Jeremy Vandermeer, MS student

Changing the Energy Mix in a Remote Microgrid

An Impact Assessment for Nome, Alaska

Nome Integration Study Team

- Marc Mueller-Stoffels,
  - Research Assistant Professor
  - Power Systems Integration Program Director
  - mmuellerstoffels@alaska.edu
- Jeremy VanderMeer,
  - MS Student at University of Oldenburg, Germany
  - jbvandermeer@alaska.edu

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Nome (*Siqnazuaq*), Alaska

- Remote
  - security of fuel access
  - high transport costs
  - $0.37/kWh before subsidy
- Cold
  - high energy consumption

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Image Sources: wikimedia.org and nbcnews.com

Wind-Diesel Grid

- Diesel Generators
  - 2x 5.2 MW
  - 0.4, 1.9 and 3.6 MW added soon
- Wind Power
  - 18x 50kW turbines
  - 2x 900kW turbines
- Load
  - 4MW average

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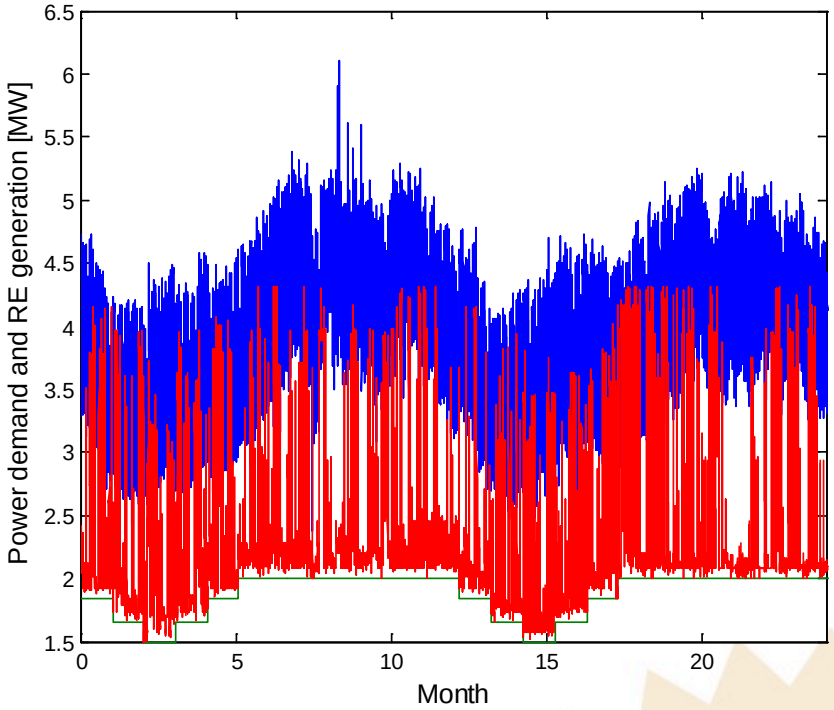
Image Sources: alaskarenewableenergy.org

Pilgrim Hot Springs

- 90°C 20m below surface, est. reservoir temp is ~150°C
- 37 miles from Nome
- Strong local interest in development of site
- Appears to be economical to develop at 2MW+

Grid Integration Assessment

- Does it make sense?
  - 2MW geothermal
  - 2.7MW wind
  - 2.5MW base load, 4MW average
- Simulation objectives
  - Reduction in diesel generator output
  - Increase in wind diversion
  - Change in diesel generator operation



