Energy Efficiency and Renewable Sources in Mining Deployments

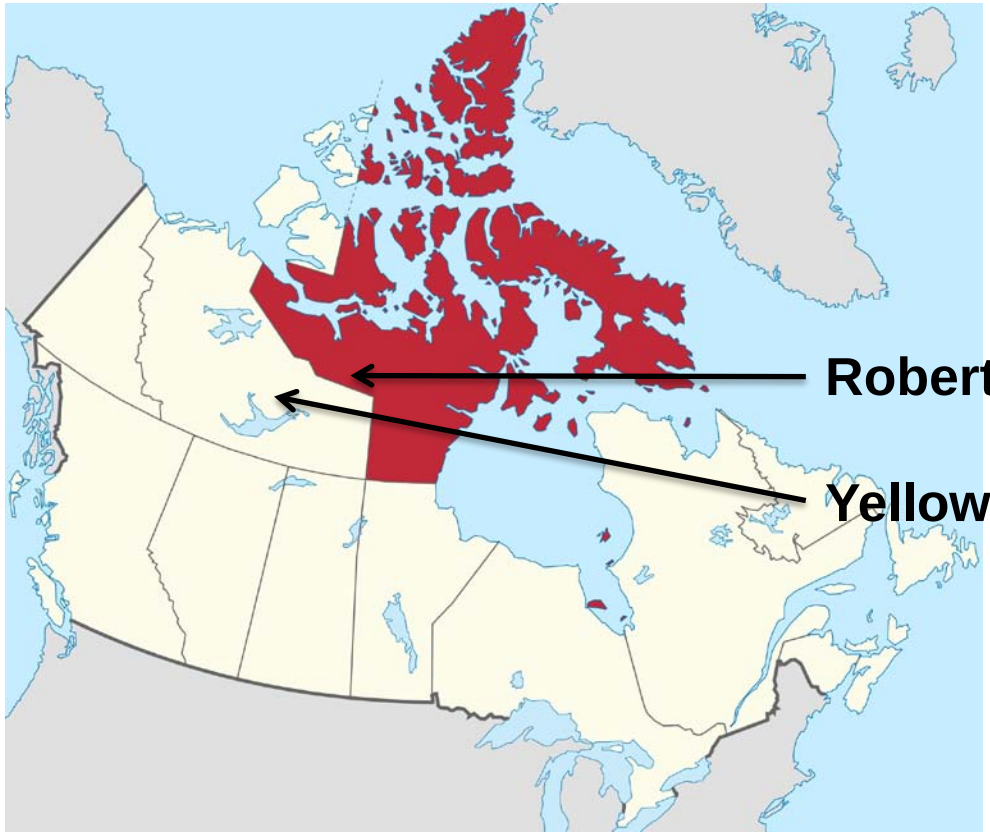
M. Escalante Soberanis, A. Alnaggar, W. Mérida

NSERC
CRSNG

Objectives

- Comparing two renewable technologies (PV and Wind) with diesel based power systems
  - Why to reduce diesel consumption
    - Lower CO_2 emissions
    - Lower net present cost of mining projects

Data Collection – Grid Location



Modeling Approach

- Collect the database of existing Data
- Modeling software used : HOMER
- Cases modeled
  - Case # 1 Data from PV system (Max population #127)
  - Case # 2 Data from Wind Energy

Benefits

- Cost
- Reliability
- Supply side opportunities
- Demand side opportunities

INTRODUCTION

- Average cost of $1.3 USD per kWh in remote communities in Northern Canada (Arriaga et al., 2013)
- Energy costs in mining industry: 15% for metals and 19% for non-metals (Levesque et al., 2014)
- Diavik Diamond Mine supply 8.5% of its power needs through wind energy with a total capacity of 9.2 MW (17 GWh yearly)

