

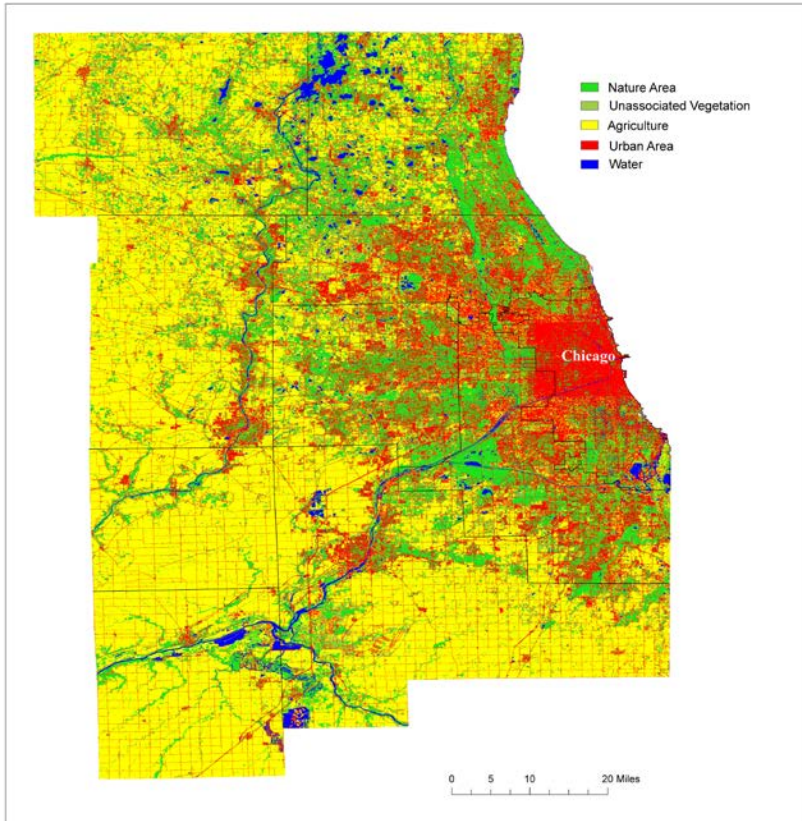
Green roofs: An energy-water nexus perspective

Reshmina William

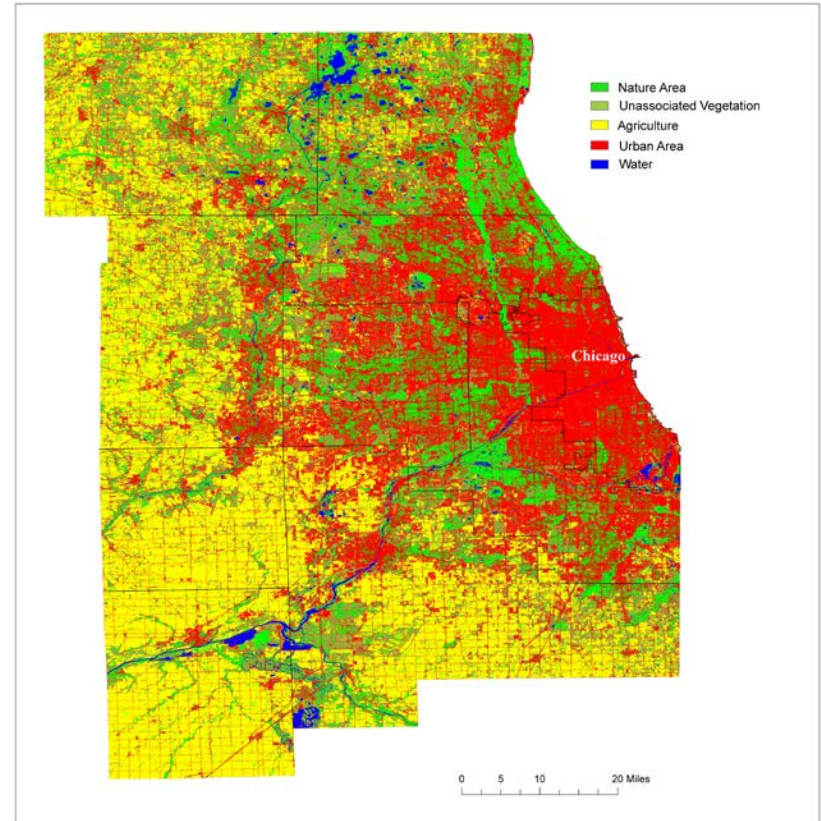
Illinois Water 2016 | UIUC | 10/27/16

Green infrastructure is a technological solution to some of the challenges introduced by urbanization.

