Industrial Energy Storage Solutions – Case Study

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Summary

The following case study was prepared based on data collected from publicly available 43101 reports in order to demonstrate the benefits of installing a utility scale energy storage system at non-road accessible mines in Northern Canada.

Utility Scale Energy Storage Systems consist of large lithium ion or aqueous ion battery banks paired with bi-directional inverter-chargers, transformers, switch gear, and HVAC systems to provide grid scale energy storage. These systems can provide several benefits to isolated grids:

1. Peak load shaving; uses the energy storage system to handle peak loads and induction loads on the grid eliminating the need for additional generators referred to as "Peaker plants". For mines with significant variable loads, energy storage systems can eliminate the need for continuously operating additional generator capacity in order to handle induction loads. This in turn allows the baseload generators to operate at maximum efficiency providing significant reductions in diesel consumption while minimizing generator maintenance costs.
2. Renewable Energy Storage; refers to charging the energy storage system when there is excess renewable generation capacity during low demand hours and discharging the excess energy during peak demand hours, maintaining a continuous electrical load on the generators for maximum fuel efficiency.
3. Generator cycling; refers to charging the energy storage system using the maximum available generator capacity (including peak load capacity) and then shutting down multiple generators (depending on the design, the entire diesel power plant may be shutdown) with the energy storage system providing the entire grid demand for the designed operating period. This application reduces annual generator operating hours extending the life of the generators while significantly reducing diesel consumption.

Methodology

The following methodology was used to model both scenarios outlined below:

1. Using www.sedar.com, Solvest verified the following information pertaining to northern Canadian mining operations; power plant sizes, number of generators, electrical load analysis, cost per kWh, and cost per litre of diesel delivered to site.
2. This information was then imputed into HOMER Energy Modeling Software and RETScreen along with the parameters for the proposed energy storage system in order to determine the fuel savings and operational cost reductions. Efficiency losses for each of the proposed components were factored in allowing for accurate energy usage calculations.

The case study below demonstrates the impact of an energy storage system at a underground mining operating with large variable loads associated with the ventilation system.

Case 1: Mine operating on diesel power plant only.

Assumptions:

- 12 MW maximum diesel generator capacity consisting of 4 x 3 MW Caterpillar Generators (Please see Appendix A for product specifications).
- Power plant operates with a continuous base load of 9 MW and an additional 3 MW induction load capacity.
- Cost per litre of diesel delivered to site is $1.13 per litre including onsite handling costs.
- Mine electrical consumption is 140,000 kWh per day.
- Cost per kWh for electrical generation including diesel cost, capital replacement costs for the power plant, transmission costs, and maintenance is 36 cents per kWh.

Please note all prices are CAD.

Electrical Supply Costs

Power Plant Size	**Base Load Capacity**	**Peak Load Capacity (Induction Load)**	**Daily Electrical Consumption**	**Cost per kWh**	**Annual Operating Cost**
12 MW	3 x 3 MW Generators	1 x 3 MW Generator	140,000 kWh	36 cents CAD	$18,396,000.00 CAD

Case 2: Mine operating with diesel generators and 20 MWh energy storage system installed.

Assumptions:

- 12 MW maximum diesel generator capacity consisting of 4 x 3 MW Caterpillar Generators (Please see Appendix A for product specifications).
- Power plant operates with a continuous base load of 9 MW, **no additional generators for peak loading are required.**
- **5 MW – 20 MWh Aqueous Ion or Lithium Ion Energy Storage System installed.**
- Energy storage system maintenance estimated at $100,000.00 CAD per year.
- Cost per litre of diesel delivered to site is $1.13 per litre including onsite handling costs.
- Mine electrical consumption is 140,000 kWh per day.
- Cost per kWh for electrical generation including diesel cost, capital replacement costs for the power plant, transmission costs, and maintenance is 36 cents per kWh.
- **Potential CAPEX savings from reducing diesel power plant size are NOT included in the financial analysis.**

Design Criteria:

- Energy storage system sized to handle all peak loading eliminating one generator from operation.
- Provide an additional 2 MW of capacity for base load firming allowing for fuel optimization of the baseload generators.

