Availability and Feasibility of Renewables in the Arctic

Magnus de Witt

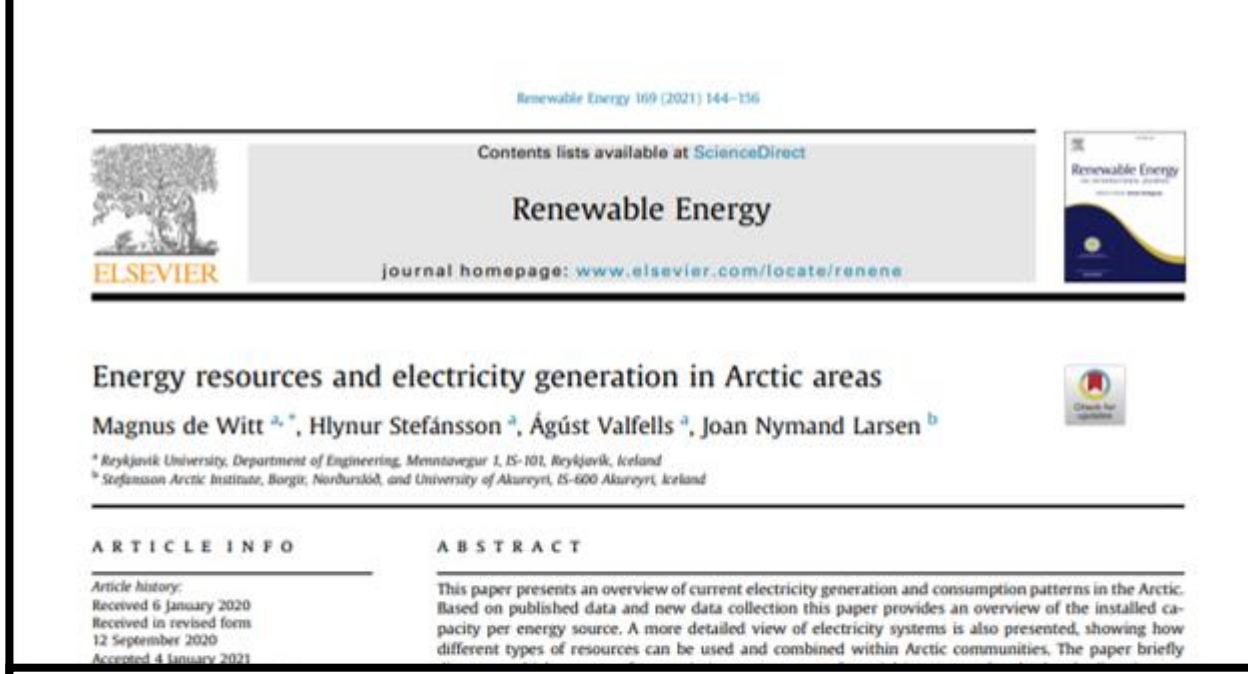
18.11.2021

Intro

- **Current Energy Situation**
- **Renewable Energy Options**
- **Feasibility of Renewables**

29.09.2021

Magnus de Witt



Renewable Energy 169 (2021) 144–156

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

ELSEVIER

Energy resources and electricity generation in Arctic areas

Magnus de Witt [a, *], Hlynur Stefánsson [a], Ágúst Valfells [a], Joan Nymand Larsen [b]

