

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



91 billion kWh



U.S. data centers in 2013

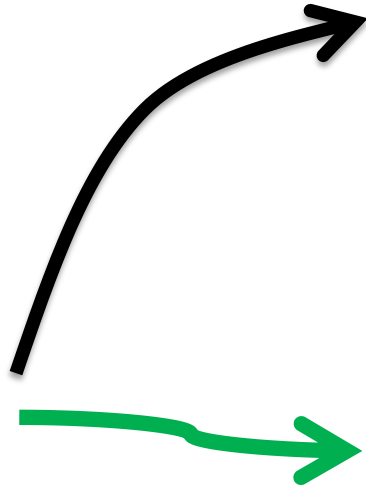
Power the entire state of Washington

Data centers are also **thirsty**



Water evaporation in Google' OR data center

Data centers are also **thirsty**



How **thirsty** are data centers?



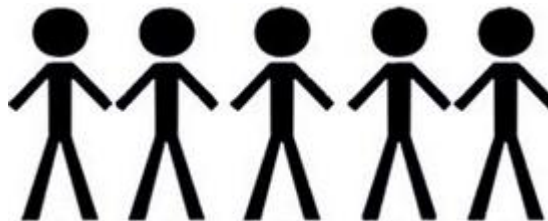
2013 Key Performance Indicators

	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

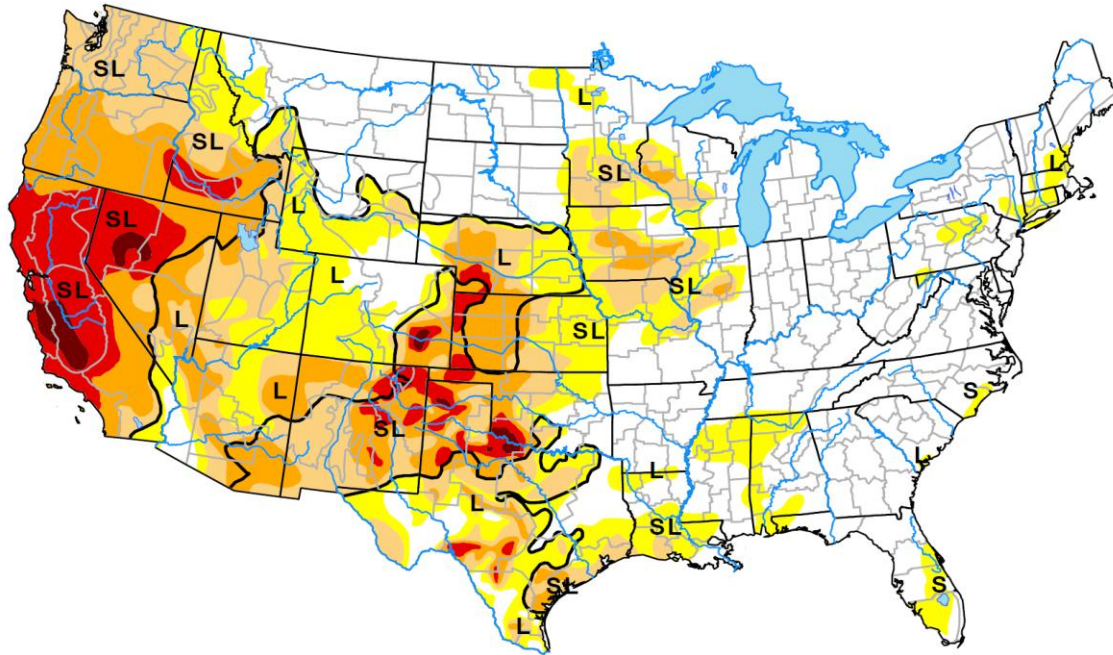


30,000+



Water is scarce

- Drought is hitting many U.S. states



<http://droughtmonitor.unl.edu/>

Water is scarce

- Drought is hitting many U.S. states



NASA images show **California's drought** deepening

USA TODAY - 16 hours ago

All of **California** is in a historic **drought**, and images taken from a NASA satellite show the dramatic decrease in the state's water storage since ...

