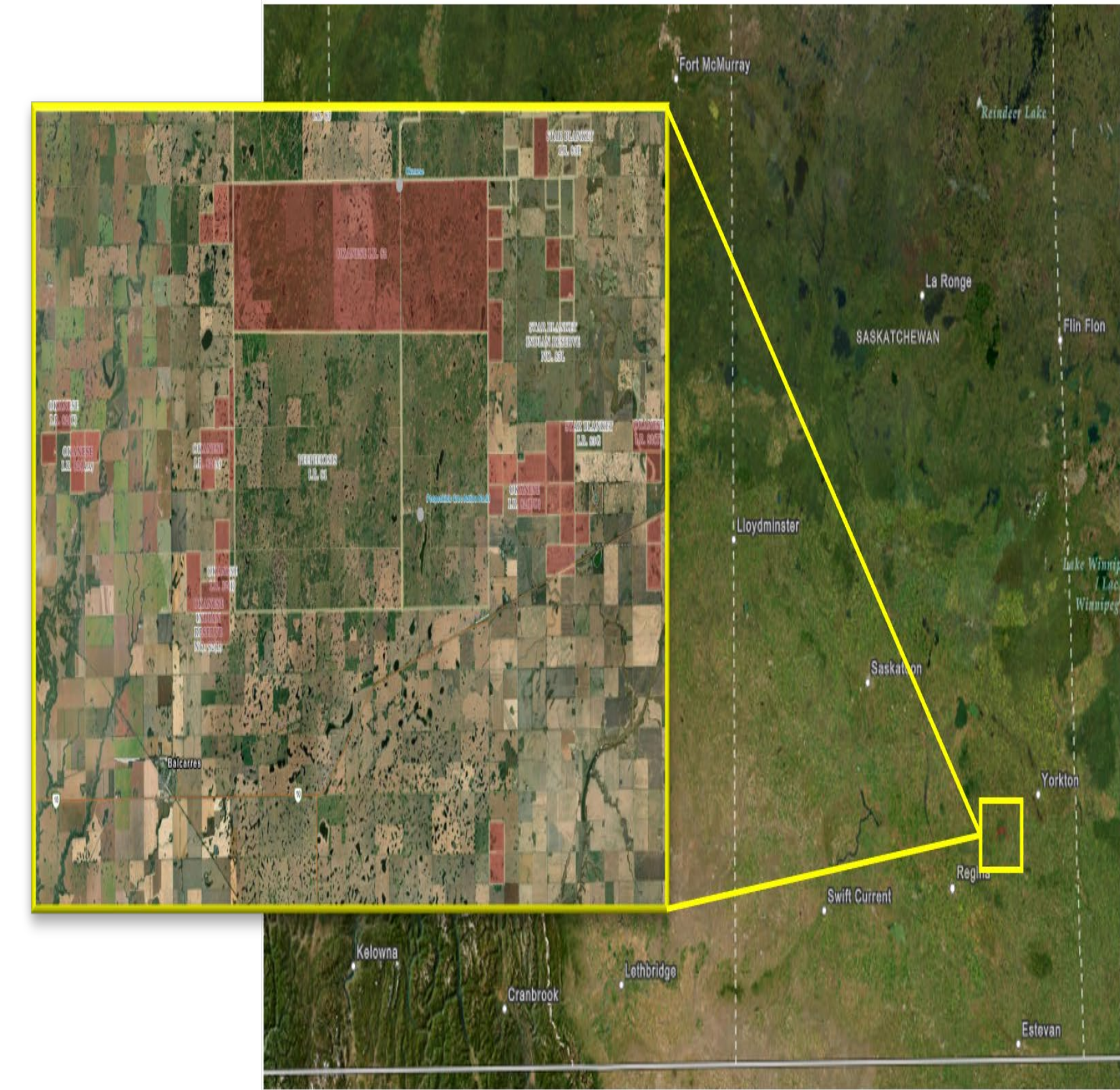


Energizing Sovereignty: A Techno-Economic and Financial Roadmap for Renewable Integration for the Okanese First Nation

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INTRODUCTION

The Okanese First Nation, a Treaty 4 signatory in Saskatchewan, is pursuing clean energy to foster self-determination and economic empowerment. The community currently relies on a provincial grid that is 85% fossil-fuel dependent. Furthermore, the suspension of SaskPower's Renewable Access Service (RAS) program has blocked traditional large-scale export projects, leaving the Nation vulnerable to high retail electricity costs. This research proposes a strategic pivot to decentralized, "Behind-the-Meter" (BtM) microgrids, allowing the Nation to bypass monopoly restrictions, transition from passive consumers to active energy owners, and retain wealth internally.