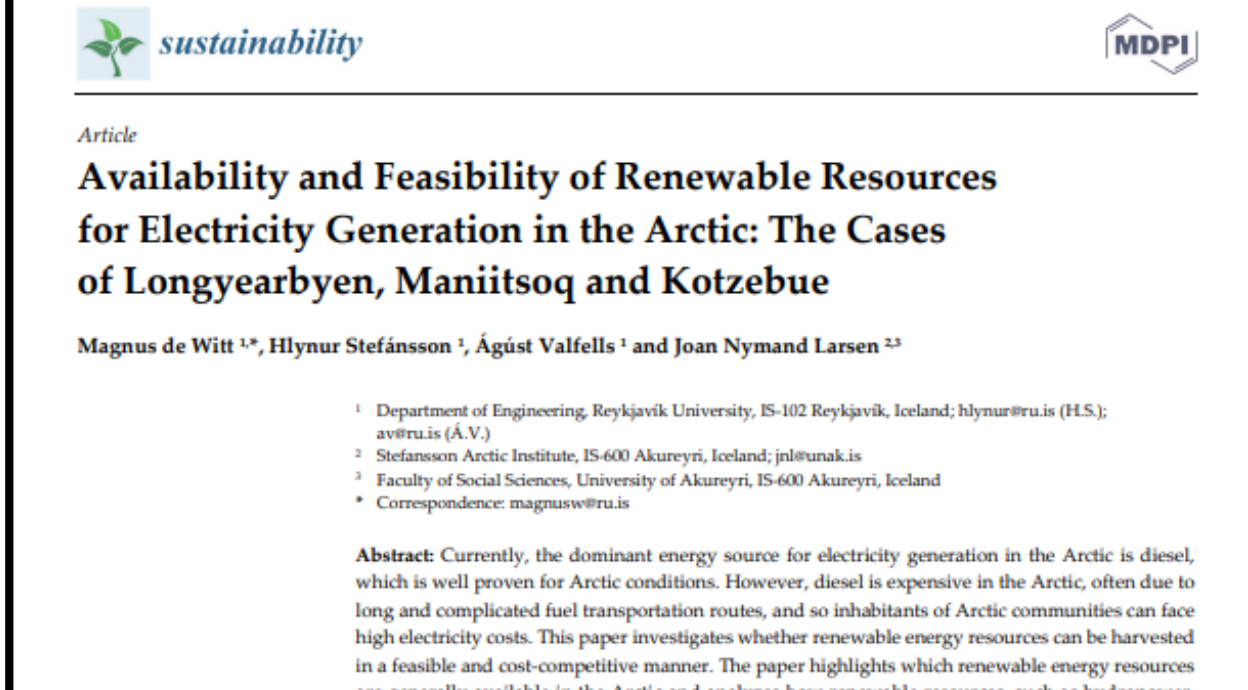
[a] Reykjavik University, Department of Engineering, Menntavegur 1, IS-101, Reykjavík, Iceland
[b] Stefansson Arctic Institute, Borgir, Norðurslóð, and University of Akureyri, IS-600 Akureyri, Iceland

ARTICLE INFO

Article history:
Received 6 January 2020
Received in revised form
12 September 2020
Accepted 4 January 2021

ABSTRACT

This paper presents an overview of current electricity generation and consumption patterns in the Arctic. Based on published data and new data collection this paper provides an overview of the installed capacity per energy source. A more detailed view of electricity systems is also presented, showing how different types of resources can be used and combined within Arctic communities. The paper briefly



sustainability

MDPI

Article

Availability and Feasibility of Renewable Resources for Electricity Generation in the Arctic: The Cases of Longyearbyen, Maniitsoq and Kotzebue

Magnus de Witt [1,*], Hlynur Stefánsson [1], Ágúst Valfells [1] and Joan Nymand Larsen [2,3]

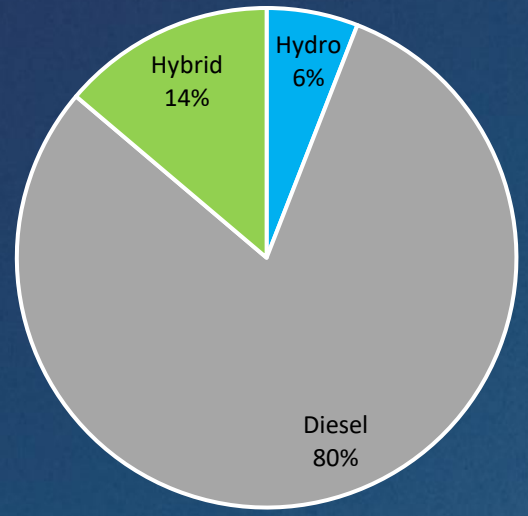
[1] Department of Engineering, Reykjavík University, IS-102 Reykjavík, Iceland; hlynur@ru.is (H.S.); av@ru.is (Á.V.)
[2] Stefansson Arctic Institute, IS-600 Akureyri, Iceland; jnl@unak.is
[3] Faculty of Social Sciences, University of Akureyri, IS-600 Akureyri, Iceland
* Correspondence: magnusw@ru.is

