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# Where do you start with Energy Storage for Mines ?

## POD 3: Mining Microgrids: Optimizing Renewables for Mines

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# Energy Storage | Saturn Power


> "Saturn Power can make energy work harder for you."

To every development, we bring extensive experience, training and capabilities, as well as a wide network of partners and consultants. Our proven approach allows us to deliver the exact expertise your project needs for a nimble and creative energy solution.

DIVERSE PORTFOLIO | Successfully developed over 200MW Solar, Wind and Energy Storage projects from early-stage development through to construction and operation, with total market value of +$350 M including Canada's largest energy storage facility.

STRONG EXPERIENCE | 15+ year track record working with multiple governments, strategic, and financial partners in North America, Europe and the Caribbean.

A financial engineering group with more than $5B of capital deployment experience.

A Canadian company and team with more than 1 GW of combined siting, permitting and project execution experience including the first battery energy storage system at the largest operational nuclear facility in the World.

# Energy Storage | What can it do for a mine operator?

## What is the ideal % of energy storage for a mine ?

| Service Category | Service Type | Service |
|---|---|---|
| Renewables-Specific | Capacity | Renewable energy time shift |
| | Quality | Renewable capacity firming |
| Grid Operator (ISO/RTO or UTILITY) | Capacity | Electric energy time shift |
| | | Electric supply capacity |
| | | Demand response |
| | Reliability (Ancillaries) | Reserve |
| | | Black Start |
| | Quality (Ancillaries) | Frequency Regulation |
| | | Ramping / Load Following |
| | | Voltage Support |
| Grid (Transmission & Distribution) | Delivery | T&D Upgrade Deferral |
| | | Congestion Relief |
| | | Transportation Services |
| | | Microgrids for Remote Service |
| | | Onsite Power |
| | Reliability | Resiliency |
| Consumer (Behind-the-Meter) | Quality | Power Quality |
| | Reliability | Backup Power |
| | Cost Reduction | Time of Use (Bill Management) |
| | | Demand Charge (Bill Mgmt.) |
| | | Onsite Renewable Shift |

Five Service Groups:

- Capacity
- Reliability
- Quality
- Delivery
- Cost Reduction

Each group has the same end goal, and improving a group upstream will provide results downstream.

The requirements and operation of each service in a group, however, can vary substantially – speed of response, how much power, duration.

Questions: location, who owns/operates it, how do they monetize.

