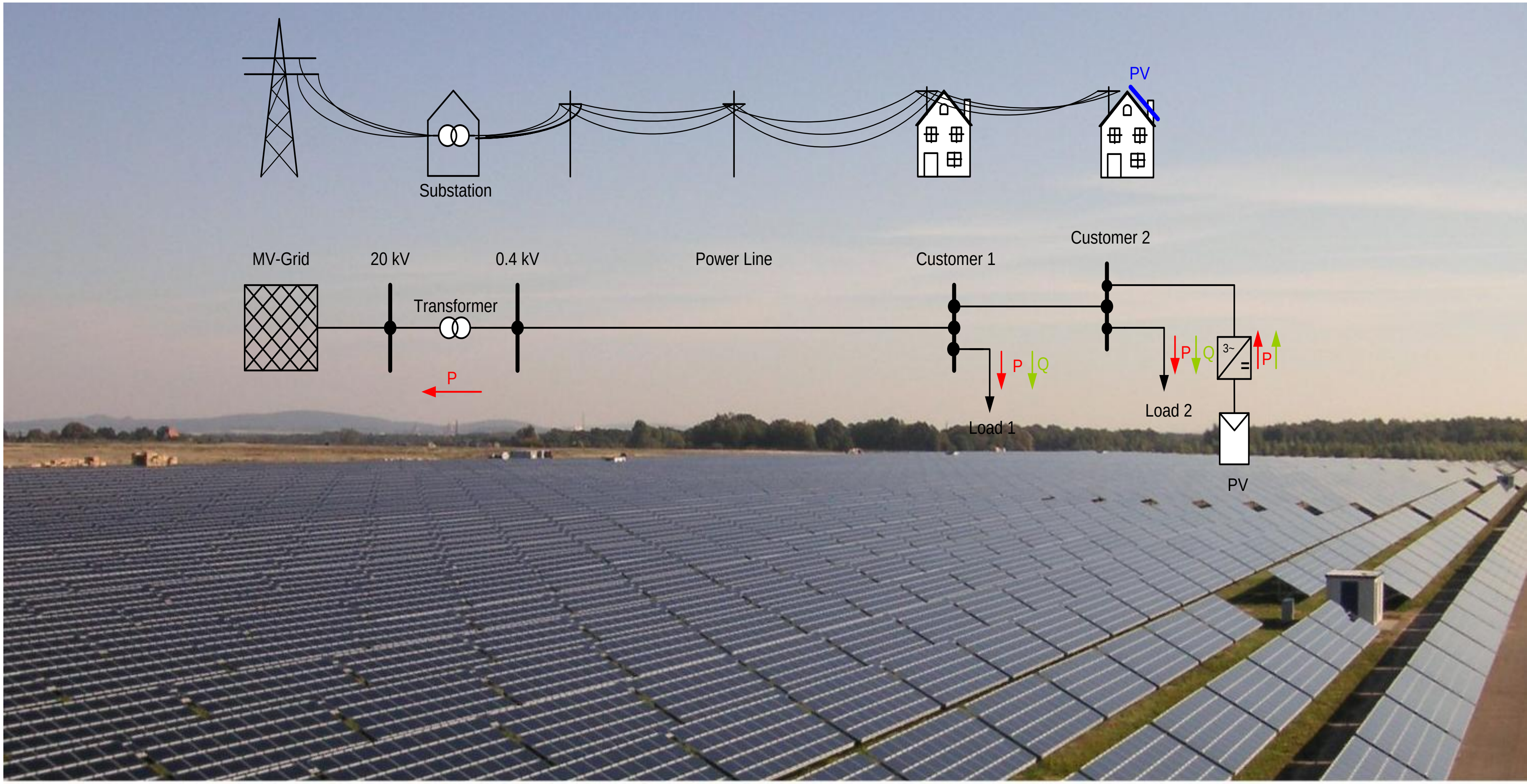
“Innovating Photovoltaics: the way ahead”
Grid integration



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Solar Europe Initiative Workshop

NH Fiera, Milan 07.05.2013

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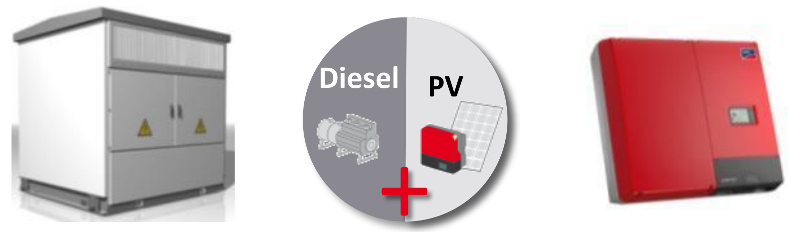
SMA is the global market and technology leader for solar inverters

Complete product portfolio

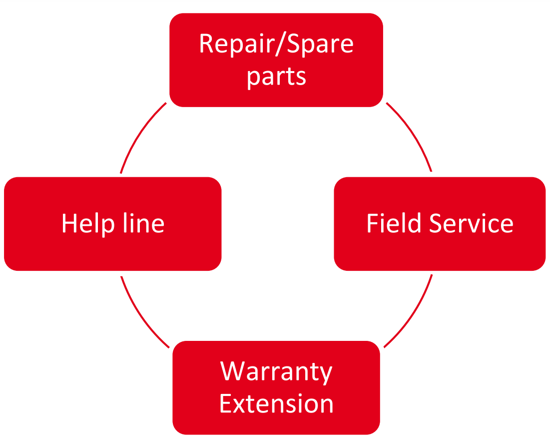
Sunny Home Manager | Sunny Boy | Sunny Tripower | Sunny Central | Sunny Island

Sound R+D Roadmap



New product plattforms | Hybrid business | Energy management

Complete service offerings



Global presence

Leading the way to optimized self-consumption

The SMA Smart Energy solution

Intelligent forecast and energy management

New Sunny Boy with integrated battery

Plant monitoring

> Without FITs solar needs to compete with electricity tariffs for households and mid-sized businesses.

> Power that is produced and used on-site does not need to be fed into the distribution grid.

> Linking the PV system with the forecast and consumption behavior is paramount.

Technologies in grid and energy management are the key to the energy transition.

