UNIVERSITY of Prince Edward ISLAND

Dalhousie University
RESL
Renewable Energy Storage Laboratory

Challenges and Impacts of Modelling Pathways Towards Net Zero Carbon for a Remote Community in Northern Canada

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Carrefour de modélisation énergétique | Energy Modelling Hub
www.cme-emh.ca

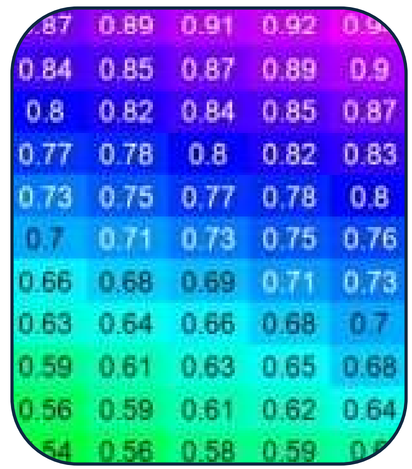
AGENDA

INTRODUCTION

RESEARCH BACKGROUND

FACTORS FOR DECARBONIZATION

FACTORS FOR MODELLING DECARBONIZATION

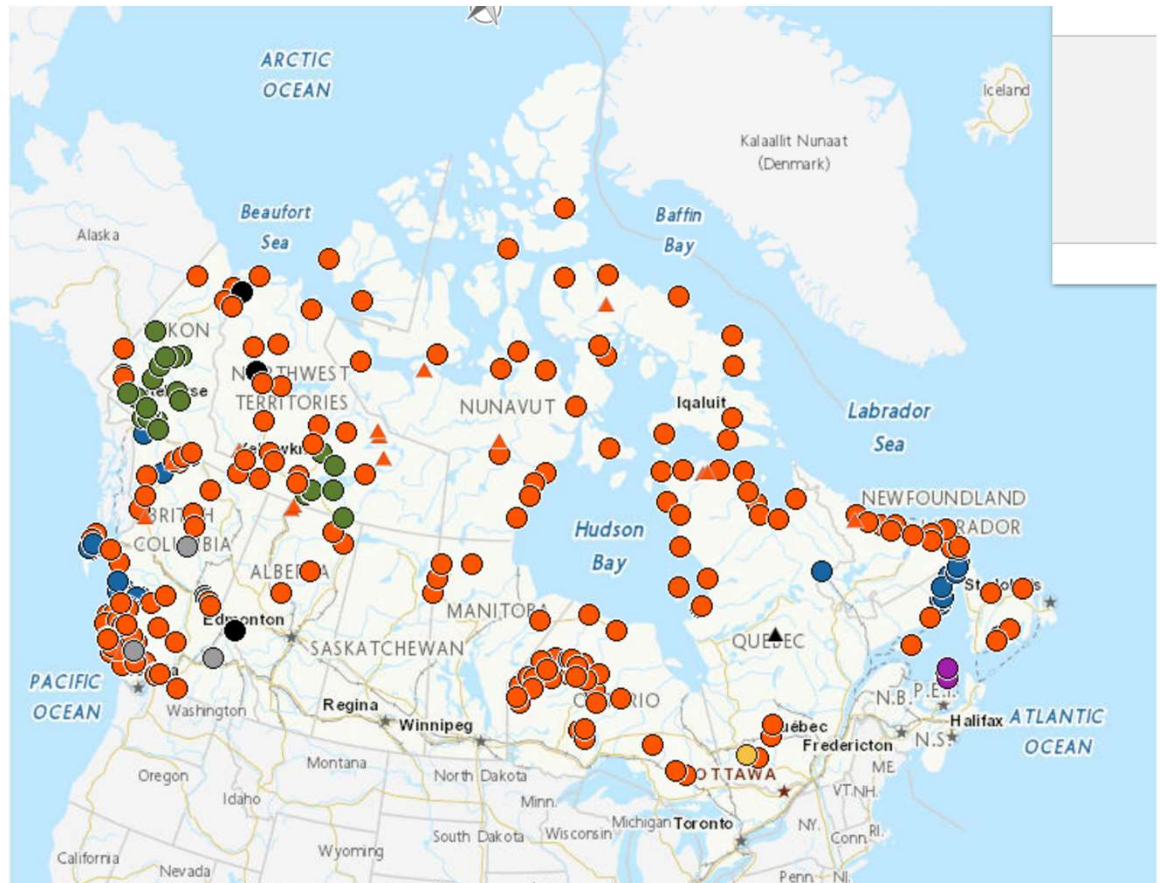


CONCLUSION

INTRODUCTION

REMOTE COMMUNITIES IN CANADA

- Over 200 remote communities in Canada
    - Majority indigenous communities and diesel powered (red dots)
- What's great about diesel?
    - No energy storage (just stored energy)
    - Historically cheap and simple
    - Energy dense
- What's not so great?
    - Carbon emissions
    - Unpredictable supply
    - No longer cheap



