



A GLOBAL POWER TECHNOLOGIES COMPANY

SolarTie™ Grid Interconnection Solution

New Northeast Solar Energy
Research Center

Brookhaven National Laboratory

March 8th and 9th, 2011

Presentation Agenda



● AMSC Overview

● SolarTie™ System Product Overview

● Proposed scope of investigation for research array

● Q&A

About American Superconductor



- Global power technologies company focused on the Renewable Energy and Smart Grid Infrastructure markets
- Founded in 1987; IPO in 1991
- One of the fastest growing public companies in the U.S.; More than 800 employees worldwide
- \$316 million in revenues in FY09; expecting revenues to exceed \$430 million in FY10
- Earnings expected to grow by 75% in FY10
- \$1.3 billion market capitalization
- Solid cash balance, no debt and positive net cash flows

Nearly 10% of World's Wind-Generated Electricity "Powered by AMSC[®]"



Wind Turbine Designs, Controls & Converters

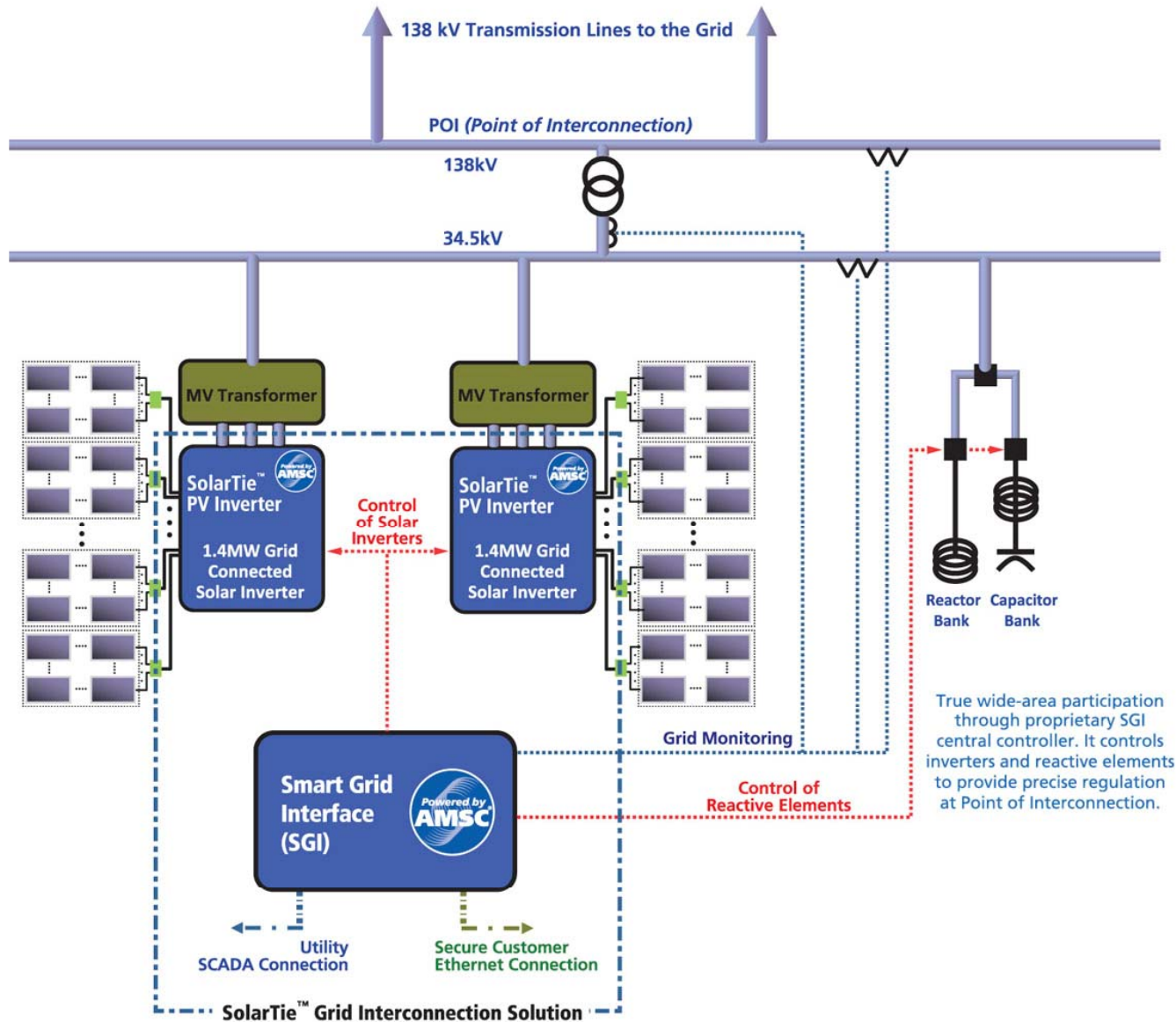
- Relied upon by more than a dozen wind turbine manufacturers worldwide, including two of the world's top 10 producers
- Utilized in thousands of wind turbines today
- Shipments to date sufficient to power 10 GW of wind power



