APPENDIX A: SURVEY RESULTS

Chesterfield Inlet - Community Energy Survey

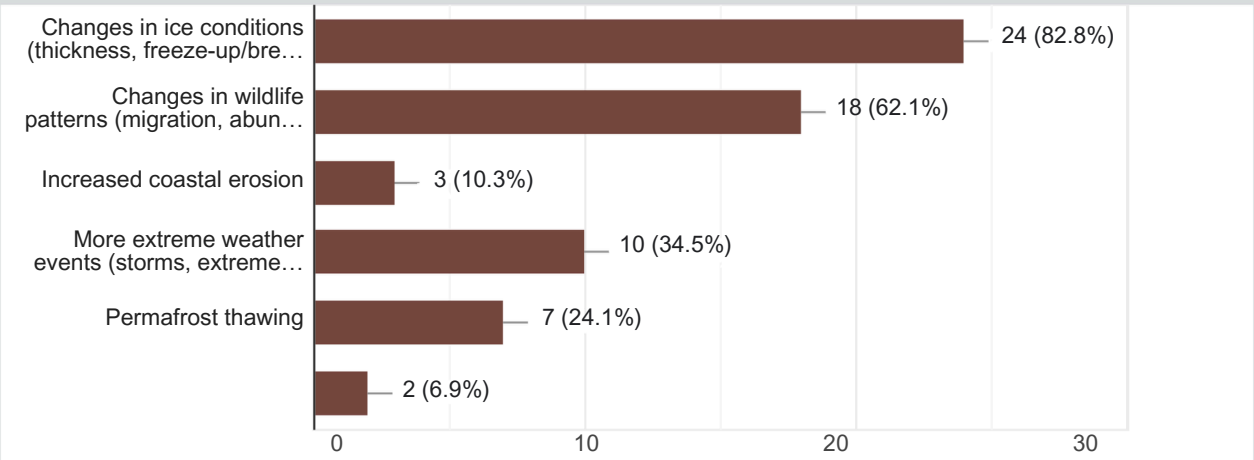
29 responses

Understanding Your Energy Needs and Priorities

Climate Change: What changes have you noticed in Chesterfield Inlet that you think are related to climate change? (Check all that apply)

Copy

29 responses



Energy Issues: How important are the following energy issues to you and your household? (Score from 1-5, with 1 being not important and 5 being very important)

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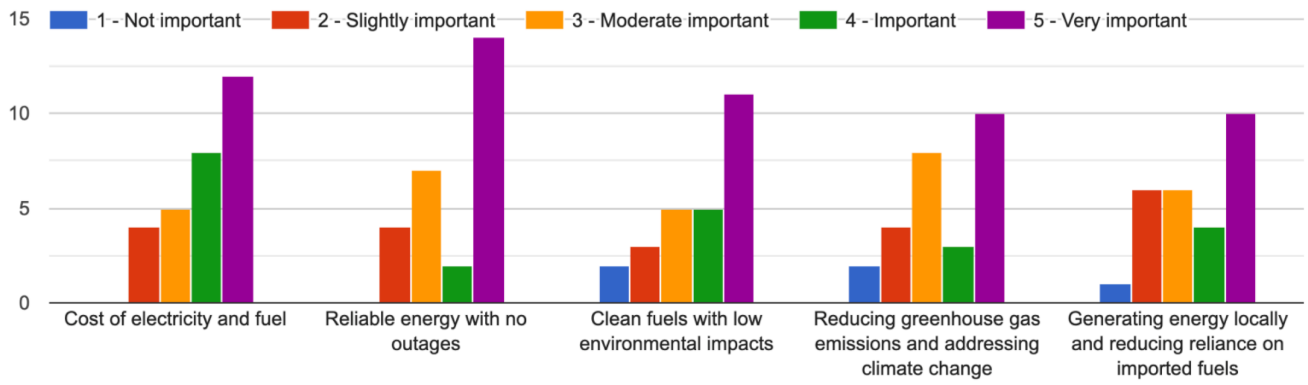


Personal Energy Challenges: Thinking about your day-to-day life, what are some challenges you face related to energy in Chesterfield Inlet?

11 responses

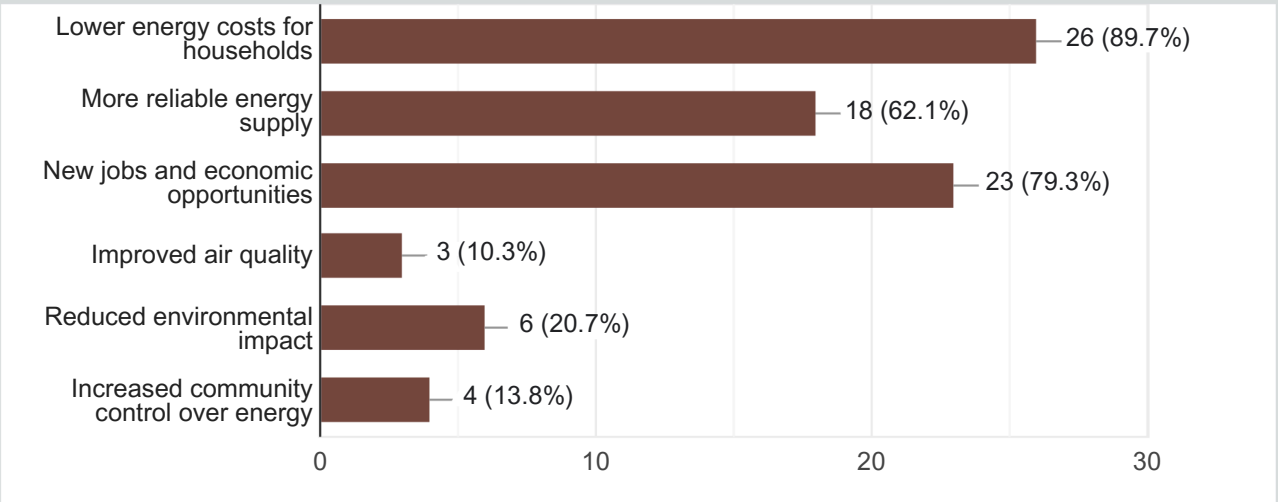
- Buying enough fuel for my house. cost to much
- Not much
- Unsure
- Cost of energy
- Trying to decrease the amount of power we use to lower our bill. The consistency of power - we are always worried that they will be a power outage with the age of the diesel generators we have in Chester.
- More knowledge to the community about clean reliable energy
- Either too warm or too hot no in-between anymore
- I don't know
- No challenge
- No challenges
- Nothing much really

Vision for a Community Energy Future

Community Benefits: What are the top three benefits you would like to see from a community clean energy project in Chesterfield Inlet? (Check all that apply)

Copy

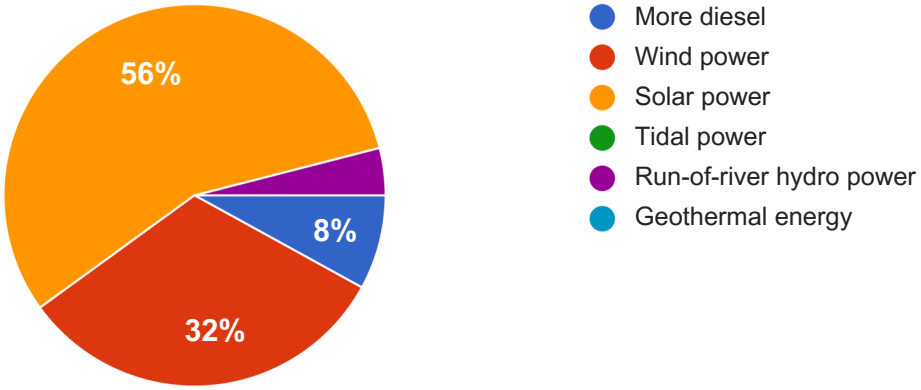
29 responses



Energy Sources: Which of the following energy sources would you (most) like to see developed in Chesterfield Inlet? (Check all that apply)

Copy

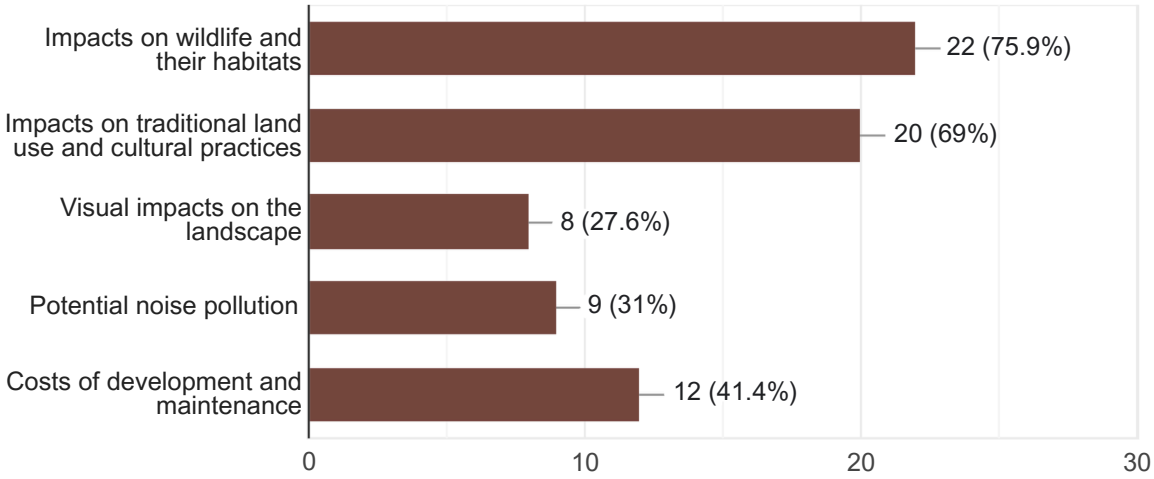
25 responses



Community Concerns: We want to understand your concerns about developing clean energy projects. Which of the following are you most concerned about? (Check all that apply)

Copy

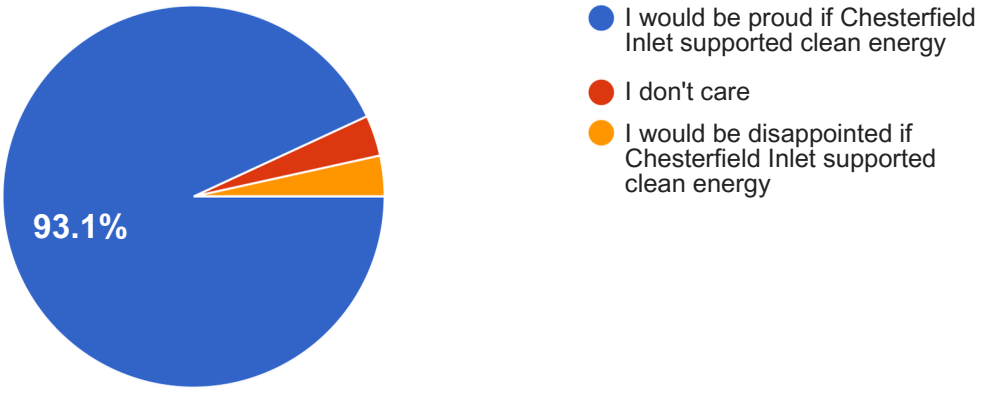
29 responses



Which statement fits your views best?

