



First Solar.

PV Plant Forecasting/Reactive Compensation

Mahesh Morjaria



First Solar.

Reactive Compensation

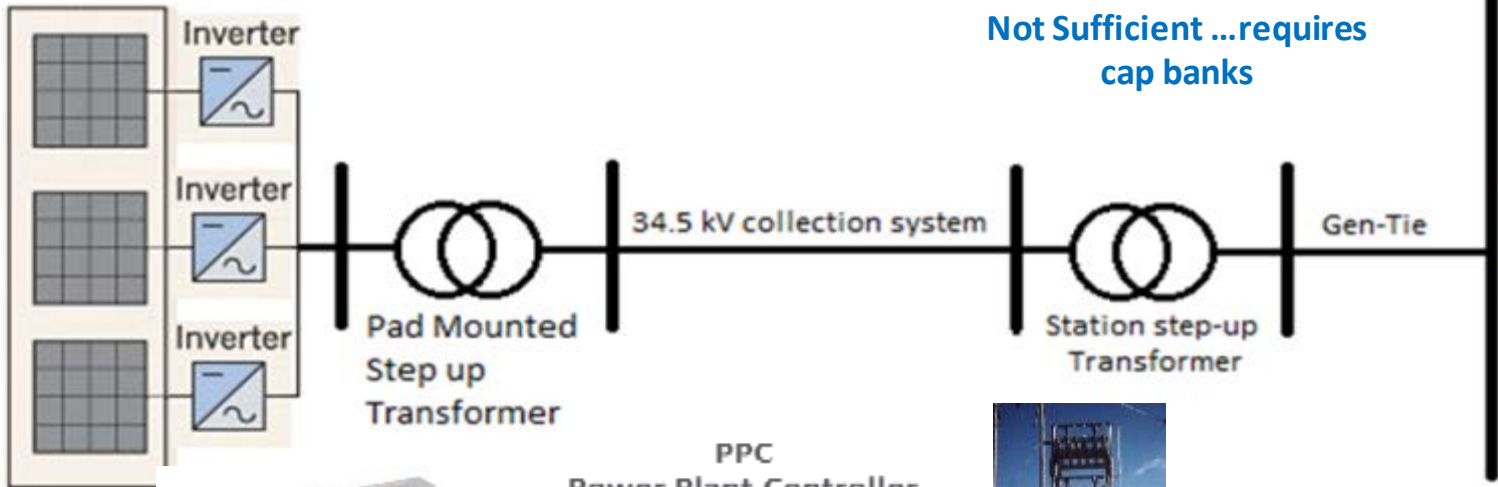
.93 PF

Reactive Losses

.97 PF

Inverters Reactive Power is Not Sufficient ...requires cap banks

Interconnection Requirements +/- .95 PF



PV Array

Inverter
Inverter
Inverter

Pad Mounted Step up Transformer

