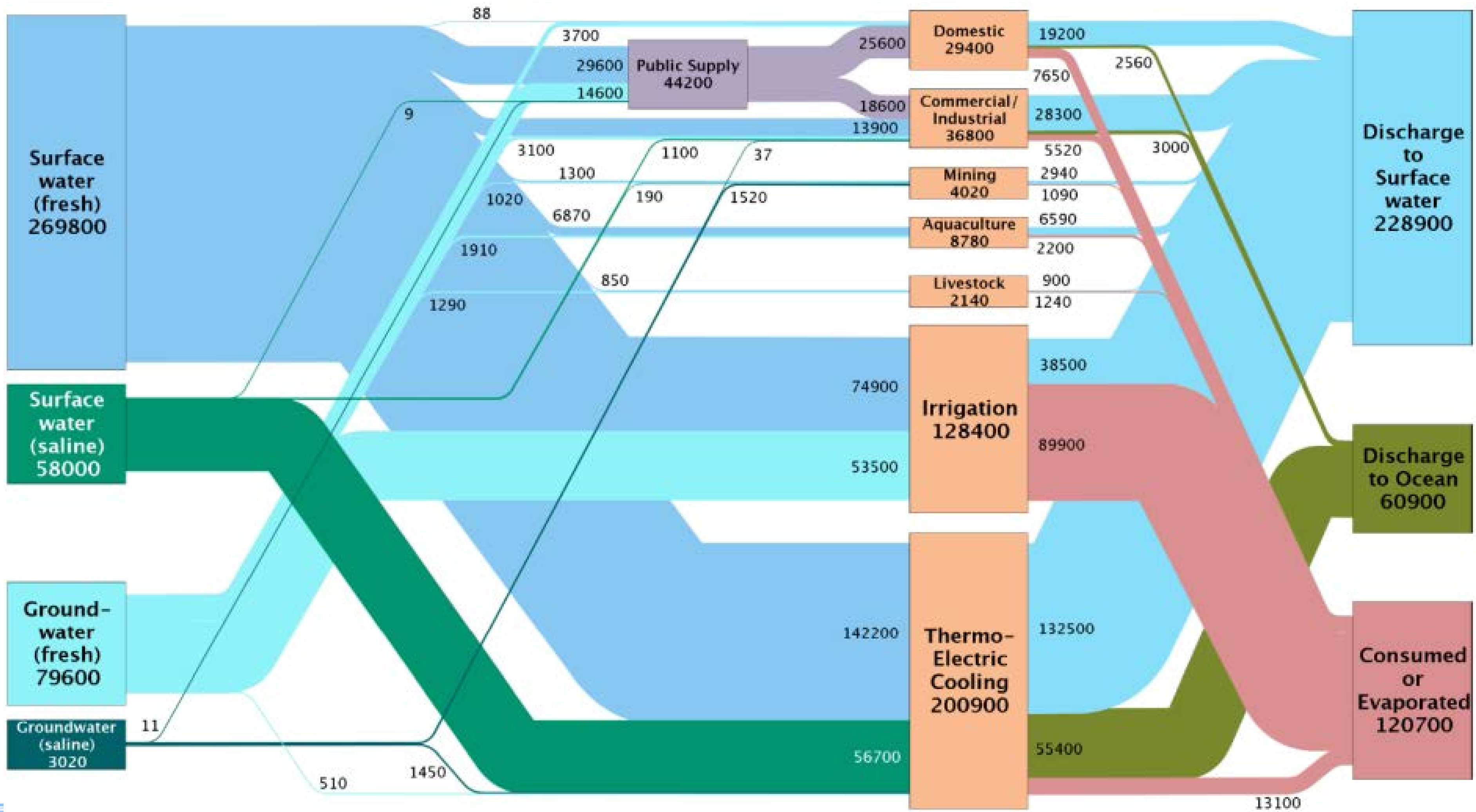
Low- or No-Water Power Plant Cooling

Nicholas Cizek

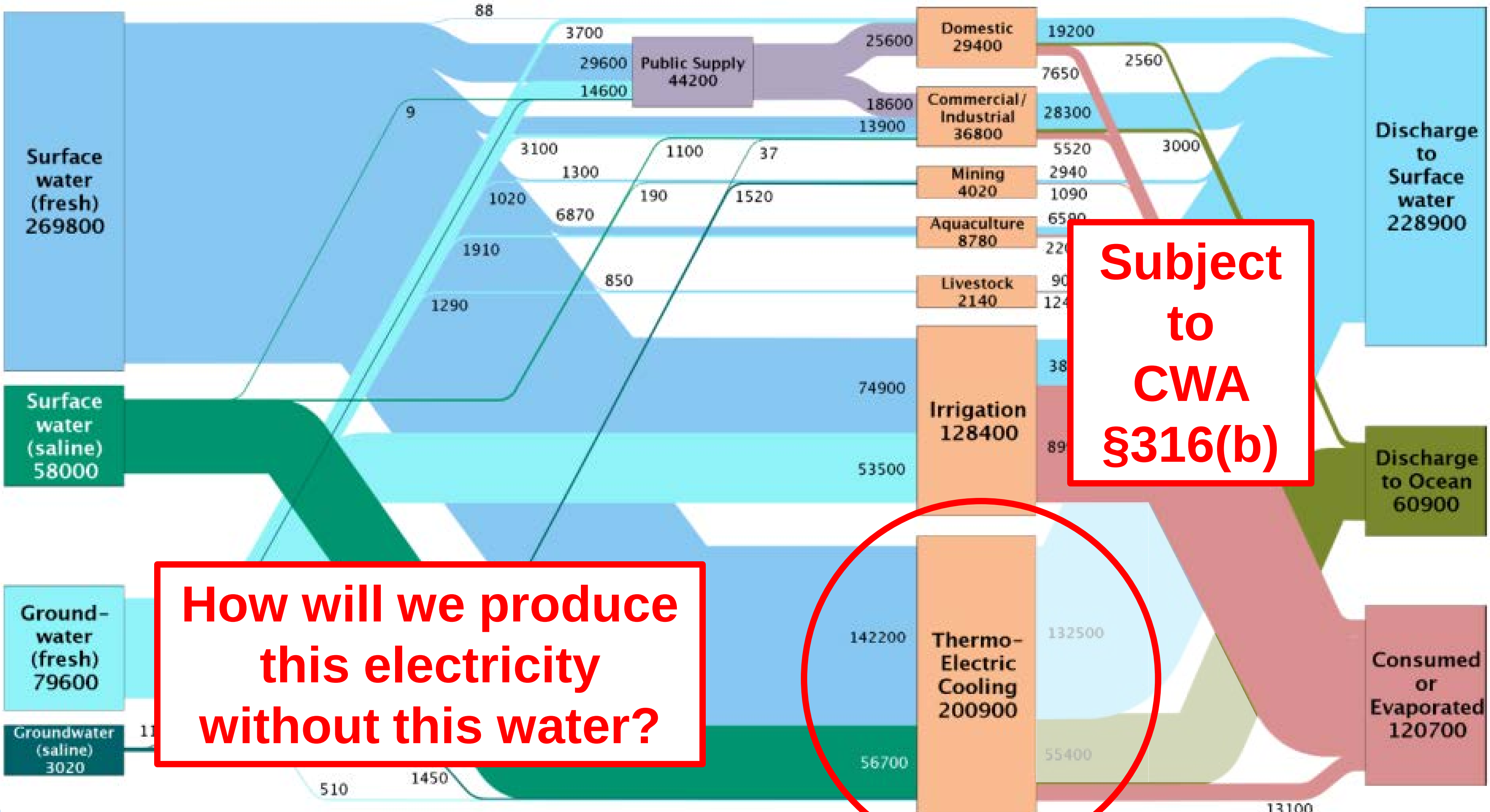
ARPA-E Fellow