Strategies to Follow

Targeted Case # 1
Residential facility

1. Track energy use
2. Energy conservation
3. Energy efficiency
4. Generator optimization
5. Energy storage
6. Solar PV

Targeted Case # 2
Processing plant

1. Wind Energy
2. Generator sizing
3. Energy Storage

Data Source for Two cases

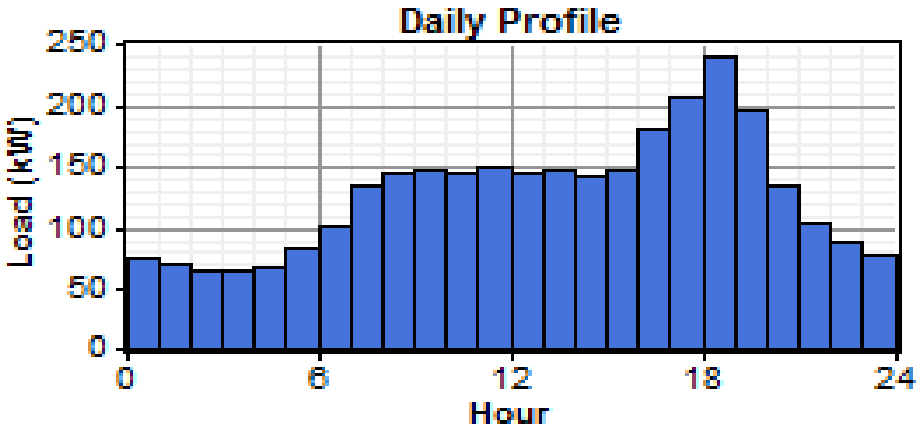
Month	Clearness Index	Daily Radiation [kWh m^{-2}]	Wind Speed Average [m s^{-1}]
January	0.394	0.110	6.3
February	0.504	0.710	6.4
March	0.556	2.100	6.3
April	0.558	3.900	6.2
May	0.520	5.150	6.0
June	0.486	5.540	5.2
July	0.511	5.440	5.7
August	0.467	3.760	6.2
September	0.453	2.190	6.8
October	0.473	0.980	7.0
November	0.444	0.220	6.0
December	0.319	0.020	5.8

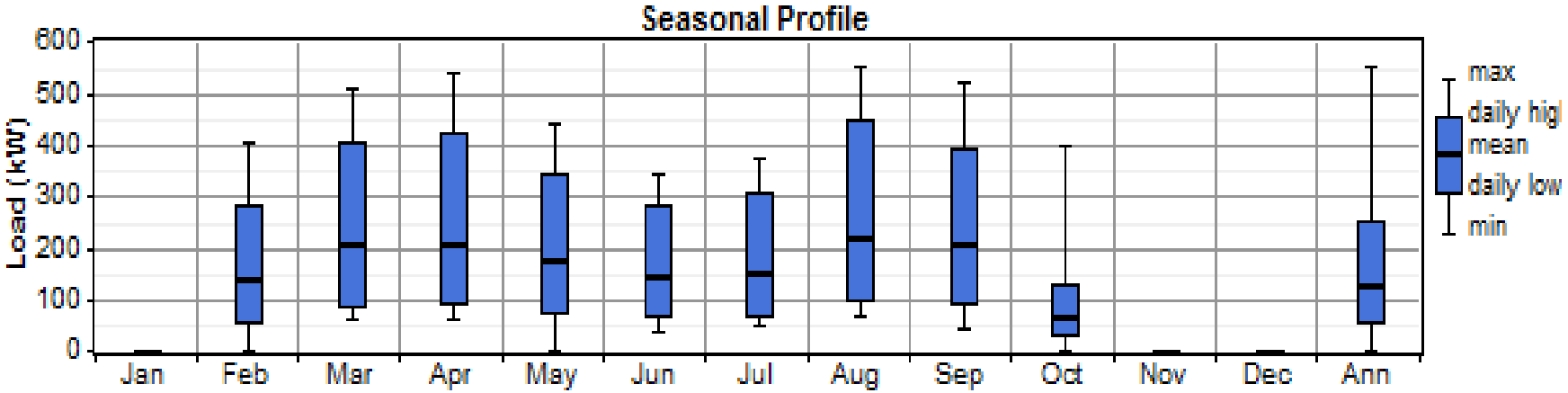
Case # 1 : Exploration Phase

- Maximum population: 127
- Minimum population: 36
- Period: February to October (270 days)
- Project lifetime: 3 years