Abstract: Currently, the dominant energy source for electricity generation in the Arctic is diesel, which is well proven for Arctic conditions. However, diesel is expensive in the Arctic, often due to long and complicated fuel transportation routes, and so inhabitants of Arctic communities can face high electricity costs. This paper investigates whether renewable energy resources can be harvested in a feasible and cost-competitive manner. The paper highlights which renewable energy resources

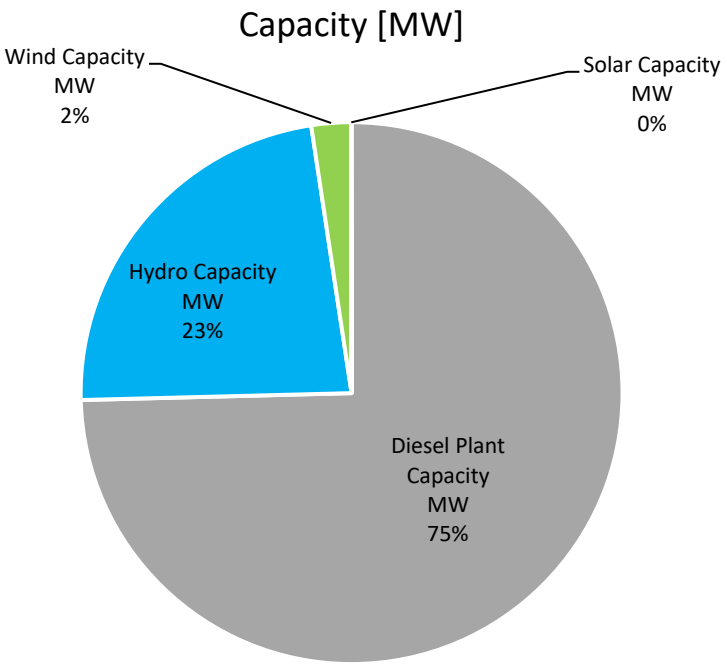
Current Electricity Supply

- Remote Arctic communities
- 80% of the Arctic communities are reliant on diesel
- The diesel fuel is imported
- Diesel has proven suitable for Arctic conditions
- Very suitable for emergency engines because of the quick black start