Land-Cover 1972



Land-Cover 1997



Energy and water are interconnected.



The role of green infrastructure in the energy-water nexus has yet not been fully explored.

- How does GI impact...

 - Water for energy*

 - Does irrigation impact green roof temperature control?

 - Energy for water*

 - Does runoff control impact WWTP energy requirements?



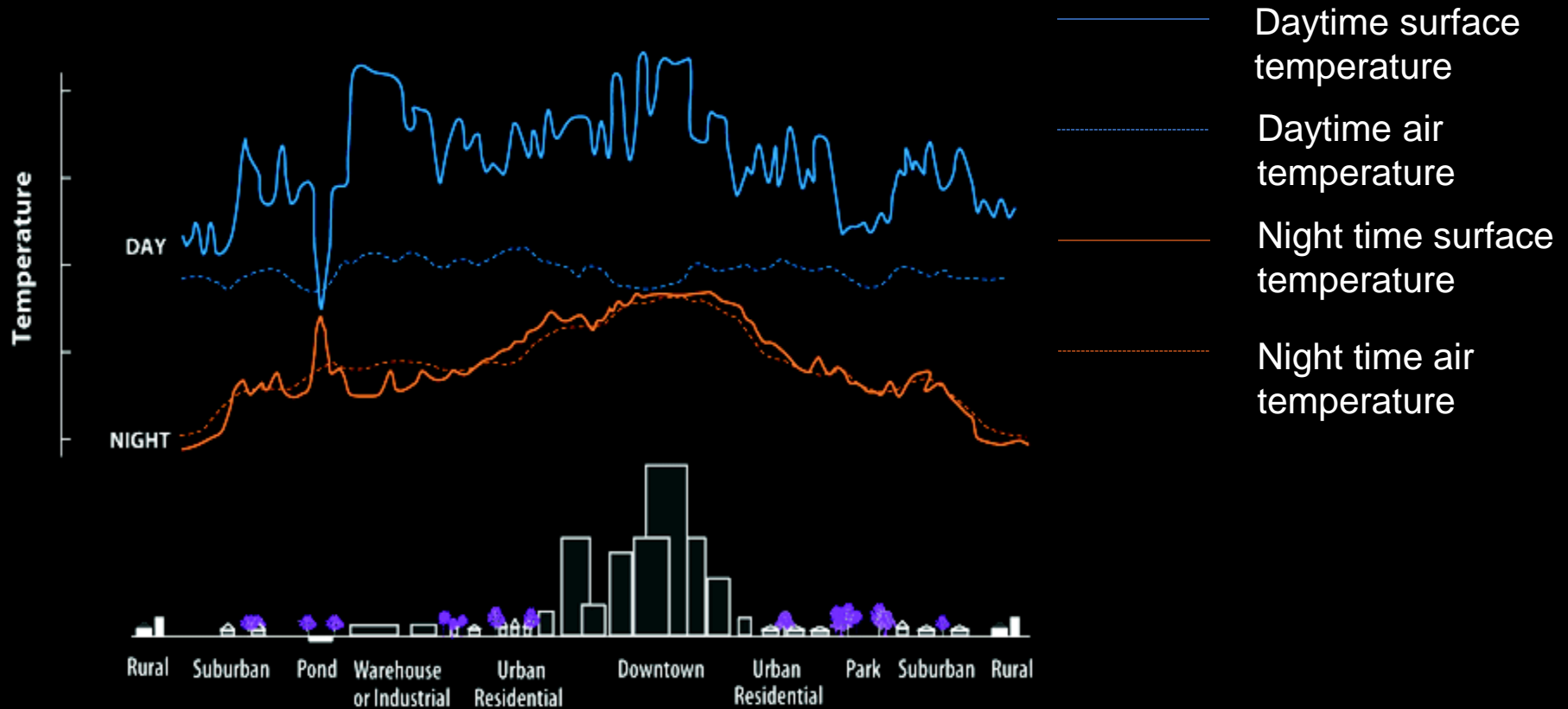
The BIF green roof was used as a case study site.



