Energy infrastructure design for low carbon, reliability and resiliency

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International District Energy Association
Annual Conference
June 25, 2019

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Global Presence
Local Solutions

45 Years of Experience in Sustainable District Energy Systems

Agenda

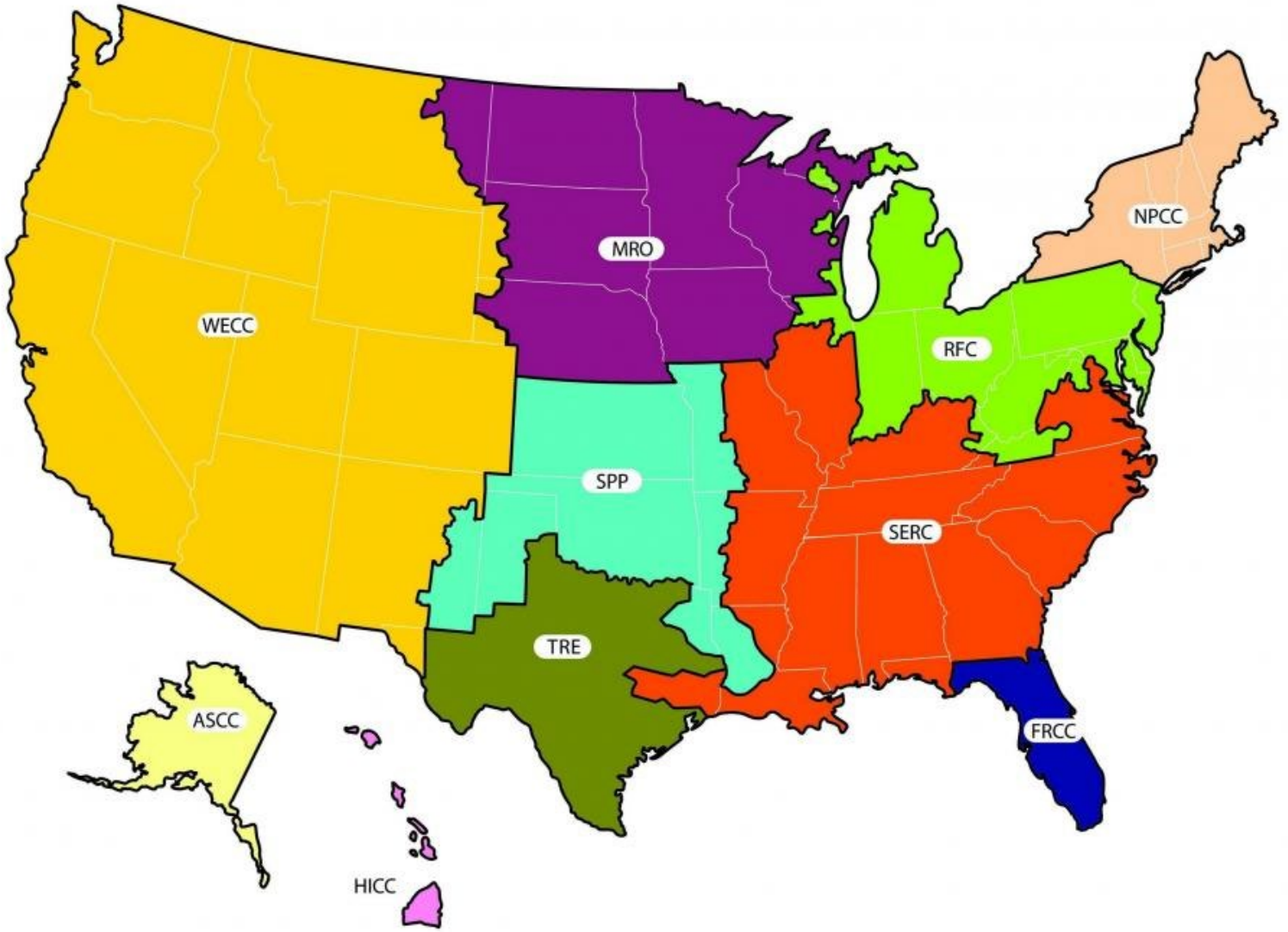
- Prioritizing goals
- Electrification!
  - Current power grids
  - Implications for heat pump approaches
  - Grid decarbonization
- Heat pump system design
- Solar energy
- Bioenergy
- Uncertainty and the importance of flexibility
- Role of district energy

Prioritizing goals

- Reliability
- Resiliency
- Environmental impacts
- Costs
- Flexibility
- Stakeholders

Current power grids

USEPA eGRID regions



This is a representational map; many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.
September 2015