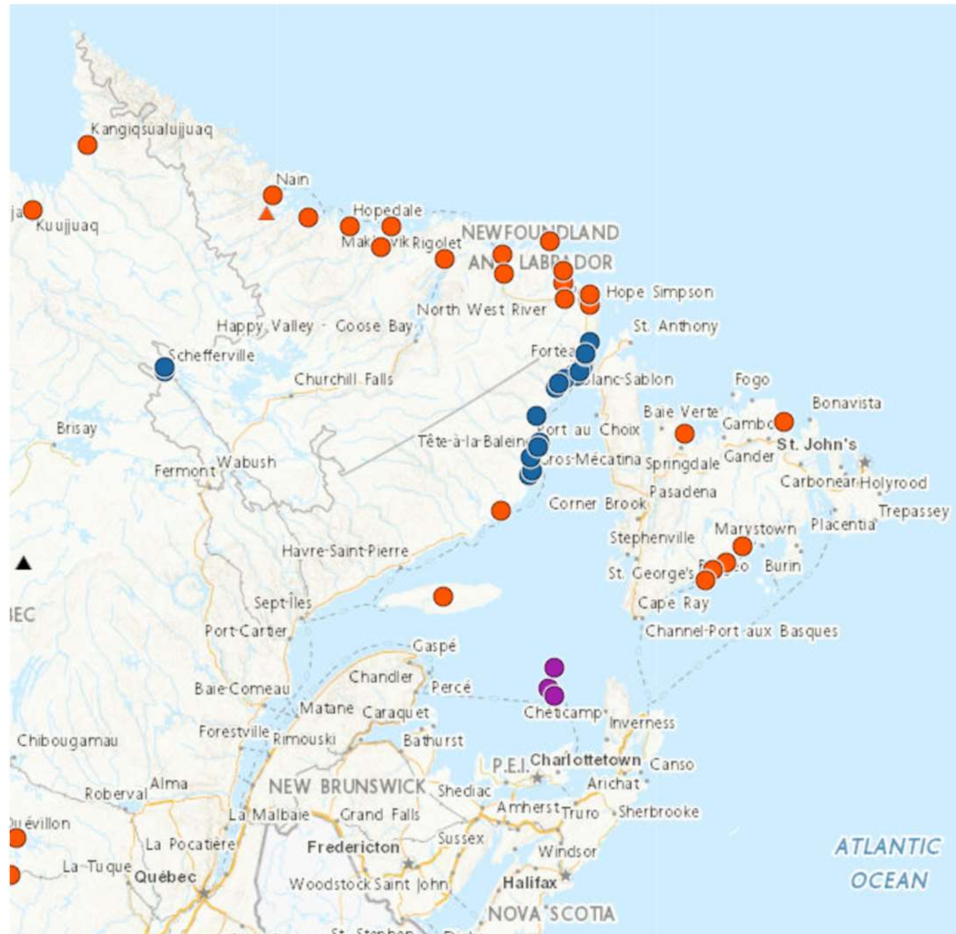
Government of Canada - https://atlas.gc.ca/rced-bdece/en/index.html

CONTEXT IN ATLANTIC CANADA

Indigenous Leadership Fund (November 2023)
- $180 million federal funding by 2029
- Part of an existing agreement between Canada and Newfoundland and Labrador

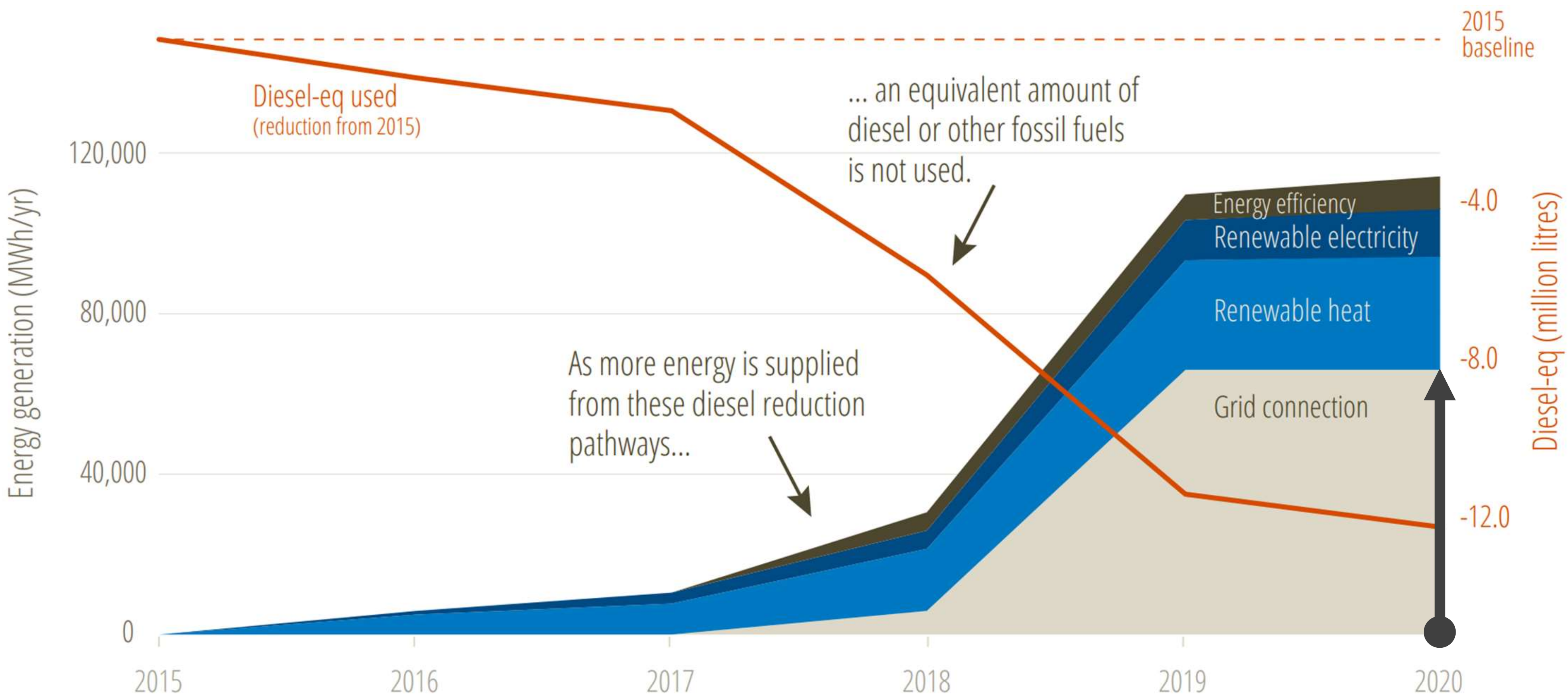
Indigenous Off-Diesel Initiative (June 2022)
- $21.6 million nationally in funding to 14 Indigenous communities
- Two communities located in Atlantic Canada