Copy

29 responses

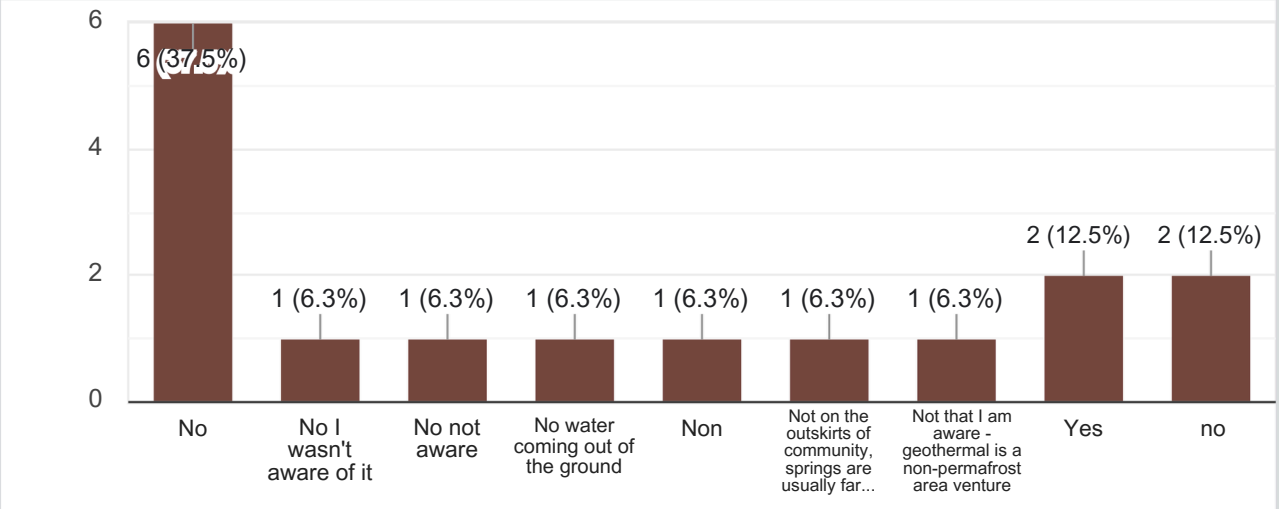


Sharing Your Knowledge and Engaging with the Project

Copy

Geothermal: Are you aware of any “springs” (sources of water flowing out of the ground during winter) around Chesterfield Inlet?

16 responses



Environmental Knowledge: We are committed to protecting the environment during this project. Please share any environmental knowledge you have about areas around Chesterfield Inlet that are important to protect. (Use this interactive map to directly indicate the relevant place of your environmental knowledge. Click here to go to the map)

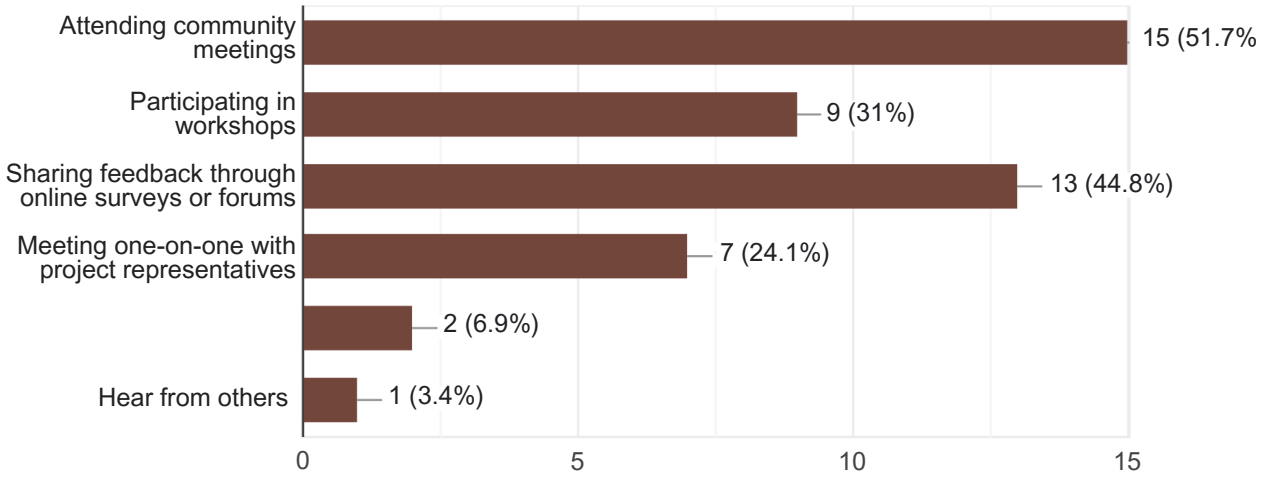
15 responses

- Yes
- Okay
- All areas
- The Thule site near the dock - Inuit artifacts along the coast
- No
- The area is important for our habitat
- I’m not sure
- Third one
- Hudson Bay
- Sorry I don't know
- Keep it clean and tidy
- Where people get fresh water.

Community Involvement: How would you prefer to be involved in the planning and development of this community energy project? (Check all that apply)

Copy

29 responses



Your Thoughts: Is there anything else you would like to tell us about your energy needs, priorities, or ideas for this project?

11 responses

No

no

Not at all

Nothing elsr

I am excited about the prospect of alternative forms of energy for our community that is 100% dependent on fossil fuels

More knowledge passed on to the community, more details needed.

Please look into our inlet for possible hydro energy source too it had a very high potential

Whatever works will be great

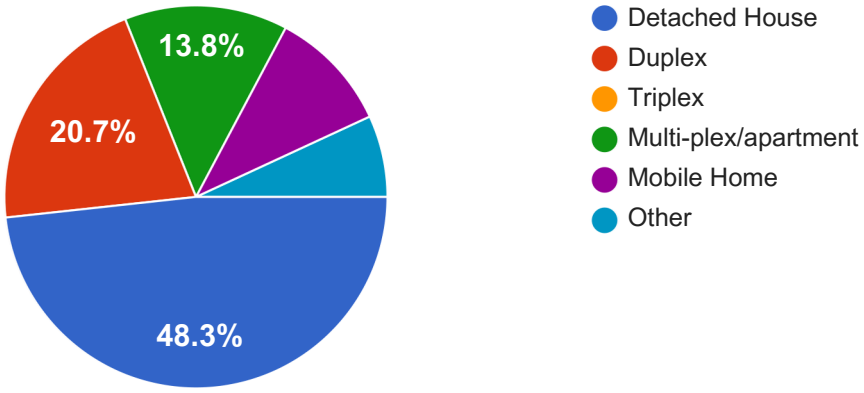
None

Housing Situation

What kind of home do you live in?

Copy

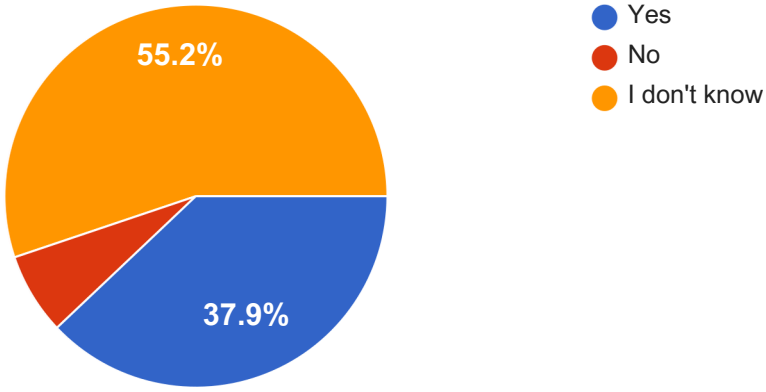
29 responses



Does your home have insulation above the entire ceiling?

Copy

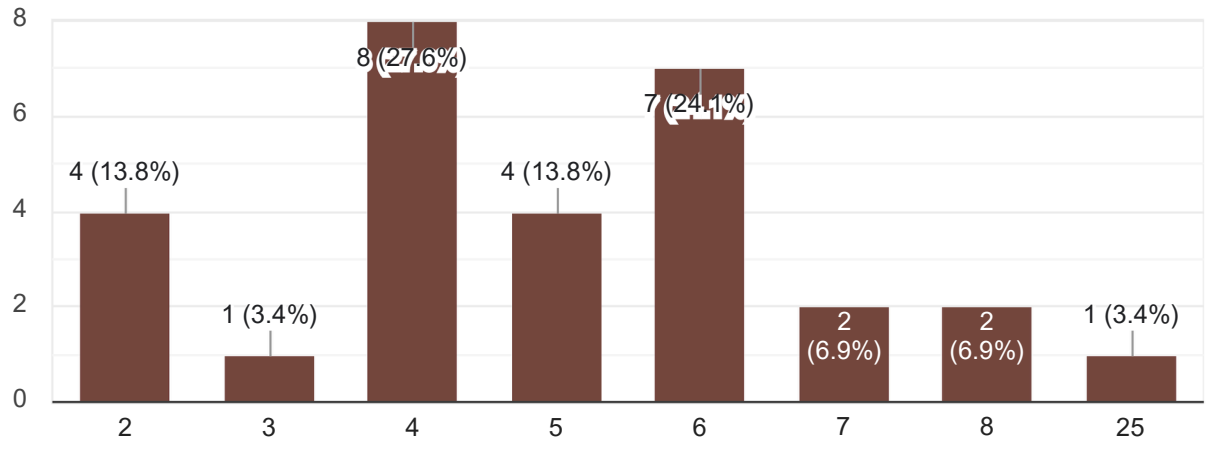
29 responses



How many people live in your home?

Copy

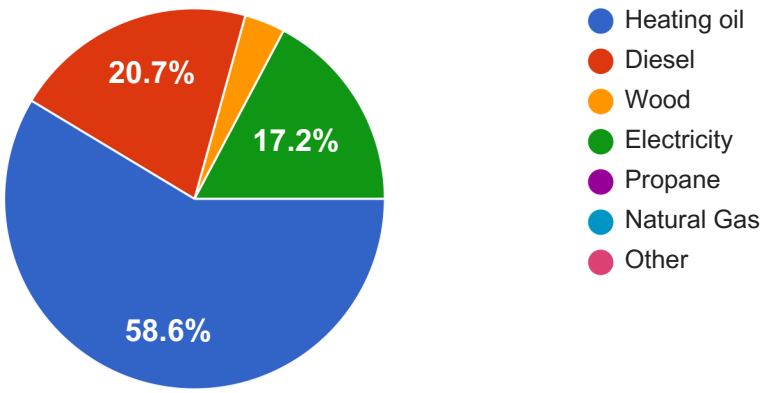
29 responses



What is the main source of energy used in your home for heating?

Copy

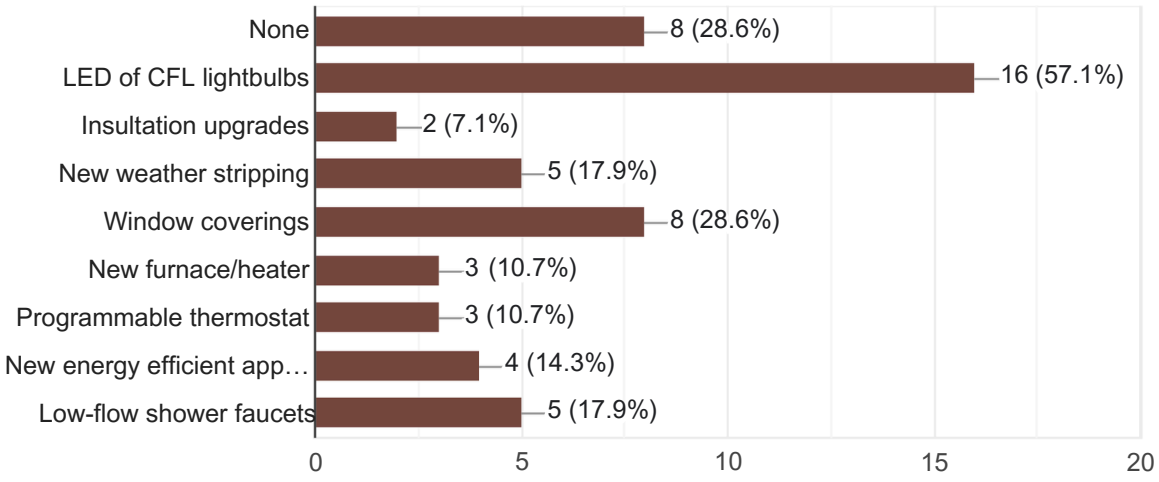
29 responses



What type of improvements has your household made to help reduce energy costs?

Copy

28 responses



How many vehicles are there in your household?

