Can Data Center Become Water Self-Sufficient?

K. Ahmed, M. A. Islam, **Shaolei Ren**, and G. Quan

Florida International University

Data center

Google's data center in Mayes County, Oklahoma

Data centers are **power**-hungry

U.S. data centers in 2013

91 billion kWh

Power the entire state of Washington

Source: Natural Resources Defense Council

Data centers are also **thirsty**

Water evaporation in Google' OR data center

Data centers are also **thirsty**

How **thirsty** are data centers?

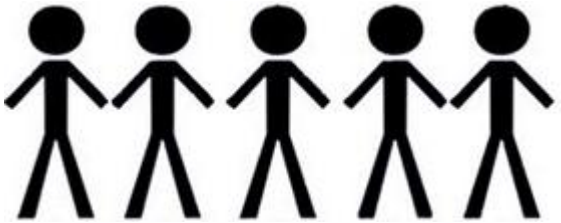
at&t

2013 Key Performance Indicators

	2010	2011	2012	2013
Absolute (gallons)	3.331B	3.357B	3.282B	3.113B
Water intensity (gallons/$ thousand revenue)[1]	26.80	26.49	25.75	24.18
Water intensity (gallons/Terabyte network traffic)	105	84	61	48

1 billion gal. per year for data center cooling

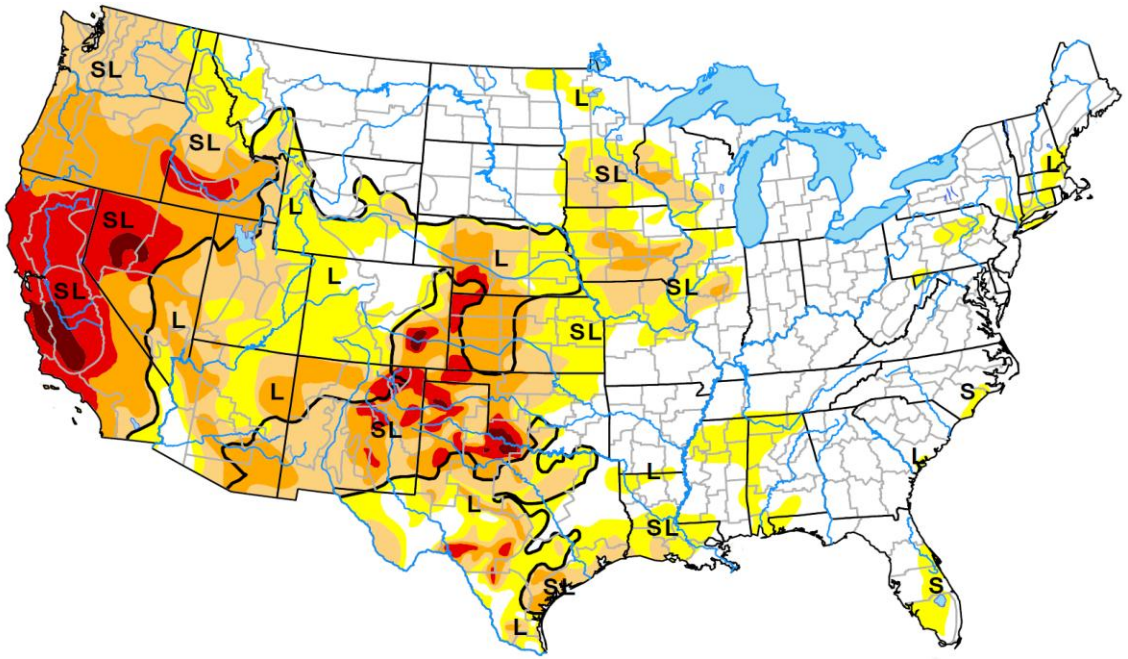
30,000+



http://www.att.com/

Water is scarce

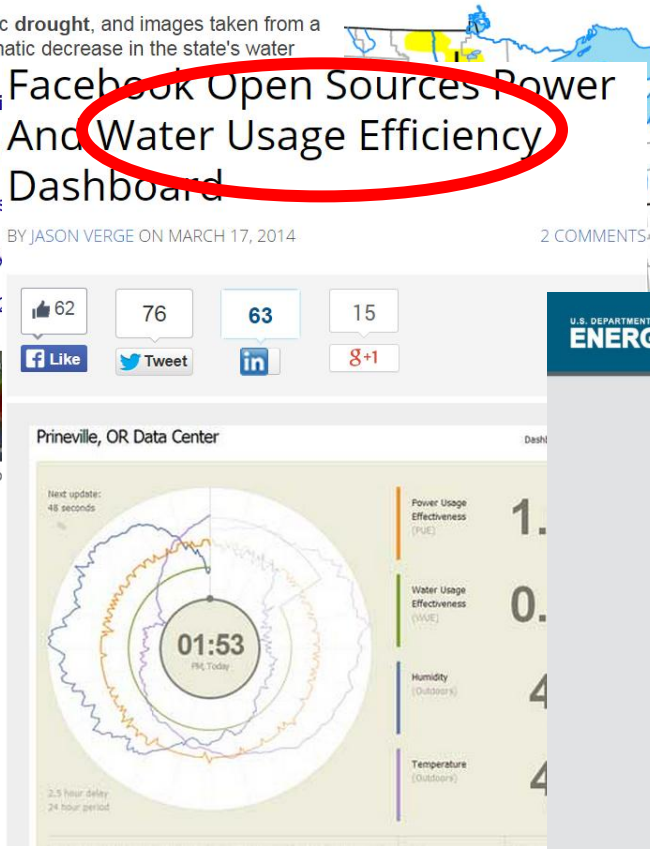
- Drought is hitting many U.S. states

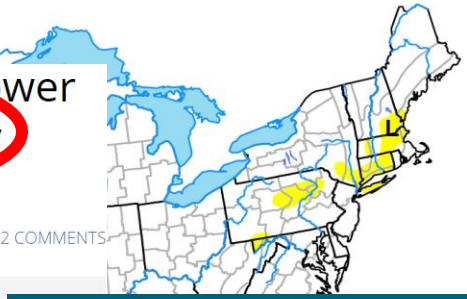


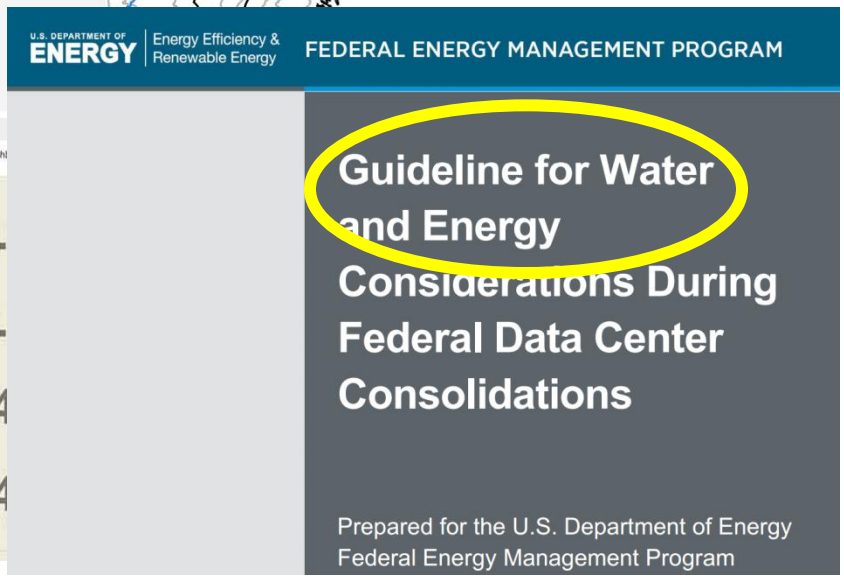
http://droughtmonitor.unl.edu/

Water is scarce

- Drought is hitting many U.S. states







How to make data centers water sustainable?

Look at energy sustainability first

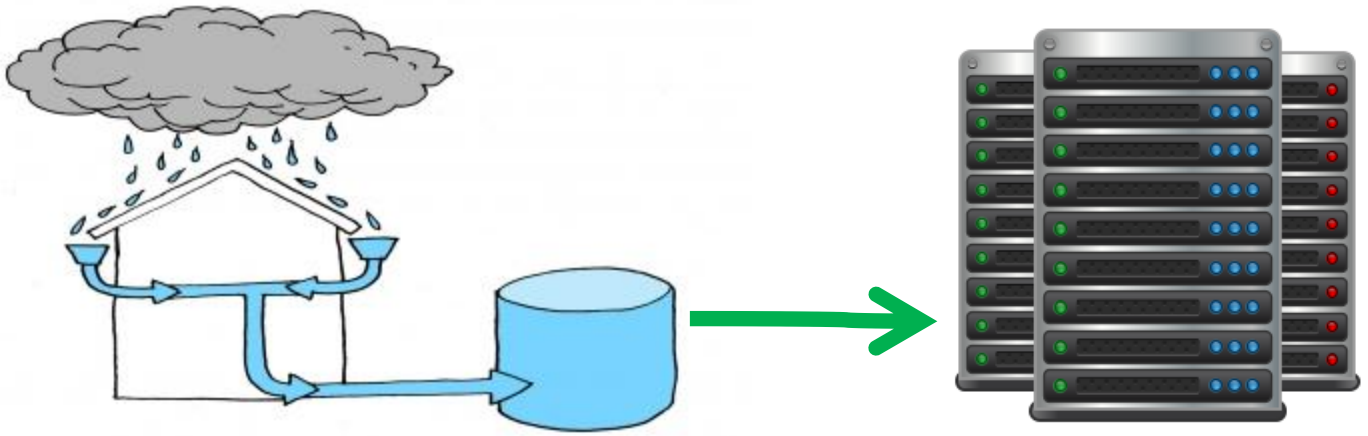
Harvest nature and (possibly) go without utility power!