- Installed in 2008
- ~300 m²
- Modular extensive (0.2 m)
- 9 different plant species
- Monitored for runoff, WQ, climate variables

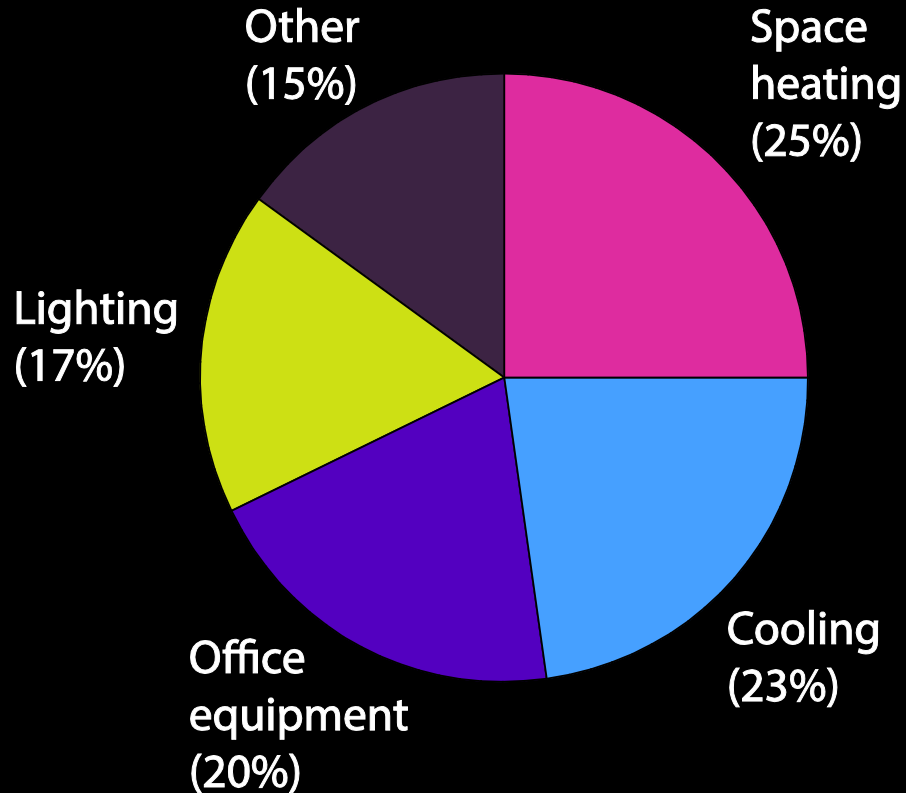


Green roofs have been proven to help mitigate the Urban Heat Island effect.

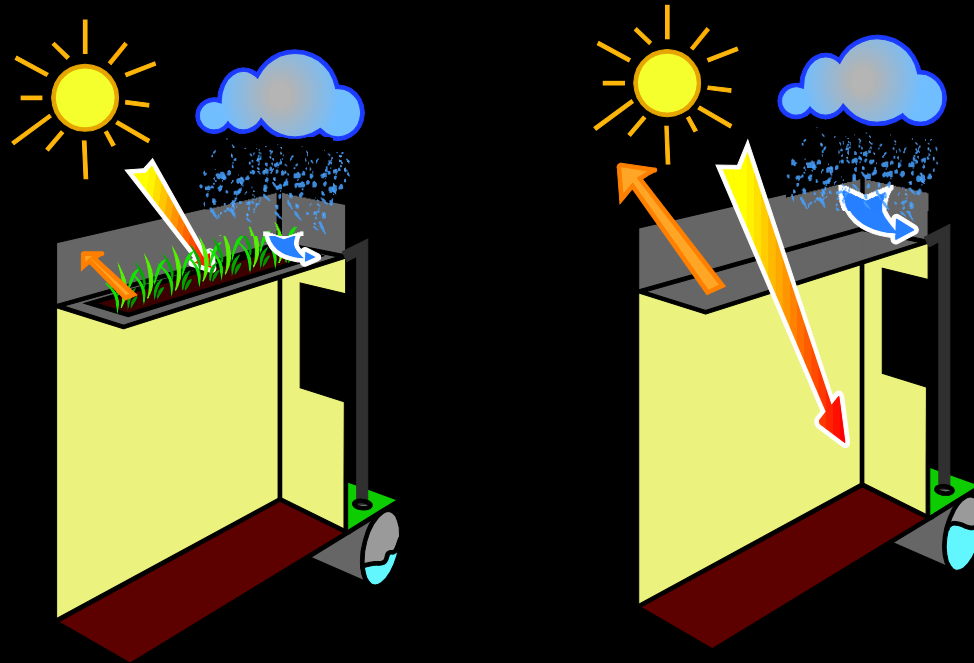


Alternative roofing strategies can help decrease building internal cooling costs.

