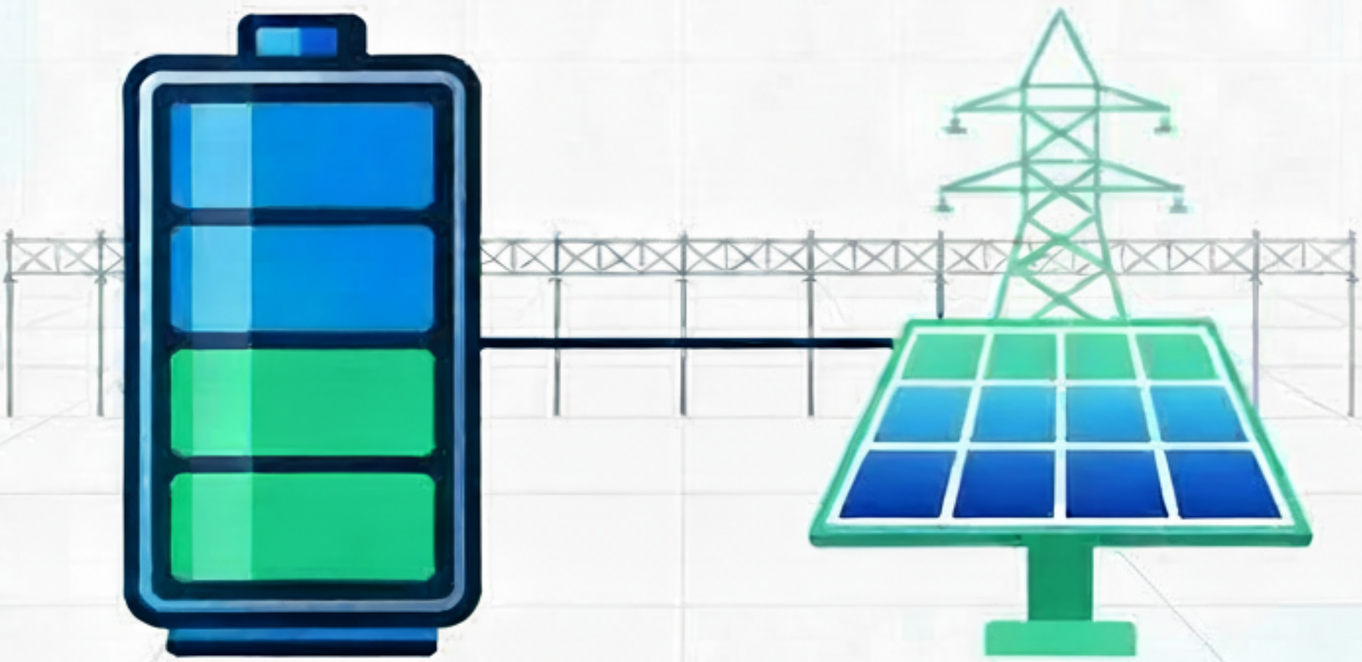
LEVELIZED COST OF CAPACITY (LCOC) ANALYSIS:
Diesel Plant vs. Battery Enery Energy Storage System



Energy Democracy Now! Co-operative Limited

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TABLE OF CONTENTS

LEVELIZED COST OF CAPACITY ANALYSIS
Diesel Plant vs. Battery Energy Storage System

Executive Summary

This analysis compares the **Levelized Cost of Capacity (LCOC)** for Maritime Electric's (MECL) proposed 100 MW gas plant against a grid-forming Battery Energy Storage System (BESS) alternative for peaking applications in Prince Edward Island. Based on MECL's August 14, 2025 Supplemental Filing and independent technical analysis, this report evaluates both options across capital costs, operational economics, and reliability profiles.