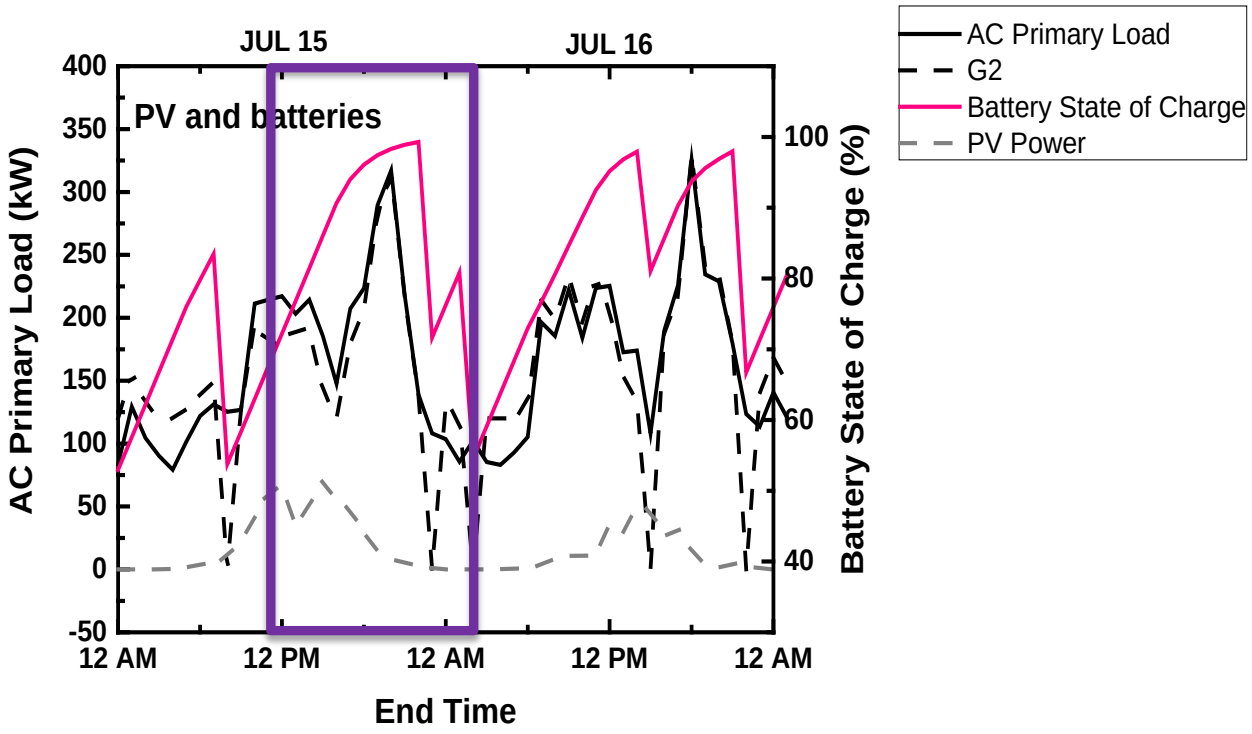
Solar PV and Solar Thermal

Data from Residential Facility





Initial Finding #1: System Behavior



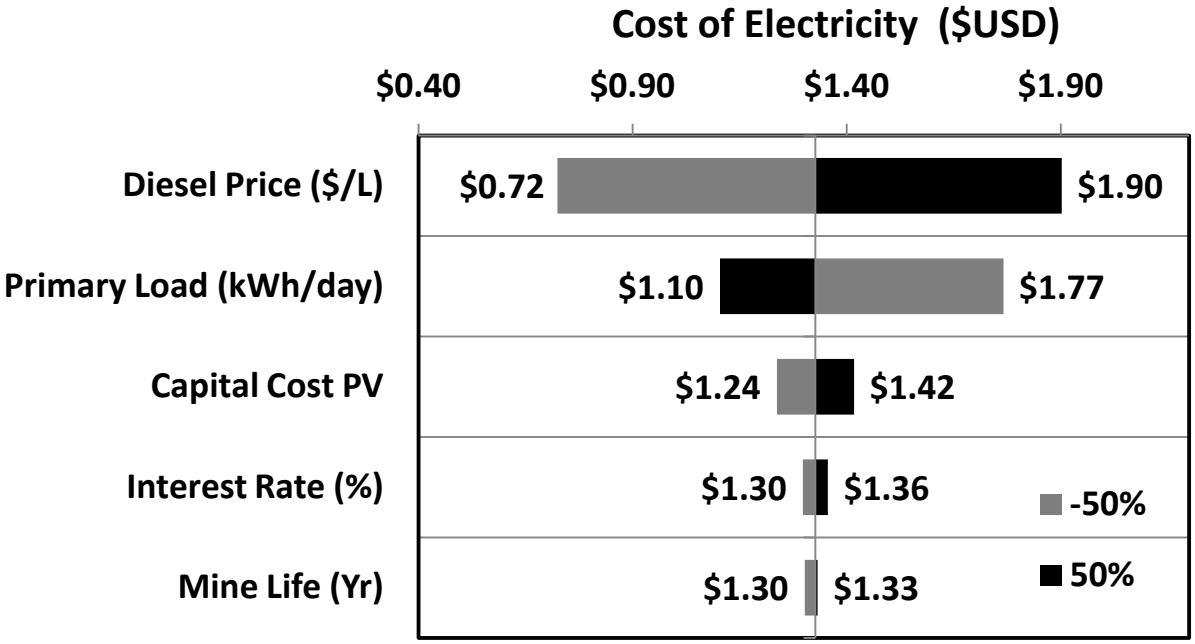
Predicted Trend of the generator with battery bank ad PV system