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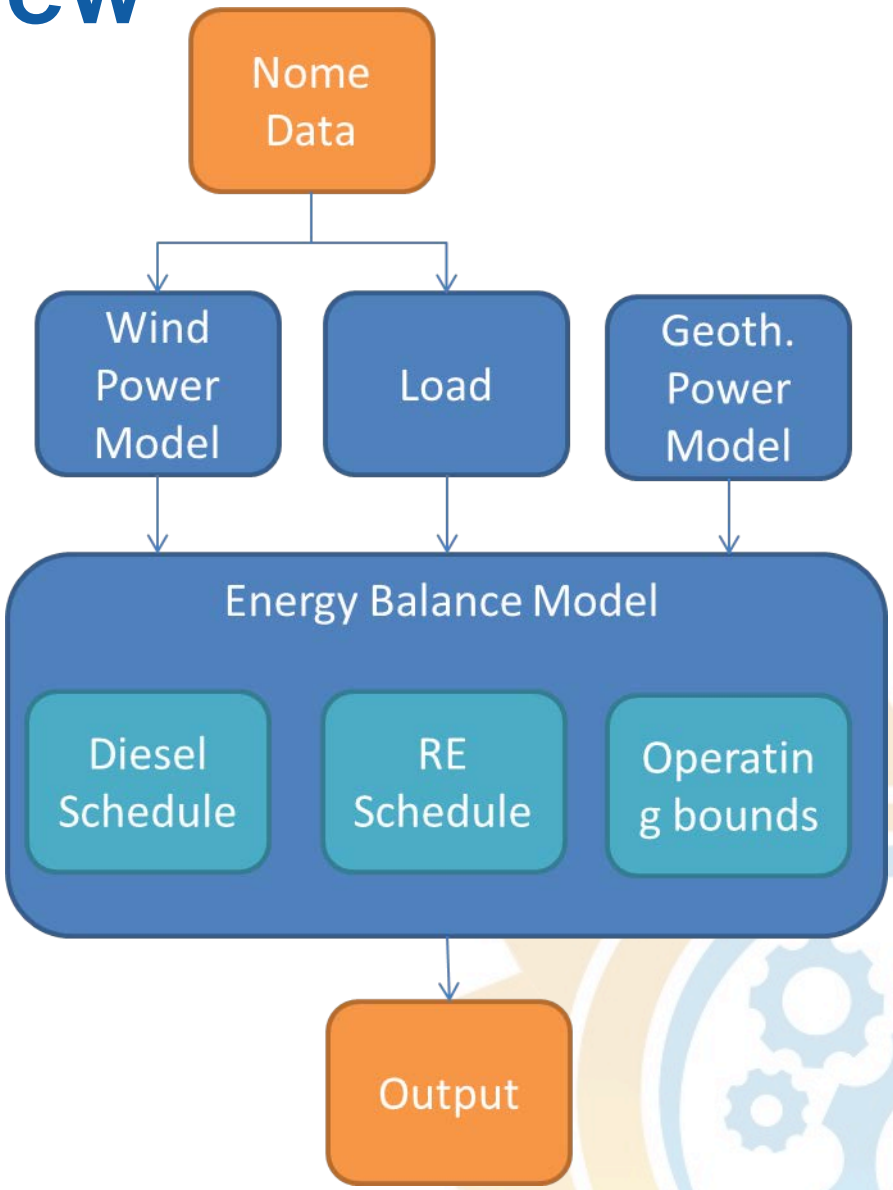
Simulation Overview

- 0-5.5MW geothermal
- Different available diesels

Case #	Available Diesels
1	1.9 MW, 3.7 MW, 5.2 MW (2)
2	0.4 MW, 1.9 MW, 3.7 MW, 5.2 MW (2)
3	1.0 MW, 1.9 MW, 3.7 MW, 5.2 MW (2)
4	All Gensets



