# Kake Heat Pump Rate Analysis

Arctic Sustainable Energy Research Conference
April 21, 2021

ACEP
Alaska Center for Energy and Power

# Outline

- Context: Heat Pumps (HP) as potential beneficial load growth
- Current Kake situation:
  - Load
  - Generation
  - Costs and complexities
- This study
- Caveats / future research

# Declining load = higher rates

| **Utility costs** | | **Last year** | **This year** |
|---|---|---|---|
| Fixed cost (distn & admin) | $/yr | 200,000 | 200,000 |
| variable cost (fuel + var O&M) | $/kWh | 0.30 | 0.30 |
| | | | |
| Electricity sales | kWh/yr | 1,000,000 → | 900,000 |
| | | | |
| Total cost | $/yr | 500,000 | 470,000 |
| **Average cost = required rate** | **$/kWh** | **0.50** → | **0.52** |
| | | | |
| Average fixed cost | $/kWh | 0.20 | 0.22 |

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# Opportunity: Increasing load = lower average cost...

| Utility costs | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Fixed cost (distn & admin) | $/yr | 200,000 | 0 | 200,000 |
| variable cost (fuel + var O&M) | $/kWh | 0.30 | 0.30 | |
| Electricity sales | kWh/yr | 1,000,000 | 200,000 | 1,200,000 |
| Total cost | $/yr | 500,000 | 60,000 | 560,000 |
| **Average cost** | **$/kWh** | **0.50** | | **0.47** |
| Average fixed cost | $/kWh | 0.20 | | 0.17 |

….then what?

# Lower uniform rates…..?

| New uniform rate | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Rate | $/kWh | 0.47 | 0.47 | |
| Utility revenue | $/yr | 466,667 | 93,333 | 560,000 |
| Utility total cost | $/yr | | | 560,000 |
| Utility margin | $/yr | | | 0 |

….might be too high for potential heat pump users

# Special rate for HP use…?

| Breakeven rate for HP use | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Rate | $/kWh | 0.50 | 0.30 | |
| Utility revenue | $/yr | 500,000 | 60,000 | 560,000 |
| Utility total cost | $/yr | | | 560,000 |
| Utility margin | $/yr | | | 0 |

Utility breaks even, and non-HP customers not worse off.

Lowest possible HP rate = marginal cost of serving HP load.

# Win-win rates

| Win-win combinations | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Rate | $/kWh | 0.49 | 0.35 | |
| Utility revenue | $/yr | 490,000 | 70,000 | 560,000 |
| Utility total cost | $/yr | | | 560,000 |
| Utility margin | $/yr | | | 0 |

Non-HP customers pay lower rates;

HP rate must be low enough to reduce HP owners' heating bills.

# Serving new load with *excess** zero-fuel hydro helps even more

| Utility costs | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Fixed cost (distn & admin) | $/yr | 200,000 | 0 | 200,000 |
| variable cost (fuel + var O&M) | $/kWh | 0.30 | 0.00 | |
| Electricity sales | kWh/yr | 1,000,000 | 200,000 | 1,200,000 |
| Total cost | $/yr | 500,000 | 0 | 500,000 |
| **Average cost** | **$/kWh** | **0.50** | → | **0.42** |
| Average fixed cost | $/kWh | 0.20 | → | 0.17 |
| Average variable cost | $/kWh | 0.30 | → | 0.25 |

