Jacobs Challenging today. Reinventing tomorrow.

Differences Between GSHP and GEN

Thermal System Performance for Every Building

Agenda

Considerations

- Vertical heat exchanger completion
- District energy and the GENs landscape
- Sources and sinks
- Resource and technology efficiency
- Network topologies
- Closing thoughts

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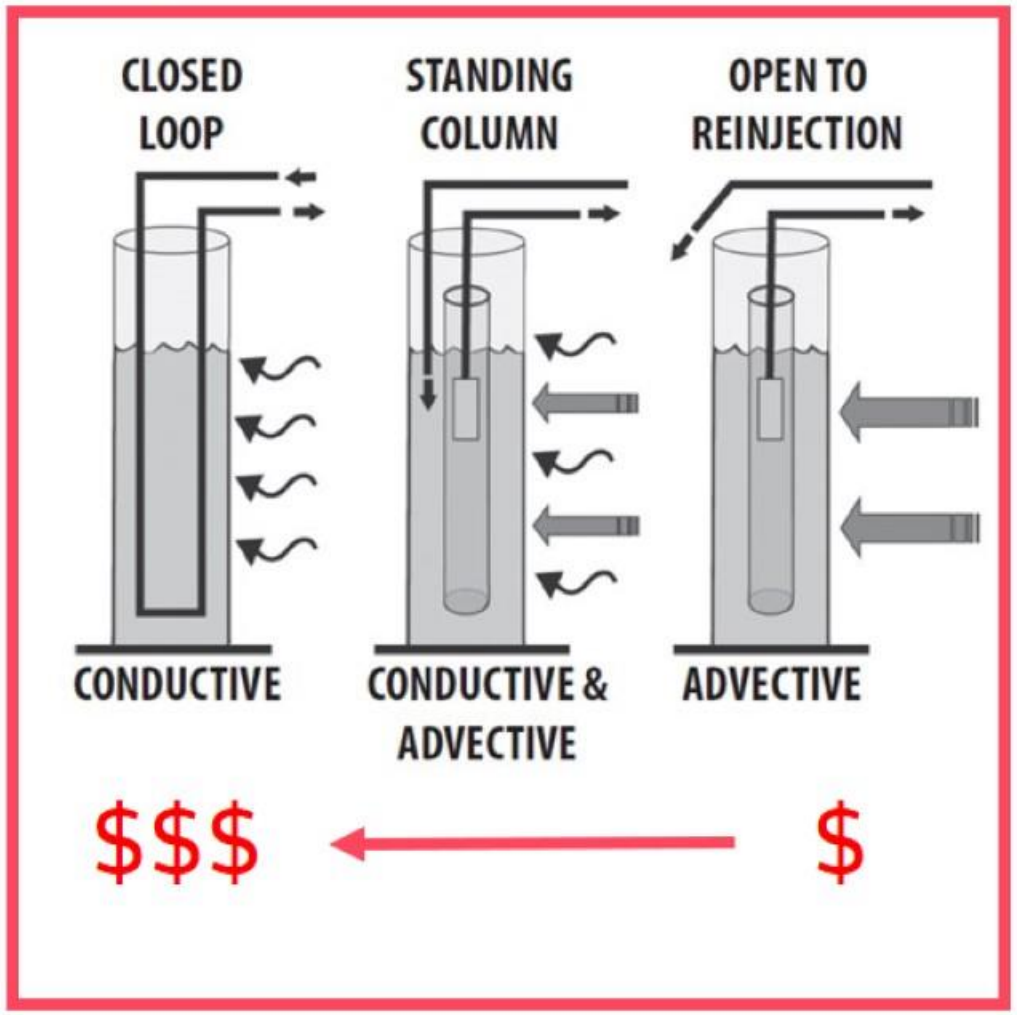
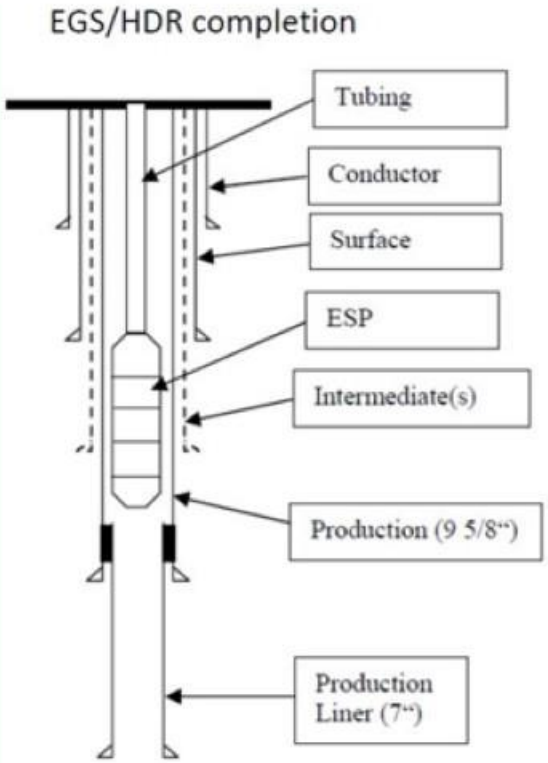
Geothermal Heating and Cooling