Average office consumption of electricity across US



Green roofs control temperature through evaporative cooling.



Green Roof

Traditional Roof

What impact does **irrigation** have on temperature control during droughts?

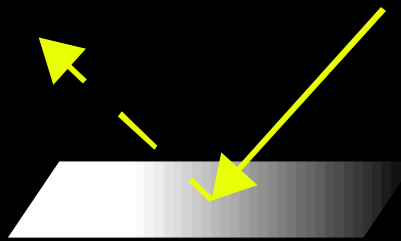
Heat fluxes from the roof were modeled using ML-Can for summer 2012.

- Canopy – root – soil model
- Couples eco-physiological processes, physical processes and below-ground states
- Outputs include
 - Latent heat fluxes
 - Sensible heat fluxes
 - Carbon uptake

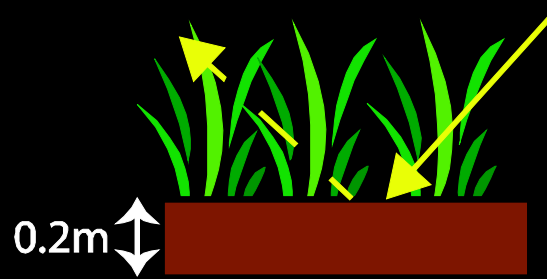


Different roofing scenarios were modeled.