Wind Plant Interconnection Solutions

- Worldwide leader in connecting renewable energy sources to the power grid
- D-VAR[®] and D-VAR RT technology utilized at more than 70 wind plants worldwide
- Shipments to date sufficient to allow interconnection of 5 GW of wind power

SolarTie™ Grid Interconnection Solution



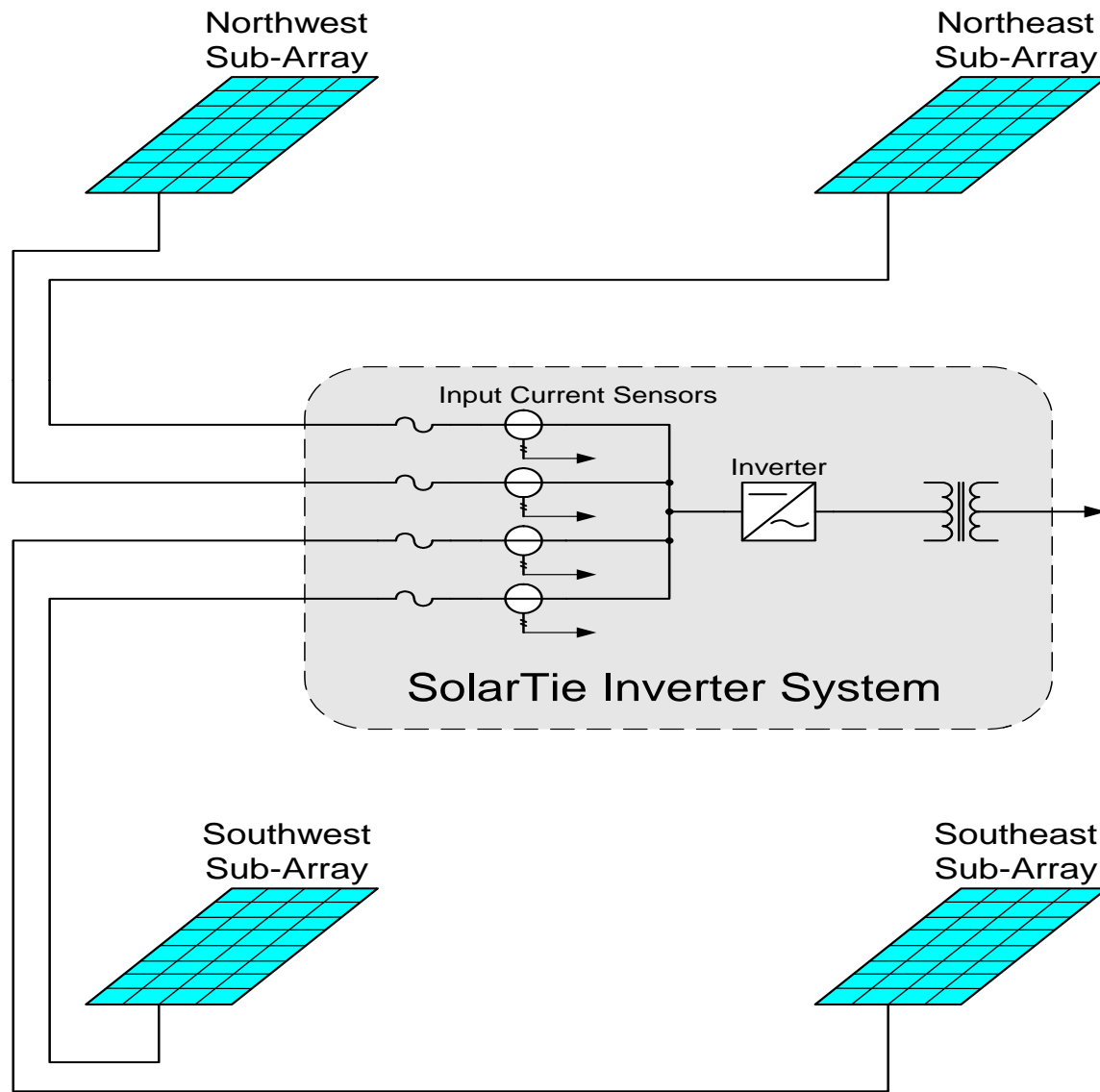
Primary investigation concerns

MW central inverter connected to PV Array



- Issues related to a central inverter fed from solar PV arrays covering a physically large area such that partial shading due to passing clouds affect harvested energy
- Energy harvest loss when sub-arrays have widely different maximum power points
- Dynamic MPP tracking efficiency of various MPPT algorithms as a cloud moves by
- Dynamic electrical characteristics of the shaded array
