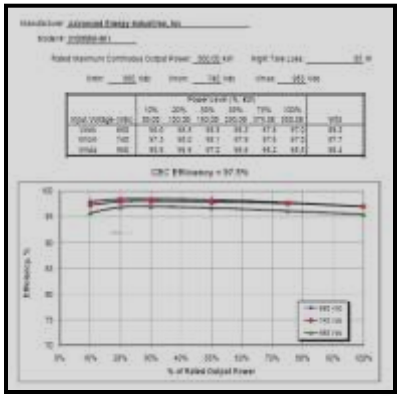
Optimization

Faster ROI



Performance

Service

高性能併網逆變器

John Hung

洪袈瀚

AE at a Glance

Toronto

Fort Collins

Shanghai

Shenzhen

Design, Service & Low-Volume Manufacturing

Fort Collins, Colorado

Manufacturing

Fort Collins, Colorado

Bend, Oregon

Shenzhen, China

Shanghai, China (SGEG)Ontario, Canada (CLS)

- **Headquarters in Fort Collins, Colorado**
- **Founded in 1981, IPO 1995**
- **Nasdaq: AEIS**
- **1,800 employees worldwide**
- **$500M revenue, $100M cash – no debt**

Diverse Markets Served

Thin Film Processing

- Semiconductor

- PV Solar & Glass

- Flat Panel Display

- Industrial

Solar Energy (Inverters)

- Utility

- Commercial

- North America

AE Solar Inverter Solution Portfolio

String

POWER: 1kW-30kW

Commercial

POWER: 30kW-500kW

Utility

POWER: 500kW-2MW

- Power conversion and architecture solutions optimized for LCOE
- Full portfolio spanning 1kW to 2MW solutions
- Positioned for WW growth with product pipeline and untapped synergies

AE – Market Share Growth, 2010

#1 Position Americas

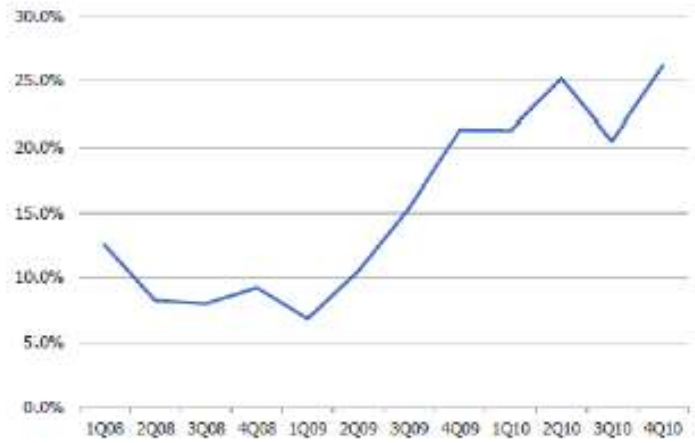
Solar Inverter: 24% of Americas

#1 Share, Americas

Figure 4

Your Company's Americas PV Inverter Market Share

(PV Inverters - Revenues - % Market Share)

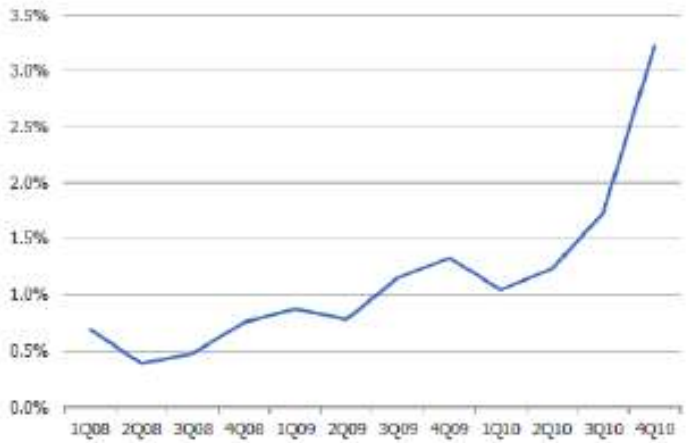


Source: IMS Research Mar-11

Figure 3

Your Company's World PV Inverter Market Share

(PV Inverters - Revenues - % Market Share)



Source: IMS Research Mar-11

#3 Largest Share Gain, WW

Source: IMS Research

New Products

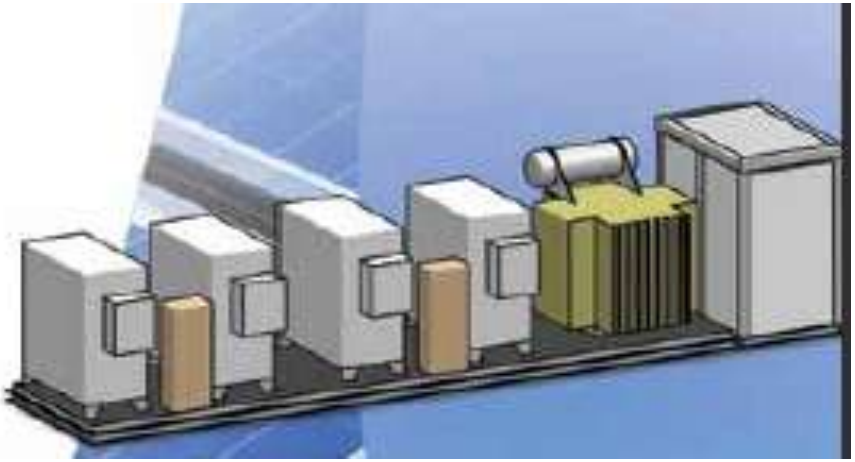
AE Solaron® 500HE Grid-Tie Inverter

Dimensions	**211 x 218 x 101 cm (83.1” x 85.4” x 40.2”)**
Weight	**1706kg**
Enclosure	IP-45 corrosion-resistant cabinet IP-65 for electronics enclosure
Output Connector	4 x 300 mm^2 (600 MCM) per phase
Input Connector	4 x 300 mm^2 (600 MCM) per pole
User Display	LCD (plus keypad)
Max Power	500 kW ,480 VAC 50Hz, 60Hz
AC Current Distortion	**<1% typical**
Efficiency	**98.4%, CEC: 98%**
Peak Efficiency	**98.7%**
Min Start-Up Power	**1 kW**
DC Voltage	±330 to ±600 VDC; Bi-Polar
Current	**750 ADC max MPP current**
Wake-Up Voltage	±425 VDC (default)
Standby Tare Losses	**85 W**
Declaration of Conformity	CE marked and UL1741 certified in N.Amer.