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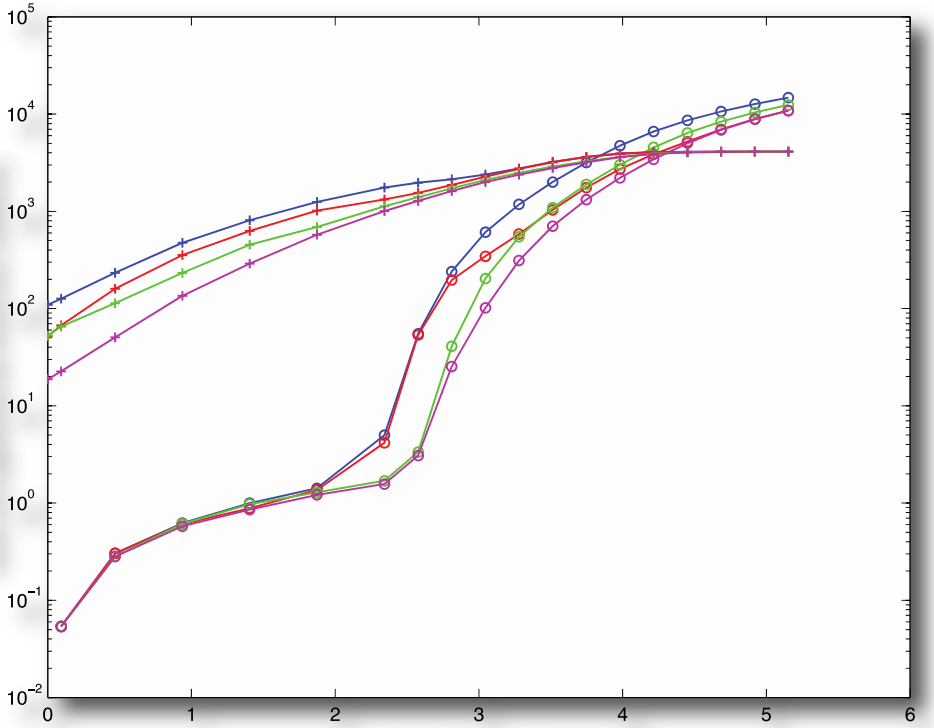
Diesel Generators

- Operating bounds
  - Spinning Reserve Capacity (SRC)
  - Minimum Optimal Loading (MOL)
  - Minimum Operating Time (MOT)
  - Warm up/cool off
- Scheduling
  - Minimize MOL
  - Maximize RE import