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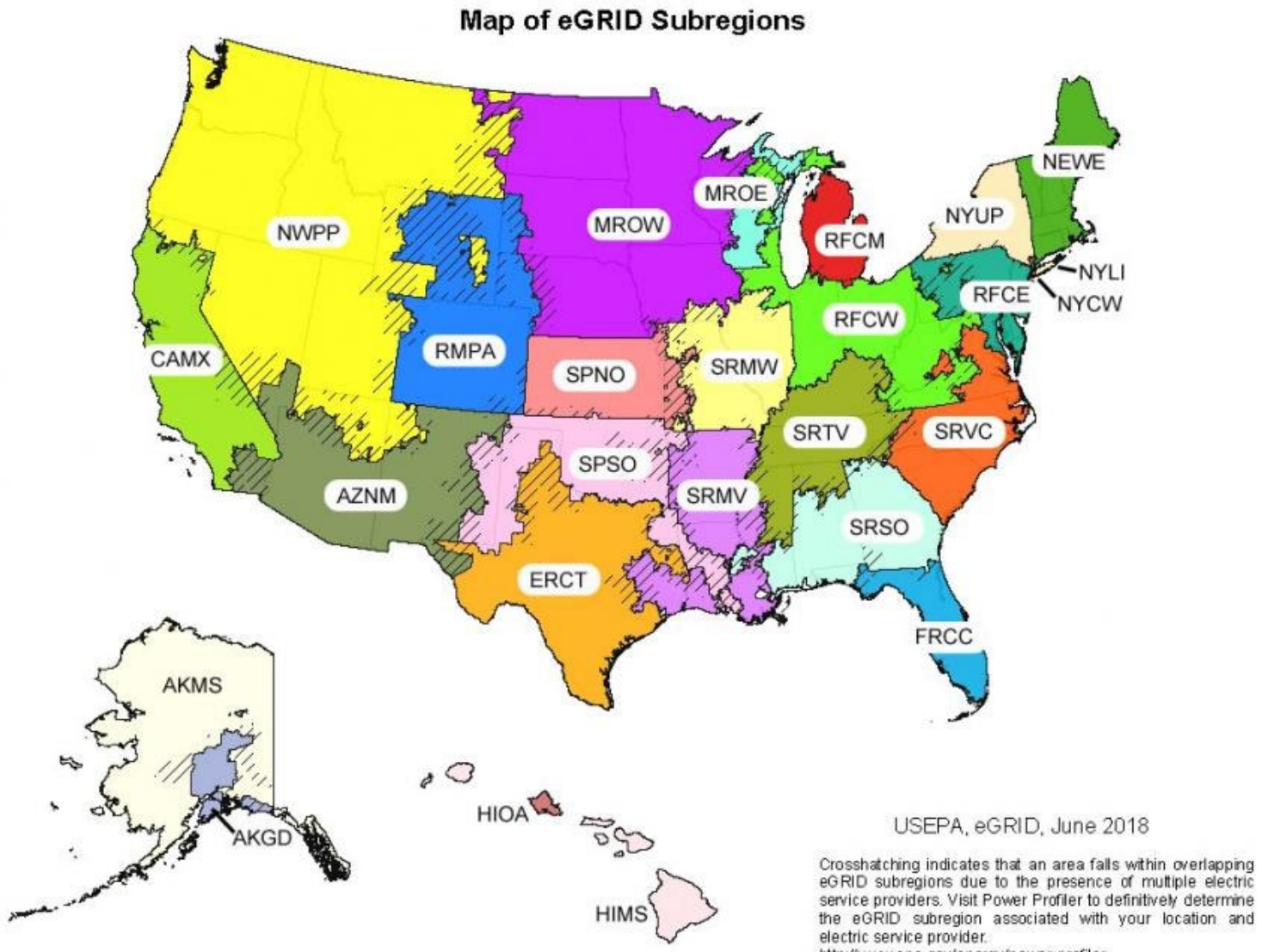
Current power grids

USEPA eGRID sub-regions



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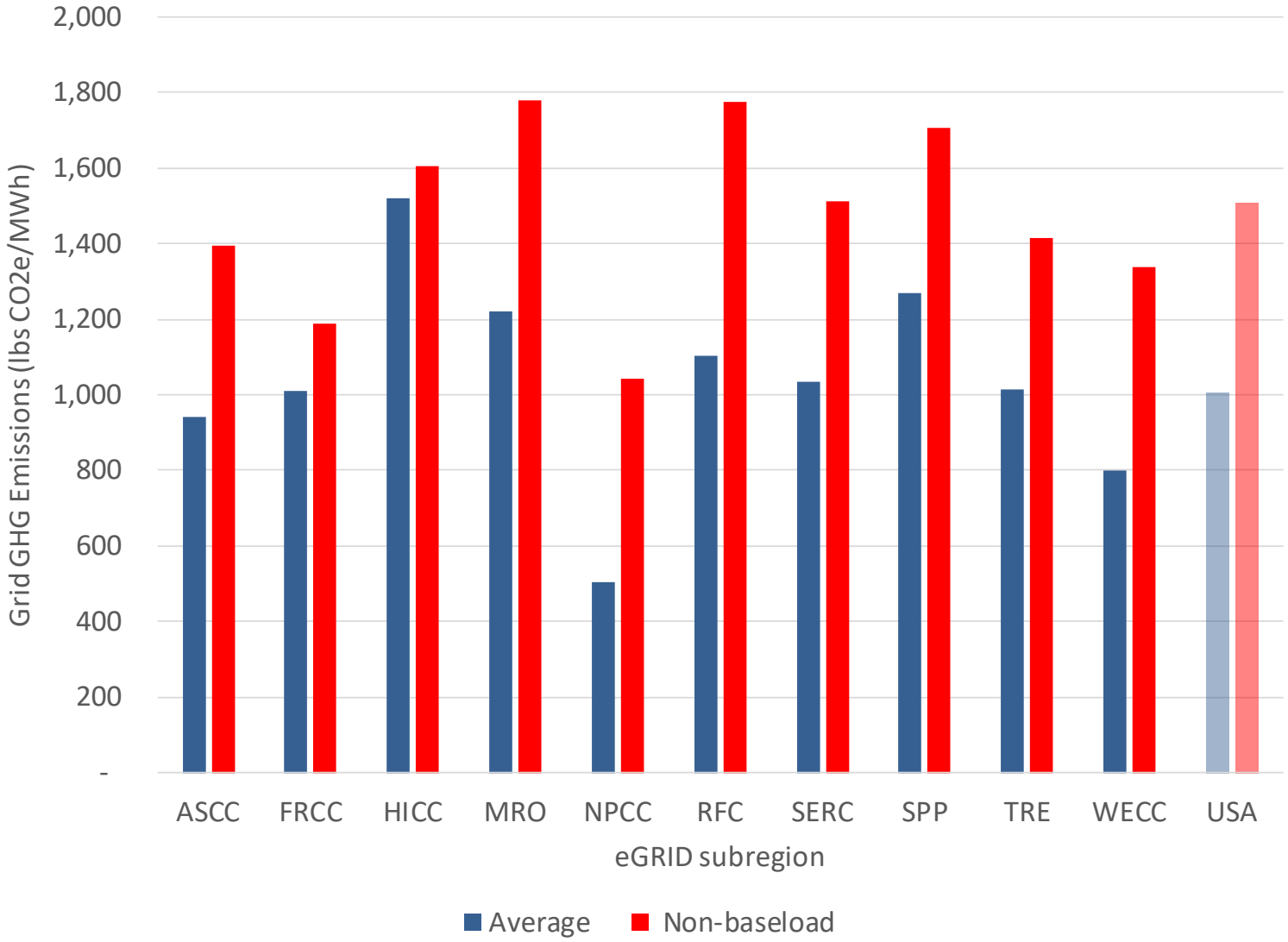
Current power grids

