

Utility-grade PV applications in extreme environments – Focusing the example of desert conditions



Agenda

1

Company

2

News for Israel: transformer compact station + SMA service hub

3

Proven system technology for desert and extreme conditions

SMA is a true growth story – more than 60 % p.a. sales increase in last five years

- > Founded in 1981
- > Sales 2011 EUR 1.7 billion
- > Shares in exports of 53.7 % (Q1-Q2/2012)
- > More than 5,500⁽¹⁾ employees all over the globe
- > Represented in 21 countries on four continents
- > Best efficiency worldwide (99 %)



On-grid



Residential
< 2 kW



Off-grid



Residential
2 kW to 30 kW



Commercial
30 kW to 500 kW



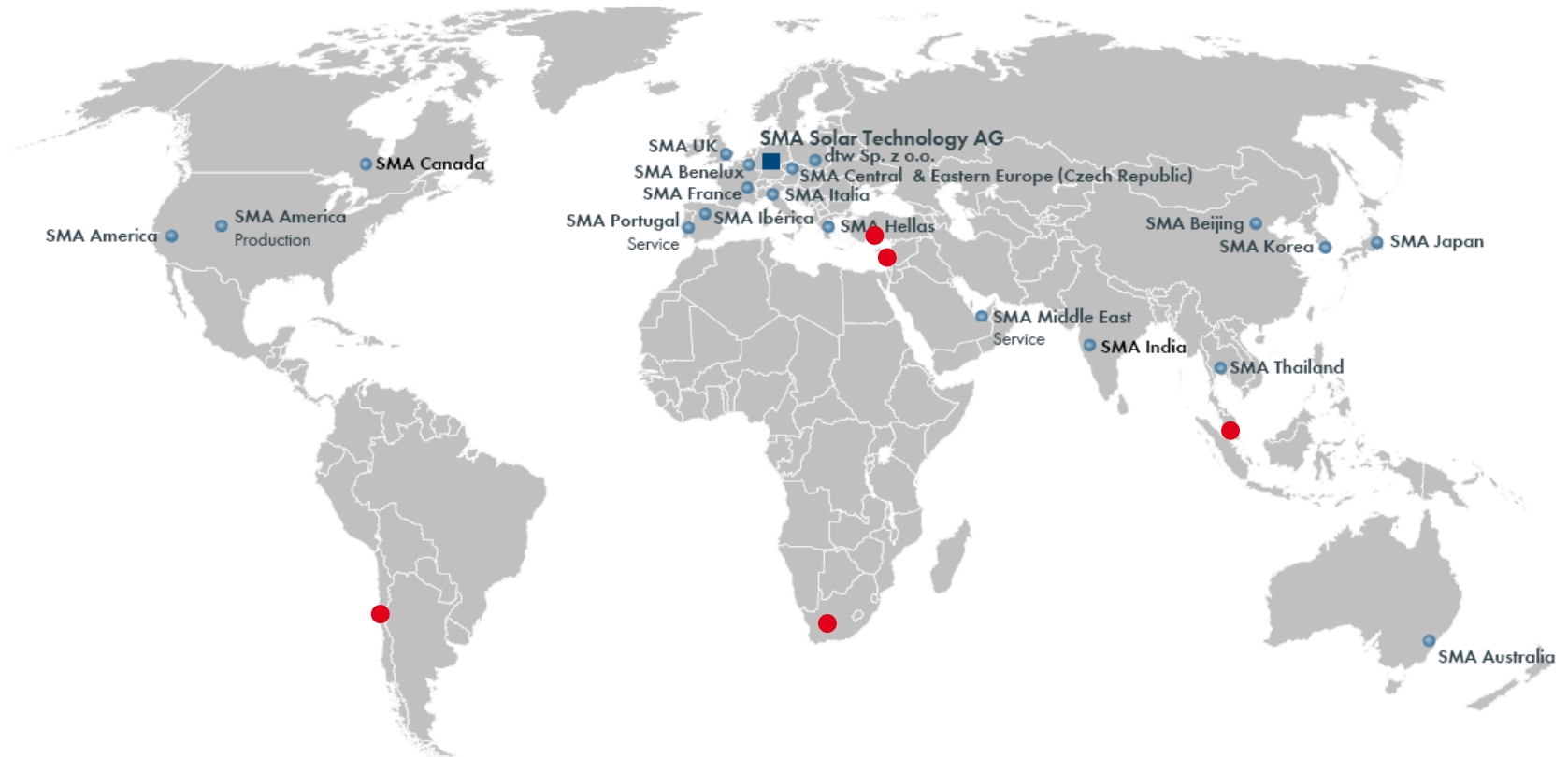
Backup



Industrial
To > 1 MW

> **SMA was again customers' first choice in 2011**

SMA is represented in 19 markets all over the globe



▶▶ In 2011, we achieved over 50% in sales abroad.

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SMA Service Hub for central inverters in Israel



- > Commissioning of the first 3 projects with Sunny Central in Q1 2013 in Israel, total volume 18 MW
- > Project pipeline of large scale projects for SMA in Israel > 80 MW in 2013
- > SMA is market leader for PV inverters in Israel