Adapted from ArcGIS Online (n.d.). <https://maps.arcgis.com/>

RESEARCH QUESTION

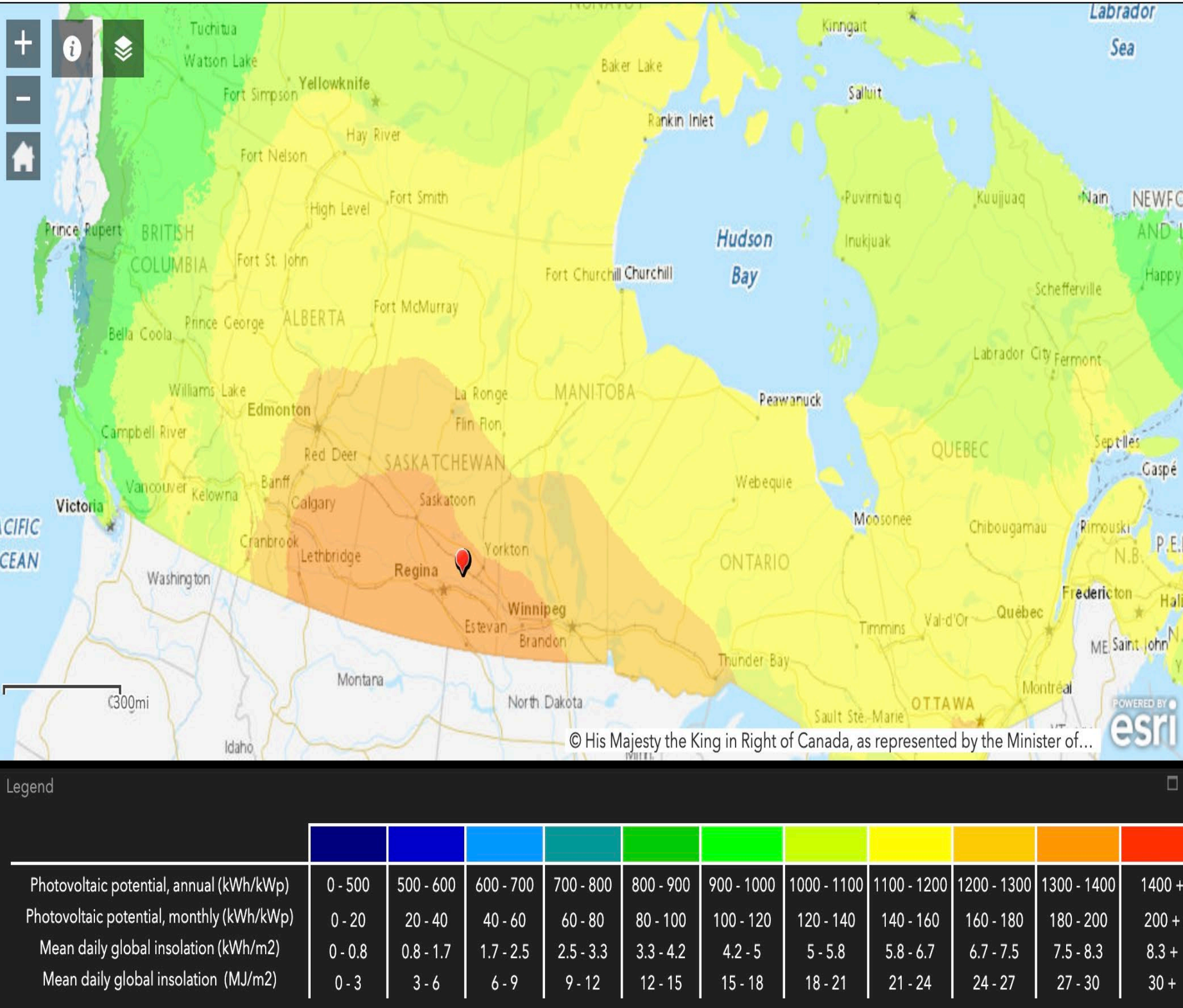
How can the Okanese First Nation achieve energy sovereignty and economic viability through a "behind-the-meter" renewable energy strategy under a restrictive utility landscape?

OPPORTUNITY

Solar Resource: Saskatchewan solar photovoltaic potentials in Canada. The Okanese First Nation territory receives exceptional annual solar irradiation, reaching up to 1300–1400 kWh/kWp/year.