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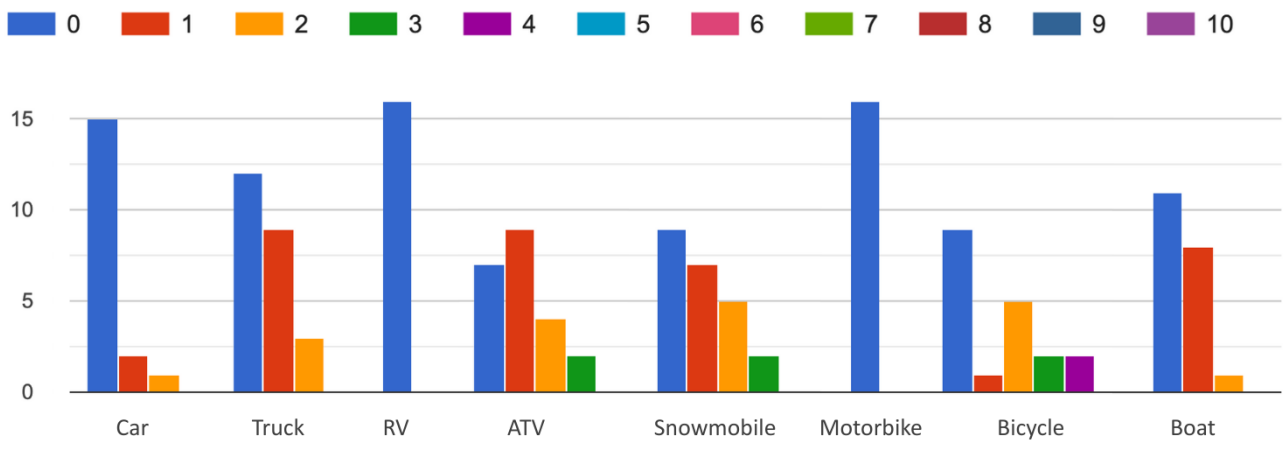

APPENDIX B: HOMER STUDY REPORT

PRELIMINARY MICROGRID MODELLING - DATA SOURCES
CHESTERFIELD INLET MICROGRID

SRC Publication No. PJ000073-1C25

March 28, 2025

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1.0 Introduction

The Saskatchewan Research Council (SRC) completed a comprehensive model to identify the necessary components required to supply between 80% and 100% of the electricity demand from renewable energy for the community of Chesterfield Inlet, Nunavut. The model evaluates the potential of solar and wind energy combined with battery storage. Presently, the community relies entirely on diesel generators for its electricity needs.

2.0 Simulation Model Details

2.1. Software

The optimization of hybrid renewable and distributed generation systems was conducted using the HOMER Energy software, version 3.18.

The HOMER optimization algorithm evaluates best overall design for the different components and configurations of the model. The optimized variables are:

- Size of the photovoltaic (PV) array
- Number of wind turbines
- Configuration of existing generators
- Number of batteries
- Size of the DC/AC converters[1]
- Maximum grid demand

2.2. Economic Constraints of Model

The HOMER model assumes the following parameters:

Currency: Canadian Dollar

Nominal discount rate: 6%

The rate at which future nominal costs are discounted, in %.

Expected inflation rate: 3%

The inflation rate expected over the project's life, in %.

Project lifetime (years): 25 Years

The number of years over which the net present cost of the project is calculated.

System fixed capital cost: $0

The fixed capital cost that occurs regardless of the system's size or architecture, in $.

System fixed O&M cost: $0

The fixed annual costs that occur regardless of the system's size or architecture, in $/yr.

Capacity shortage penalty: 0$/kWh

A penalty applied to the system for any capacity shortage, in $/kWh.

[1] The HOMER software uses the generic term converter to include both AC to DC rectifying and DC to AC inverting.

Replacement cost:

The HOMER model does not account for replacement costs associated with the existing generators, wind turbines, solar PV, and converter systems. However, it does include the replacement cost for the battery storage system.

Economies of scale.

The model account for the following economies of scale for solar PV arrays.

Economies of Scale of PV arrays

Solar Array Capacity (MW)	CAPEX
0.5	$5,988,390
1	$8,471,290
1.5	$11,300,530
2	$13,764,200
2.5	$16,223,690
3	$18,680,190
3.5	$21,134,440
4	$23,586,910
4.5	$26,550,780
5	$29,000,560

The HOMER model account for the following economies of scale for wind turbines.

Economies of Scale of Wind Turbine

Turbine Type	Number of Wind Turbine	CAPEX
EWT DW61	1	15,610,000
EWT DW61	2	23,690,000
EWT DW61	3	33,110,000
EWT DW61	4	40,520,000
NPS 100C-24	1	6,270,000
NPS 100C-24	2	7,960,000
NPS 100C-24	3	9,760,000
NPS 100C-24	4	11,560,000
NPS 100C-24	10	23,340,000

2.3. System Constraints of Model

The HOMER model assumes the following parameters:

Maximum simulations per optimization: 5000

The maximum number of simulations that the software simulates during the optimization process. HOMER conducts these simulations to evaluate different combinations of system components and configurations to identify the most cost-effective and efficient design for a hybrid renewable and distributed generation system.

System design precision: 0.01 (or 1%)

System design precision refers to the allowable relative error in decision variables, such as PV array and Windmill farm capacity, during an optimization process. This precision determines when the optimization can be considered converged.

Derating factor: 0%

Wind turbines are assumed to work at their full rated capacity without any reduction, which is an ideal scenario.

Maximum capacity shortage: 0%

The system operates without any extra capacity to handle unexpected changes in load or renewable power output. This can be risky as it might not cope well with sudden fluctuations.

Minimum renewable fraction: 80%

The minimum allowable value of the annual renewable fraction, in %.

Operating reserve: 0%

Operating reserve is surplus operating capacity that ensures reliable electricity supply even if the load suddenly increases, or renewable power output suddenly decreases.

Load Factor: 52%

Measure of the average load compared to the peak load over a specific period. It is calculated as the ratio of the average load to the peak load.

Emissions penalties: 0$/t

Diesel Retail Cost: $1.498/liter [2]

Generator Minimum Load Ratio: 30%

Generator Minimum Run Time: 60 minutes

[2] Source: https://www.gov.nu.ca/sites/default/files/news-documents/2024-07/2024-03_PPD_Carbon_Tax_Price_List_-_ENG.pdf

Search Space:

The HOMER simulations involve an optimization of each value specified in the Search Space.

HOMER Model - Search Space Per Equipment

Equipment Type	Comments
EWT DW61	Search Space: between 0 and 8
NPS 100C-24	Search Space: between 0 and 24
Solar arrays of 150kW	Optimized by Homer algorithm
Converter (kW)	Search Space: 500 and 1000
Li-On Battery	Optimized by Homer algorithm

2.4. Electrical Load Profile

The load profile is based on the monthly totals of electrical generation provided by QEC, spanning from April 2019 to October 2024. Additionally, QEC supplied yearly data and forecasts from 1995 to 2025.

The HOMER model assumes a residential load profile with a Morning Peak, Midday Fluctuations, Evening Peak, Nighttime stability. The model account for hourly and seasonal variations of the electrical load.

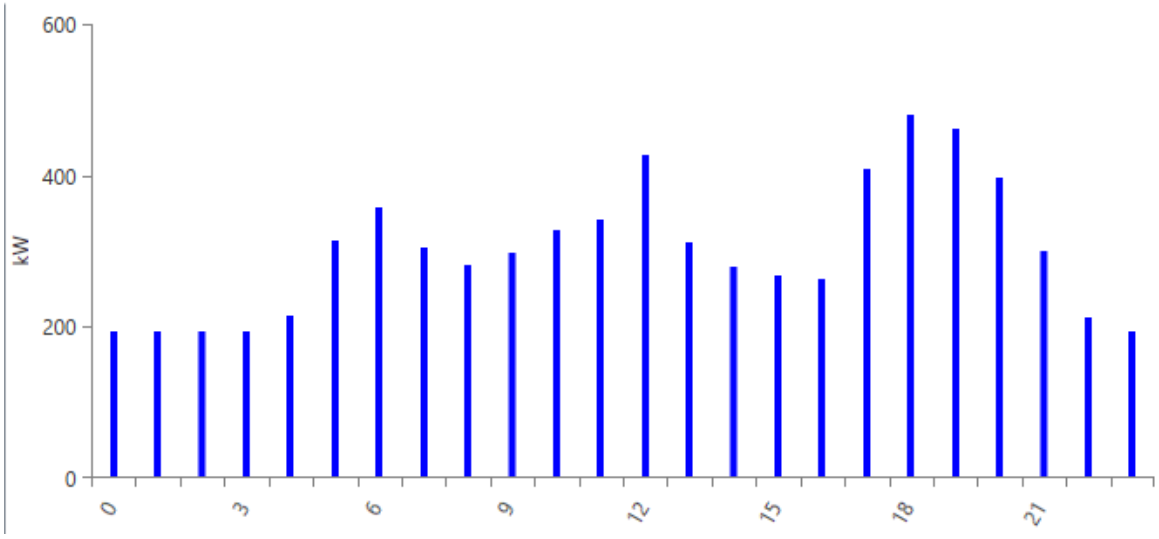
The model is developed to meet the projected electrical Generation (kWh) for the year 2030 [3].

HOMER Model - Electrical Load

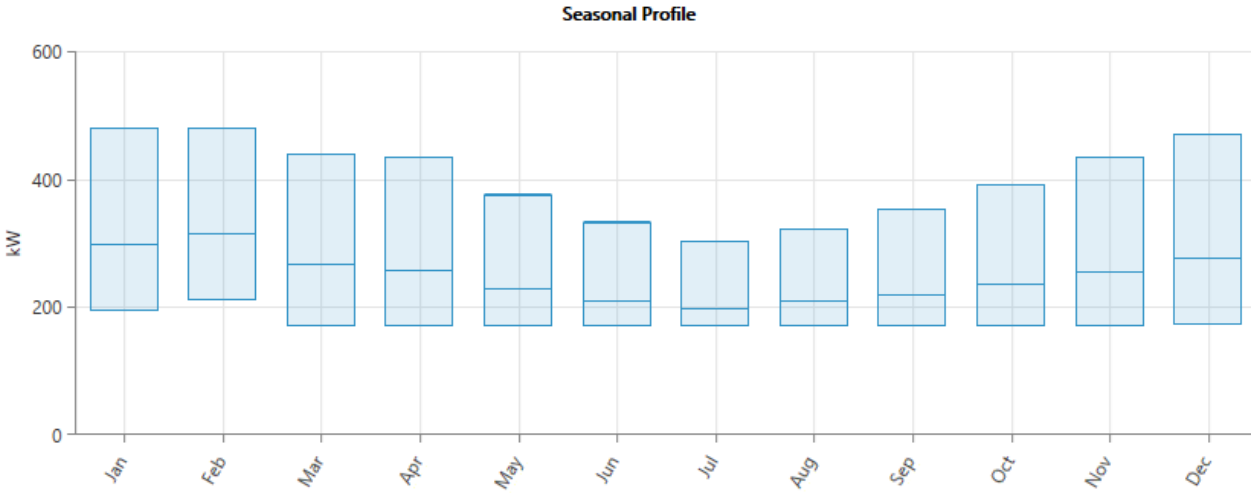
Modelling data	Value
Average (kWh/Day)	5943
Average (kW)	247
Load Factor (%)	52
Peak Load (kW)	480
Min Load (kW)	170
Day to Day Random Variability (%)	6.28

[3] Source: Table 1. Community Load Forecast (605_Plant efficiencies, Sheet 605).