Google

Microsoft

Can data centers operate **without** utility water?

- Rainfall comes from nature, just like solar and wind
  - No utility water usage!
- But, very challenging
  - Highly unpredictable and limited



Let's see if **rainfall** is enough for water self-sufficiency…

Google

EQUINIX

What's so special about this new data center in Rio de Janeiro?

Many things. First of all, the new facility – called RJ2 – is the only certified Tier III data center in the city of Rio de Janeiro. This means our Rio customers will experience unmatched reliability and uptime when they colocate with us in RJ2. And RJ2 is the biggest data center in the state of Rio, with 15,000 square meters of space. The new facility is designed for minimal water and power consumption and CO_2 emissions – for example, water consumption is reduced by at least 70% thanks to a rain water harvesting system.

Cooling systems for **large** data centers

- "cooling tower" **v.s.** "outside air"

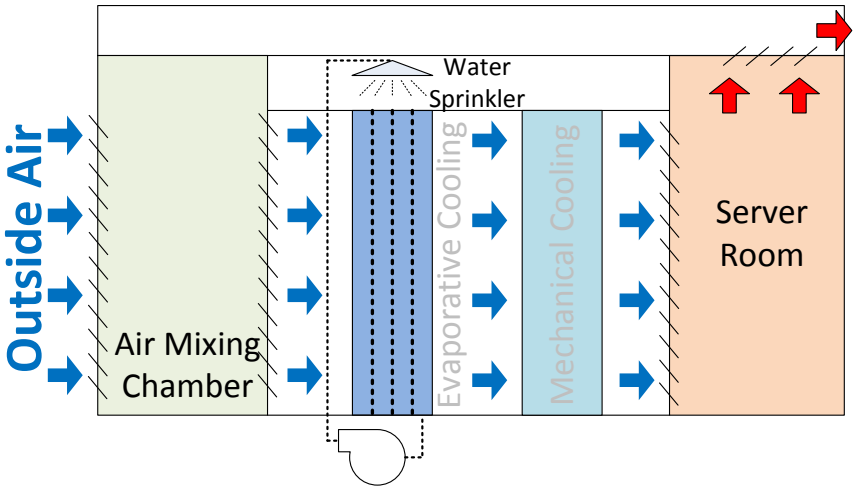
Water evaporation carries heat (air is used inside data center)

