De-risking the development and integration of renewable energy
High penetration, max fuel savings
Mainstream’s vision

The world is now experiencing a once-off transition to sustainability....to survive and to gain critical competitive advantage each country and company must go through this transition

Mainstream is a dynamic and flexible platform to deliver wind and solar plant in response to the global transition to renewable energy
Mainstream’s profile

- Global wind and solar developer operating in key global mining markets
- 8 GW off-shore wind, 11GW onshore wind (230 MW in construction) 500 MW solar Pipeline (100 MW in construction)
- Not tied to any technology provider = best overall solution (price, performance, warranty) for each project
- Highly experienced board of management with track record in the delivery and financing of renewable energy plants
- Key investors who operate in the mining space
Mainstream’s solution

- De-risk the development process from project inception to operation
- Provide optimum technical solution based on best price, performance, warranty and bankability
- Provide project finance and long-term ownership capability leaving Mining Co. capital free for allocation to core activities
De-risking the development and integration of renewable energy

Customer perception and fears

- “Renewable energy production output won’t meet our demand profile”
- “Renewable energy is too expensive...so how much will this cost me?”
- “Costs aside, how can renewable energy meet our unique power quality requirements?”
- “How will renewable energy be integrated with our incumbent system?”
- “Where has this been done before?”
De-risking the development and integration of renewable energy

The solution must…

- Reduce LCOE
- Maintain or improve power quality
- Enable the customer to retain control of their power supply
- Ensure everyone needs to get paid (or save money!)
ABB’s profile

- A major global energy technology company
- Proven track record in supplying turnkey PV and hydro plants
- Experienced in the integration of large renewable energy plants
ABB’s solution

- A leading technical solution provider to integrate renewables at high penetration levels
- High penetration - maximum fuel saving
- Power quality is maintained through new unique technology
- Global presence and strong local expertise
Remote Mining Sector

- Proven technology platform
- Global mining player

- Development Platform
- Finance Platform
- Ownership Platform

Total De-risked Offering Through Collaboration
The benefits of collaboration

- Maximum savings possible
- Bankable Technology Performance
- Energy Hedge
- Fixed Price for a quantity of mine electricity
- Operations Sustainability

Unique Complete Solution + Maximum High Penetration =  
Maximum Savings possible  
Bankable Technology Performance  
Energy Hedge  
Fixed Price for a quantity of mine electricity  
Operations Sustainability
Problems and solutions
The problem
Future risk of fuel cost spikes

Energy
- Energy cost is a very substantial portion of the operational cost of a mine
- Intelligent integration of renewables can address both energy cost and carbon footprint for mines

Solar
- $13,000/kW

Wind
- $7,000/kW

Oil
- $32/barrel

US Energy Information Administration Data
Renewable energy integration

Offering: renewable energy integration

Solar farm

Wind farm

Diesel power station

Load
Renewable energy integration challenges
Diesel power station

- Frequency and voltage control
- Fault current
- System inertia
- Spinning reserve
- Step load (load increase and reject)
- Unbalanced load supply
- Firm capacity
- Active & reactive power supply
- Loadsharing between generators
- Automatic dispatch control
Renewable energy integration
High penetration leads to short payback and higher ROI

Low renewable energy contribution

- Control system: none/simple
- Grid frequency: within operational limits

High renewable energy contribution

- Control system: sophisticated
- Grid frequency: stable
Renewable energy integration challenges
Managing power output fluctuations

- Inherent volatility of renewable energy can compromise grid stability
- The renewable energy integration solution must address requirements traditionally fulfilled by diesel generation (base load)
  - Frequency and voltage control
  - Sufficient spinning reserve
  - Sufficient active and reactive power supply
  - Peak shaving and load levelling
  - Load sharing between generators
  - Fault current provision
- Renewable energy generation capacity should be sized to maximize ROI and fuel savings

ROI: Return on investment
Renewable energy integration challenges
.....keeping the system together

Wind /solar PV / diesel system
- Spinning reserve
- Unbalanced load supply
- Active and reactive power supply
- Load sharing between generators
- Automatic dispatch control
Renewable energy integration challenges
Microgrid technology solutions - typical penetration levels

<table>
<thead>
<tr>
<th>Wind/solar/diesel systems</th>
<th>Annual Average Contribution</th>
<th>Peak Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>No integration</td>
<td>7-10%</td>
<td>20%</td>
</tr>
<tr>
<td>Automated dispatch</td>
<td>10-15%</td>
<td>22%</td>
</tr>
<tr>
<td>Grid stabilizing</td>
<td>40-60%</td>
<td>100%</td>
</tr>
<tr>
<td>Automated demand response</td>
<td>60-80%</td>
<td>100%</td>
</tr>
<tr>
<td>Energy storage</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
ABB’s PowerStore™ flywheel system

Grid stabilization

- Stabilizes frequency and voltage fluctuations
  - Heavy-duty application: dynamic power injection and absorption in milliseconds
- Maximizes fuel savings through highest possible renewable penetration
- Proven track record
  - 3,000 kW installed and 2,100 kW under commissioning
What the Powerstore does
Grid fluctuations due to renewable energy input
What the Powerstore does
Powerstore injection/rejection of real power
What the Powerstore does
Damping of frequency fluctuations
System control – real time active control
Distributed power control and dispatch system
System control – real time active control
Distributed power control and dispatch system

- PV/CPV Generation
- Wind Turbine Generator
- Control Centre
- Pumping Load
- Cooling/Heating Loads
- Microgrid Plus
- Communication Network
- Other Consumers/Micro-Grid
- Smart Consumers

Energy storage
Grid stabilizing system
Multiple working examples
**Experience and references**

**History**

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>System Type</th>
<th>Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>Napperby, Northern Territory</td>
<td>Automation of diesel power station (Battery system)</td>
<td>0% Penetration</td>
</tr>
<tr>
<td>1998</td>
<td>Denham, Western Australia</td>
<td>Wind/diesel</td>
<td>15% Penetration</td>
</tr>
<tr>
<td>2001</td>
<td>Mawson, Antarctica</td>
<td>Wind/grid stabilizing</td>
<td>85% Penetration</td>
</tr>
<tr>
<td>2007</td>
<td>Coral Bay, Western Australia</td>
<td>Wind/diesel/flywheel</td>
<td>95% Penetration</td>
</tr>
<tr>
<td>2010</td>
<td>Marble Bar and Nullagine, Western Australia</td>
<td>Solar/diesel/flywheel</td>
<td>100% Penetration</td>
</tr>
</tbody>
</table>

Penetration is annual average renewable energy as percentage of total energy generated.
Project experience
Ross Island, wind/diesel system, Antarctica

Stage 2 plans are to increase the number of wind turbines, creating a high penetration system.

RIWE Stage 1 – Crater Hill Wind Farm

- Low penetration Wind-Diesel System (22% average, 61% max).
- 3000kg Flywheel (1800 - 3600rpm) that can sink or source 500kW for 30secs.
Project experience
Ross Island, wind/diesel system, Antarctica

- Two power systems coupled by frequency converter:
  - 6 x 1500 kW / 60 Hz diesel
  - 3 x 225 kW / 50 Hz diesel
  - 3 x 330 kW wind turbines
  - 1 x 500 kW flywheel
- Option to include electric heating load
- Integration of US/NZ power system network
Business case

Total net savings need to be a minimum 10% of current mine energy costs

- Current Costs:
  - 20 MW (175GWh) Power Plant using 15m gallons p.a. @ $5/gal = $75m

- Target Savings:
  - 10% net savings = $7.5m

- Cost of Wind Farm
  - 10 MW Wind farm cost = $5m p.a.($150 / MWh)

- Total Savings Required From High Penetration System
  - $12.5m

- Target level of penetration achieved by PowerStore installation needs to deliver minimum savings of
  - 17% of current diesel consumption (175GWh) or
  - $12.5m (as per above example)
Business case

- Customer-driven collaborative approach required
- PPA model, B&T, BOOT
- Business model dependent on customer profile
- Power system integrators who design, supply and construct Renewable Energy Power Stations
- Enable organisations to make the transition from fossil fuel based generation to Renewable energy based generation
- Specialists in high penetration of wind and/or solar in diesel/gas plants
Thank You.
Mainstream and ABB
The right combination for your success