NASA Satellites Put **California** in a Drought
Mashable - Oct 3, 2014

Satellite Images Reveal Severity of **California's** Drought
NBCNews.com - 20 hours ago

Satellite images reveal shocking groundwater loss
Highly Cited - Los Angeles Times - Oct 2, 2014

If a Tree Falls in the Forest, But No Scientist Says
In-Depth - Huffington Post - Oct 3, 2014

Space photos show **California** drying since 2001
Blog - SFGate (blog) - Oct 3, 2014



Mashable Environmenta... Catholic Online SFGate (b

Facebook Open Sources Power And Water Usage Efficiency Dashboard

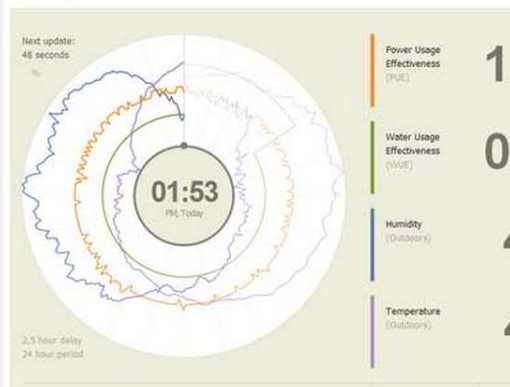
BY JASON VERGE ON MARCH 17, 2014

2 COMMENTS

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Prineville, OR Data Center



U.S. DEPARTMENT OF ENERGY Energy Efficiency & Renewable Energy FEDERAL ENERGY MANAGEMENT PROGRAM

Guideline for Water and Energy Considerations During Federal Data Center Consolidations

Prepared for the U.S. Department of Energy Federal Energy Management Program

How to make data centers **water sustainable?**

Look at **energy** sustainability first



Harvest **nature** and (possibly) go without utility power!



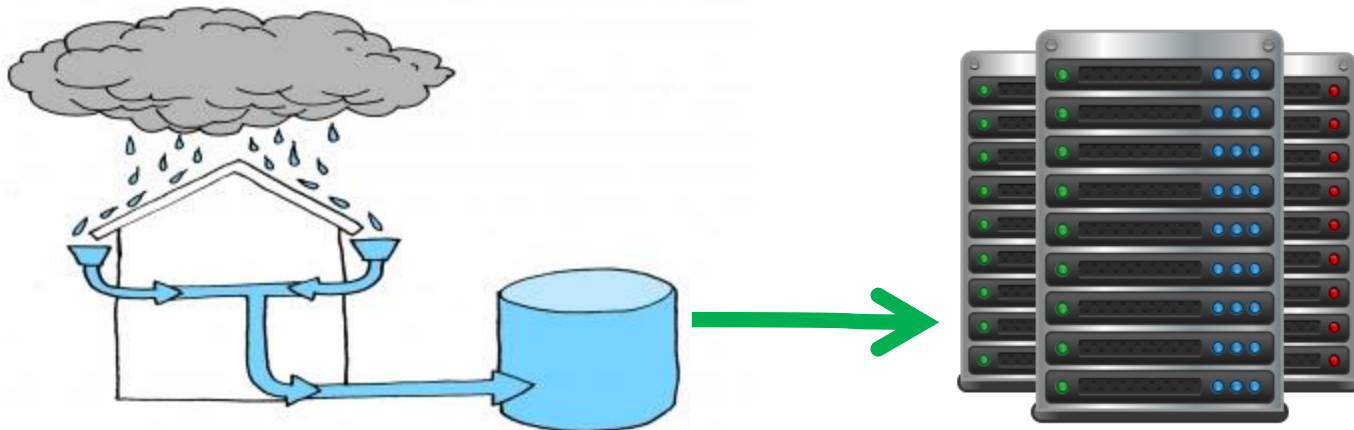
Google



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...



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

Google



EQUINIX

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 collocate 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 CO₂ 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)