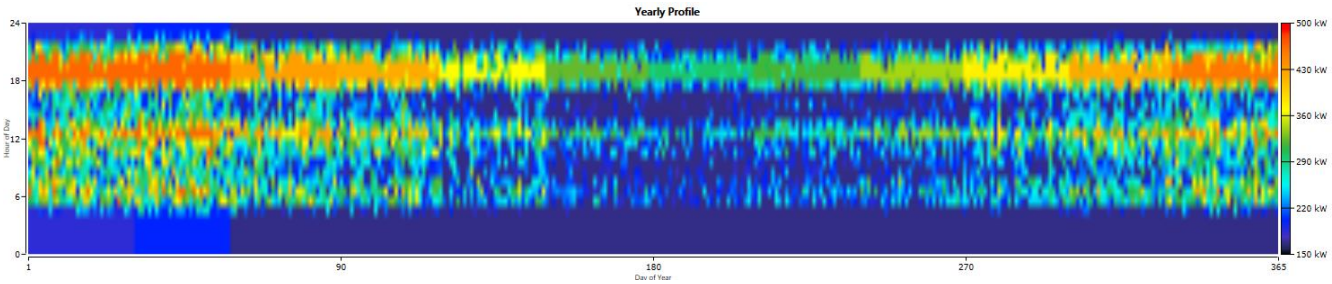
The following figures illustrate the hourly, seasonal and one-year electric load.



HOMER Model - Seasonal Profile



HOMER Model - Monthly profile per hour



2.5. Weather Data

The HOMER model uses time series data with *hourly* resolution. The dataset includes the following parameters:

- Date and Time
- Global Horizontal Irradiance (GlobHor) in W/m²
- Ambient Temperature (T_Amb) in °C
- Wind Velocity (WindVel) in m/s

The model is also using *monthly* resolution data. The dataset includes the following parameters:

- Month
- Global Horizontal Irradiance (kWh/m²)
- Ambient Temperature (°C)
- Wind Speed (m/s)

3.0 HOMER Model Equipment

3.1. Diesel Generators

QEC provided details of the existing diesel generators.

The Homer model evaluates electricity generation with and without existing diesel generators that currently generate all the community's electricity. All diesel generators remain active in all scenarios with exception in scenarios with 100% renewable fraction. The model is based on the existing generators[4], and account for their remaining lifetime.

Diesel Generation Equipment.

Generator	Rating
Detroit S60-1	320kW
Detroit S60-2	320kW
Volvo D16-1	400kW

[4] Source: Table 3. Community RFC Planning and Expected Engine Retirement (Chesterfield Inlet✓, Sheet 605, Table installed unit)

3.2. Wind Turbines

3.2.1. EWT DW61

The HOMER model is using time series data consisting of Hourly Wind EYA Timeseries for 1 wind turbine model DW61:

The power output characteristics of the DW61 have been calibrated using the hourly wind EYA data, ensuring that its performance predictions match realistic wind conditions as recorded in the dataset.

It should be noted that the Homer model does not account for downtime periods attributable to icing losses. As a result, the model exhibits an approximate annual performance overestimation of 0.37%.

3.2.2. NPS 100C-24

The HOMER model is using time series data consisting of Hourly Wind EYA Timeseries for 1 wind turbine model NPS 100C-24:

The power output characteristics of the NPS have been calibrated using the hourly wind EYA data, ensuring that its performance predictions match realistic wind conditions as recorded in the dataset.

It should be noted that the Homer model does not account for downtime periods attributable to icing losses. As a result, the model exhibits an approximate annual performance overestimation of 0.20%.

3.3. Photovoltaic Arrays

The Homer model is using time series data consisting of hourly Solar EYA Timeseries for a 150kWac photovoltaic array:

The power output of the photovoltaic array has been calibrated to match time series data consisting of Hourly Solar Energy Yield Assessment (EYA) profiles for one photovoltaic array model.

3.4. Energy Storage

3.4.1. Li-Ion Batteries

The HOMER model is using idealized generic Li-Ion batteries with the following properties.

- Nominal Voltage (V): 600
- Nominal Capacity (kWh): 100
- Nominal Capacity (Ah): 167
- Roundtrip Efficiency (%): 90
- Max charge current (A): 167
- Max discharge current (A): 500
- Minimum State of Charge: (%): 20

The Homer model is assuming a procurement cost of $131,679 per 100kWh. The model assumes that every 5 years, the batteries will need to be replaced at an average cost of $72,235 per 100 kWh. This replacement cycle is expected

to continue for a total period of 25 years. The model would not accept a declining replacement cost over the 25-year lifetime.

3.5. Energy Conversion

The Homer model is including a converter for the battery storage. The converter can handle power flow in both directions, allowing the system to charge the batteries from the grid and discharge stored energy back to the grid when needed. The Homer model is assuming a procurement cost of $91,605 per 500kW and conversion efficiency of 95%.

The Homer model is assuming no conversion cost for the PV system.

3.6. Altiro Energy

The Altiro Energy system is an energy storage solution that operates similarly to a battery. The Homer model does not account for Altiro Energy Storage. Further evaluation is required to validate if Altiro Energy system can be modeled adequately and integrated in the HOMER optimization algorithm.

Operating Methodology

- The system functions like a battery, storing chemical energy and discharging high-grade heat (close to 2000°C).
- The heat can be used for industrial processes or to generate electricity via a steam turbine.
- The charging process involves converting iron oxide to metallic iron using green electricity, making it carbon-free.
- The iron is burned to release heat, which can be captured and reused, closing the loop.

Round Trip Efficiency

- Charging efficiency: 60-80% depending on the process.
- Heat generation efficiency: 90+%.
- Power generation efficiency: 50%.
- Roundtrip efficiency: 55-75% for heat, 30-40% for power generation.

Energy Recovery Methodology

- The system burns iron to release energy, which can be converted to power using a steam turbine or thermophotovoltaic cells.

Size (Energy Density)

- Iron has an energy density of 2050 kWh-thermal per ton and 8200 kWh-thermal per cubic meter.
- A MW-scale burner fits in 1-2 shipping containers.
- The energy carrier (iron) is decoupled from the burner, allowing scalability by stockpiling more fuel.

Cost

Preliminary information for the sizing and costing of an Altiro iron storage system are below.

System Specifications

- **Electric Usable Energy Delivered**: 150 kW
- **Storage Capacity**: 100 hours at rated 150 kWe
- **Minimum Discharge Run Time**: 8 hours
- **CAPEX**: $4 million for the iron burner system, power generation turbine, and iron recharge system
- **Roundtrip Efficiency**: 25%
- **Discharge Rate**: Twice as fast as the recharge rate.
- **Iron Fuel Required**: 22.5 tons (approximately 1 sea container)

Operational Costs

- **Burner Power Generation OPEX**: 2-4% of CAPEX
- **Recharging OPEX**: $25 per ton of throughput plus the cost of electricity (kWh) with an efficiency of 75%

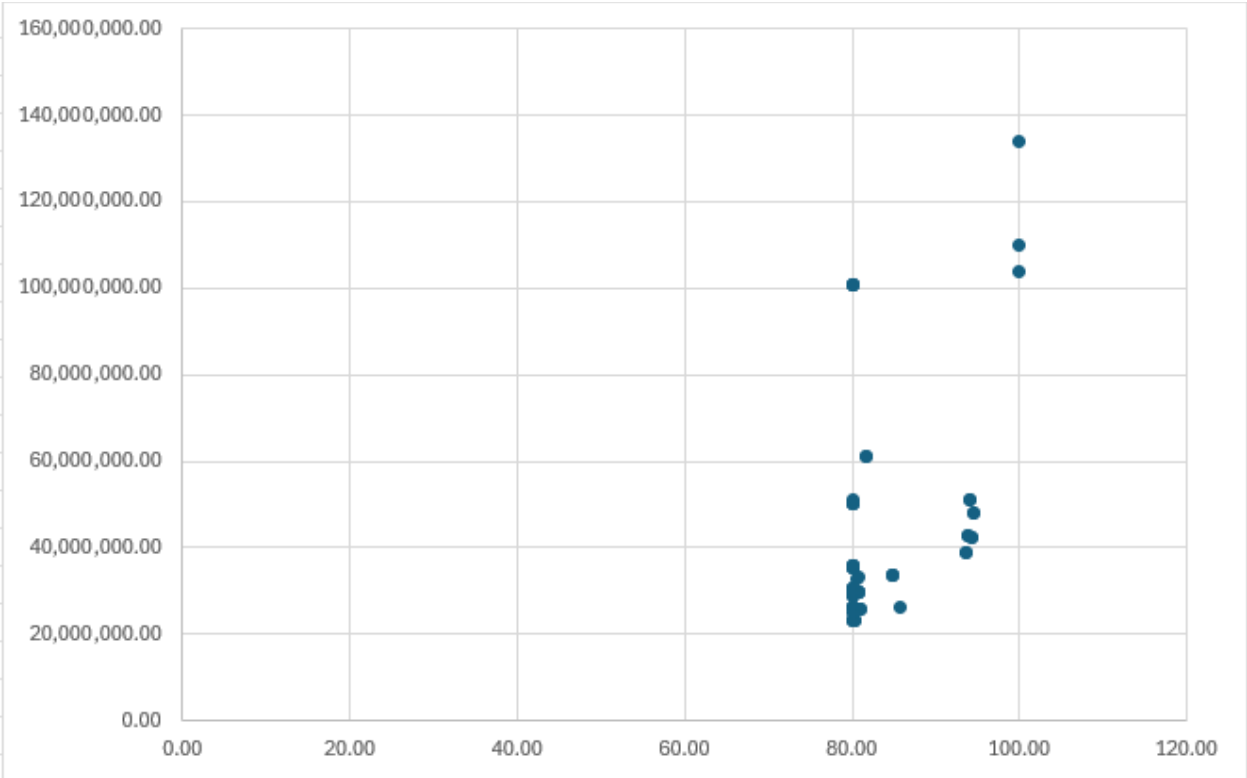
3.7. Tidal Energy

The HOMER model does not account for a Tidal Energy System. Further evaluation is required to determine the viability of a hydrokinetic energy system and if it can be modeled adequately and integrated in the HOMER optimization algorithm.

4.0 HOMER Optimization Results

The HOMER optimization algorithm generated different optimization scenarios of renewable energy fractions, between 80% and 100%. These scenarios include various combinations with and without solar, wind, energy storage, and existing diesel generators.

Figure 1: CAPEX as a function of Renewable Fraction of System

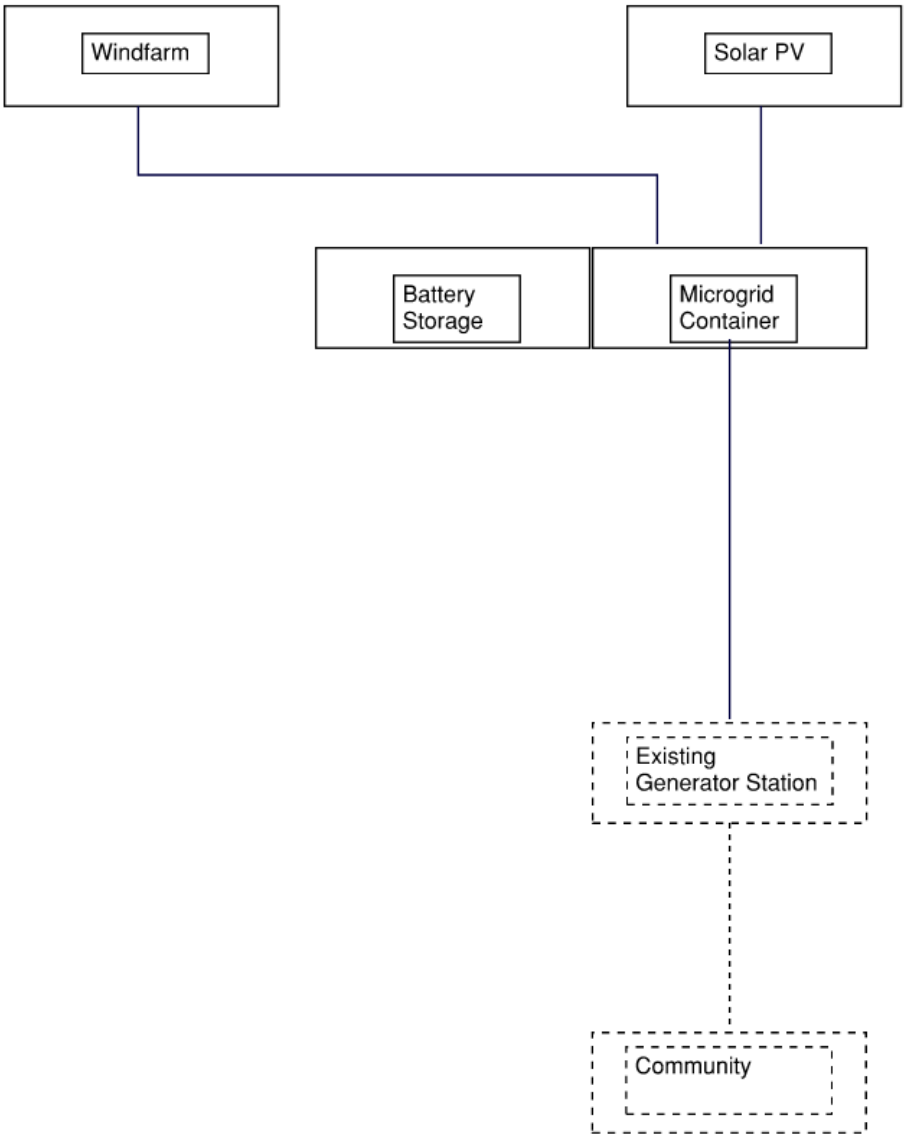


The capital expenditure (CapEx) required for achieving renewable energy penetration levels between 80% and 100% ranges from $23,300,000 to $134,000,000. For more detailed information, including specific breakdowns and insights, refer to Appendix A and the Community Energy Plan.