- Voltage fluctuations of the AC system output due to generated power changes as a cloud moves by

Suggested Physical Arrangement



Requirements:

- ✓ Array size: 700 kW – 1,000 kW
- ✓ 1000 VDC panel configuration



Controls and Communications Goals

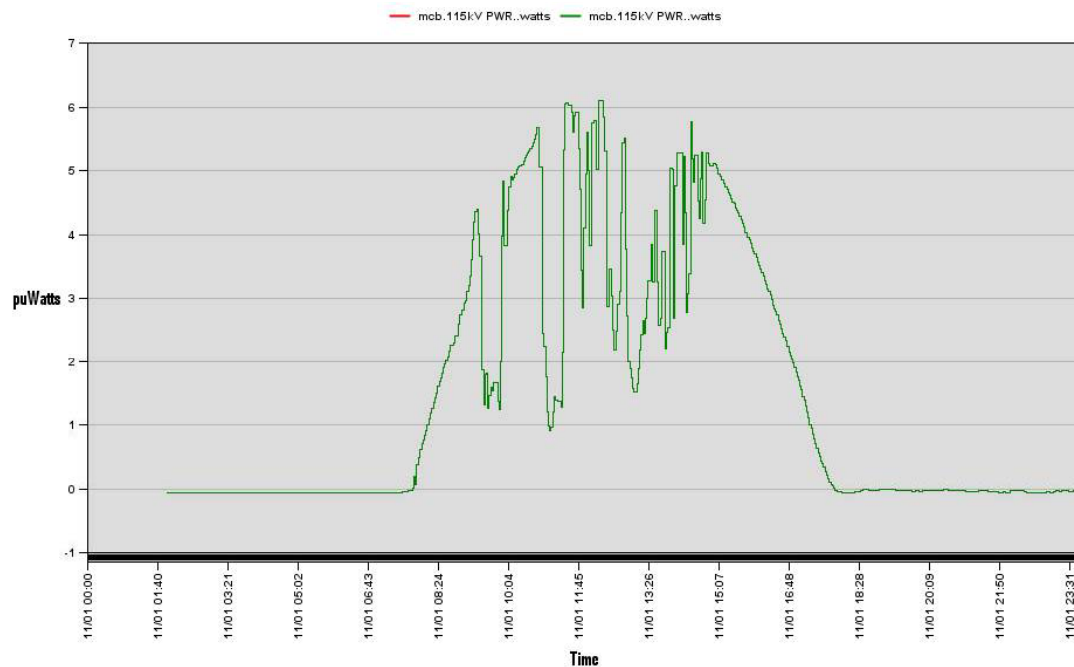


- Integration of central controller with array sensors and weather station (temperature, wind speed, irradiance, pressure, etc)
- Implementation of predictive algorithms for comparison and report of actual versus predicted power production
- Implementation of string-level current monitoring using the SGI (Smart Grid Interface) and SolarTie inverter – current measurement done by an “off-the-shelf” device and sent to inverter via communication channel (e.g. RS-485)
- Algorithm development for early detection of string-level issues based on current measurement