Results - Diverted RE

- Critical level of geothermal
- More diverse diesel fleet = less RE diversion



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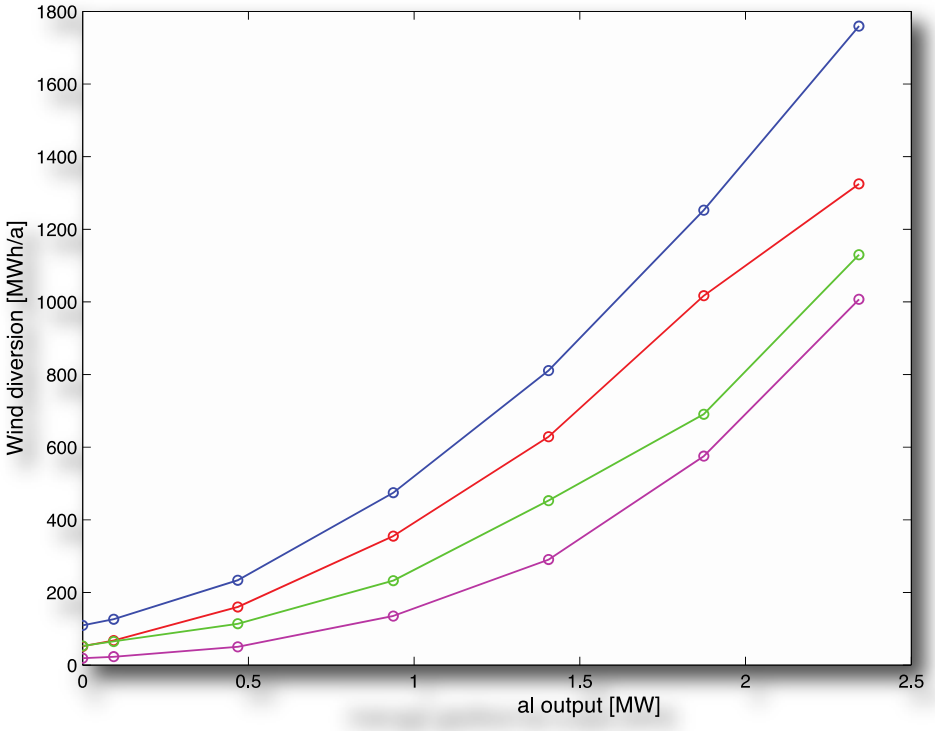
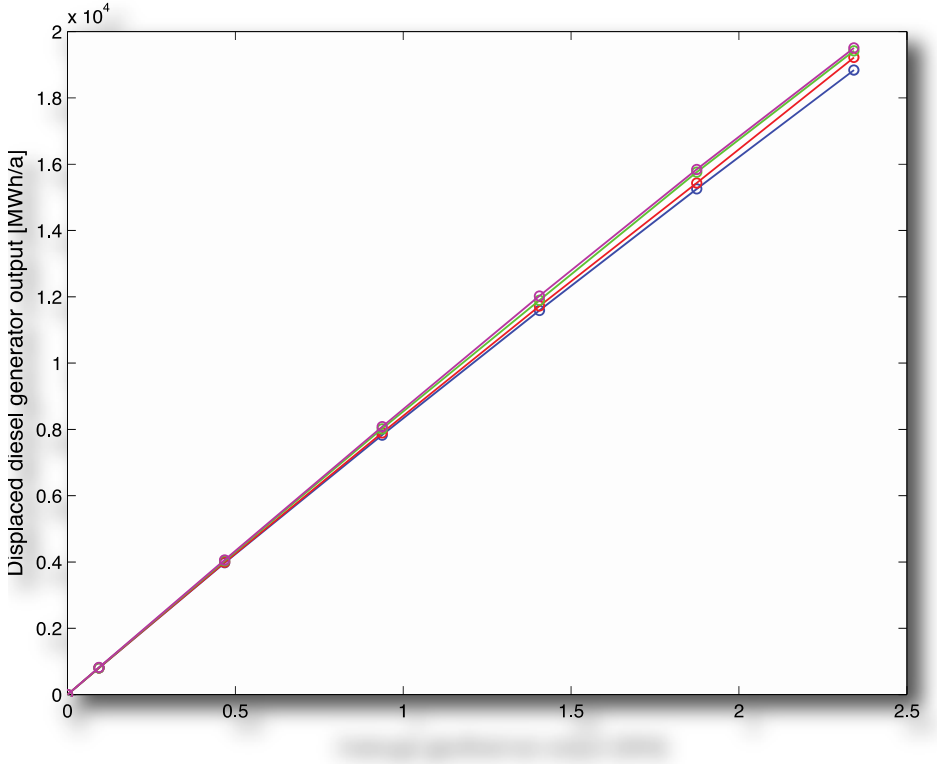
Diverted RE vs. Displaced Diesel