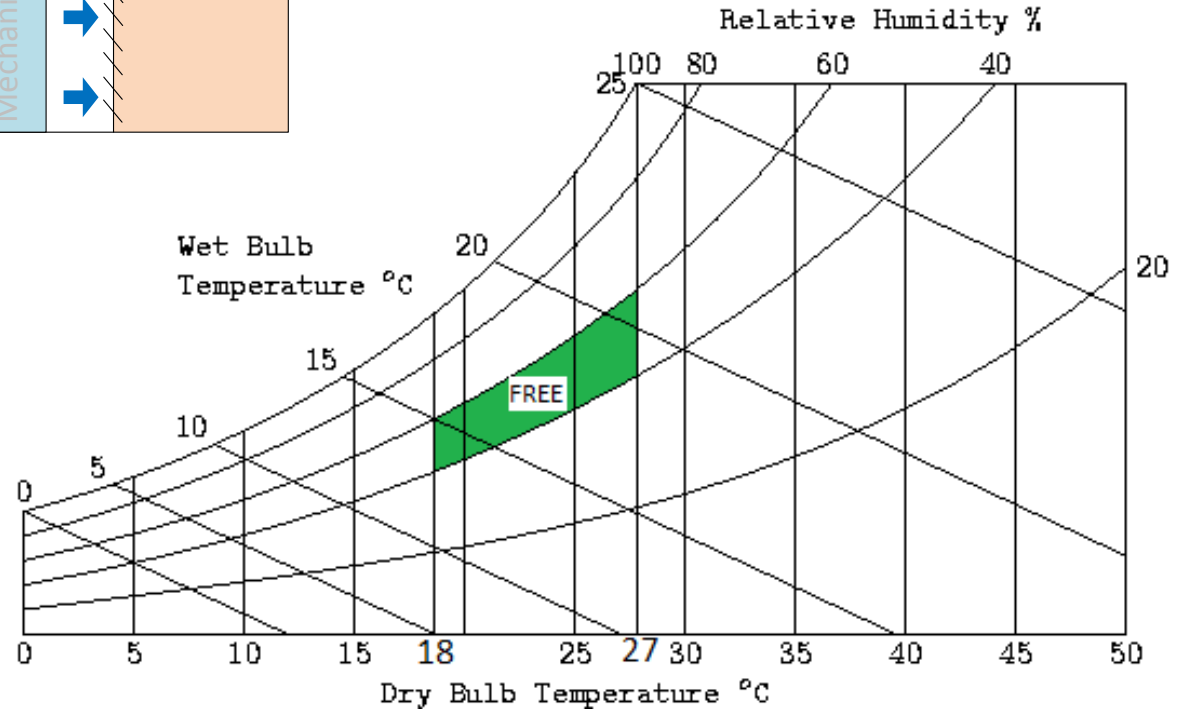
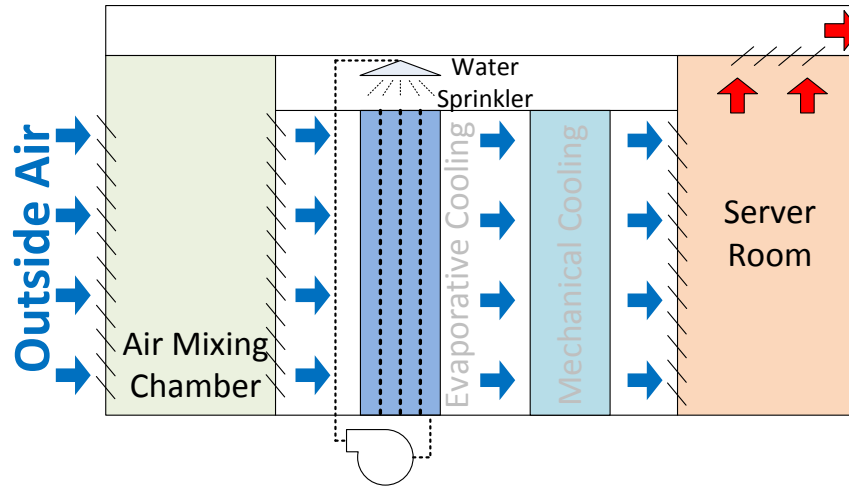
> 2 L/kWh