Wah-ila-toos Partnership (April 2022)
- $300 million federal funding
- Dedicated to projects in Indigenous, **rural,** and remote communities in Canada



Government of Canada - https://atlas.gc.ca/rced-bdece/en/index.html

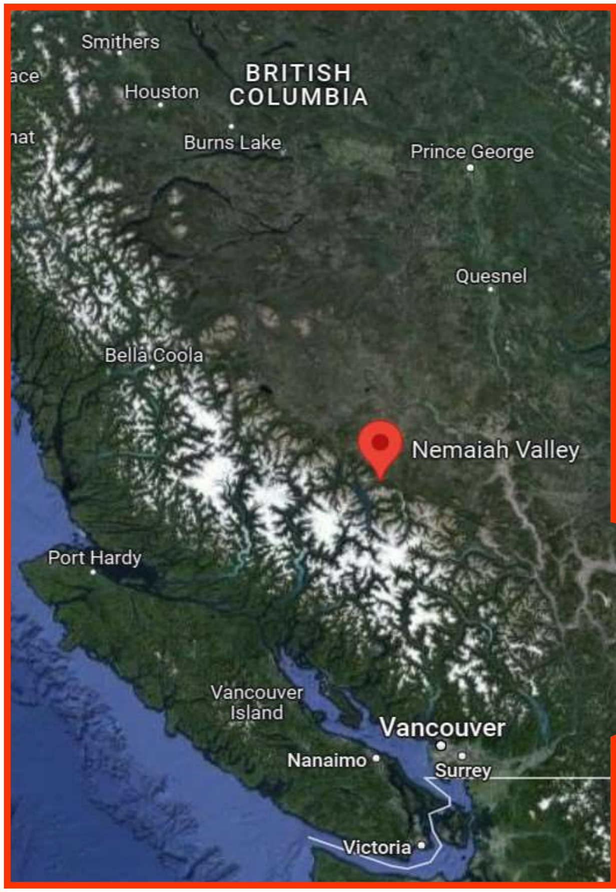
WORK TO DATE…

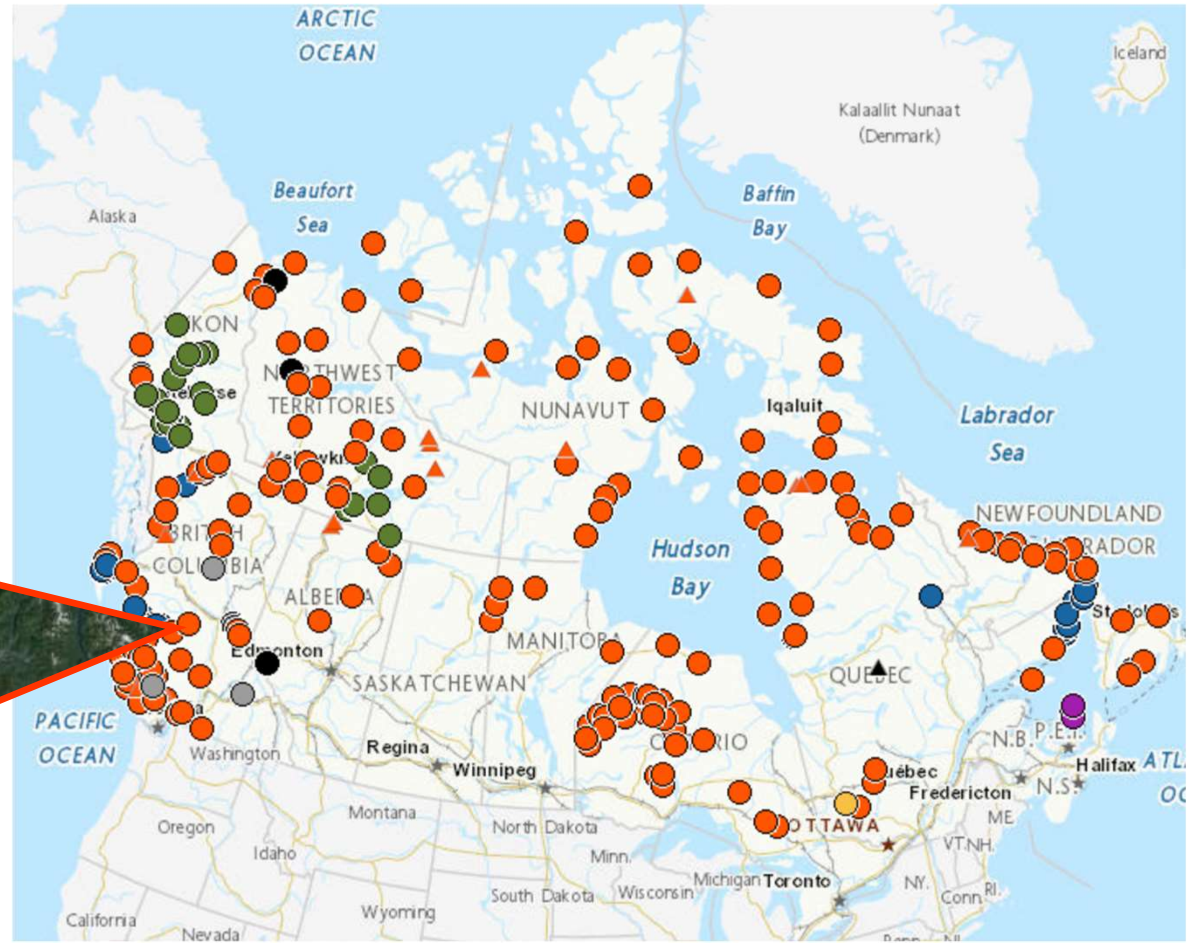


Pembina Institute – https://www.pembina.org/reports/diesel-reduction-technical-report-final.pdf

RESEARCH BACKGROUND

CASE STUDY – NEMAIAH VALLEY

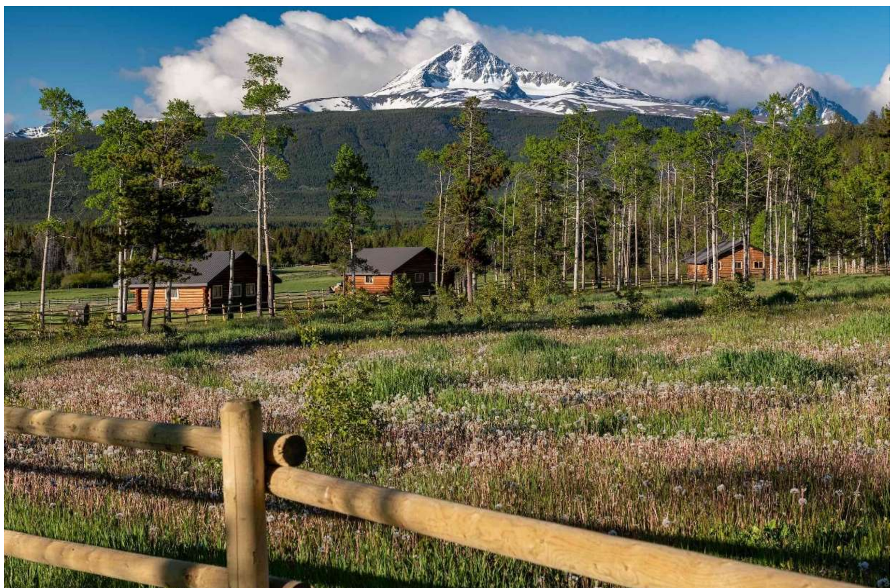




CASE STUDY – NEMAIAH VALLEY

- Typical temperature range: -30°C to 30°C