- Many different flavors
- Peak load capacity varies by type
- Maintenance costs for open hole are higher than closed loop exchangers, but negligible compared to capital cost savings
- Other challenges exist



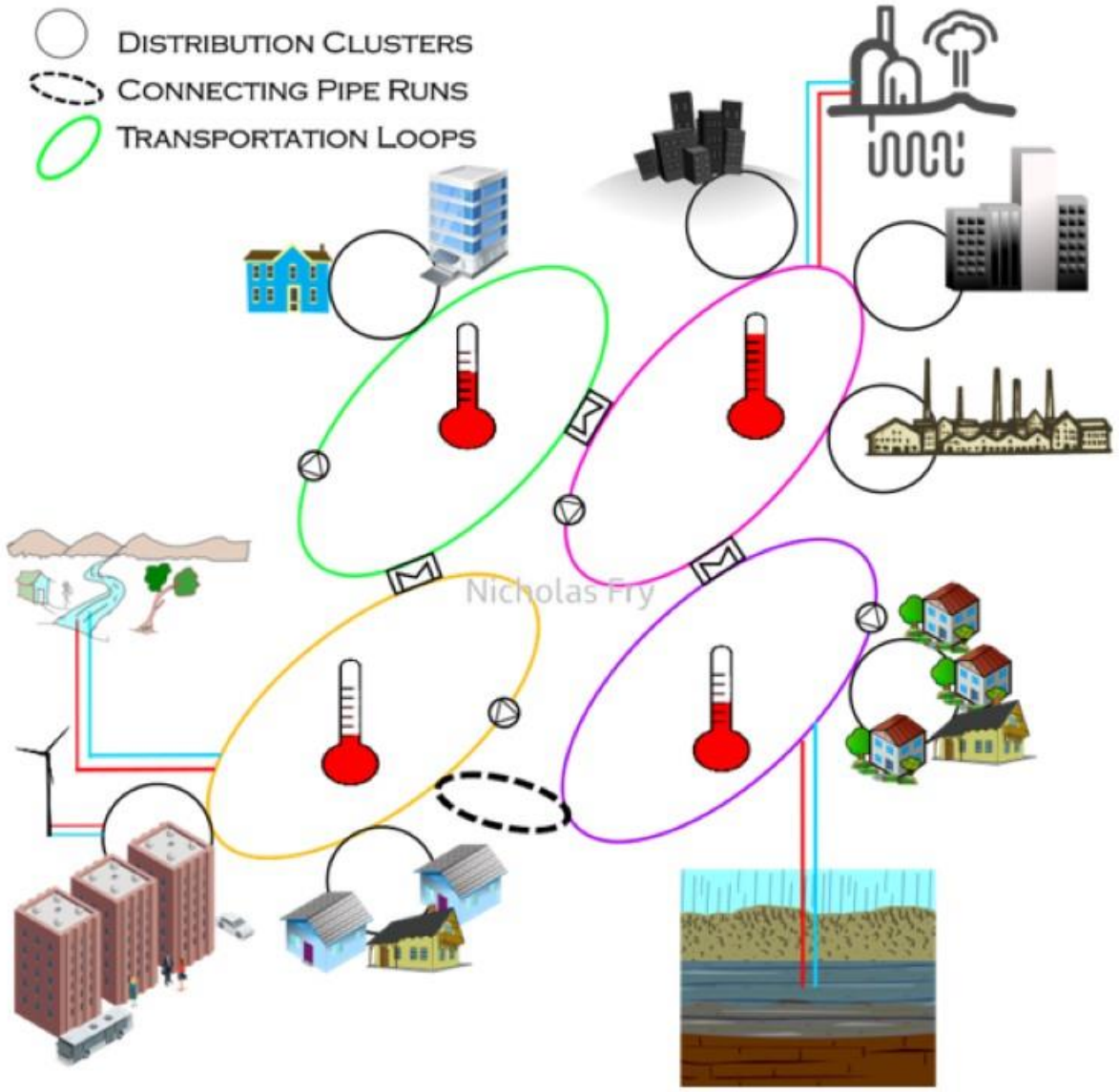


(Egg et al., 2013)