34.5 kV collection system

Station step-up Transformer

Gen-Tie

POI BUS

Inverters with Wide Range Reactive Power Compensation



+

PPC Power Plant Controller



+

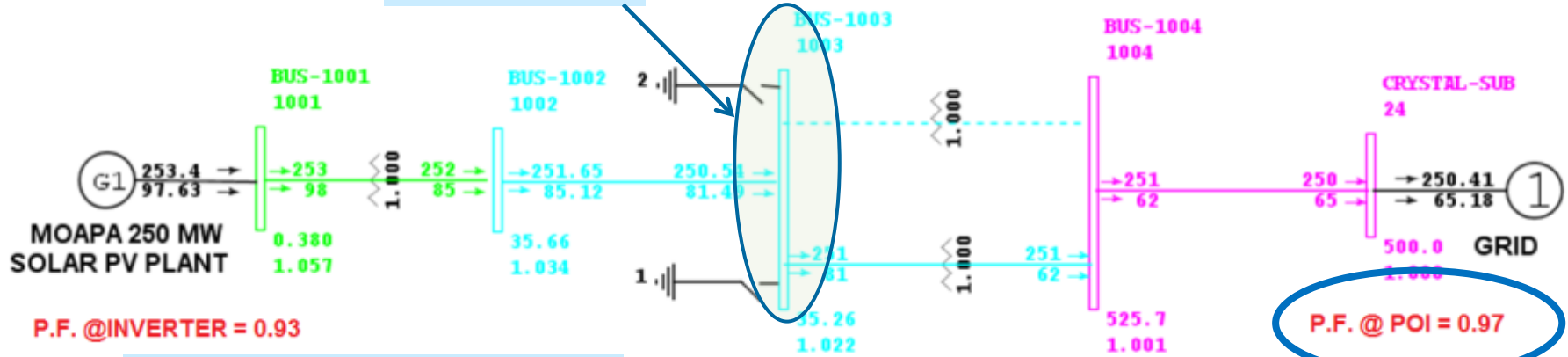


Capacitor Banks

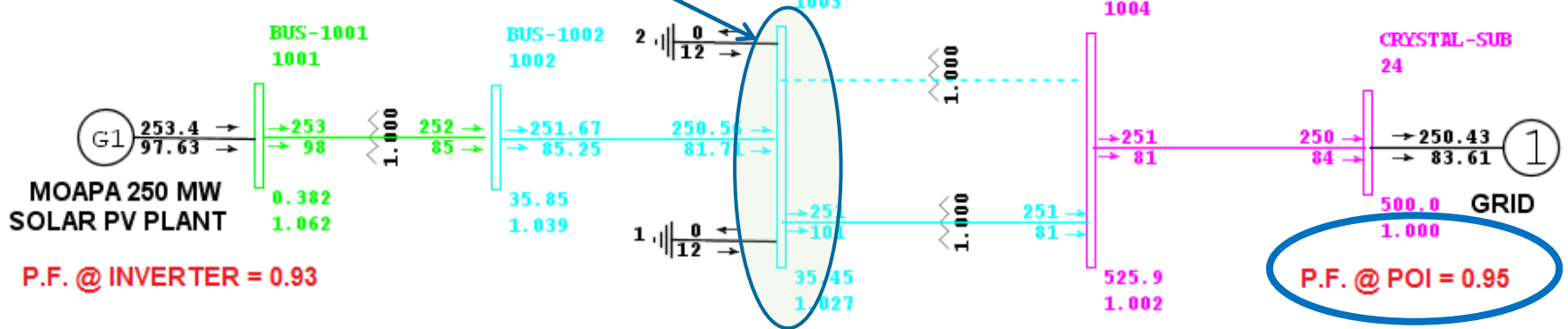
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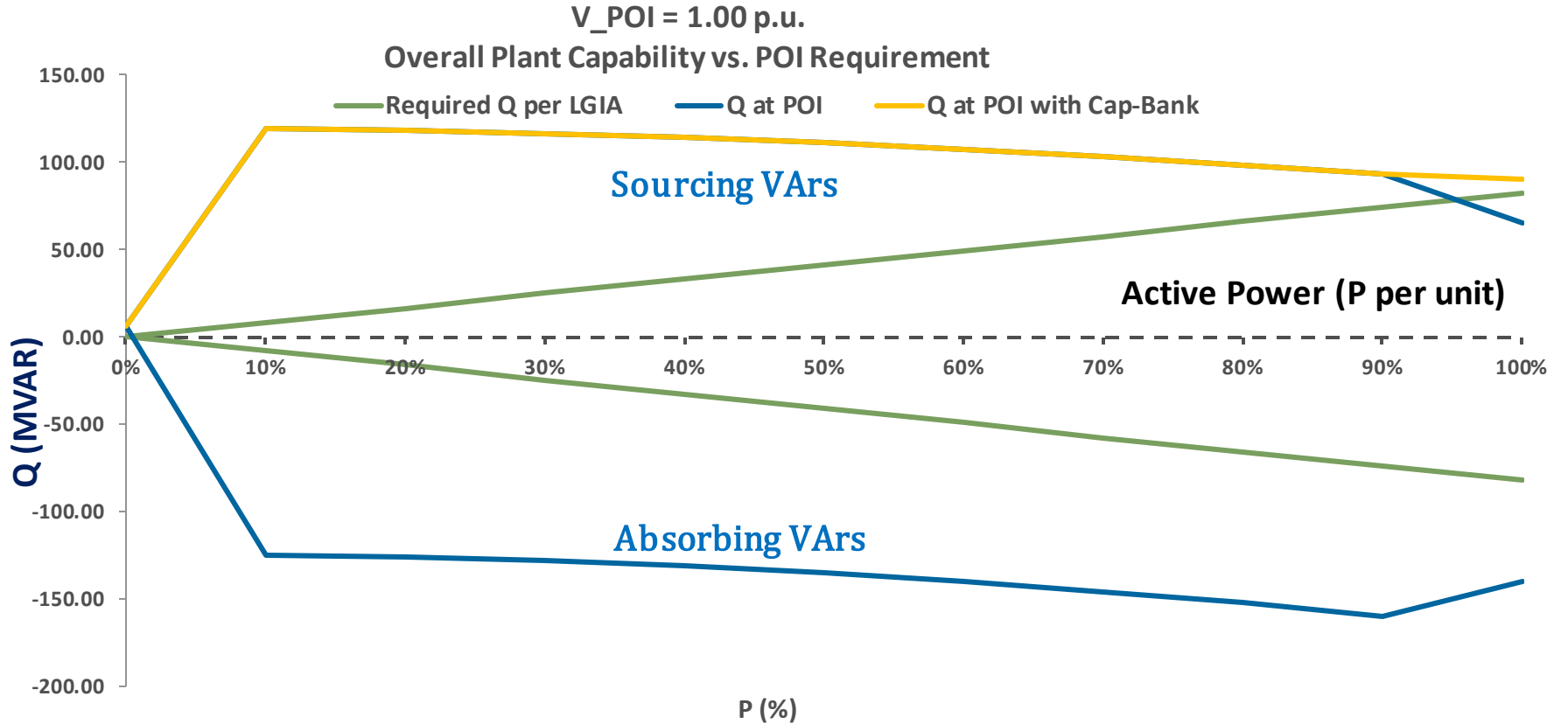
STATCOM Characteristics