Initial Finding # 2: Exploration Phase

Architecture	Annualized Cap. (USD)	Diesel Savings
Genset | Battery	$40K	**74K** Liters
Genset | Battery | Solar PV	$90K	**140K** Liters

Generators alone will consume 1.5 million liters of diesel over 3 years of operation

Sensitivity of the Statistical Model



Tornado chart of five parameters' impact on the COE for the exploration phase. COE of base case was calculated as $1.327 USD.

Recommendation # 1 : Solar Water Heating

- Generation: 1 to 14 kWh/day
- Water heating
  - Highest energy consumption
- Why:
  - Savings: 10-37 Liters/day of diesel
  - Payback: as short as 150 days of use.

Recommendation # 2 : Use CFL

Disadvantages of **Incandescent** lamps

- Higher consumption per day (3.5 KWh)
- More lamps required

Solution : Install CFL bulbs!!

Requirement : Initial Capital:= $1,000 ballasts = $3,000

Advantages of CFL

- Less Lamps (1:4 per W)
- 30,000 kWh/year less than **incandescent** lamps
- $25K per year savings!!

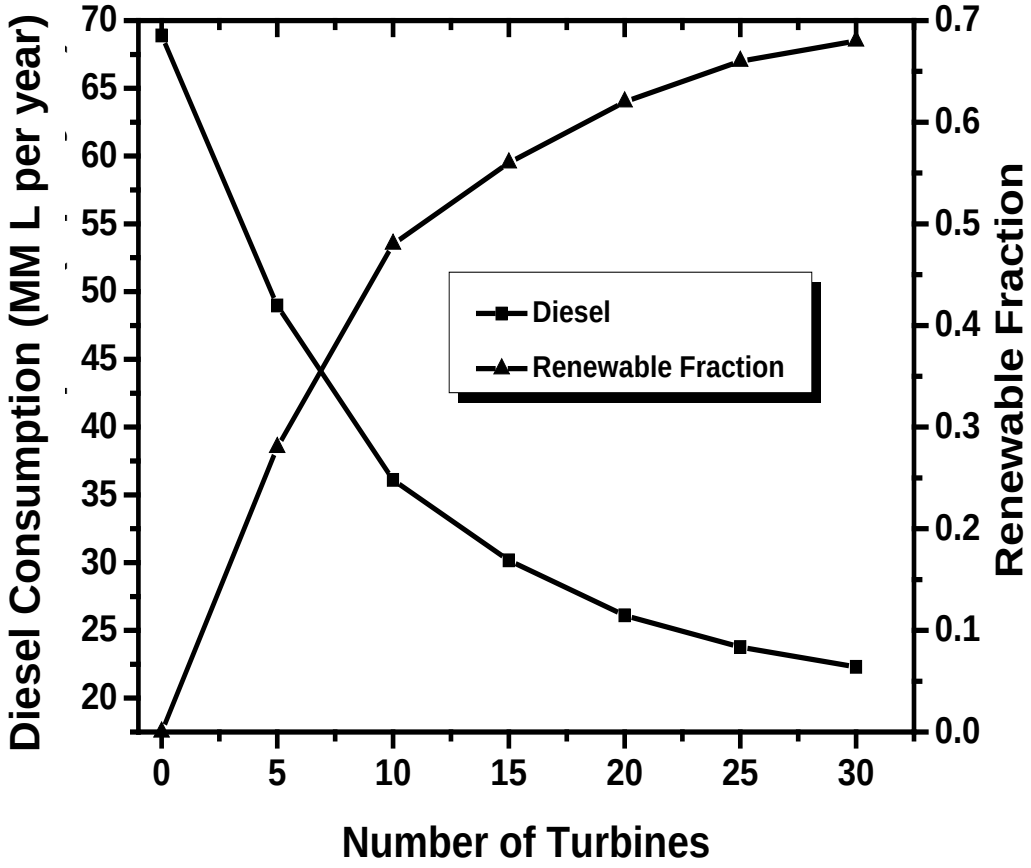
Conclusions on Case 1

- PV feasible if load is 3,000-6,000 kWh per day
- 50,000 L if diesel saved per year