AE solAron®

Commercial, Grid-Tie PV Inverters

AE Solaron PowerStation (1-2MW)



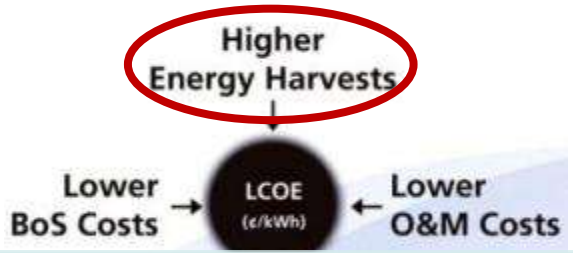
Advanced Energy deploys stainless steel PV inverters for U.S. Navy project in Hawaii

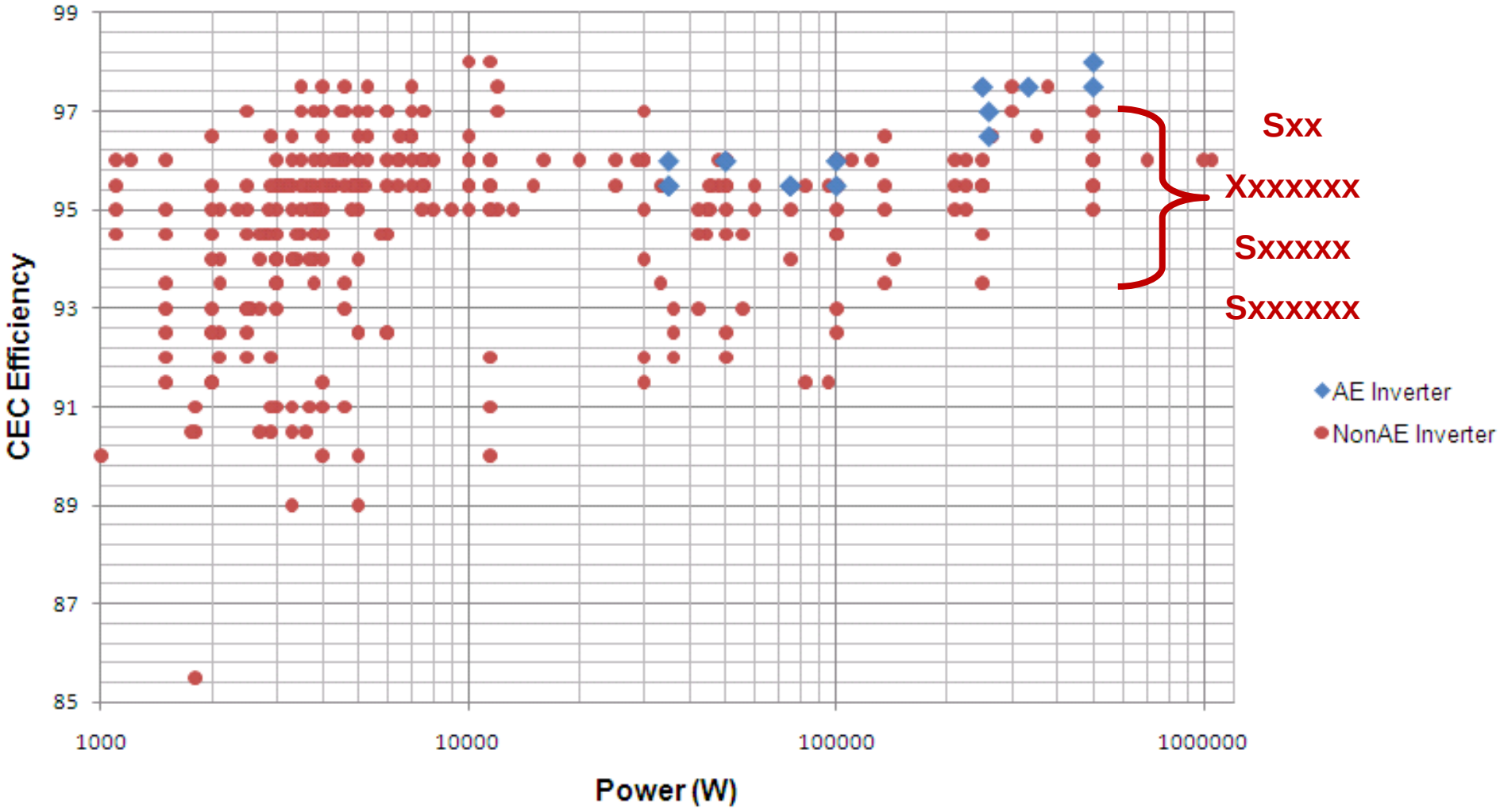
Solaron 333x6

PVP260-SS x3

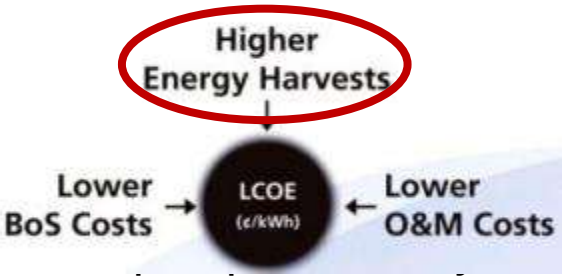
Optimizing Levelized Cost of Energy (LCOE)

Solaron Leadership, 2011



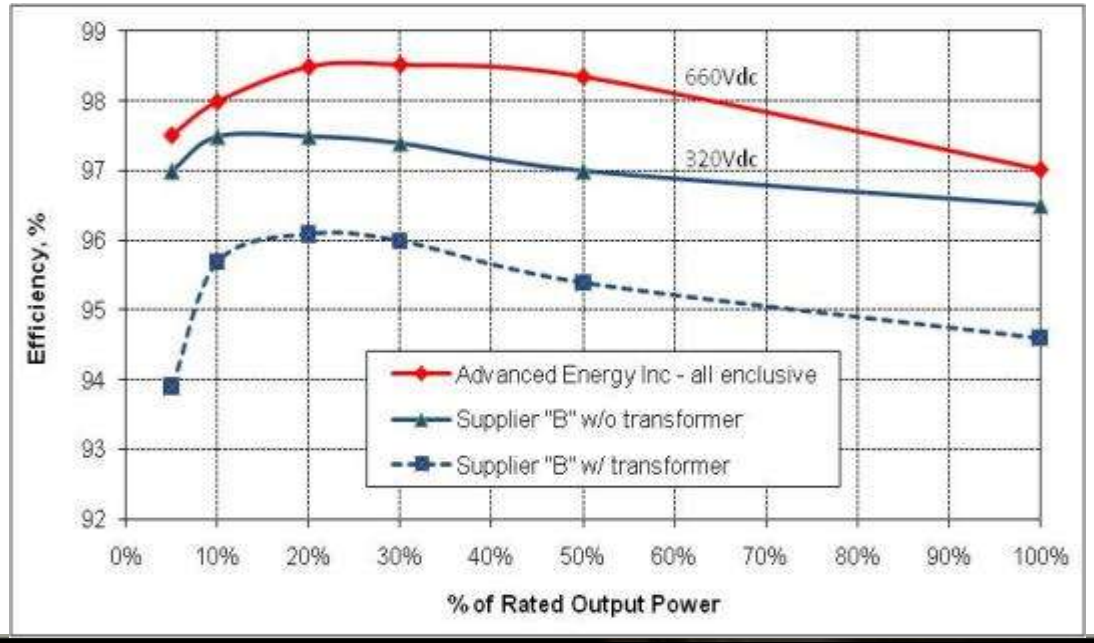


Efficiency – Use “Apples to Apples” Comparison

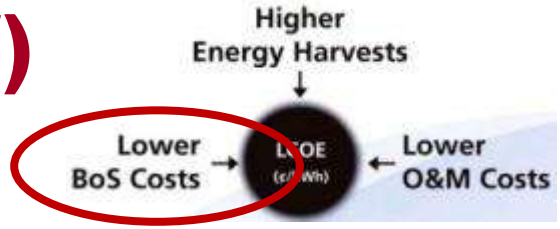


- Does the efficiency rating include: Transformer, cooling supply?
- What is the overall efficiency rating method (CEC, EU, PV voltage specific, peak weighted, etc)?
- Evaluate PV voltage and power plots to compare normal operating points

What are your needs and what are you comparing to?



Reducing System Cost ($/W)

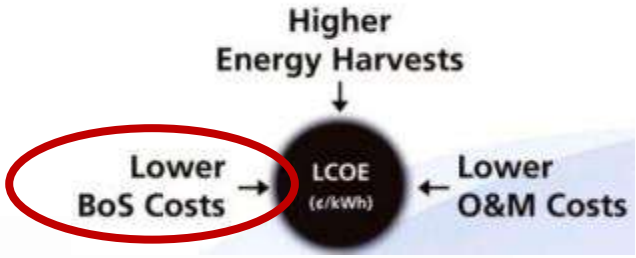


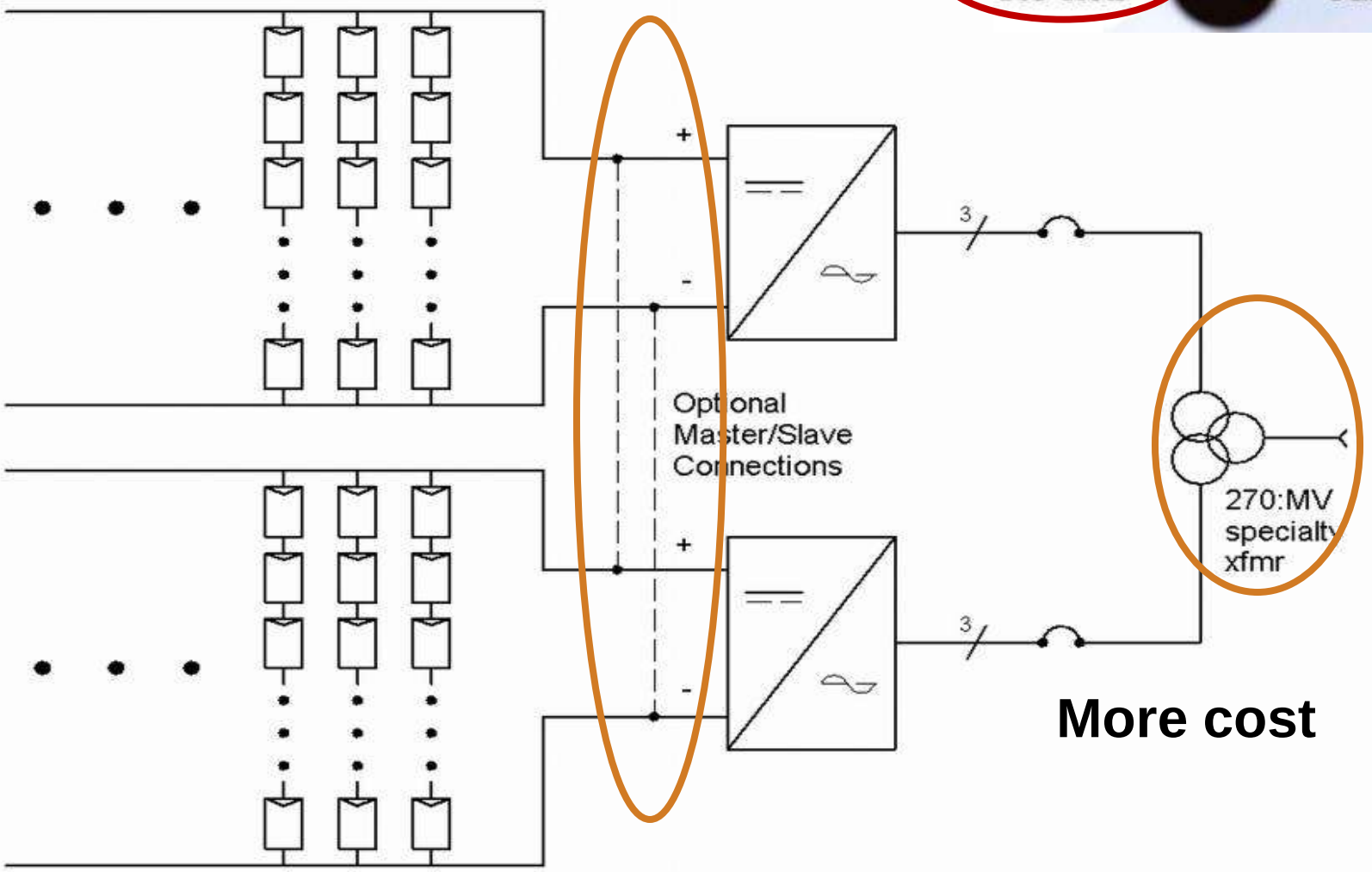
Inverter can reduce costs across the plant

- **Outdoor-ready inverters**
  - High NEMA, IP ratings
  - Smaller size per MW = less site prep, cranes
  - Pre-integrated ambient PowerStations

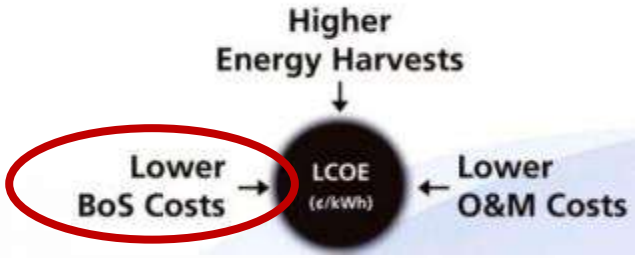
- **System reductions**
  - High efficiency = fewer modules needed
  - 4:1 parallel connection into MV transformer
  - Higher DC voltages, smaller cables
  - Integrated data server in every inverter

European Utility Scale system Configuration





AE Utility Scale System Configuration



+ 600

Advanced Energy Solaron 500

+

-

3

3

3

3

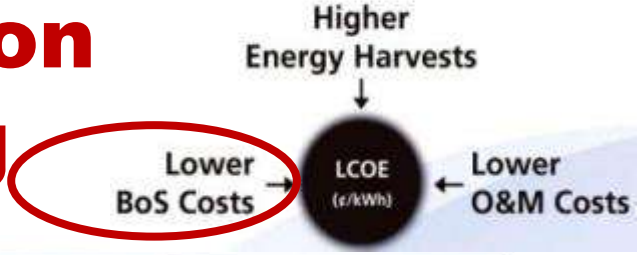
480:MV

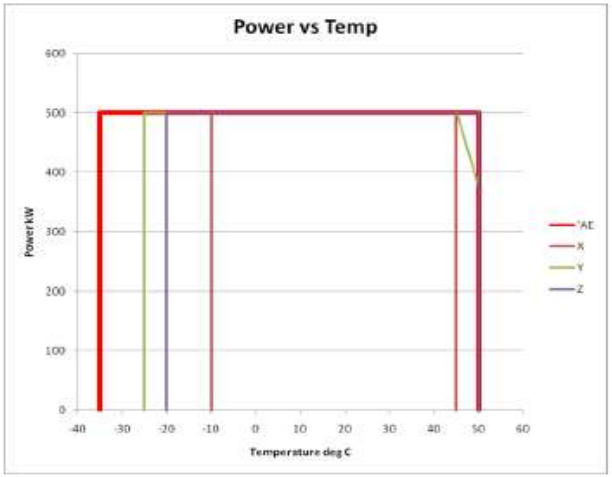
Utility transformer has simple construction and does not need to be “inverter duty”.

Unlimited number of inverters may be paralleled.

- 600

Outdoor design, installation and operation cost saving





Smaller enclosure, less solar heat gain

Wide temperature operating range

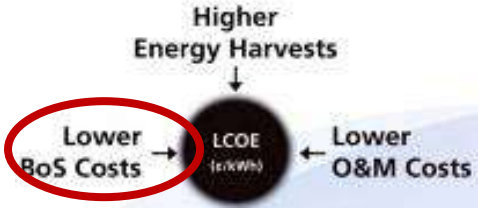
Maximize energy harvest

50°C Environment

-35 ℃~50 ℃

-35°C Environment

Lower BoS Costs



Illustrative 2MW example

A Fewer Panels (or more power)

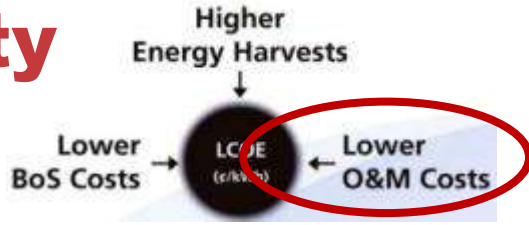
N Solarons: 1MV transformer B

C Less copper

Optional house D

Fewer pads F

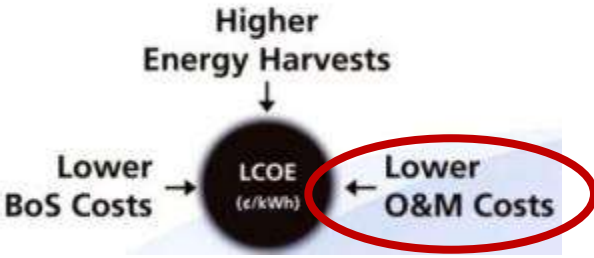
Reducing O&M Costs & Variability



Improve uptime and stabilize lifetime cash flow

- **High Reliability Designs**
  - Aerospace, semiconductor expertise
  - Advanced cooling: Solaron liquid, PVP air-dam
- **Warranties worth owning**
  - 5 or 10 years standard by model
  - Extensions to 10, 15, or 20 years
  - Responsive, especially via remote monitoring
- **SafeGuard & SiteGuard Services**
  - Customizable: simple PM to full service
  - System telemetry & proactive diagnostics
  - Uptime guarantees available
  - Design and Installation consulting
  - Three decades of service, international footprint

Thorough Reliability Test Processes



Reliability Tested & Qualified Assemblies

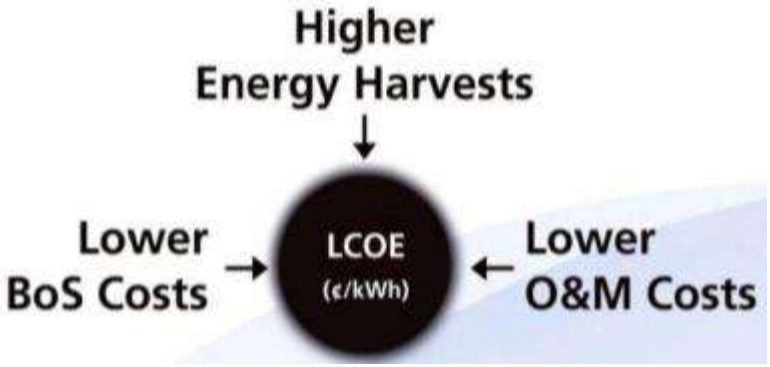
- Entire Cooling System from sweat joints to coolant mixture
- Line Reactors
- Auxiliary Power Supply
- AC and DC Fans
- Thin Film Capacitor
- Snubber Assembly
- Current Sensors
- Mounting Hardware
- High Power Crimps
- High Power Connections

LCOE Drivers

Max efficiency, up to 99%

PV System Uptime, >99%

Full power temperature range, -35-50C



Easy installation

Less copper, Fewer transformers

Integrated disconnects

1-2MW substation bundles

Outdoor ready

Long design life, 20+ years

High reliability

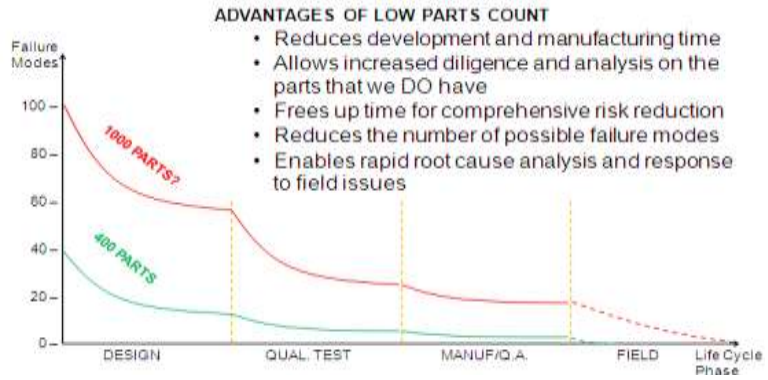
Warranty up to 20 years

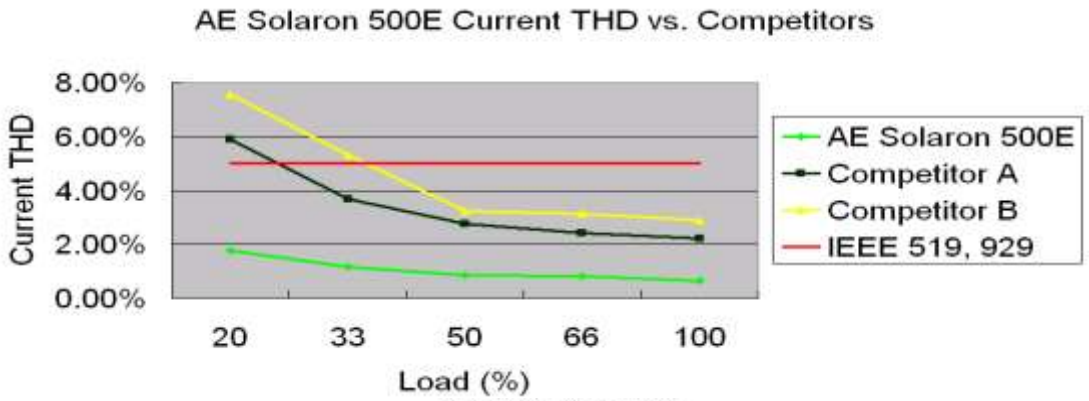
Remote monitoring

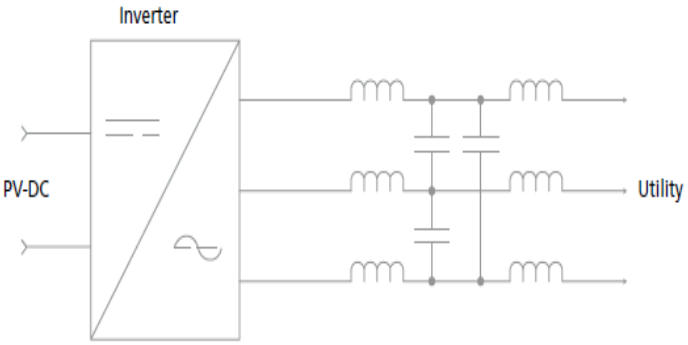
Plant wide field services

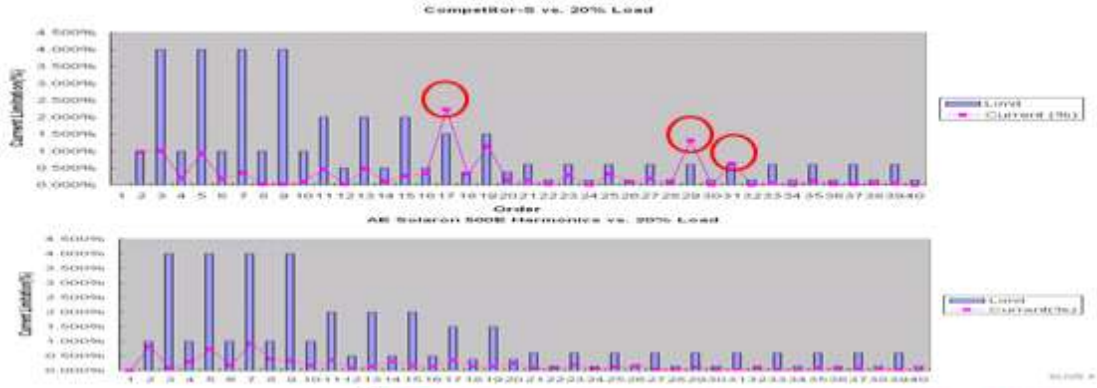
Better Technology
Advanced Technology

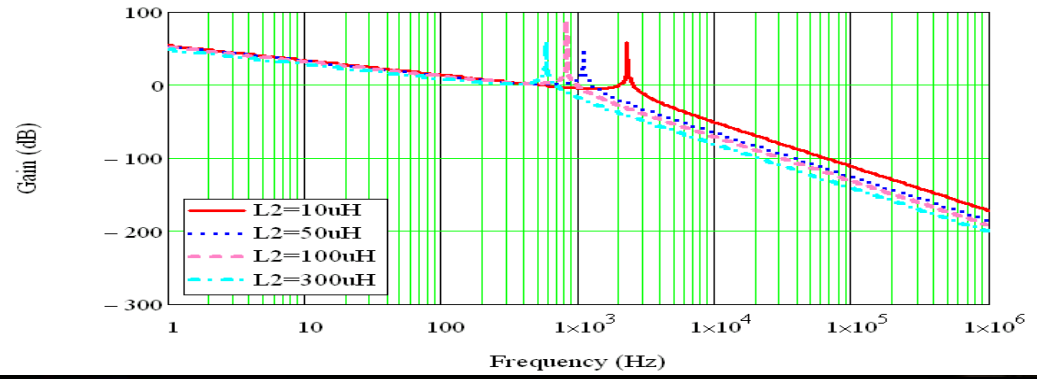
Better Technology:

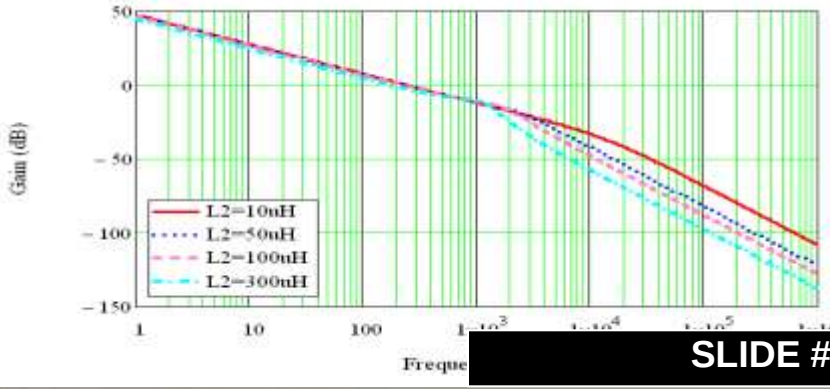




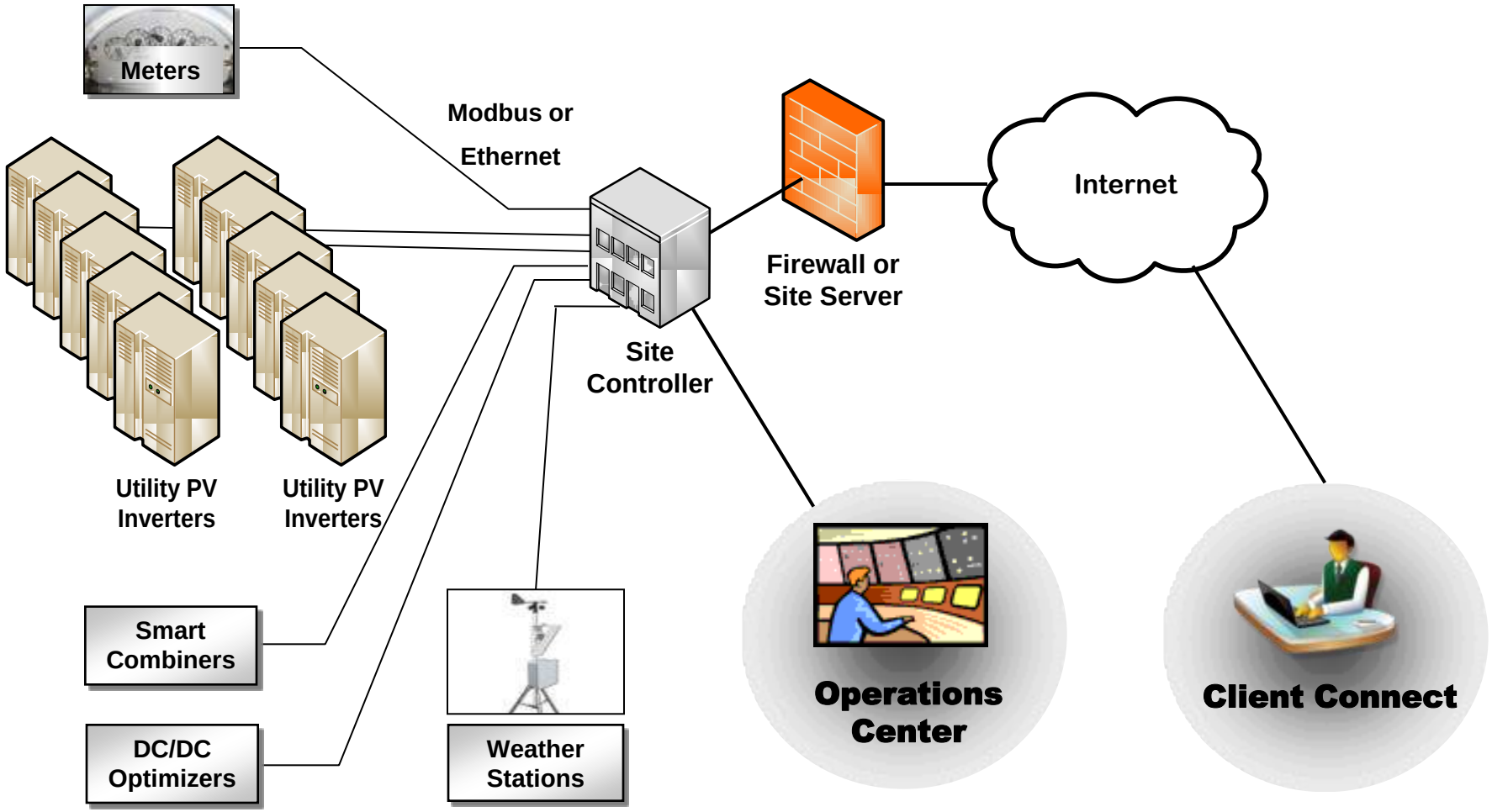








Better Technology:
Grid-Friendly Site Controls



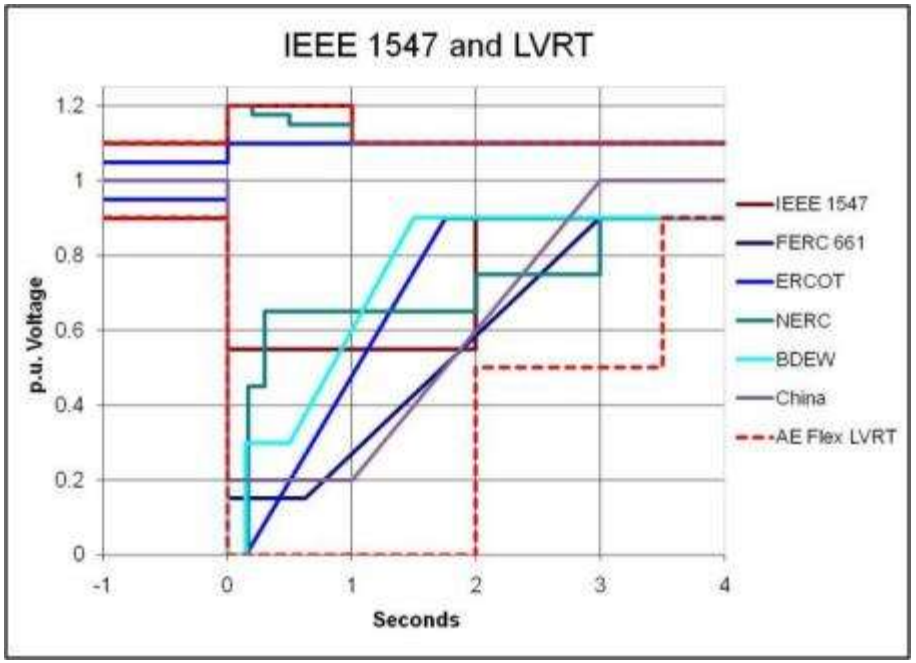
Better Technology:

AE Enables Choice for Smart Grid Support

Utility Control Features:

- ✓ Active Power Remote Set point
- ✓ Reactive Power Fixed Q (kVARs)
- ✓ Remote Disconnect/Connect

- ❑ Ride-Through (LVRT, HVRT, ZVRT)
- ❑ Reconnect Ramp Rate Control
- ❑ Active Power Limit, Over-Frequency
- ❑ Reactive Power Fixed Cos (Phi)
- ❑ Reactive Power Dynamic Q (kVARs)
- ❑ Autonomous Watt/VAR Control
- ❑ Autonomous Volt/VAR Control



Flexibility for Emerging Standards: EPRI, BDEW, Cal ISO, Ercot

Monitoring

Data Monitoring Solutions

AE offers you a monitoring solution for any project size

Choice, Simplicity, Turn-key, World Class Support

Inverter Direct Monitoring

- **Free - web based monitoring service**
- **Simplicity - inverter integrated communications**
- **OEM branded options**
- **Support - backed by world class AE Service**

Premium Monitoring

- **Turnkey - Factory Integrated Monitoring HW from leading suppliers saves you field labor and costs**
- **Choice - Validated 3rd Party Monitoring Providers**
- **Open - Modbus communications connect to external monitoring & SCADA systems**
- **Support - Application Engineers is ready**

DECK Monitoring · SunEdison simplifying solar · DRAKER LABORATORIES · meteo control Energy & Weather Service · ENERGY RECOMMERCE · ArgusON AN SPX BRAND · OBVIUS · SunSpec alliance

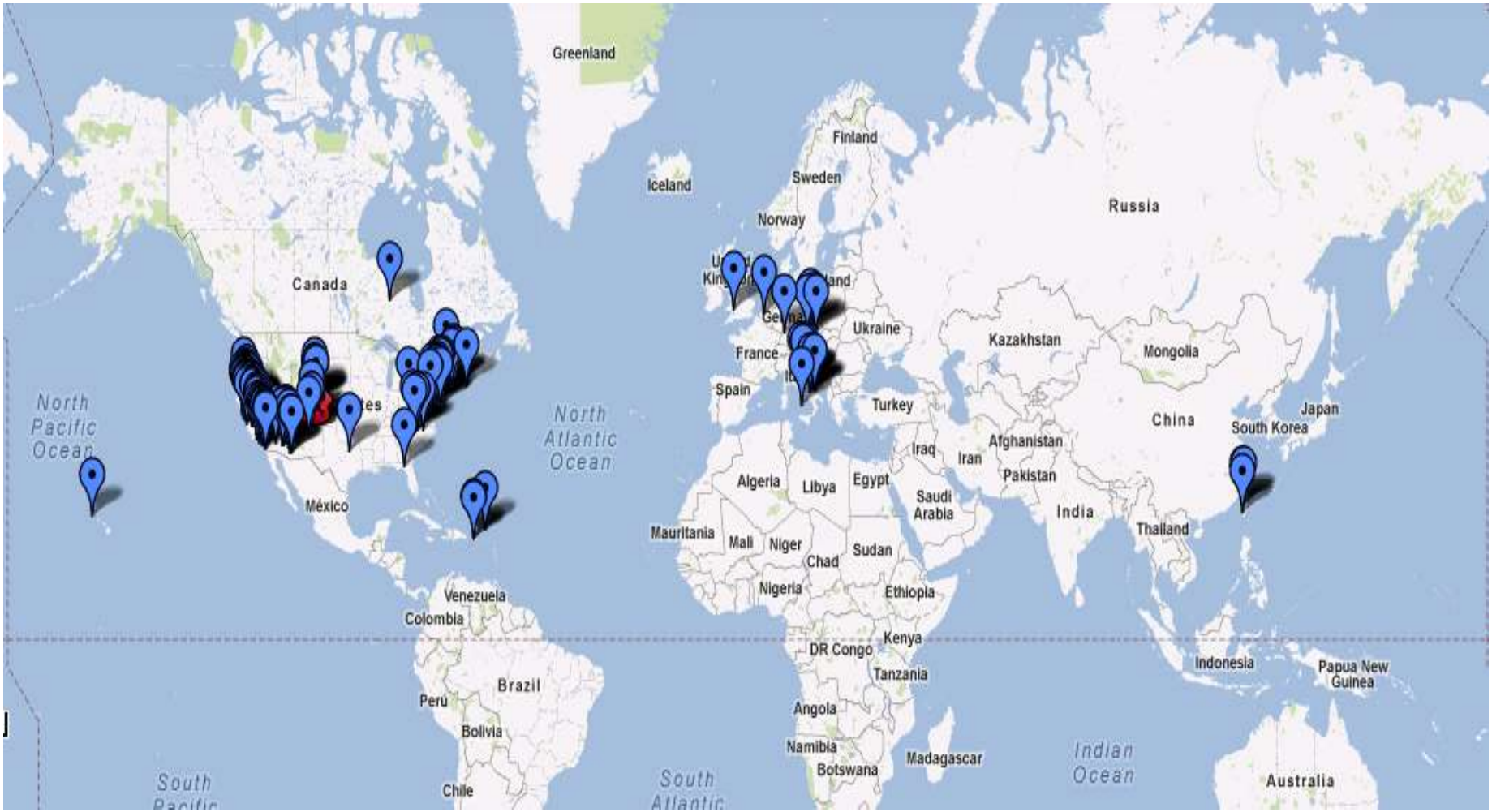
Data Monitoring System: Inverter, Weather, String monitor, Revenue Meter

Sample Projects

AE solAron®

AE PVPowered™

AE Solaron Inverter map



Advanced Energy® Utility Solar Inverters Selected for 150 MW Solar Power Plant by Zachry Industrial, Inc.