Grid GHG emissions



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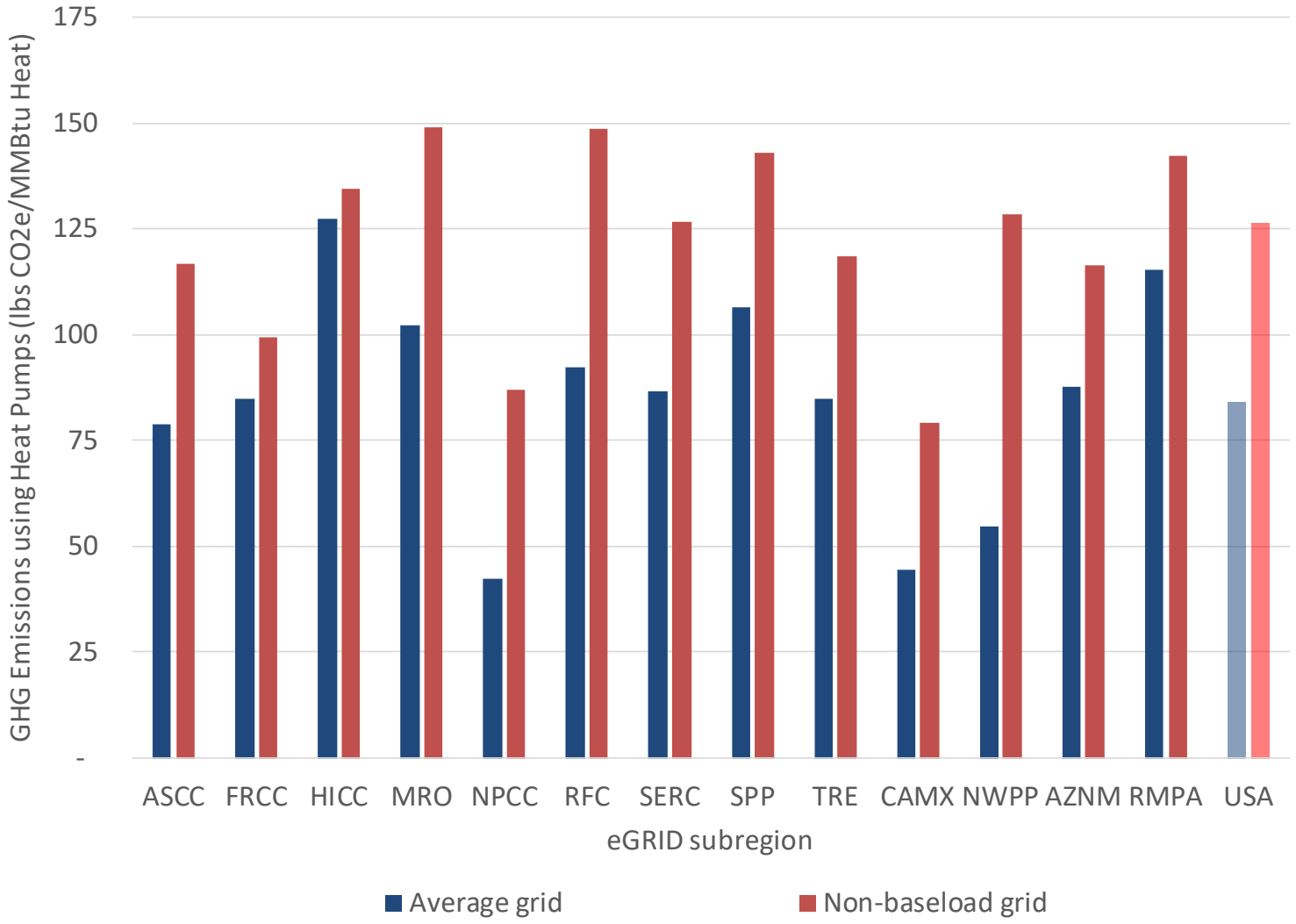
Implications for heat pump approaches