▶ **SMA offers 100% service and support in Israel**

SMA Service – Sunny Central Service concept for Israel

Custom fit – Security thanks to modular design principle

- > Modular, individually combinable, flexible
- > Long-term, adjustable period
- > Higher availability
- > Amount of self-responsibility vs. SMA support can be selected individually



TCS and transformers ready for Israel



TCS - TRANSFORMER COMPACT STATION

- > Description: Steel Housing, transformer, LV distribution and MV Switchgear
- > Power classes: 800/1600 kVA ready for sales, more coming soon
- > Voltage-level: 6,6 - 24kV others on request
- > Accessories: LV cable set, basement for CP
- > **Operation temperature range: -20 up to 50 °C**



TRANSFORMER

- > Description: stand-alone indoor and outdoor medium voltage transformer
- > Power classes: 800/1600 kVA ready for sales, more coming soon
- > Voltage-levels: from 6,6 kV - 35kV
- > ONAN and KNAN (biodegradable oil) version
- > Vector group: Dy11, Dy11y11, YNd11, YNd11d11
- > **Operation temperature range: -20 up to 50 °C**

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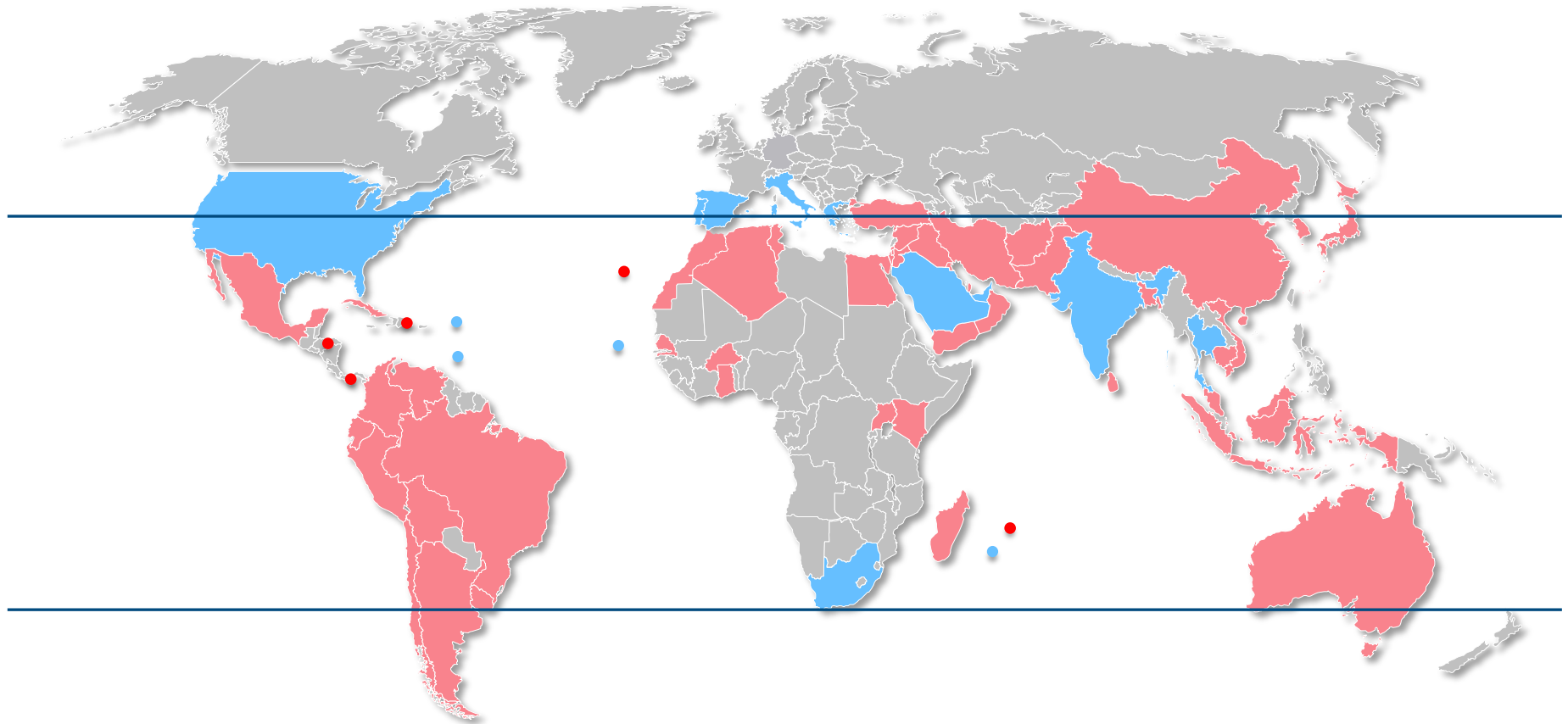
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Proven system technology for desert and extreme conditions

