Modeling a Sustainable Energy Transition in Northern Greenland: Qaanaaq Case Study

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Abstract

Many remote subsistence communities in the high Arctic rely solely on fossil fuels for heat and electricity. In Greenland, the government has reduced support for subsistence communities that receive significant fuel subsidies. In order to help enable a pathway for subsistence communities in northwest Greenland to continue their right to self determination, the feasibility of cost saving energy system improvements via renewable energy is explored.

Introduction

Qaanaaq, Greenland is the hub for several primarily subsistence communities in Northwest Greenland. Qaanaaq, located at 77 N latitude, has a population of about 600 people. Qaanaaq's diesel-only energy system is modelled to find the optimal solar and battery energy storage (BES) capacity additions that would minimize overall energy generation costs, and thus maximize project savings for the Greenlandic national utility, Nukissiorfiit.

Methodology

- Qaanaaq's 5 diesel generators are modeled in a cost minimizing, savings maximizing MILP optimization following Qaanaaq's current dispatch order
- Fixed axis solar and Li-ion BES capacity are unforced variables .
- The combination of generators that minimizes total cost over the project lifespan is chosen.
- Electricity sale price is 1.65 Danish Kroner (DKK)/kWh
- Nukissiorfiit estimate to generate electricity in Qaanaaq is 5 DKK/kWh

Table I: Optimized Parameters and Predicted Cost of Energy. Project lifetime savings are the new capacity capital costs subtracted from savings from decreased generation costs

	Solar Capacity	BES Capacity	Overall Cost of Energy	Project Lifetime Savings
Optimized Scenario	750 kW	80kWh	4,0 DKK/kWh	17.000.000 DKK
Forced BES	600 kW	300 kWh	4,1 DKK/kWh	17.300.000 DKK
Base Case (Diesel Only	0 kW	0 kW	5,0 DKK/kWh	0 DKK

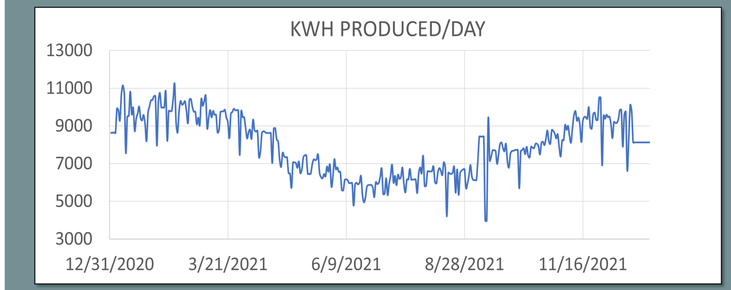

Figure 1: Known energy production in Qaanaaq from 2020-2021. Summertime demand rarely exceeds 300 kWs, and winter demand can exceed 400 kW. Polar day and night make for large seasonal demand changes as opposed to diurnal cycles.

Figure 2: Qaanaaq, Greenland in summer

Results

- By forcing 300 kWh of BES into the model, 1-hr ancillary service can be provided to the town
- 600 kW of solar + 300 kWh BES maximizes project savings by reducing capital costs
- 750 kW of solar + 80 kWh BES minimizes cost to generate electricity by minimizing diesel

Conclusion

Solar and BES can lower energy generation costs in Qaanaaq. Savings do not exceed subsidized sale price but can contribute to decreased costs to subsidize the community for the Government.

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