Turn Trade-offs into Opportunity

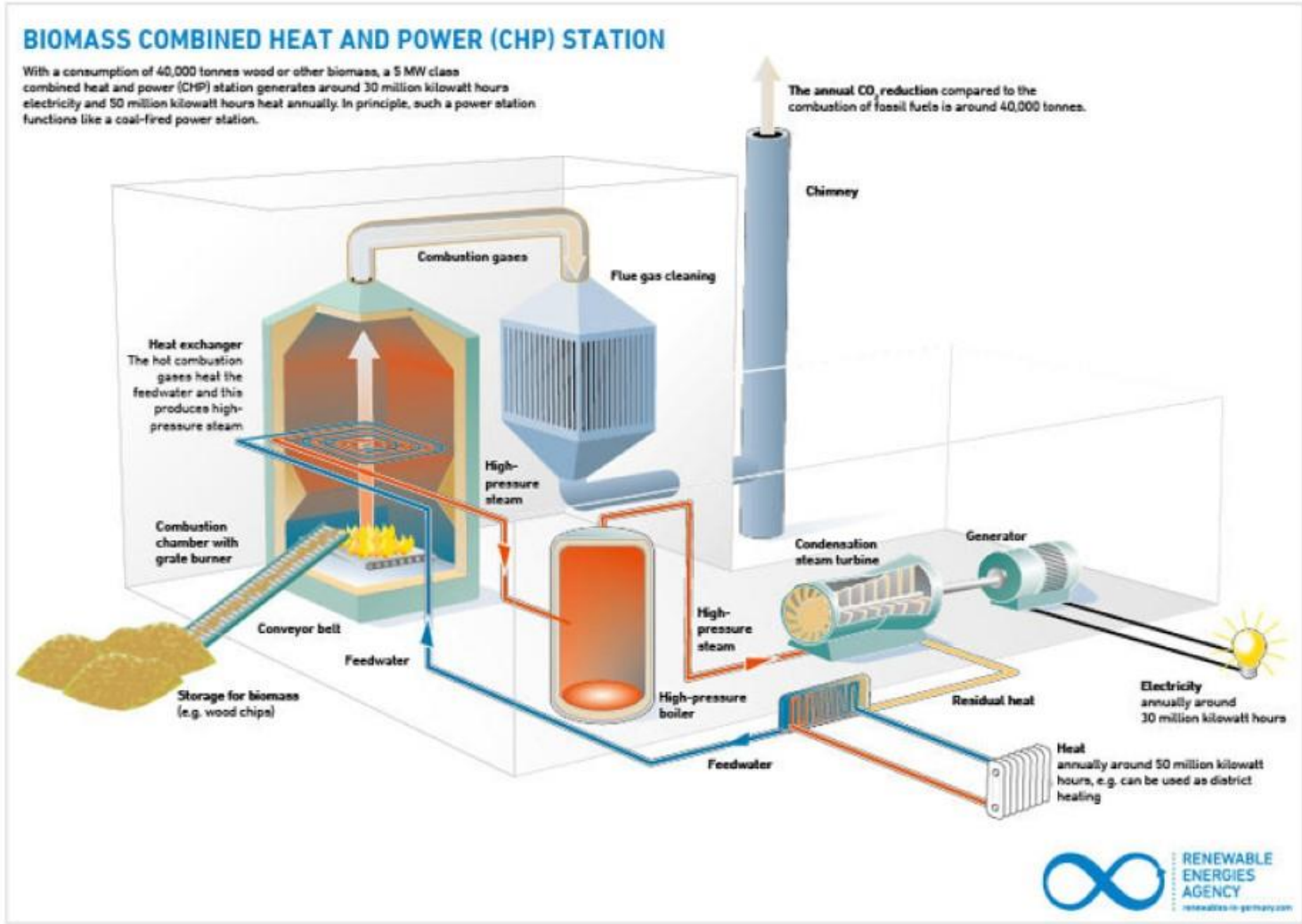
- Greater integration of geothermal for districts
- Modularity
- High-performance
- Multi-source
- Multiple temperature regimes

(Fry et al., 2024a)