Grid-connected PV plants with SMA inverters in sunbelt regions



- String inverters
- String inverters and central inverters

Project examples



Masdar City (Abu Dhabi)

- > Installed capacity: 10 MWp
- > 16 x Sunny Central 560HE
- > Conditions:
 - > High temperatures ($> 50^{\circ}\text{C}$)
 - > Sand & dust
 - > Salinity in the air



Sal Santiago (Cape Verde Islands)

- > Installed capacity: 5 MWp
- > 6 x Sunny Central 630HE-11; 1 x Sunny Central 500HE-11
- > Conditions:
 - > Chemically-aggressive environment (near the coast)
 - > Salinity in the air and the mist
 - > High humidity

Project examples



Martinique (Caribbean)

- > Installed capacity: 1 MWp
- > 2 x Sunny Central 500CP
- > Conditions:
 - > Tropical climate
 - > Heavy rainfall
 - > High humidity



Wildkogel (Austria)

- > Installed capacity: 1 MWp
- > 89 x Sunny Mini Central 11000
- > Conditions:
 - > Low temperatures (<math><-20^{\circ}\text{C}</math>)
 - > High altitude (2,200m)

▶▶ In addition to the climatic conditions in the earth's sunbelt, the power load in the inverters is also higher due to increased irradiation, the addition of tracking systems or over-dimensioning of the PV array

Project examples SCxxxCP

Location: Hyder, **Arizona, USA**
Inverters: 34 x SC500CP (17.0 MWac)
Maximum temperature = ca. 50 °C

Location: Prescott, Arizona, USA
Inverters: 13 x SC800CP (10.4 MWac)
Maximum temperature = ca. 50 °C

Location: Agua Caliente, Arizona, USA - Phase 1
Inverters: 144 x SC720CP (90 MW)
Maximum temperature = ca. 50 °C

Location: Agua Caliente, Arizona, USA - Phase 2
Inverters: 170 x SC720CP (100 MW)
Maximum temperature = ca. 50 °C

Location: Agua Caliente, Arizona, USA - Phase 3
Inverters: 170 x SC720CP (112 MW)
Maximum temperature = ca. 50 °C

Location: Silver State North, **Nevada, USA**
Inverters: 84 x SC720CP (50 MW)
Maximum temperature = ca. 47 °C

Location: Dover, Delaware, USA
Inverters: 12 x SC800CP + 1 x SC500CP
Maximum temperature = ca. 43 °C

Location: **Baramati (Pune), India**
Inverters: 2 x SC630CP
Maximum temperature = ca. 45 °C