Estimated US Water Flows 2005 (MGD), Total: 400 BGD



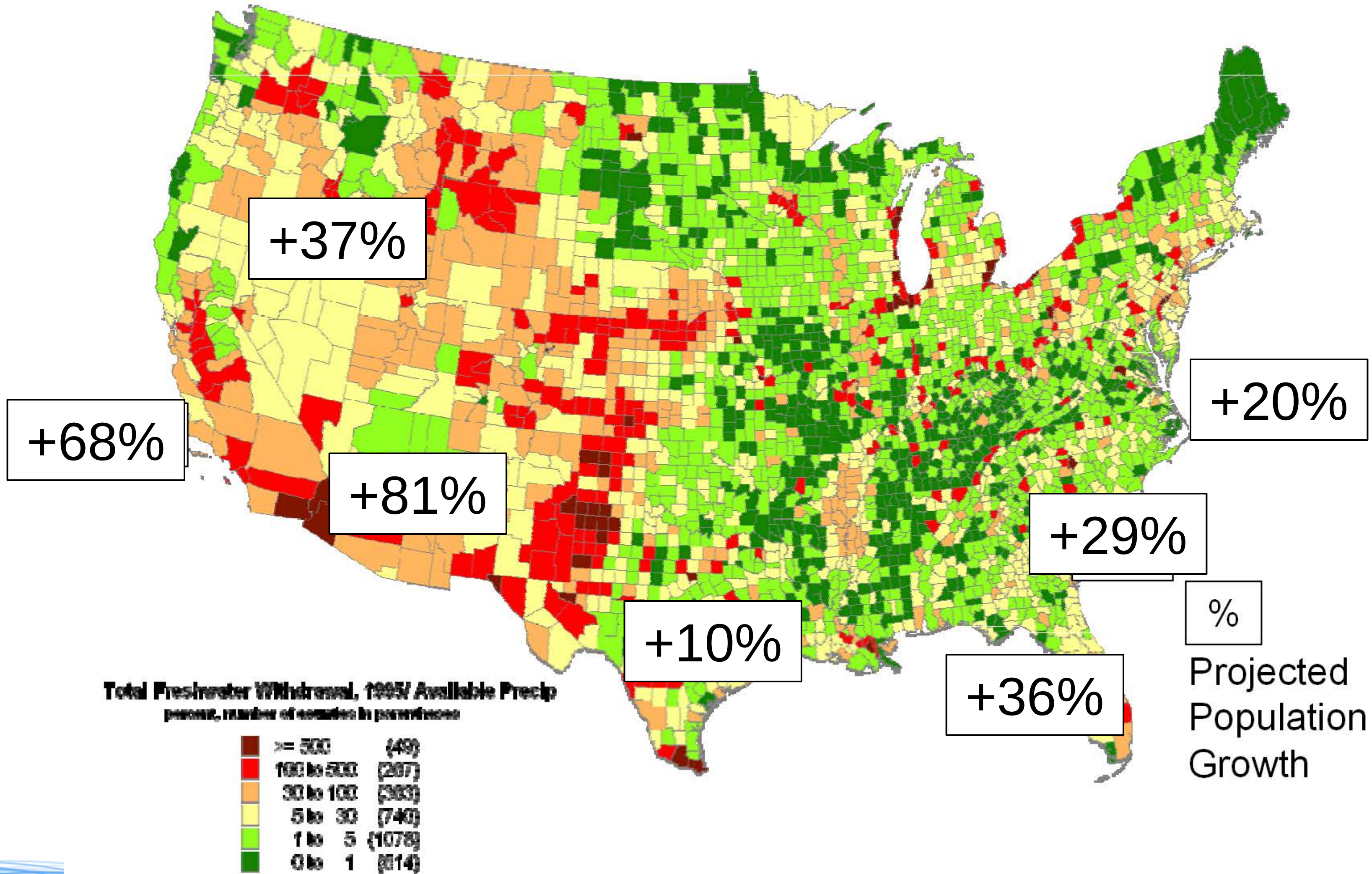
AJ Simons (LLNL and USDOE), 2010. Based on J Kenny (USGS), 2009

Estimated US Water Flows 2005 (MGD), Total: 400 BGD