5.0 Conceptual Electrical Distribution

The figure below presents the conceptual layout of Chesterfield, designed to provide a visual representation of the electrical distribution. The layout represents the spatial organization, infrastructure, and key features envisioned for Chesterfield.

Figure 2: Conceptual Electrical Distribution



6.0 Appendix A - Expanded Scenarios, Definitions, Architecture, and Cost Parameters

See data file for expanded scenarios

7.0 Appendix B - CAPEX

See data file

Index	Architecture/EWT DW61	Architecture/NPS 100C-24	Architecture/150KW Array	Architecture/G1 (kW)	Architecture/G2 (kW)	Architecture/G3 (kW)	Architecture/100LI (#)	Architecture/Converter (kW)	Architecture/Dispatch	Cost/NPC ($)	Cost/LCOE ($/kWh)	Cost/Operating cost ($/yr)	Cost/CAPEX ($)	Cost/Fuel cost ($/yr)	Cost/OPEX ($/yr)	System/Ren Frac (%)	System/Total Fuel (L/yr)	System/Cap Short (%)	System/Cap Short (kWh/yr)
1		5	4.166667	320	320	400	25	500	CC	2.83E+07	0.7431868	284032	23,400,000	183444.5	0	80.05207	122459.6	0	0
2		5	3.559028	320		400	28	500	CC	2.85E+07	0.7461984	293864.6	23,300,000	181206.7	0	80.28471	120965.7	0	0
3		5	3.559028		320	400	28	500	CC	2.85E+07	0.7461984	293864.6	23,300,000	181206.7	0	80.28471	120965.7	0	0
4		5	3.559028	320	320		28	500	CC	2.85E+07	0.7468584	295296	23,300,000	182638.1	0	80.15548	121921.3	0	0
5		5	3.559028			400	28	500	CC	2.85E+07	0.7474089	295939.3	23,300,000	183281.4	0	80.09209	122350.7	0.06373603	1382.488
6	1		5.507943			400	22	500	CC	3.01E+07	0.7895057	221032.6	26,200,000	132515.6	0	85.65274	88461.69	0.09927469	2153.351
7	2			320		400	19	500	CC	3.08E+07	0.8087536	259506.5	26,300,000	183060	0	80.13477	122203	0	0
8	2				320	400	19	500	CC	3.08E+07	0.8087536	259506.5	26,300,000	183060	0	80.13477	122203	0	0
9	2			320	320	400	19	500	CC	3.08E+07	0.8087721	259546.6	26,300,000	183100.2	0	80.1307	122229.8	0	0
10	2			320	320		19	1000	CC	3.09E+07	0.8113328	259891.3	26,400,000	183444.8	0	80.06061	122459.8	0	0
11		3	8.333333	320			47	1000	CC	3.24E+07	0.8504287	363848.5	26,000,000	174744.1	0	81.0043	116651.6	0.09085673	1970.759
12		3	8.333333		320		47	1000	CC	3.24E+07	0.8504287	363848.5	26,000,000	174744.1	0	81.0043	116651.6	0.09085673	1970.759
13	1					400	71	1000	CC	3.34E+07	0.8754901	468529.4	25,100,000	182861	0	80.09851	122070.1	0.06658447	1444.273
14	2		4.557292	320	320	400			CC	3.41E+07	0.8933545	197904	30,600,000	197904	0	80.01691	132112.2	0	0
15	2		4.557292	320		400			CC	3.41E+07	0.8936237	198487.9	30,600,000	198487.9	0	80.01691	132501.9	0	0
16	2		4.557292		320	400			CC	3.41E+07	0.8936237	198487.9	30,600,000	198487.9	0	80.01691	132501.9	0	0
17	2		4.557292	320	320				CC	3.41E+07	0.894292	199937.5	30,600,000	199937.5	0	80.01691	133469.6	0	0
18	2		0.2604167	320	320	400	18	500	CC	3.42E+07	0.8974791	249047.7	29,900,000	176624.8	0	80.84982	117907	0	0
19	2		0.2604167	320		400	18	500	CC	3.42E+07	0.8977292	249590.2	29,900,000	177167.2	0	80.78792	118269.2	0	0
20	2		0.2604167		320	400	18	500	CC	3.42E+07	0.8977292	249590.2	29,900,000	177167.2	0	80.78792	118269.2	0	0
21	2		0.2604167	320	320		18	1000	CC	3.43E+07	0.9001154	249556.6	29,900,000	177133.6	0	80.75813	118246.7	0	0
22		11		320		400	39	1000	CC	3.54E+07	0.9287292	339758	29,400,000	182841.6	0	80.04991	122057.1	0	0
23		11			320	400	39	1000	CC	3.54E+07	0.9287292	339758	29,400,000	182841.6	0	80.04991	122057.1	0	0
24		10		320	320		48	1000	CC	3.54E+07	0.9288608	374765.7	28,800,000	181637.8	0	80.17756	121253.6	0	0
25		10		320	320	400	48	1000	CC	3.55E+07	0.9294702	376087.7	28,800,000	182959.8	0	80.02369	122136	0	0
26	1	2		320		400	43	1000	CC	3.57E+07	0.9352735	355826.9	29,400,000	182816.5	0	80.05092	122040.4	0	0
27	1	2			320	400	43	1000	CC	3.57E+07	0.9352735	355826.9	29,400,000	182816.5	0	80.05092	122040.4	0	0
28	1	2		320	320		43	1000	CC	3.57E+07	0.9353701	356036.4	29,400,000	183026	0	80.02666	122180.2	0	0
29	1	2		320	320	400	44	1000	CC	3.59E+07	0.9407408	360197.4	29,500,000	183163.5	0	80.00708	122272	0	0
30		10				400	52	500	CC	3.62E+07	0.9497181	394198.5	29,300,000	184976.7	0	80.00272	123482.4	0.09756589	2116.286
31	1	1				400	57	1000	CC	3.68E+07	0.9661699	413132.4	29,600,000	183793.1	0	80.00888	122692.3	0.09558275	2073.27
32	1	2	1.041667	320		400	42	1000	CC	3.90E+07	1.021582	306998.8	33,600,000	138011.9	0	84.94234	92130.77	0	0
33	1	2	1.041667		320	400	42	1000	CC	3.90E+07	1.021582	306998.8	33,600,000	138011.9	0	84.94234	92130.77	0	0
34	1	2	1.041667	320	320	400	42	1000	CC	3.90E+07	1.021882	307648.9	33,600,000	138662	0	84.8657	92564.76	0	0
35	1	2	0.1302083	320	320		42	1000	CC	3.90E+07	1.021959	346465.5	32,900,000	177478.6	0	80.63615	118477	0	0
36		11	10.15625	320	320	400			CC	3.90E+07	1.023618	198816.4	35,500,000	198816.4	0	80.00266	132721.3	0	0
37		11	10.15625	320		400			CC	3.91E+07	1.023873	199370.1	35,500,000	199370.1	0	80.00266	133090.8	0	0
38		11	10.15625		320	400			CC	3.91E+07	1.023873	199370.1	35,500,000	199370.1	0	80.00266	133090.8	0	0
39		11	10.15625	320	320				CC	3.91E+07	1.024541	200819.7	35,500,000	200819.7	0	80.00266	134058.5	0	0
40	1	3	9.114583	320	320	400			CC	3.94E+07	1.033237	198372.4	35,900,000	198372.4	0	80.01912	132424.8	0	0
41	1	3	9.114583	320		400			CC	3.94E+07	1.033497	198936.1	35,900,000	198936.1	0	80.01912	132801.1	0	0
42	1	3	9.114583		320	400			CC	3.94E+07	1.033497	198936.1	35,900,000	198936.1	0	80.01912	132801.1	0	0
43	1	3	9.114583	320	320				CC	3.94E+07	1.03418	200415.9	35,900,000	200415.9	0	80.01912	133789	0	0
44	1	1	0.1302083			400	56	1000	CC	4.01E+07	1.05241	402781.8	33,000,000	177465.9	0	80.70801	118468.6	0.08592789	1863.848
45	1		15.88542	320			57	500	CC	4.39E+07	1.152708	288897.1	38,900,000	59557.76	0	93.63133	39758.18	0.09732474	2111.055
46	1		15.88542		320		57	500	CC	4.39E+07	1.152708	288897.1	38,900,000	59557.76	0	93.63133	39758.18	0.09732474	2111.055
47	1	2	8.333333	320			69	500	CC	4.85E+07	1.272994	334575	42,600,000	56953.62	0	93.92487	38019.77	0.09870426	2140.978
48	1	2	8.333333		320		69	500	CC	4.85E+07	1.272994	334575	42,600,000	56953.62	0	93.92487	38019.77	0.09870426	2140.978
49	2			320			141	500	CC	5.33E+07	1.397747	621413.3	42,300,000	54100.11	0	94.32461	36114.89	0.09804993	2126.785
50	2				320		141	500	CC	5.33E+07	1.397747	621413.3	42,300,000	54100.11	0	94.32461	36114.89	0.09804993	2126.785
51			50	320		400	68	1000	CC	5.84E+07	1.532319	457383.4	50,400,000	183785.6	0	80.03467	122687.3	0	0
52			50		320	400	68	1000	CC	5.84E+07	1.532319	457383.4	50,400,000	183785.6	0	80.03467	122687.3	0	0
53			49.47917	320	320	400	70	1000	CC	5.85E+07	1.532558	464713.9	50,300,000	183069.1	0	80.09815	122209	0	0
54			49.47917	320	320		70	1000	CC	5.85E+07	1.532681	464981.9	50,300,000	183337.1	0	80.07045	122387.9	0	0
55	2	1		320			138	500	CC	5.89E+07	1.545819	608306.9	48,200,000	53064.25	0	94.43933	35423.4	0.09785509	2122.559
56	2	1			320		138	500	CC	5.89E+07	1.545819	608306.9	48,200,000	53064.25	0	94.43933	35423.4	0.09785509	2122.559
57			50			400	73	1000	CC	5.94E+07	1.558711	477089.3	51,100,000	183373.9	0	80.18092	122412.5	0.01137266	246.6824
58		15		320			150	500	CC	6.27E+07	1.64622	659126.3	51,200,000	55601.62	0	94.15164	37117.23	0.09962281	2160.902
59		15			320		150	500	CC	6.27E+07	1.64622	659126.3	51,200,000	55601.62	0	94.15164	37117.23	0.09962281	2160.902
60			50	320			150	1000	CC	7.48E+07	1.961699	774055.2	61,200,000	170530.5	0	81.6403	113838.8	0.02947432	639.3227
61			50		320		150	1000	CC	7.48E+07	1.961699	774055.2	61,200,000	170530.5	0	81.6403	113838.8	0.02947432	639.3227
62	8	15		320	320	400			CC	1.05E+08	2.749597	193356.1	101,000,000	193356.1	0	80.01337	129076.2	0	0
63	8	15		320		400			CC	1.05E+08	2.749934	194087.6	101,000,000	194087.6	0	80.01337	129564.5	0	0
64	8	15			320	400			CC	1.05E+08	2.749934	194087.6	101,000,000	194087.6	0	80.01337	129564.5	0	0
65	8	15		320	320				CC	1.05E+08	2.750776	195913	101,000,000	195913	0	80.01337	130783.1	0	0
66	3		50				225	1000	CC	1.20E+08	3.151632	905287	104,000,000	0	0	100	0	0.09875542	2142.088
67	3	1	50				225	1000	CC	1.26E+08	3.315697	905287	110,000,000	0	0	100	0	0.08338288	1808.645
68	4	12					510	1000	CC	1.70E+08	4.453656	2051984	134,000,000	0	0	100	0	0	0
													134,000,000			100			
													23,300,000			80			