Location: **Rajasthan, India**
Inverters: 8 x SC630CP
Maximum temperature = ca. 50 °C

Location: **Gujarat, India**
Inverters: 16 x SC630CP
Maximum temperature = ca. 50 °C

Location: Dhama, India
Inverters: 5 x SC630CP + 2 x 720CP
Maximum temperature = ca. 45 °C

Location: Rajasthan, India
Inverters: 6 x SC800CP
Maximum temperature = ca. 50 °C

Location: **Sicily, Italy**
Inverters: 11 x SC800CP
Maximum temperature = ca. 45 °C

Location: Ginosa Tarent, Italy
Inverters: 11 x SC800CP
Maximum temperature = ca. 43 °C

Location: Foggia, Italy
Inverters: 6 x SC630CP
Maximum temperature = 43 °C

Location: **Belize, Guadeloupe**
Inverters: 8,3 MW with SCxxxCP
Maximum temperature = ca. 40 °C

Location: BIS St. Rose, Guadeloupe
Inverters: 1 MW with SCxxxCP
Maximum temperature = ca. 40 °C

Location: **Thailand**
Inverters: 16 x SC800CP
Maximum temperature = ca. 40 °C

Demanding stress tests ensure reliability under all conditions

- > Walk-in climate chamber is a must for reliable technology testing
 - > Inverters are tested to the limits of their operational capabilities at temperatures ranging from $-40\text{ }^{\circ}\text{C}$ to $+90\text{ }^{\circ}\text{C}$
 - > The chamber can also create relative humidity of between 10% and 90%.
 - > Endurance tests of up to 1,000 hours
- ▶▶ Climate chamber test shows: Highest reliability in extreme climate conditions



To assure reliability test far beyond the required norms are indispensable

Sand & dust test



- > Accordance with IEC norms
- > Wind speeds up to 20 m/s and with desert like particles

- ▶▶ Result: desert-proof
No harmful amounts of dust in inverter cabinet

Seismic qualification test



- > Accordance with global norms
- > Tests at 1.5g, simulating earthquake of 8.5 on Richter scale

- ▶▶ Result: no damages detected
Withstand rough transportation and handling

Electromagnetic compatibility

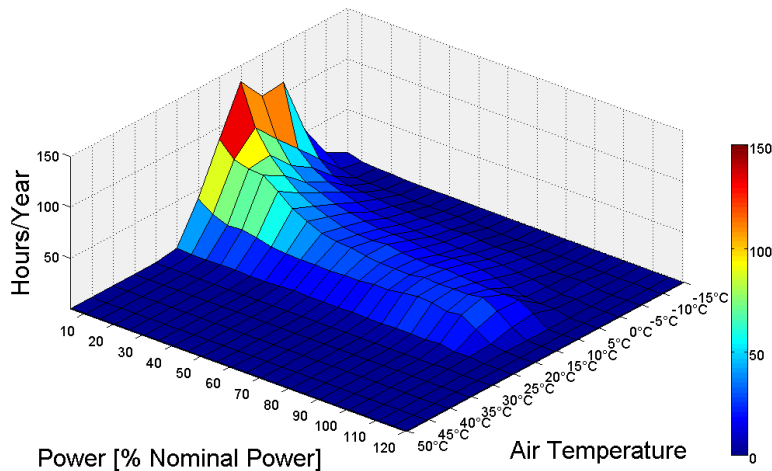


- > Accordance with IEC norms
- > Electro magnetic compatibility and emissions

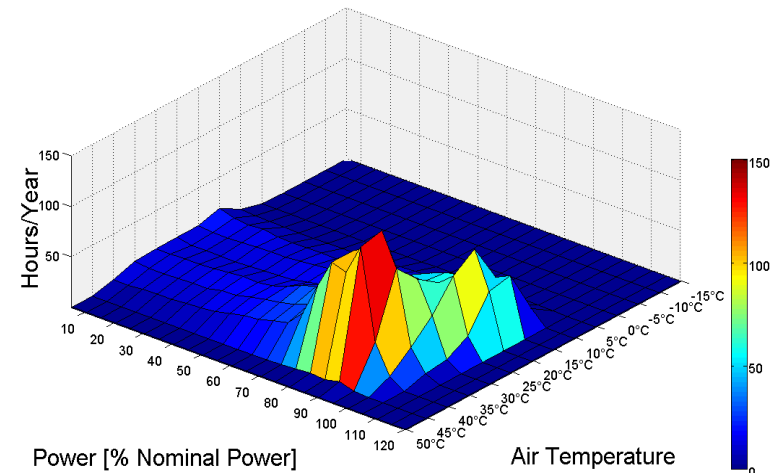
- ▶▶ Result: normative requirements fulfilled
Even more stringent SMA requirements fulfilled

