Geothermal-Enabled Zero Energy Community

A techno-economic design study to address cold-climate challenges

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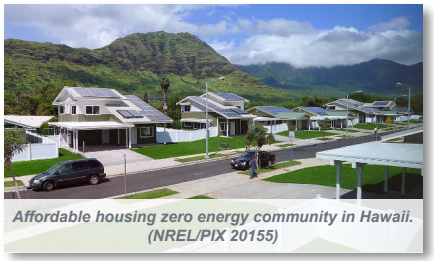
Introduction:

"Zero energy" construction is the practice of employing energy efficiency and renewable energy so that a site's annual primary energy needs can be cost-effectively met with renewable energy technologies, usually on-site.



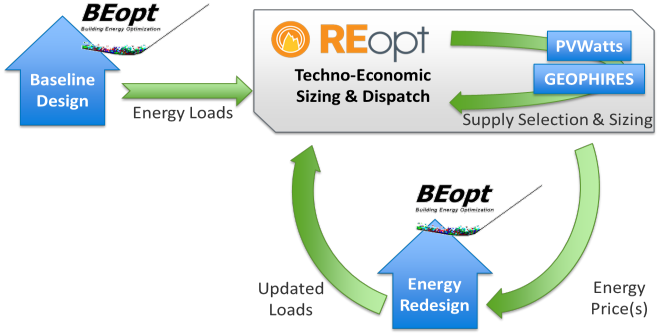
Affordable housing zero energy community in Hawaii. (NREL/PIX 20155)

A zero energy building's total cost of ownership is usually lower than minimum-code construction. But in colder climates, there are several significant challenges:

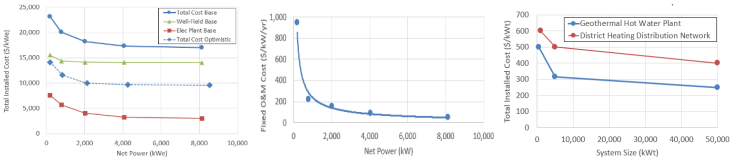
- **Thermal loads are higher** due to cold weather
- **Solar photovoltaics performance is worse**, due to lower incident sunlight, snow, etc.
- **Solar generation is less aligned with energy demands** throughout the year

Our Hypothesis:

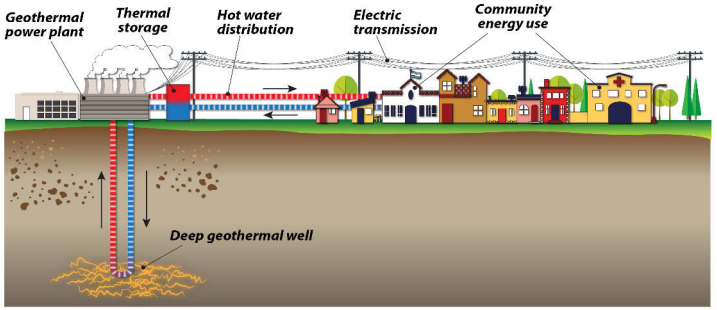
Geothermal power generation, and/or heat and power cogeneration, can be techno-economically competitive with PV and grid power for enabling zero energy community development in cold climates.



Techno-Economic Analysis Workflow



Capital and Operating Cost Assumptions for geothermal: Electric only capital (left), Electric-only operating and maintenance (center) and Direct-use thermal capital (right)



Scenario Description:

Location: Pocatello, Idaho.

Building stock: Mix of residential (single-family detached, single-family attached, and multifamily) and commercial (retail and restaurant) representative of recent communities in similar locations.

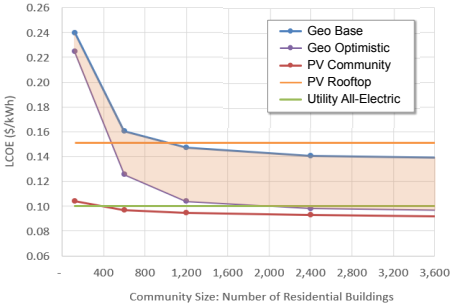
Utility tariff: Blended rate based on existing Idaho Power tariffs

Geothermal resource: Base/pessimistic and Optimistic resources simulated, to bound the likely outcomes.

Findings:

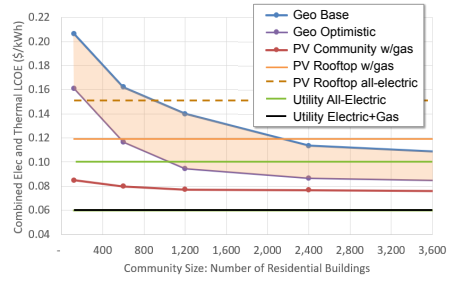
All-Electric Community

- At ZNE community sizes above 1,100-homes, geothermal is more cost-effective than rooftop PV
- With excellent reservoir conditions, geothermal power can be competitive at smaller delivered capacities



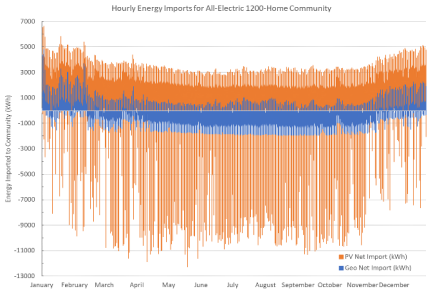
Electric+Direct Use Community

- Geothermal power and direct use is not as economically competitive due to low price of natural gas
- Community sizes above 2,200 still show benefit from using geothermal power and thermal generation, vs. rooftop PV
- Thermal energy storage is beneficial for reducing well sizes



Grid Impacts

- Geothermal power supply is a much better match to energy demands of a community, reducing impacts on power grid



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Journal paper under review, documenting electric and electric+direct use cases

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