Key Findings:

Metric	Gas Plant (Base Case)	BESS (Grid-Forming)	Advantage
Capital Cost	$334.2 million	$184.0 million	**BESS saves $150.2M (45%)**
LCOC (Capacity Basis)	$366 CAD/kW-year	$284 CAD/kW-year	**BESS is 22% cheaper**
Emissions	35,000-47,000 t CO_2/yr	0 direct emissions	**BESS aligns with climate goals**

Note: This analysis does not incorporate the federal 30% Clean Technology Investment Tax Credit available for eligible battery energy storage systems in Canada, nor any other capital rebates or subsidies. The results are therefore presented on a stand-alone, pre-incentive basis and demonstrate that, on its own merits, BESS is already significantly cheaper than the proposed gas plant on a capacity basis. If the 30% federal ITC for clean technology were applied to the BESS capital cost, the cost advantage of BESS over the gas plant would increase further.

Recommendation

For peaking capacity applications, **capacity-basis LCOC is the appropriate metric** as the primary value is maintaining dispatchable capacity, not maximizing energy generation.[7][23]. For peaking capacity applications (<200 cycles/year), **BESS offers superior economics on a capacity basis, 45% lower capital costs, and zero direct emissions**, making it the preferred option for PEI's renewable energy transition.

Part 1: Gas Plant LCOC Analysis

1.1 Technology Specification

Asset: 2×50 MW ProEnergy PE6000 aeroderivative combustion turbines[1]

Base Technology: Refurbished General Electric LM6000 turbines

Fuel: Dual-fuel capability (Natural Gas primary / Ultra-Low Sulfur Diesel backup)

Intended Use: Peaker plant / Security of supply

Technical Parameters:

- **Heat Rate:** 8,595 Btu/kWh (8.595 MMBtu/MWh)[2]
- **Net Efficiency (LHV):** 39.7%[2]
- **Response Time:** 5 minutes from cold start to full load[2]
- **Ramp Rate:** 50 MW/min[2]

1.2 Capital Cost Scenarios

Based on MECL's filing and risk analysis:

Scenario	Capital Cost (CAD)	Source/Basis
Low Capex	$324,000,000	S&L estimate for 2×PE6000 units[1]
Medium Capex (Base)	$334,229,000	MECL total project cost (Table 2)[1]
High Capex (30% Overrun)	$434,500,000	Risk-adjusted cost overrun scenario[1]

1.3 Operating Parameters & Assumptions

Fuel Cost (Natural Gas):

- **2025 Delivered Price (Maritimes):** $4.50 CAD/MMBtu
- **30-Year Average Projection:** $5.50 CAD/MMBtu
- **50-Year Average:** $6.50 CAD/MMBtu

Basis: Canada Energy Regulator (CER) forecasts show AECO-C prices rising from $2.71/GJ (2025) to $4.37/GJ (2034), converted to MMBtu with Maritimes transport premium (~$1.00-1.80/ MMBtu) added to eastern delivery costs.[3][4][5]

Operation & Maintenance Costs:

- **Fixed O&M:** $50.00 CAD/kW-year
  (Source: AESO CONE study reports $57.3/kW-year for aeroderivative CT; US DOE estimates $16.30/kW-year; mid-range $50/kW used)[6][7]
- **Variable O&M:** $5.50 CAD/MWh
  (Source: CAISO default $4.80/MWh for combustion turbines; adjusted for CAD and aeroderivative maintenance)[8]

Financial Parameters:

- **Discount Rate:** 7.0% (WACC)
  (Source: Ontario Energy Board 2025-2026 WACC: 6.28-6.40%; Canadian utility range: 6-8%)[9][10]

Capacity Factor Scenarios:

- **10% CF:** 876 hours/year (conservative peaking)
- **15% CF:** 1,314 hours/year (moderate peaking)

Justification: Typical peaker plants operate 300-2,000 hours annually, equivalent to 3.4-22.8% CF. MECL's application describes "peaking and backup capacity", supporting low-utilization assumptions.[1][11][12]

Lifespan Scenarios:

- **30-Year Life:** Conservative estimate for refurbished equipment
- **50-Year Life:** MECL's claimed service life[1]

1.4 Gas Plant LCOC Results

Levelized Cost of Capacity comparison showing BESS offers 20-36% lower costs on a capacity basis (CAD/kW-year) compared to the gas plant across all scenarios.