*hydro available after serving existing non-HP load

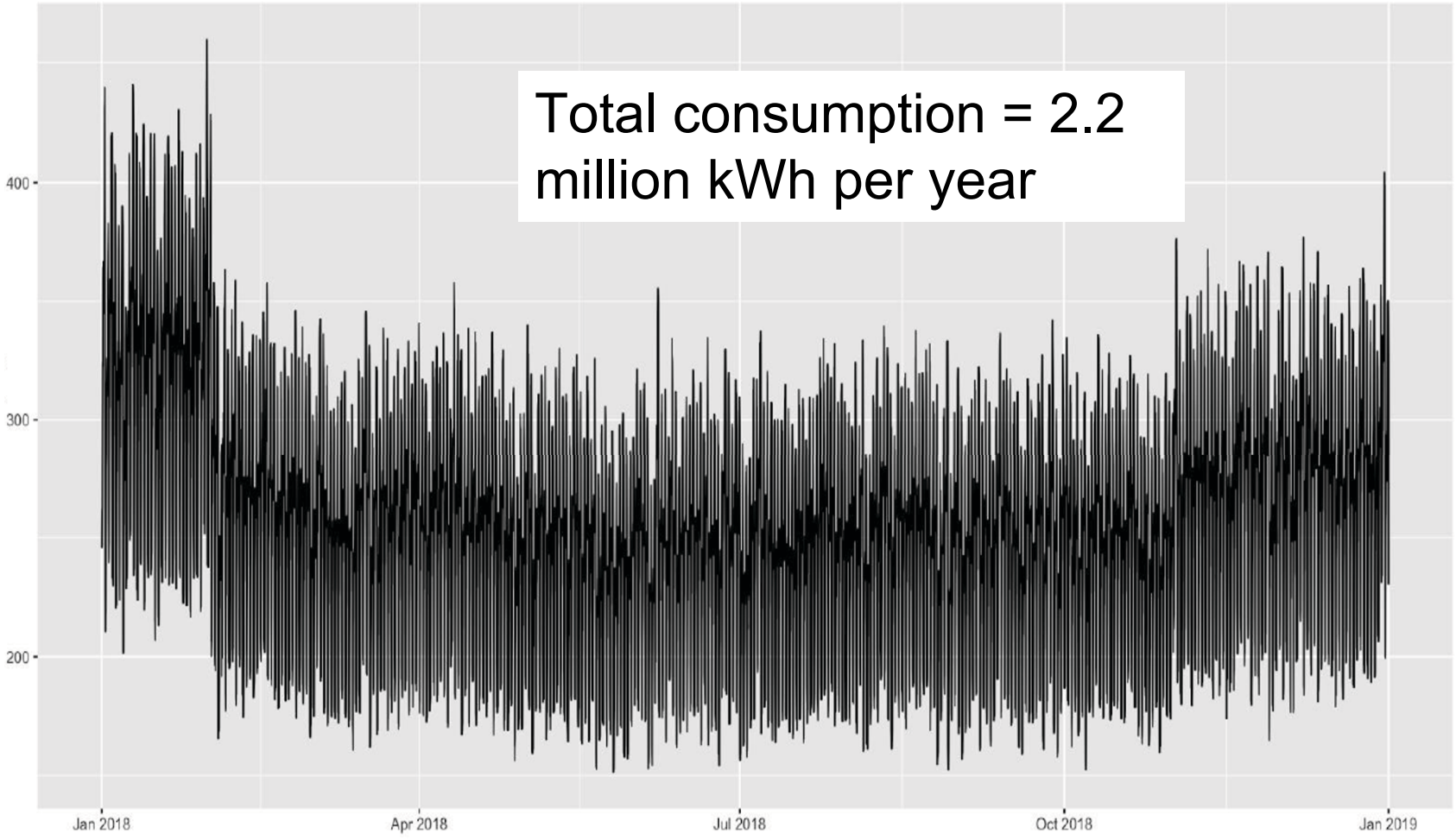
# Many win-win rate combinations with excess* hydro

| Win-win combinations | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Rate | $/kWh | 0.46 | 0.20 | |
| Utility revenue | $/yr | 460,000 | 40,000 | 500,000 |
| Utility total cost | $/yr | | | 500,000 |
| Utility margin | $/yr | | | 0 |

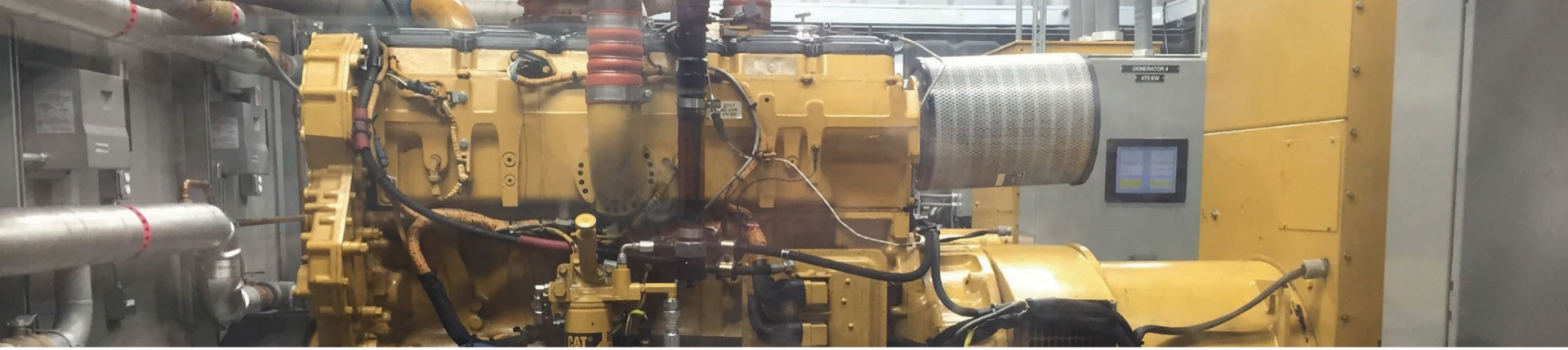
| Win-win combinations | | non-HP | HP load | with HP |
|---|---|---|---|---|
| Rate | $/kWh | 0.48 | 0.10 | |
| Utility revenue | $/yr | 480,000 | 20,000 | 500,000 |
| Utility total cost | $/yr | | | 500,000 |
| Utility margin | $/yr | | | 0 |