AJ Simons (LLNL and USDOE), 2010. Based on J Kenny (USGS), 2009

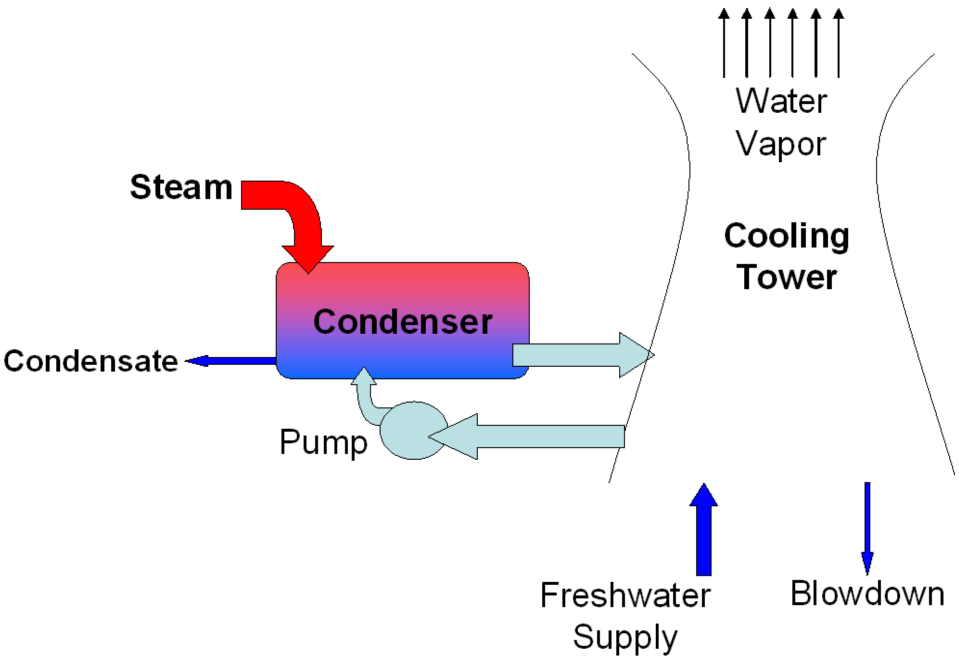
30% Population Increase by 2030, Mostly in DRY PLACES



