PV Inverter Technology for the new markets and challenges

I. Muñiz | SMA Solar Technology AG | 15.5.2012

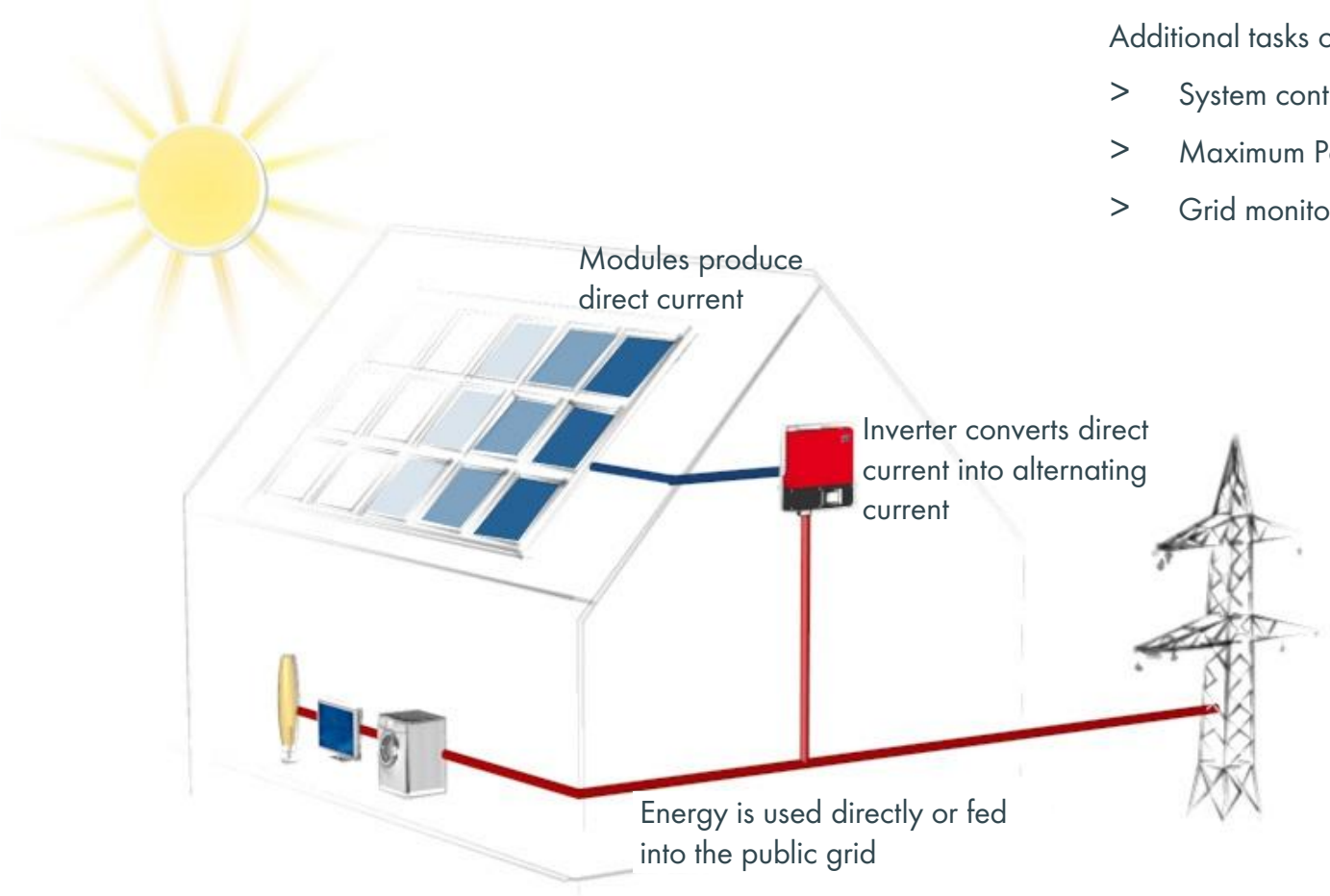
SMA solar inverters are the heart and brain of every PV system

Additional tasks of the inverter:

> System control and monitoring

> Maximum Power Point (MPP)-Tracking

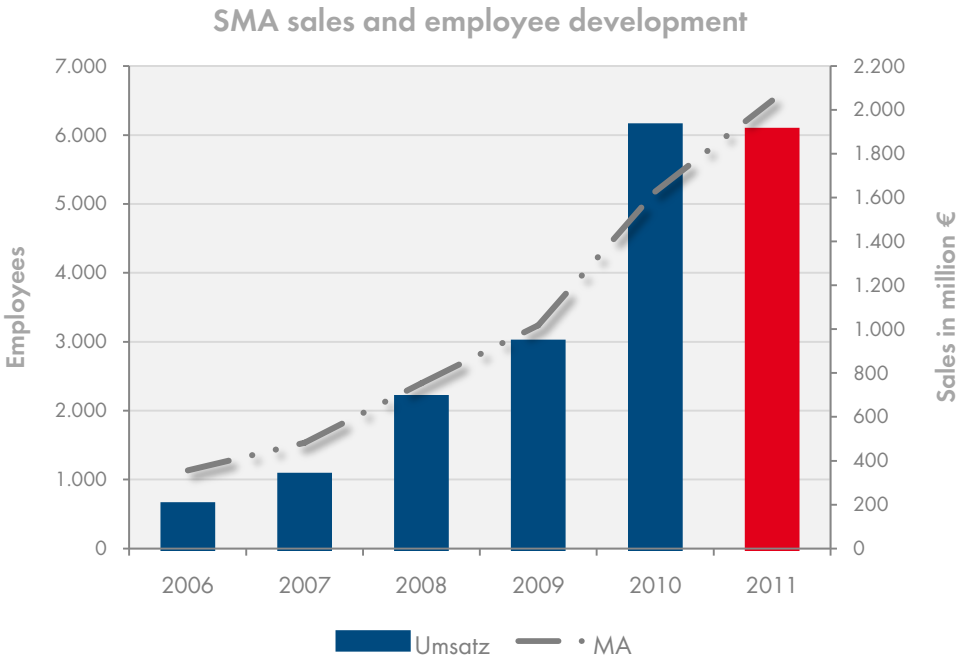
> Grid monitoring and services



The PV system produces energy at the point of consumption; therefore, energy management is of great importance.