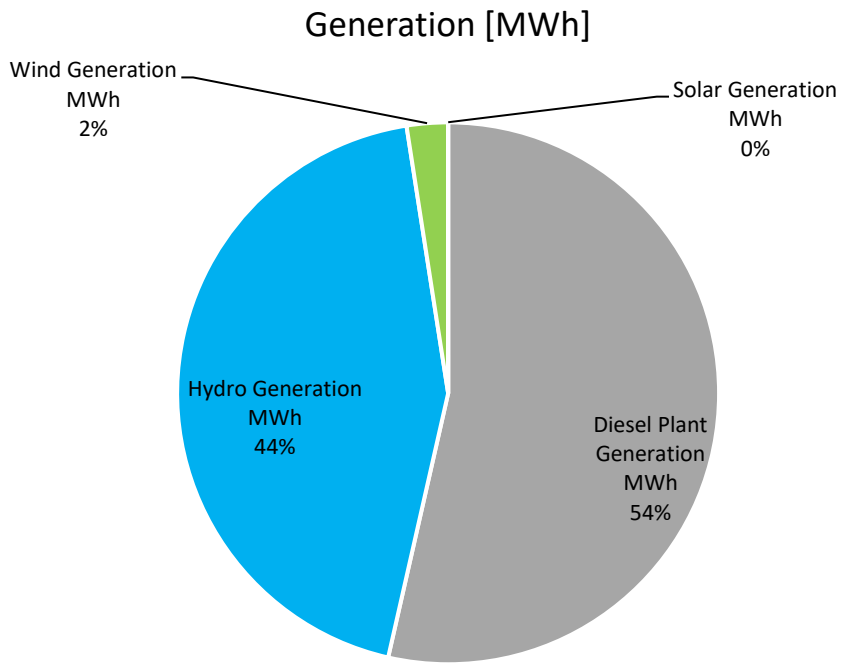
El. Supply by Communities



Current electricity Generation



Current electricity Generation



Electricity Supply

- Fuel Import
  - Risk of fuel spills
  - High expenses
  - Risky transportation


Source: Mark Moore

Table 4
Summary of the main properties of energy generation technologies and energy sources in the Arctic. * The high spread in cost per kW is the result of the vast range of engine sizes.

	Diesel	Hydro-	PV	Wind
Lifetime (Years)	10–20	50–100	25	20
Cost per kW (USD)	1800–10,000 USD*	2000–6500 USD	5500–7500 USD [39]	2500–7000 USD
Payback time [years]	3	20	20 [13] ~5 [70] 2–7 [26]	10
Environmental impact	Land use CO2 PM NOX Noise	Land use Fish migration	Land use	Land use Birdlife Visual effect Noise

Electricity Supply - Hydro

- Large installation
- Supply can follow demand

Electricity Supply - Wind

- Significant wind potential in coastal areas, where the majority of the communities is located
- Higher performance under cold conditions
- Material properties
- Ice formation at the blades
- Impact on wildlife

Electricity Supply - PV

- Installed Capacity of 1.6MW
  - 30% under 10kWp
  - 70% above 10kWp
- Cold temperatures increases the efficiency up to 20%
- Reflection of snow increases the yield

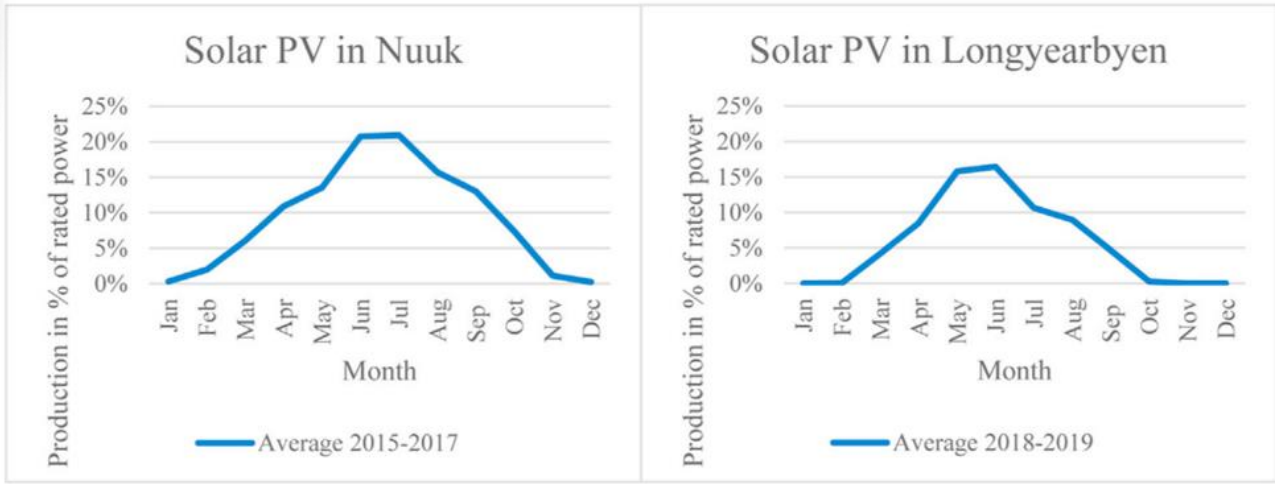


Fig. 11. The figures show examples of the use of solar power based on monthly averages in selected locations in the Arctic. Solar power for electricity generation in Nuuk (64110 01”N, 51430 0900W) (Data provided by Nukissiorfiit the national electricity company of Greenland) and Longyearbyen (78140 5100N, 15290 4900E) (Data provided by Avinor the national own airport operator in Norway).