Agenda

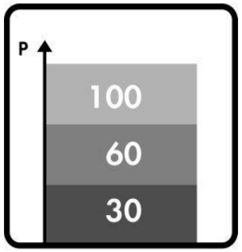
1 **Grid integration of PV Power Plants**

2 Voltage Support

3 Balancing PV Power

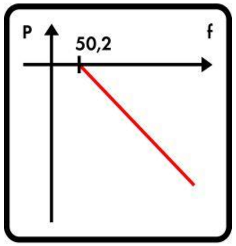
4 Roadmap

Requirements in Germany and Italy



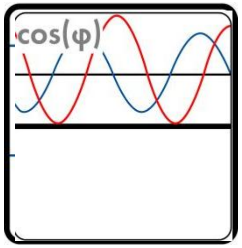
> Ability to control PV generation to a specified % of nominal power rating (Remote Dispatch)

BDEW Guidelines, CEI 0-21, CEI 0-16*



> Ability to automatically reduce active power with frequency deviations (Over Frequency Response)

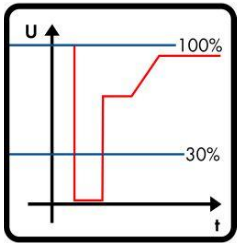
BDEW Guidelines, VDE AR-N 4105, CEI 0-21, CEI 0-16*



> Ability to supply/absorb reactive power during PV operation

> Ability to control power factor (PF Control Mode)

BDEW Guidelines, VDE AR-N 4105, CEI 0-21, CEI 0-16*



> Fault Ride-Through (LVRT)

> Ability to supply reactive current during fault ride-through period

BDEW Guidelines, VDE AR-N 4105, CEI 0-21, CEI 0-16*

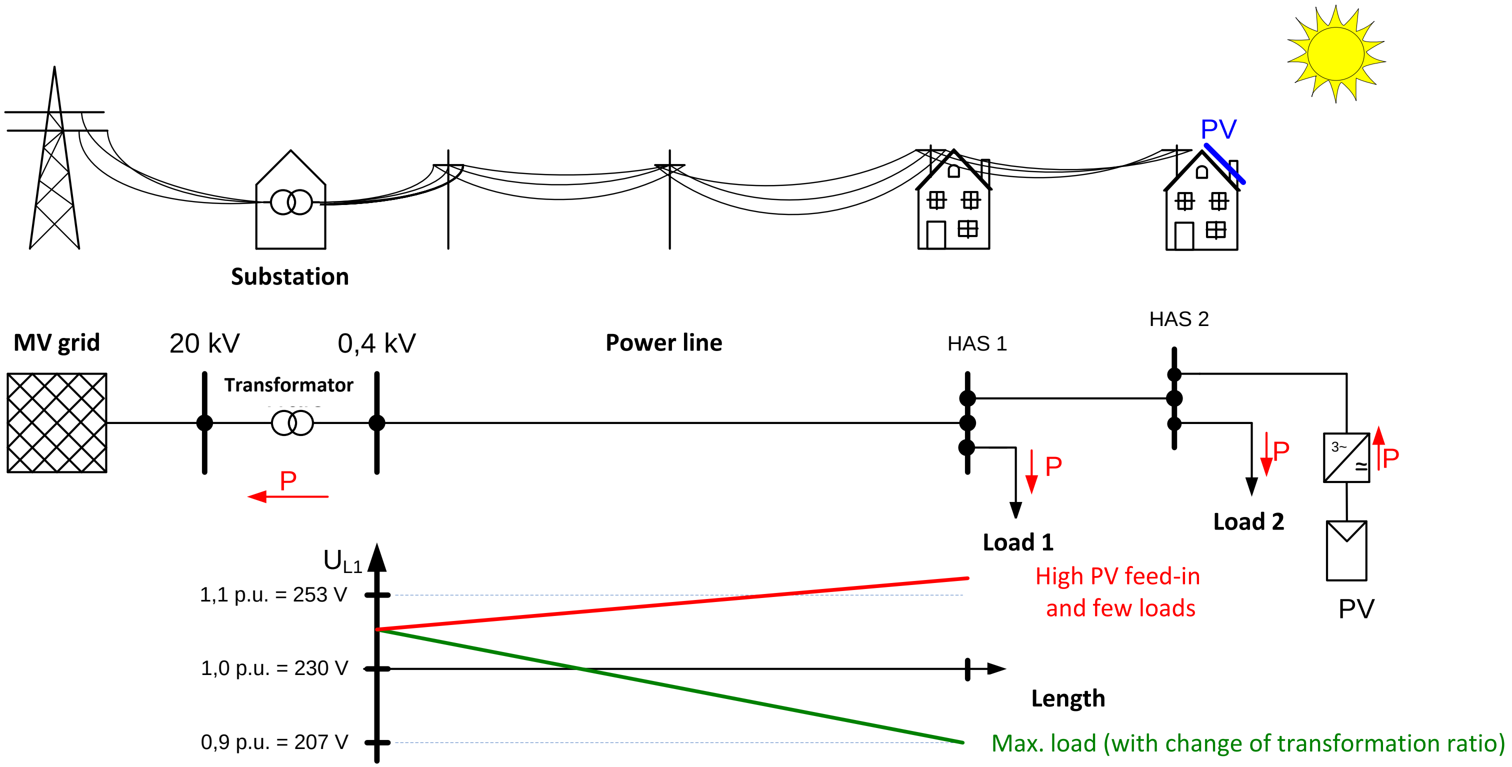
* German Association of Energy and Water Industries (BDEW)

Agenda

1. Grid integration of PV Power Plants
2. **Voltage Support**
3. Balancing PV Power
4. Roadmap

Voltage support: power flow reversal – a technical issue?

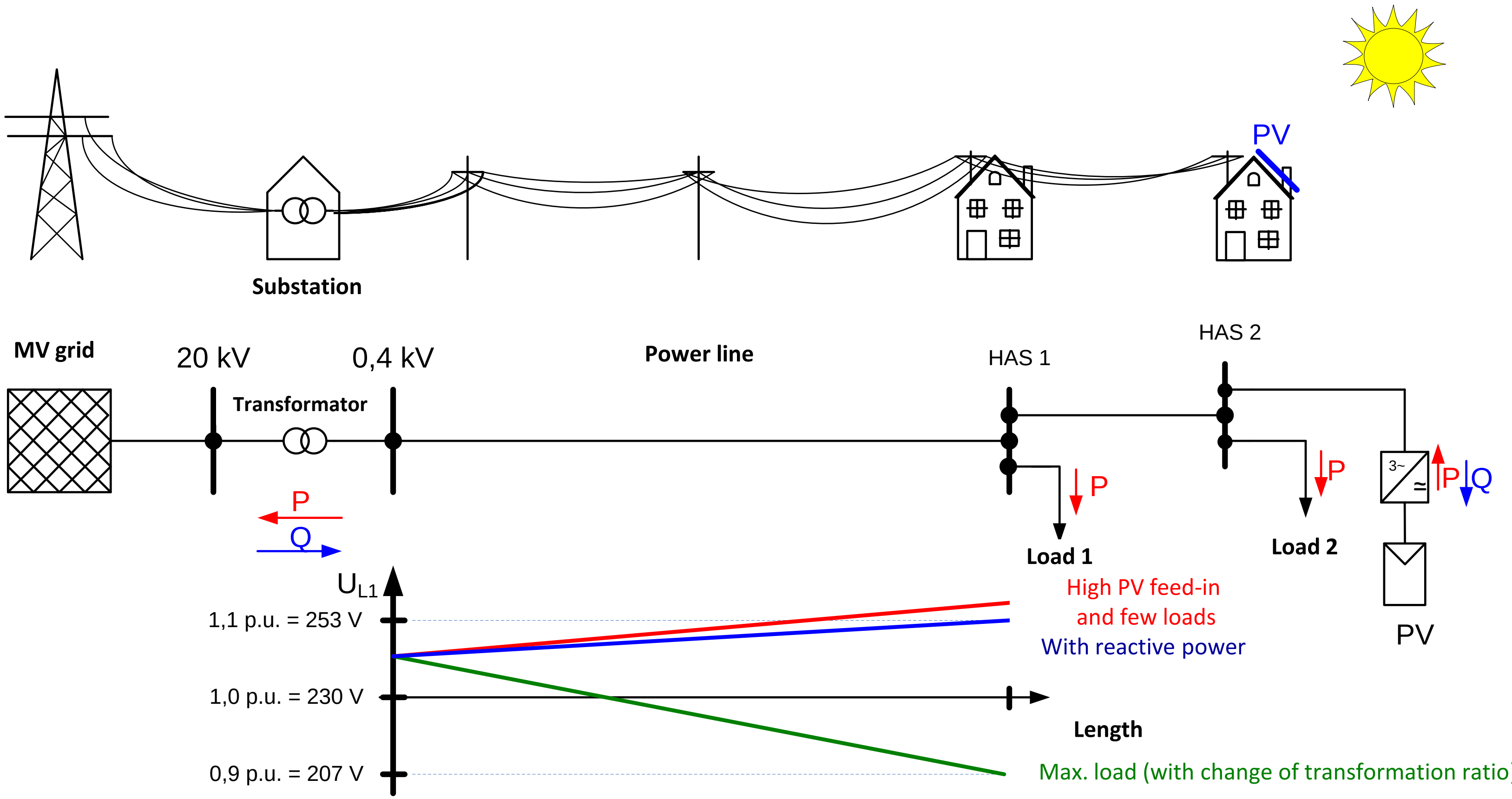
> Example: Installation of a PV system
>
> Few loads in the morning → reverse power flow & surpassing of EN 50160 thresholds



Voltage Problems were previously associated with costly grid development involving increased amounts of copper, new cables and more powerful transformers.

Supporting voltage through reactive power supply

> Example: Under-excited reactive power share reduces the voltage rise



PV plants are the only possibility to realise decentralised voltage control on the LV grid

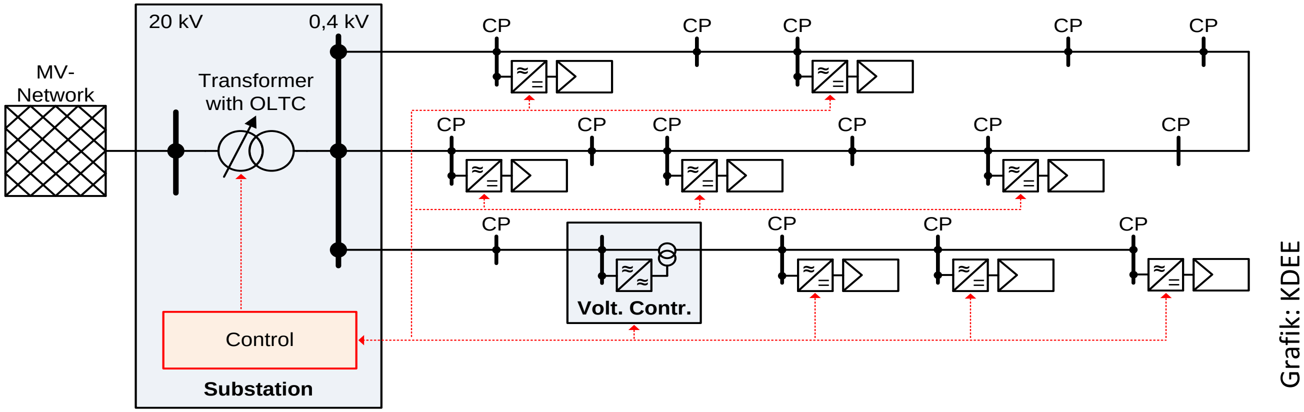
Solutions for Voltage Support in Distribution Networks

Investigations regarding

- > Measures to increase the Hosting Capacity of existing Networks for PV-Plants
- > Interactions between different network operating equipment devices (Controllable PV-Plants, Transformers with On-Load-Tap-Changers, Storage, Voltage Controllers etc.)

within several national and international research projects

[Bülo, 2012]



BMU-funded Project Aktives, intelligentes Niederspannungsnetz

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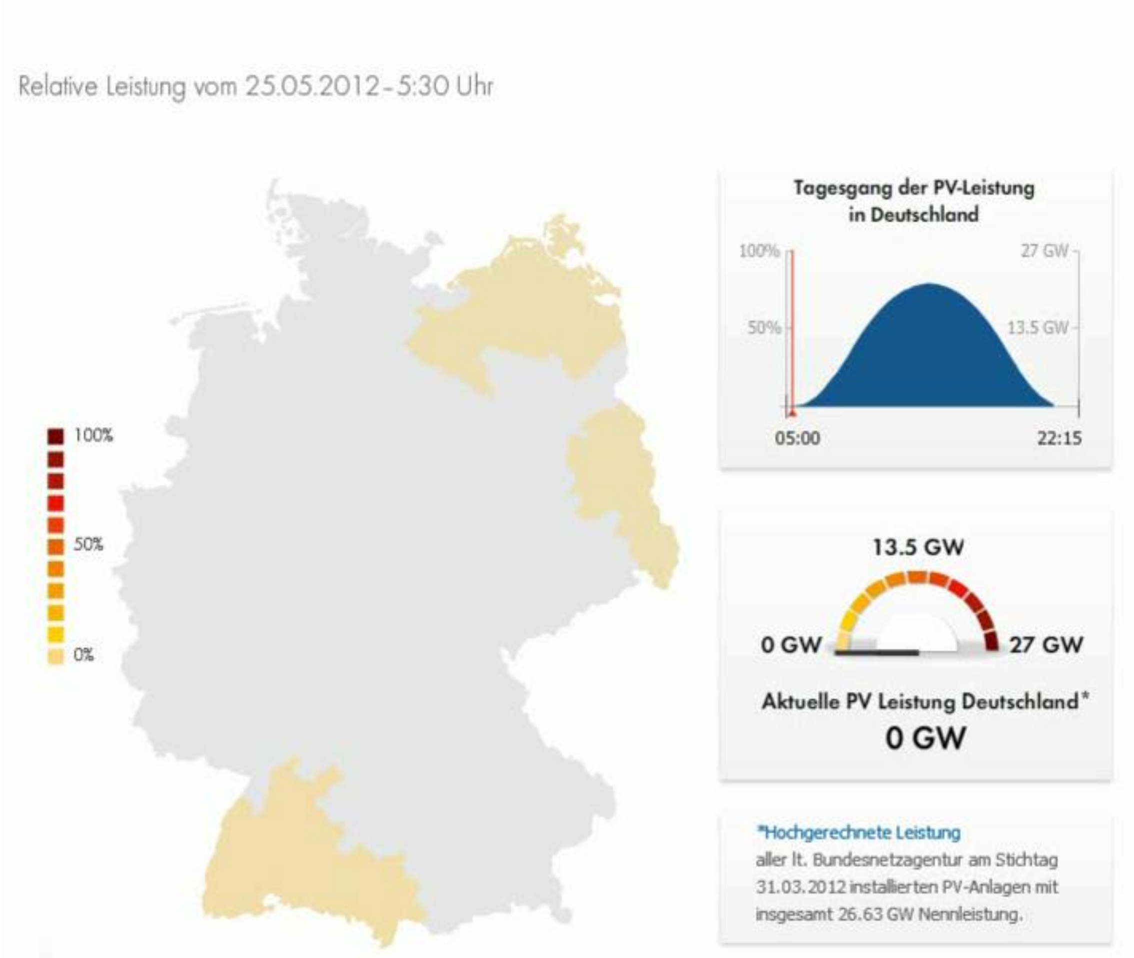
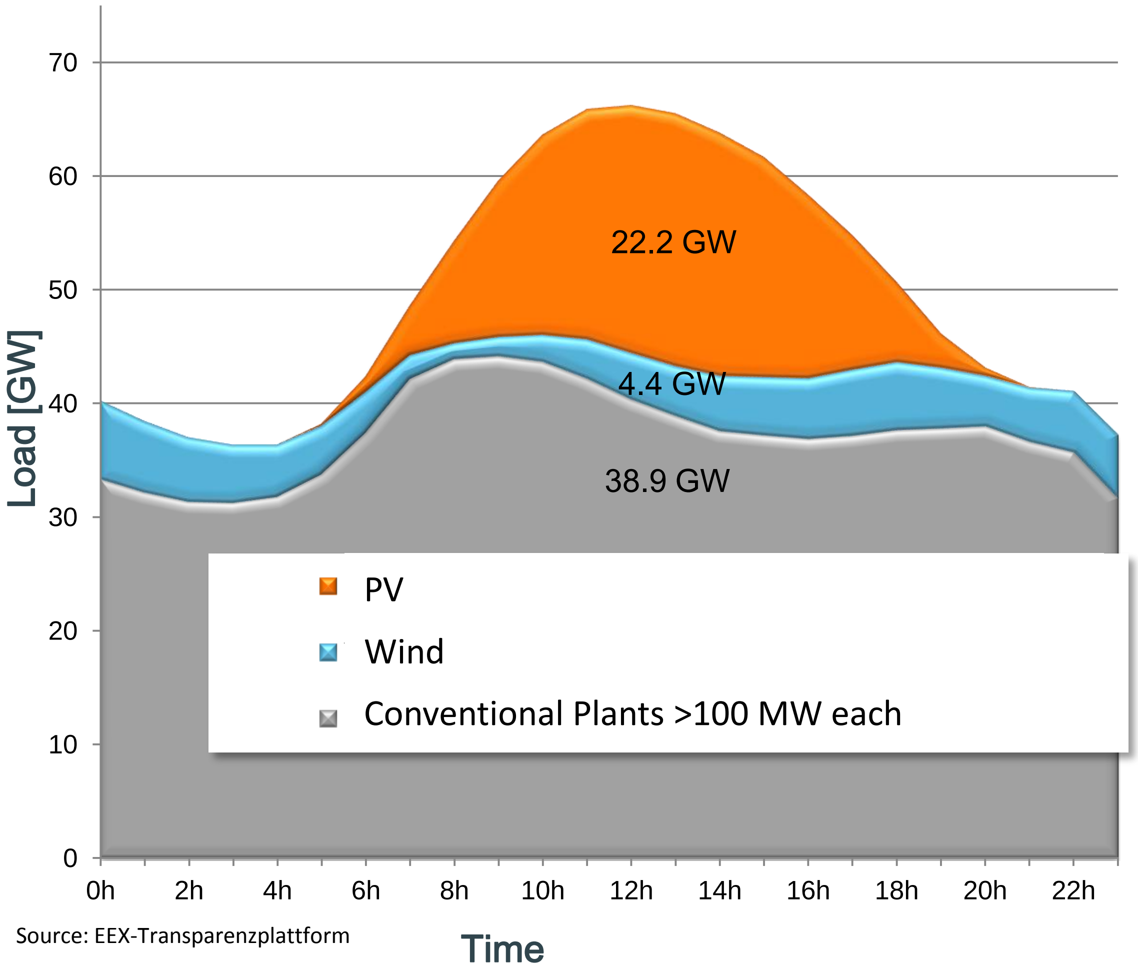
PV Performance in Germany

(http://www.sma.de/unternehmen/pv-leistung-in-deutschland.html)



Source: SMA, Sunny Portal

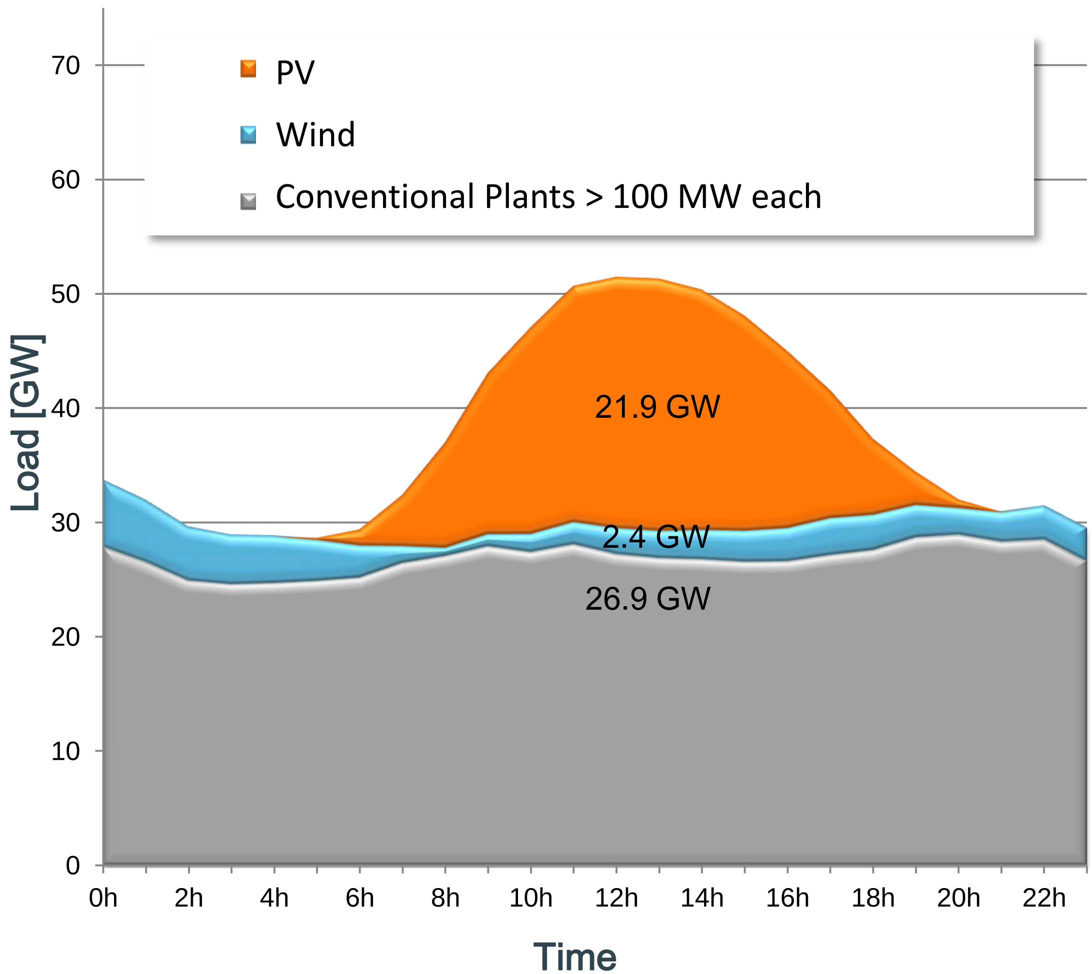
Generation in Germany on Friday, May 25th 2012
PV Performance compared with conventional Generation



Source: EEX-Transparenzplattform

Up to 34 % of the load covered by PV on a sunny Friday.

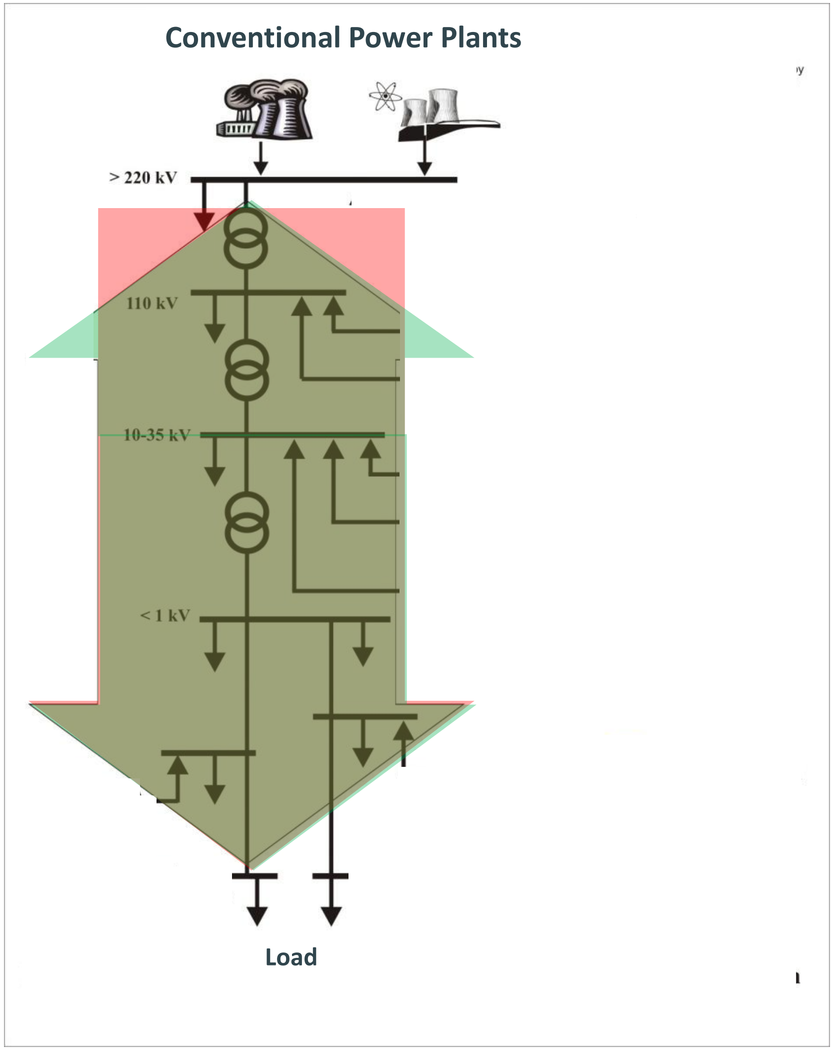
Generation in Germany on Saturday, May 26th 2012
PV Performance compared with conventional Generation



Up to 43 % of the load covered by PV on a sunny Saturday.

In 2013 50% of load covered by PV is expected at times.

Integration of Renewable Energy into the Grid Structure



In Germany:

> just 15% of the PV-infeed fall upon PV-plants in the Megawatt-power range [BSW 2012]

> Solar Power is mainly provided by PV-plants in the kW-power range

> app. 98% of all PV-plants / 70% of Energy are fed into low voltage networks

Paradigm replacement in electrical power supply:

> From top-down structure to fluctuating bidirectional power flows

> Distribution grids need to be "collection grids"

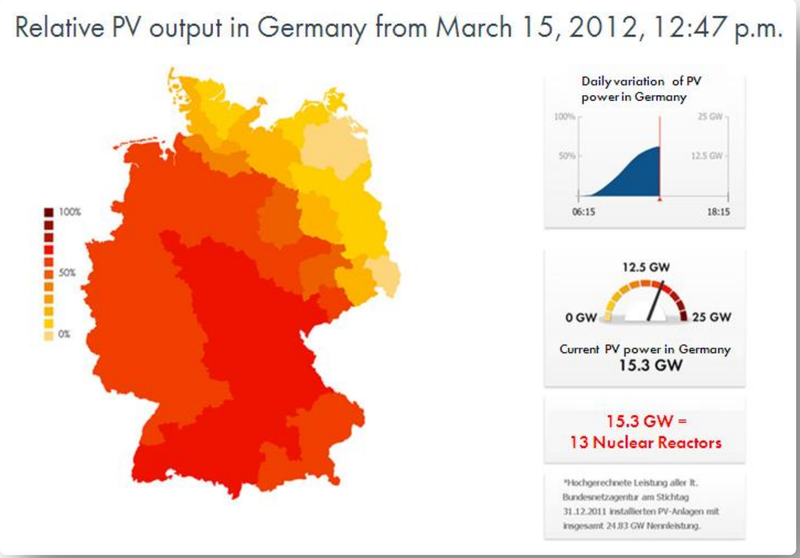
Challenges:

1. Rising **Hosting Capacity** of distribution networks
2. Maximizing concordance of production and consumption → **Energy Management**
3. Provision of **System Services** for a secure and robust network operation

Motivation

PV achievements until now

- > Significant contribution to electricity supply
- > Midday peak load increasingly covered



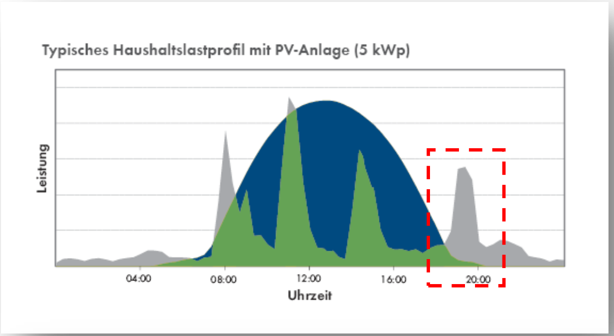
Source: www.sma.de/en/company/pv-electricity-produced-in-germany.html

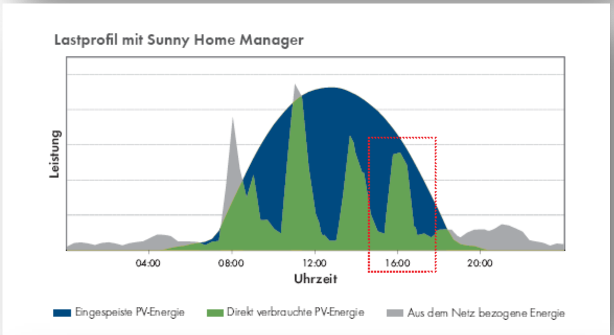
Key challenges for the energy revolution

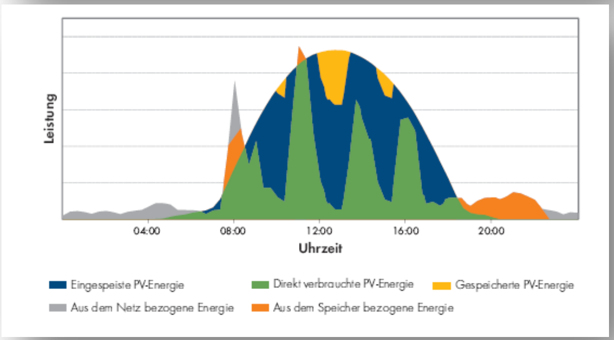
- > More dynamic grid load
- > Storage -- essential in various manifestations

How can PV utilize its unique strengths in combination with local energy storage?

Harmonization of production and consumption using Energy Management (1)







20 – 40 % possible private consumption Rate without special measures

Increase of private consumption rate using manual or automatic load management

Further increase of the self consumption using battery storage

Exemplary

Harmonization of production and consumption using Energy Management (2)

Storage provides more than just increase of the rate of self-consumption

> Feed-in-Management (e.g. 70%-Limitation)

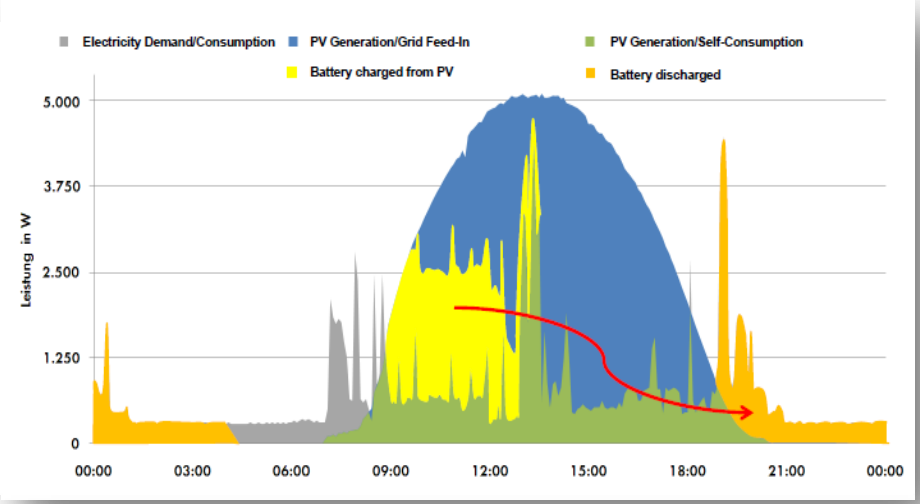
> Limitation of (local) Feed-in peaks

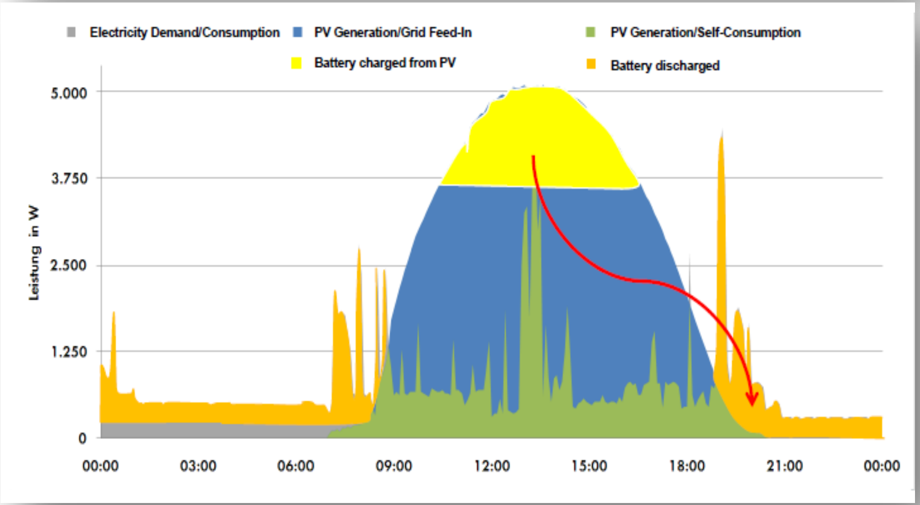
> Limitation of (local) Load peaks

> Equalization of Load Curve

> Provision of (pooled) active power reserve

- **Local Energy Management must become a part of a electricity production system with even better balancing technologies**
- **For a target-oriented Energy Management, a good prediction of feed-in-power and load are needed**





[Laschinski, 2012]

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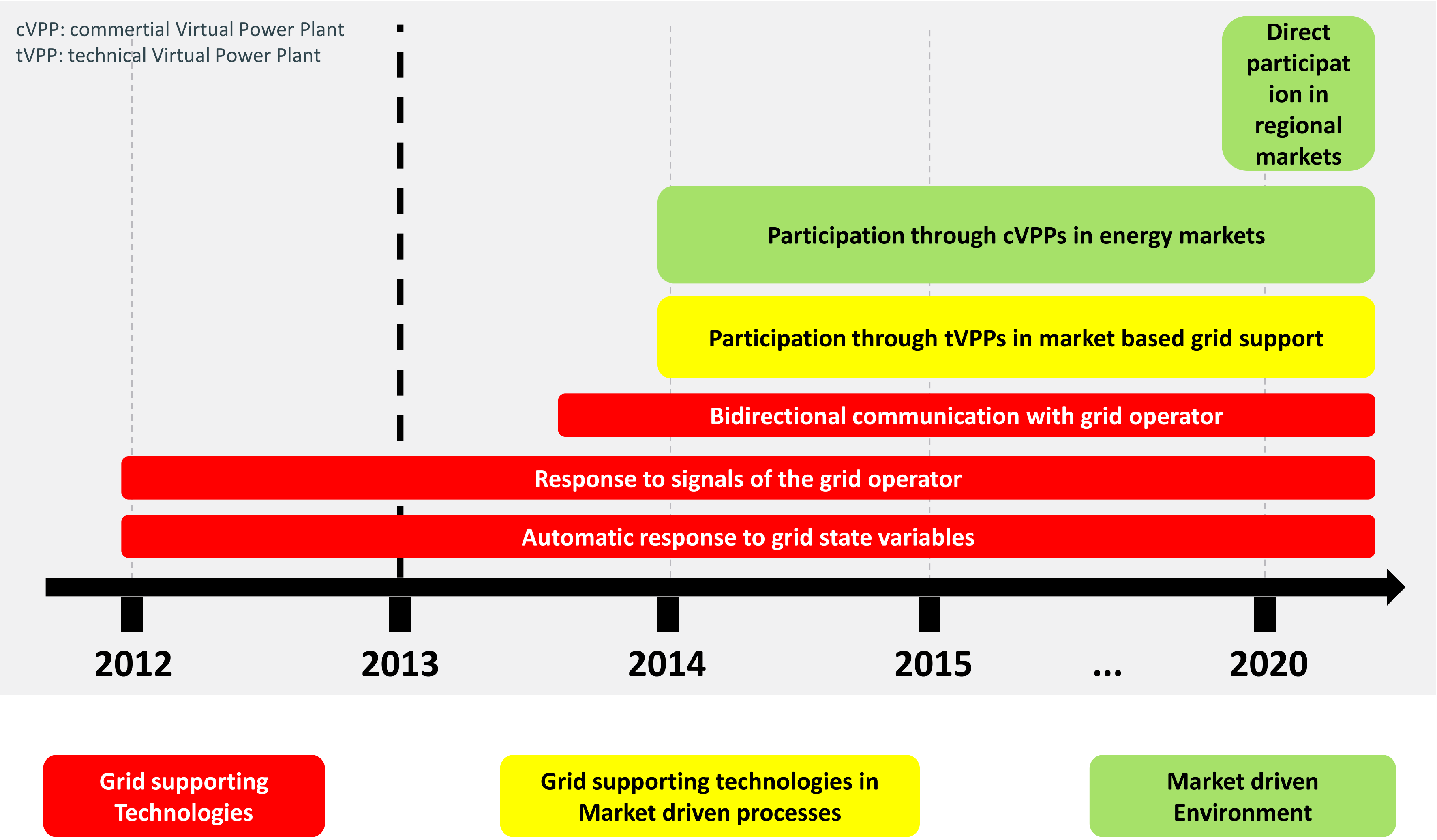
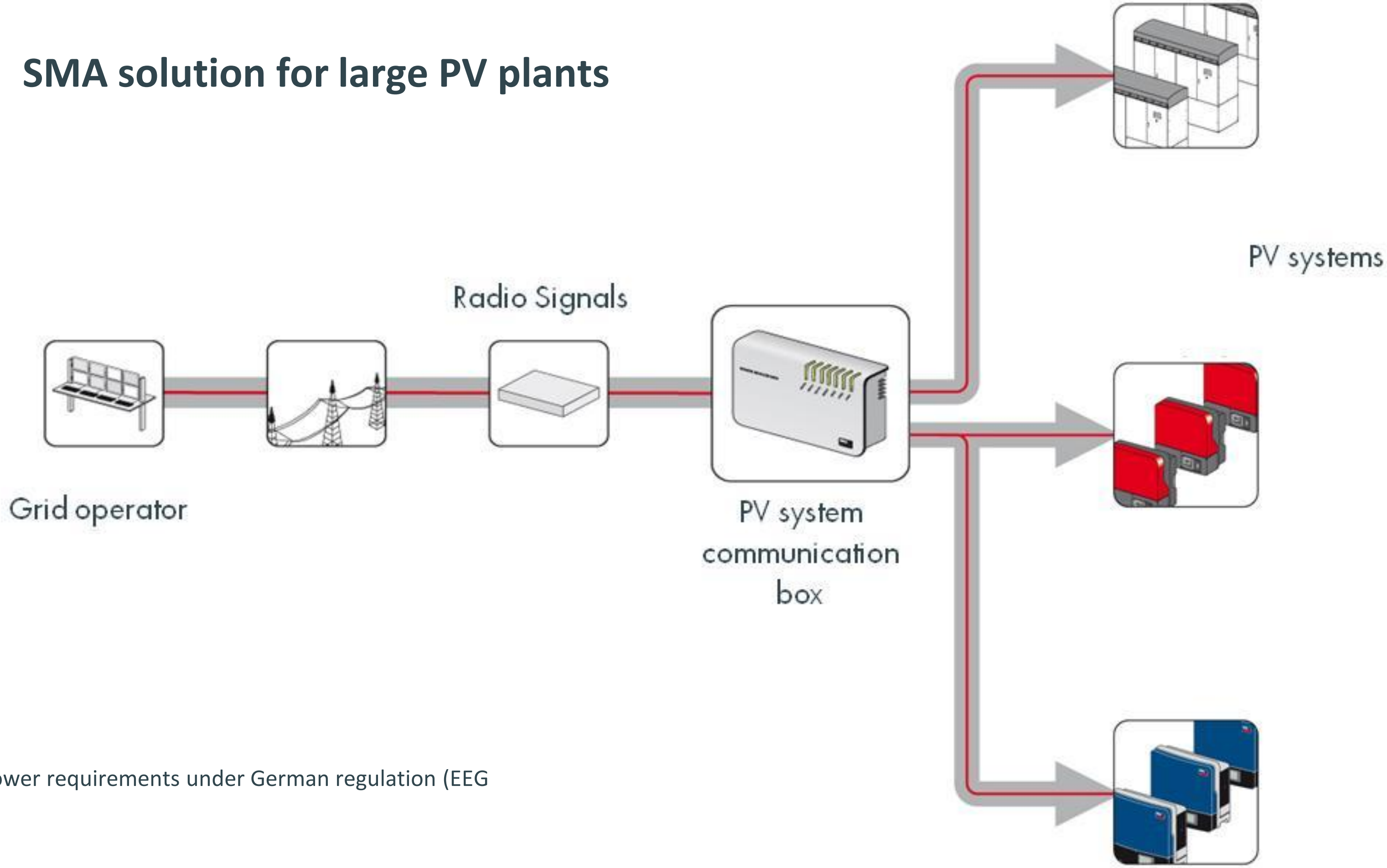
Vision of the future role of Smart inverter based systems



Example 1: Response to signals of the grid operator

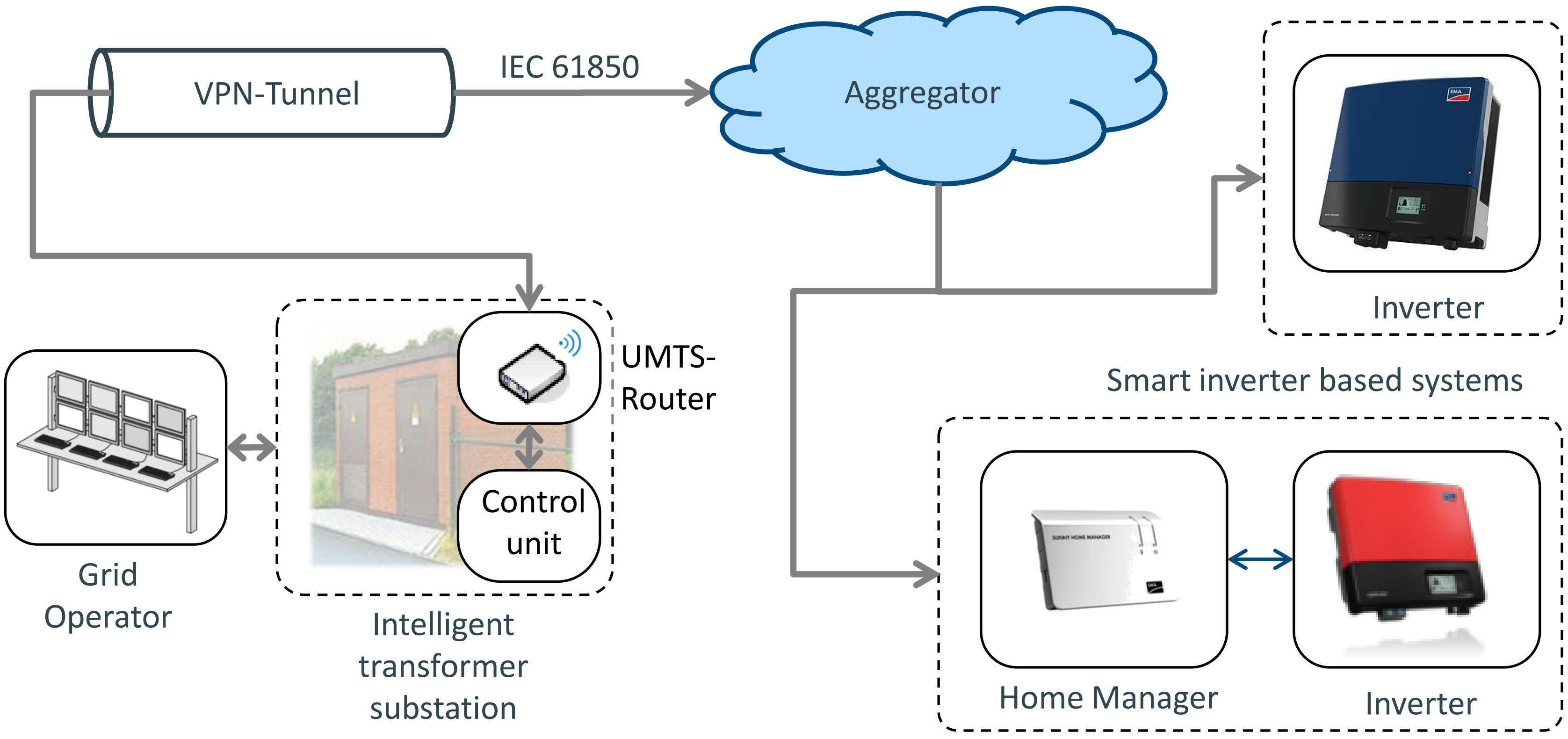
>> Fulfilling today requirements*

SMA solution for large PV plants



*Active Power requirements under German regulation (EEG 2012)

Example 2: Controlling a group of PV systems though an aggregator*



*Use Case tested within the project "Aktives, intelligentes Niederspannungsnetz", funded by the German Ministery of Environment (FKZ 0325202).
Partners: SMA, Fraunhofer IWES, Uni Kassel, E-on Mitte, J. Schneider Elektrotechnik GmbH

Outlook on future Developments

- Standard communication protocol (**IEC 61850**) and data models
- **PV and storage** as integrated system components
- Aggregation of distributed PV-plants → **Virtual Power Plants**
  - PV-plants become flexible controllable for different applications
  - Targeted system services using distributed PV-Systems becomes possible
- **Extended system services** and more flexible control of large PV-plants
  - Extended reactive power range (also in the night)
  - Active power reserve and limitation of negative power gradients

Conclusions

> The PV systems are evolving from passive inverters to Smart inverter based systems, assuming a keystone function in the Smart Grid

> In the future, PV systems will assume different roles depending on the grid state, facing new challenges and new opportunities, from market driven to grid supporting

> The main barriers opposing high penetration of PV in the future Smart Grid go from market design to standardization of communication technologies or regulation of roles

> Expensive network reinforcements can be avoided by intelligent use of converters in PV-plants

> Especially aggregated and combined with Storage and Energy Management Systems, the power provided by PV-plants can be integrated into the utility very well

SOLAR TECHNOLOGY

Thank You

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