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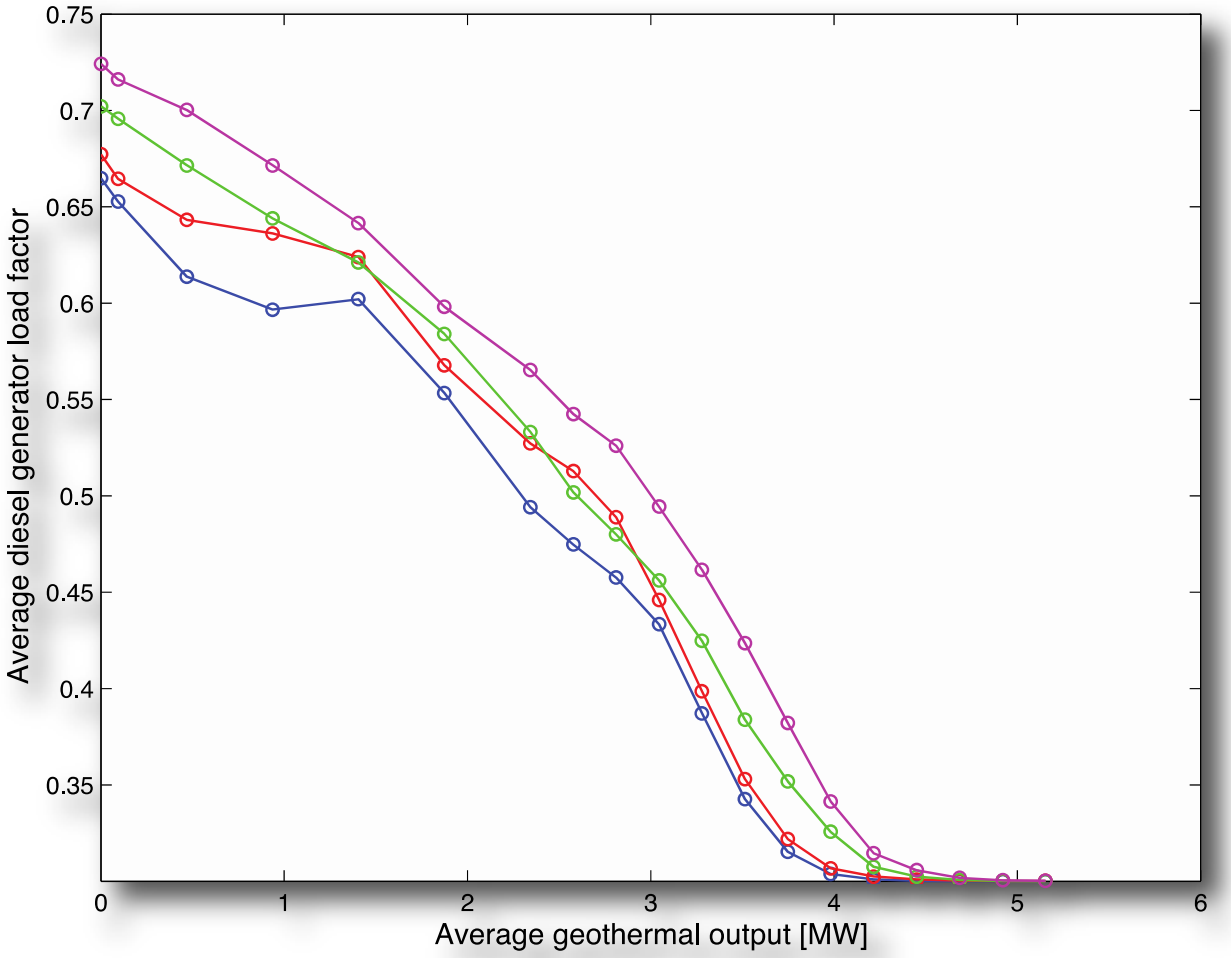
Impact on Diesels - Loading