# Energy Storage | What can it do for a mine operator?

## What is the future of energy storage ?

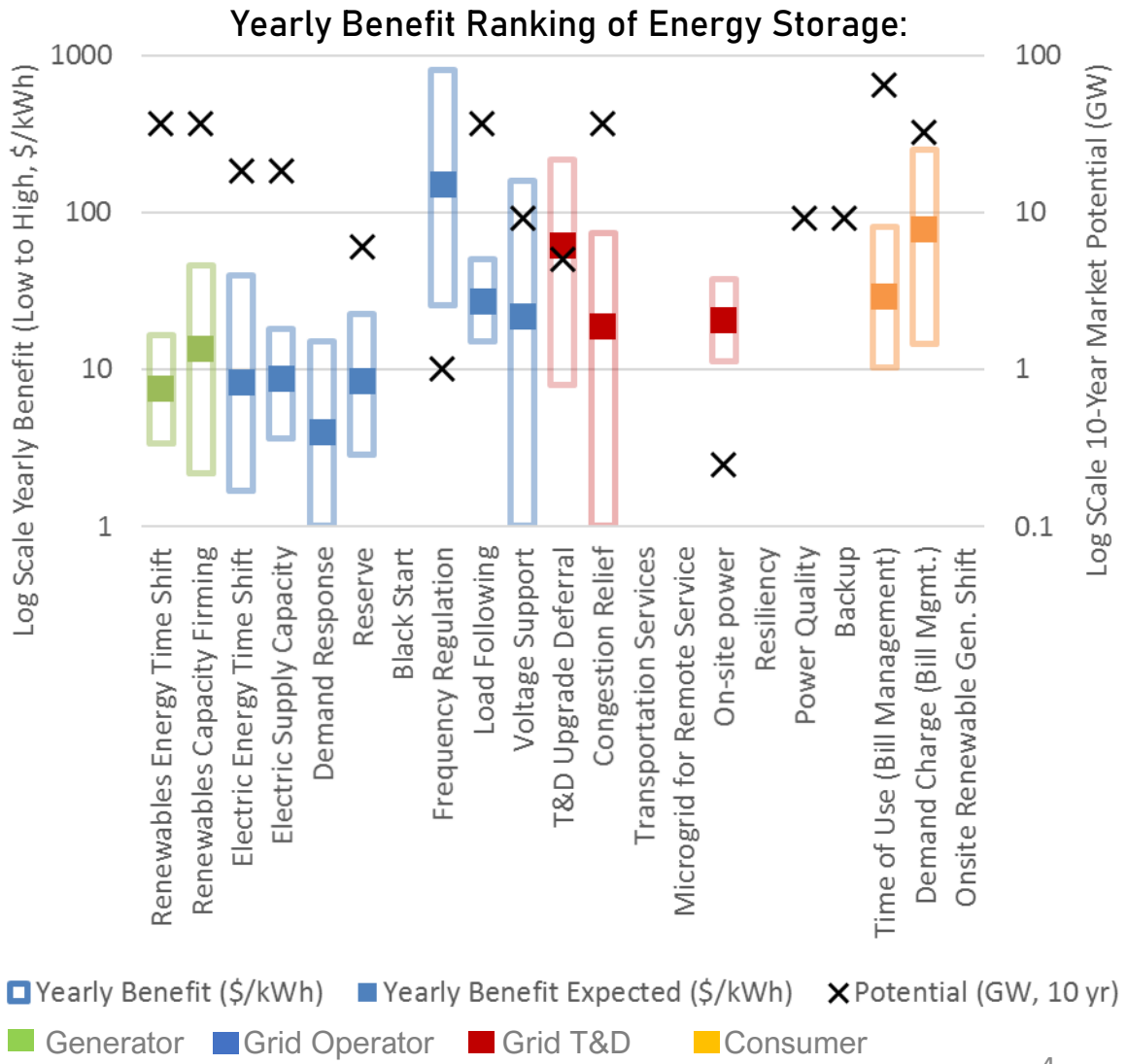
Application Ranking of Energy Storage:

**Leading**
- Frequency Regulation
- Demand Charge Management (e.g. GA)
- Demand Response
- Reserve

**Emerging**
- T&D Upgrade Deferral
- Voltage Support
- Time of Use Management
- Congestion Relief
- Load Following
- On Site Power
- Renewables Capacity Firming
- Electric Supply Capacity
- Electric Energy Time Shift
- Renewables Energy Time Shift

Long-term BESS deployment strategies with solutions for emerging services are available now. Contact the presenter.

Extrapolated from Sandia National Laboratories (SNL) & Electric Power Research Institute (EPRI) Data



# Energy Storage | Key considerations at Feasibility Stage

TECHNOLOGIES | Different forms of Energy Storage: Mechanical (compressed air, flywheel etc.), Electro-magnetic, Electro-chemical (solid state batteries, flow batteries, fuel cells)

LOAD PROFILE | Large load swings and optimum load displacement strategies – impacts sizing and revenue modelling

INTERCONNECTION POINTS | HV vs. LV, physical distances, switchgear mods req'ed, critical load protection from poor power quality, Trfm loading etc.

FINANCIAL OPTIONS| Evaluate different financial models: Shared Benefits, Lease, Capex, Hybrid. Also, Termination Schedule, Buyout options. Revenue Forecast Assumptions

OPERATIONS SENSITIVITY | Understand the site operations and customer needs. What are critical loads? How does the operations limit battery charging flexibility ?