Land Flexibility: The Nation holds rights to over 10,000 hectares of reserve land.

The Strategic Fit: Capitalizing on this solar potential through a Behind-the-Meter (BtM) model transforms a natural resource into direct operational savings using a minimal land footprint.

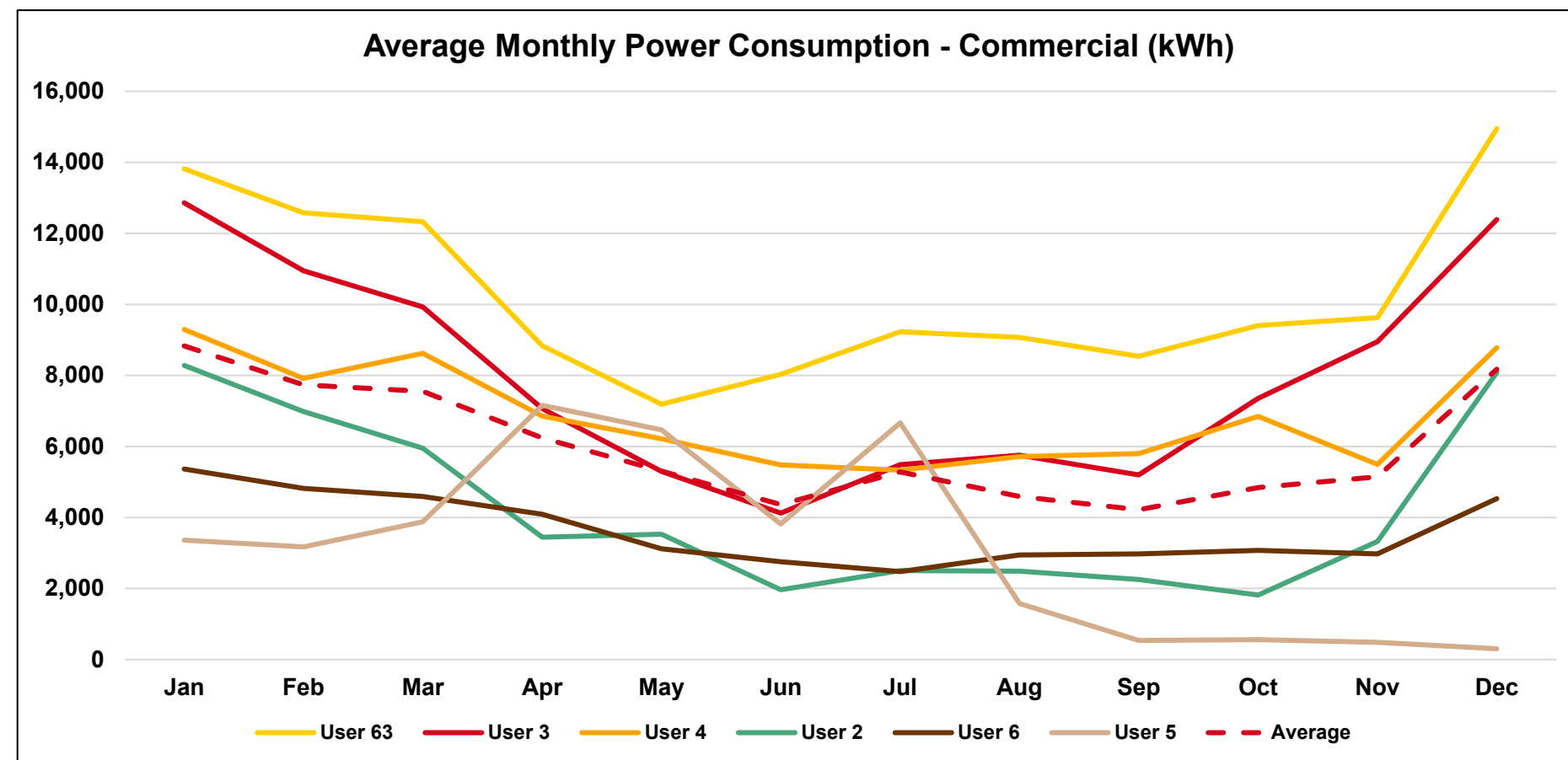
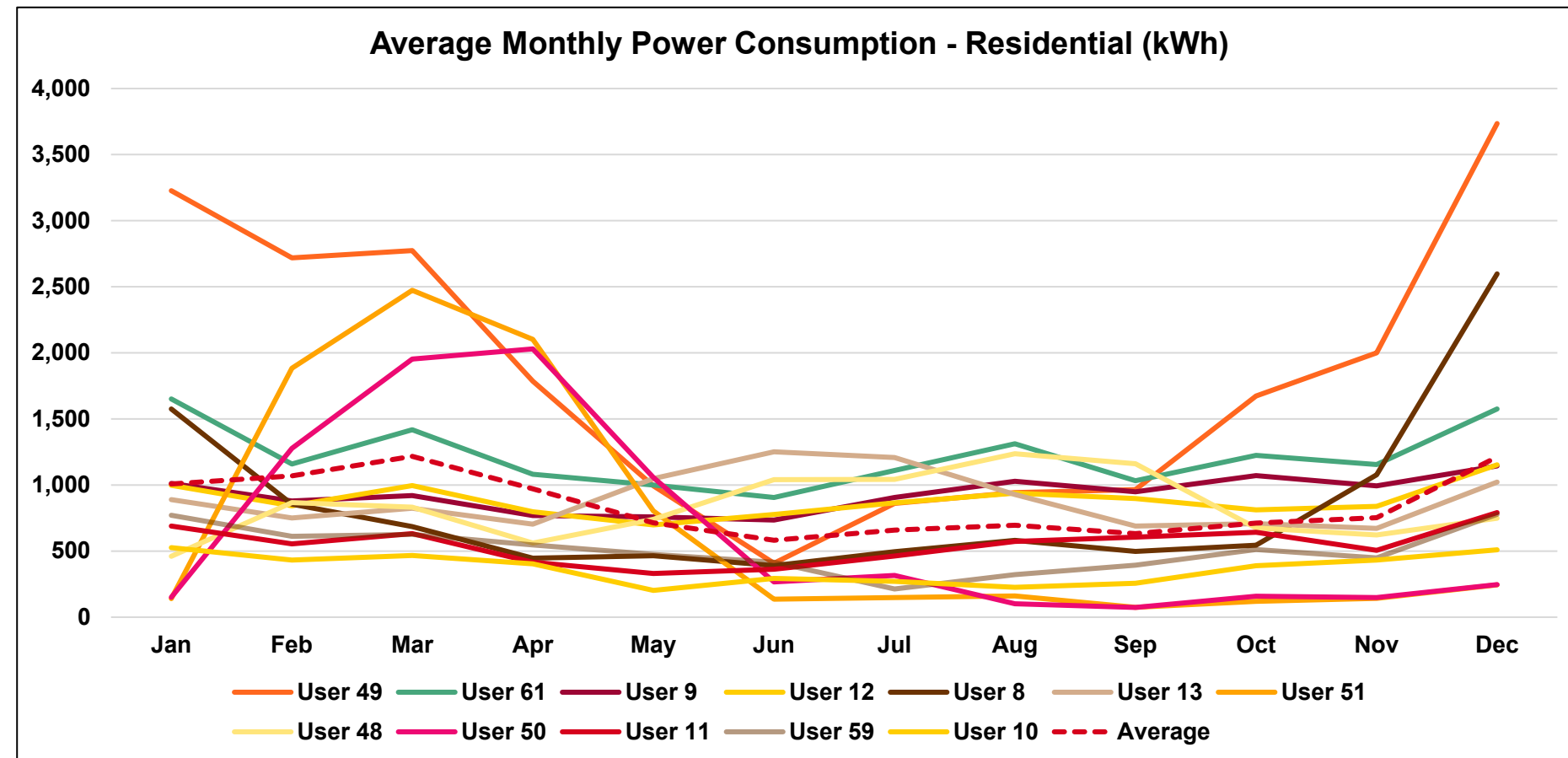