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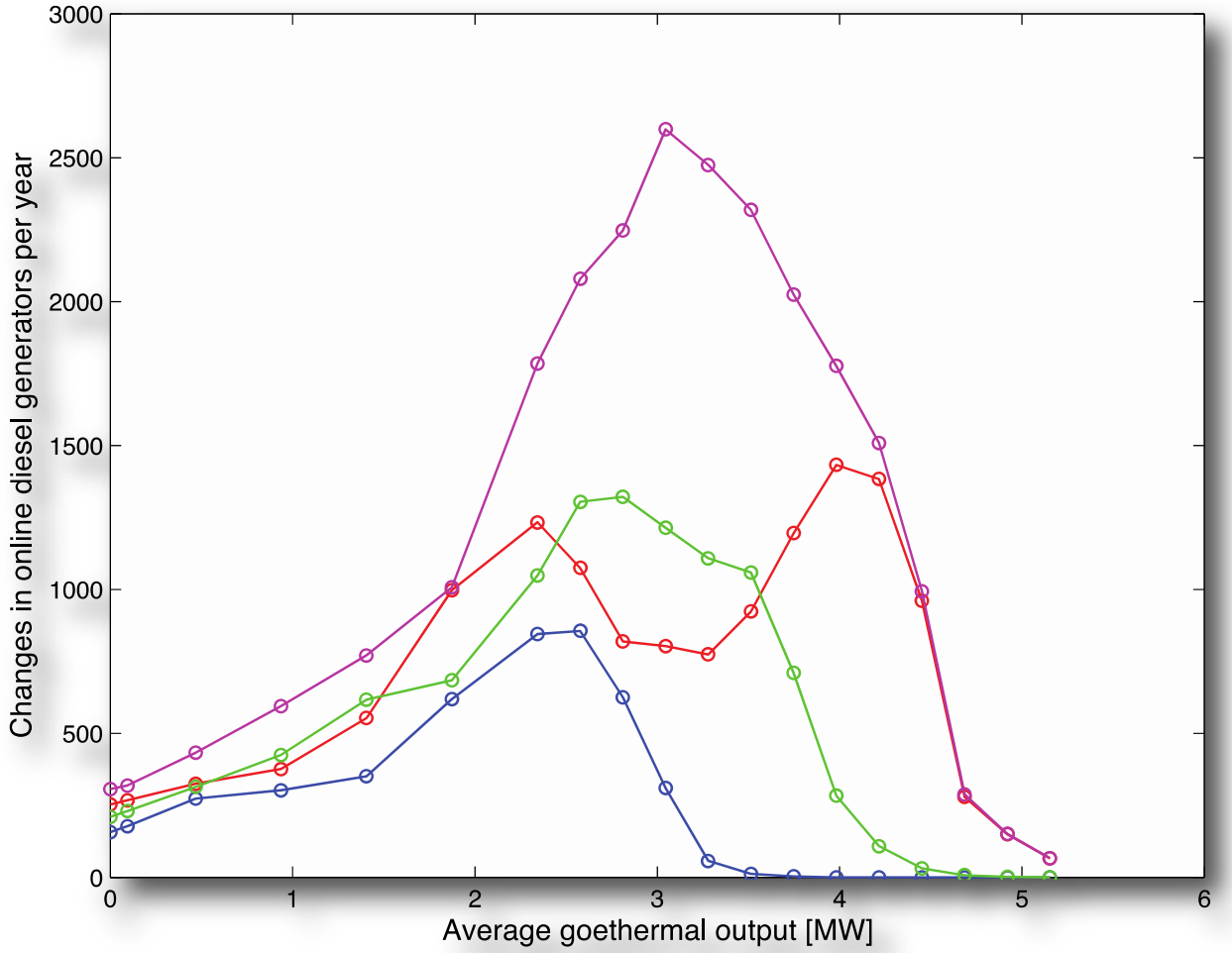
Impact on Diesels - Switching



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Energy mix at 2 MW Geothermal

Total Annual Demand	**35,300 MWh**
Total Wind Energy	4,110 MWh
Scenario 1	
Diesel displaced	15,300 MWh
Wind diverted	1,252 MWh
Geothermal diverted	1.42 MWh
Scenario 2	
Diesel displaced	15,500 MWh
Wind diverted	1,017 MWh
Geothermal diverted	1.36 MWh

Scenario 3	
Diesel displaced	15,800 MWh
Wind diverted	691 MWh
Geothermal diverted	1.29 MWh
Scenario 4	
Diesel displaced	15,900 MWh
Wind diverted	575 MWh
Geothermal diverted	1.21 MWh

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Conclusions

- Adding geothermal:
  - displaces diesel output (linear)
  - increases RE diversion (quadratic)
  - increases diesel switching
  - reduces diesel loading
- Adding diesel generators:
  - reduces RE diversion
  - displaces diesel output
  - increases loading
  - increases switching
- At geothermal outputs above the base load, an engineering solution allowing load following is desirable.

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Jeremy VanderMeer, BS
Alaska Center for Energy and Power
University of Alaska Fairbanks
jbvandermeer@alaska.edu

Questions?

U.S. DEPARTMENT OF ENERGY

ALASKA ENERGY AUTHORITY

Unaatuq LLC
City of Nome/NJUS
Bering Straits Native Corporation
White Mountain Native Corporation
Sitnasuak Native Corporation
Nome Chamber of Commerce
Norton Sound Economic Development Corporation

Arctic Region Supercomputing Center

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