GHG emissions using heat pumps at COP 3.5



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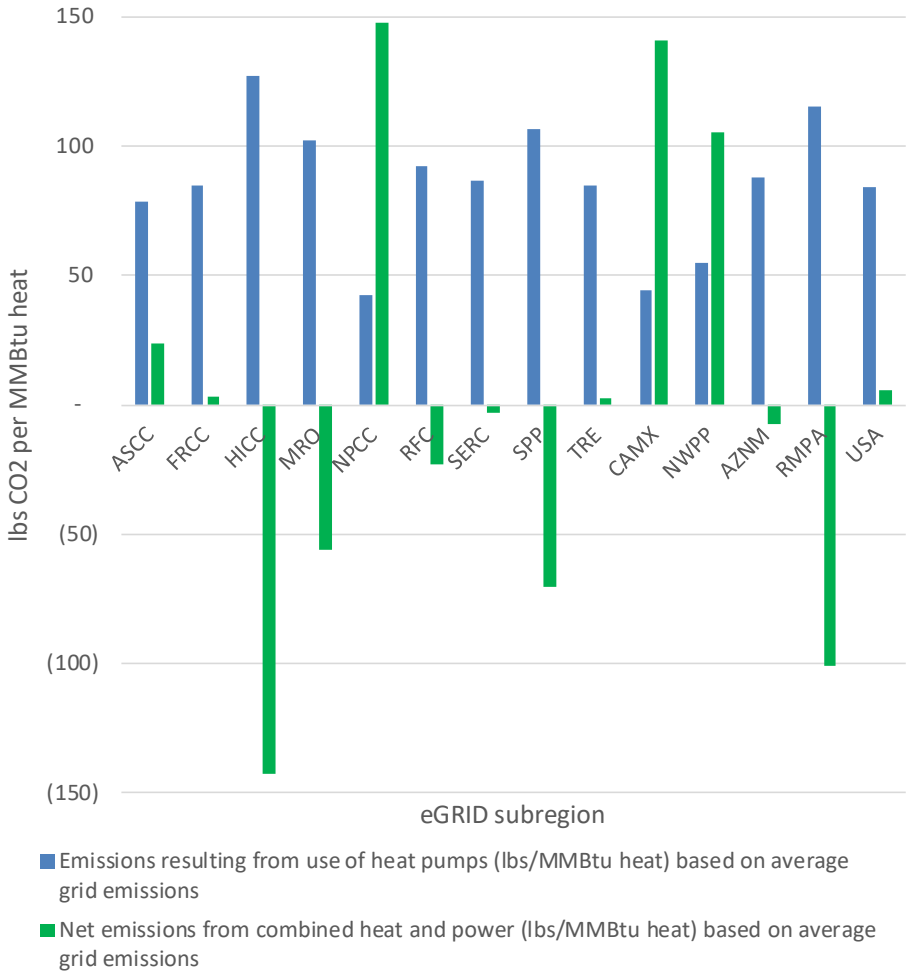
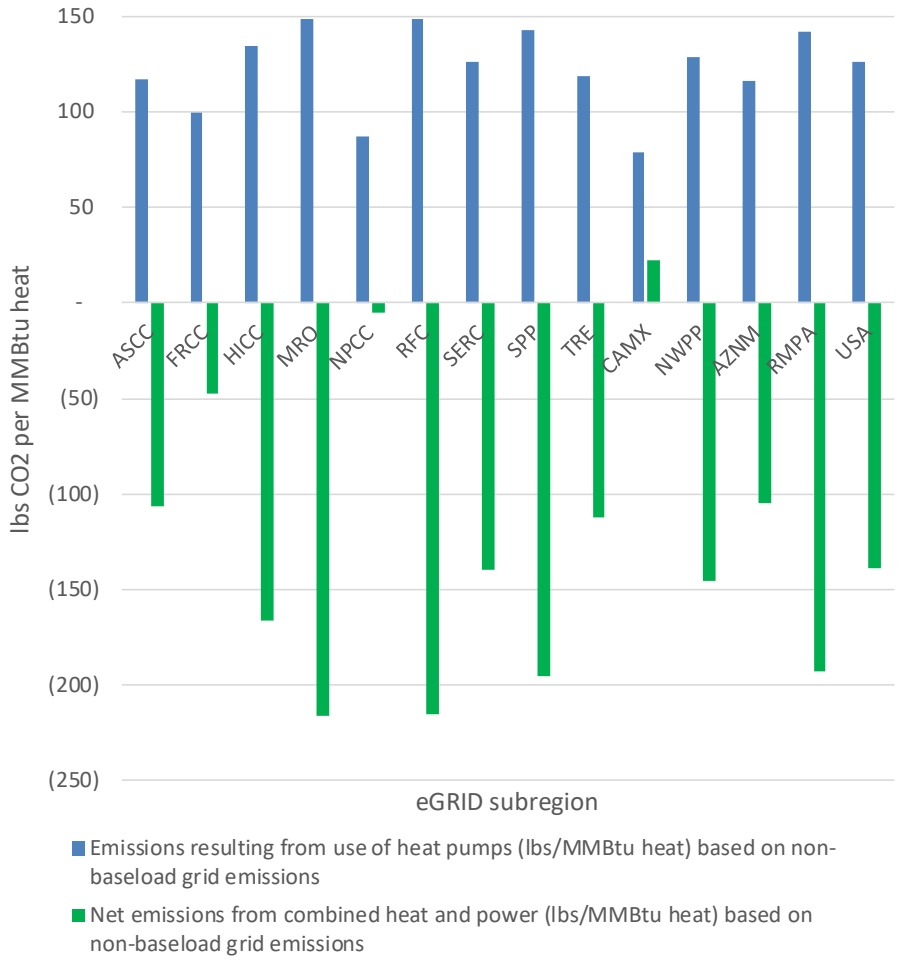
Implications for heat pump approaches

