NEC ENERGY SOLUTIONS

Large Scale Energy Storage Development Worldwide

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NEC Energy Solutions
Clean Energy Business Council - Energy Storage: The Future of Renewable Energy
Dubai
9th March 2015

NEC Energy Solutions History

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First high power rack designed for grid energy storage, the HR Rack

First multi-megawatt grid energy storage installation completed, called GSS™

First containerized HR GSS™ installation completed

First LD GSS™ installation completed

Surpassed 100MW installed w/ Auwahi site

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NEC acquires A123 Energy Solutions and forms **NEC Energy Solutions**

A123 ENERGY SOLUTIONS

ESG begins rebranding itself as **A123 Energy Solutions**

A123 Systems establishes **Pack & Systems Group** in Hopkinton, MA in early 2006

ALM 12V7 General Availability

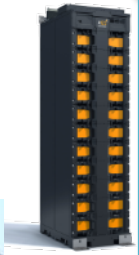
2006 2007 2008 2009 2010 2011 2012 2013 2014

First high power submodule developed using A123's ANR26650M1 cell

A123 announces establishment of **Energy Solutions Group (ESG)**

First *containerized* grid energy storage product delivered, called H-APU

New ESG headquarters established in Westborough, MA



First high energy rack designed, the LD Rack

4,000x 48V batteries delivered to a major storage hardware OEM

First *building-based* HR GSS™ completed

First *building-based* LD GSS™ installations completed

About NEC Energy Solutions

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Advanced Energy Storage

Electric Grid

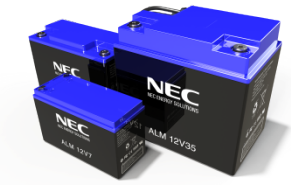
HR GSS™ for high power applications

LD GSS™ for long duration applications

- Increase grid reliability
- Enable renewable energy
- Increase plant efficiency/utilization

Commercial

Standard Battery Products



Configure-to-Order and OEM Batteries

- Improve performance
- Lighter weight
- Lower total cost of ownership over lead acid

Electric Grid

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Energy Storage Solutions for a Smarter Grid

Generation

- **Frequency Regulation**
- **Frequency Response**
- **Renewable Integration**
- **Power Plant Hybridization**

Improve plant efficiency and output, lower O&M costs, and decrease plant emissions, with no water consumption, no emissions of its own, and rapid deployment capability.

Transmission

- **Voltage Support**
- **Dynamic Line Rating Support**
- **Renewable Integration**
- **Upgrade Deferral**

Increase grid reliability, increase asset efficiency and utilization, enable wind and solar, defer upgrades to transmission assets.

Distribution

- **Upgrade Deferral**
- **Community Energy Storage**
- **Microgrids**

Improve power quality, increase asset efficiency and utilization, smart grid ready; aggregation and automation, defer upgrades and support distribution assets.

Providing benefits throughout the electricity supply chain

Widespread Utilization of Renewable Energy → Grid Instability

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- Renewable generation resources such as wind and solar provide clean, sustainable energy but they are often variable and intermittent.
- With the implementation of greater amounts of renewable generation, grid operators face challenges in balancing generation and consumption - load balancing.
- In many cases, where renewable generation makes up a significant proportion of overall generation, grid operators can limit the rate of change of a renewable generation resource. This may prevent grid connection - lost revenue or penalties.

Energy Storage For Renewable Generation - Benefits

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- Capacity firming - smoothes the output and controls the ramp rate (MW/min) to eliminate rapid voltage and power swings on the electrical grid - secure grid connection and maximum revenue for generator.
- Provide ancillary services to improve the stability, reliability and capacity of power networks - additional revenue stream for generator.
- Peak load shifting - energy storage can be used to shift the peak generation from the renewable energy plant to be used when the demand requires it.
- Relieve network capacity constraints and increase renewable hosting capabilities - defer upgrade investment for grid operator.
- Hybrid plant with diesel generation/fuel cells and wind/solar - off grid generation.
- Maximizes renewable generation plant investment and security of supply.