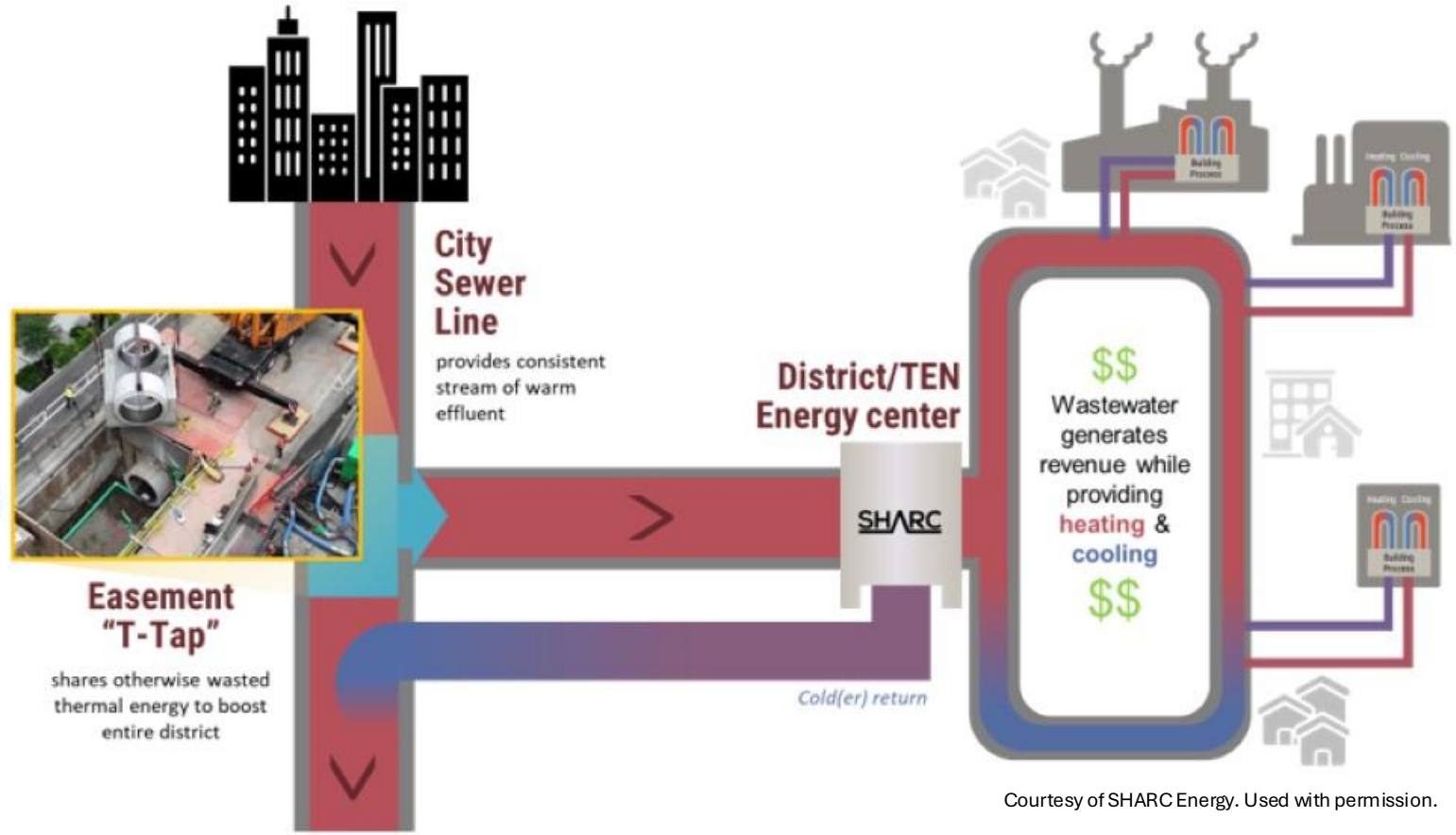
Combined Heat and Power

- Many varieties
- Advantages:
  - High efficiency
  - May be renewably sourced
- Disadvantages:
  - May not be sustainable
  - Exposed to single source fuel price volatility
  - Higher operating temperature regimes



Wastewater Energy Transfer

- Several manufacturers
- Heat pump dependent
- Advantages:
  - Can be used for heat extraction or rejection
  - Leverages a waste stream
  - Good hybridization options
- Disadvantages:
  - Authorities
  - Franchise agreements
  - Security of supply