Comparing heat pumps to CHP

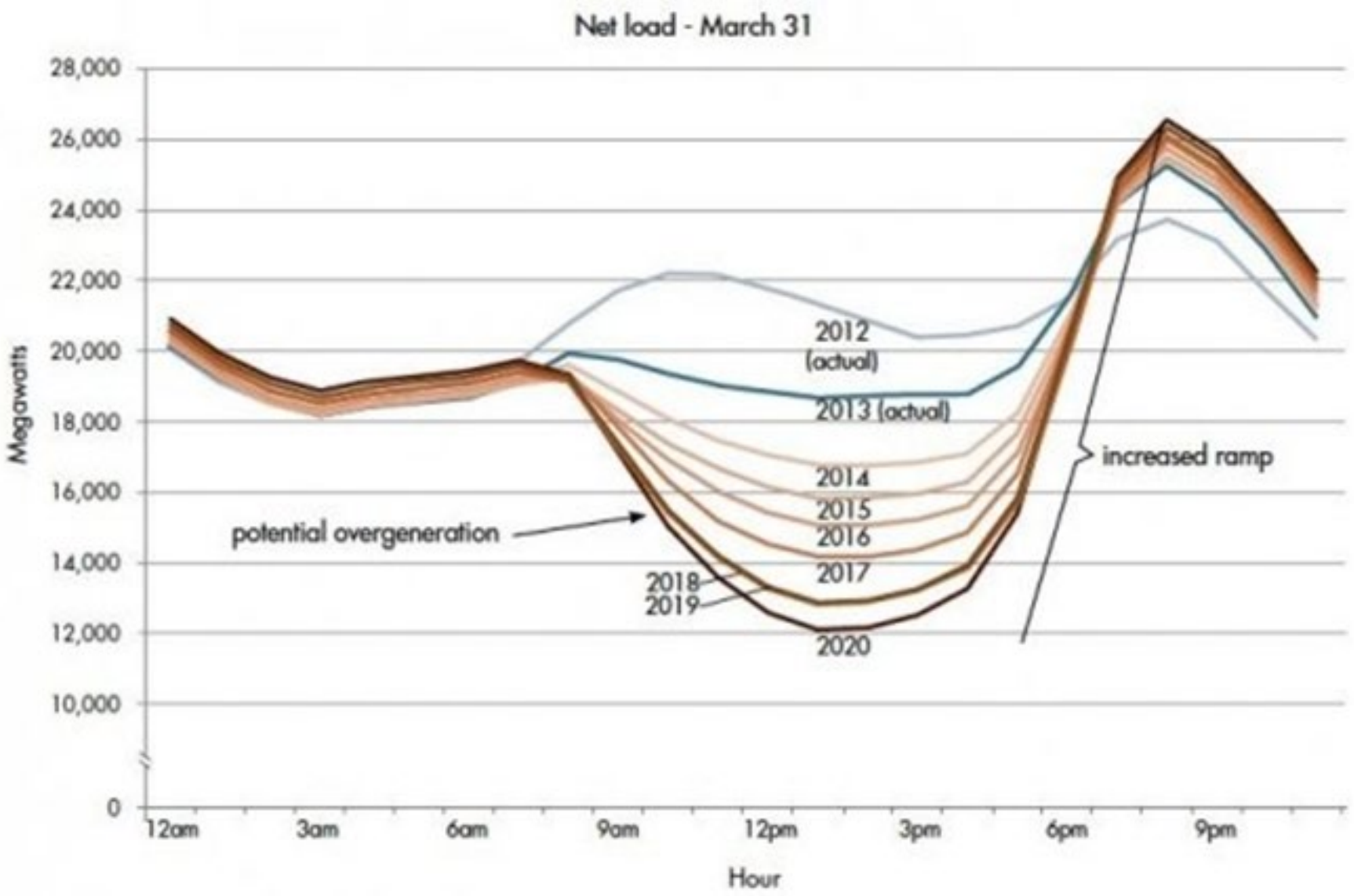
Assuming average grid emissions



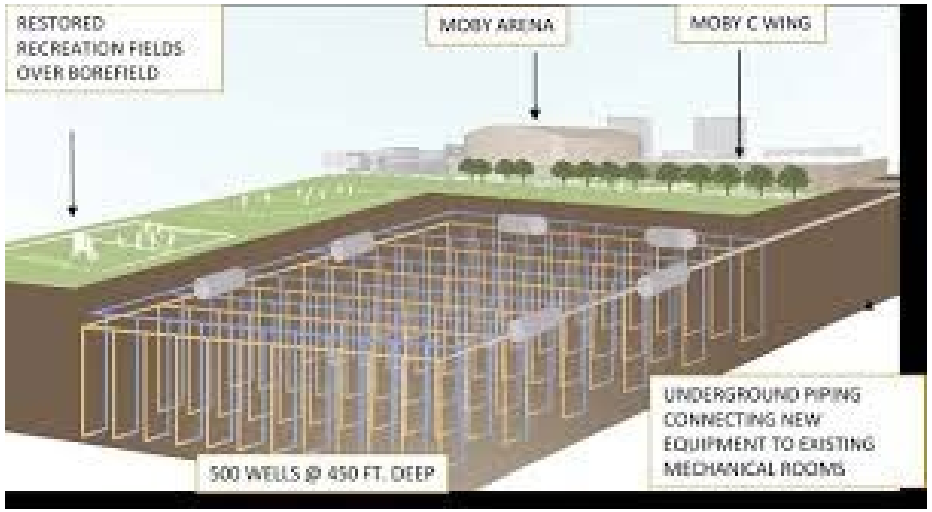
Assuming non-baseload emissions

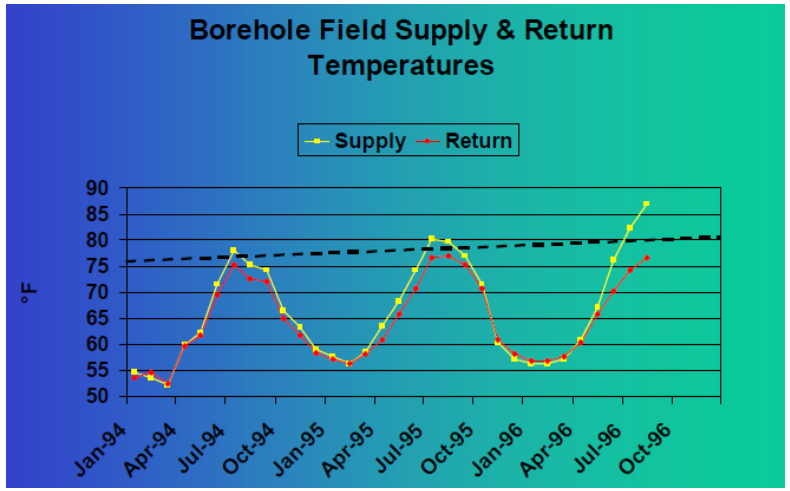


Grid decarbonization

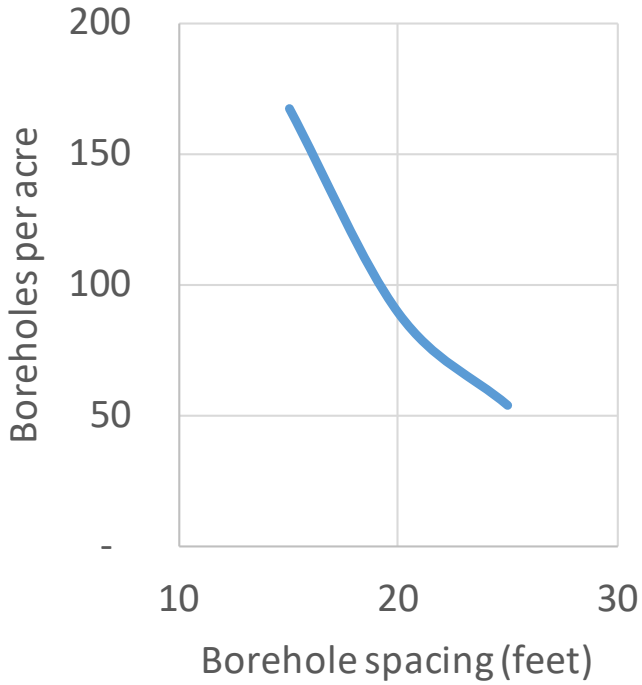


Geoexchange





- Depth vs area
- Geologic factors
- Avoid long-term cooling or heating of ground