FACILITY IMPACTS | Location, Safety (NFPA 855), Environmental Impact, Extreme Weather conditions.

## FEASIBILITY STUDY will:

- Categorize Benefits, Risks and System Impacts of all possible options
- Confirm all the assumptions
- Remove ambiguity of simplistic modelling of benefits
- Extend into permitting

# Energy Storage | Feasibility Study Methodology for BESS

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## FEASIBILITY ENGINEERING

| Analysis | Options |
|---|---|
| OPERATIONS NARRATIVE | |
| HONI / UTILITY FEEDER(S) RELIABILITY | |
| INTERCONNECTION OPTIONS | |
| HYDRO REVENUE METERING POINTS | |
| SWITCHGEAR MODIFICATION REQ'ED | |
| LOAD FLOW ANALYSIS | |
| PROTECTION / REVERSE POWER-FLOW | |
| POWER QUALTIY ANALYSIS | |
| TELEMETRY REQUIREMENTS | |
| LOAD PROFILE ANALYSIS | |
| SIZING CALCULATIONS | |
| EQUIPMENT SITING LOCATION, GEOTECH | |
| SITE CIVIL CONSTRUCTION PREPARATION | |
| PLANT SAFETY: ESS, FIRE, NFPA 855 | |
| OPERATIONS IMPACTS | |
| ENVIRONMENTAL IMPACTS | |
| MAINTENANCE REQUIREMENTS | |
| PERMITTING: CIA / SIA, DCR | |
| PERMITTING: AHJ | |
| PROJECT EXECUTION SCHEDULE | |

## BIDDERS RATING SYSTEM

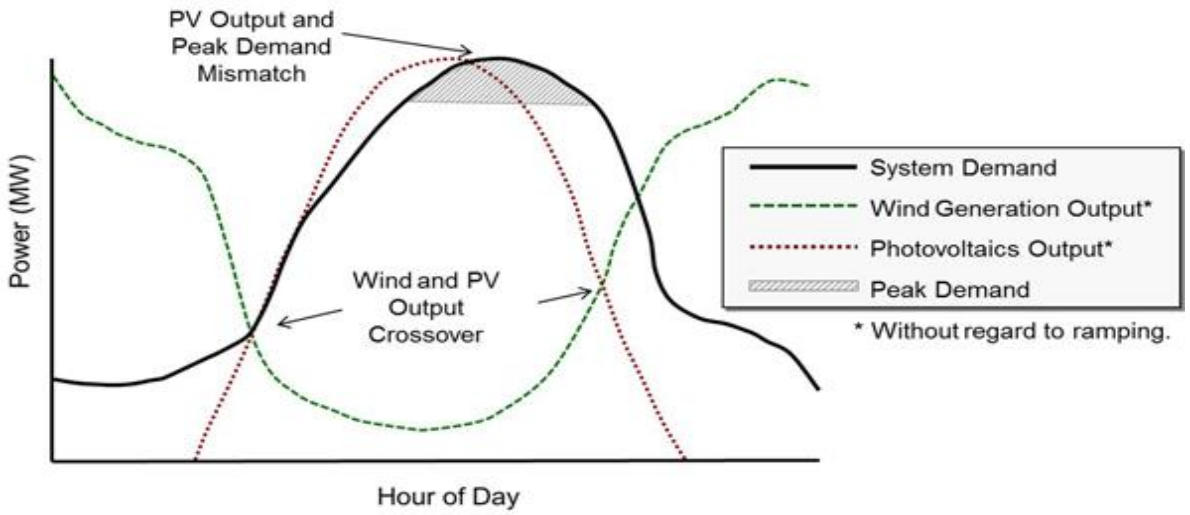
| TECHNICAL FEASIBILITY | | WEIGHT | Bid X | Bid Y |
|---|---|---|---|---|
| SYSTEM OVERVIEW | Solution options, containers vs. purpose building.. | | | |
| PCS SPECIFICATIONS | Ratings, Nom. power capacity, Op.temp, UL/CSA.. | | | |
| BATTERY SPECIFICATIONS | Chemistry, Efficiency, Degradation, DoD, Op.temp | | | |
| COMPANY EXPERIENCE | Past projects overview, in-house O&M team… | **HIGH** | | |

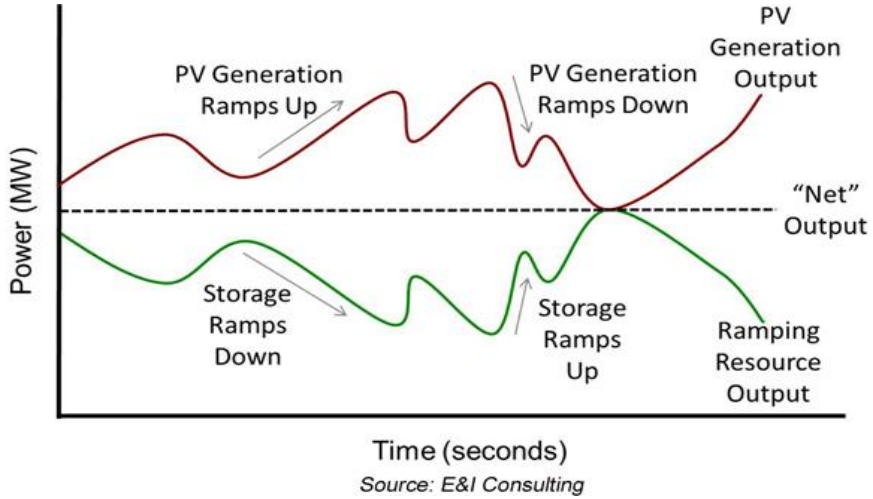
NOTE: Sample of the evaluation categories shown. For more details / overview of the complete methodology contact the presenter.

| FINANCIAL FEASIBILITY | | WEIGHT | Bid X | Bid Y |
|---|---|---|---|---|
| REVENUE % | Term length, Flat curve, Accelerated curve… | | | |
| REVENUE STREAMS $ | Breakdown by rev. stream, NPV… | | | |
| REVENUE STREAMS FORECASTS | Detailed annual forecast, Date, Source… | **HIGH** | | |
| TERMINATION COST SCHEDULE | Detailed annual schedule… | | | |
| BUYOUT COST OPTIONS | Specify when… | | | |
| CAPEX | Specify what is included… | | | |
| OPERATION COST | Dispatching, Asset readiness protocol… | | | |
| MAINTENANCE COST | Routine, Preventative, Corrective, Augmentation… | | | |
| PEAK FORECASTING COST | In-house / 3rd party… | | | |
| INSURANCE COST | Details of coverage… | | | |

| COMMERCIAL TERMS | | WEIGHT | Bid X | Bid Y |
|---|---|---|---|---|
| HEAD OF TERMS | Regulatory risk, Load shortfall, Termination, End of term options… | **HIGH** | | |
| WARRANTY | Battery degradation schedule, Extended equipment warranty… | | | |
| PERFORMANCE | Peak performance track record, How is performance calculated… | **HIGH** | | |

# Energy Storage| BESS Integration into Renewables, Key Benefits




*Source: E&I Consulting*

PEAK LOAD SHAVING| Optimize with flexible, fast-acting generation asset (AC and DC coupled)

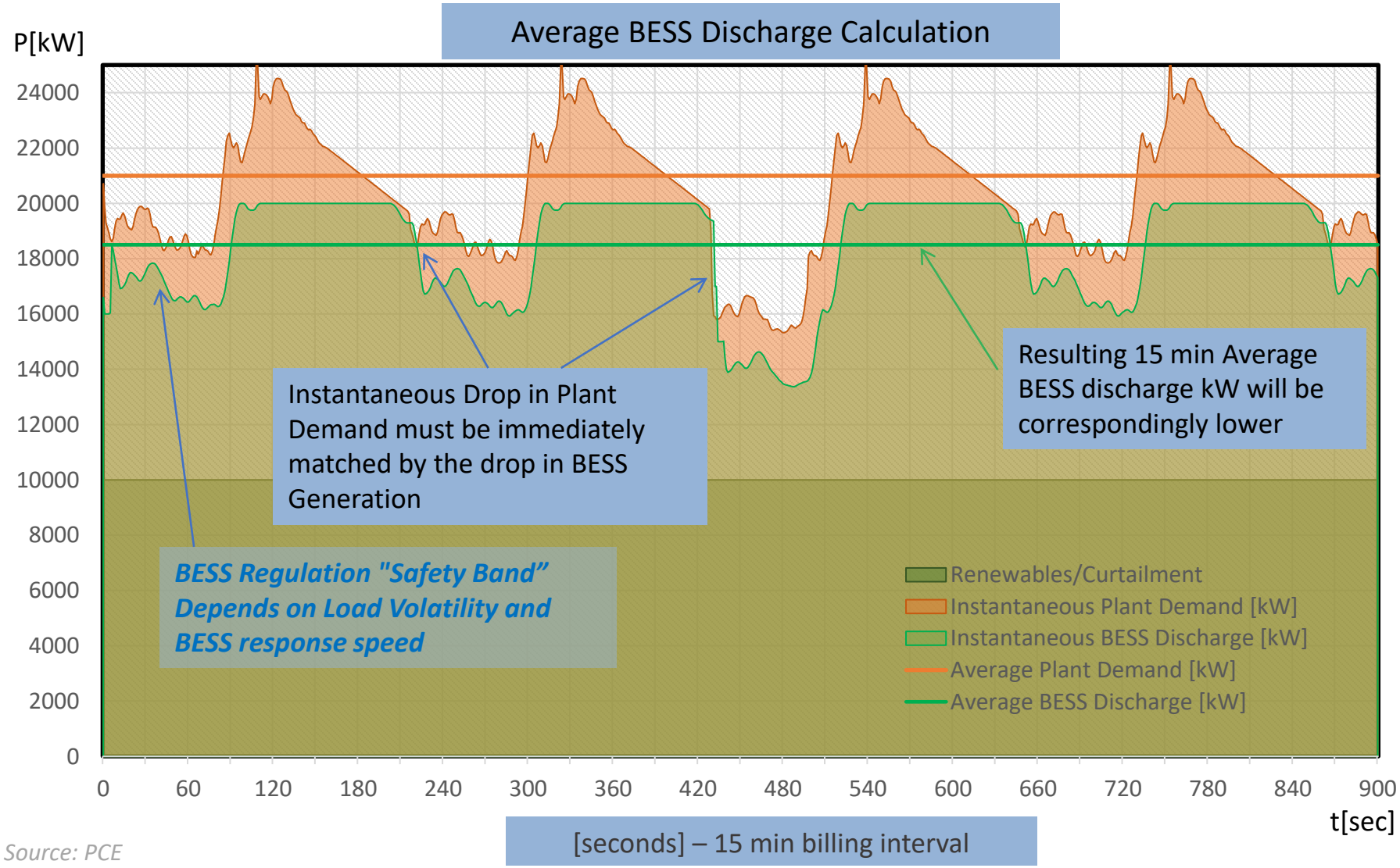
CLIPPING RECAPTURE| Store surplus energy from renewables in the batteries on DC side, if power exceeds the inverter size (DC coupled)

RAMP RATE CONTROL | Balance greater changes in generation fluctuations. Always ensure the required 'Net Output' (DC coupled)

PV SMOOTHING | Balance short changes in irradiation (DC coupled)

# Key Takeaway #1 | Load Variability Impact on Financial Modelling

## LOAD PROFILE ANALYSIS | Eg. Behind-the-Meter BESS (Illustrative, based on Ontario specific model)




*Source: PCE*

### LOAD OPTIMIZED modelling (Green chart)

10MW/17MWh BESS
8.5MW load displacement

| BENEFITS | PROMISED | RESULTED |
|---|---|---|
| TOTAL ANNUAL REV. | $1.3 M | $1.3 M |
| TOTAL 10yr REV, NPV | $10.4 M | $10.4 M |