Solley (USGS), 1998; EPRI, 2003; Campbell (US DOC), 1997

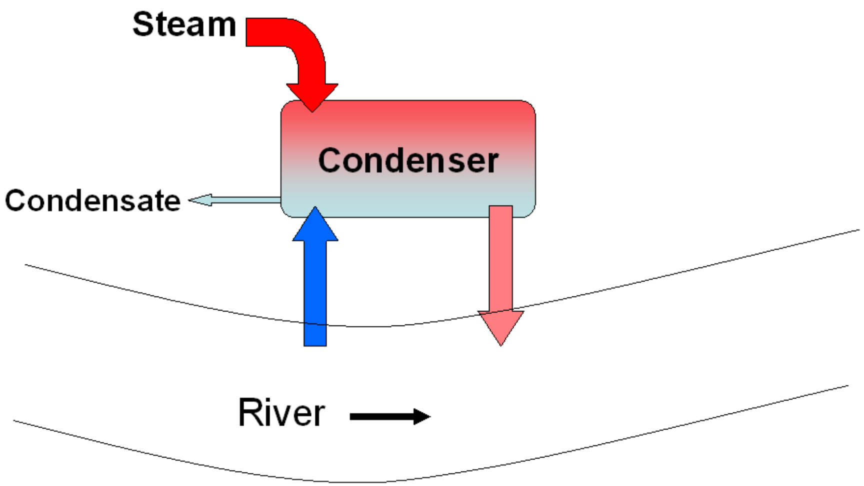
Traditional Power Plant Cooling

“Closed Loop” Cooling



Q Evaporates H_2O

“Open Loop” Cooling



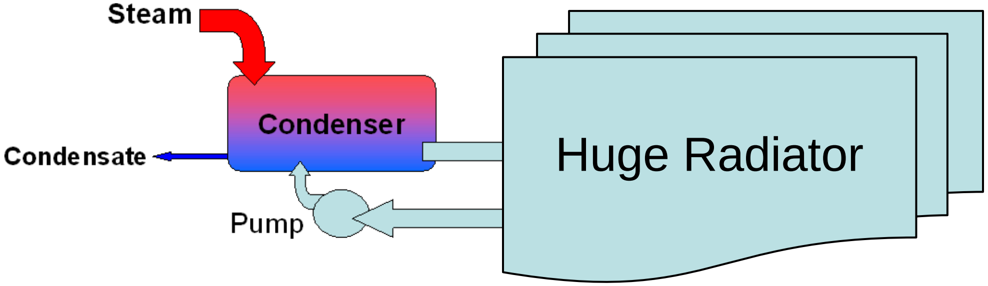
Q Raises River Temp

- Raises Air Temp
- Evaporates H_2O

Problem Statement

Dissipate GW-scale low-grade heat (95 F) into air without evaporating water

Air Cooled Power Plant



Q Raises Air Temp Only

But $T_c = T_{air,day}$ instead of $T_{water} = T_{air,ave}$

~10% Less Electricity

Are there dry-cooling tech pathways to achieve

$T_c = T_{air,ave}$, not $T_c = T_{air,day}$

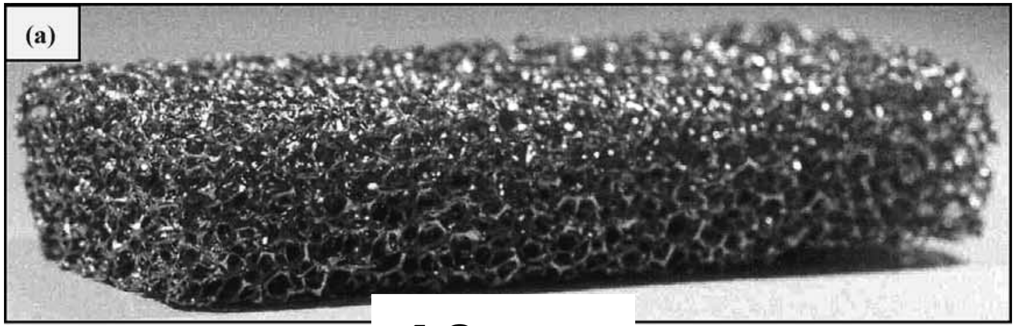
to avoid ~10% efficiency loss?