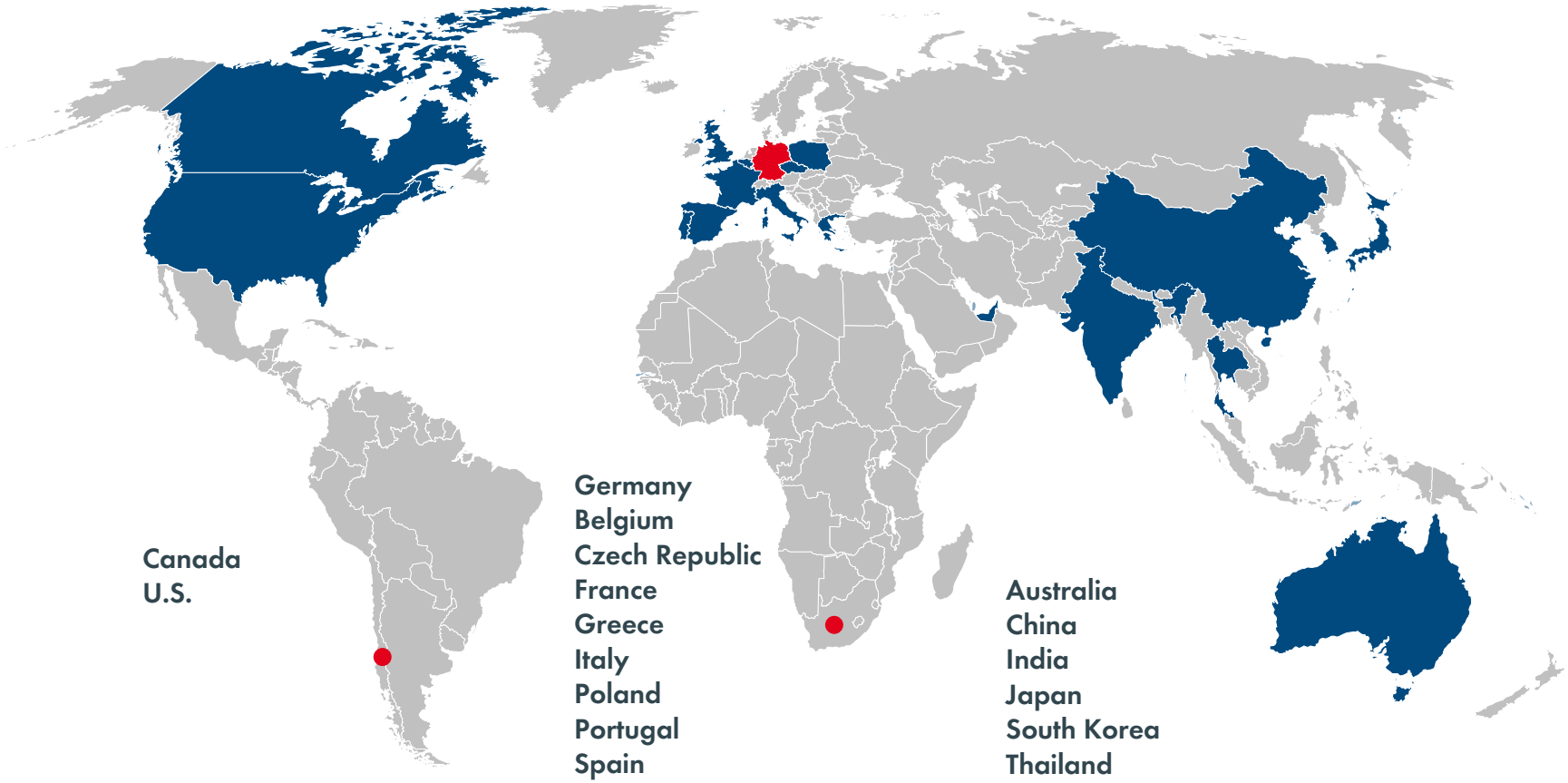
SMA is a true growth story – more than 60% p.a. sales increase in last five years

- Founded in 1981
- Sales 2011 EUR 1.7 billion
- Shares in exports of 56.3% (HY1/2011)
- More than 5,000 employees all over the globe
- 20 foreign subsidiaries in 19 countries on four continents
- Best efficiency worldwide (99%)



SMA was customers' first choice in 2011

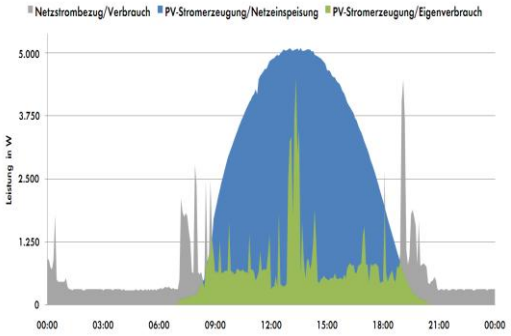
SMA is represented in 19 countries all over the globe