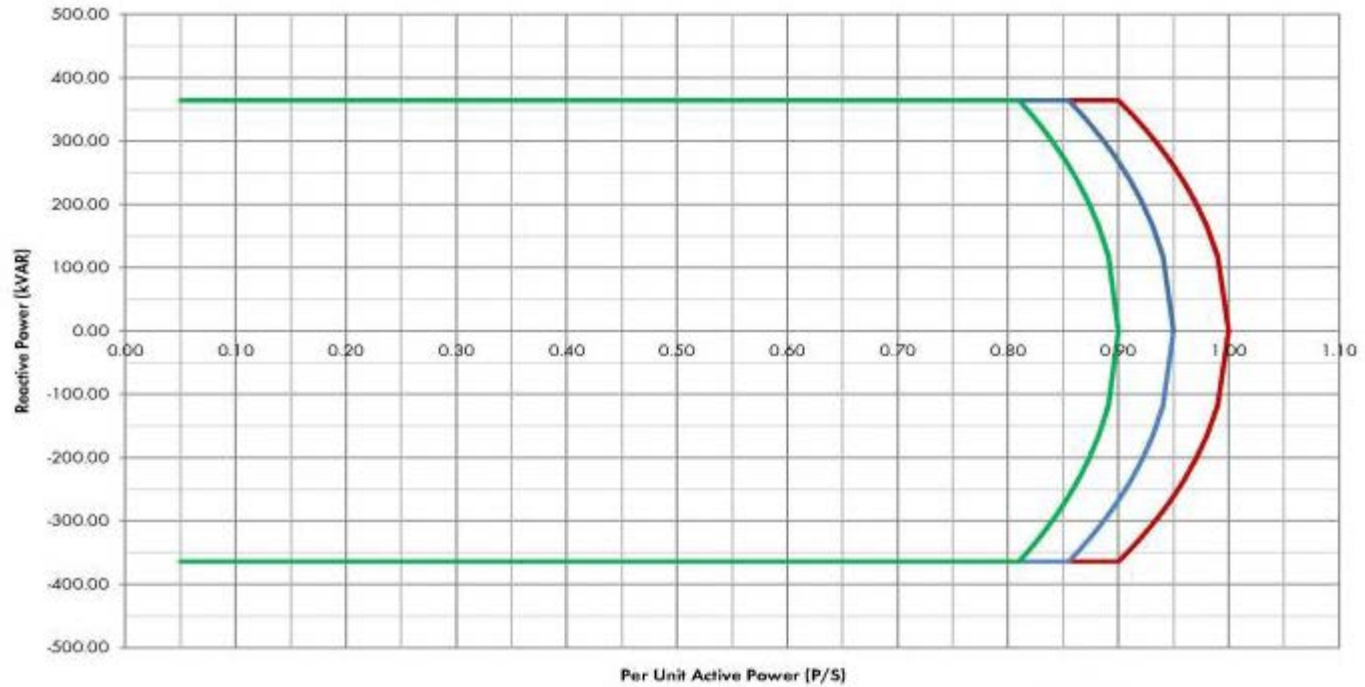
Cap-Banks Offline



12+12 = 24 MVAR Cap-Banks Online







Active power Base: 800kW
 Results @ Temperature: 50°C

— U_n
 — $0.95U_n$
 — $0.9U_n$

- Separate graphical representation

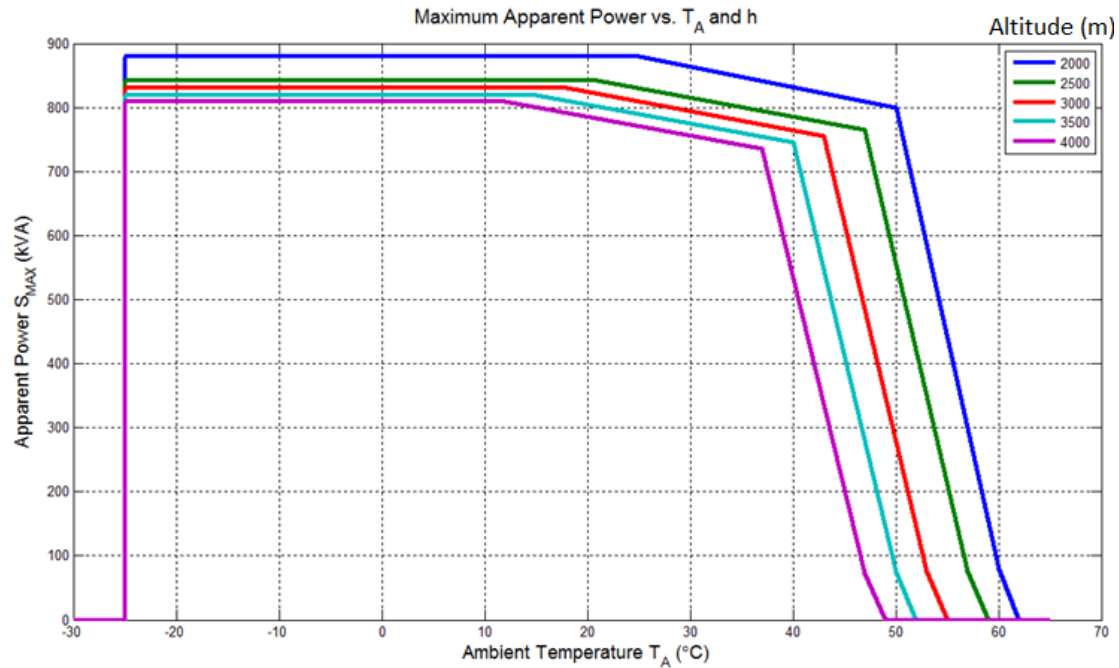
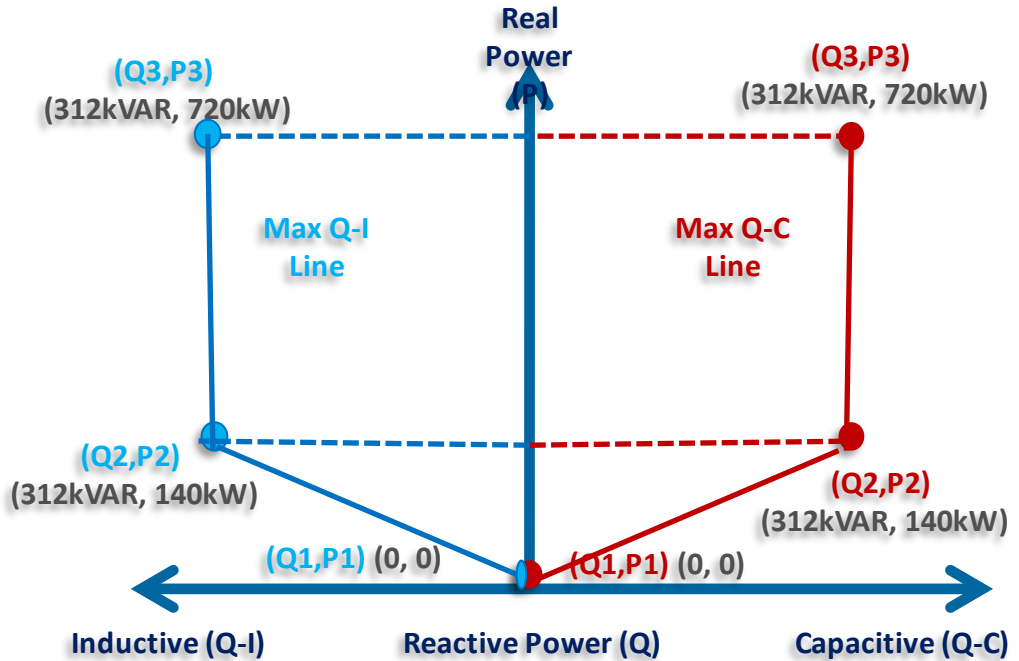


Figure 1: Plots of the maximum apparent power S_{MAX} for the SMA 800CP XT with respect to ambient temperature T_A . S_{MAX} and the derating temperature points decrease with increasing altitude.