(Natural Resources Canada, n.d.)

BASELINE ANALYSIS

A techno-economic evaluation anchored in the demand patterns of the target community and optimal siting.

- Load Profiling (SaskPower Data):** Analysis of 15 months data revealed a residential cluster consuming 122,697 kWh/year and the commercial Community Center (User 3) consuming 95,347 kWh/year.



- Geospatial Siting (ArcGIS Online, n.d.):** To overlay critical infrastructure (community buildings, houses), SaskPower 25 kV primary lines, and land-use data.



WHAT IS POSSIBLE?

Four distinct 100 kWdc system configurations were engineered to match the community's demand profile and meet the SaskPower Interconnection requirements:

- Case 1:** 100 kW Solar PV (Residential - 12 homes).
- Case 2:** 100 kW Solar PV (Commercial).
- Case 3:** 100 kW Solar PV + 225.6 kWh BESS (Residential).
- Case 4:** 100 kW Solar PV + 225.6 kWh BESS (Commercial).

RESULTS

Hourly energy generation, operating cash flows, and performance parameters were simulated over a 25-year lifespan using NREL's System Advisor Model (SAM) with local weather data.

Metric	Case 1 (Res. PV)	Case 2 (Com. PV)	Case 3 (Res. BESS)	Case 4 (Com. BESS)
Net Capital Cost	\$231,929	\$182,755	\$381,706	\$332,532
Net Present Value (NPV)	\$118,426	\$89,672	-\$57,640	-\$78,577
Real LCOE (¢/kWh)	12.04 ¢	8.91 ¢	21.66 ¢	17.83 ¢
Simple Payback	10.0 years	10.0 years	18.0 years	19.5 years
Capacity factor - AC capacity (%)	14.29	15.37	13.77	14.83
Annual AC energy Y1 (kWh)	125,215	134,608	119,870	129,068
Avoided GHG (tCO2e/yr)	87.2	87.1	83.5	83.5

SENSITIVITY ANALYSIS

Integrating a 225.6 kWh Battery Energy Storage System (BESS) provides critical islanded autonomy during outages and active peak-shaving capabilities. However, under standard commercial financing (6% interest), this introduces a financial deficit.

Sensitivity Analysis - Case 3: Solar PV + BESS (Residential)				
Impact on Financial Metrics	Scenario A Interest rate 2%	Scenario B 25% Incentive	Scenario C 50% Incentive	Scenario D 100% BESS
Net Capital Cost (\$)	381,706	286,279	190,853	247,609
Electricity load total - Year 1	122,697 kWh			
Electricity Price - Year 1	15.4 ¢/kWh			
Simple Payback period (years)	18.0	13.0	7.3	10.9
Real LCOE (¢/kWh)	14.46¢	16.45¢	11.24¢	14.34¢
Net Present Value - NPV (\$)	73,141	37,065	131,770	75,443
Internal Rate of Return - IRR	1.6%	-2.4%	10.0%	1.8%

Sensitivity Analysis - Case 4: Solar PV + BESS (Commercial)				
Impact on Financial Metrics	Scenario A Interest rate 2%	Scenario B 25% Incentive	Scenario C 50% Incentive	Scenario D 100% BESS
Net Capital Cost (\$)	332,532	249,399	166,266	198,435
Electricity load total - Year 1	95,347 kWh			
Electricity Price - Year 1	15.6 ¢/kWh			
Simple Payback period (years)	19.5	15.5	8.5	11.1
Real LCOE (¢/kWh)	11.88¢	13.52¢	9.21¢	10.88¢
Net Present Value - NPV (\$)	35,356	3,928	86,432	54,506
Internal Rate of Return - IRR	-3.0%	-7.4%	4.7%	-0.3%

Sensitivity analysis proves that combining a 50% capital grant with standard financing (6% interest rate) eliminates the resilience premium (Scenario C).

CONCLUSION & NEXT STEPS

This research demonstrates that the Okanese First Nation can successfully achieve energy sovereignty and bypass SaskPower's restrictive export monopoly by adopting a "Behind-the-Meter" strategy.

To implement this roadmap, the following actionable steps are recommended:

- Phased Deployment:** Initiate a phased rollout starting with standalone commercial PV (Case 2) at the Community Center to capture savings, followed by the residential cluster (Case 1).
- Targeted Funding Strategy:** To offset the "resilience premium" of battery storage (Cases 3 & 4), leverage this data-driven roadmap to secure 50% capital grants from infrastructure financial institutions and clean energy promotion organizations.
- Local Employment & Capacity Building:** Mandate local-hiring clauses in EPC contracts and utilize the annual Operations & Maintenance to train and employ community members for system maintenance.
- Future Agrivoltaics & EV Readiness:** Utilize the land footprint to integrate agrivoltaics (combining energy generation with sustainable agriculture) and prepare the microgrid for future Electric Vehicle (EV) charging stations.

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METHODOLOGY

A multidimensional framework aligned with SDGs 7, 9, and 11 was deployed, executing a structured methodology from primary data acquisition to socio-economic validation.

The methodology includes 6 primary components: Data Acquisition and Customer Baselineing, Geospatial Analysis and Siting, Microgrid Electrical Architecture and Engineering Configuration, Techno-Economic and Financial Modeling, Community Engagement and Information Governance, and Results and Discussion:

