2 MW Flywheel System Integration

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Project Overview

- 2 MW electric crane brought in to Kodiak to replace aging diesel crane
- Study of existing electrical grid to determine what system upgrades were needed
- Implementation of Flywheel Energy Storage System (FESS)
- Results of FESS and crane on Kodiak electric grid
System Stats

• 27 MW Peak Load
• 6,000 Meters
• 203 Miles Overhead
• 141 Miles Underground
• 99.8% Renewable Energy
• Vertically Integrated
Residential, 26
Commercial, 15
Industrial, 29
Processors, 30
Kodiak Electric One-line Diagram

Not Shown:
Hartman Sub Diesel 16.4 MW
Swampy Acres Sub Diesel 7.7 MW
Nyman Sub Diesel 6.3 MW

Terror Lake Hydro
12.5 MVA
12.5 MVA
12.5 MVA

17 Mile 138KV Transmission Line

Airport Substation
Swampy Acres Substation
Hartman Substation

Nyman Substation

Flywheels

1 MW

3MW/2MWh Battery

High Substation

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New MATSON Crane

- Converted From Diesel to 2 MW Electric
- ABB Drives and Electrical
- ZPMC Crane Manufacturer
Electric Power systems, Inc (EPS) study

- ABB Supplied Crane Loading Information
- EPS study was used to determine system voltage effects and transient stability
Overview of Solution
Overview of Solution
PowerStore Flywheel

Components
- Flywheel
- Flywheel converter
- Grid converter
- Connection to grid
- ECMS controller

![Diagram of PowerStore Flywheel System]

- 1,800-3,400 RPM
- 440Vac 50/60Hz
- 440Vac 60-120Hz
- 2.9T

Inverters 500–1,500 kVA
18 MWs Flywheel
PowerStore Grid Stabilizing Generator Inverter Technology

- Power Converters are based on ABB PCS100
- Converter pairs (flywheel and grid) are housed in racks
- Depending on size of PowerStore different size racks are used
- Racks are suitable for indoor installation only
PowerStore Grid Stabilizing Generator
Flywheel Technology

**Performance Data:**
- Net. energy content: 16.5 MWs
- Max Input/output power: 1650 kW
- Speed range: 1800 to 3400 rpm
- Total weight: 6000 kg
- Rotor weight: 2900 kg
- Idling losses: ~12 kW
- Greasing frequency: 5 years
- Bearing service life: 8 years

**Features:**
- Helium filled
- Magnetic support
- Redundant bearings
PowerStore Grid Stabilizing Generator Control and SCADA

- ECMS controller interfaces to both inverters and flywheel
- Automatic start/stop, temperature de-rating, state of charge control
- Frequency and voltage control and power/SOC sharing between multiple PowerStore units
- Web based graphical user interface
- Communication link to upper level KEA SCADA and power management
- Data recording and alarm management
PowerStore Grid Stabilizing Generator Control modes

**Grid Support Mode**
- Parallels with conventional grid
- Frequency support enabled
- Voltage support (like a STATCOM) disabled
- Renewable energy smoothing – Absorb & inject real power to smooth wind farm

**Crane Support Mode**
- Peak lopping – limit crane demand on feeder / network
- Crane de-rate under special circumstances
Crane 12 Hour Endurance Test

Crane Full Power Mode (Endurance Test), 23 Ton Container, 12-14-15

Time (MM:SS:MS)

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Typical Crane Usage
Crane De-rate Mode

Crane Derate Mode (500 kW Max), 40 Ton Container, 12-12-15

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Flywheel Frequency Support Testing

3 MW - DG Trip (June 5)
Flywheel Crane Mode/Frequency Support Mode

3/7/2016 - Crane operation

Power (kW) vs. Time (s)

- Crane
- Flywheel
- Frequency

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Flywheel Characteristics

- 85% Round Trip Efficiency
- 27,000 KWH Monthly
- Fault Currents do not exceed 200% of Inverter Rating (4 MW Combined)
- Cooling
- SCADA Integration
- Frequency Support Limitations (16.5 MWs per Flywheel)
- ABB Customer Support
Project Economics

- KEA Total Cost $3.5 M
  - Feeder Ties $1.1 M
  - Site Preparation, Feeder Tap, FESS $2.4 M
- MATSON Contribution $400,000
- City of Kodiak Contribution $400,000
Planning Process From ABB Side

• Work with KEA to understand technical requirements for crane integration.
• Controls custom built for respective crane and KEA grid.
• Assist local engineering house for foundation designs.
• Logistics – Delivery to Kodiak.
• Full power testing FAT in lower 48.
• Remote access for monitoring and control.
QUESTIONS