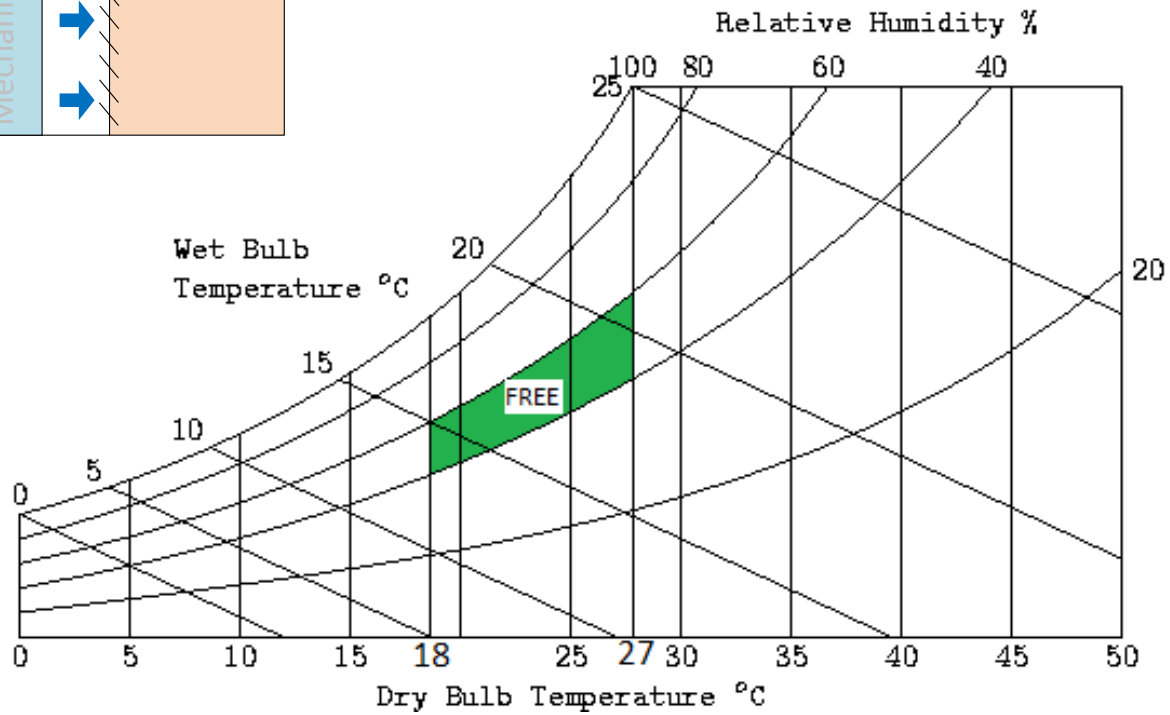
> 2 L/kWh

Cold air directly enters data center to remove heat

< 0.5 L/kWh

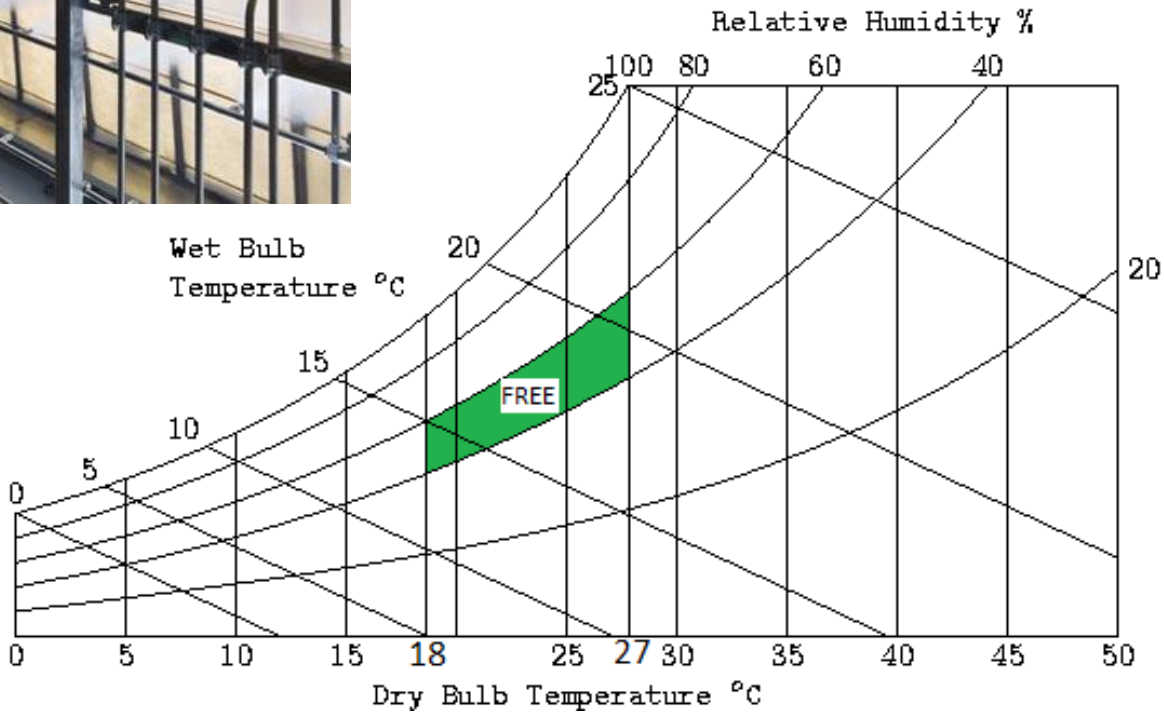
Water usage for fresh air cooling





