Cooling-Tower Water-Use Calculation Method for Multi-City Data Center Co

Overview

The goal of this model is to estimate cooling-tower makeup water for a 100 MW data center in different U.S. cities. The method is intentionally simplified to support a dashboard that compares climate-adjusted water use and sustainability metrics. It is not intended for engineering design, but for consistent, transparent comparison across locations.

Key Inputs

Inputs that vary by city:

- Average cold-water supply temperature (55-60 deg F depending on climate).
- Cooling tower Range (deg F), typically 10-15 deg F.
- Cycles of Concentration (CoC), typically 3-5 based on water hardness/softness.
- IT Load (fixed at 100 MW).
- Load Factor (0.6 for hyperscale cloud, 0.8 for AI/ML clusters).

Converting IT Load to Cooling Tons

Formula:

Tons = (IT Load in kW) / 3.517

For 100 MW: Tons approx. 28,400

Cooling-Tower Water Calculations

Formulas used:

Evaporation (gpm) = 0.001 x Tons x Range

Blowdown (gpm) = Evaporation / (CoC - 1)

Drift (gpm) = 0.01 x Evaporation

Peak Makeup (gpm) = Evaporation + Blowdown + Drift

Peak Makeup (MGD) = Peak Makeup (gpm) x 1440 / 1,000,000

Peak Annual Makeup (MGY) = Peak Makeup (MGD) x 365

Actual Annual Makeup (MGY) = Peak Annual Makeup x Load Factor

Choosing Range and CoC by City

Range and CoC are the two main variables that change water use.

Guidance:

- Colder cities -> lower supply temperature (approx. 55 deg F) and smaller Range (approx. 10 deg F)
- Hotter cities -> higher supply temperature (approx. 60 deg F) and larger Range (approx. 12-15 deg F)
- Soft water -> higher CoC (4-5)
- Hard water -> lower CoC (3-4)

Simple online research is sufficient for this project.

Example: Denver

Denver case:

- IT Load: 100 MW
- Load Factor: 0.8 (AI/ML) or 0.6 (Cloud)
- Range: 10 deg F or 15 deg F depending on scenario
- CoC: 3-5 depending on water hardness

These values are used to compute Peak Makeup and Annual Makeup using the formulas above.

How Teammates Should Use the Spreadsheet

Steps:

1. Select a city.
2. Assign cold-water supply temperature (55-60 deg F).
3. Choose Range (10-15 deg F) based on climate.
4. Choose CoC (3-5) based on water hardness.
5. Enter Load Factor (0.6 or 0.8).
6. Read off Peak Makeup and Annual Makeup.
7. Use these values in the dashboard for sustainability scoring.

Purpose of the Dashboard

The dashboard compares cities on:

- Climate-adjusted electricity use
- Climate-adjusted water use
- Grid carbon intensity
- Water stress
- Combined sustainability score

Closing Summary

This method is simple, transparent, and consistent across cities. It enables fair comparison of data center water use and sustainability, even if the exact engineering values differ from real-world systems.