FORT COLLINS, Colo., May 02, 2011—Advanced Energy Industries, Inc. (Nasdaq: AEIS), today announced that its **Solaron® PV inverters** and **SafeGuard® service program** have been selected to power a **150-megawatt** project located in **Arizona**. The project was awarded to Advanced Energy by Zachry Industrial, Inc., a leading U.S. EPC provider. The Solaron PV inverters were selected for this project through a rigorous competitive bidding process.

"After evaluating multiple inverter options, we found Advanced Energy provided the leading product and service offering for the project," said Al Hood with Zachry Industrial, Inc. "We look forward to working with Advanced Energy on this momentous project which reflects Zachry's commitment to the solar market."

The project is slated to begin construction in **mid-2011 and be completed in 2013**. When completed, we believe the project will be one of the largest photovoltaic solar installations in North America with a planned output capacity that is currently larger than any solar PV project installed worldwide.

The project will utilize the Solaron 500kW inverters configured as **2MW PowerStation™ solutions** and will be supported by Advanced Energy's SafeGuard Plus inverter uptime program.

PG&E - 35MW

Location: Coalinga, CA, USA

Size:35MW

Developer: Cupertino Electric, Inc

Solaron 500's

Duke Energy - 17MW

Location: East Coast, USA

Size:17MW

Developer: SunEdison

Solaron 500’s

SMUD utility - 6MW

Location: California, USA

Size: 6MW

Developer: SMUD

Integrator: SPI

Solaron 500’s, 333’s, RPT’s

CSU 5.3MW, cold weather

Location: Fort Collins, Colorado

Size: 5.3MW

Developer: FRV

Integrator: AMEC, GES

Solaron 500's, 333's

SFPUC, utility – 5MW

Location: San Francisco, California

Size: 5MW

Developer: Recurrent

Integrator: Bass Electric

Solaron 500's

University of Toledo – 1.12MW

Location: Ohio, USA

Size: 1.12MW

Developer: Constellation Energy

Integrator: Advanced Distributed Generation, LLC

PV Powered 100 and 260 kW's

"We chose PV Powered inverters because we were looking for a cost-effective and highly-reliable American-made product with high efficiency. We like the inverters' simplistic and rugged design, and the responsiveness and quality of PV Powered's technical support exceeds that of any other inverter company that we've dealt with."

-Keith Dandridge, Project Manager at ADG

Germany

Location: Germany

Size: <1MW

Developer: Erka

Integrator: SiTiZn, Parity

Solaron 500E, Utility Active Controller

Czech Republic

Location: Brno, Czech Republic

Size: 15MW

Developer: Photon Energy

Solaron 500E, Utility Active Controller

(curtailment, remote kVar setting etc.)

China - AE 500kW (10MW total project size)

Location: XiTieShan, Qinghai, China

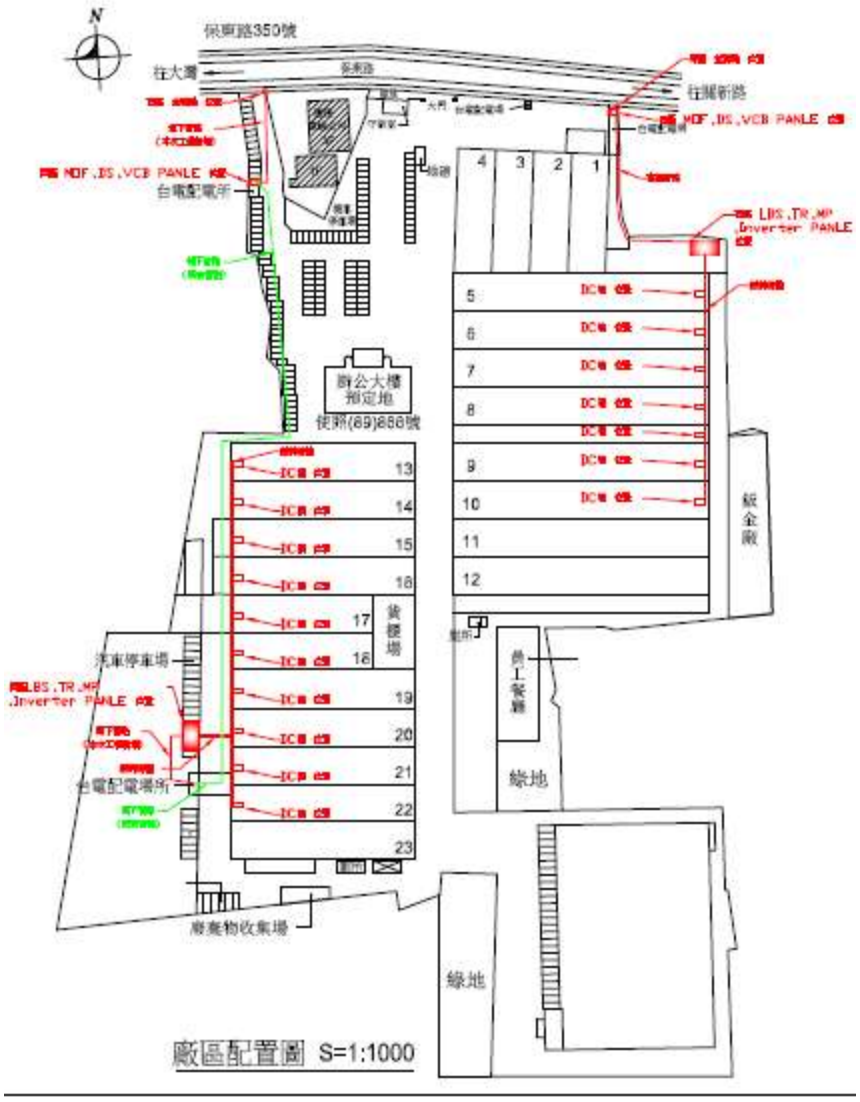
Size: 10MW (AE among multiple suppliers)

Developer: CGN

Integrator: 713

Solaron 500E, SGEG BOS

Taiwan 1MW Roof Top Project



Min temperature: 7℃

Max temperature: 39℃

Altitude: 21M

John Hung, Regional Application & Technical Sales Manager, *IEEE Member*

洪袈瀚

大中華區技術業務經理

+886-919-196868 (Taiwan)
+86-135-85512627(China)

john.hung@aei.com

HQ: 1625 Sharp Point Drive, Fort Collins, CO 80525

www.advancedenergy.com

ADVANCED ENERGY®

NasdaqGM: AEIS

www.aei.com/inverters