*hydro used for HP only after serving existing non-HP load

# Modeled Kake electric load




Based on 2019-2020 data - Peak load 465 kW in Jan 2020



# Kake generation

- 4 x 450 kW diesel generators
  - Effective operational capacity of 720 kW

Plus:

- 500 kW Hydro (Gunnuk Creek) - new!

# Kake cost situation

Marginal cost of diesel =

17.7 cents per kWh (fuel)

+ 10.6 cents per kWh (nonfuel O&M)

= 28.3 cents per kWh total

This is the minimum rate for any new load,

*-- absent further complexities*

# Further complexities:

- Some HP load can be served by excess hydro
- Some HP load will pay full/regular non-HP rate
- Hence, an HP incentive rate for use greater than 500 kWh per month can be less than full marginal cost of diesel
- *Also* - IPEC has postage stamp rates for hydro and non-hydro communities!

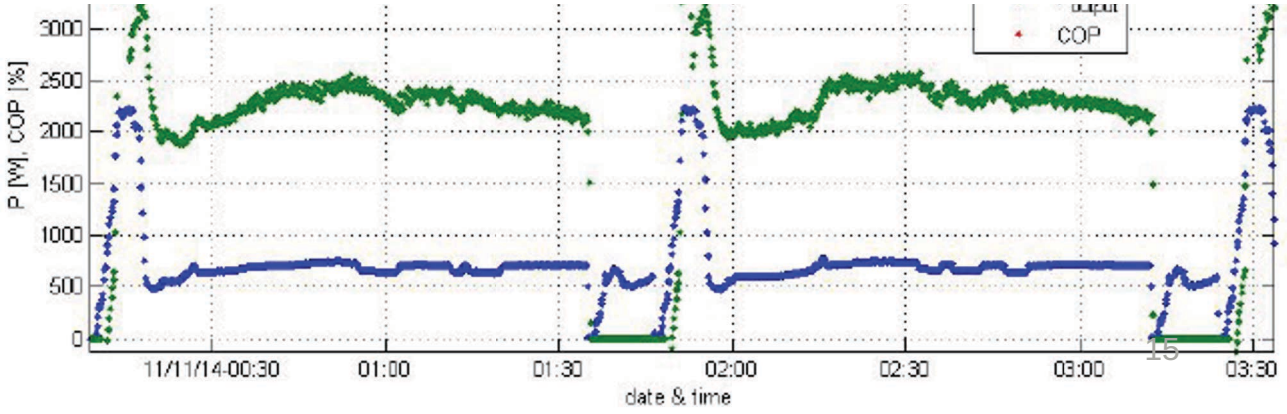
# Additional Considerations

Housing authority installing HP already…

-better indoor air quality, less maintenance

~doubles winter household electricity load

~max coincident load?? (vs. existing generation limits)



