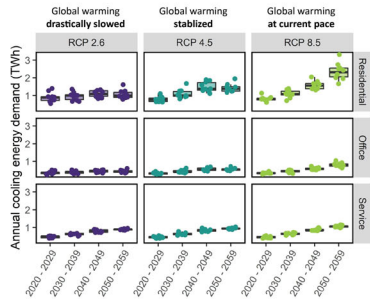


Gautier Rouaze, Zhengmao Lu
Energy Transport Advances Laboratory (ETA-Lab), EPFL, Lausanne

Motivations

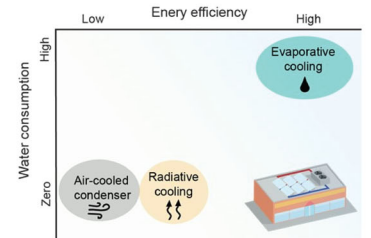
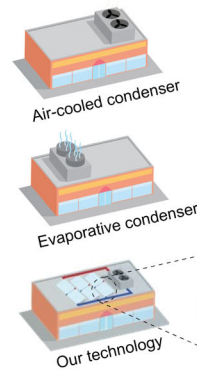
Cooling trends in Switzerland



Mutschler et al. 2021

- Air conditioning technology uptake will significantly contribute to future cooling demands
- Need to "limit cooling energy demand impacts on the future energy systems particularly in countries with temperate climates"

State of the Art / Opportunity space



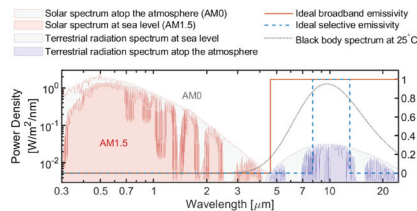
- Existing condensers for AC systems are either inefficient or use too much water
- Our technology: combining passive radiative cooling and passive evaporative cooling

Passive Radiative Cooling



Ying et al., 2020

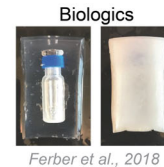
Challenges: Max. cooling power (<120 W/m²), parasitic heating, RH



Passive Evaporative Cooling



Kindangen et al., 2016



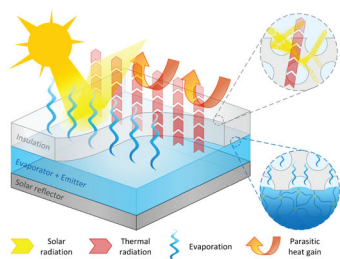
Ferber et al., 2018



MIT D-Lab, 2018

Challenges: Water consumption, environmental heating, RH

Previous work: Insulated Cooling with Evaporation and Radiation (ICER)

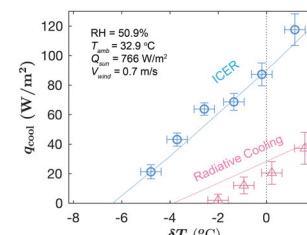
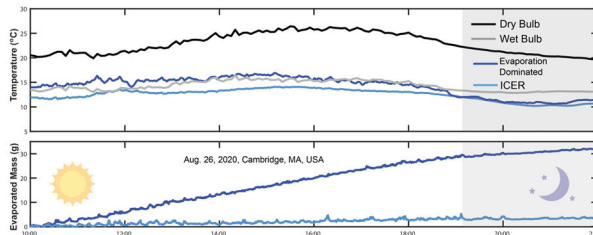
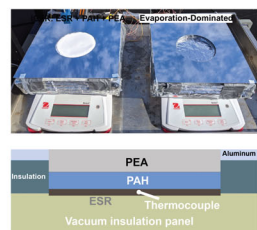
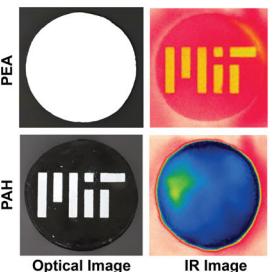


Insulation layer (top)
Low thermal conductance, high vapor permeance
High solar reflectance, high IR-transmittance

Evaporation layer (middle)
High water capacity, high IR-emittance

Solar reflection layer (bottom)
High solar reflectance (3M ESR film)

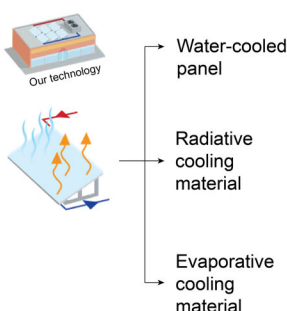
Layer	Material	Visible spectrum	IR spectrum
Insulation	Polyethylene aerogel (PEA)	Opaque	Transparent
Evaporation	Polyacrylamide hydrogel (PAH)	Transparent	Opaque



- -10°C below ambient temperature
- 300% enhancement in daytime cooling power over radiative cooling
- High cooling power despite high air density and high RH

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Ongoing work: Cold Water Generation with Evaporative Radiative Cooling Panels



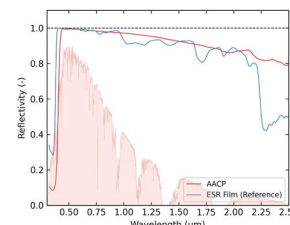
Suggested radiative cooling material

- Anti-aging cooling paint (AACP)
 - High solar reflectivity (TiO₂ Nanoparticles light scattering)
 - High emittance in the LWIR
 - Reduced NIR absorbance
 - Increased UV resistance
 - Hydrophobic coating (anti fouling)

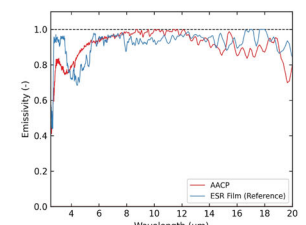


Song et al. 2022

High Solar Reflectance



High Mid-IR Emittance



Material synthesized at ETA-Lab