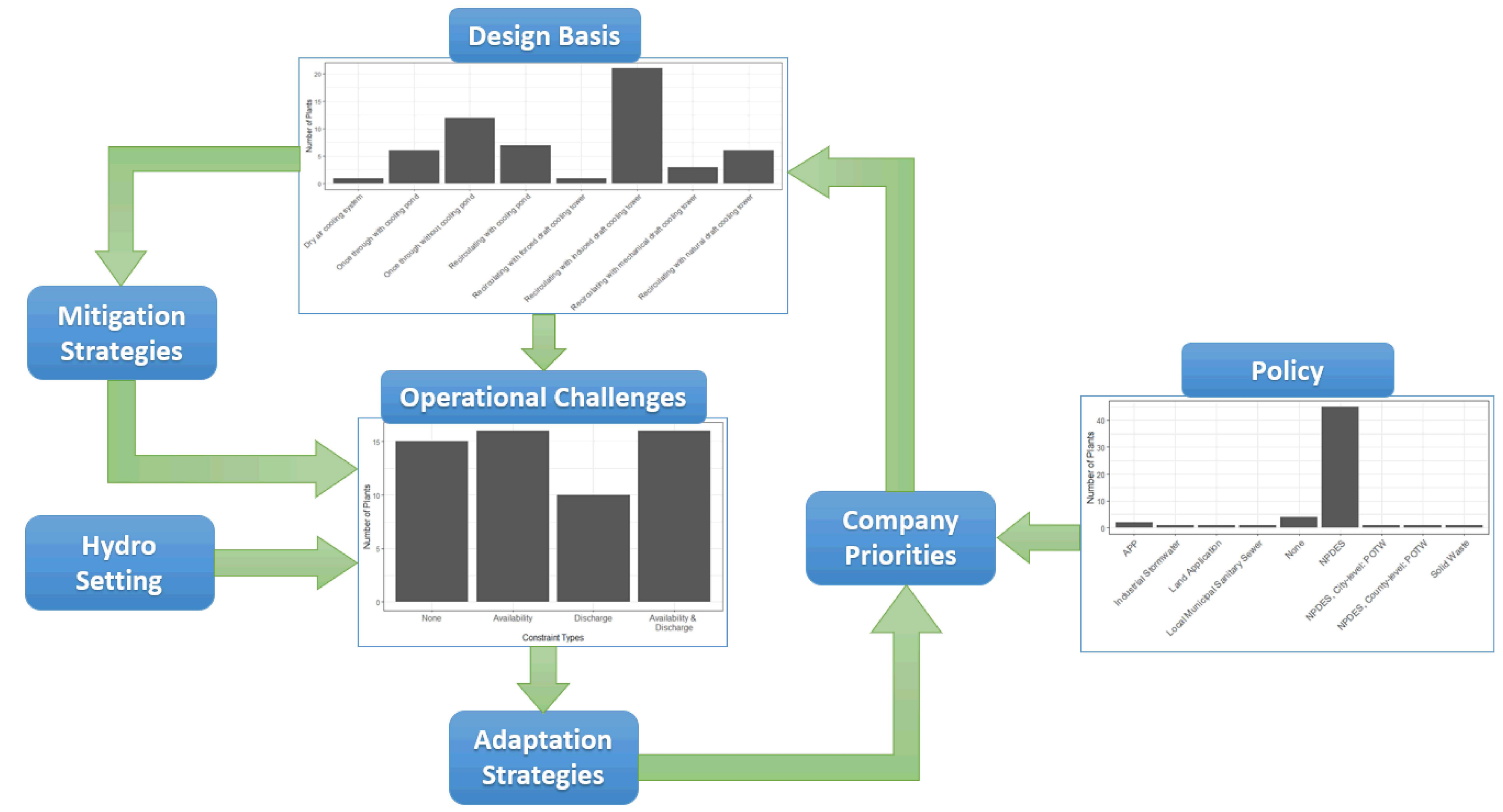

Figure 2. Factors that influence power plant's risks to water-related constraints. In addition to the hydrological setting and design basis, power plants are also influenced by operational challenges that impact their adaptation and mitigation strategies. Additionally, company priorities (regarding diversification of energy sources) and policy changes influence these activities.

Methods

- A semi-structured interview approach with plant owners and operators was implemented to obtain water constraint information.
- A number of details (including design basis, company priorities and hydrological settings) were collected during the interviews (Figure 2).
- The collected data was coded and captured in a database to identify patterns and compare strategies among power plants.