The first Step: Inverter load profiles differ in each region

Typical load profile in
Munich - Germany
(fixed tilt system)



Possible load profile in
Israel
(dual-axis tracking system)

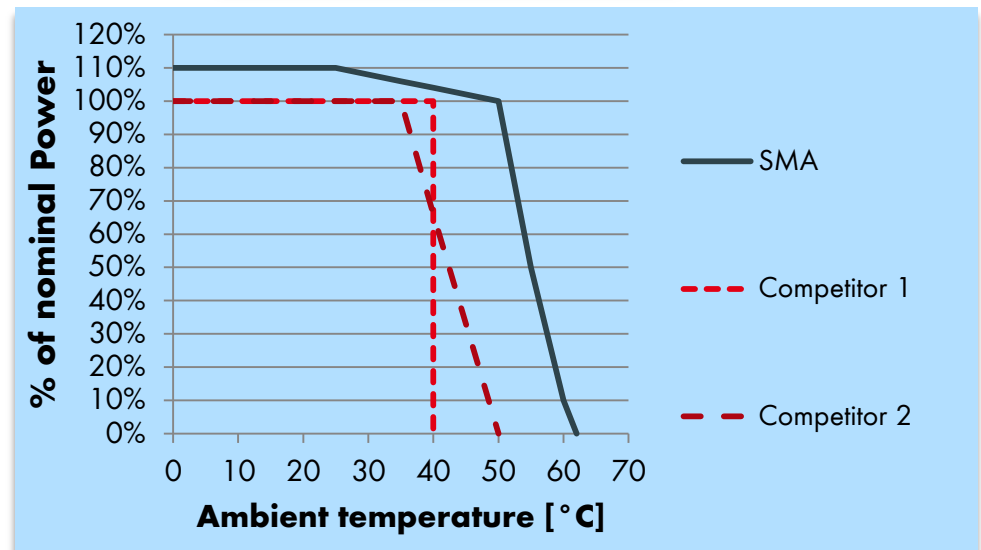
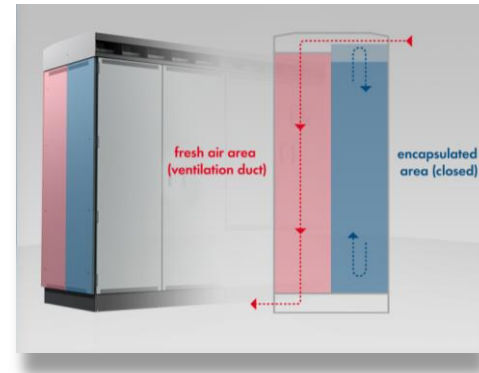


Requirements:

- ▶▶ Inverter frequently operates at upper load limit
- ▶▶ This, combined with high temperatures, causes electrical components to wear faster
- ▶▶ "Real" Solar inverters are required; those made specifically for solar applications