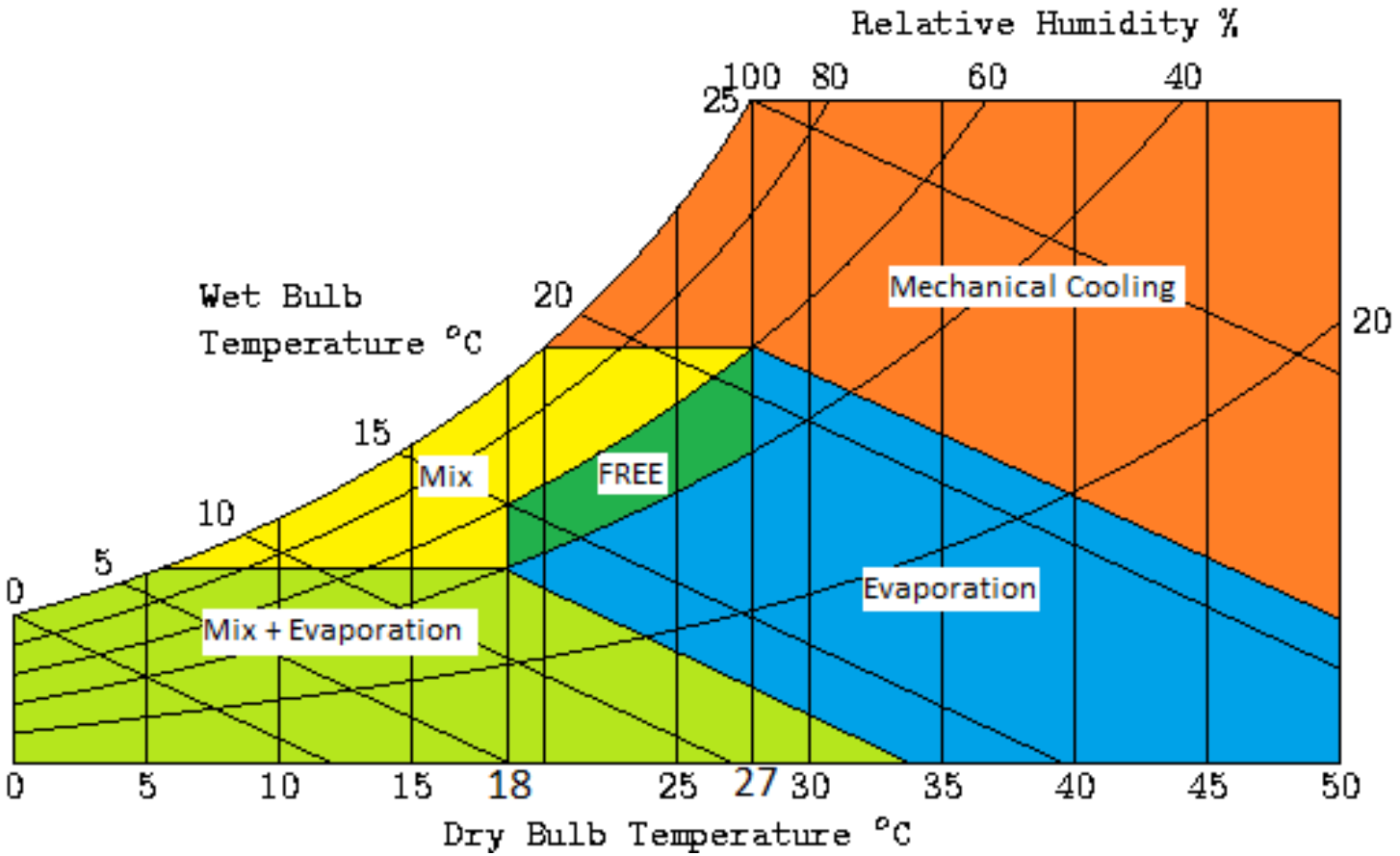
Based on ASHRAE recommended operating condition

Water usage for fresh air cooling



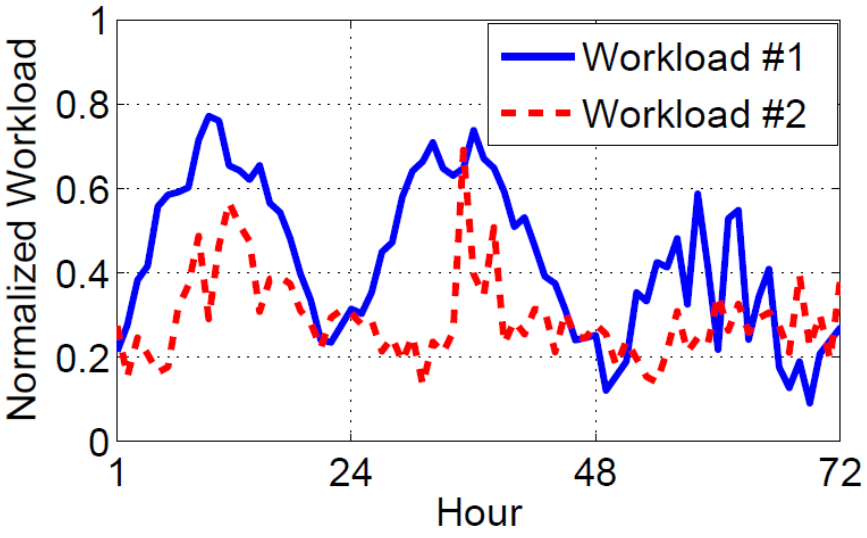
Based on ASHRAE recommended operating condition