Comprehensive Results Table:

Capital Scenario	Capacity Factor	Lifespan	LCOC (CAD/kW-year)
Low Capex	10%	30-year	$357.33
Low Capex	10%	50-year	$338.53
Low Capex	15%	30-year	$380.44
Low Capex	15%	50-year	$365.41
Medium (Base)	**10%**	**30-year**	**$365.57**
Medium (Base)	10%	50-year	$345.94
Medium (Base)	15%	30-year	$388.69
Medium (Base)	15%	50-year	$372.82
High (30% Overrun)	10%	30-year	$446.38
High (30% Overrun)	10%	50-year	$418.60
High (30% Overrun)	15%	30-year	$469.49
High (30% Overrun)	15%	50-year	$445.47

1.5 Base Case Detailed Breakdown

Medium Capex | 10% CF | 30-Year Lifespan

Annual Operation: 87,600 MWh (876 hours at full capacity)

Cost Components (CAD/MWh):

- **Capital Recovery:** $307.47/MWh (73.7% of total)
- **Fixed O&M:** $57.08/MWh (13.7%)
- **Variable O&M:** $5.50/MWh (1.3%)
- **Fuel Cost:** $47.27/MWh (11.3%)
- **Total LCOC:** $417.32 CAD/MWh

Annual Costs:

- Annualized Capital (CRF=0.08059): $26,934,313
- Fixed O&M: $5,000,000
- Variable O&M: $481,800
- Fuel Cost: $4,141,071
- **Total Annual Cost: $36,557,184**

Part 2: BESS LCOC Analysis

2.1 Technology Specification

Asset: 100 MW / 400 MWh Grid-Forming Battery Energy Storage System

Application: Peaking capacity with grid-forming capabilities for voltage/frequency support

Duration: 4-hour storage (optimal for daily peaking cycles)

Grid-Forming Capabilities:[13][14][15]

- Voltage source behavior (vs. current source in grid-following)
- Synthetic inertia emulation
- Frequency regulation (instantaneous response)
- Black start capability
- Islanded operation support

2.2 Capital Cost Development

Base BESS Cost: $1,600 CAD/kW (utility-scale, 100 MW)[16][17][18]

Sources:

- NREL ATB 2024: 4-hour BESS ~$1,371/kW (USD)[17][16]
- Canadian market: $1,200-2,400/kW for commercial systems[18]
- Adjusted for CAD exchange and utility-scale economies

Grid-Forming Premium: 15% additional cost[19][20]

Source: Wood Mackenzie analysis indicates grid-forming adds ~15% to system costs for upgraded inverters, controls, and software[19]

Total BESS Cost: $1,840 CAD/kW

Total Project Investment: $184,000,000

Cost Comparison to Gas Plant:

- MECL Base Case: $334.2M
- BESS Investment: $184.0M
- **Capital Savings: $150.2M (44.9% reduction)**

2.3 Operating Parameters & Assumptions

Fixed O&M: 2.5% of capital cost annually = $4,600,000/year[16][17][21]

- Industry standard: 2-5% for BESS systems[22]
- NREL methodology: 2.5% includes augmentation for rated capacity maintenance[16]
- Equivalent to $46.00 CAD/kW-year

Variable O&M: $0.50 CAD/MWh[16]

- Minimal for BESS (no combustion, minimal wear)
- Primarily monitoring and control systems

Round-Trip Efficiency: 85%[17][16]

- Modern lithium-ion BESS: 80-90% efficiency
- 85% conservative mid-range estimate

Charging Cost Economics:

- **Off-Peak Wholesale Rate:** $65.00 CAD/MWh

  (Estimated PEI/Maritimes off-peak rate; Maritime Electric retail ~$0.17/kWh)

- **Effective Charging Cost:** $76.47 CAD/MWh (accounting for 15% efficiency loss)

Lifespan Structure:

- **Project Life:** 25 years
- **Battery Replacement:** Year 15 (one mid-life replacement)[22][16]
- **Replacement Cost:** 60% of initial system cost ($110.4M)
- **NPV of Replacement:** $40.0M (discounted at 7%)

2.4 BESS Utilization Scenarios (Peaking Application)

Scenario	Annual Cycles	Equivalent CF	Annual Discharge (MWh)
Conservative	100 cycles/year	4.6%	40,000 MWh
Moderate	150 cycles/year	6.8%	60,000 MWh
Active	200 cycles/year	9.1%	80,000 MWh

Justification: Peaking pattern analysis shows 100-200 full discharge cycles annually represents typical peaking duty (1-2 cycles every 2-3 days during peak seasons).[11][12]

2.5 BESS LCOC Results

Comprehensive Results:

Utilization Scenario	Annual Cycles	LCOC (CAD/MWh)	LCOC (CAD/kW-year)
Conservative	100 cycles/yr	$672.54	$269.02
Moderate (Base)	**150 cycles/yr**	**$474.02**	**$284.41**
Active	200 cycles/yr	$374.76	$299.80

2.6 Base Case Detailed Breakdown

BESS: 150 cycles/year | 25-year Life

Annual Operation: 60,000 MWh discharged (150 full cycles)

Cost Components (CAD/MWh):

- **Capital Recovery:** $320.38/MWh (67.6% of total)
- **Fixed O&M:** $76.67/MWh (16.1%)
- **Variable O&M:** $0.50/MWh (0.1%)

- **Charging Cost:** $76.47/MWh (16.1%)
- **Total LCOC:** $474.02 CAD/MWh

Capital Structure:

- Initial CAPEX: $184,000,000
- Battery Replacement NPV (Year 15): $40,014,041
- **Effective CAPEX:** $224,014,041

Annual Costs:

- Annualized Capital (CRF=0.08581): $19,222,761
- Fixed O&M: $4,600,000
- Variable O&M: $30,000
- Charging Cost: $4,588,235
- **Total Annual Cost: $28,440,996**

Part 3: Comparative Analysis & Summary

3.1 LCOC Comparison Summary

Base Case Comparison (Most Comparable Scenarios):

Metric	Gas Plant	BESS	Difference
Capital Investment	$334.2M	$184.0M	**-$150.2M (BESS)**
LCOC (CAD/kW-year)	$365.57	$284.41	**-$81.16 (BESS)**
Annual Emissions	35,000-47,000 t CO_2	0 t CO_2 direct	**Zero carbon (BESS)**

3.2 Critical Interpretation: Energy vs. Capacity Basis

Capacity-Basis LCOC ($/kW-year):

- Measures cost to maintain 1 kW of available capacity for one year
- **More relevant for peaking/reliability services**
- Aligns with capacity market payment structures
- BESS advantage: 20-36% lower across all scenarios

Expert Assessment: For peaking applications, **capacity-basis LCOC is the appropriate metric** as the primary value is maintaining dispatchable capacity, not maximizing energy generation.[7][23]

3.3 Reliability Profile Comparison

Characteristic	Gas Plant	BESS (Grid-Forming)
Response Time	5 minutes[2]	Instantaneous (milliseconds)[13][14]
Continuous Duration	Unlimited (fuel-dependent)	4 hours (single charge)
Fuel Dependency	Requires natural gas supply	Requires grid charging capability
Grid Services	Synchronous inertia	Voltage support, synthetic inertia, frequency regulation[13][14][15]
Black Start	Yes (with external generator)[1]	Yes (independent capability)[13][14]
Emissions Intensity	450-670 g CO_2/kWh[24][25]	0 g CO_2/kWh direct
Cycling Stress	High thermal stress, degradation	Minimal degradation within cycle limits
Maintenance	Higher (combustion equipment)	Lower (solid-state, battery augmentation)

3.4 Risk Assessment

Gas Plant Cost Risks:

Risk Factor	Impact on LCOC	Mitigation
30% Capital Overrun	+$92/MWh (+22%)	Strong project management, fixed-price contracts
Natural Gas Price +$2/MMBtu	+$17/MWh (+4%)	Hedge contracts, dual-fuel capability
20-Year Actual Life	+$65/MWh (+16%)	Conservative lifespan assumptions
Carbon Pricing $100/tonne	+$45-67/MWh (+11-16%)	Shift to BESS or renewable integration

BESS Cost Risks:

Risk Factor	Impact on LCOC	Mitigation
Battery Replacement +30%	+$26/MWh (+5.5%)	Long-term supply contracts, technology tracking
Charging Cost +$20/MWh	+$24/MWh (+5%)	Time-of-use optimization, renewable charging
Reduced Cycle Life (10 years)	+$45/MWh (+9.5%)	Conservative augmentation planning
Grid-Forming Premium +30%	+$17/MWh (+3.6%)	Technology maturity improving rapidly[13][19]

3.5 Environmental Impact Analysis

Gas Plant Annual Emissions (10% CF, 87,600 MWh/year):

- Simple-cycle heat rate: 8,595 Btu/kWh
- Emissions intensity: ~0.450-0.670 kg CO_2/kWh[24][25]
- **Annual CO_2:** 39,420-58,692 tonnes/year
- **30-year total:** 1.18-1.76 million tonnes CO_2

BESS Emissions:

- Direct operational emissions: 0 tonnes
- Indirect (charging): Depends on grid mix

Carbon Cost Implications:

At Canada's carbon pricing trajectory ($100/tonne CO_2 by 2030):

- Gas plant carbon cost: $3.9-5.9M/year
- **BESS becomes economically superior on energy basis** under carbon pricing

3.6 Alignment with PEI Energy Strategy

PEI's Energy Goals:[27][29]

- 100% renewable electricity by 2030
- Net-zero emissions by 2040
- 27% generation deficit projected by 2033
- Boosting on-island wind and solar capacity

Technology Alignment:

Criterion	Gas Plant	BESS
Renewable Integration	Competes with renewables	**Enables renewables** (storage, grid services)
2030 Emissions Target	Adds 40,000-59,000 t CO_2/yr	**Zero direct emissions**
Grid Stability (High RE)	Synchronous inertia	**Grid-forming services critical for RE grids**[13][14]
Capital Availability	$334M	**$184M (frees $150M for renewables)**

Strategic Assessment: BESS directly supports PEI's renewable transition by providing grid stability services essential for high renewable penetration, while the gas plant perpetuates fossil fuel dependency counter to 2030 targets.[29][27]

3.7 Recommended Decision Framework

BESS is the Economically Superior Choice When:

✓ Primary objective is **peaking capacity** (<200 cycles/year)

✓ **Capacity-basis economics** are prioritized (market structure, capacity payments)

✓ **Capital constraints** favor lower upfront investment ($150M savings)

✓ **Environmental compliance** and renewable targets are binding

✓ Grid infrastructure can provide **reliable off-peak charging**

✓ Grid services (voltage support, frequency regulation) have **explicit value**[13][14]

Detailed Calculation Methodology

Gas Plant LCOC Calculation

Formula:

```
LCOC ($/MWh) = (Annualized Capital + Annual OPEX) / Annual Generation
Where:
- Annualized Capital = CAPEX × CRF
- CRF = [r(1+r)^n] / [(1+r)^n - 1]
- Annual OPEX = Fixed O&M + Variable O&M + Fuel Cost
- Annual Generation = Capacity × 8,760 hours × Capacity Factor
```

Step-by-Step Example (Medium Capex, 10% CF, 30-year):

1. **Capital Recovery Factor (CRF):**
    - r = 0.07, n = 30 years
    - CRF = [0.07(1.07)^30] / [(1.07)^30 - 1] = 0.08059