# Study


ACEP Technical Report

Kake Heat Pump Rate Analysis for Inside Passage Electric Cooperative

Shivani Mathur, Steve Colt and Michelle Wilber

February 2021

-Break even rate for utility: ~8 to 10 cents/kWh + COPA

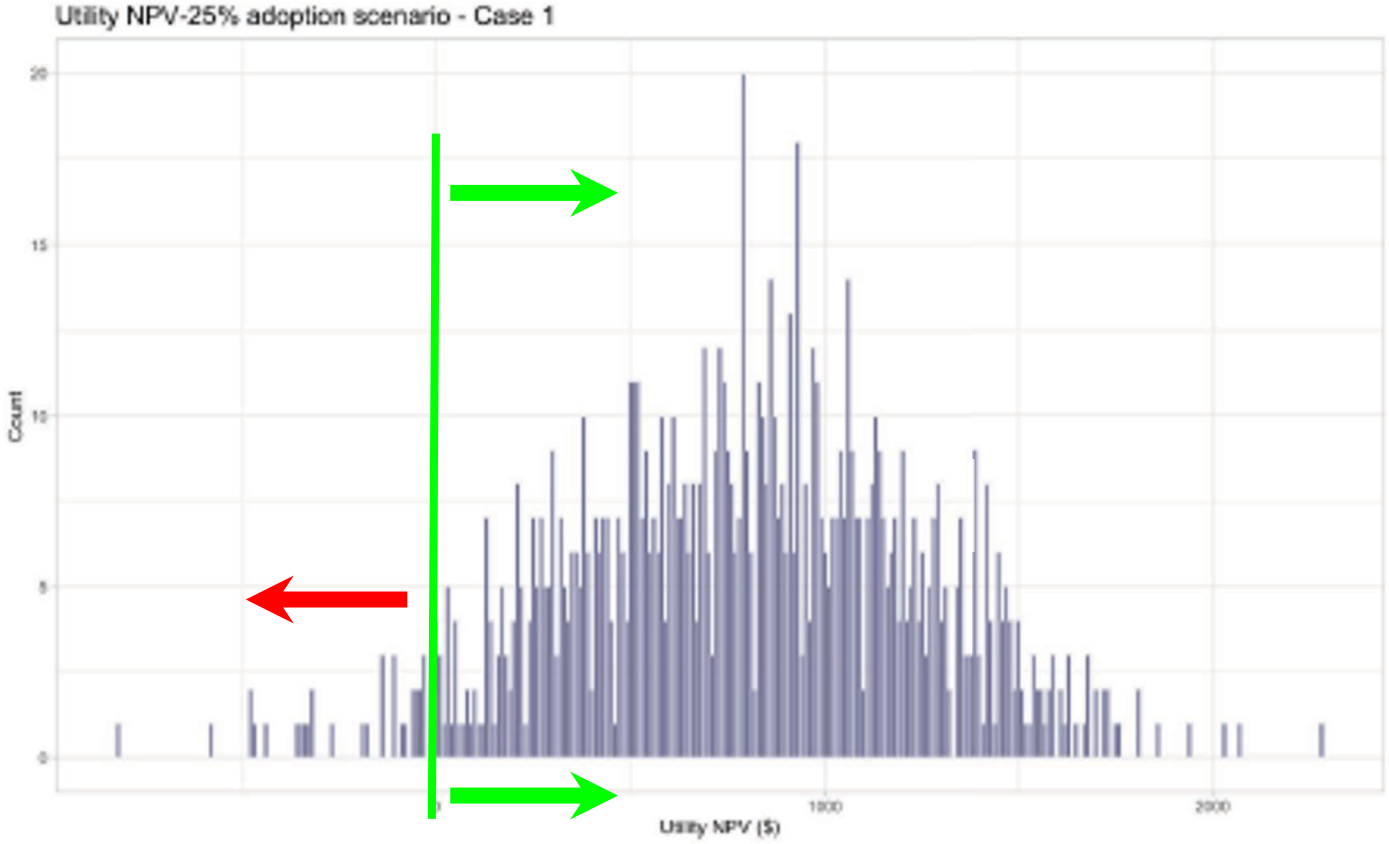
= (approx) 23 - 25 cents/ kWh

-varied hydroelectric potential, fuel price and marginal non-fuel cost of power from diesel generation in sensitivity analysis