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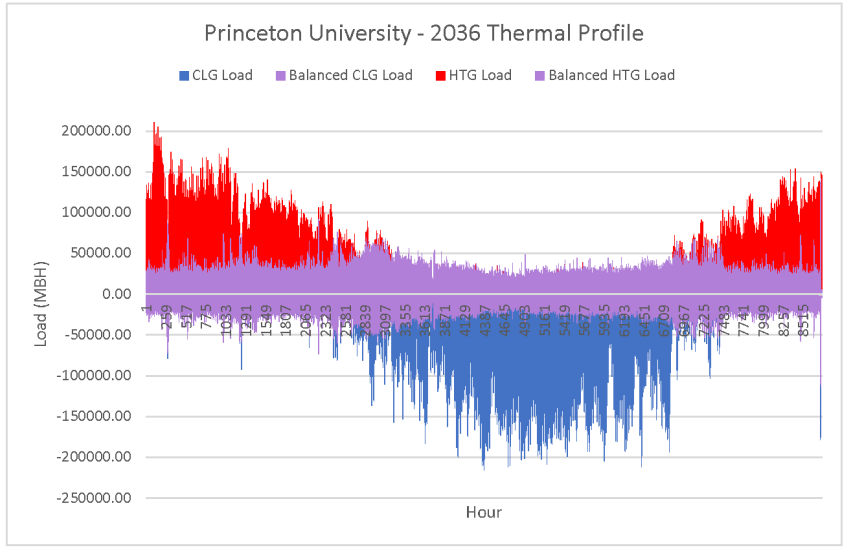
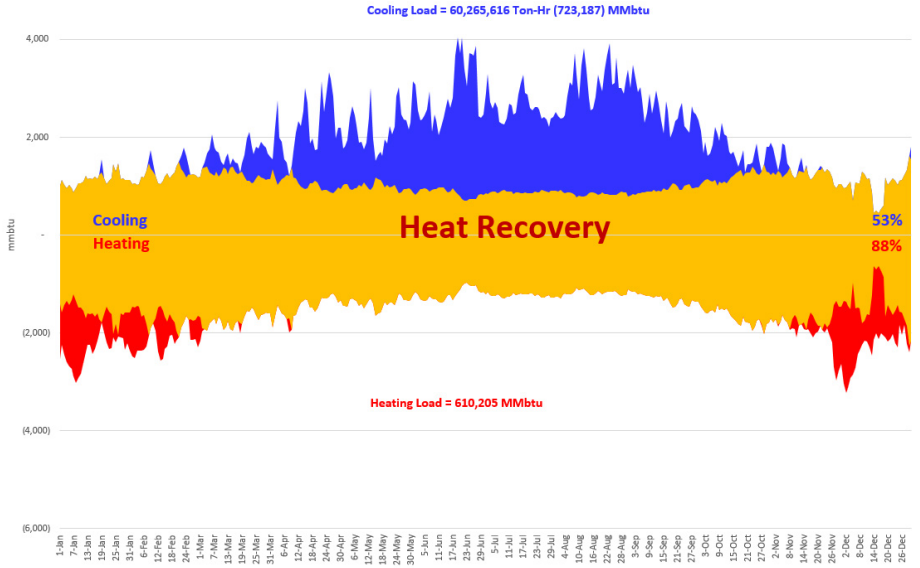
Chiller heat recovery

- Essential to analyze 8760 hour loads!
- Coincident or near-coincident heating & cooling loads

Princeton University



Stanford University



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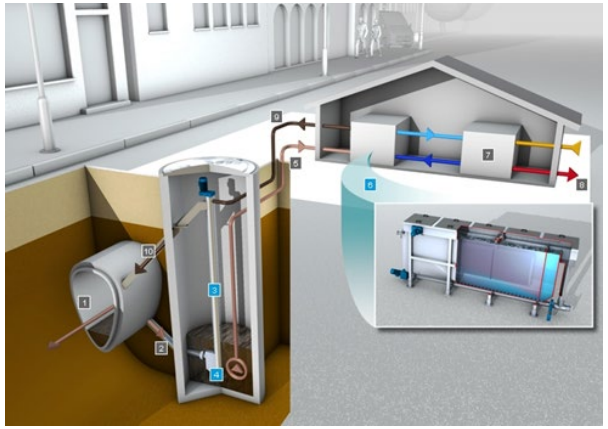
Sewage heat recovery