2. **Annualized Capital:**
    - $334,229,000 × 0.08059 = $26,934,313/year
3. **Annual Generation:**
    - 100 MW × 8,760 hr × 0.10 = 87,600 MWh
4. **Annual OPEX:**
    - Fixed O&M: 100,000 kW × $50/kW = $5,000,000
    - Variable O&M: 87,600 MWh × $5.50/MWh = $481,800
    - Fuel: 87,600 MWh × 8.595 MMBtu/MWh × $5.50/MMBtu = $4,141,071
    - **Total OPEX:** $9,622,871
5. **Total Annual Cost:**
    - $26,934,313 + $9,622,871 = $36,557,184
6. **LCOC:**
    - $36,557,184 / 100,000 kW = **$365.57 CAD/kW-year**

<u>**BESS LCOC Calculation**</u>

Formula:

LCOC ($/MWh) = (Annualized Effective Capital + Annual OPEX) / Annual Discharge

Where:

- Effective Capital = Initial CAPEX + NPV(Replacement Cost)

- NPV(Replacement) = Replacement Cost / (1+r)^replacement_year

- Annual OPEX = Fixed O&M + Variable O&M + Charging Cost

- Annual Discharge = Energy Capacity × Annual Cycles

Step-by-Step Example (150 cycles/year, 25-year life):

1. **Effective Capital:**
    - Initial: $184,000,000
    - Replacement (Year 15): $110,400,000 / (1.07)^15 = $40,014,041
    - **Effective CAPEX:** $224,014,041

2. **Capital Recovery Factor:**
   - r = 0.07, n = 25 years
   - CRF = 0.08581
3. **Annualized Capital:**
   - $224,014,041 × 0.08581 = $19,222,761/year
4. **Annual Discharge:**
   - 400 MWh × 150 cycles = 60,000 MWh
5. **Annual OPEX:**
   - Fixed O&M: $184,000,000 × 0.025 = $4,600,000
   - Variable O&M: 60,000 MWh × $0.50/MWh = $30,000
   - Charging: (60,000 / 0.85) × $65/MWh = $4,588,235
   - **Total OPEX:** $9,218,235
6. **Total Annual Cost:**
   - $19,222,761 + $9,218,235 = $28,440,996
7. **LCOC:**
   - $28,440,996 / 100,000 kW = **$284.41 CAD/kW-year**

Part 4: Data Sources

Primary Filing:

Maritime Electric Company Limited, "Supplemental Filing - On-Island Capacity for Security of Supply Project," August 14, 2025, Island Regulatory and Appeals Commission[1]

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Part 5: Conclusion

This comprehensive LCOC analysis demonstrates that for peaking applications in Prince Edward Island, **a 100 MW grid-forming BESS offers:**

1. **$150.2 million (45%) lower capital costs** than the proposed gas plant
2. **$81/kW-year (22%) lower LCOC on a capacity basis**, the appropriate metric for peaking services
3. **Zero direct carbon emissions**, aligning with PEI's 100% renewable electricity goal by 2030
4. **Superior grid services** (voltage support, synthetic inertia, frequency regulation) critical for renewable integration

While the gas plant shows lower energy-basis LCOC ($417 vs. $474/MWh) at 10% capacity factor, this metric is misleading for peaking duty where capacity availability—not energy volume—drives value. The BESS's instantaneous response, grid-forming capabilities, and compatibility with PEI's renewable transition make it the **economically and strategically superior choice** for the stated application.[13][23][14][30]

For scenarios requiring extended backup capability beyond 4 hours, a **hybrid portfolio of 50 MW gas + 75 MW BESS** optimizes economics ($308M total vs. $334M base case) while providing both rapid peaking response and multi-day outage resilience.

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About Energy Democracy Now! Co-operative Limited

Energy Democracy Now! Co-operative Limited is a community-based advocacy organization working to put Islanders in charge of their energy future. Founded in 2023 and incorporated in 2023, we believe the climate crisis demands more than small fixes — it requires a bold shift from corporate control of fossil fuels to renewable energy that is owned, governed, and guided by local communities.

We're building a future where decisions about energy on PEI are made transparently, with health, fairness, and community well-being at the centre.

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