- Estimate max available capacitive and inductive VAR based on Current Real Power Output of the Inverter



Inverter VAR Capability Model



105% at 35C

100% at 50C

GE
Power Conversion

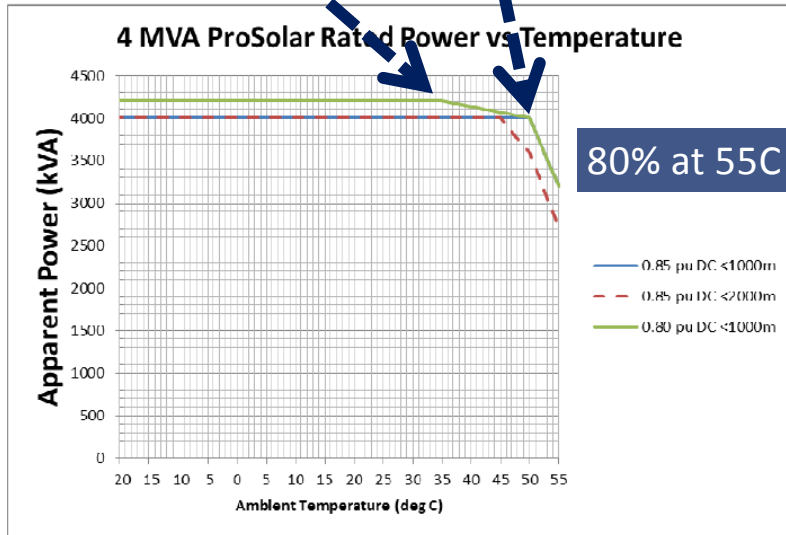
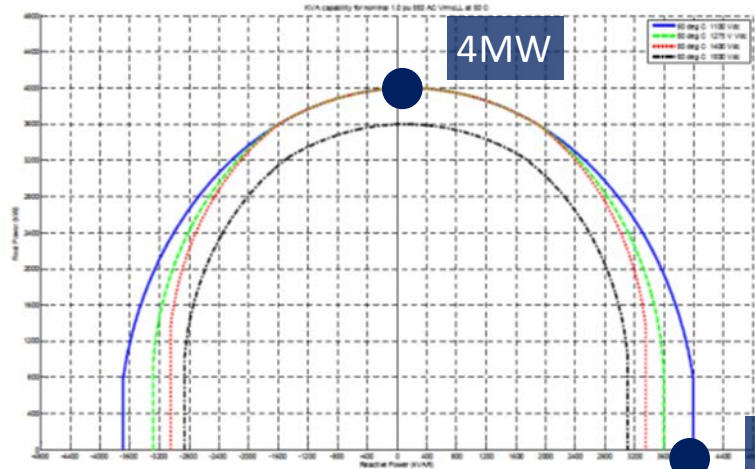


Figure 8: Rated power as a function of temperature for <1000m and <2000m

- ✓ NERC/WECC Voltage & Frequency Ride-thru Compliant
- ✓ BDEW Certified
- ✓ Night VARs
- ✓ Dynamic active/reactive power via SCADA (EtherNet/IP)
- ✓ Active power droop function of frequency