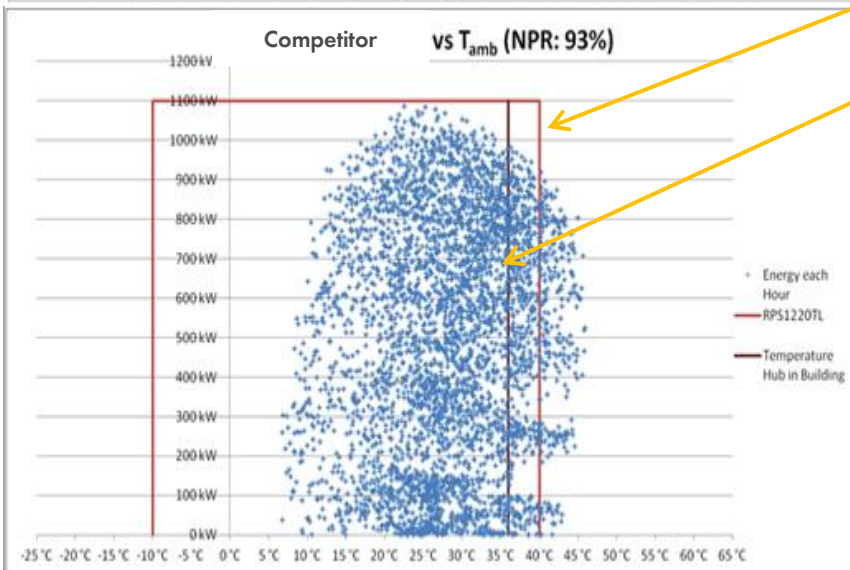
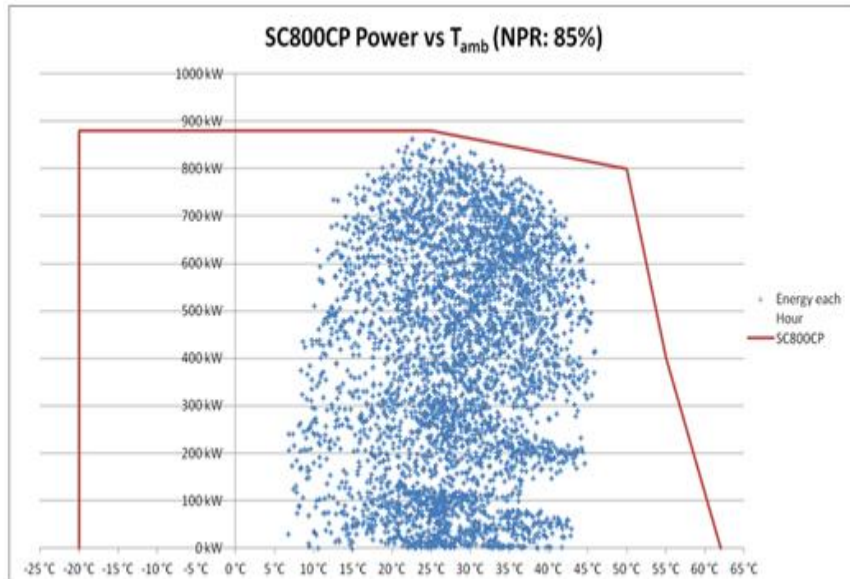
Cooling concept

- > Full power up to 50°C ambient temperature, only possible with heat exchanger
- > Our research sees a clear advantage on air cooling
 - > + Serviceability
 - > + less material cost
 - > + less life cycle cost
 - > + robust design



- ▶▶ Cooling of the power electronics is not critical; cooling of the interior components is more important

Temperature Degradation



Situation:

Competitor Inverters show comparable efficiency and self consumption values.

Very important:

COMPARE TEMPERATURE DEGRADATION

What to do:

To map the temperature / watt coordinate for each load-hour of the year (4000).

To analyze the degradation at ambient temperature 40 °C.

As the inverter is enclosed – degradation will start even earlier (we assume at 36C) -> 20% loss over 1 year

Competitors will certainly argue the use of a cooling system, but:

- Additional Investment Costs
- Additional operational costs (cleaning / spare parts)
- Additional selfconsumption
- Additional risk of failure

The new Sunny Central CP XT – eXTended Power

Sunny Central - AC output range (kVA)



**Inverter without
transformer**

**MV application
with
1 inverter**

**MV application
with
2 inverters**



From 500 kVA
to 1800 kVA

SMA has the global utility-grade experience

- > **Strong global presence** and first mover strategy
- > **Over 6 GW Sunny Central** capacity installed worldwide
- > More than **800 large-scale projects** in over **30 countries in 2010** alone
- > **Highly bankable** with a solid balance sheet



- ▶ Our business is global – wherever our customers plan projects, we support you with | | local expertise



SOLAR TECHNOLOGY