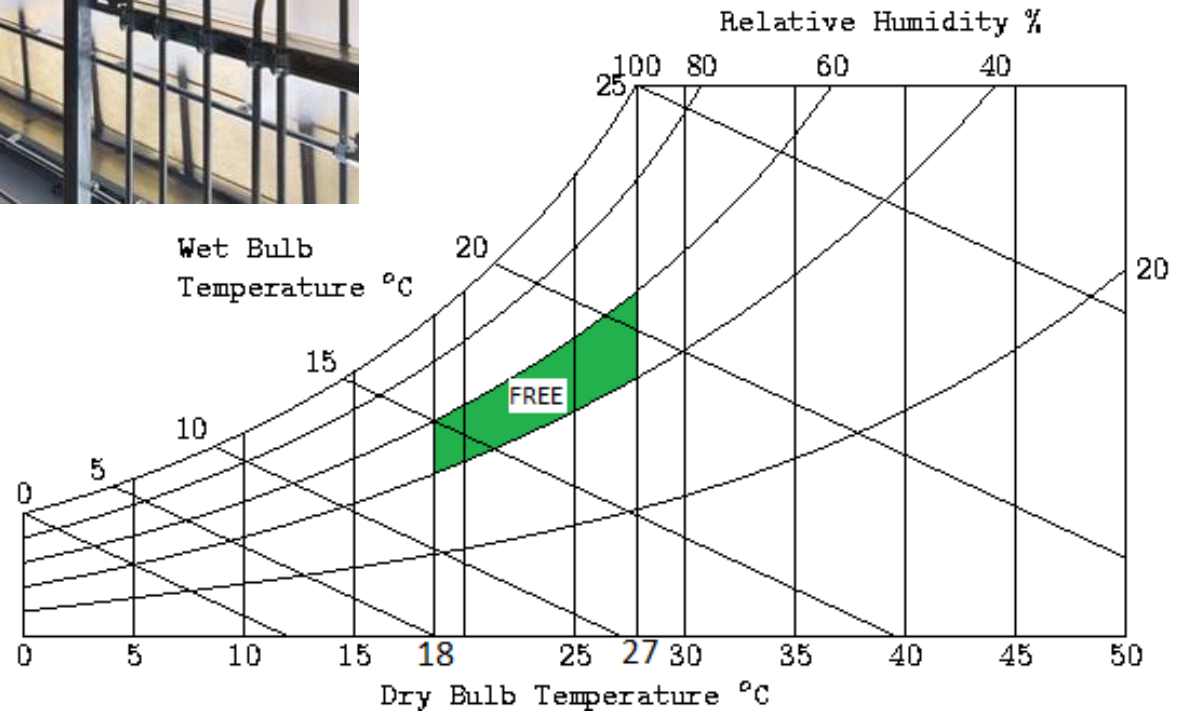
Cold air directly enters data center
to remove heat