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

The challenges for the PV inverter technology

Hybrid Systems



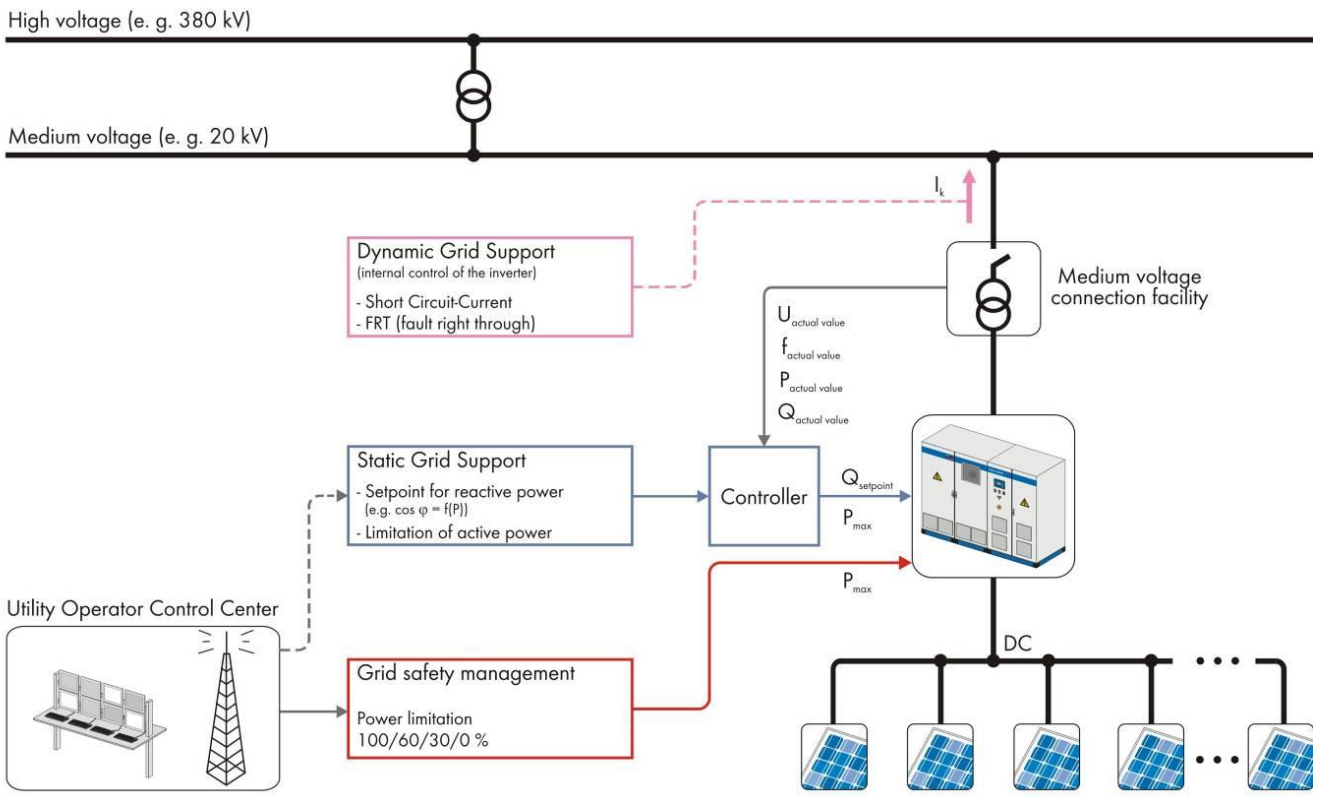
Storagemanagement

Grid and Energymanagement

CONCLUSION: The inverter changes from a power electronic device to a system manager.

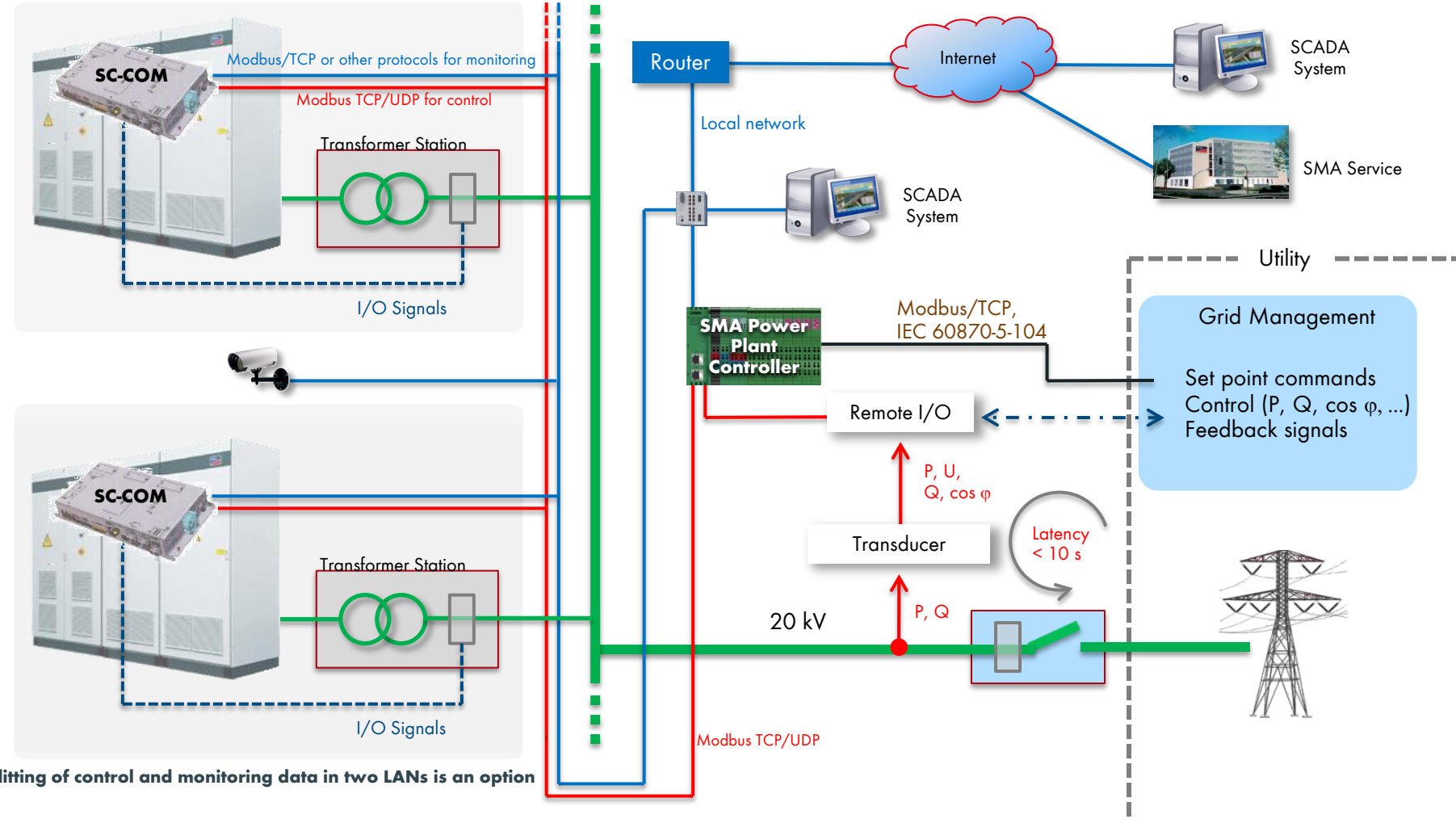
PV system as contributor to the Grid Management

Simplified illustration of grid control using PV plants (medium-voltage grid)