- Home to the Xeni Gwet'in Indigenous Peoples
- Population of 200 permanent residents (82 homes)
- Commercial sites including office building, convenience store, daycare, health centre

- First indigenous community in Canadian history to legally obtain "Aboriginal Title" land ownership
  - Right to occupy land, control how it is used, and benefit economically from the resources



Nemiah Valley Lodge - https://www.nemiahvalleylodge.com/nemiahgallery

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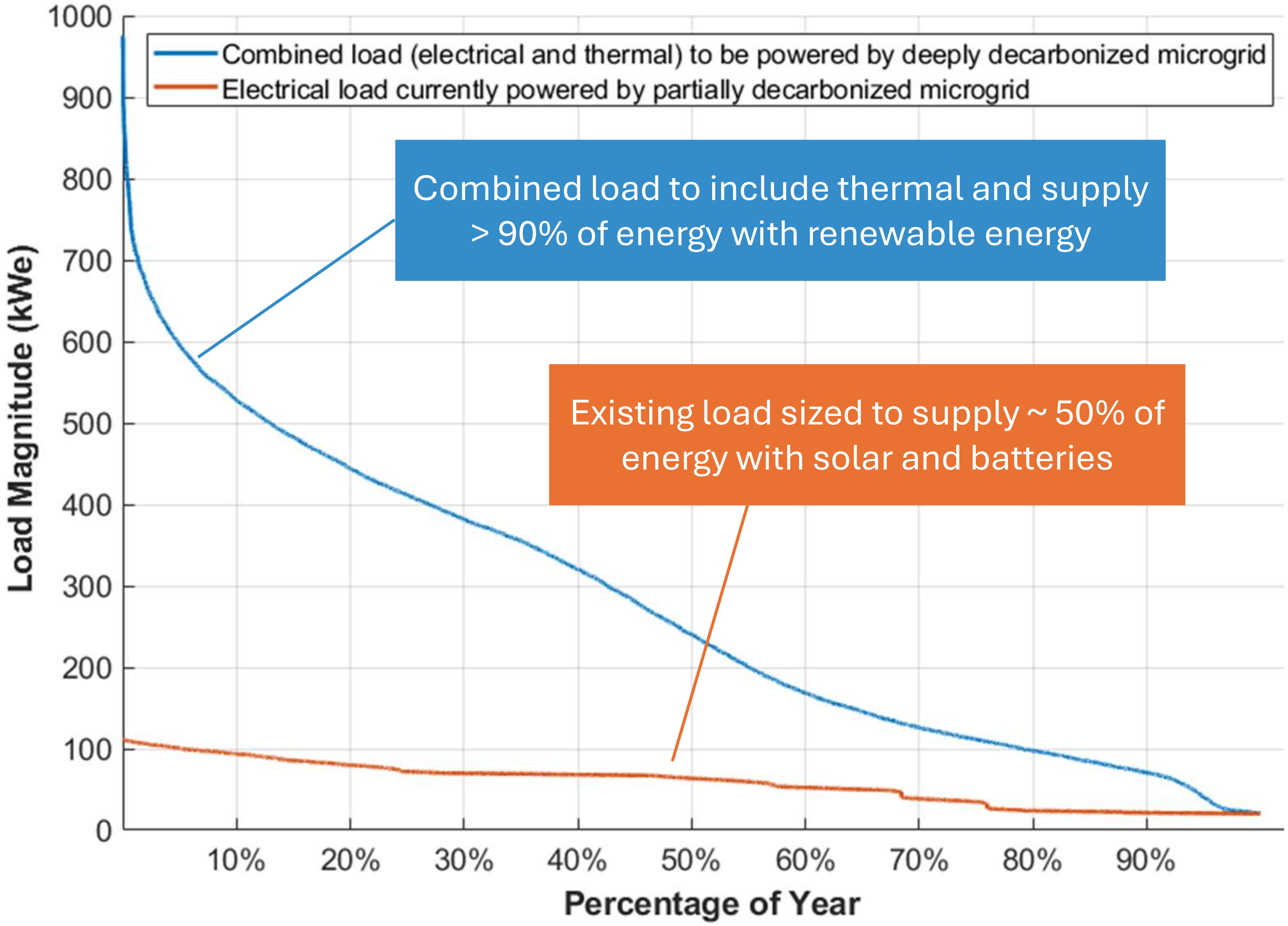
CURRENT MICROGRID