- Location, location, location
- Key considerations include adequate flows & temperatures:
  - Daily and seasonal variations in sewage or effluent flow and temperature
  - 8760 heating & cooling loads



- Significant Swedish experience with treated sewage effluent
- Vancouver system taps untreated sewage

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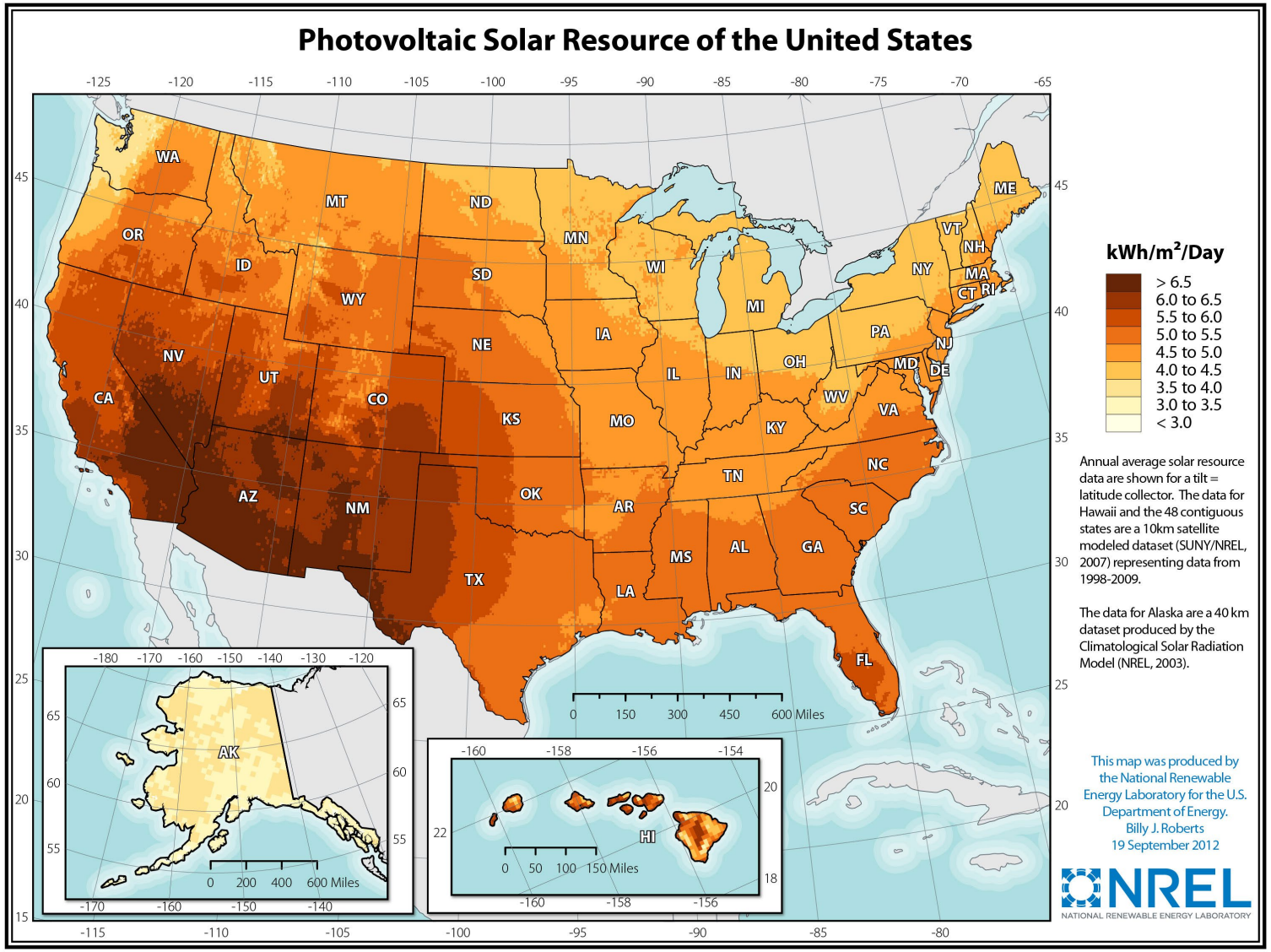
Solar energy