< 0.5 L/kWh

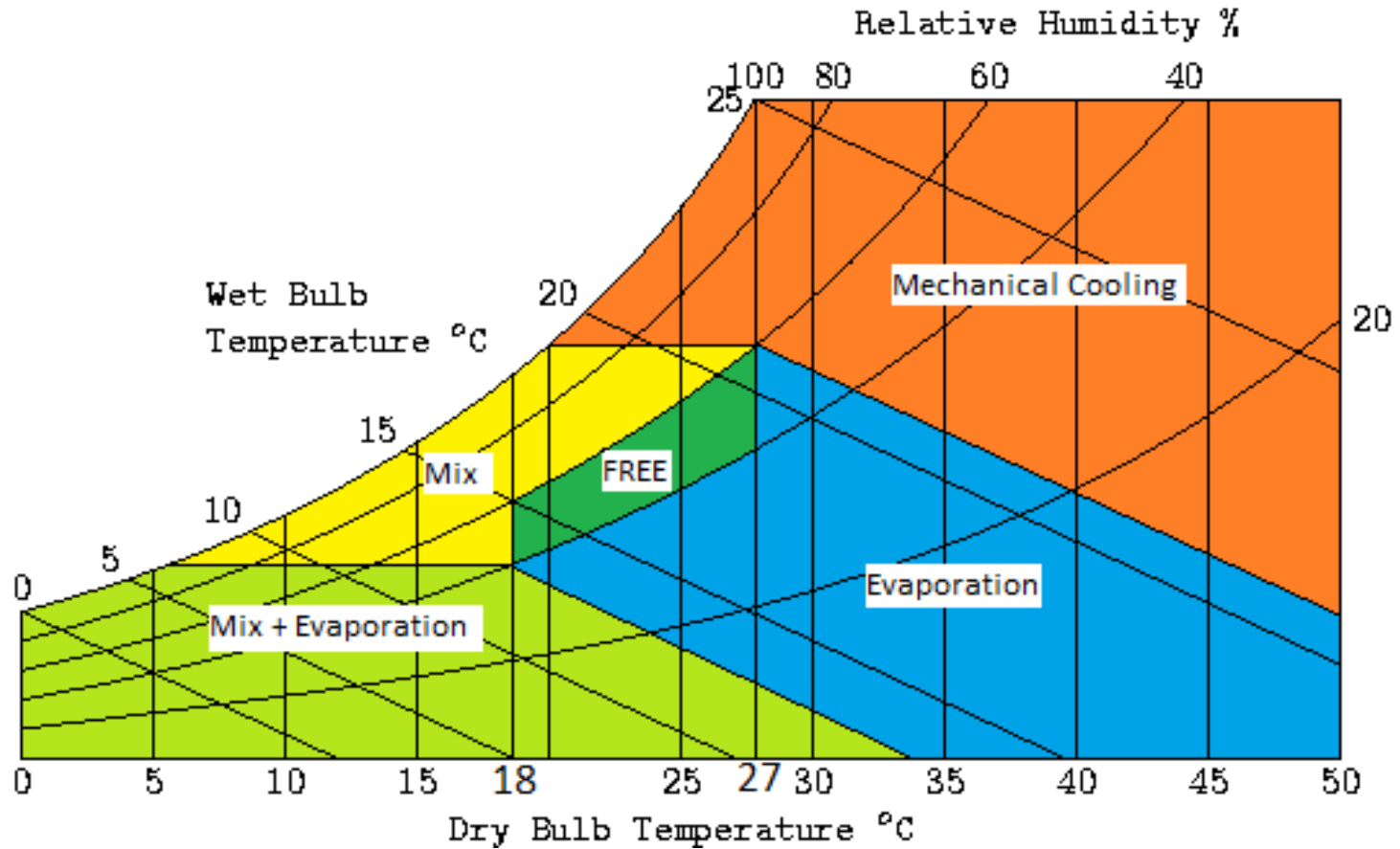
Water usage for fresh air cooling



Water usage for fresh air cooling

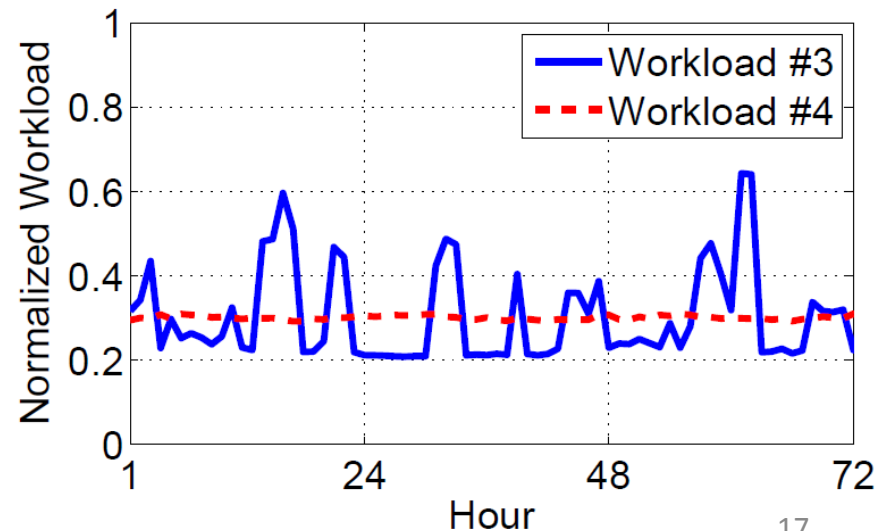
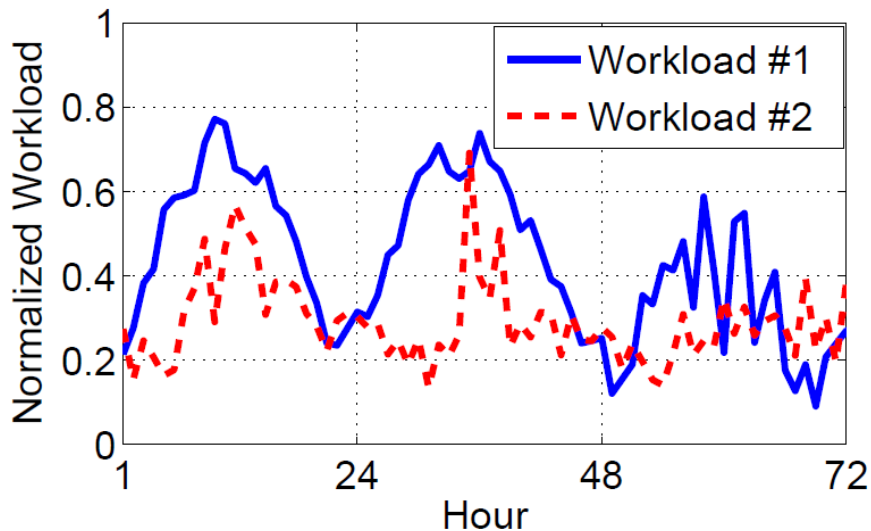