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Grid Storage Solution (GSS™)

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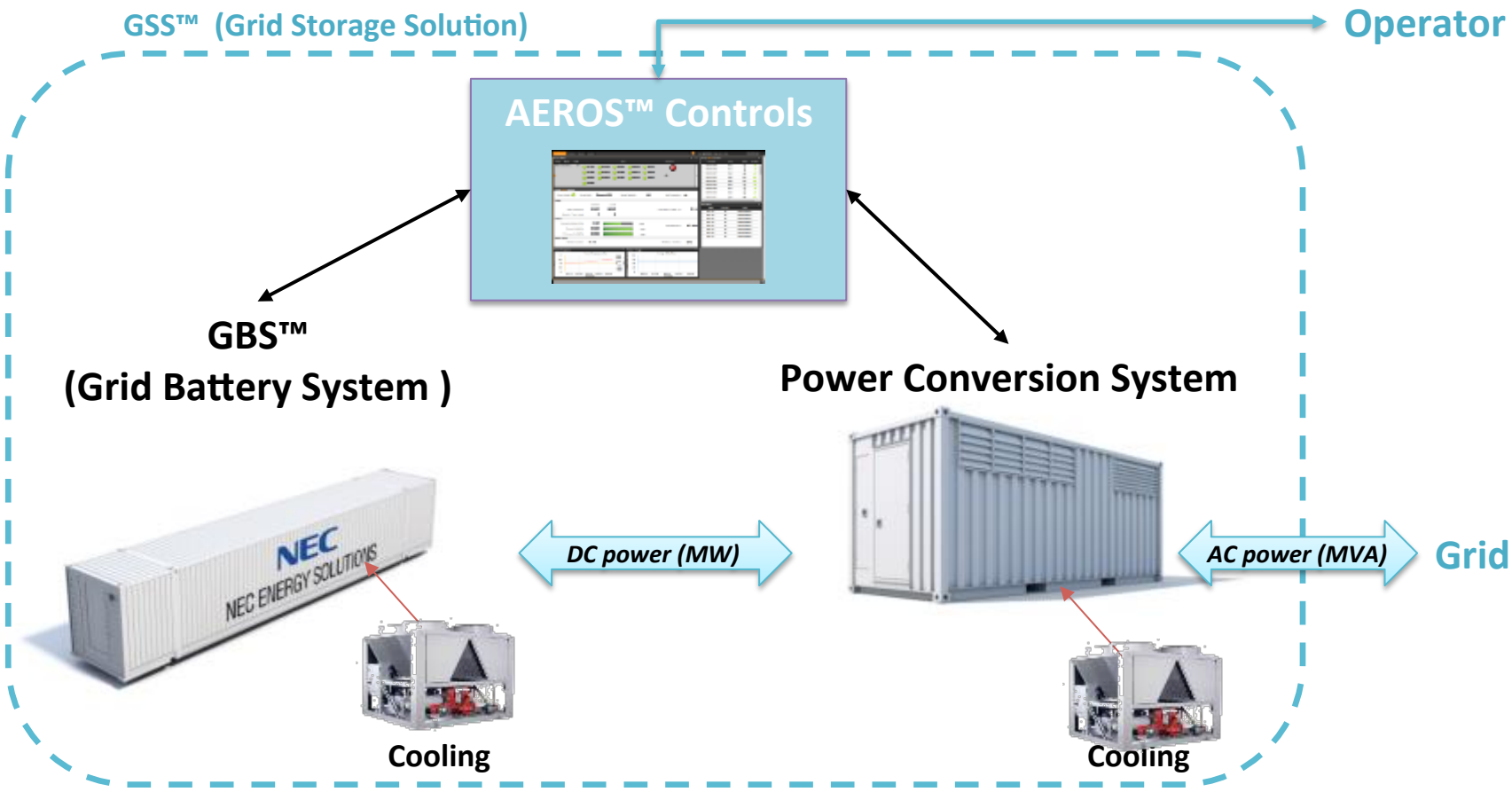
Three major functional components



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GSS™ Deployments

Global GSS™ Deployments

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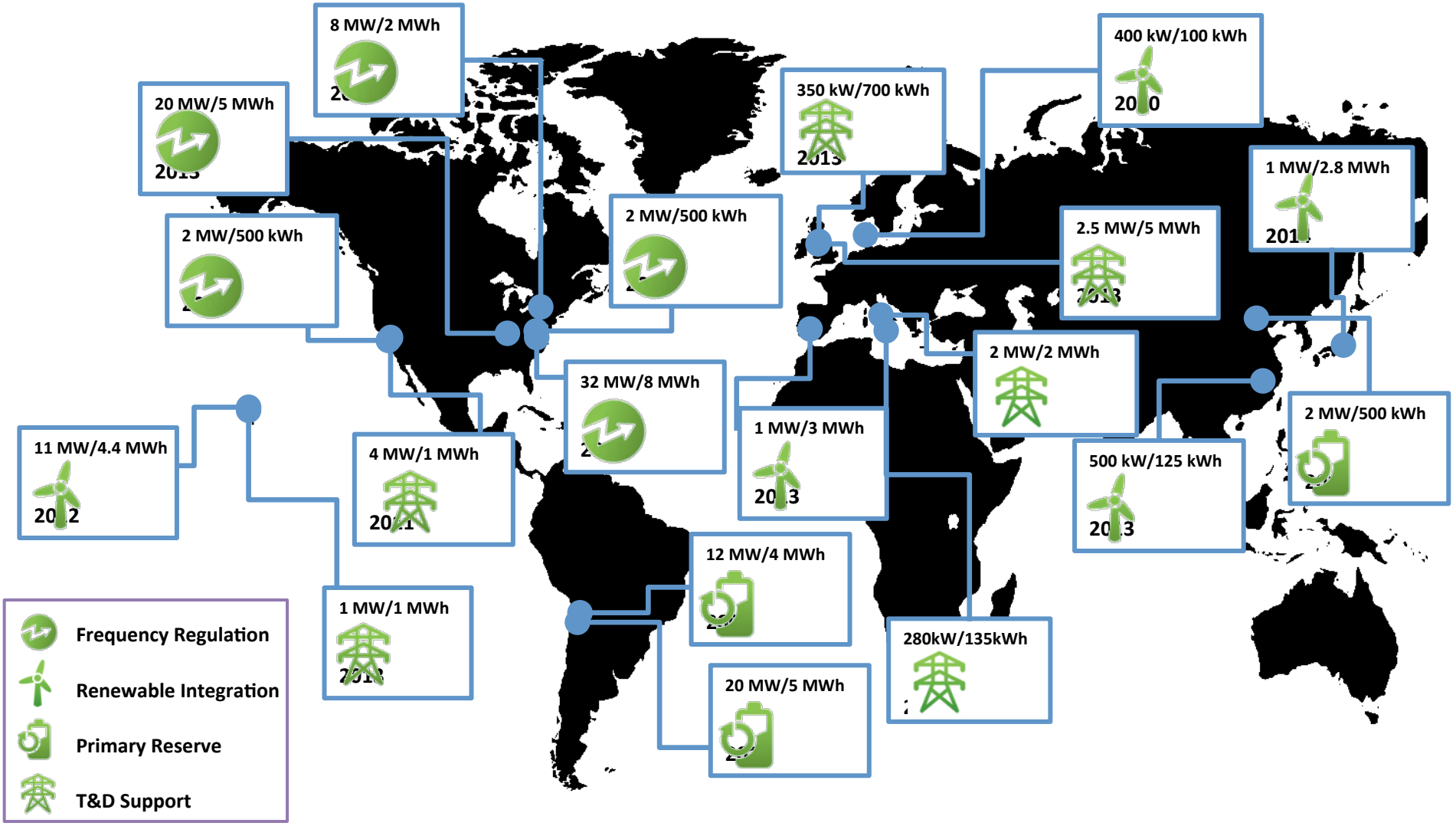
Grid Storage Solution installations around the world



32MW/8MWh GSS™

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Laurel Mountain (USA)

- Frequency Regulation
- 32 MW Power Capability
- 8 MWh Energy Capacity
- 16 Battery Containers
- 8 Inverter Containers
- External Chillers, Transformers
- Operational since 2011

12MW/4MWh GSS™

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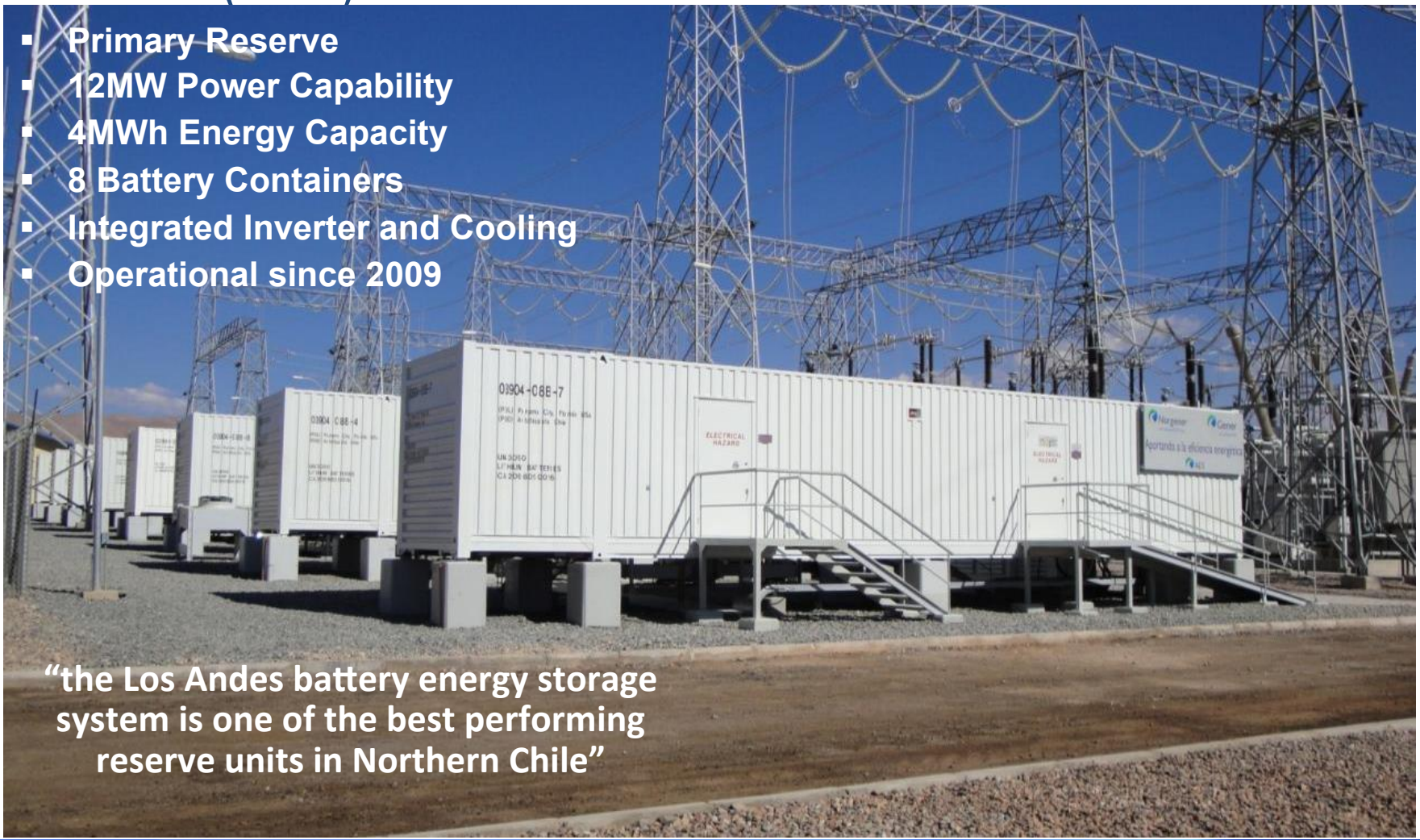
Los Andes (Chile)



20 MW/5MWh GSS™

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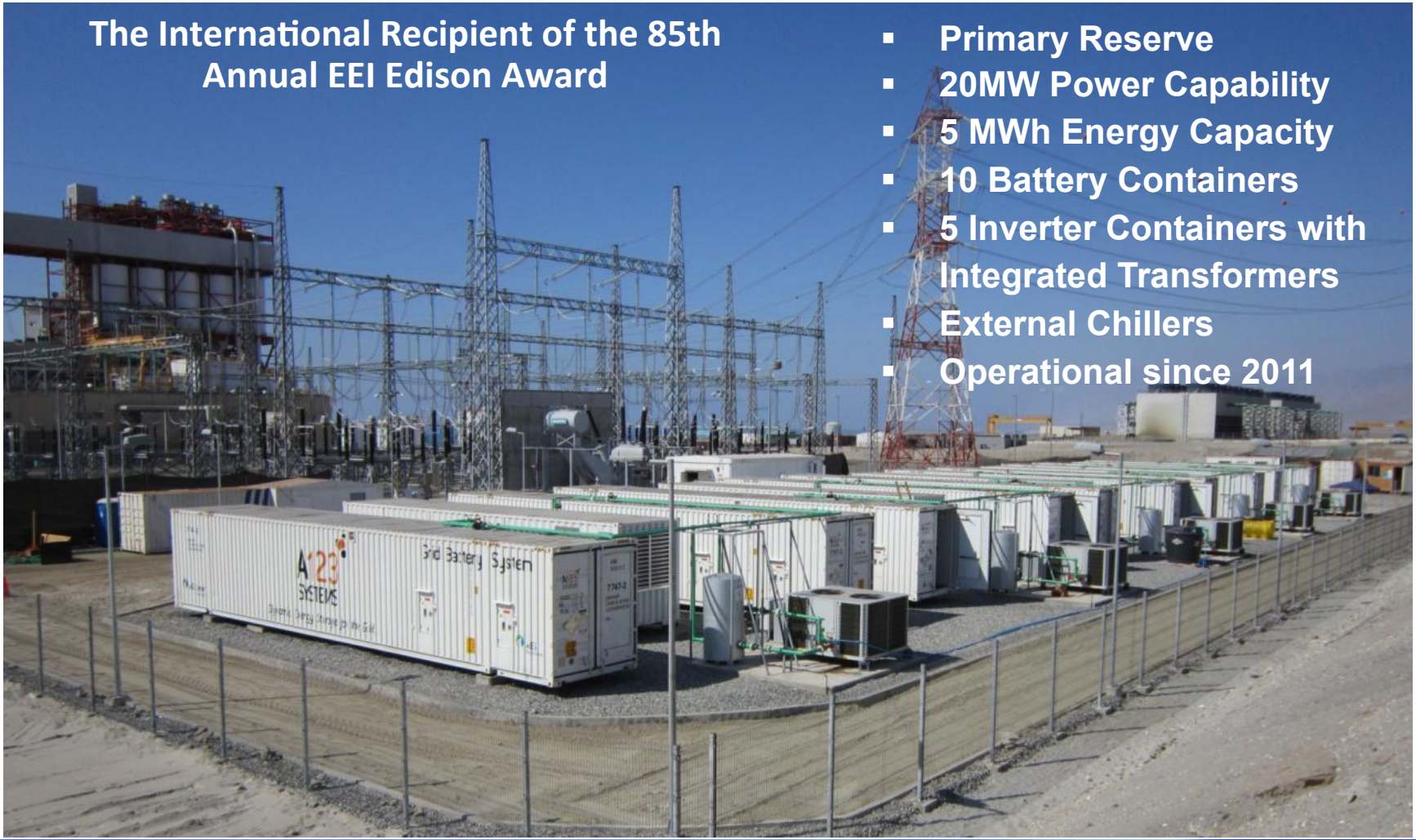
Angamos (Chile)



2.5MW/5MWh GSS™

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Darlington (UK)

- T&D Support Pilot
- 2.5 MW Power Capability
- 5 MWh Energy Capacity
- Two Battery Containers with Integrated Cooling
- One Inverter Container
- Installed at the Rise Carr substation
- Commissioned 2013

100kW/200kWh GSS™

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Wooler (UK)

- **T&D Support Pilot**
- **Two LD Racks**
- **One 100kW/kVA inverter with integral isolation transformer**
- **One AEROS™ Control Rack**
- **Installed in a custom enclosure with integral cooling**
- **Commissioned 2013**