- Existing microgrid has been partially decarbonized to power 50% of electrical load with PV/Battery
- Space heating and domestic hot water (thermal loads) are not currently served by the microgrid

Equipment Installed

- 3 x 95 kW diesel generators
- 250 kW central PV (dc-coupled)
- 28 kW residential distributed PV (ac-coupled)
- 1 MWh BES
- 2 x 150 kVA power conversion system

ENERGY USE IN THE NEMAIAH VALLEY



Currently…

- **Thermal load** served by burning wood and liquid propane furnaces
- **Electrical load** served by microgrid

Interested in…

- **Thermal and electrical** load served by microgrid

A PV/BES system can't economically serve both the electrical and thermal loads.

DECARBONIZING THE NEMAIAH VALLEY

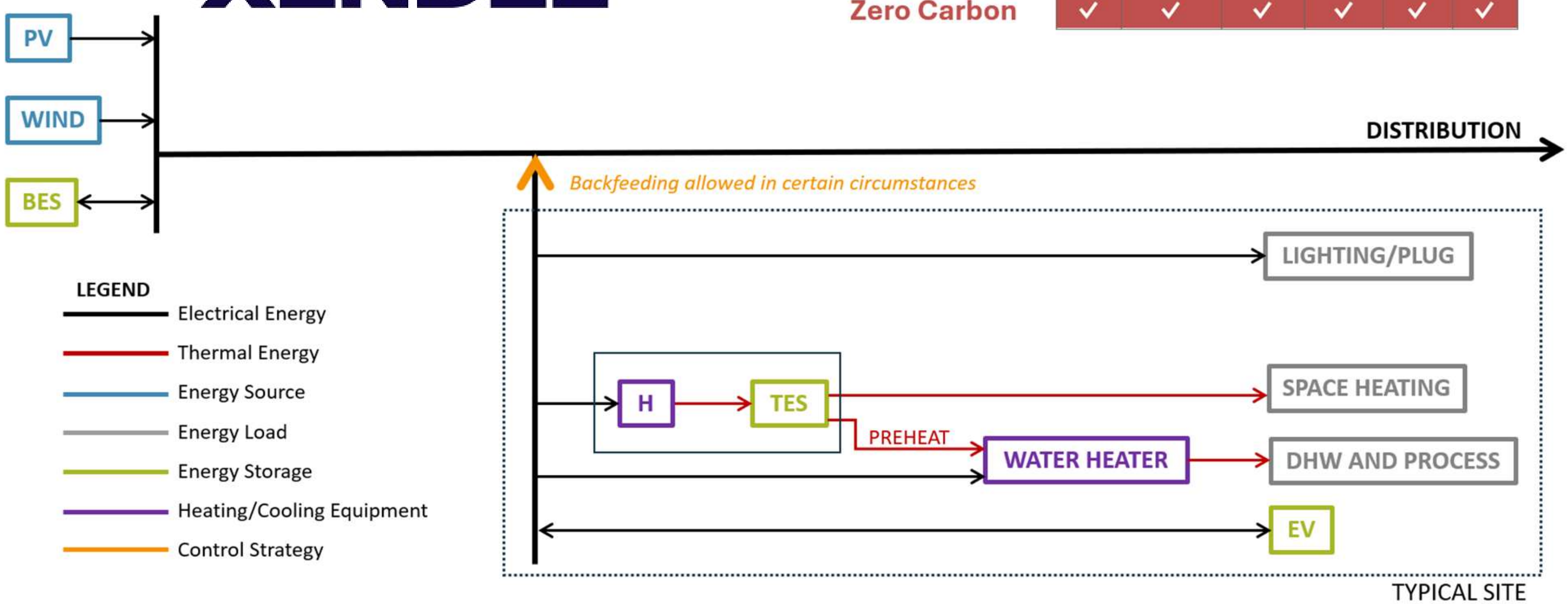
MODELLING SOFTWARES

HOMER Pro

XENDEE

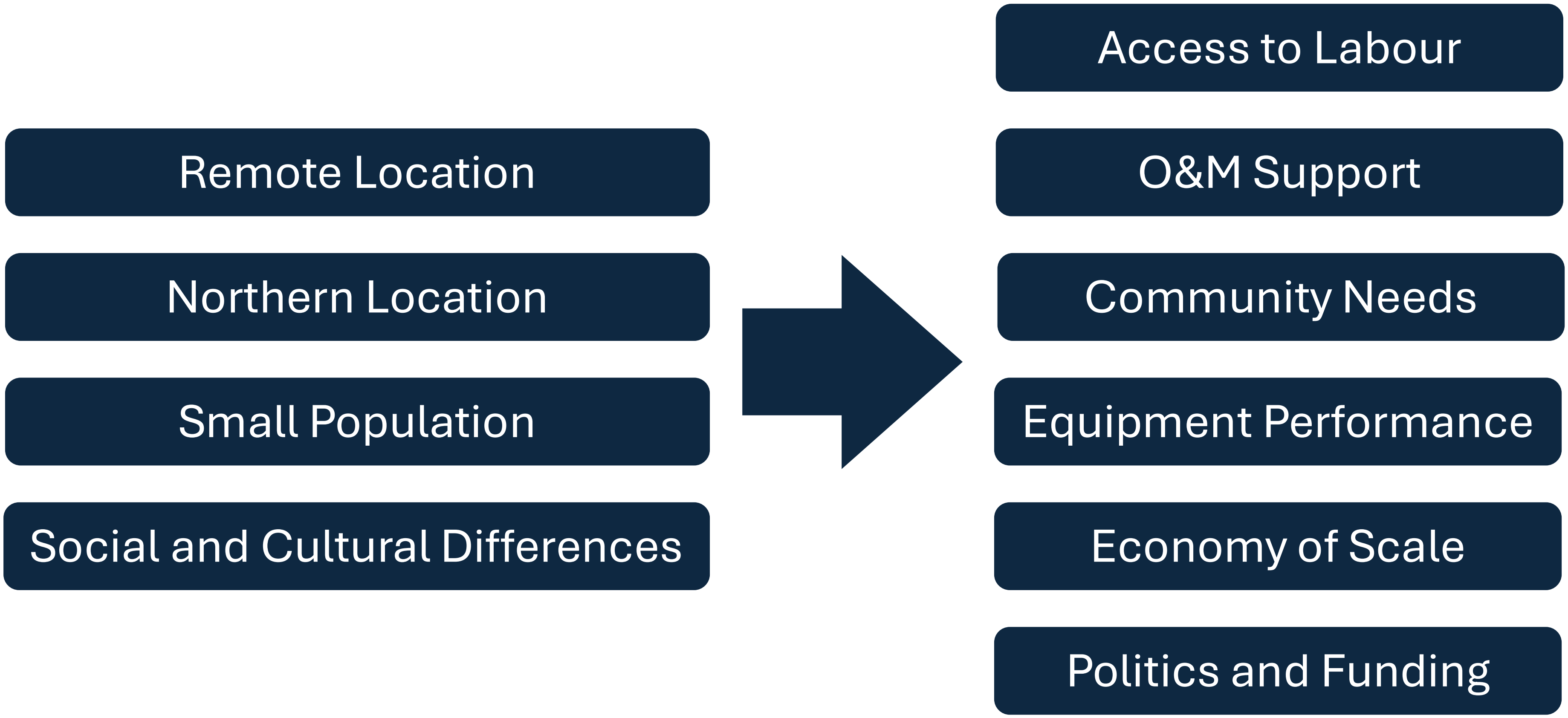
DECARBONIZATION PATHWAYS

	PV	Wind	BES	TES	HP	EV
BES Storage	✓	✓	✓			
Hybrid Storage	✓	✓	✓	✓		
Heat Pump	✓	✓	✓	✓	✓	
Electric Vehicle	✓	✓	✓	✓		✓
Zero Carbon	✓	✓	✓	✓	✓	✓



FACTORS FOR DECARBONIZATION

DECARBONIZING – CHALLENGES AND IMPACTS



CHALLENGES IN THE MODELLING CONTEXT…

INPUTS

1. Identifying current conditions
2. Atypical and variable load profiles across communities
3. Unpredictable project economics
4. Community needs

SYSTEM BEHAVIOR

1. Deep decarbonization
2. Impact of microgrid controllers on system stability

Whapmagoostui, Quebec – CBC Radio (2016)