Operation of fresh air cooling

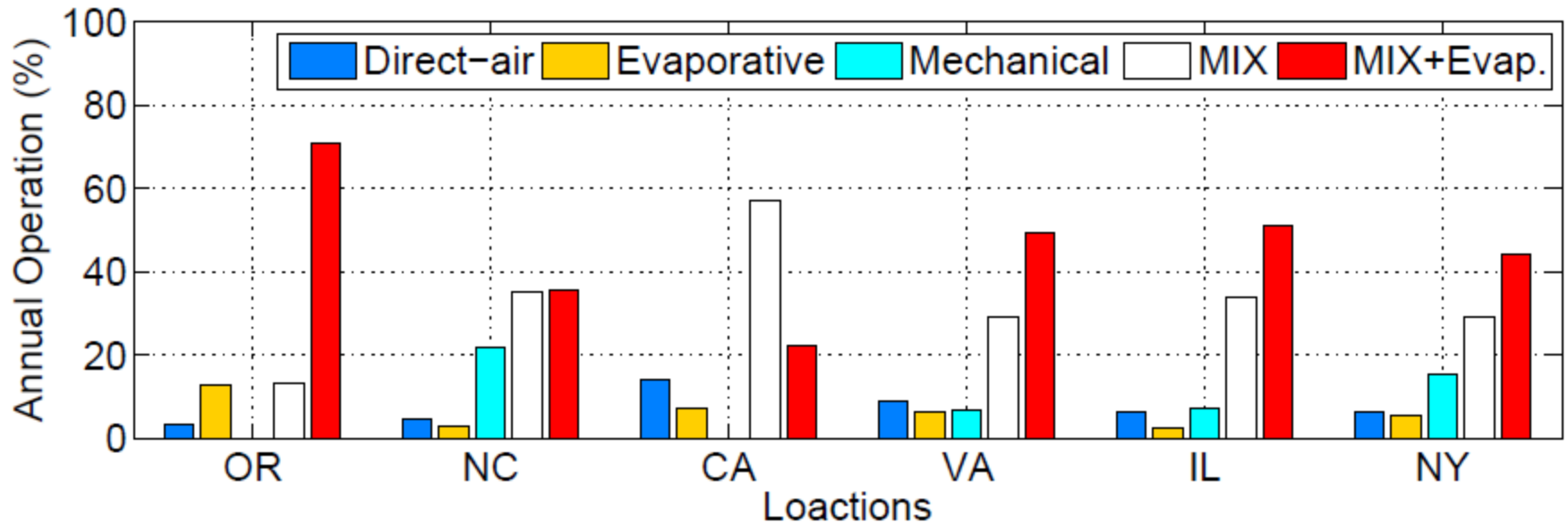


Case study

- Six U.S. locations
 - Prineville (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

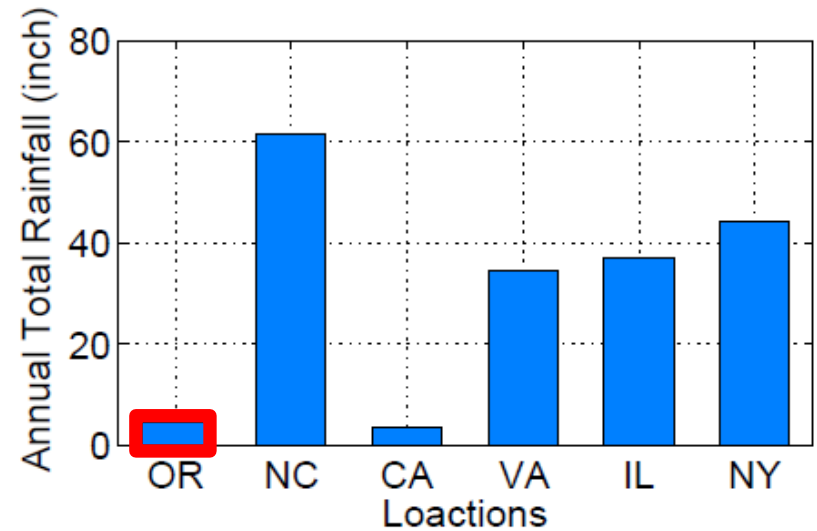
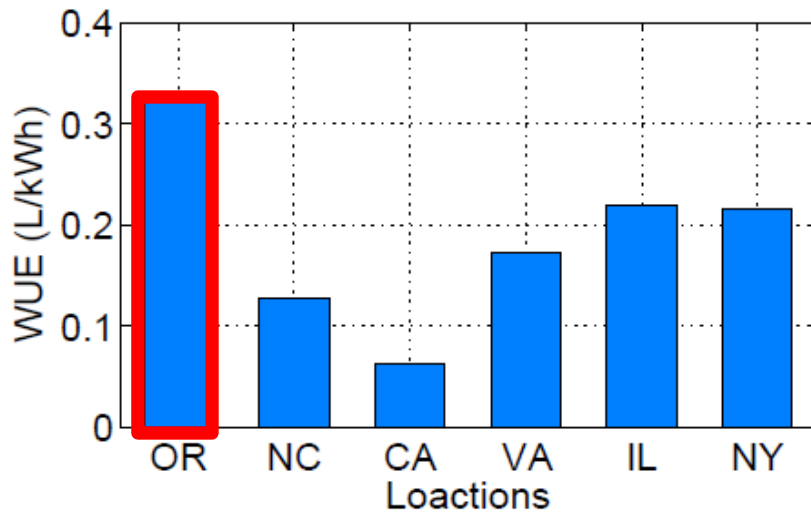