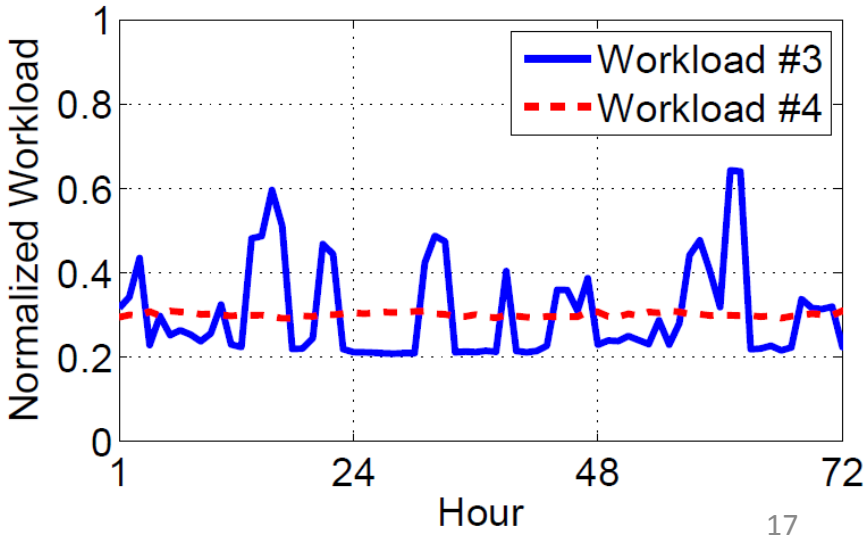
Operation of fresh air cooling



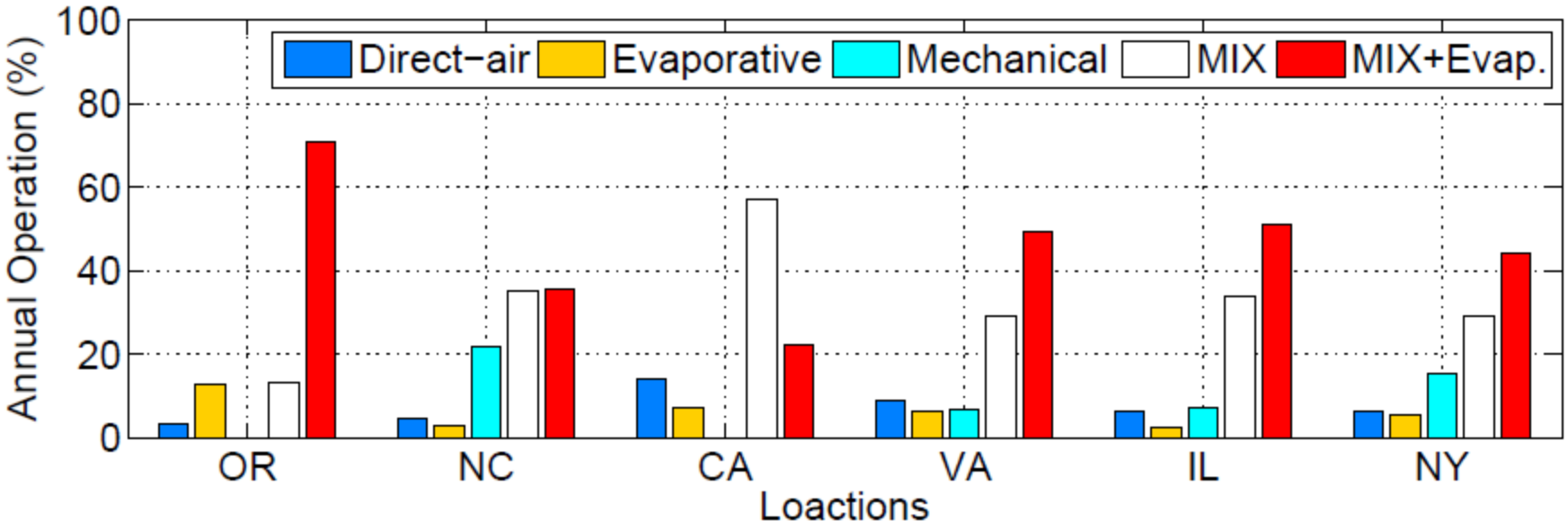
Case study

- Six U.S. locations
  - Prinevile (OR), Forest City (NC), Los Angeles (CA), Ashburn (VA), Chicago (IL), and New York (NY)
- 10MW peak IT power (idle server power 60%)
- 1 million water storage tank