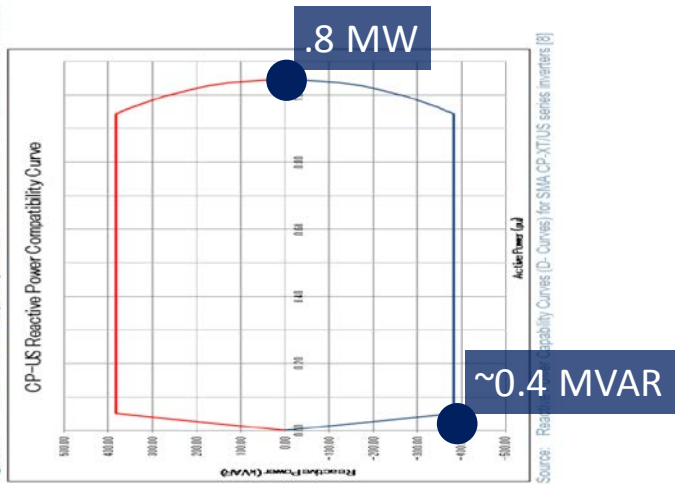
Active Power P->



4.0 MVAR

Active Power P->

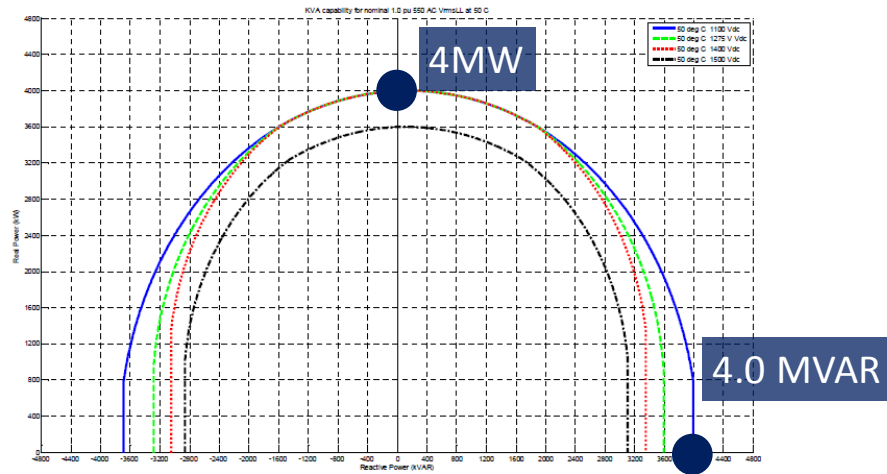
Figure 2-1: Reactive Power Capability Curve for SMA CP-XT series inverter—838.4 kVA