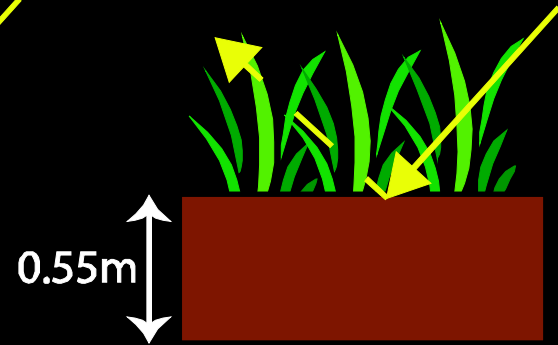
a) Black roof
albedo = 0.05



b) Green roof 1:
Extensive
Prairie Junegrass

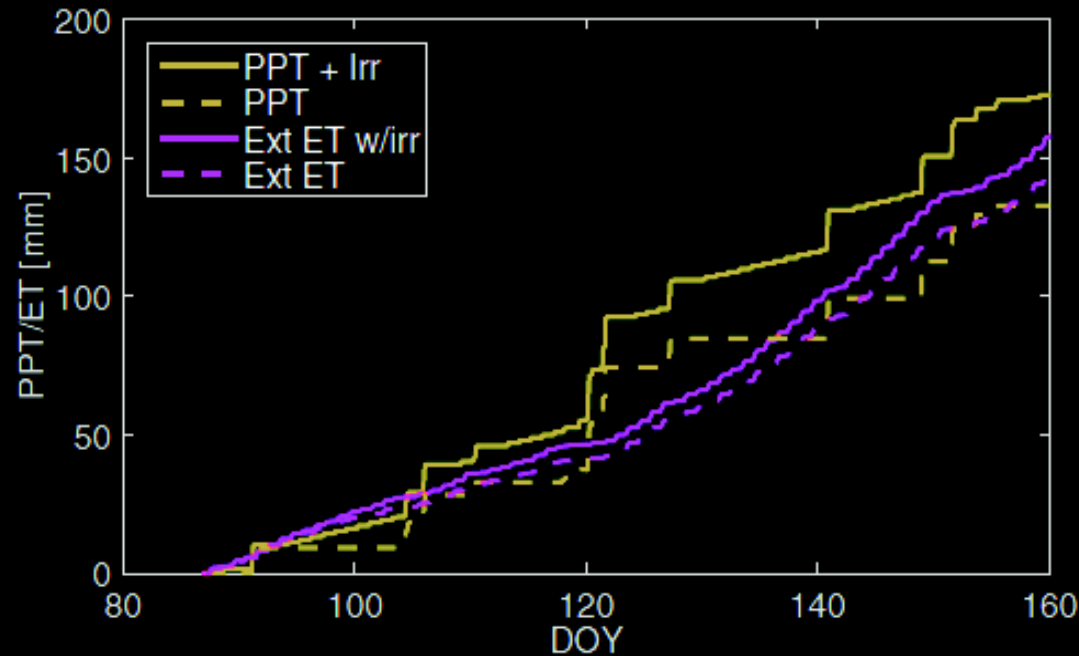


c) Green roof 2:
Intensive
Prairie Junegrass



- No irrigation
- With irrigation:
 - If previous 48h dry, add 1mm irrigation from 6AM - 6:30AM

Irrigation impacts the partitioning of heat fluxes.



- Increased carbon uptake
- Increased latent heat
- Reduced sensible heat
- Partitioning changes throughout day and season



The impacts of irrigation on surface temperatures are minimal.

- Irrigation does not have a large impact on green roof surface temperatures
 - However, the addition of irrigation does cause slight decreases in soil temperature
 - Biggest difference is caused by differences in soil depth, rather than soil moisture



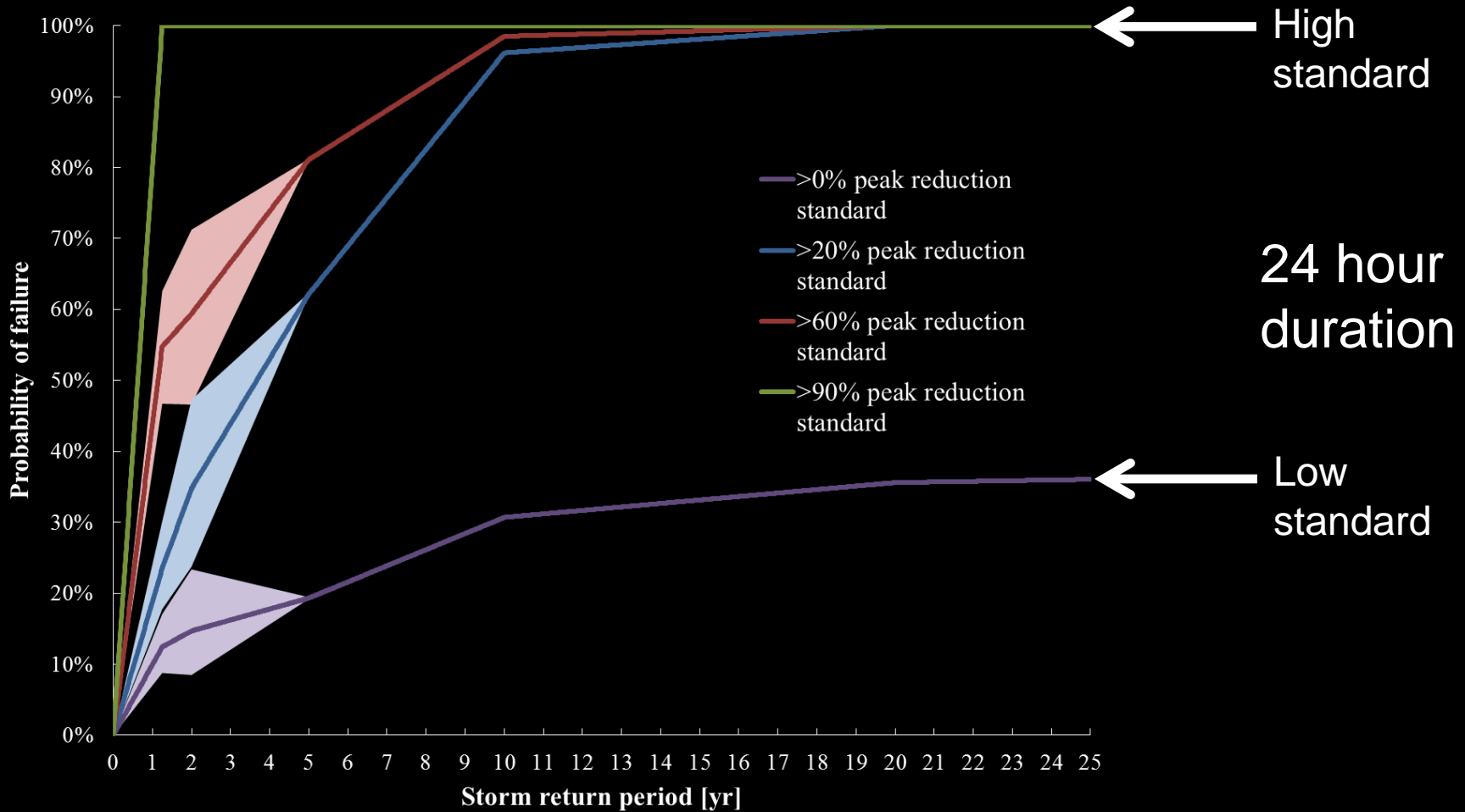
Does irrigation impact green roof temperature control?