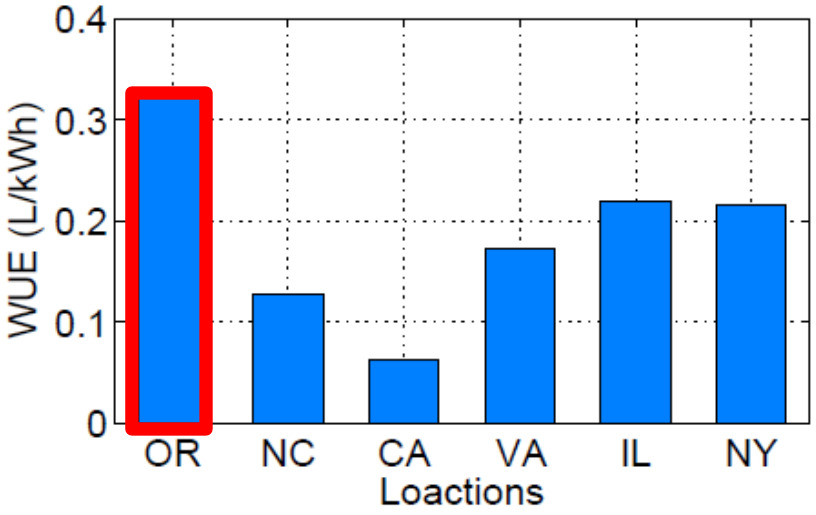


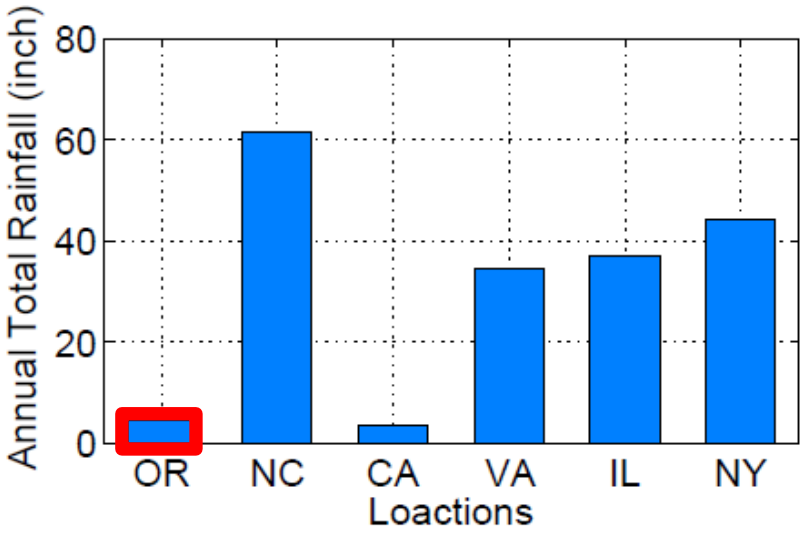
Percentage of operation modes



- Depending on climate conditions, fresh air cooling may frequently require water for humidity and temperature control