Energy Security

- Responsiveness of the Grid
- Hybrid Systems
  - The Diesel generator can handle up to the non-dispatchable energy
  - Diesel Generators can provide a constant voltage and frequency
- Diversification of energy sources

Energy Affordability

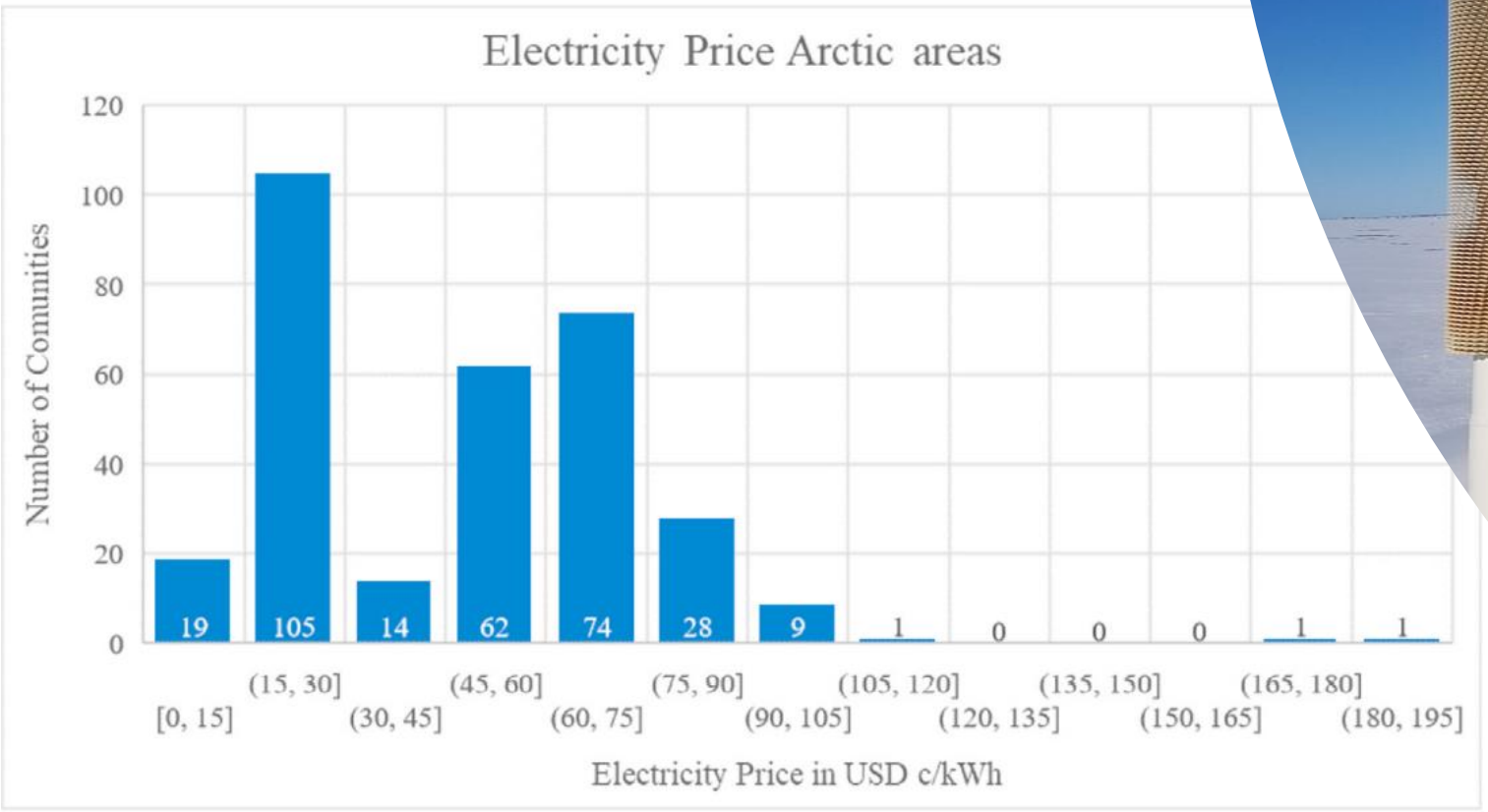


Fig. 13. Electricity price in Arctic areas, which can range from 8 to 181 USD ¢/kWh (both prices are found in Alaska).