- High amperage bi-directional inverters, capable of charging the batteries quickly and efficiently.
- Long lasting – high cycle battery technologies selected to ensure 20-year operating life span.
- Integrated remote monitoring allows manufacturers to fix many of the potential hardware problems online without site visits.

Based on the criteria outlined above, Solvest proposes a design consisting of a 5MW – 20MWh Energy Storage System in order to handle the peak loading for the mine while eliminating the need for the 4th 3MW generator:

Electrical Supply Costs

Diesel Power Plant Size	Base Load Capacity	Peak Load Capacity (Induction Load)	Daily Electrical Consumption	Cost per kWh	Annual Operating Cost
9 MW	3 x 3 MW Generators	5MW – 20 MWh Energy Storage System	140,000 kWh	36 cents CAD	$15,471,000.00 CAD

Budget

The following table contains the estimated budget for the proposed project. This budget was estimated extremely conservatively in order to present the highest cost scenario. Many of these costs can be lowered with proper project planning and co-ordination.

Description	Cost	Notes
Batteries	$6,000,000.00	Lithium Ion or Aqueous Ion Batteries – 20 MWh
Bi-Directional Inverters	$3,500,000.00	5MW Inverting/Charging capacity include transformers and switch gear.
System Controller/Monitoring Package	$500,000.00	Smart Grid/Battery Management System that monitors and controls all the cells of each battery container ensuring optimal charging and discharging.
Heating/Insulation Package	$500,000.00	-40C insulation + heating/HVAC package to maintain optimal battery operating conditions.
Pad construction	$200,000.00	Construction of a large concrete pad to house the Energy Storage Solution.
Installation	$300,000.00	Includes all labour and electrical installation costs.
Shipping/Logistics	$500,000.00	Shipping costs for 5 x 40’ + 5 x 20’ shipping containers and electrical materials from global suppliers to site.
Project Management and Engineering	$500,000.00	This includes all design, engineering, and project management costs.
Total Cost:	**$12,000,000.00 CAD**	**Plus applicable taxes.**

Key Benefits:

1. Eliminate the need for peak load generator capacity.
2. Reduce diesel consumption related to electrical generation by 16% annually.
3. Provide additional grid stability by firming the base load power supply allowing for optimal operation of the remaining generators.
4. Reduce operating costs by $2,981,000.00 CAD per year.
5. Reduce the impact of carbon taxes by reducing diesel consumption.
6. Improve the environmental image and public perception of the exploration project.
7. Solvest in partnership with RBC offers utility scale leasing options a with 2 to 5 year terms, allowing for the entire cost of the system to be written off against federal taxes.

We trust that the foregoing information is satisfactory and details the benefits our proposed technology could add to your operations, please do not hesitate to contact the undersigned.

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The following pages contain the supporting appendixes for this proposal

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Appendix B: CAT 3 MW Generator Fuel Consumption

C175-20 ACERT
2520 ekW/ 3150 kVA
50 Hz/ 1500 rpm/ 11000 V

Image shown may not reflect actual configuration

	Metric	English
Package Performance		
Genset Power Rating without Fan @ 0.8 Power Factor	2520 ekW	
Genset Power Rating	3150 kVA	
Aftercooler (Separate Circuit)	46.0 ° C	114.8 ° F
Fuel Consumption		
100% Load with Fan	639.8 L/hr	169.0 gal/hr
75% Load with Fan	486.6 L/hr	128.5 gal/hr
50% Load with Fan	342.8 L/hr	90.6 gal/hr
25% Load with Fan	201.4 L/hr	53.2 gal/hr
Cooling System*		
Engine Coolant Capacity	440.0 L	116.2 gal
Inlet Air		
Combustion Air Inlet Flow Rate	232.5 m³/min	8210.5 cfm
Max. Allowable Combustion Air Inlet Temp	48 ° C	119 ° F
Exhaust System		
Exhaust Stack Gas Temperature	410.7 ° C	771.3 ° F
Exhaust Gas Flow Rate	541.3 m³/min	19113.4 cfm
Exhaust System Backpressure (Maximum Allowable)	6.7 kPa	27.0 in. water