### AVERAGE DEMAND modelling

11MW/22MWh BESS
8.7MW load displacement

| BENEFITS | PROMISED | RESULTED |
|---|---|---|
| TOTAL ANNUAL REV. | $1.9 M | $1.0 |
| TOTAL 10yr REV, NPV | $14.5 M | $7.7 M |

### PEAK DEMAND modelling

15MW/30MWh BESS
8.8MW load displacement

| BENEFITS | PROMISED | RESULTED |
|---|---|---|
| TOTAL ANNUAL REV. | $2.8 M | $0.5 M |
| TOTAL 10yr REV, NPV | $21.9 M | $3.8 M |

*Assumptions: shown load profile applies over 1hr GA peak, for all CP5*

For more details including shared % and revenues considered in this model, contact the presenter.

# Key Takeaway #2 | Assumptions impact on Financial Modelling

FORECAST & PERFORMANCE ASSUMPTIONS | Behind-the-Meter BESS 10MW / 20MWh (Illustrative, based on Ontario specific model)

| | REALISTIC | AGGRESSIVE |
|---|---|---|
| November 2020* | **Forecast Date:** Nov'20<br>**Forecast Scenario:** BASE<br>**Peak Performance:** 90% | **Forecast Date:** Nov'20<br>**Forecast Scenario:** HIGH<br>**Peak Performance:** 100% |
| April 2020 | **Forecast Date:** Apr'20<br>**Forecast Scenario:** BASE<br>**Peak Performance:** 90% | **Forecast Date:** Arp'20<br>**Forecast Scenario:** HIGH<br>**Peak Performance:** 100% |

NOV'20* Forecast | Realistic vs. Aggressive

RESULTS IMPACTED by:
Customer Share: **11%**
Total Annual Rev.: **$0.91 M CAD**
Total 10yr Rev.NPV: **$6.98 M CAD**

APR'20 Forecast | Realistic vs. Aggressive

RESULTS IMPACTED by:
Customer Share: **10%**
Total Annual Rev.: **$1.59 M CAD**
Total 10yr Rev.NPV: **$12.04 M CAD**

REALISTIC Forecast | Nov'20* vs. Apr'20

RESULTS IMPACTED by:
Customer Share: **17%**
Total Annual Rev.: **$1.55 M CAD**
Total 10yr Rev.NPV: **$12.06 M CAD**

AGGRESSIVE Forecast| Nov'20* vs. Apr'20

RESULTS IMPACTED by:
Customer Share: **16%**
Total Annual Rev.: **$2.23 M CAD**
Total 10yr Rev.NPV: **$17.12 M CAD**

** Note: Forecast after Ont.2020 Budget CEP GA cost relief Nov.5th*

For more details including shared % and revenues considered in this model, contact the presenter.

# Energy Storage | What helps determine the project success ?

FUNCTIONAL SPECIFICATION | Selection of a qualified Energy Developer. Well structured RFQ process with a weighted rating system of bidders across technical, financial, commercial categories

FORECAST ASSUMPTIONS | Revenue forecast assumptions confirmed and from a credible source. *Adjusted for Ont.2020 Budget CEP GA cost relief Nov.5th*

NOTE: To hear different perspectives about the Ont.2020 CEP and its overall impact on the electricity market dynamics, join the Live Expert Panel Discussion on Dec.9th. Contact the presenter for details.

LOAD ANALYSIS| Performed on 1sec interval load data. 'Safety Band' determined in discussion with the End User. Understand customer operations.

CONTRACTUAL ALIGNMENT| Head of Terms: Regulatory policy risk, load commitment, termination conditions etc.

TERM| Revenue shaping and termination schedule according to the mine operations lifecycle and financial goals.

THANK YOU

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