Reactive Power Q



Active Power P->



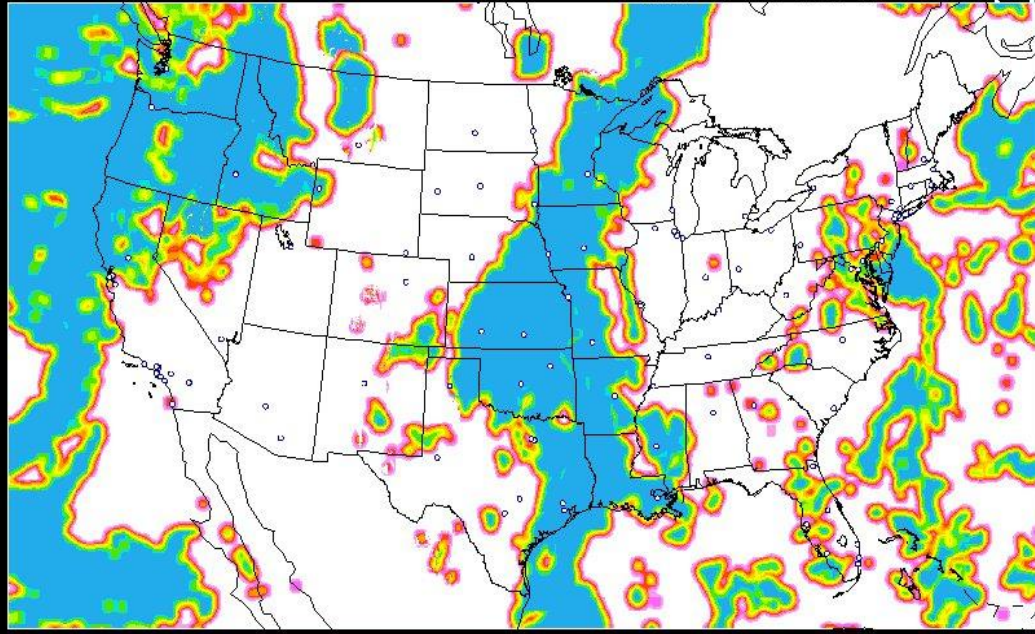
Reactive Power Q



Automated Forecasting Process

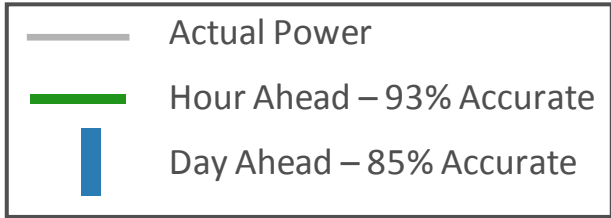
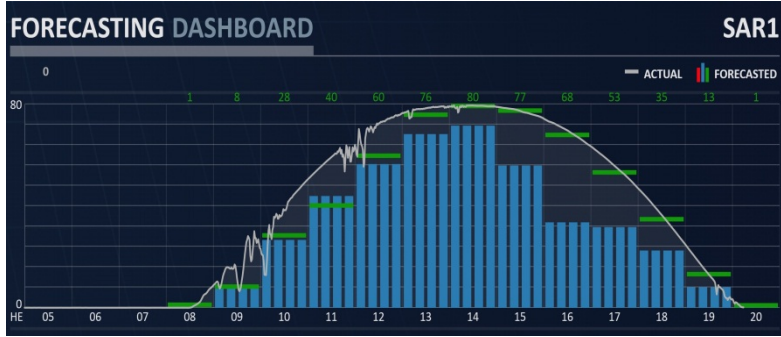
HRRR 03/20/2012 (20:00) 0h fcst - Experimental

Valid 03/20/2012 20:00 UTC
Low-Level Cloud Cover (%)