Percentage of operation modes



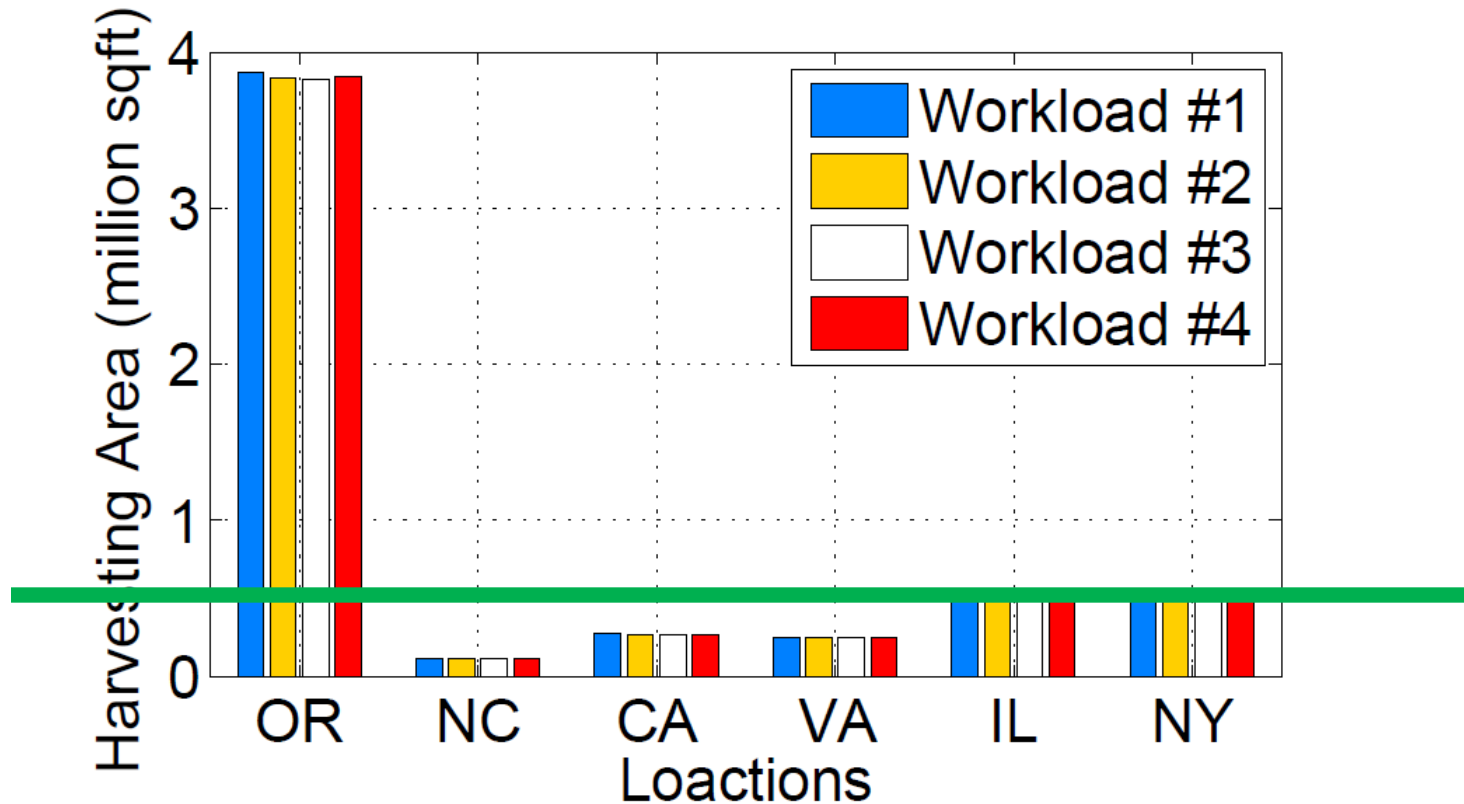
- Depending on climate conditions, fresh air cooling may frequently require water for humidity and temperature control