1MW/3MWh GSS™

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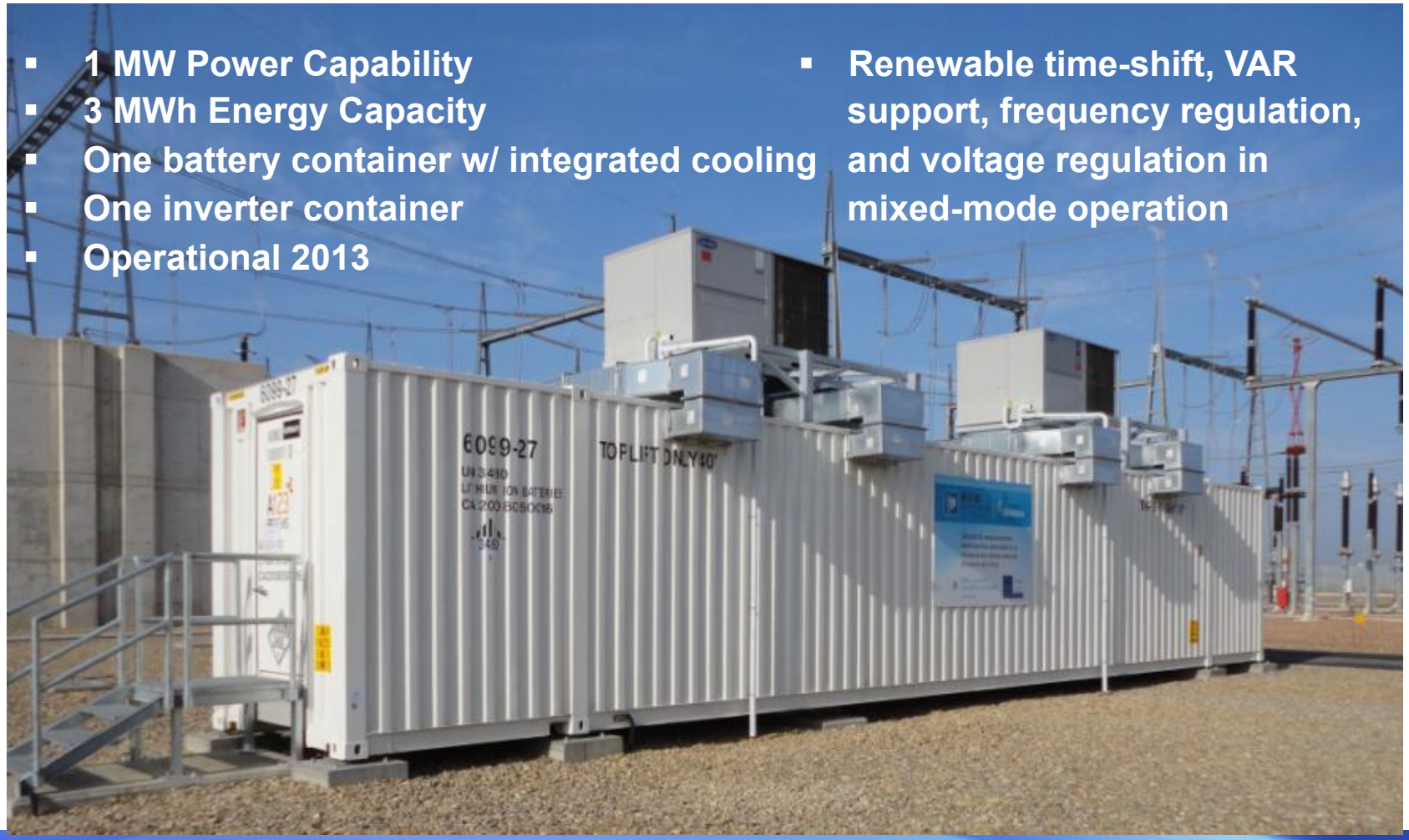
Seville (Spain)



- 1 MW Power Capability
- 3 MWh Energy Capacity
- One battery container w/ integrated cooling
- One inverter container
- Operational 2013

- Renewable time-shift, VAR support, frequency regulation, and voltage regulation in mixed-mode operation

1MW/2.8MWh GSS™

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Soma (Japan)

- Peak load management
- 1 MW Power Capability
- 2.8 MWh Energy Capacity
- One battery container w/integrated cooling
- One inverter container
- Operational 2013

Energy Storage - Conclusions

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- May be necessary to develop policy and regulatory changes.
- Allows increased utilization of renewable energy sources.
- Storage technology performance will advance and costs will decrease.
- Electricity storage is available and is proven.


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