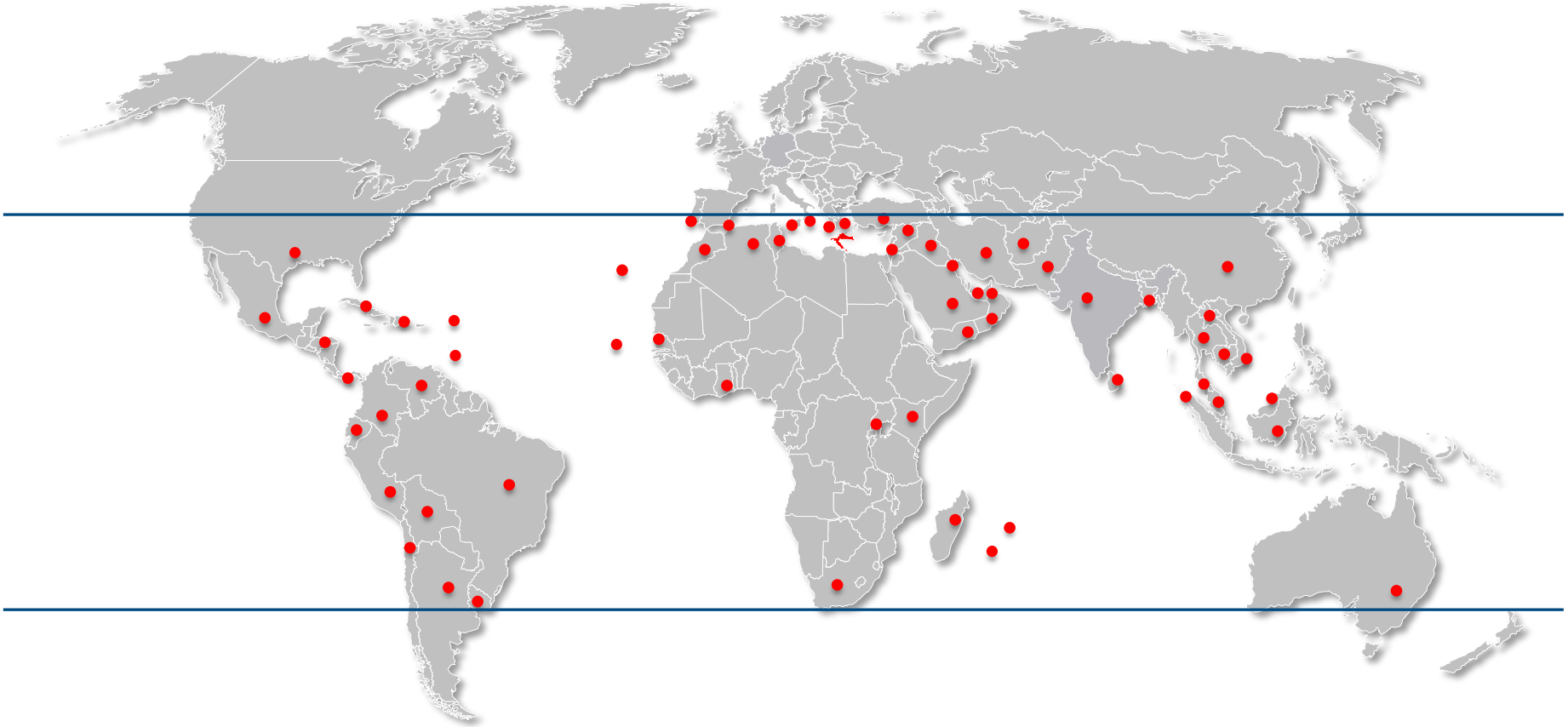
Source: Erzeugungsanlagen am Mittelspannungsnetz. BDEW, Release June 2008

Control and Monitoring System with SMA for an utility-grade PV plant



Splitting of control and monitoring data in two LANs is an option

PV plants with SMA inverters in sunbelt regions



Utility Grade PV-plants examples

Masdar City (Abu Dhabi)

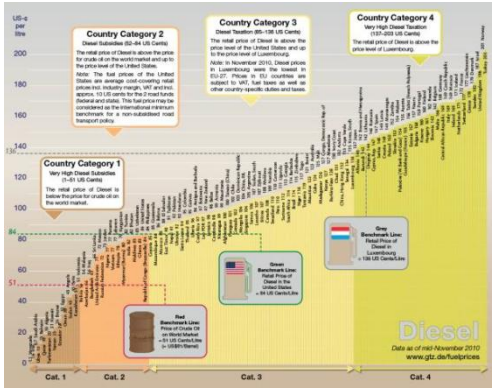
> Installed capacity: 10 MWp
> 16 x Sunny Central 560HE
> Conditions:
    > High temperatures (> 50°C)
    > Sand & dust
    > Salinity in the air

Sal Santiago (Cape Verde Islands)

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

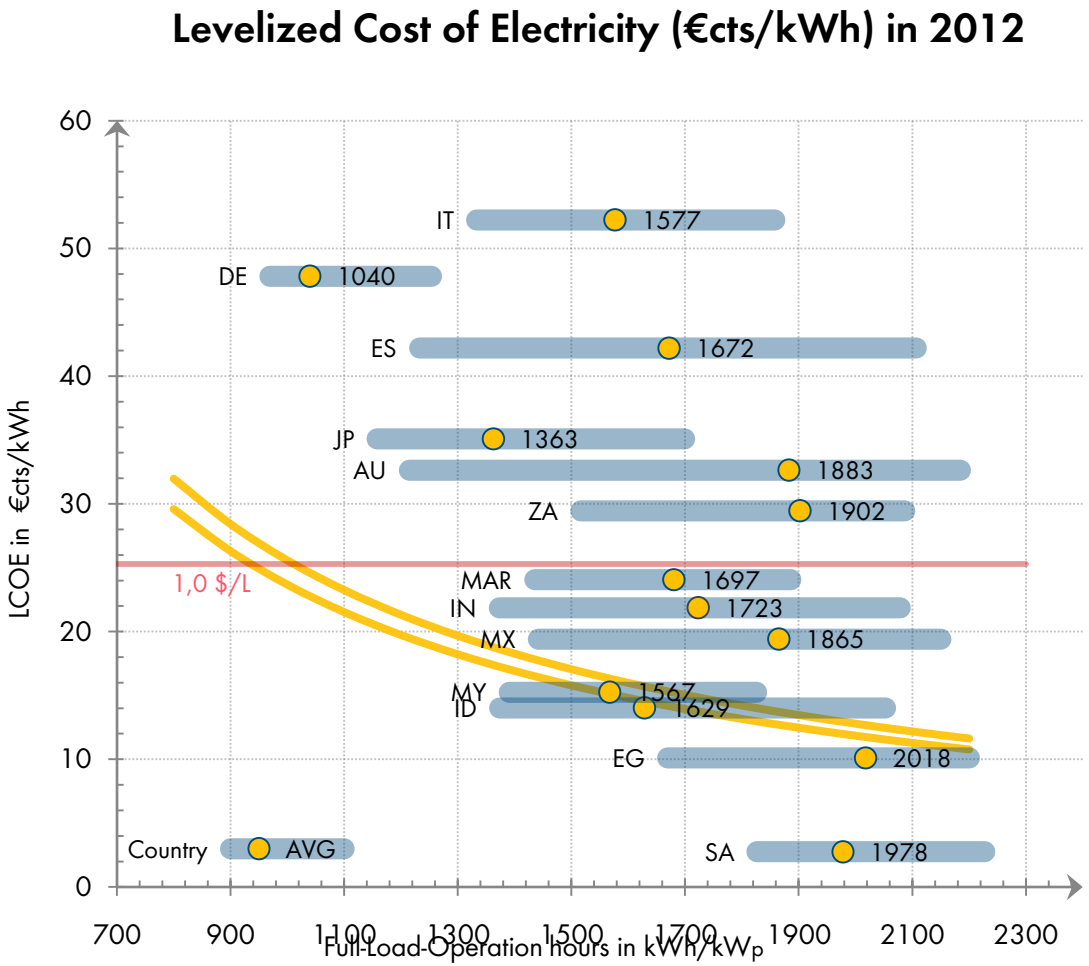
World Off-Grid Markets – Based on Figures From 2010

- Average market growth: approx. 10-20 %
- **BUT:**
  - Approx. 39 GW of new diesel gensets and 33 GW of new gas turbines ordered every year!*
  - Only in the US, approx. 125 GW of diesel gensets installed today**
  - PV prices decreased significantly in 2010 and even more in 2011
  - Grid Parity only a question of diesel price!
- **Conclusion:** Renewable off-grid power supply will be one of the dominating future PV markets.



