Wrangell Energy Future

GreenSparc Anchor Customer Explorer

Model User Guide & Calculation Reference

SEAPA's Tyee Lake hydropower is at capacity. Wrangell's electricity load is growing fast from heat-pump adoption, forcing increasing reliance on expensive diesel generation. A third turbine (~$20M) is needed. This interactive model explores whether a GreenSparc data-center anchor customer can make that expansion financeable — and drive community electricity rates below today's level.

This document describes every adjustable parameter in the model sidebar, where each default value comes from, and the 20 backend calculations that drive the three scenarios.

- Status Quo — diesel creep, rising rates
- Expansion Only — capital burden on ratepayers
- Expansion + Anchor — rates go down

Data sources: EIA-861 (2023), EIA-860 (2025), SEAPA/FERC filings, Ketchikan Daily News (2024)

Contents

1. How to Use the App

Launch the app with: streamlit run streamlit_app.py
Requirements: pip install streamlit pandas plotly

The interface has two areas:

Sidebar (left)

Contains all 23 adjustable parameters organized into collapsible sections: Wrangell System, Load Growth, SEAPA Expansion, GreenSparc Anchor Customer, and Community Baseline. Change any slider or input and the model recalculates instantly.

Main Panel (right)

Displays results across four tabs:

1. Rate Trajectory — line chart of $/kWh through 2035 for all three scenarios
2. Diesel Displacement — diesel usage, cost bars, and energy-mix stacked areas
3. Expansion Viability — waterfall and cumulative charts showing anchor debt coverage
4. Community Impact — household bills, savings tables, jobs, and economic activity

At the top, three metric cards show the 2030 rate outlook for each scenario compared to today's rate.

2. Sidebar Controls Reference

The table below documents every adjustable parameter. "Source" indicates where the default value was derived. "Model Effect" describes how changing the parameter propagates through the calculations.

Wrangell System

Parameter	Default	Source	Effect on Model
2023 Baseline Load (20k-80k)	40,708 MWh/yr	EIA-861 2023 Short Form, utility 21015	Starting point for all load projections. Higher values increase future demand, accelerate diesel reliance, and raise rates in every scenario.
Current SEAPA Energy Cap (20k-60k)	40,200 MWh/yr	Back-calculated: 40,708 total minus 508 diesel	Ceiling of cheap hydro. Demand above this cap is served by diesel. Lowering it accelerates diesel dependency.
SEAPA Wholesale Rate ($50-150)	$93/MWh	Back-calculated from 2023 EIA-861 revenue	Cost of every hydro MWh. Also sets the floor for anchor margin — anchor only contributes if tariff exceeds this.
Fixed Costs ($500k-5M)	$1,200,000/yr	Estimate: 5 FT staff + overhead (pending audit)	Flat annual cost in every scenario/year. Raises baseline rate equally across all scenarios.
Diesel All-in Cost ($80-300)	$150/MWh	Fully-loaded estimate incl. remote delivery, O&M, permits	Year-zero diesel unit cost. Higher values widen the Status Quo cost penalty and increase expansion savings.
Diesel Escalation (0-6%)	3.0%/yr	Fuel price inflation assumption	Compounds annually on diesel cost. At 3%, diesel roughly doubles in 24 years. Higher values make Status Quo progressively worse.
Diesel Floor (0-2,000)	200 MWh/yr	Minimum for testing, maintenance, peak spikes	Minimum diesel even when hydro is ample. Small effect unless set high.

Load Growth

Parameter	Default	Source	Effect on Model
Phase 1 Growth Rate (1-10%)	5.0%/yr	Historical: +19% over 2019-2023 (~4.5% CAGR)	Compound growth during rapid heat-pump adoption. Higher values accelerate load, worsen Status Quo, increase expansion urgency.
Phase 1 End Year (2026-2028)	2027	Assumption: adoption saturates ~4 years out	When growth transitions from fast to steady-state. Later = more years of fast growth and higher peak loads.
Phase 2 Growth Rate (0.5-5%)	2.0%/yr	Post-saturation baseline growth assumption	Long-term load trajectory. Even small changes compound significantly over 2028-2035.