Results

- A total of 57 plants across 27 utilities have been interviewed to date. These plants represent a significant portion of the U.S. coal-fired power plant fleet by capacity (26.2%) and state coverage (47.8%) (Table 1; Figure 3).

	Total	Interviewed	Interviewed (% of Total)
Utilities	220	27	12.3
Plants	353	57	16.1
States with Coal Plants	46	22	47.8
Plant Capacity (GW)	273.3	71.5	26.2

Table 1. Summary of interviewed plants conducted for analysis.

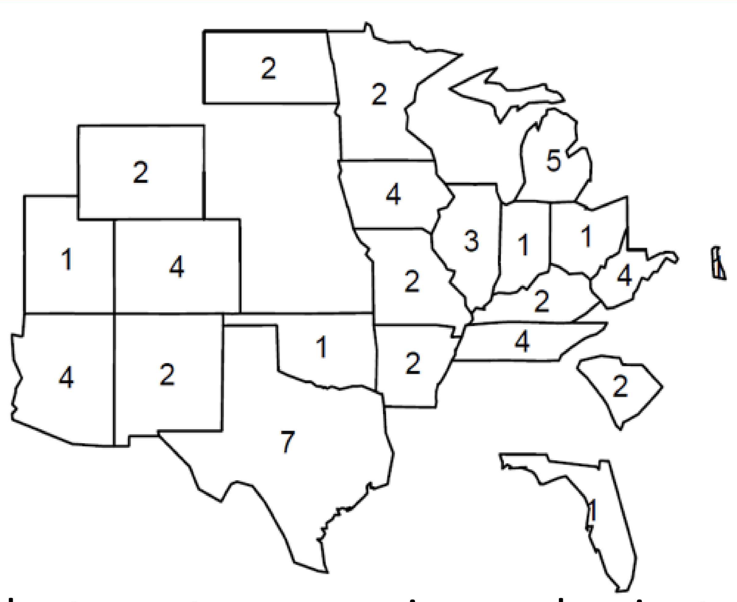

Figure 3. Interviewed plants by state.

- For the interviewed plants, water source issues dominate with 16 plants having only availability issues and another 16 with both availability and discharge issues. Another 10 plants only had discharge issues while 15 plants reported no water- related constraints .

Constraint Type	Drought	Drought Flood	Drought Flood Normal	Drought Normal	Flood	Flood Normal	Normal	Total
Availability Only	9	5	0	0	2	0	0	16
Availability Discharge	1	4	3	3	1	1	0	16
Discharge Only	4	0	0	0	1	0	3	8

Table 2. Breakdown of water constraints

- Plants with no water-related constraints are distributed among 10 states. Plants in the southwestern region noted design modification while plants in the north and east parts of the U.S. noted ample water supply as the underlying causes of no water-related issues (Table 3). Although the constraint category varied, all plants used recirculating cooling technology.

State	Water Source	Cause
AZ	Fresh surface water	Design Modifications
AZ	Fresh groundwater	Ample Supply
CO	Fresh surface water	Design Modifications
MN	Fresh surface water	Ample Supply
ND	Fresh surface water	Ample Supply
OH	Fresh surface water	Ample Supply
OK	Fresh surface water	Ample Supply
SC	Fresh surface water	Ample Supply
SC	Fresh surface water	Ample Supply
TX	Fresh surface water	Ample Supply
TX	Plant discharge/ Reclaimed water	Design Modifications
TX	Fresh groundwater	Design Modifications
UT	Fresh surface water	Design Modifications
WV	Fresh surface water	Ample Supply
WV	Fresh surface water	Ample Supply

Table 3. Plants with no water-related constraints.

- Plants acquire water through a number of different mechanisms, including contracts, local-level permits, and state-level programs; state-level programs dominate and range between permits, rights, and reporting requirements.
- Water constraints are observed across all types of water-securing mechanisms, from local contracts to state-level regulations and federally controlled regions.