Energy Affordability

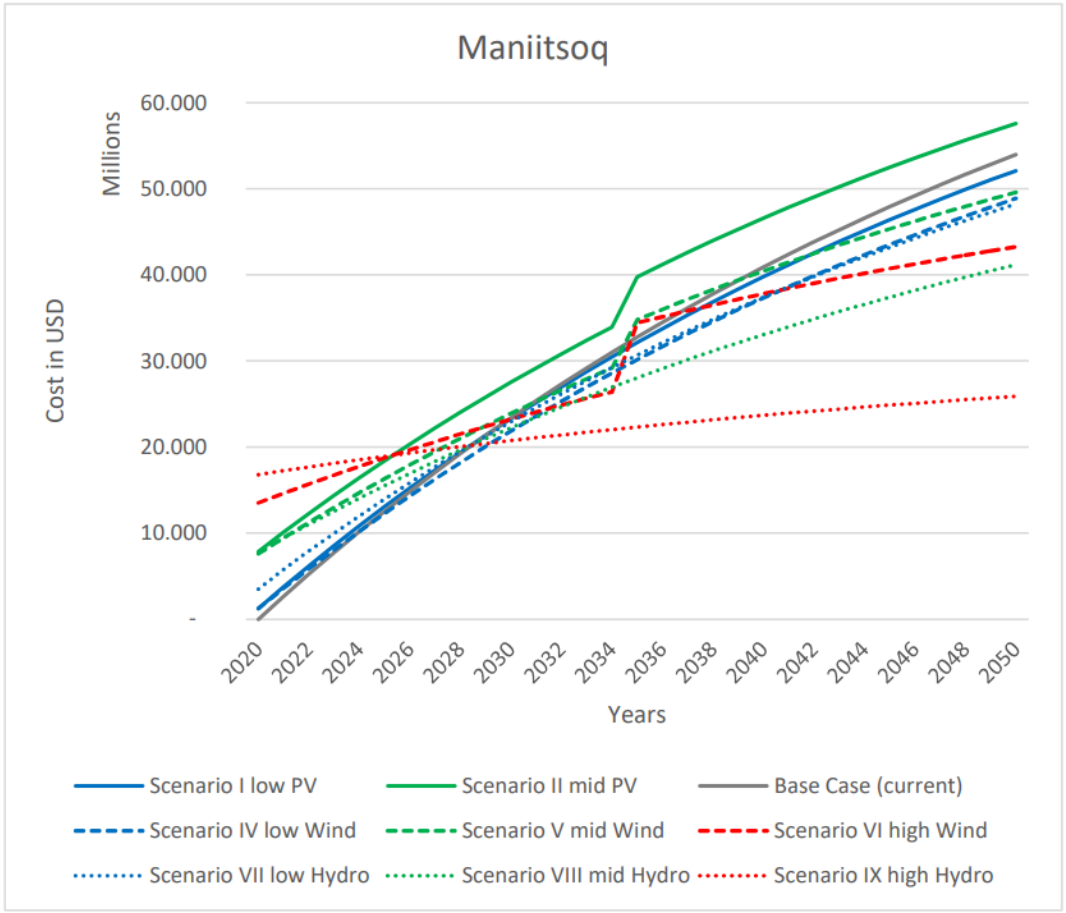


Figure 4. Scenario analysis of possible power generation for Maniitsoq shows the accumulated net present value of cost for power generation with a diesel price of 0.85 $/l; capacity factor of 28%; and fuel consumption of 0.25 l/kWh. The other input data are explained in Table 1, and the scenarios are presented in Table 2. The current setup is close to the base case; Maniitsoq has 0.1% renewables in the mix.