SEAPA Expansion

Parameter	Default	Source	Effect on Model
Target Online Year (2026-2029)	2027	SEAPA confirmed target: Dec 2027	When new hydro + anchor come online. Delay extends diesel reliance and shifts all benefits later.
New Energy for Wrangell (10k-60k)	37,000 MWh/yr	5 MW x 8,760 hr x 0.845 CF (Wrangell share)	Additional hydro capacity from expansion. Must exceed load growth + anchor to eliminate structural diesel.

Total Expansion Capex ($10M-50M)	$20,000,000	SEAPA 3rd turbine engineering estimate	Flows through PMT formula to annual debt service. Higher capex = larger debt payments.
Wrangell Debt Share (20-60%)	40%	Proportional to load vs total SEAPA membership	Fraction of capex Wrangell finances. At 40% of $20M = $8M principal.
Financing Rate (3-8%)	5.0%	Municipal bond rate assumption	Interest rate on debt. Higher rates increase annual payments, making anchor coverage more critical.
Bond Term (20/25/30)	25 years	Standard municipal bond terms	Longer terms reduce annual payments but increase total interest paid.

Anchor Customer

Parameter	Default	Source	Effect on Model
Nameplate Load (0.5-5.0)	2.0 MW	GreenSparc data-center sizing	Combined with capacity factor, determines annual anchor demand and revenue. Larger = more revenue but more hydro consumed.
Capacity Factor (0.70-0.99)	0.90	Data center typical: 0.85-0.95	Fraction of time at full load. Nameplate x CF x 8,760 = annual MWh. Higher CF = more energy and revenue.
Anchor Tariff ($0.07-0.20)	$0.12/kWh	Proposed: above SEAPA ($0.093) but below retail ($0.123)	MOST SENSITIVE LEVER. Margin above SEAPA cost x MWh = annual debt coverage. Determines whether Scenario C beats today's rate.

Community

Parameter	Default	Source	Effect on Model
Residential Accounts (500-3,000)	1,174	EIA-861 2023 customer count	Display only — scales per-household savings. Does not affect rates or system economics.
Avg Household kWh/yr (3k-20k)	9,000	Estimate for Wrangell residential usage	Converts $/kWh to annual bills. Display only.
Local Spending Multiplier (1.0-2.5)	1.7x	Standard rural economic multiplier	Display only — scales economic impact estimates on Community tab.
Jobs per MW (0.5-5.0)	1.5	Industry estimate for operating data centers	Display only — estimates ongoing jobs on Community tab.

3. Backend Calculations

The model runs 20 calculations for each year (2023-2035) across three scenarios. Hydro is dispatched first as the cheapest source; diesel fills the gap. Anchor revenue offsets total system cost, reducing the rate borne by community customers.

Calculation 1: Community Load Projection

Two-phase compound growth models Wrangell's demand from existing customers.

```
if year <= phase1_end:
  load = base_mwh x (1 + r1)^(year - 2023)
else:
  terminal = base_mwh x (1 + r1)^(phase1_end - 2023)
  load = terminal x (1 + r2)^(year - phase1_end)
```

Inputs: base_mwh, r1, phase1_end, r2

Calculation 2: SEAPA Energy Cap

Maximum hydro energy available. Steps up when the 3rd turbine comes online.

```
if expansion AND year >= expansion_year:
  cap = seapa_cap + expansion_new_mwh
else:
  cap = seapa_cap
```

Inputs: seapa_cap, expansion_new_mwh, expansion_year

Calculation 3: Anchor Energy Demand

Annual MWh consumed by the anchor customer. Only active in Scenario C post-expansion.

```
anchor_mwh_yr = anchor_mw x anchor_cf x 8,760
(only in Scenario C, year >= expansion_year)
```