- Water is required to irrigate green roofs during times of drought
- The addition of irrigation does impact heat fluxes and plant growth
- However, the impacts of irrigation on surface temperatures are negligible

How do green roofs impact energy for water?



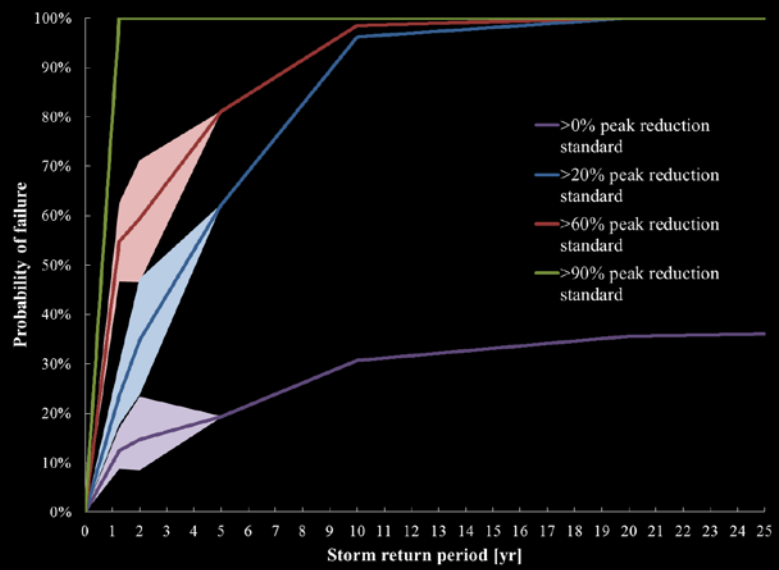
Fragility curves can be used to assess green roof performance variability.



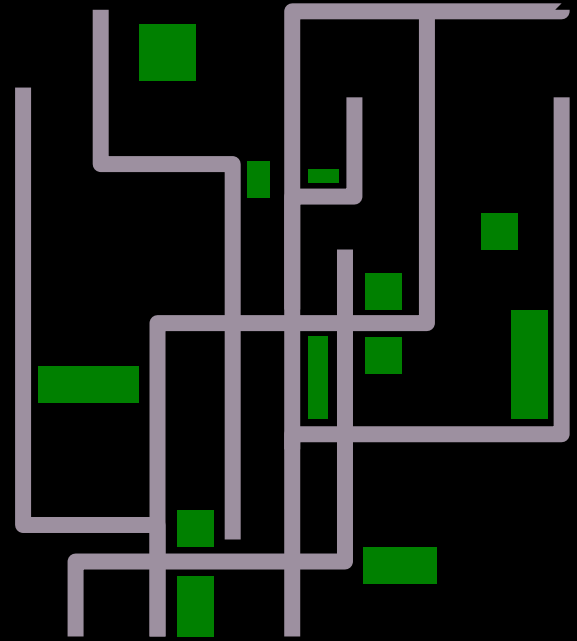
[William and Stillwell, IN REVIEW]

Green infrastructure performance is tied to the amount of water entering a combined sewershed.