Index	System/Elec Prod (kWh/yr)	System/Therm Prod (kWh/yr)	System/Elec Cons (kWh/yr)	System/Therm Cons (kWh/yr)	System/Clipped Energy (%)	System/Clipped Energy (kWh/yr)	System/Excess Therm (kWh/yr)	System/Unmet load (%)	System/Unmet load (kWh/yr)	System/$CO_{2,e}$ (kg/yr)	System/MRP (%)	G1/Capacity	G1/Hours	G1/Production (kWh)	G1/Fuel (L)	G1/O&M Cost ($/yr)	G1/Fuel Cost ($/yr)	G2/Capacity	G2/Hours	G2/Production (kWh)
1	6735908	0	2169084	0	15.74101	1060300	0	1.45E-15	3.15E-11	320303.1	677.6741	320	1250	369195.7	104606.5	0	156700.5	320	71	22720
2	6568799	0	2169084	0	13.54052	889449.3	0	1.55E-15	3.36E-11	316395.8	618.0029	320	1193	353827.2	100207.6	0	150110.9			
3	6568799	0	2169084	0	13.54052	889449.3	0	1.55E-15	3.36E-11	316395.8	618.0029							320	1193	353827.2
4	6571602	0	2169084	0	13.59386	893334.4	0	1.54E-15	3.33E-11	318895.1	618.0029	320	1328	392958.6	111317.4	0	166753.5	320	125	37485.71
5	6572830	0	2168347	0	13.55272	890797.4	0	0.03398192	737.0964	320018.3	618.0029									
6	5552564	0	2168000	0	53.23171	2955725	0	0.04998109	1084.132	231378.8	1089.36									
7	7621024	0	2169084	0	65.89541	5021905	0	1.29E-15	2.80E-11	319631.8	1152.941	320	1188	340525.5	96797.44	0	145002.6			
8	7621024	0	2169084	0	65.89541	5021905	0	1.29E-15	2.80E-11	319631.8	1152.941							320	1188	340525.5
9	7621112	0	2169084	0	65.91216	5023239	0	1.26E-15	2.73E-11	319701.9	1152.941	320	1199	344036.9	97784.38	0	146481	320	107	34240
10	7622632	0	2169084	0	65.85909	5020196	0	1.38E-15	3.00E-11	320303.7	1152.941	320	1252	369110.1	104602.8	0	156695	320	203	63392
11	7116604	0	2167918	0	19.9443	1419357	0	0.05375711	1166.037	305111.8	1068.039	320	1391	411811.3	116651.6	0	174744.1			
12	7116604	0	2167918	0	19.9443	1419357	0	0.05375711	1166.037	305111.8	1068.039							320	1391	411811.3
13	4204032	0	2168367	0	37.05206	1557680	0	0.03306783	717.2688	319284.3	576.4706									
14	8839053	0	2169084	0	71.44555	6315110	0	1.19E-16	2.59E-12	345550.1	1544.475	320	2079	346698.9	106342.7	0	159301.3	320	174	21402.56
15	8839053	0	2169084	0	71.44555	6315110	0	1.19E-16	2.59E-12	346569.5	1544.475	320	2079	344761.6	105852.5	0	158567.1			
16	8839053	0	2169084	0	71.44555	6315110	0	1.19E-16	2.59E-12	346569.5	1544.475							320	2079	344761.6
17	8839053	0	2169084	0	71.44555	6315110	0	1.27E-16	2.76E-12	349100.6	1544.475	320	2281	392655.5	119779.6	0	179429.9	320	376	40794.56
18	7674969	0	2169084	0	66.18165	5079421	0	1.33E-15	2.88E-11	308395.5	1172.003	320	1185	337235.9	95938.3	0	143715.6	320	99	31456
19	7676312	0	2169084	0	66.17538	5079829	0	1.35E-15	2.93E-11	309342.7	1172.003	320	1169	332714.8	94651.08	0	141787.3			
20	7676312	0	2169084	0	66.17538	5079829	0	1.35E-15	2.93E-11	309342.7	1172.003							320	1169	332714.8
21	7676958	0	2169084	0	66.1379	5077379	0	1.43E-15	3.11E-11	309284	1172.003	320	1224	358556.4	101681.8	0	152319.4	320	188	58816
22	7753819	0	2169084	0	26.65844	2067047	0	1.84E-15	4.00E-11	319250.3	603.3823	320	1161	355404.7	100319.9	0	150279.3			
23	7753819	0	2169084	0	26.65844	2067047	0	1.84E-15	4.00E-11	319250.3	603.3823							320	1161	355404.7
24	7396191	0	2169084	0	22.98418	1699954	0	1.99E-15	4.32E-11	317148.6	548.5294	320	1216	374989.4	105767.7	0	158440	320	176	54976
25	7399529	0	2169084	0	23.06008	1706337	0	1.94E-15	4.20E-11	319456.8	548.5294	320	1175	362957.3	102356.2	0	153329.6	320	90	28800
26	4560066	0	2169084	0	50.21442	2289811	0	1.85E-15	4.01E-11	319206.6	686.1176	320	1166	357906.3	100997.7	0	151294.5			
27	4560066	0	2169084	0	50.21442	2289811	0	1.85E-15	4.01E-11	319206.6	686.1176							320	1166	357906.3
28	4560592	0	2169084	0	50.17419	2288240	0	1.86E-15	4.04E-11	319572.3	686.1176	320	1226	377714.7	106546.8	0	159607.1	320	177	55523.83
29	4561017	0	2169084	0	50.2533	2292061	0	1.82E-15	3.95E-11	319812.4	686.1176	320	1170	359882.6	101533.5	0	152097.2	320	85	27200
30	7399760	0	2167964	0	22.98453	1700800	0	0.05163031	1119.905	322978.3	548.5294									
31	4205916	0	2168068	0	45.69172	1921755	0	0.04683223	1015.83	320911.7	631.2941									
32	4731789	0	2169084	0	52.22551	2471201	0	1.73E-15	3.75E-11	240975.5	761.8113	320	865	265089.9	74818.15	0	112077.6			
33	4731789	0	2169084	0	52.22551	2471201	0	1.73E-15	3.75E-11	240975.5	761.8113							320	865	265089.9
34	4733452	0	2169084	0	52.26138	2473767	0	1.71E-15	3.71E-11	242110.7	761.8113	320	876	269456.2	76021.37	0	113880	320	73	23136
35	4582100	0	2169084	0	50.45	2311669	0	1.97E-15	4.28E-11	309886.4	695.0955	320	1192	366642	103440.8	0	154954.3	320	171	53376
36	1.05E+07	0	2169084	0	46.60812	4876894	0	1.51E-16	3.27E-12	347143.2	1590.93	320	2151	349448.7	107683.5	0	161309.9	320	165	20653.74
37	1.05E+07	0	2169084	0	46.60812	4876894	0	1.51E-16	3.27E-12	348109.9	1590.93	320	2151	347822.8	107272.1	0	160693.6			
38	1.05E+07	0	2169084	0	46.60812	4876894	0	1.51E-16	3.27E-12	348109.9	1590.93							320	2151	347822.8
39	1.05E+07	0	2169084	0	46.60812	4876894	0	1.53E-16	3.33E-12	350641	1590.93	320	2350	394001.5	120738.4	0	180866.1	320	364	39757.74
40	7346561	0	2169084	0	70.47484	5177477	0	1.31E-16	2.84E-12	346367.9	1604.639	320	2120	347495.2	106911.5	0	160153.4	320	168	20912.71
41	7346561	0	2169084	0	70.47484	5177477	0	1.31E-16	2.84E-12	347352.2	1604.639	320	2120	345761.8	106472.9	0	159496.5			
42	7346561	0	2169084	0	70.47484	5177477	0	1.31E-16	2.84E-12	347352.2	1604.639							320	2120	345761.8
43	7346561	0	2169084	0	70.47484	5177477	0	1.31E-16	2.84E-12	349936	1604.639	320	2323	393001.4	120243.4	0	180124.7	320	371	40400.71
44	4225498	0	2168131	0	45.988	1943222	0	0.04391644	952.5844	309864.2	640.5485									
45	8147345	0	2167775	0	68.10806	5548999	0	0.06036115	1309.284	103990.8	2150.745	320	539	138058.3	39758.18	0	59557.76			
46	8147345	0	2167775	0	68.10806	5548999	0	0.06036115	1309.284	103990.8	2150.745							320	539	138058.3
47	6481616	0	2167570	0	65.35056	4235772	0	0.06977388	1513.454	99443.8	1474.219	320	525	131682.9	38019.77	0	56953.62			
48	6481616	0	2167570	0	65.35056	4235772	0	0.06977388	1513.454	99443.8	1474.219							320	525	131682.9
49	1.14E+07	0	2167612	0	40.99363	4674237	0	0.06787586	1472.284	94461.45	1152.941	320	557	123020.5	36114.89	0	54100.11			
50	1.14E+07	0	2167612	0	40.99363	4674237	0	0.06787586	1472.284	94461.45	1152.941							320	557	123020.5
51	1.75E+07	0	2169084	0	64.97797	1.14E+07	0	3.52E-15	7.63E-11	320898.6	5860.389	320	1162	337247.7	95735.18	0	143411.3			
52	1.75E+07	0	2169084	0	64.97797	1.14E+07	0	3.52E-15	7.63E-11	320898.6	5860.389							320	1162	337247.7
53	1.74E+07	0	2169084	0	64.70044	1.13E+07	0	3.55E-15	7.71E-11	319647.6	5799.343	320	1173	343585	97437.09	0	145960.8	320	127	40215.36
54	1.74E+07	0	2169084	0	64.6796	1.13E+07	0	3.64E-15	7.89E-11	320115.5	5799.343	320	1235	363200.6	102955.4	0	154227.1	320	218	69088
55	1.15E+07	0	2167638	0	43.73182	5028821	0	0.06666847	1446.095	92652.78	1207.765	320	550	120535.2	35423.4	0	53064.25			
56	1.15E+07	0	2167638	0	43.73182	5028821	0	0.06666847	1446.095	92652.78	1207.765							320	550	120535.2
57	1.75E+07	0	2169021	0	64.92358	1.14E+07	0	0.002883371	62.54272	320179.8	5860.389									
58	9422936	0	2167612	0	33.54878	3161280	0	0.06787586	1472.284	97083.16	822.7941	320	563	126769.8	37117.23	0	55601.62			
59	9422936	0	2167612	0	33.54878	3161280	0	0.06787586	1472.284	97083.16	822.7941							320	563	126769.8
60	1.75E+07	0	2168767	0	64.91882	1.14E+07	0	0.01460691	316.8362	297754.7	5860.389	320	1462	398179	113838.8	0	170530.5			
61	1.75E+07	0	2168767	0	64.91882	1.14E+07	0	0.01460691	316.8362	297754.7	5860.389							320	1462	398179
62	3.31E+07	0	2169084	0	93.44638	3.09E+07	0	1.97E-17	4.26E-13	337609.3	5434.117	320	1629	323944.5	96553.8	0	144637.6	320	218	26675.47
63	3.31E+07	0	2169084	0	93.44638	3.09E+07	0	1.97E-17	4.26E-13	338886.5	5434.117	320	1629	321542.5	95946.09	0	143727.2			
64	3.31E+07	0	2169084	0	93.44638	3.09E+07	0	1.97E-17	4.26E-13	338886.5	5434.117							320	1629	321542.5
65	3.31E+07	0	2169084	0	93.44638	3.09E+07	0	2.23E-17	4.83E-13	342073.8	5434.117	320	1883	382467.3	113635.9	0	170226.6	320	472	51059.47
66	2.39E+07	0	2167232	0	89.21589	2.14E+07	0	0.08538014	1851.967	0	6719.386									
67	2.39E+07	0	2167536	0	90.69856	2.17E+07	0	0.07134806	1547.599	0	6758.774									
68	1.79E+07	0	2169084	0	87.32516	1.57E+07	0	1.89E-15	4.10E-11	0	2963.765									