Energy Affordability

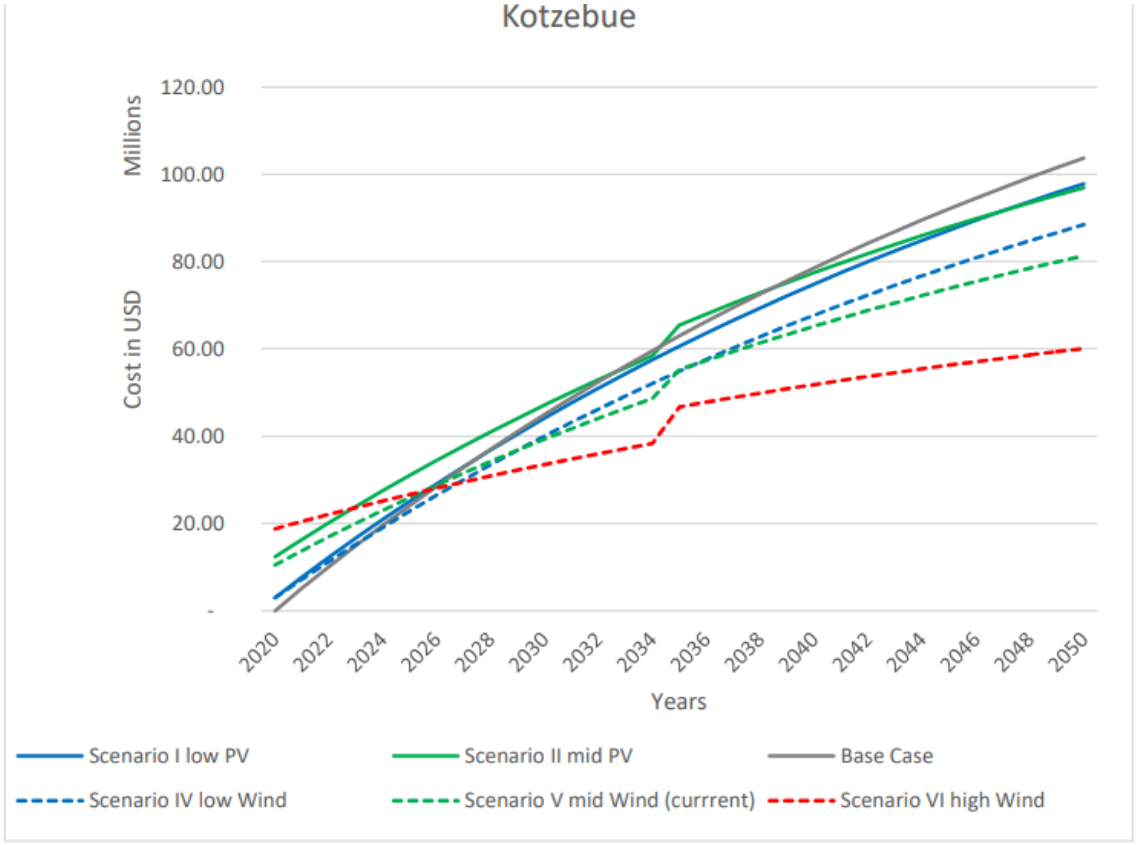


Figure 5. Scenario analysis of possible power generation for Kotzebue shows the accumulated net present value of the cost for power generation with a diesel price of 0.91 $/l; capacity factor of 17%; and fuel consumption of 0.28 l/kWh. The other input data are explained in Table 1, and the scenarios are presented in Table 2. The current setup is close to scenario V; Kotzebue has 18% renewables in the mix.

Conclusion

- Energy source diversification
- Renewables make the electricity price more robust
- Renewables can help to reduce the cost burden
- There is no one fits all solution
- The integration process has to be studied further

Thanks for your Attention

Magnus de Witt
Reykjavik University
magnusw@ru.is