* The Marine and Stationary Authority, 32nd Power Generation Order Survey, 2011
** REPP (Renewable Energy Policy Project) Report „BLENDING WIND AND SOLAR INTO THE DIESEL GENERATOR MARKET", Winter 2001

PV is today cost effective



Cost of Diesel Energy

> Most countries in the sunbelt region reach costs of PV energy well below the diesel costs

PV CapEx: 2,5-2,7€/Wp (>1MW), PV OpEx: 1,5% p.a., Degradation: 0,4% p.a., PR: 0,85, Diesel CapEx: 0,3€/W (>1MW), O&M: (3%+1% p.a.) p.a., Lifetime: 12 years, 6,4% interest rate, Fuel consumption: 0,275L/kWh, Specified period: 25 years, 1,35$/€, Diesel price data from GTZ & TheAA

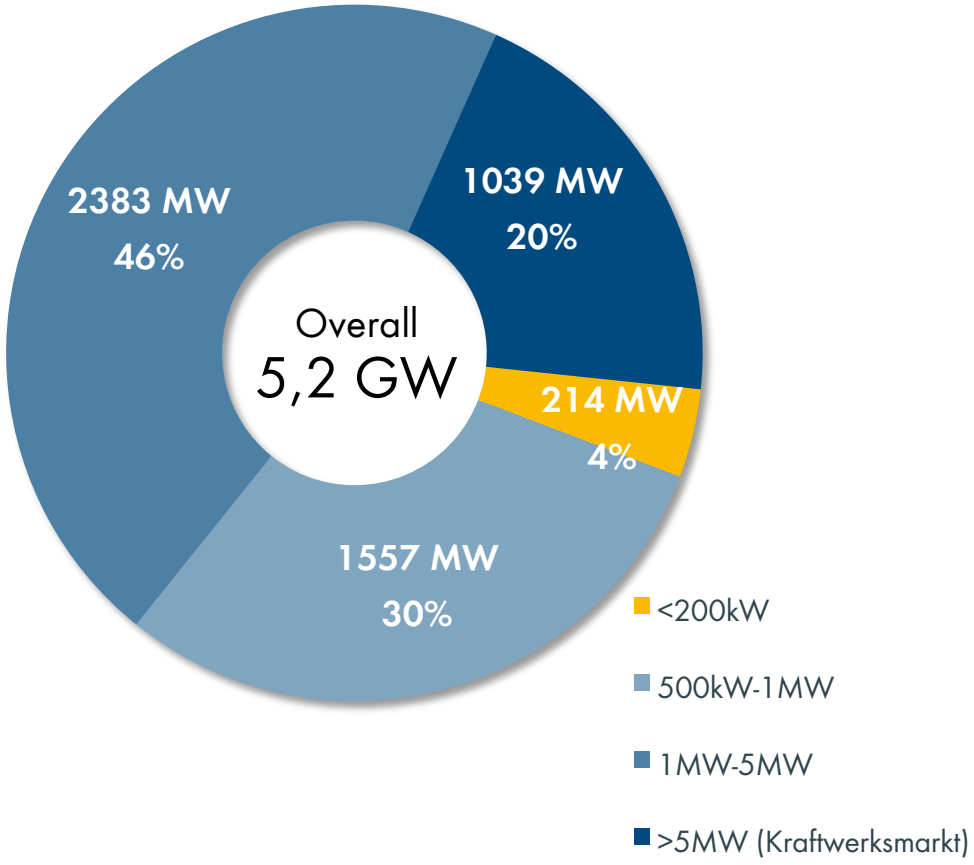
Indirect Market Assessment (New Installations)

> In 2010 Diesel generators for continuous operation summing an installed capacity of 18 GW commisioned.

> An Analysis of the IEA assess that 27% of the new installed power until 2020 will be in form of minigrids (off-grid)

BUT

> Only in India there are currently 58GW Diesel-gensets operating 24/7*



*Source: Dialogue with customer

Diesel and Large-Scale Stand-Alone Grids: One of the Most Significant Future PV Markets

Fuel saver

- Diesel-PV-hybrid systems
- Standard PV inverter

Fuel saver+

- Diesel–PV-hybrid systems
- Standard PV inverter
- Battery inverter (non autonomous)

Netzgekoppelte Batterie-WR

Diesel-dominated stand-alone Grid

- Diesel + PV + wind
- Standard PV inv.
- Battery inverter (voltage controlled)
- Diesel generator as system manager

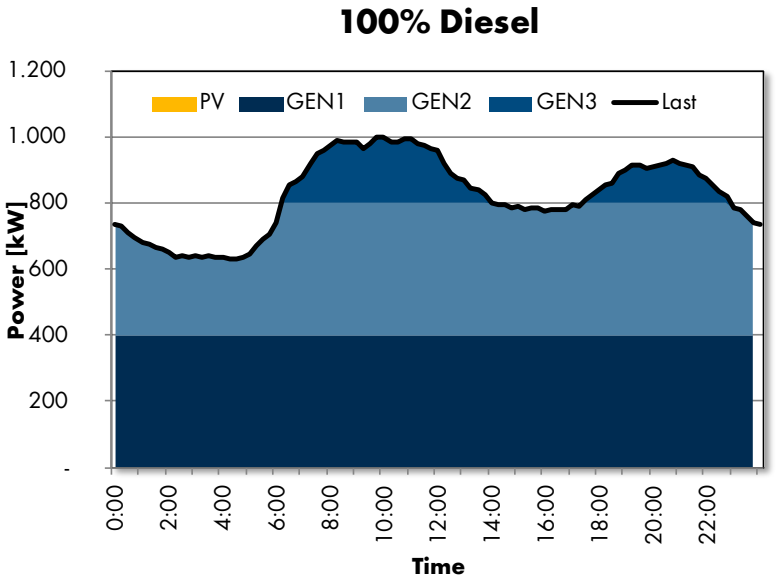
Inverter-dominated Stand-alone Grid

- Diesel + PV + wind
- Standard PV inverter
- Battery inverter (voltage controlled)
- Battery inverter as system manager

Example of a diesel-based island system (Fuel Saver)

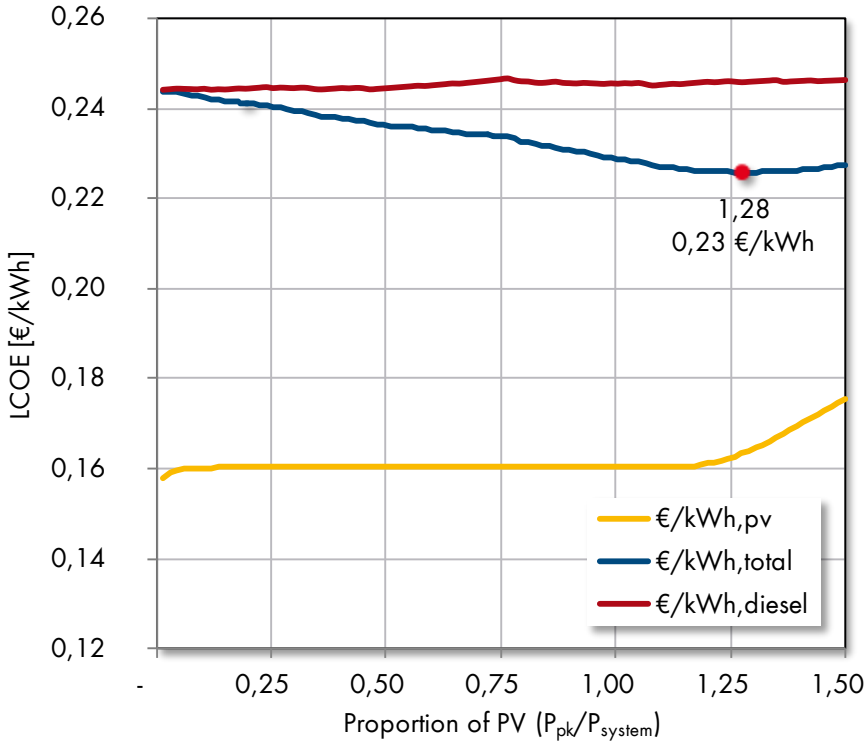
> Island System

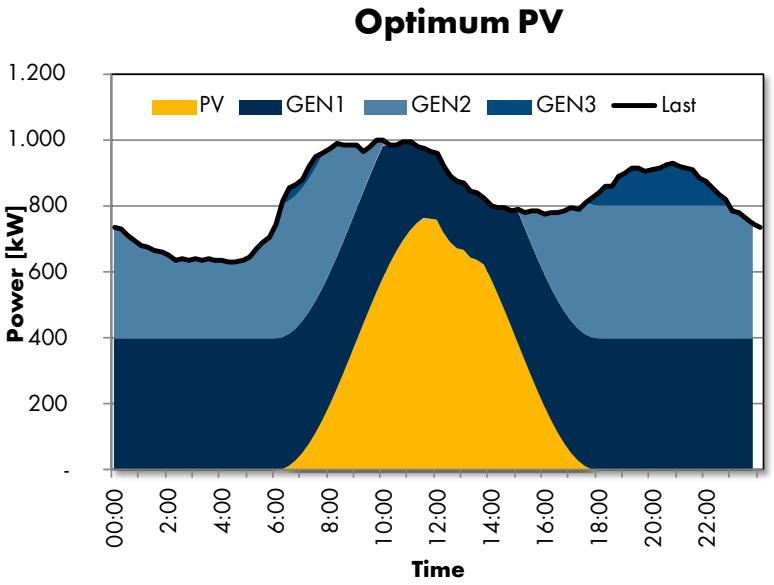
- Peak power: 1000 kW
- 3 x 400 kW Diesel
- Irradiation: 1998 kWh/m²·a
- Location: Antalya(Average sunbelt country)
- Diesel Retail Price (est. Dec 2011): 1,30 $/L



Example of a diesel-based island system (Fuel Saver)

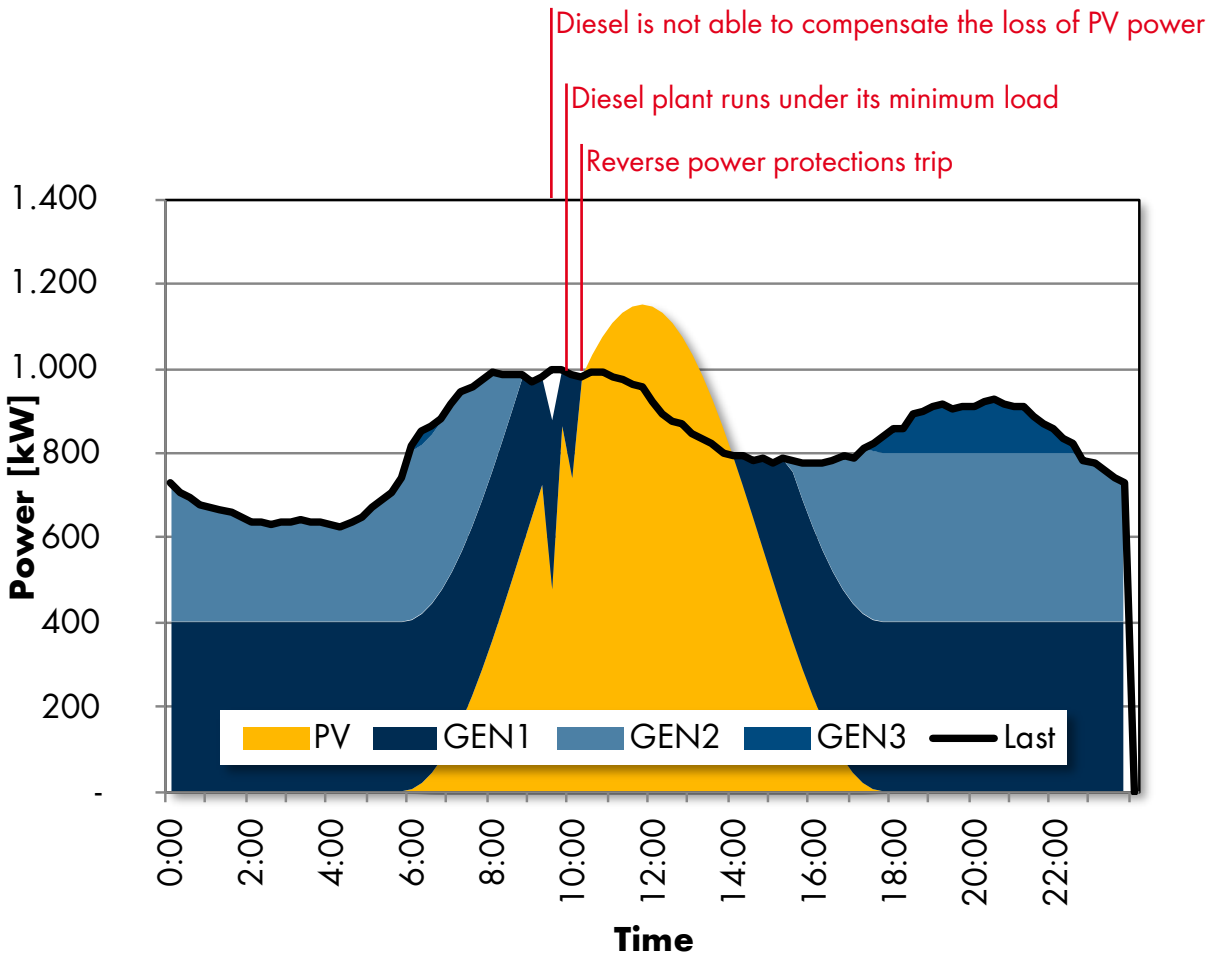
> Pure PV integration (no batteries) is able to reduce costs but bring a couple of challenges when it exceeds a certain penetration level.