- Energy efficiency and PV can reduce up to 0.83 MWh per person per year

Case # 2 : Wind Energy Extraction Phase

- Constant Load: 23 MW
- Systems Investigated
  - Diesel Generators :20 MW ; 11 MW
  - Wind farm : 16.5 MW ;
  - Storage system : 43 MWh
  - AC/DC converter : 15 MW

Initial Findings: Extraction Phase

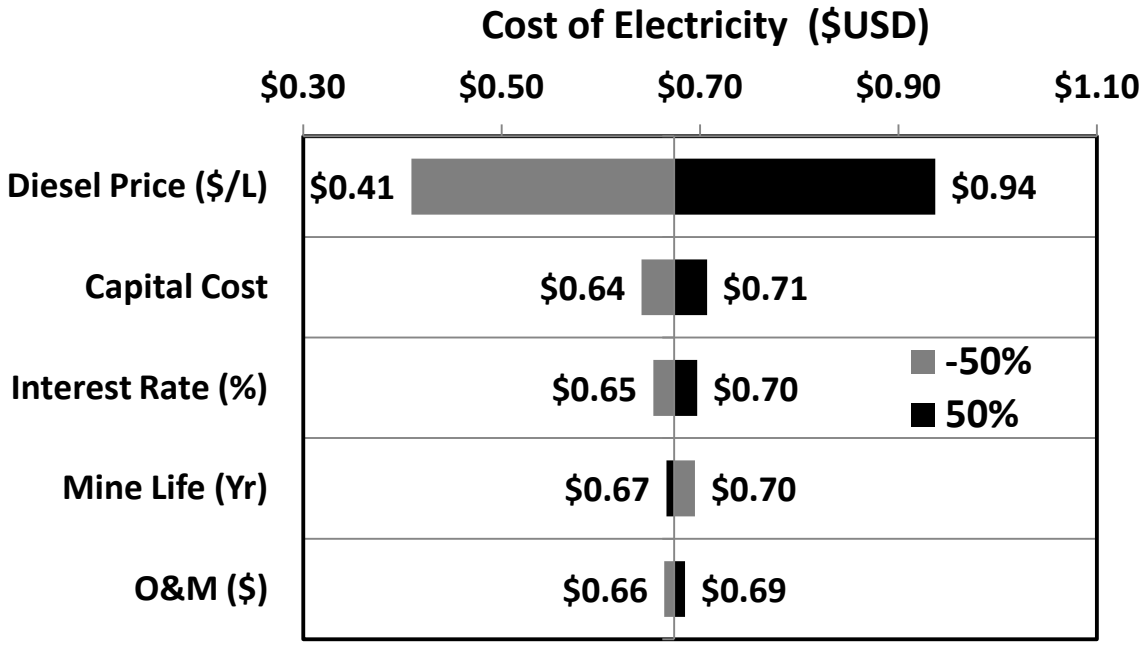


Comparison of Wind and Diesel

	Annualized Cap. (USD)	Diesel Savings
Case # 1 **Genset + Battery**	$13 Million	**41** Million Liters
Case # 2 **Genset | Battery | Wind**	$9 Million	**240** Million Liters

Generators alone will consume 730 million liters of diesel over 10 years of operation

Model Sensitivity



Tornado chart of five parameters' impact on the COE for the extraction phase. COE of base case was calculated as $0.674 USD.

Conclusions in Wind Systems

- Wind farm could save 25 million L of diesel per year
- 33% reduction in CO2

Future Perspectives

- Provincial and federal energy grants
- Installing an anemometer for wind measurements
- Energy monitoring system
- Insulations for water heating systems
- Heat Recovery

Acknowledgments

- NSERC
- Industrial Partner

mauricio.escalante@mech.ubc.ca

walter.merida@ubc.ca