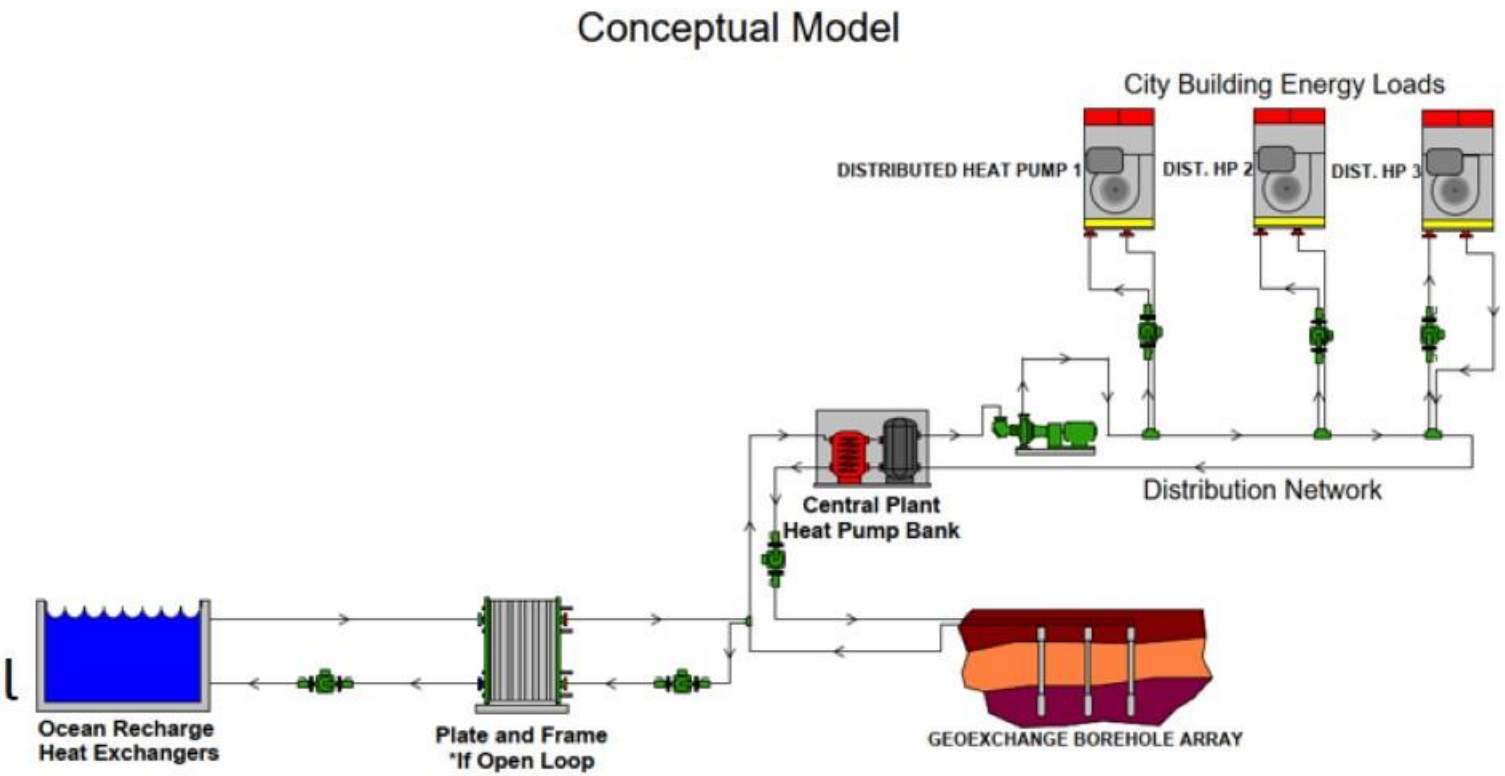


Courtesy of SHARC Energy. Used with permission.

(image used with permission from SHARC)

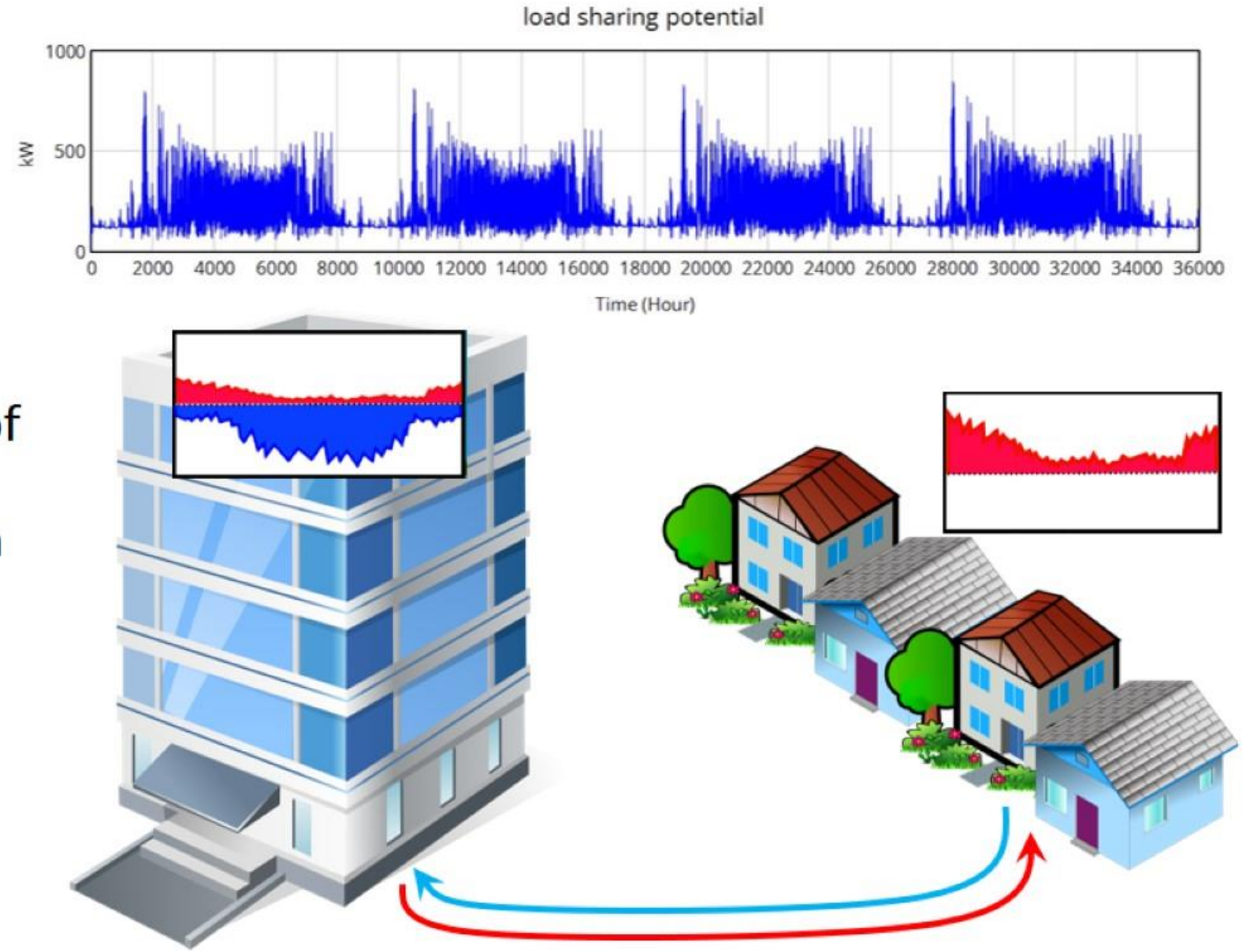
Surface Water Energy Transfer

- Many global operators
- Heat pump or passive
- Advantages:
  - Can be used for heat extraction or rejection
  - Combines well with seasonal storage
- Challenges:
  - Authorities
  - Regulations on differential temperature