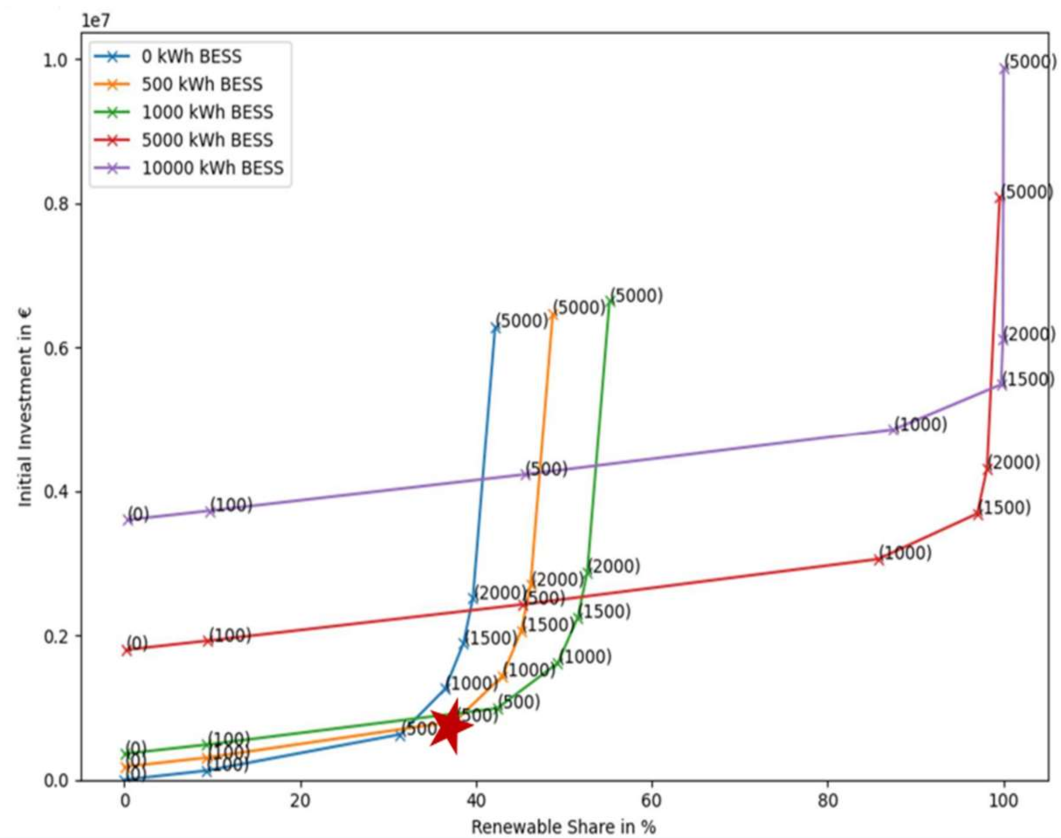
Gaultois, Newfoundland and Labrador – Feehan (2023)

Prairie Creek Zinc Mine, Northwest Territories – Williams (2021)

CHALLENGES IN THE MODELLING CONTEXT...

SYSTEM BEHAVIOR

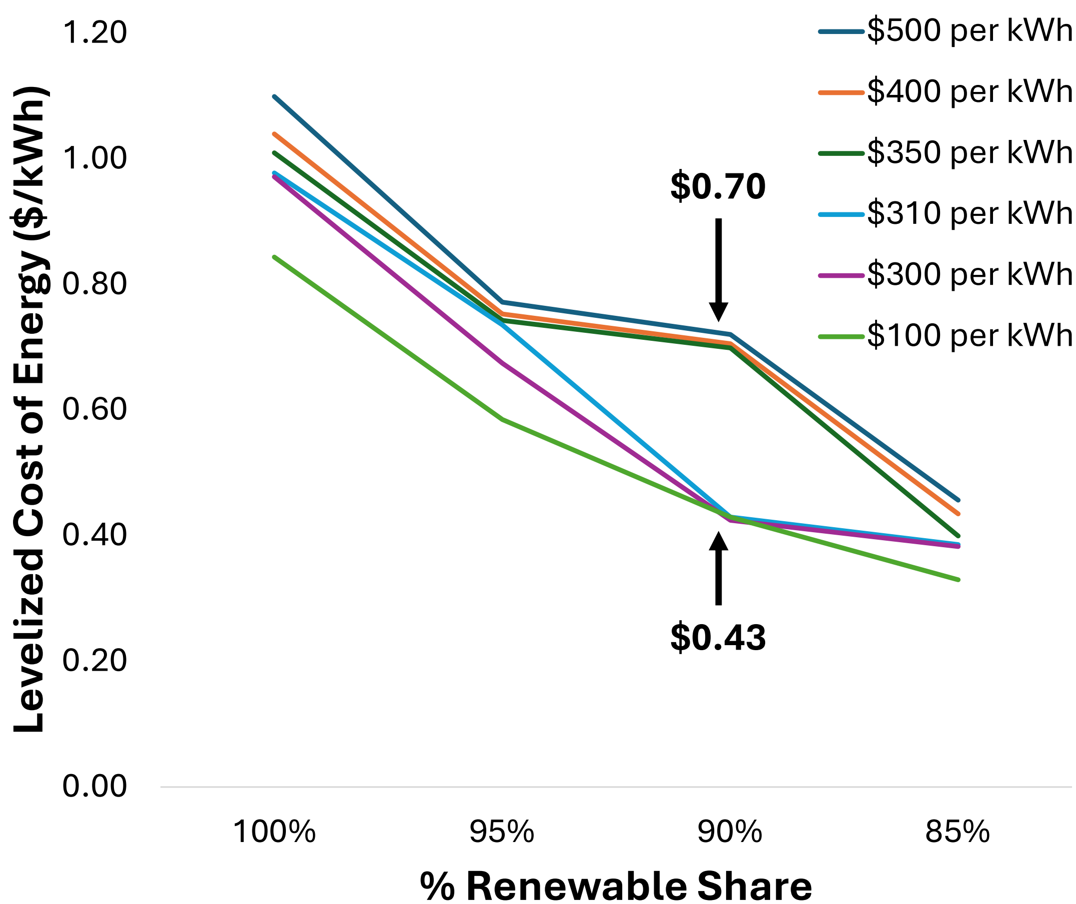
1. Deep decarbonization
   - Plot shows differences in capital cost for a Haiti community at different % of renewable shares
   - Non-linear rise in capital cost due to system oversizing to meet 100%



ANALYSIS, CLASSIFICATION AND ECONOMICAL COMPARISON OF LI-ION BATTERY OFF- GRID SYSTEMS, F. Stortz (2024) - https://www.ise.fraunhofer.de/