Other Areas of Interest Clouds



- Voltage fluctuations of the AC system output due to generated power changes as a cloud moves by
 - Investigate dynamic VAR compensation algorithms to compensate for voltage fluctuations

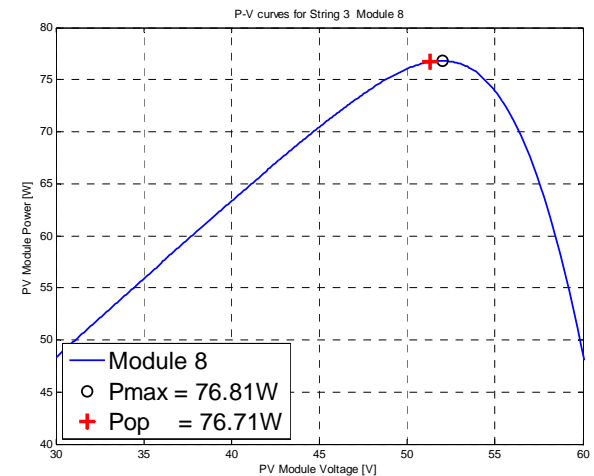
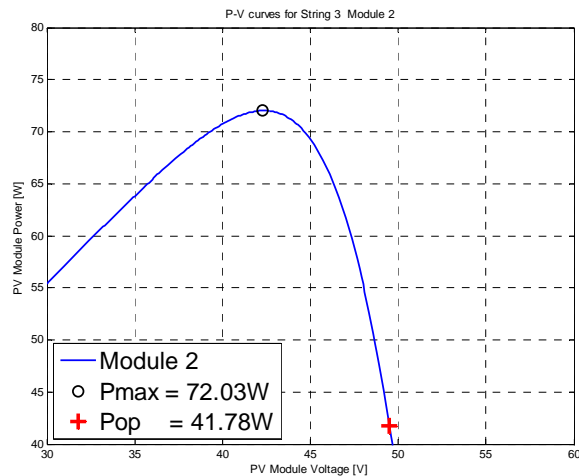
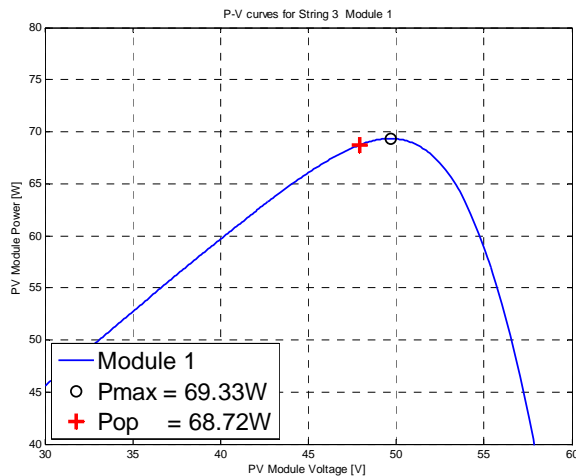


Other Areas of Interest

MPPT Efficiency



- Harvest efficiency “hit” due to:
 - Static module mismatch
 - Operating point shifts due to wiring voltage drops
 - Dynamic effects
 - Temperature variations (wind variations)
 - Irradiance changes when clouds pass by



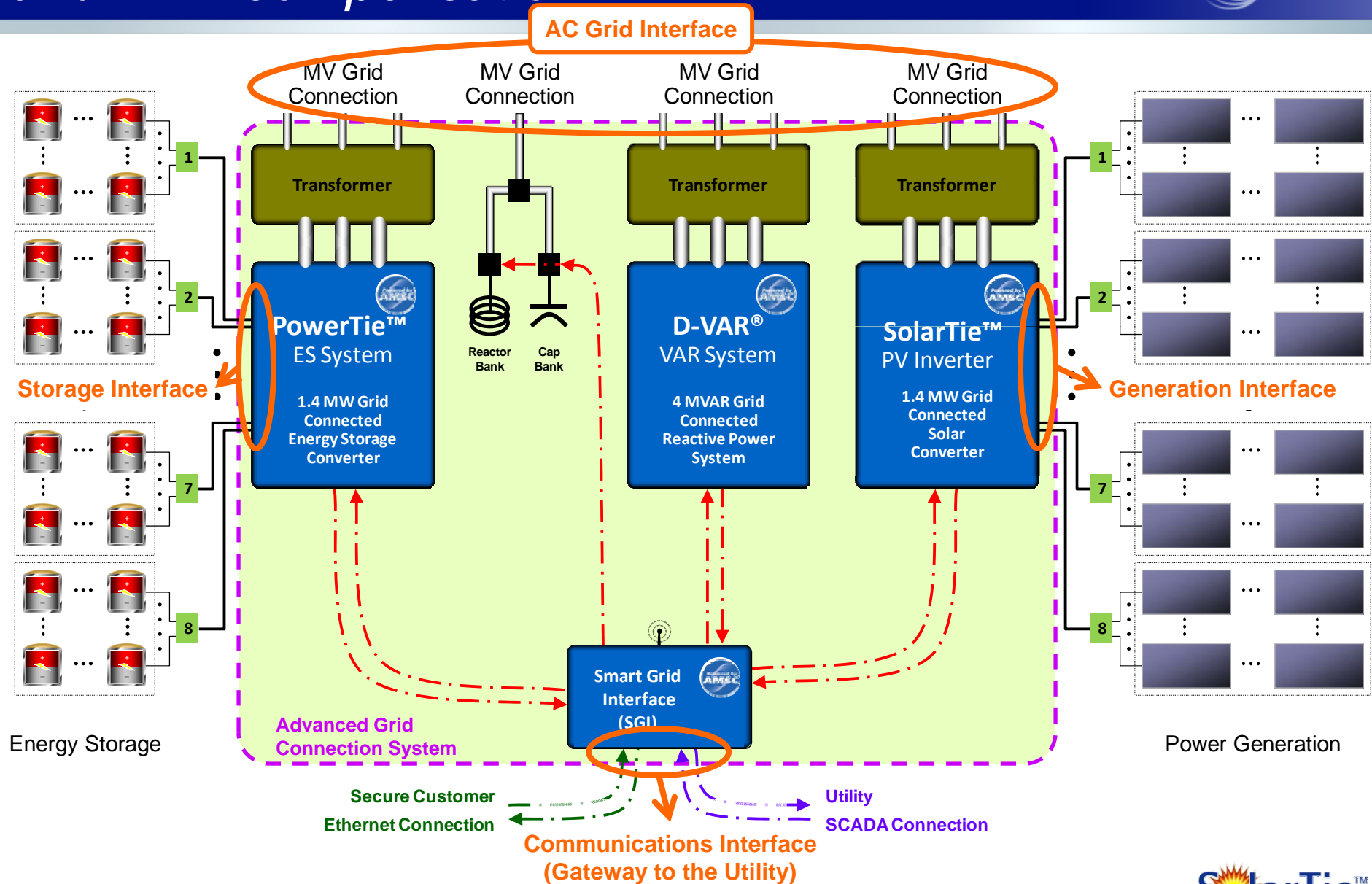
Other Areas of Interest

Smart Grid and Energy Storage



- Integration of solar plants in the smart grid – what is needed for a solar plant to be integral part of the smart grid
- Inclusion of energy storage in a solar plant and its effects. The energy of the storage bank would vary for different studies:
 - Spinning reserve for grid support;
 - Reduce dP/dt due to sun irradiation variance
 - Mass storage for peak shifting
 - *The energy storage would come in a second stage of this study, giving the first priority to previous mentioned bullets.*

Solar plant with Energy Storage device and VAR compensation



Contact AMSC



Cathy Stewart
Regional Sales Manager
978-842-3037 ph
508-954-7541 cell
cstewart@amsc.com

American Superconductor and design, Revolutionizing the Way the World Uses Electricity, AMSC, Powered by AMSC, D-VAR, dSVC, PQ-IVR, PowerModule, Secure Super Grids, Windtec and SuperGEAR are trademarks or registered trademarks of American Superconductor Corporation or its subsidiaries. The Windtec logo and design is a registered European Union Community Trademark.