Water efficiency and rainfall



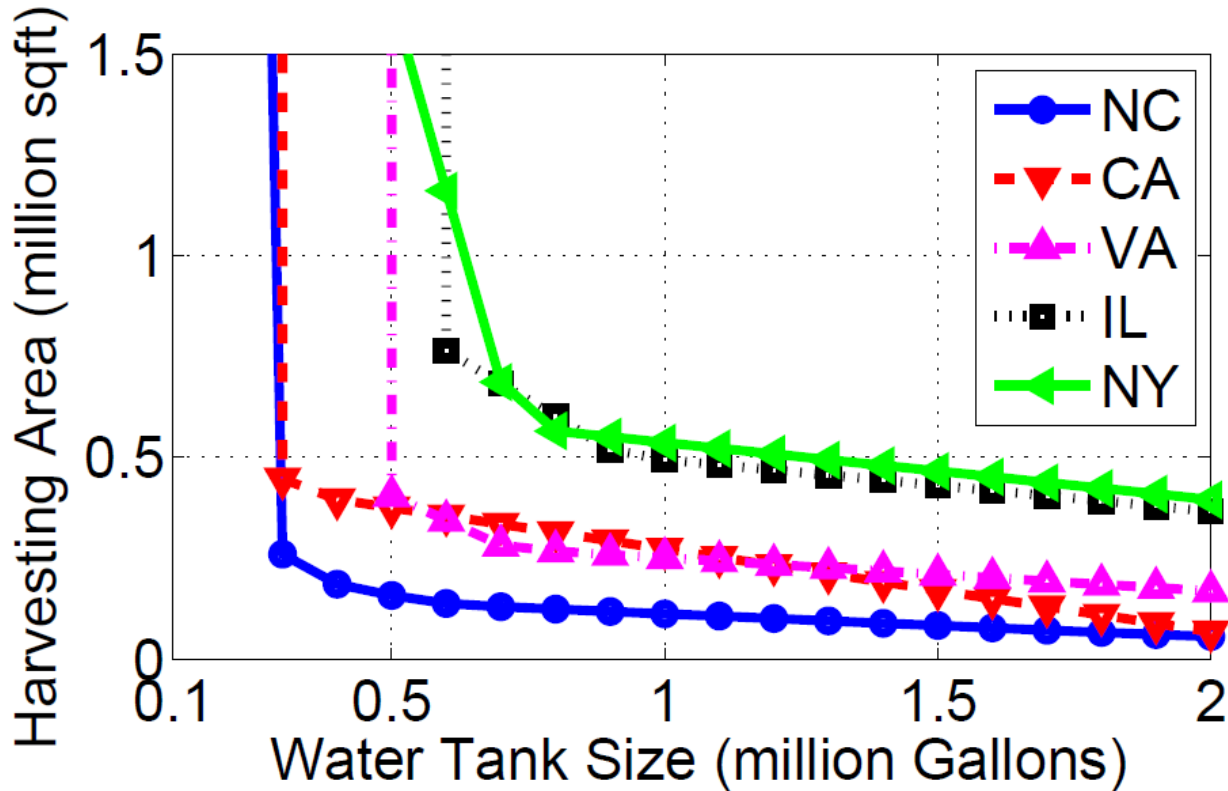
- Water efficiency and rainfall don't always match
 - Geographic load balancing could help mitigate this problem

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			Feasibility	Harvesting Area
	60% - 1 million gallons	0% - 1 million gallons	0% - 2 million gallons		
Prineville, OR	3,868,000	1,112,500	522,550	None	>500,000 sqft
Forest City, NC	111,600	15,000	"zero"	High	<100,000 sqft
Los Angeles, CA	272,400	8,500	"zero"	High	<100,000 sqft
Ashburn, VA	250,000	59,000	10,750	High	<100,000 sqft
Chicago, IL	494,000	136,000	29,150	High	<100,000 sqft
New York, NY	536,000	146,000	25,650	High	<100,000 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...