Inputs: anchor_mw, anchor_cf

Calculation 4: Total System Demand

Everything the grid must serve.

```
total_mwh = community_mwh + anchor_mwh
```

Inputs: Calc #1 + Calc #3

Calculation 5: Diesel Dispatch

Diesel fills whatever hydro can't cover, subject to an operational floor.

```
diesel_mwh = max(diesel_floor, total_mwh - cap)
```

Inputs: diesel_floor, Calc #4, Calc #2

Calculation 6: Hydro Dispatch

The complement of diesel — everything not served by diesel.

```
hydro_mwh = total_mwh - diesel_mwh
```

Inputs: Calc #4, Calc #5

Calculation 7: Diesel Unit Cost Escalation

Diesel gets more expensive each year due to fuel inflation.

```
diesel_rate = diesel_base_cost x (1 + escalation)^(year - 2023)
```

Inputs: diesel_base_cost, diesel_escalation

Calculation 8: SEAPA Hydro Cost

Total annual cost of hydropower at the wholesale rate.

```
seapa_cost = seapa_rate x hydro_mwh
```

Inputs: seapa_rate, Calc #6

Calculation 9: Diesel Cost

Total annual cost of diesel generation.

```
diesel_cost = diesel_rate x diesel_mwh
```

Inputs: Calc #7, Calc #5

Calculation 10: Annual Debt Service (PMT)

Standard annuity formula for Wrangell's share of expansion financing.

```
principal = capex x wrangell_share
payment = principal x r x (1+r)^n / ((1+r)^n - 1)
(only Scenarios B & C, year >= expansion_year)
```

Inputs: capex, wrangell_share, financing_rate, bond_term

Calculation 11: Anchor Revenue

Gross annual revenue from the anchor customer's tariff payments.

```
anchor_revenue = anchor_mwh x anchor_tariff_mwh
(only Scenario C, year >= expansion_year)
```

Inputs: anchor_tariff, Calc #3

Calculation 12: Total Annual System Cost

Full cost of running Wrangell's electric system for one year.

```
total_cost = fixed_cost + seapa_cost + diesel_cost + debt_service
```

Inputs: fixed_cost, Calc #8, #9, #10

Calculation 13: Community Cost

What existing ratepayers actually bear after anchor offsets.

```
community_cost = total_cost - anchor_revenue
(In Scenarios A & B, anchor_revenue = 0)
```

Inputs: Calc #12, Calc #11

Calculation 14: Retail Rate

Cost per kWh for Wrangell residents, with a regulatory floor.

```
rate = max($0.05, community_cost / (community_mwh x 1,000))
```

Inputs: Calc #13, Calc #1

Calculation 15: Anchor Margin

Annual dollar contribution toward expansion debt — the key financial mechanism.

```
margin = anchor_mwh_yr x (anchor_tariff - seapa_rate)
```

Inputs: anchor_tariff, seapa_rate, Calc #3

Calculation 16: Anchor Capex Coverage Ratio

Fraction of Wrangell's annual debt covered by anchor margin. >= 100% means anchor fully funds expansion.

```
coverage = margin / debt_service_yr
```

Inputs: Calc #15, Calc #10

Calculation 17: Diesel Avoided (C vs A)

Total diesel generation eliminated by Expansion + Anchor vs Status Quo.

```
avoided = SUM(diesel_A[year] - diesel_C[year])  for 2023-2035
```

Inputs: Calc #5 across scenarios

Calculation 18: CO2 and Barrels Avoided

Environmental impact using standard diesel emission and energy density factors.

```
co2_tonnes = avoided_mwh x 0.7
barrels = avoided_mwh / 0.01709
```

Inputs: Calc #17

Calculation 19: Household Annual Bill

Converts per-kWh rate to a yearly dollar figure for a typical household.

```
bill = rate_kwh x hh_kwh
```