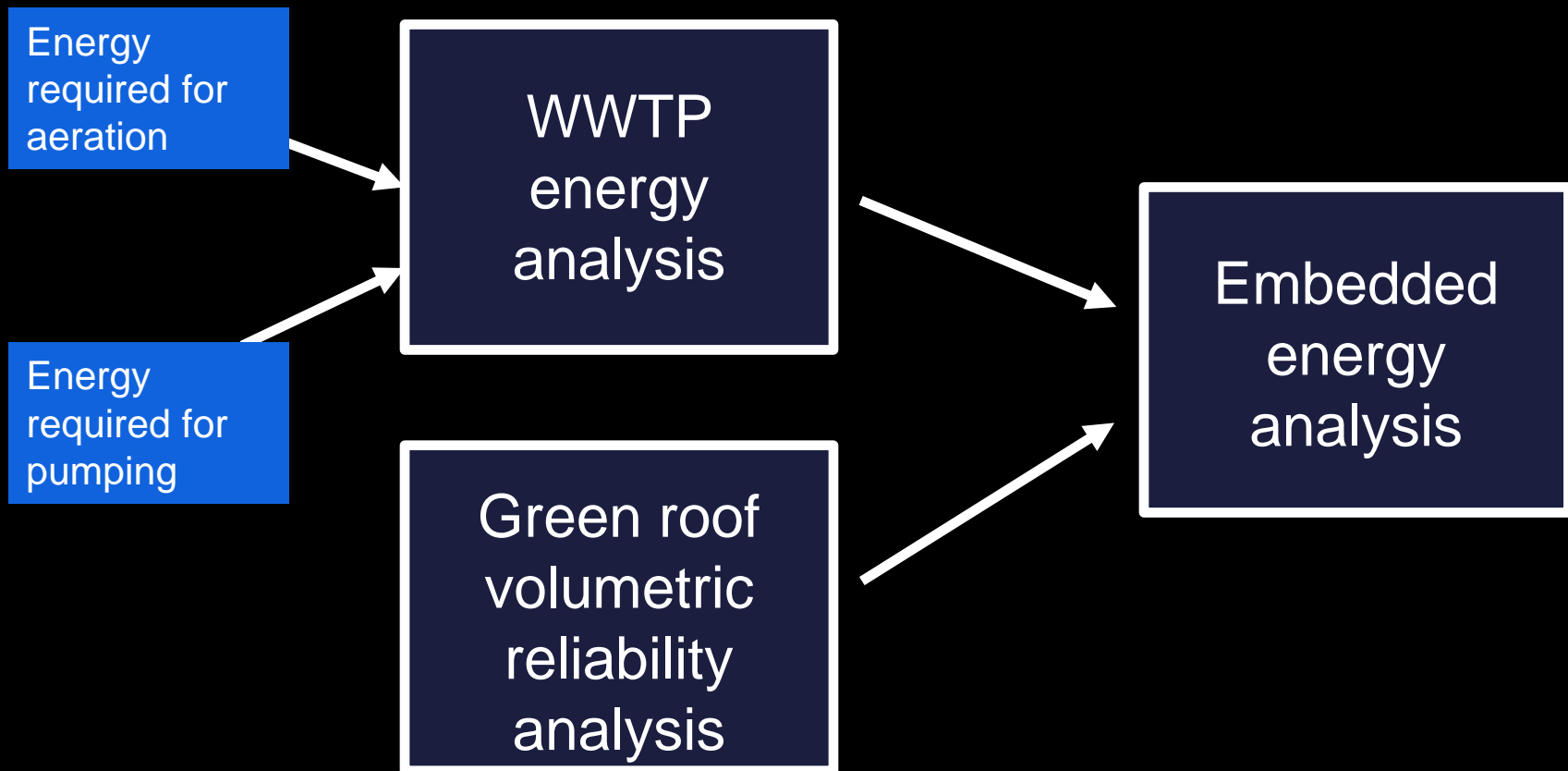
Probabilistic performance



Combined Sewershed



Energy is used in two main capacities in wastewater treatment.



Conclusions

- The role of green infrastructure within the urban energy-water nexus remains unexplored
- Irrigation does have some impact on green roof temperature performance.
- Energy use at wastewater facilities might be impacted by GI stormwater runoff retention
- The energy-water nexus provides an alternative framework for gaging green infrastructure sustainability



QUESTIONS?



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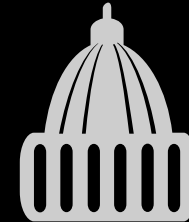
Stillwell Research Group



water



energy



policy