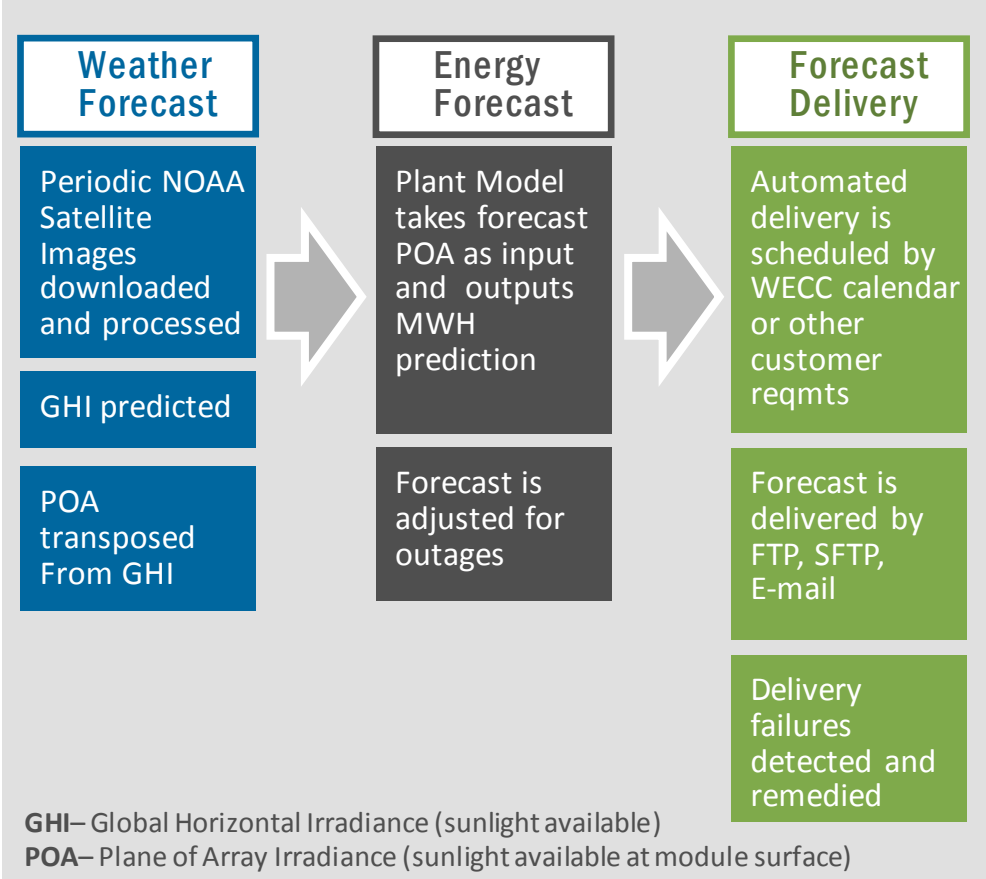


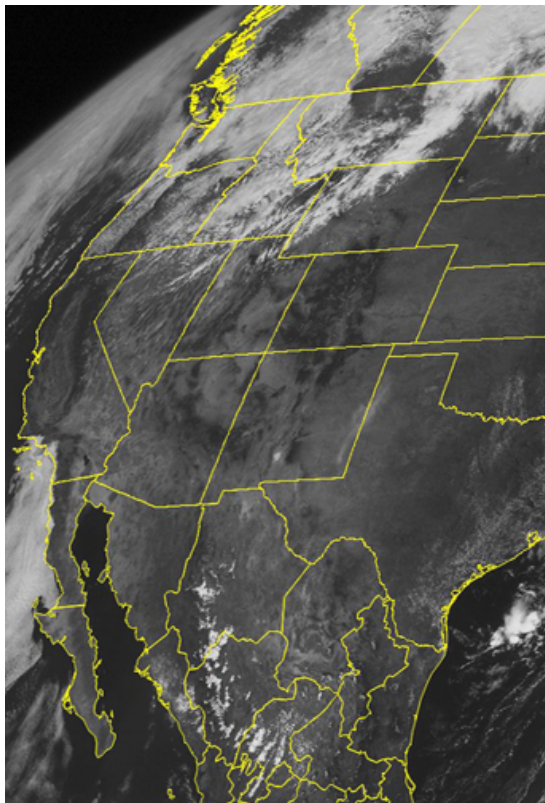
10 20 30 40 50 60 70 80 90 95

- Forecasting is a standard requirement of most new PPA's
- First Solar's fully automated forecasting system delivers accurate energy and availability forecasts for any required schedule
- 11 plants currently being forecast with First Solar's state of the art system



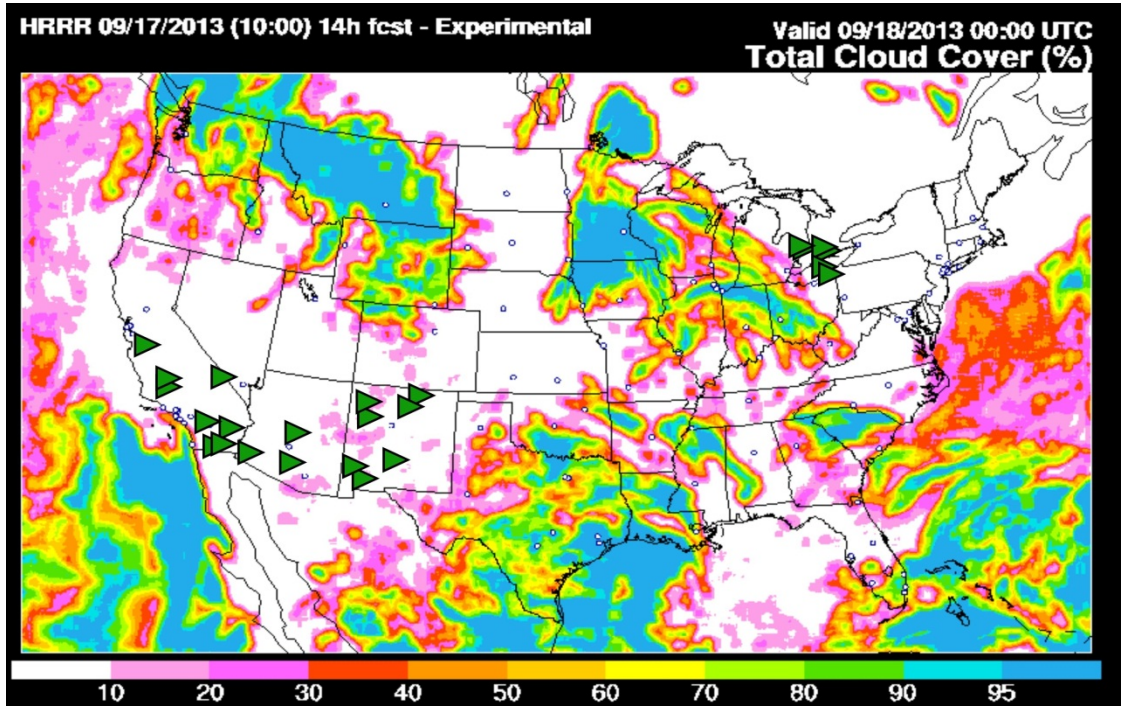
Dashboard





Type	Based on
Yearly	<ul style="list-style-type: none">• Weather predictions and patterns• Planned maintenance outages• Historical data compiled on similar plant performance
Monthly	<ul style="list-style-type: none">• Weather forecasts from satellite metrological data• Scheduled maintenance outages• Experience and expertise on plant performance and compiled data
Daily	<ul style="list-style-type: none">• Actual weather information from satellite and site-based data• Scheduled maintenance outages• Tracking plant performance
Hourly	<ul style="list-style-type: none">• Actual weather information• Actual outages• Actual plant performance

Note: All reports are broken down into hourly segments



Dashboard

- Current Weather
- Redundant indication of irradiance
- 15 Hour look ahead
- CAPE—Convective Available
– Potential Energy
– (Environmental Stability)
- NOAA – National Oceanic and
Atmospheric Administration
- Weather Alerts for 5 mile radius