DEEPER DECARBONIZATION – NEMAIAH VALLEY

- Plot shows LCOE for varying costs of energy storage with PV/Wind/ESS system
- Difference at 90% renewable share between $310 and $350 per kWh
  - Increasing ESS cost increases generation capacity
- Peak demand occurs at low solar resource – dependent on wind
  - Model phases out PV due to sensitivity of peak demand and resource availability



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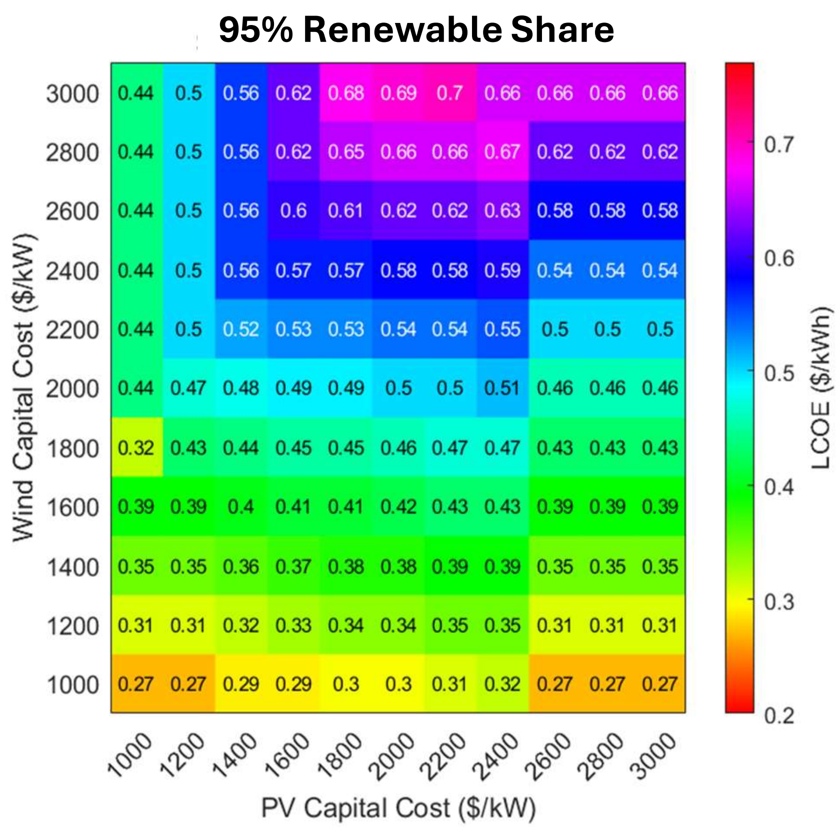

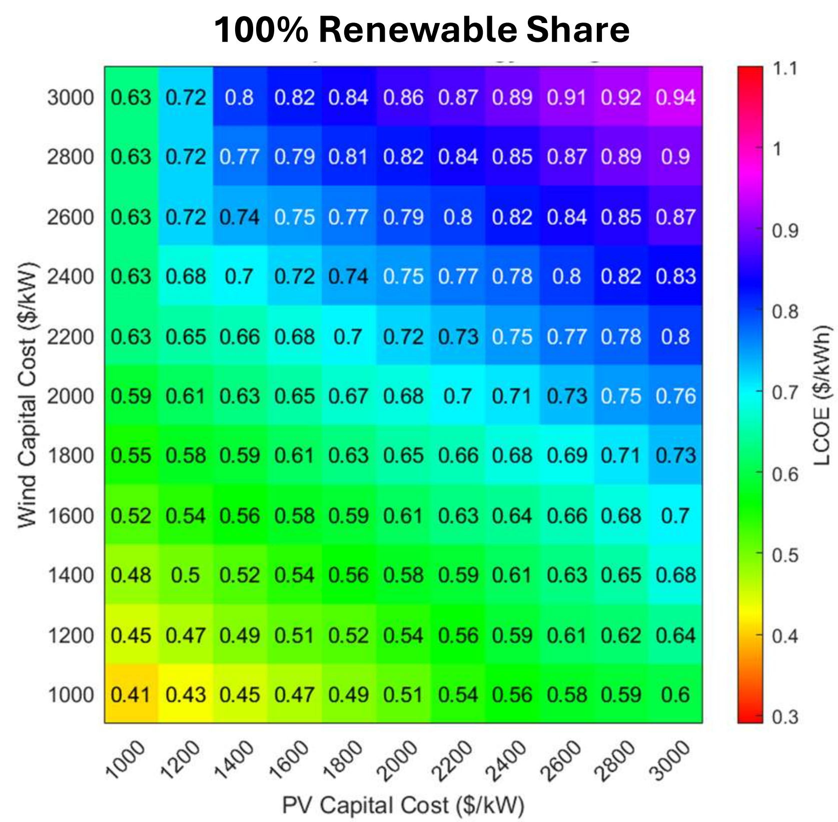

CONCLUSION

CONCLUSION

- Model limits are more sensitive to load and resource inputs at deeper decarbonization
    - Better understanding of these inputs may help mitigate economic impact of oversizing system
    - Often more challenging to obtain than grid-connected communities

- **Not just community engagement – community involvement**
    - "So many of our communities are already mitigating climate change, they're already creating pathways for adaptation to climate change and yet we're not recognized as being key players. Yes, we'll need solar, wind and geothermal energy, but unless we also have that intimate connection and understanding of the land, I don't know if there is any hope." *Eriel Deranger (2020), Executive Director of Indigenous Climate Action (ICA)*

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