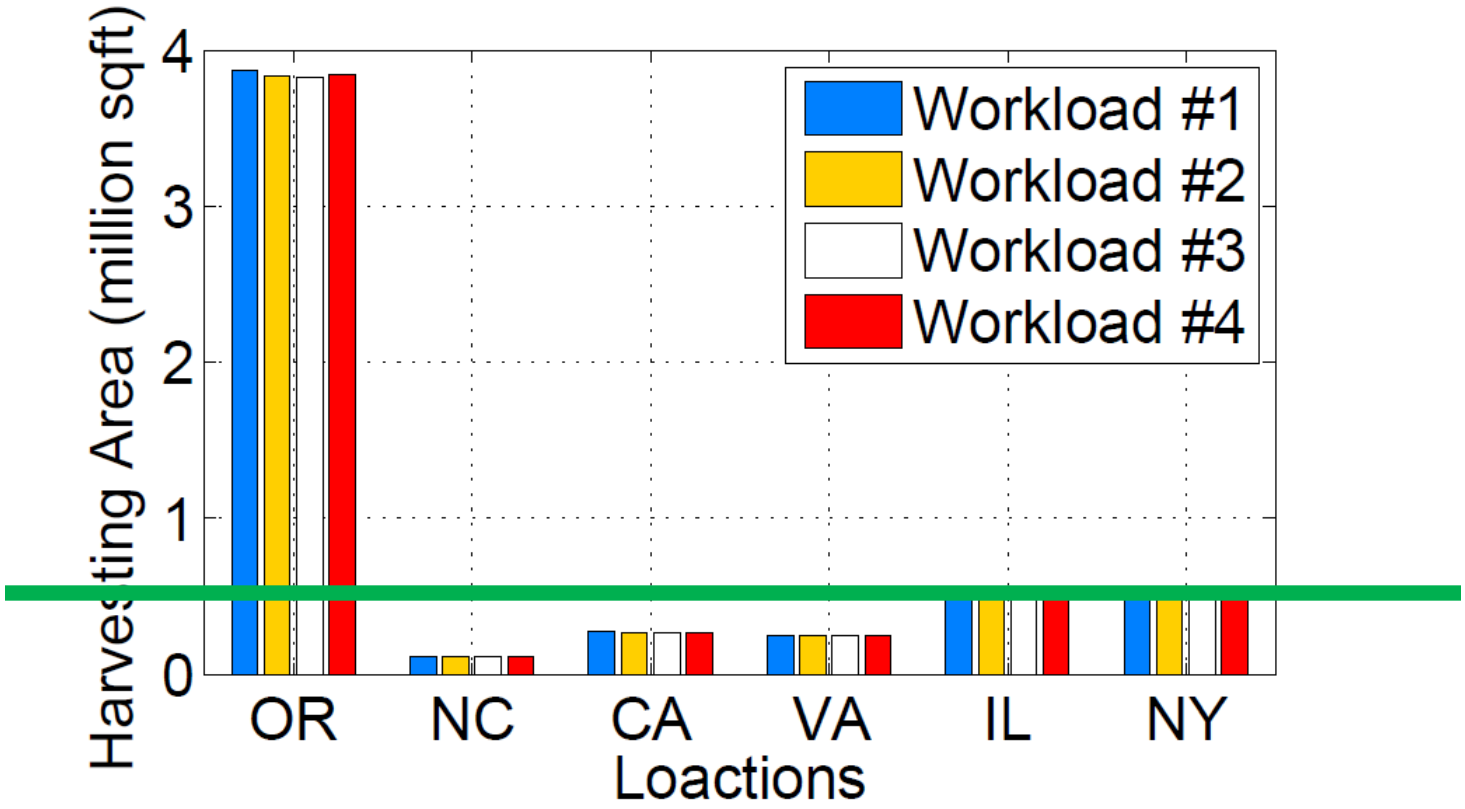
Water efficiency and rainfall





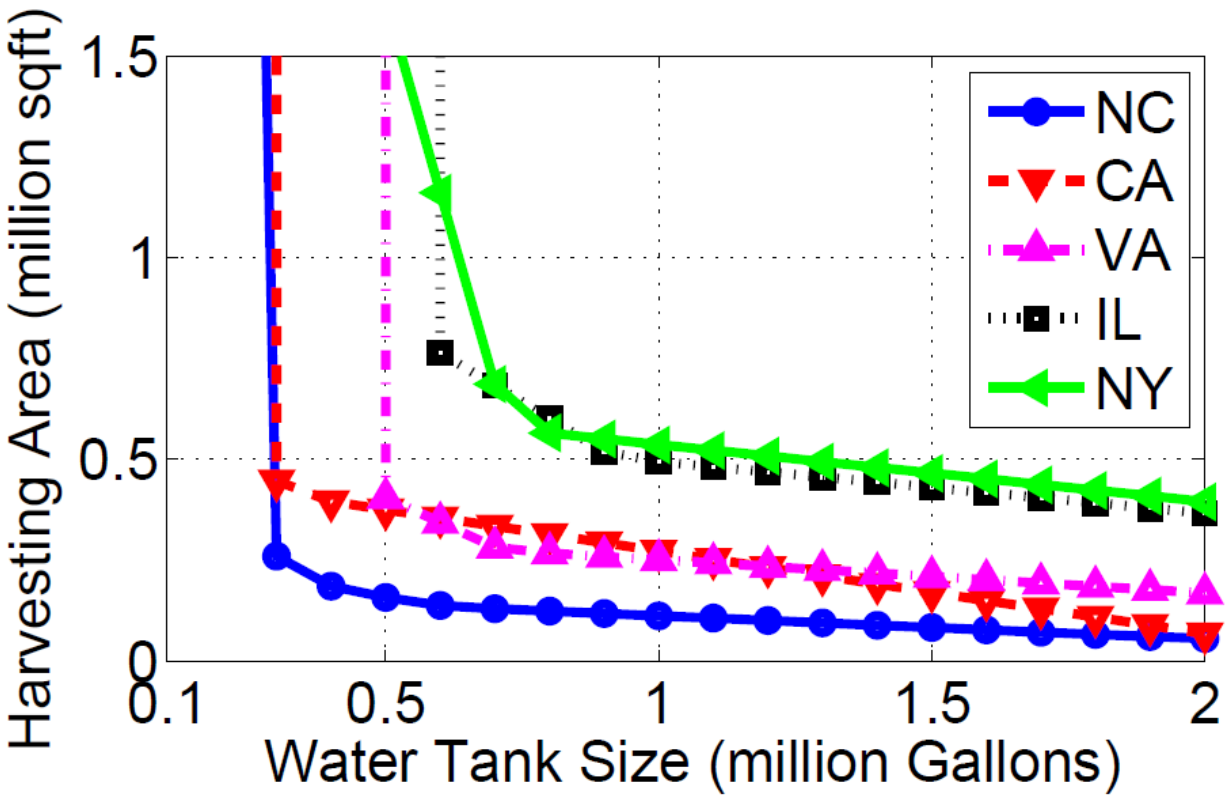
- Water efficiency and rainfall don't always match
  - Geographic load balancing could help mitigate this problem

Minimum rainfall harvesting area



- Not all locations are feasible for water self-sufficiency

Impact of water tank size



- For a 10MW data center, 1 million gallons are a reasonable size for water self-sufficiency

Summary of findings

	Static Power (% Peak Power) - Water Tank Size		
	60% - 1 million gallons	0% - 1 million gallons	0% - 2 million gallons
Prineville, OR	3,868,000	1,112,500	522,550
Forest City, NC	111,600	15,000	**"zero"**
Los Angles, CA	272,400	8,500	**"zero"**
Ashburn, VA	250,000	59,000	10,750
Chicago, IL	494,000	136,000	29,150
New York, NY	536,000	146,000	25,650

Feasibility	Harvesting Area
High	<100,000 sqft
Medium	<200,000 sqft
Low	<500,000 sqft
None	>500,000 sqft

- For water self-sufficiency
  - **"Too cold air"** isn't necessarily good
  - Better power proportionality
  - Bigger water tanks
  - Geographic load balancing

Messages

- Data centers can be very thirsty
- Fresh air cooling is **not** water-free
- Water self-sufficiency using rainfall is possible for data centers
  - But, of course, still a long way to go…