-Monte Carlo simulations on above parameters

https://acep.uaf.edu/projects-(collection)/bee.aspx

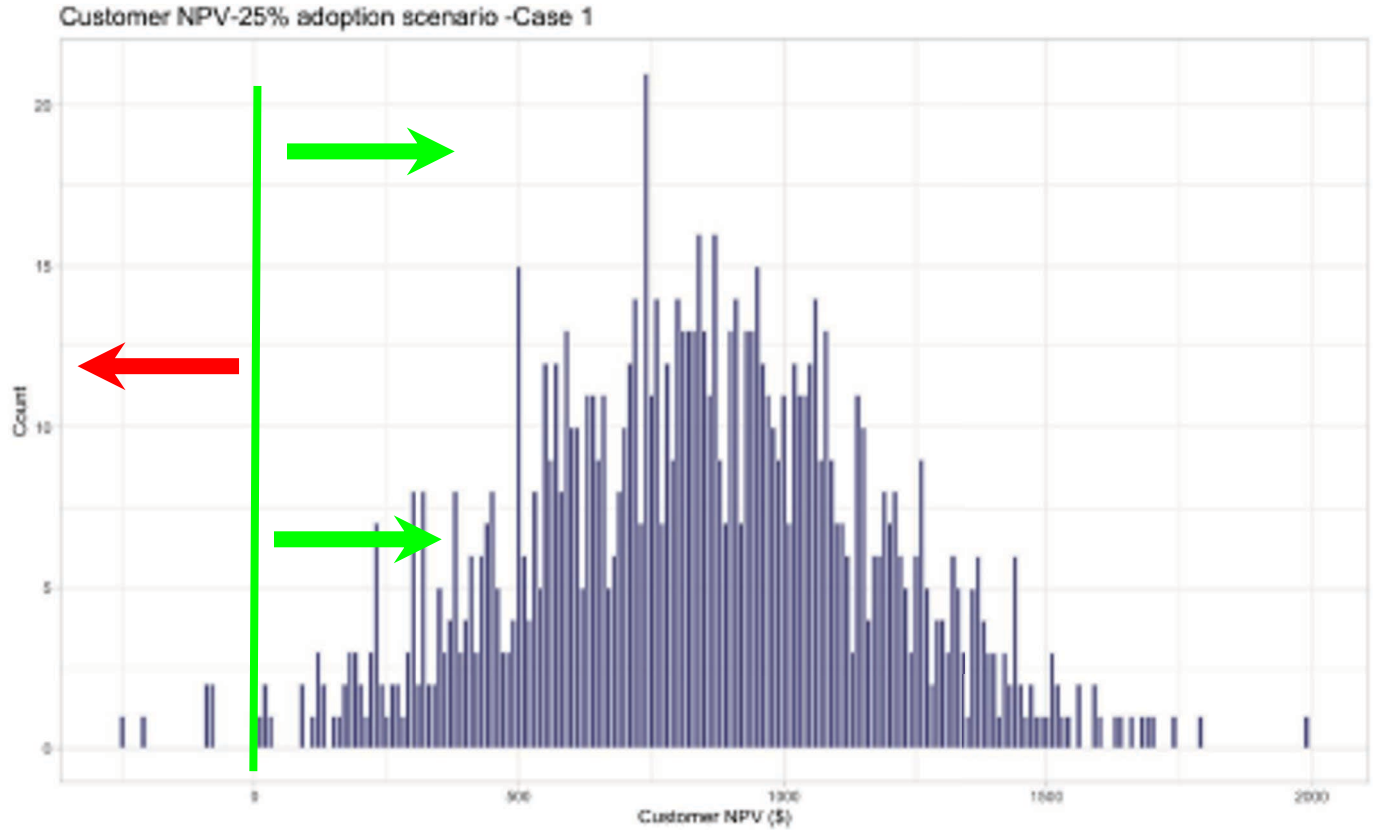
*Utility NPV - HP incentive rate = $0.1200/kWh*




# Monte Carlo Simulations

| Description | Utility NPV |
|---|---|
| Standard deviation | 442,085 |
| Average | 789,131 |
| Minimum | (818,418) |
| Maximum | 2,276,064 |
| Median | 795,044 |
| Probability of positive NPV | 96% |

*Customer NPV - HP incentive rate = $0.1200/kWh*




# Monte Carlo Simulations

| Description | Customer NPV |
|---|---|
| Standard deviation | 333 |
| Average | 834 |
| Minimum | (246) |
| Maximum | 1,991 |
| Median | 839 |
| Probability of positive NPV | 99% |

# Caveats and Future work

- Split costs between HA and resident not accounted for (install/electricity)
- More experience will nail down some parameters
  - true costs of HP installation/maintenance
  - energy usage of HPs (back up heating?)
  - coincident peak load of HPs?
  - hydro availability and variability

- What about other communities?
  - climate/costs/generation sources


The End
Thank You
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# beyond here is junk DNA

*Stuff I am not sure what to do with, yet, but not worth discarding, either*