Inputs: Calc #14, hh_kwh

Calculation 20: Cumulative Household Savings

Total savings per household from choosing Scenario C over Status Quo, 2027-2035.

```
savings = SUM((rate_A[y] - rate_C[y]) x hh_kwh)  for y in 2027-2035
community_wide = savings x n_hh
```

Inputs: Calc #14, hh_kwh, n_hh

4. Interpreting the Results

Rate Trajectory Tab

The hero chart. Three lines show $/kWh from 2023 to 2035. A dashed gray line marks today's rate (12.32 cents/kWh). The green Scenario C line dropping below that reference line is the central value proposition: the anchor customer doesn't just prevent rate increases — it actively lowers rates below today's level.

Diesel Displacement Tab

Shows the physical consequence of each scenario. Under Status Quo, diesel usage grows from ~500 MWh/yr to thousands of MWh/yr by 2035. The stacked area charts make it visually clear how much of Wrangell's power comes from expensive diesel vs cheap hydro. The aggregate metrics (MWh avoided, cost saved, CO2 reduced) quantify the environmental and financial benefit.

Expansion Viability Tab

The large percentage display at the top is the single most important number: what fraction of Wrangell's expansion debt the anchor covers. The waterfall chart breaks down the annual flow: debt service in, anchor margin offsetting, residual on ratepayers. The cumulative chart shows whether anchor contributions keep pace with debt over time. Green shading between the lines = anchor is covering more than debt.

Community Impact Tab

Translates system-level economics into household-level outcomes. The grouped bar chart shows annual bills side by side. The savings table quantifies the per-household and community-wide benefit of Scenario C vs Status Quo. The economic impact panel estimates jobs, payroll, and local spending from the anchor customer.

Key Sensitivities to Explore

1. Anchor Tariff: slide from $0.10 to $0.14/kWh and watch coverage swing from partial to surplus. This is the most sensitive lever.

2. Anchor Size: increasing from 2 MW to 3 MW dramatically increases margin.

3. Diesel Escalation: at 5%/yr instead of 3%, the Status Quo becomes much worse, strengthening the expansion case.

4. Load Growth Rate: faster Phase 1 growth accelerates the urgency — diesel costs balloon sooner.

5. Wrangell Debt Share: lowering from 40% to 30% reduces annual payments and improves all expansion scenarios.

5. Data Sources & Caveats

Data Sources

EIA-861 Short Form (2023): Wrangell baseline load (40,708 MWh), revenue ($5,010,000), customer count (1,174 residential). Utility ID 21015.

EIA-860 (2025): Wrangell diesel plant capacity and specifications. Plant ID 95.

SEAPA/FERC Filings: Tyee Lake hydro capacity, utilization, and the confirmed need for a 3rd turbine.

Ketchikan Daily News / Frontier Media (2024): Local reporting on SEAPA capacity constraints and expansion planning.

SEAPA Wholesale Rate ($93/MWh): Back-calculated from 2023 actuals — not a published tariff. Formula: (total revenue - fixed costs - diesel costs) / hydro MWh.

Model Caveats

This is an illustrative projection tool, not a rate-case or regulatory filing.

- The SEAPA wholesale rate is inferred, not published. Actual contract terms may differ.

- Wrangell's 40% SEAPA debt share is a proportional-load estimate. Actual allocation depends on inter-utility agreements.

- Diesel costs use fully-loaded estimates including remote fuel delivery. Actual costs vary with oil markets and barge schedules.

- Two-phase load growth is assumption-driven. Actual heat pump adoption rates may be faster or slower.

- Fixed costs (~$1.2M/yr) are estimates pending Wrangell Electric audit.

- The model uses annual averages. It does not capture hourly dispatch, seasonal hydro variability, or peak demand constraints.

- CO2 factors (0.7 tonnes/MWh) and diesel energy density (0.01709 MWh/barrel) are standard industry approximations.