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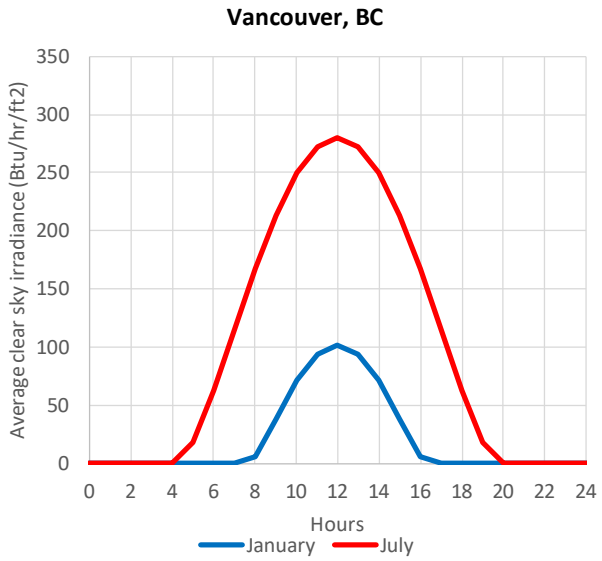
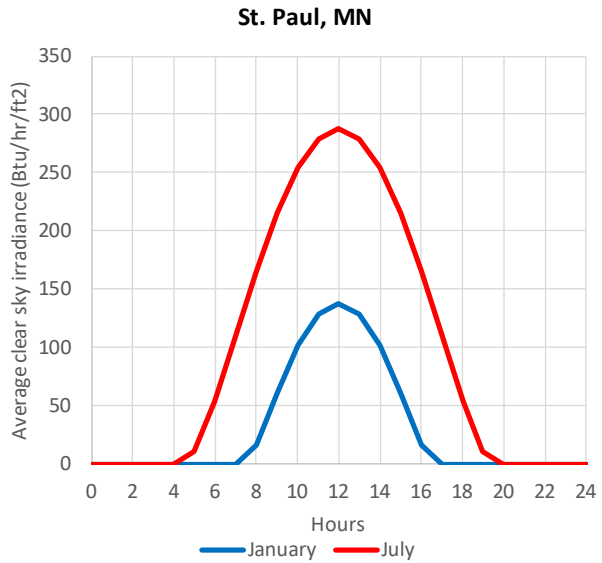
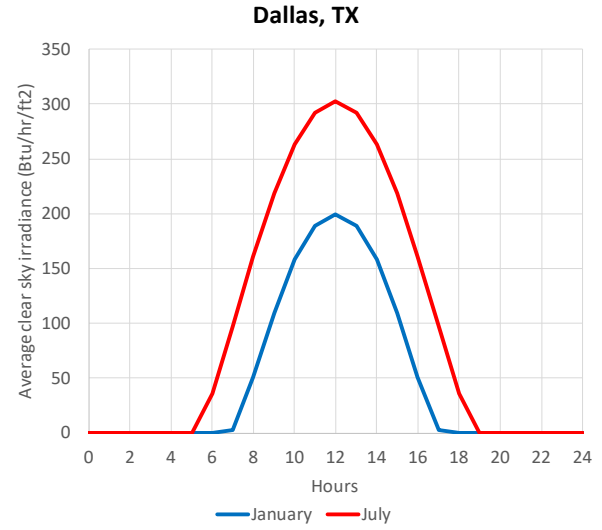
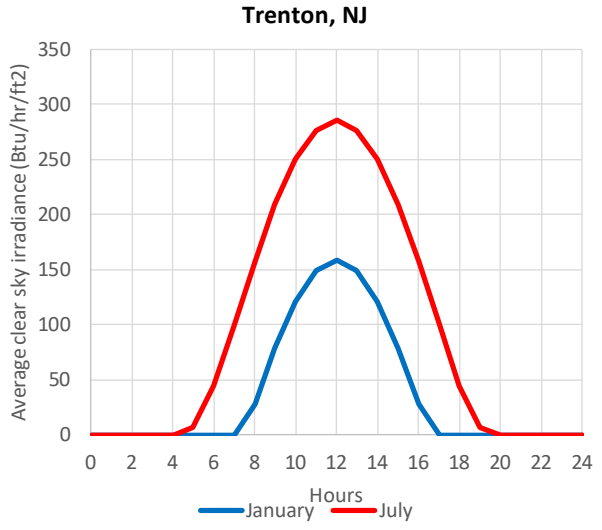
Solar energy









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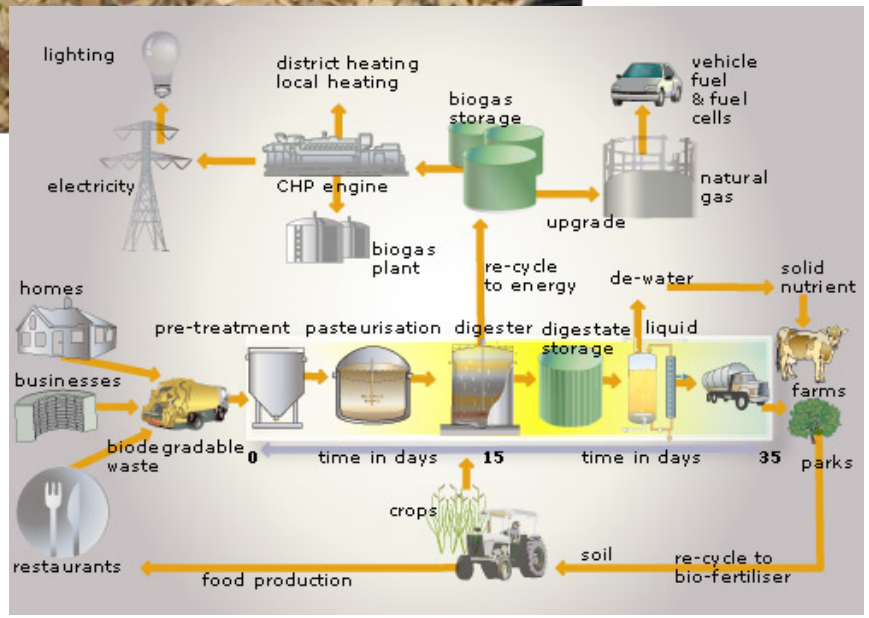
Bioenergy



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Uncertainty and the importance of flexibility

- Design for flexibility to evolve the infrastructure!
- Things will change!
  - Prices
  - Technologies
  - Regulations & policies
  - Weather & loads

- Will power grid emissions be significantly reduced in a way that is cost-effective and reliable?
- Will power transmission and distribution systems be reliable and resilient?

Role of district energy

1. Take advantage of load diversity
2. Facilitate resiliency
3. Facilitate integration of waste heat & renewables
4. Optimize thermal/electric balance
5. Facilitate integration of heating & cooling
6. Optimize opportunities for daily & seasonal storage
7. Facilitate fuel/energy source switching

Thanks for your attention!

Questions?

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