Index	G2/Fuel (L)	G2/O&M Cost ($/yr)	G2/Fuel Cost ($/yr)	G3/Capacity	G3/Hours	G3/Production (kWh)	G3/Fuel (L)	G3/O&M Cost ($/yr)	G3/Fuel Cost ($/yr)	EWT DW61/Capacity	EWT DW61/Capital Cost ($)	EWT DW61/Production (kWh/yr)	EWT DW61/O&M Cost ($/yr)	NPS 100C-24/Capacity	NPS 100C-24/Capital Cost ($)	NPS 100C-24/Production (kWh/yr)	NPS 100C-24/O&M Cost ($/yr)	150KW Array/Capacity	150KW Array/Capital Cost ($)	150KW Array/Production (kWh/yr)
1	6384.32	0	9563.711	400	103	40771.56	11468.81	0	17180.27					5	1.34E+07	1774295	0	4.166667	6612222	1111290
2				400	186	73814.17	20758.19	0	31095.76					5	1.34E+07	1774295	0	3.559028	6159157	949226.7
3	100207.6	0	150110.9	400	186	73814.17	20758.19	0	31095.76					5	1.34E+07	1774295	0	3.559028	6159157	949226.7
4	10603.89	0	15884.62											5	1.34E+07	1774295	0	3.559028	6159157	949226.7
5				400	1173	431672.5	122350.7	0	183281.4					5	1.34E+07	1774295	0	3.559028	6159157	949226.7
6				400	872	311048.6	88461.69	0	132515.6	1	1.56E+07	3417635	0					5.507943	7612298	1469021
7				400	227	90368.06	25405.52	0	38057.47	2	2.37E+07	6835271	0							
8	96797.44	0	145002.6	400	227	90368.06	25405.52	0	38057.47	2	2.37E+07	6835271	0							
9	9621.44	0	14412.92	400	133	52704.89	14823.94	0	22206.26	2	2.37E+07	6835271	0							
10	17857.06	0	26749.87							2	2.37E+07	6835271	0							
11														3	9760000	1064577	0	8.333333	9888734	2222580
12	116651.6	0	174744.1											3	9760000	1064577	0	8.333333	9888734	2222580
13				400	1151	431537.3	122070.1	0	182861	1	1.56E+07	3417635	0							
14	6973.887	0	10446.88	400	202	65348.6	18795.6	0	28155.8	2	2.37E+07	6835271	0					4.557292	6903478	1215473
15				400	376	88688.48	26649.39	0	39920.78	2	2.37E+07	6835271	0					4.557292	6903478	1215473
16	105852.5	0	158567.1	400	376	88688.48	26649.39	0	39920.78	2	2.37E+07	6835271	0					4.557292	6903478	1215473
17	13689.98	0	20507.6							2	2.37E+07	6835271	0					4.557292	6903478	1215473
18	8845.408	0	13250.42	400	117	46691.49	13123.35	0	19658.77	2	2.37E+07	6835271	0					0.2604167	3699661	69455.61
19				400	211	84011.48	23618.11	0	35379.92	2	2.37E+07	6835271	0					0.2604167	3699661	69455.61
20	94651.08	0	141787.3	400	211	84011.48	23618.11	0	35379.92	2	2.37E+07	6835271	0					0.2604167	3699661	69455.61
21	16564.93	0	24814.26							2	2.37E+07	6835271	0					0.2604167	3699661	69455.61
22				400	194	77329.55	21737.17	0	32562.29					11	2.41E+07	3903450	0			
23	100319.9	0	150279.3	400	194	77329.55	21737.17	0	32562.29					11	2.41E+07	3903450	0			
24	15485.89	0	23197.86											10	2.23E+07	3548591	0			
25	8092.8	0	12123.01	400	105	41545.65	11687.05	0	17507.2					10	2.23E+07	3548591	0			
26				400	189	74806.01	21042.72	0	31522	1	1.56E+07	3417635	0	2	7960000	709718.1	0			
27	100997.7	0	151294.5	400	189	74806.01	21042.72	0	31522	1	1.56E+07	3417635	0	2	7960000	709718.1	0			
28	15633.45	0	23418.91							1	1.56E+07	3417635	0	2	7960000	709718.1	0			
29	7643.2	0	11449.51	400	117	46580.73	13095.33	0	19616.8	1	1.56E+07	3417635	0	2	7960000	709718.1	0			
30				400	1232	433533.7	123482.4	0	184976.7					10	2.23E+07	3548591	0			
31				400	1164	433421	122692.3	0	183793.1	1	1.56E+07	3417635	0	1	6270000	354859	0			
32				400	156	61523.43	17312.63	0	25934.31	1	1.56E+07	3417635	0	2	7960000	709718.1	0	1.041667	4282173	277822.4
33	74818.15	0	112077.6	400	156	61523.43	17312.63	0	25934.31	1	1.56E+07	3417635	0	2	7960000	709718.1	0	1.041667	4282173	277822.4
34	6507.488	0	9748.217	400	90	35683.43	10035.91	0	15033.79	1	1.56E+07	3417635	0	2	7960000	709718.1	0	1.041667	4282173	277822.4
35	15036.29	0	22524.36							1	1.56E+07	3417635	0	2	7960000	709718.1	0	0.1302083	3602575	34727.8
36	6703.795	0	10042.29	400	199	63656.76	18333.96	0	27464.27					11	2.41E+07	3903450	0	10.15625	1.14E+07	2708769
37				400	364	85936.45	25818.72	0	38676.45					11	2.41E+07	3903450	0	10.15625	1.14E+07	2708769
38	107272.1	0	160693.6	400	364	85936.45	25818.72	0	38676.45					11	2.41E+07	3903450	0	10.15625	1.14E+07	2708769
39	13320.15	0	19953.58											11	2.41E+07	3903450	0	10.15625	1.14E+07	2708769
40	6796.196	0	10180.7	400	203	64994.26	18717.15	0	28038.29	1	1.56E+07	3417635	0	3	9760000	1064577	0	9.114583	1.06E+07	2430947
41				400	371	87640.32	26328.2	0	39439.64	1	1.56E+07	3417635	0	3	9760000	1064577	0	9.114583	1.06E+07	2430947
42	106472.9	0	159496.5	400	371	87640.32	26328.2	0	39439.64	1	1.56E+07	3417635	0	3	9760000	1064577	0	9.114583	1.06E+07	2430947
43	13545.54	0	20291.22							1	1.56E+07	3417635	0	3	9760000	1064577	0	9.114583	1.06E+07	2430947
44				400	1129	418275.7	118468.6	0	177465.9	1	1.56E+07	3417635	0	1	6270000	354859	0	0.1302083	3602575	34727.8
45										1	1.56E+07	3417635	0					15.88542	1.57E+07	4236793
46	39758.18	0	59557.76							1	1.56E+07	3417635	0					15.88542	1.57E+07	4236793
47										1	1.56E+07	3417635	0	2	7960000	709718.1	0	8.333333	9888734	2222580
48	38019.77	0	56953.62							1	1.56E+07	3417635	0	2	7960000	709718.1	0	8.333333	9888734	2222580
49										2	2.37E+07	6835271	0							
50	36114.89	0	54100.11							2	2.37E+07	6835271	0							
51				400	242	95817.11	26952.13	0	40374.29									50	4.13E+07	1.33E+07
52	95735.18	0	143411.3	400	242	95817.11	26952.13	0	40374.29									50	4.13E+07	1.33E+07
53	11312.41	0	16945.99	400	120	47887.37	13459.5	0	20162.34									49.47917	4.09E+07	1.32E+07
54	19432.54	0	29109.95															49.47917	4.09E+07	1.32E+07
55										2	2.37E+07	6835271	0	1	6270000	354859	0			
56	35423.4	0	53064.25							2	2.37E+07	6835271	0	1	6270000	354859	0			
57				400	1219	429880.2	122412.5	0	183373.9									50	4.13E+07	1.33E+07
58														15	3.13E+07	5322886	0			
59	37117.23	0	55601.62											15	3.13E+07	5322886	0			
60																		50	4.13E+07	1.33E+07
61	113838.8	0	170530.5															50	4.13E+07	1.33E+07
62	8702.175	0	13035.86	400	254	82906.81	23820.22	0	35682.7	8	7.02E+07	2.73E+07	0	15	3.13E+07	5322886	0			
63				400	472	111984.3	33618.43	0	50360.4	8	7.02E+07	2.73E+07	0	15	3.13E+07	5322886	0			
64	95946.09	0	143727.2	400	472	111984.3	33618.43	0	50360.4	8	7.02E+07	2.73E+07	0	15	3.13E+07	5322886	0			
65	17147.17	0	25686.46							8	7.02E+07	2.73E+07	0	15	3.13E+07	5322886	0			
66										3	3.31E+07	1.03E+07	0					50	4.13E+07	1.33E+07
67										3	3.31E+07	1.03E+07	0	1	6270000	354859	0	50	4.13E+07	1.33E+07
68										4	4.05E+07	1.37E+07	0	12	2.59E+07	4258309	0			