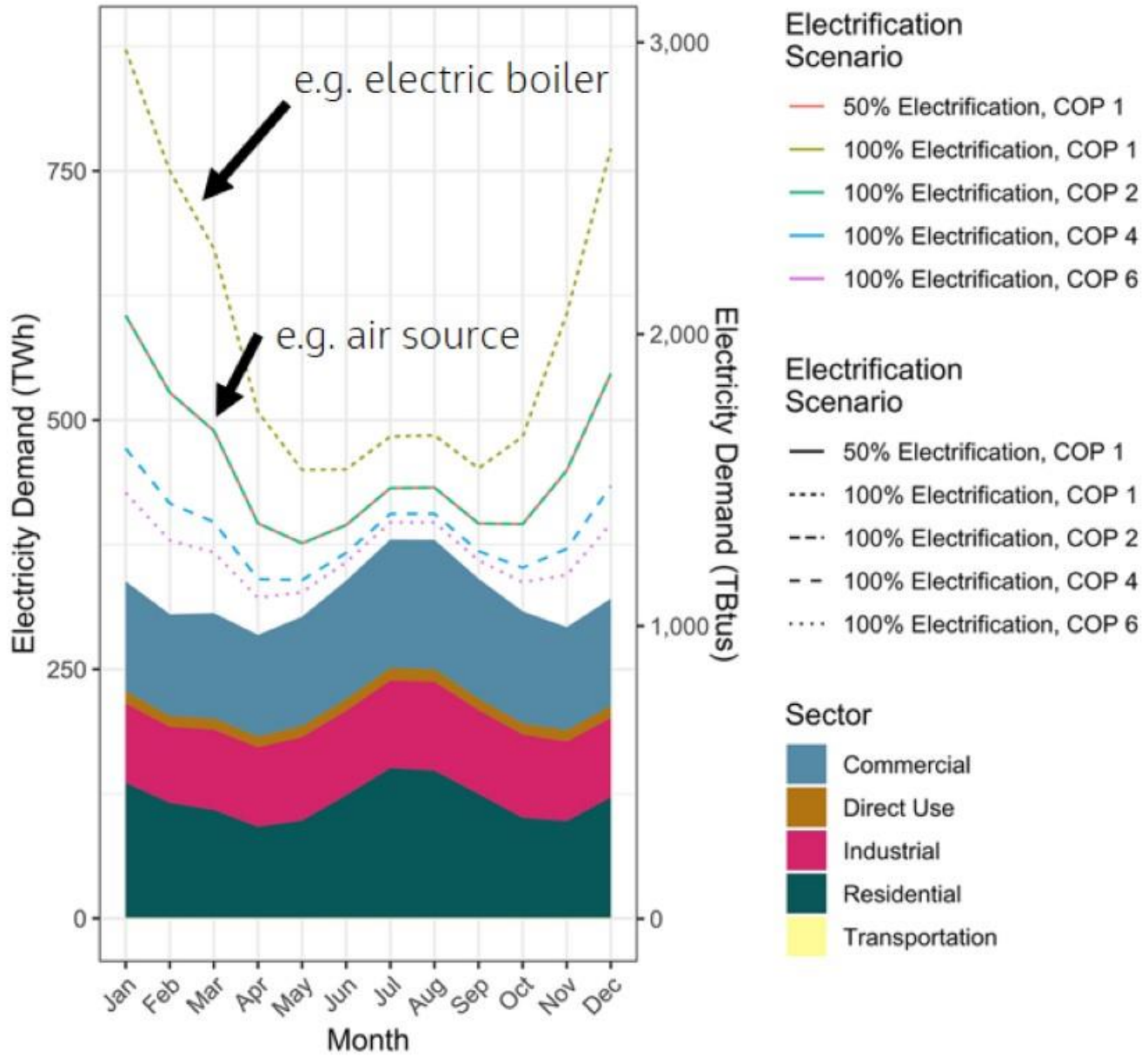
Load Sharing

- Many structures heat and cool simultaneously
  - Variations in time
  - Variations in amplitude
- Can provide mechanism of energy arbitrage
  - Sales of passive heat from one customer to the next
- Challenges:
  - Resource Recovery
  - Storage
  - Retrofit/Capitalization