Assumptions
Diesel price of 130 US ct/L disregarding Maintenance costs
LCOE for PV based on study from the EPIA for the Sunbelt countries

The main challenge: Grid and Energy Management



Challenges

- The first problem in the integration of PV in the grid is the management of overproduction.

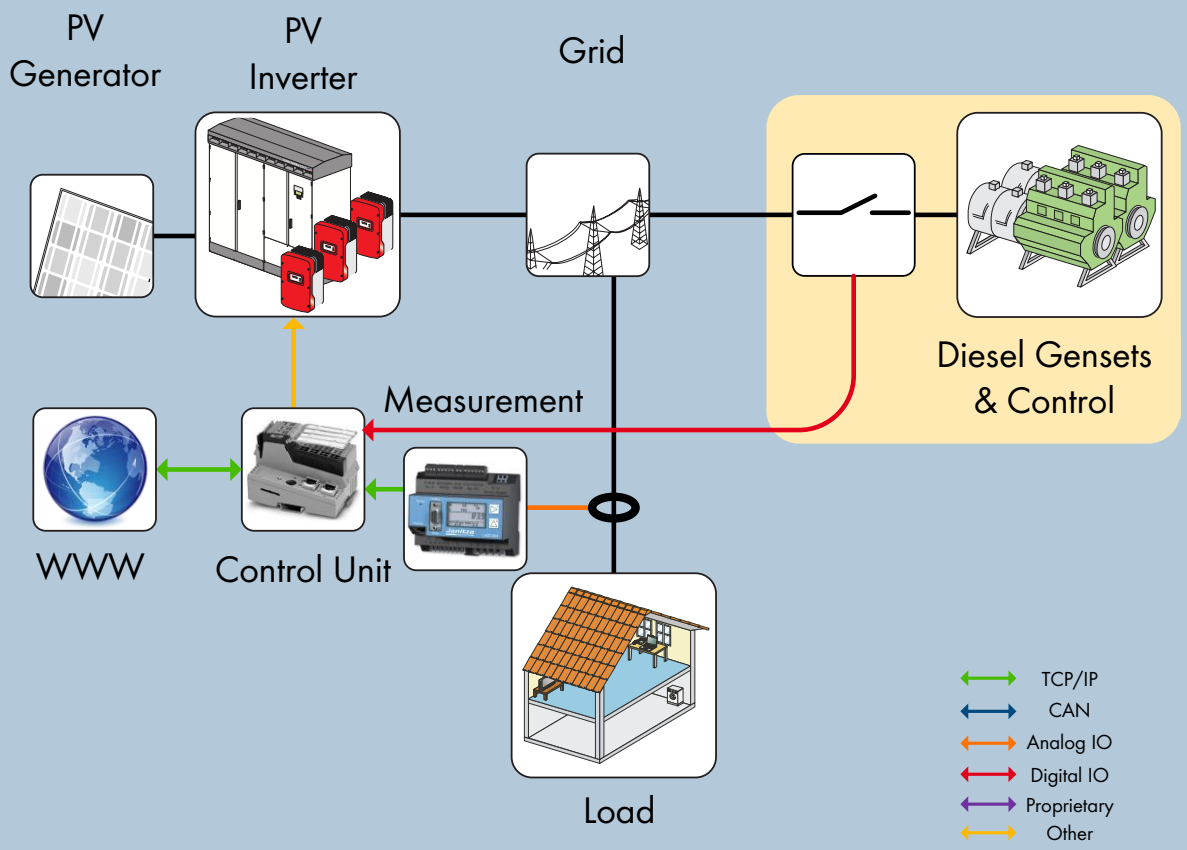
- The second challenge is the grid management to compensate for large steps in the irradiation (spinning reserve).

SMA Solutions for PV-Diesel Systems (Without Storage)

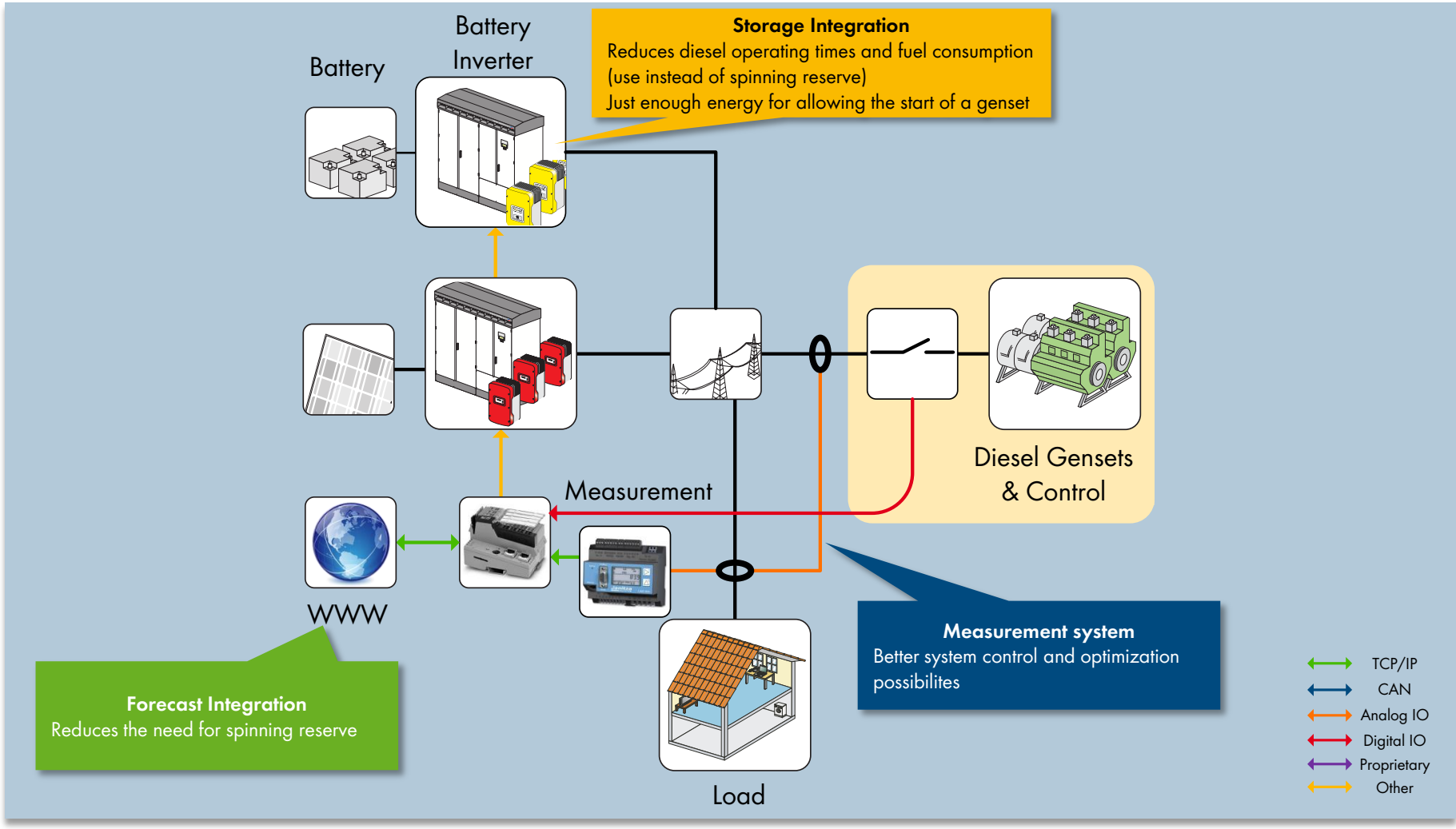
If:
- Diesel minimum load is known.
- PV installed power is known.

Then:
- the inverter will be limited to measured load – minimum diesel load.

Exceptions:
- Secondary diesel units are running under shut-off conditions.
- There is not enough spinning reserve.



Advanced possibilites for system optimization



Tasks of Energy Storage Systems in Tomorrow's Energy Supply

Energy Storage




Generation
- Stabilization
- Balancing/Smoothing of Volatile Sources
- Guaranteed Forecast

Transmission
- Ancillary Services
- Frequency Control

Distribution
- Demand Side Management
- Peak Power Provision

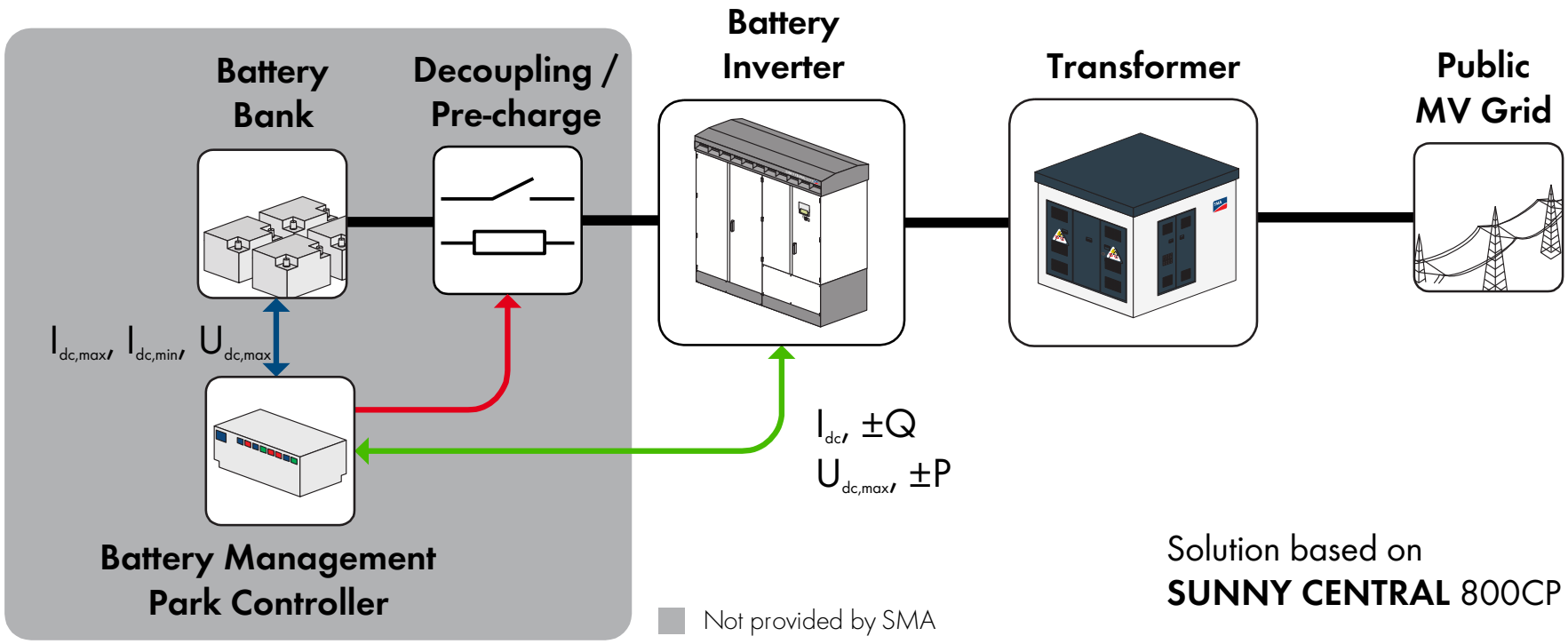
Load Demand
- Time Shifting
- Grid Relief by Direct Consumption

Requirements Regarding Power

Energy

Requirements Regarding Energy

Multifunctional PV Inverter – Storage for Generation Management



> Main challenge: System control interface allowing customer's scada system a direct access to the inverter control with very short response times

> First project already in operation since summer 2011