Thermal Battery (low vapor pressure)

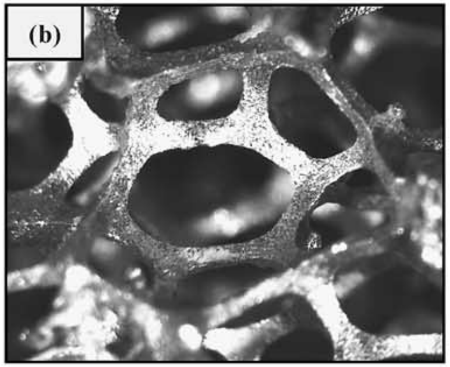
- Earth
- Liquid besides water

Dry Cooling Tech Paths To Wet Cooling LCOE

Increase Surface Area – thermally conducting polymer, metal foam



10 cm

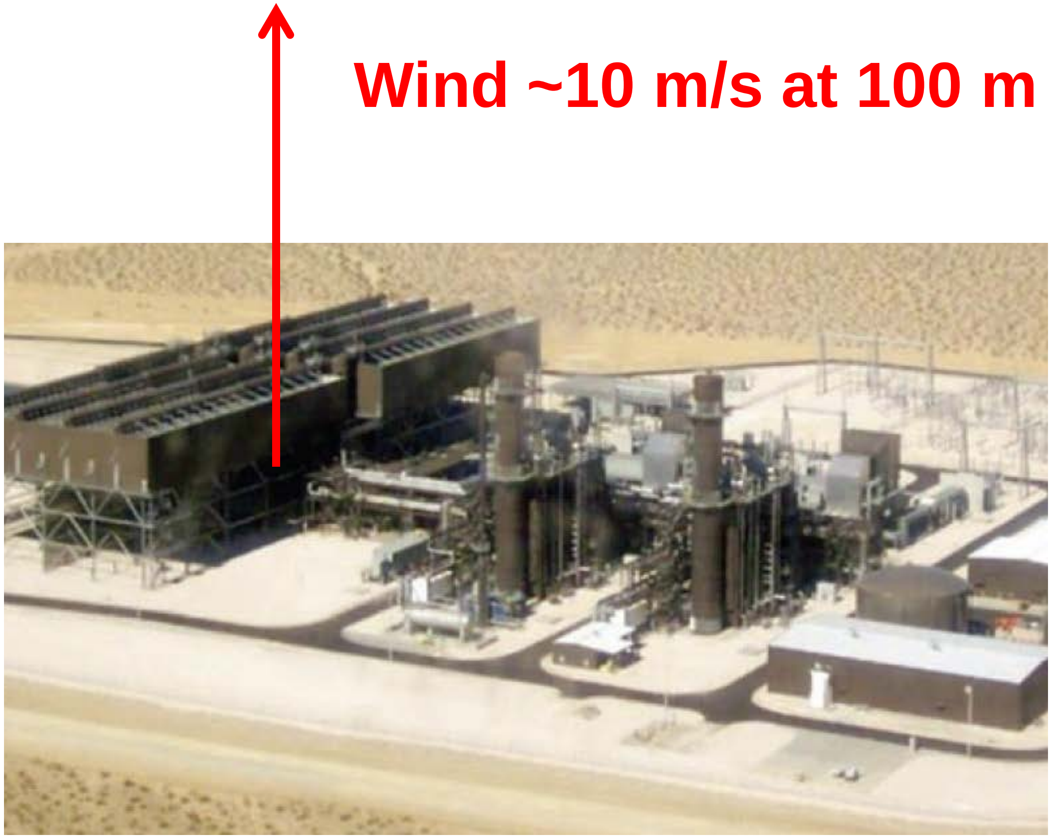


7 mm

Boomsma, *et al*, Mechanics of Materials, 2003

Dry Cooling Tech Paths To Wet Cooling LCOE

Increase Air Speed – elevate condenser



Dry Cooling Tech Paths To Wet Cooling LCOE

Increase Heat Transfer Coefficient – coatings, nanostructures

Non-Rankine bottoming cycle – parallel Stirling

Techno-Economic Goal

Dry Cooled Power Plant LCOE

< 5¢/kWh

Low-/No-Water Power Plant Cooling Name

I MPROVING

C OOLING

E FFICIENCY of

PO WER

P LANTS