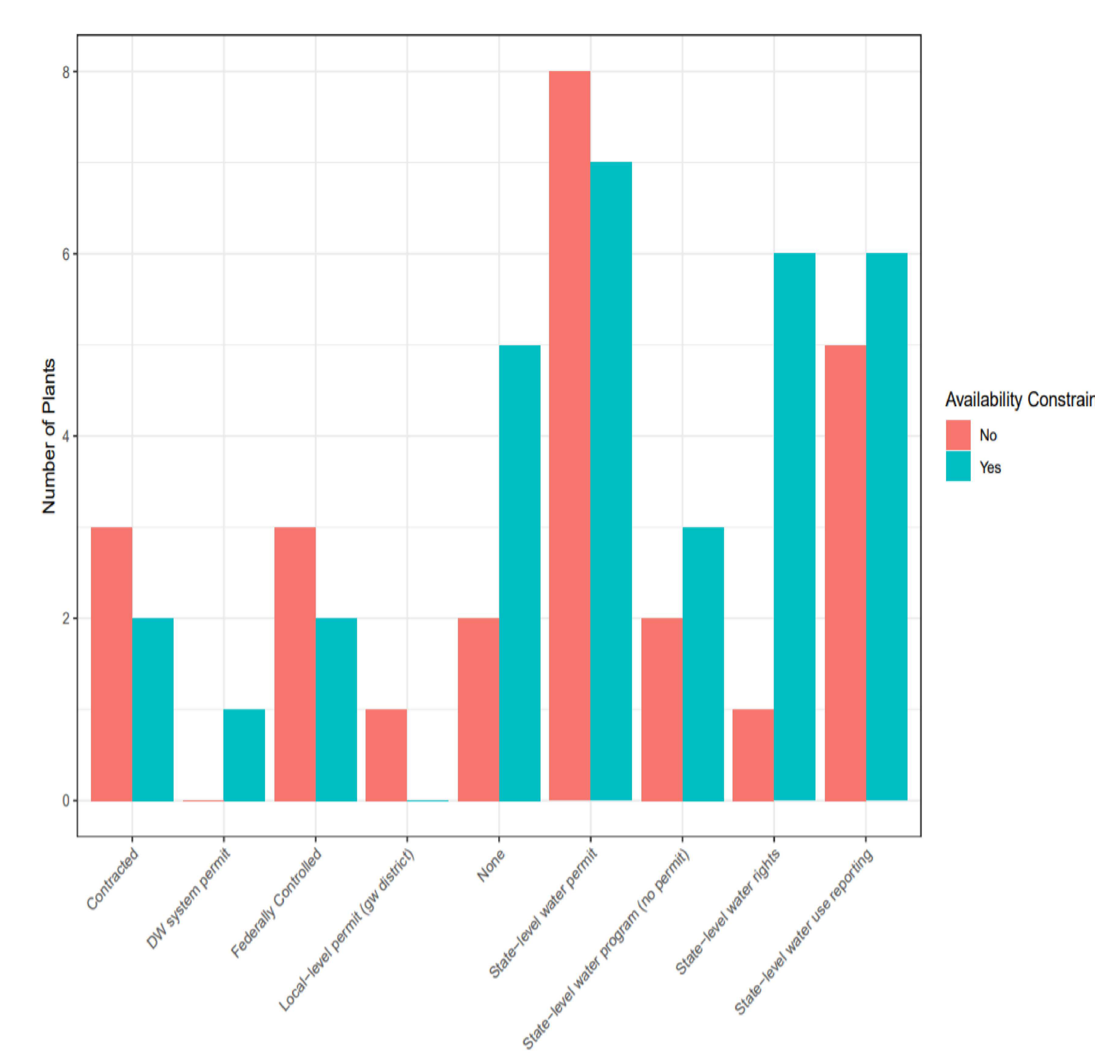

Figure 5. Different mechanisms are used to secure water at plants with availability-related constraints

Discussion/Ongoing Work

- This research has highlighted both vulnerabilities and opportunities for risk mitigations in the coupled human and natural system associated with the water management for energy resources.
- Our findings indicate that while there are geographical differences in water availability, actual constraints faced by plants are both exacerbated and mitigated by engineered, operational, activities, and policy constraints.
- Additional analysis is required to evaluate how the different hydrological settings and associated frequencies intersect with the types of strategies implemented.
- Influences of company-level and policy-level changes on plant strategies, including retirement plants also need to be evaluated.
- Other factors that may influence water related constraints that are not considered here include age of plant, thermal efficiency of the plant, and the age of the cooling system. These factors are currently being assessed.

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References

[1] Rooks, Jennifer and Tune, Lee 2015 UMD Teams Awarded more than Five Million Dollars to Improve Power Plant Cooling. (College Park, MY: University of Maryland)