Index	150KW Array/O&M Cost ($/yr)	100LI/Quantity	100LI/Electrolyte	100LI/CellStacks	100LI/Auxiliary Load Percent (%)	100LI/Autonomy (hr)	100LI/Annual Throughput (kWh/yr)	100LI/Nominal Capacity (kWh)	100LI/Accessible Capacity (kWh)	Converter/Capacity	Converter/Rectifier Mean Output (kW)	Converter/Inverter Mean Output (kW)
1	0	25	0	0	0	8.077159	429600	2500.005	2000.004	500	51.62805	44.19825
2	0	28	0	0	0	9.046418	447710.8	2800.006	2240.004	500	53.80396	46.06152
3	0	28	0	0	0	9.046418	447710.8	2800.006	2240.004	500	53.80396	46.06152
4	0	28	0	0	0	9.046418	441748.3	2800.006	2240.004	500	53.10384	45.44809
5	0	28	0	0	0	9.046418	470535.3	2800.006	2240.004	500	56.40569	48.40976
6	0	22	0	0	0	7.1079	362037	2200.004	1760.004	500	43.40783	37.24721
7		19	0	0	0	6.138641	362501.2	1900.004	1520.003	500	43.58284	37.29497
8		19	0	0	0	6.138641	362501.2	1900.004	1520.003	500	43.58284	37.29497
9		19	0	0	0	6.138641	357291	1900.004	1520.003	500	42.93855	36.75893
10		19	0	0	0	6.138641	381227.6	1900.004	1520.003	1000	45.7729	39.22158
11	0	47	0	0	0	15.18506	555944.3	4700.009	3760.008	1000	66.44987	57.19684
12	0	47	0	0	0	15.18506	555944.3	4700.009	3760.008	1000	66.44987	57.19684
13		71	0	0	0	22.93913	606953.6	7100.014	5680.011	1000	72.67522	62.44479
14	0											
15	0											
16	0											
17	0											
18	0	18	0	0	0	5.815555	346128.3	1800.004	1440.003	500	41.59533	35.61048
19	0	18	0	0	0	5.815555	349850.2	1800.004	1440.003	500	42.06054	35.9934
20	0	18	0	0	0	5.815555	349850.2	1800.004	1440.003	500	42.06054	35.9934
21	0	18	0	0	0	5.815555	367085.9	1800.004	1440.003	1000	44.08085	37.76665
22		39	0	0	0	12.60037	492693.3	3900.008	3120.006	1000	59.00541	50.68943
23		39	0	0	0	12.60037	492693.3	3900.008	3120.006	1000	59.00541	50.68943
24		48	0	0	0	15.50815	538132.1	4800.01	3840.008	1000	64.47306	55.36427
25		48	0	0	0	15.50815	523510.3	4800.01	3840.008	1000	62.71362	53.85995
26		43	0	0	0	13.89271	499461.6	4300.009	3440.007	1000	59.78827	51.38577
27		43	0	0	0	13.89271	499461.6	4300.009	3440.007	1000	59.78827	51.38577
28		43	0	0	0	13.89271	509526.3	4300.009	3440.007	1000	60.99936	52.42125
29		44	0	0	0	14.2158	493223.3	4400.009	3520.007	1000	59.03761	50.74396
30		52	0	0	0	16.80049	550033.6	5200.01	4160.008	500	66.05291	56.58873
31		57	0	0	0	18.41592	572138.9	5700.011	4560.009	1000	68.50976	58.86298
32	0	42	0	0	0	13.56963	453059.1	4200.008	3360.007	1000	54.20465	46.61177
33	0	42	0	0	0	13.56963	453059.1	4200.008	3360.007	1000	54.20465	46.61177
34	0	42	0	0	0	13.56963	448718.2	4200.008	3360.007	1000	53.6823	46.16516
35	0	42	0	0	0	13.56963	500301.1	4200.008	3360.007	1000	59.88929	51.47214
36	0											
37	0											
38	0											
39	0											
40	0											
41	0											
42	0											
43	0											
44	0	56	0	0	0	18.09284	562790.6	5600.011	4480.009	1000	67.38487	57.9012
45	0	57	0	0	0	18.41592	373636.8	5700.011	4560.009	500	44.72946	38.44062
46	0	57	0	0	0	18.41592	373636.8	5700.011	4560.009	500	44.72946	38.44062
47	0	69	0	0	0	22.29296	383822.5	6900.014	5520.011	500	46.00269	39.48855
48	0	69	0	0	0	22.29296	383822.5	6900.014	5520.011	500	46.00269	39.48855
49		141	0	0	0	45.55518	573171	14100.03	11280.02	500	68.64862	58.96917
50		141	0	0	0	45.55518	573171	14100.03	11280.02	500	68.64862	58.96917
51	0	68	0	0	0	21.96987	992858.8	6800.014	5440.011	1000	118.9085	102.1476
52	0	68	0	0	0	21.96987	992858.8	6800.014	5440.011	1000	118.9085	102.1476
53	0	70	0	0	0	22.61605	989642.8	7000.014	5600.011	1000	118.5033	101.8167
54	0	70	0	0	0	22.61605	1005193	7000.014	5600.011	1000	120.4394	103.4166
55		138	0	0	0	44.58592	561384.8	13800.03	11040.02	500	67.25417	57.75657
56		138	0	0	0	44.58592	561384.8	13800.03	11040.02	500	67.25417	57.75657
57	0	73	0	0	0	23.58531	1032538	7300.015	5840.012	1000	123.707	106.2299
58		150	0	0	0	48.46296	590409.7	15000.03	12000.02	500	70.80209	60.74272
59		150	0	0	0	48.46296	590409.7	15000.03	12000.02	500	70.80209	60.74272
60	0	150	0	0	0	48.46296	1008041	15000.03	12000.02	1000	120.225	103.7096
61	0	150	0	0	0	48.46296	1008041	15000.03	12000.02	1000	120.225	103.7096
62												
63												
64												
65												
66	0	225	0	0	0	72.69444	303813.2	22500.04	18000.04	1000	36.19828	31.257
67	0	225	0	0	0	72.69444	300623.3	22500.04	18000.04	1000	35.83823	30.92883
68		510	0	0	0	164.774	508616.7	51000.1	40800.08	1000	60.92147	52.32767

Key Simulation Results Terms	Definition
Architecture/EWT DW61	Capacity and performance metrics for the EWT DW61 wind turbine.
Architecture/NPS 100C-24	Capacity and performance metrics for the NPS 100C-24 wind turbine.
Architecture/150KW Array	Capacity and performance metrics for a 150 kW solar array.
Architecture/G1, G2, G3 (kW)	Capacity and performance metrics for generators 1, 2, and 3.
Architecture/100LI (#)	Number and specifications of 100LI battery units.
Architecture/Converter (kW)	Capacity and performance metrics for the power converter.
Architecture/Dispatch	Strategy for dispatching energy resources.
Cost Metrics	
Cost/NPC ($)	Net Present Cost of the system.
Cost/LCOE ($/kWh)	Levelized Cost of Energy.
Cost/Operating cost ($/yr)	Annual operating costs.
Cost/CAPEX ($)	Capital Expenditure.
Cost/Fuel cost ($/yr)	Annual fuel costs.
Cost/OPEX ($/yr)	Operational Expenditure.
System Metrics	
System/Ren Frac (%)	Renewable Fraction of the energy system.
System/Total Fuel (L/yr)	Total fuel consumption per year.
System/Cap Short (%)	Capacity shortage percentage.
System/Cap Short (kWh/yr)	Capacity shortage in kWh per year.
System/Elec Prod (kWh/yr)	Total electricity production per year.
System/Therm Prod (kWh/yr)	Total thermal production per year.
System/Elec Cons (kWh/yr)	Total electricity consumption per year.
System/Therm Cons (kWh/yr)	Total thermal consumption per year.
System/Clipped Energy (%)	Percentage of energy clipped (not used).
System/Clipped Energy (kWh/yr)	Amount of energy clipped in kWh per year.
System/Excess Therm (kWh/yr)	Excess thermal energy produced.
System/Unmet load (%)	Percentage of unmet load.
System/Unmet load (kWh/yr)	Amount of unmet load in kWh per year.
System/CO? (kg/yr)	CO? emissions per year.
System/MRP (%)	Marginal Renewable Penetration.
Generator Metrics	
G1, G2, G3/Capacity	Capacity of generators 1, 2, and 3.
G1, G2, G3/Hours	Operating hours of generators 1, 2, and 3.
G1, G2, G3/Production (kWh)	Electricity production of generators 1, 2, and 3.
G1, G2, G3/Fuel (L)	Fuel consumption of generators 1, 2, and 3.
G1, G2, G3/O&M Cost ($/yr)	Operation and Maintenance costs of generators 1, 2, and 3.
G1, G2, G3/Fuel Cost ($/yr)	Fuel costs of generators 1, 2, and 3.
Specific Component Metrics	
EWT DW61/Capacity	Capacity of the EWT DW61 wind turbine.
EWT DW61/Capital Cost ($)	Capital cost of the EWT DW61 wind turbine.
EWT DW61/Production (kWh/yr)	Annual production of the EWT DW61 wind turbine.
EWT DW61/O&M Cost ($/yr)	Operation and Maintenance cost of the EWT DW61 wind turbine.
NPS 100C-24/Capacity	Capacity of the NPS 100C-24 wind turbine.
NPS 100C-24/Capital Cost ($)	Capital cost of the NPS 100C-24 wind turbine.
NPS 100C-24/Production (kWh/yr)	Annual production of the NPS 100C-24 wind turbine.
NPS 100C-24/O&M Cost ($/yr)	Operation and Maintenance cost of the NPS 100C-24 wind turbine.
150KW Array/Capacity	Capacity of the 150 kW solar array.
150KW Array/Capital Cost ($)	Capital cost of the 150 kW solar array.
150KW Array/Production (kWh/yr)	Annual production of the 150 kW solar array.
150KW Array/O&M Cost ($/yr)	Operation and Maintenance cost of the 150 kW solar array.
Battery Metrics	
100LI/Quantity	Number of 100LI battery units.
100LI/Electrolyte	Electrolyte type used in 100LI batteries.
100LI/CellStacks	Number of cell stacks in 100LI batteries.
100LI/Auxiliary Load Percent (%)	Auxiliary load percentage for 100LI batteries.
100LI/Autonomy (hr)	Autonomy hours of 100LI batteries.
100LI/Annual Throughput (kWh/yr)	Annual throughput of 100LI batteries.
100LI/Nominal Capacity (kWh)	Nominal capacity of 100LI batteries.
100LI/Accessible Capacity (kWh)	Accessible capacity of 100LI batteries.
Converter Metrics	
Converter/Capacity	Capacity of the power converter.
Converter/Rectifier Mean Output (kW)	Mean output of the rectifier.
Converter/Inverter Mean Output (kW)	Mean output of the inverter.

Appendix B - CAPEX

Expenses	Type	Description	Quantity	Unit	Unit Cost $	Operation and Maintanance Cost	Comments Note 1
Equipment	Microgrid Controller	Prefabricated, pre-wired system required to control and monitor power system	1	Each	$1,000,000	Exluded from Model	Supply and assembly of electrical and control components required to control and monitor power system.
Equipment	Wind turbine	Manufacturer EWT; Model DW61	1	Each	$15,610,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model DW61	2	Lot	$23,690,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model DW61	3	Lot	$33,110,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model DW61	4	Lot	$40,520,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model NPS100C-24	1	Each	$6,270,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model NPS100C-24	2	Lot	$7,960,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model NPS100C-24	3	Lot	$9,760,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model NPS100C-24	4	Lot	$11,560,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Wind turbine	Manufacturer EWT; Model NPS100C-24	10	Lot	$23,340,000	Note 1	Assumes no new or improved roads. Only a minor segment of access road to the site from the existing road and 12kV interconnection line
Equipment	Solar PV	Photovoltaic Solar Array	0.5	MW	$5,988,390	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	1	MW	$8,471,290	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	1.5	MW	$11,300,530	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	2	MW	$13,764,200	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	2.5	MW	$16,223,690	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	3	MW	$18,680,190	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	3.5	MW	$21,134,440	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	4	MW	$23,586,909	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	4.5	MW	$26,550,780	Note 1	Assumes DC/AC converter cost included
Equipment	Solar PV	Photovoltaic Solar Array	5	MW	$29,000,560	Note 1	Assumes DC/AC converter cost included
Equipment	Battery Storage	Generic Li-Ion batteries	100	kWh	$131,679	Note 1	Average replacement cost $72,235 per 100 kWh OPEX cost 2% of CAPEX
Equipment	Inverter system (Batteries)	Group of inveters collecting and transforming renewable to be stored in the battery storage system	500	kw	$91,605	Note 1	OPEX cost 2% of CAPEX
Equipment	Cabling infrastructure for interconnection of the multiple power source	Interconnection system to transport and connect to the microgrid controller	1	Lot	By Others	Exluded from Model	
Services	Detailed engineering microgrid Controller	Detail design of microgrid power and controls systems	1	Lot	$750,000	Exluded from Model	Detailed desing of power and control components required to control and monitor power system
Services	Detailed engineering interconnection	Detailed design of electrical distribution to interconnect windfarm, solar farm to microgrid controller to the existing generating	1	Lot	$750,000	Exluded from Model	
Services	Shipping - Microgrid Controller	Shipping cost from fabrication location to destination	1	Lot	-	Exluded from Model	
Services	Civil works	Access Road, foundations, trenching for cabling/conduits, fencing, ground grid	1	Lot	-	Exluded from Model	

Note 1 CAPEX cost depends on the optimization scenario selected. Refer to Appendix A for detailed cost

KIVALLIQ ALTERNATIVE ENERGY

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