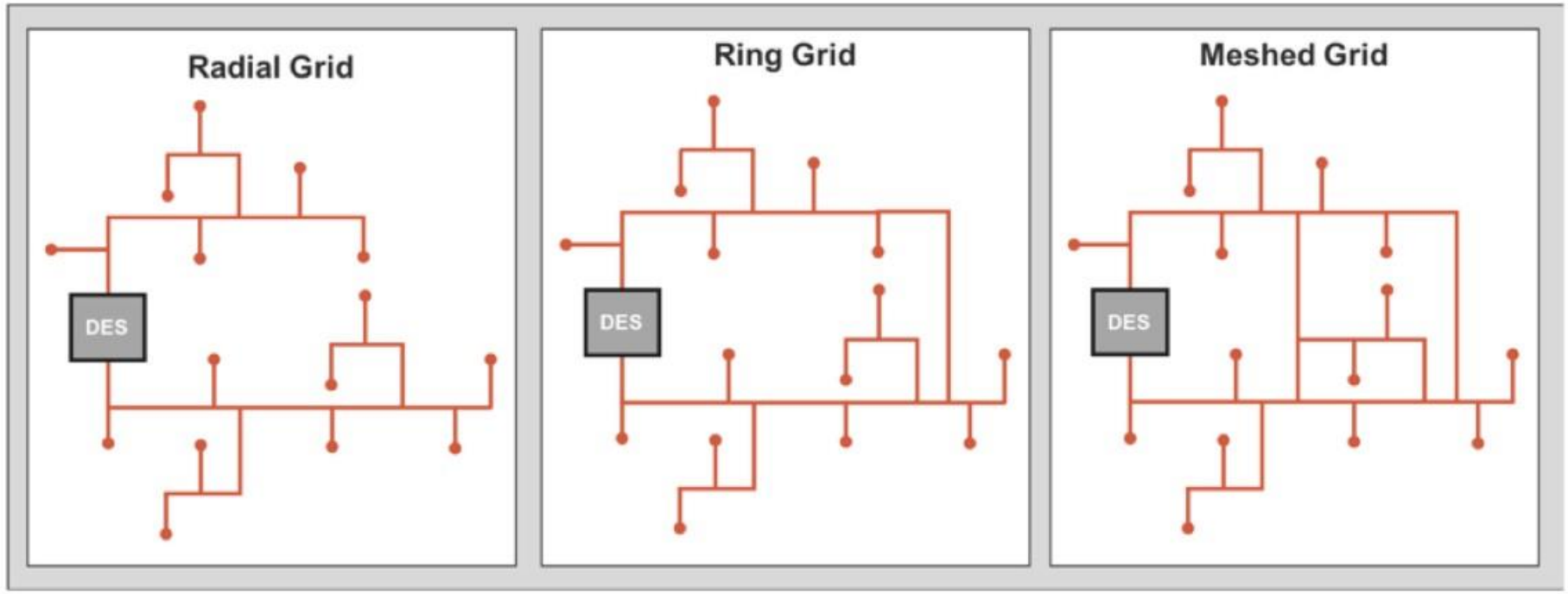
Comparisons

- Electrification of heating and cooling can have beneficial or damaging impacts.
- Approach matters.
- **Most large fluctuations of electricity demand are handled by fossil peaker plants.**
- Flattening the demand variability requires an emphasis on seasonal performance, seasonal storage.



(Buonocore et al., 2022)

Basic Topologies



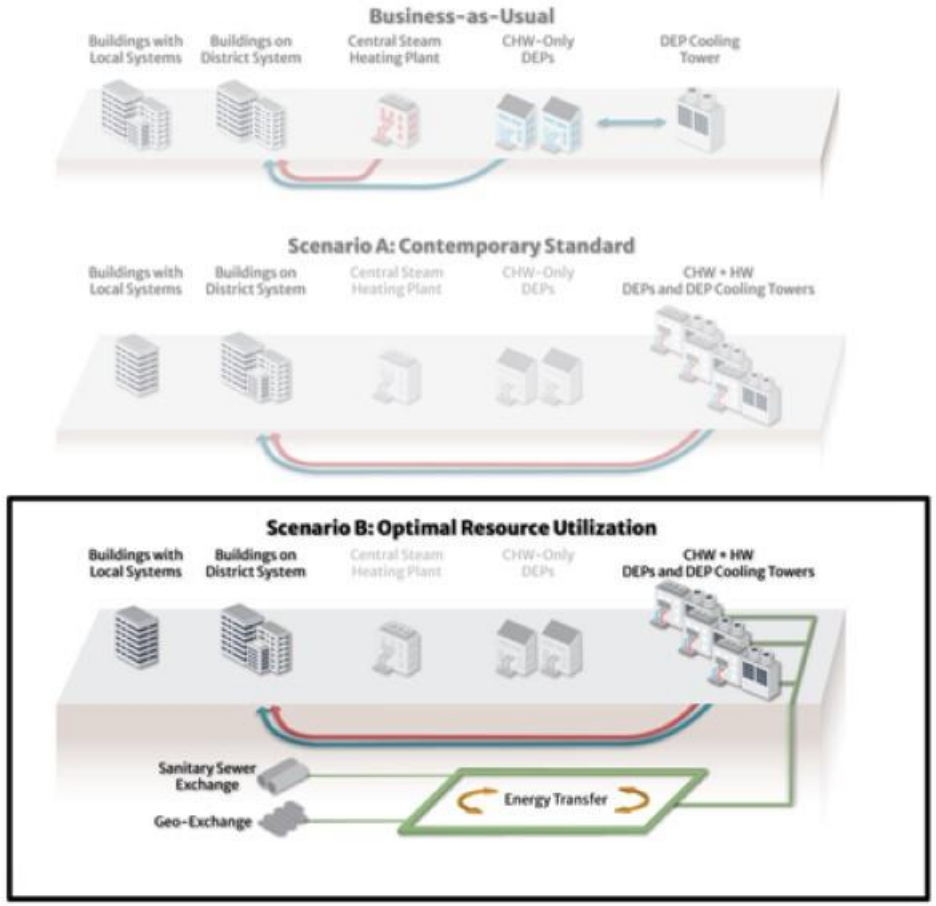
Network topologies for community-scale heating and cooling systems.

(von Rhein et al., 2019)

Decentralized Configurations

Radial distributed heat pump topology with central energy transfer station and borefield. (Fry et al., 2024b)

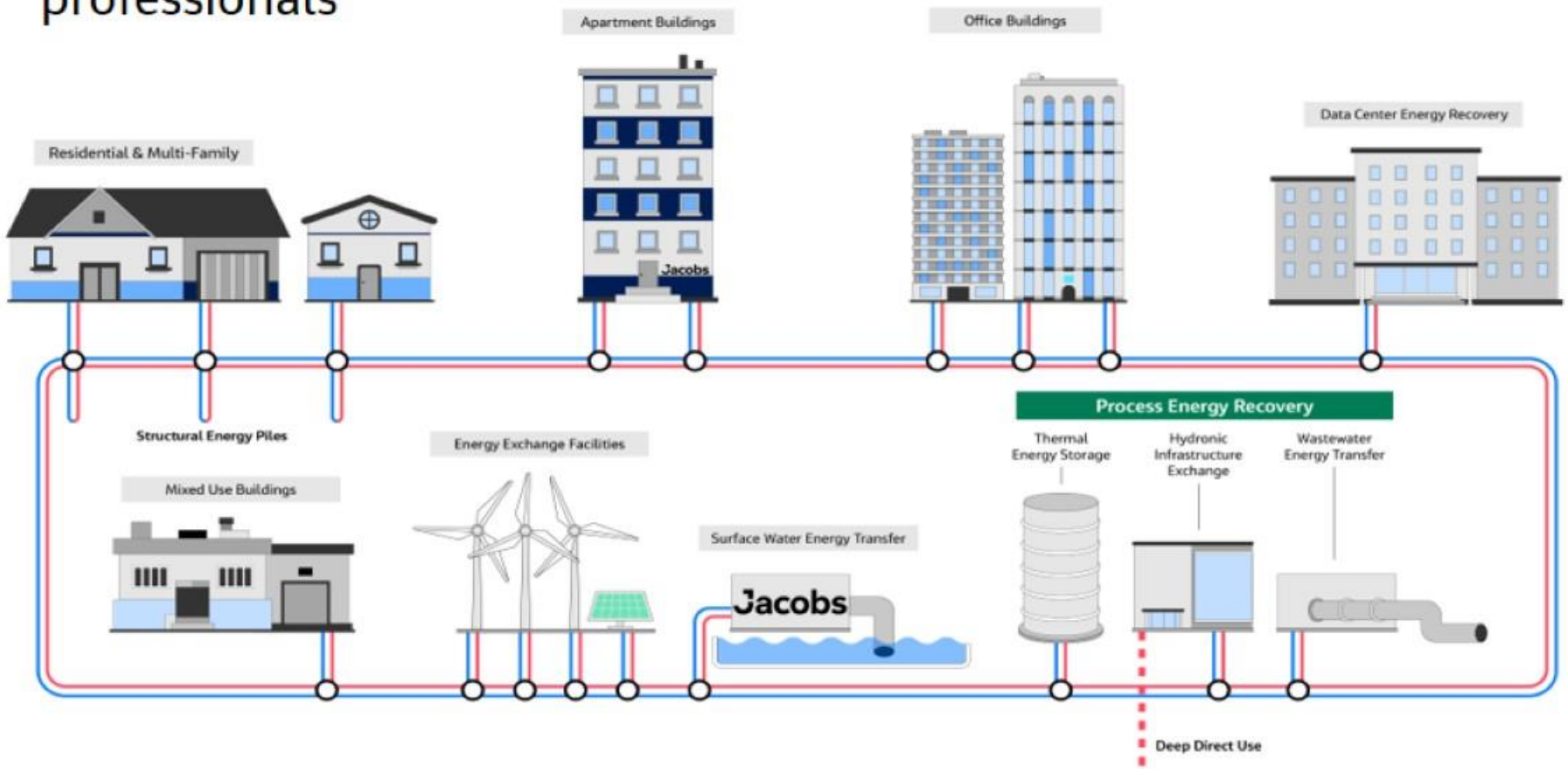
Hybrid Configurations



Distributed heat and power plants with an energy spine to transport and share thermal energy from various sources and sinks. (Fry et al., 2025).

Multi-source and Temperature

- More subsurface integration means more performance enhancement potential
- Requires interdisciplinary study between good surface and subsurface professionals



Closing Thoughts

- Different types of structures require different temperature regimes
- **Variations on sources and sinks are numerous for GENs**
- GSHP may not leverage the full potential of load diversity that GENs can
- System configuration has implications:
  - Sizing of equipment
  - Access to sources and sinks
  - Contract models
  - Maximum reductions in primary energy consumption

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“By skimping on design, the owner gets costlier equipment, higher energy costs, and a less comfortable building; the tenants get lower productivity and higher rent and operating costs.”

- Amory Lovins

Former Chairman of the Rocky Mountain Institute

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Thank you!

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