IEA PVPS
Task 19

PV Integration in Stromnetze und Energiemärkte

Prof. Gerd Heilscher, Technische Hochschule Ulm, Task 19 Task Manager

PV-Dialog: Perspektiven und Projekte aus der Photovoltaikforschung - Online – 09. Juli 2025

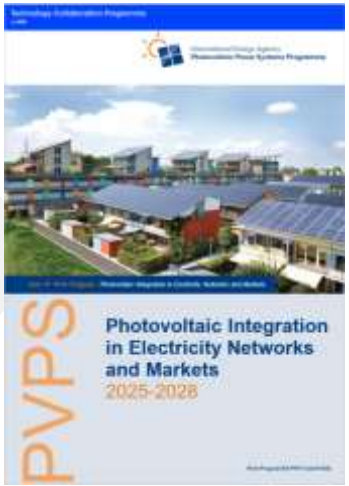
Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Internationale Energie Agentur – Technologie Programm

Das **IEA Photovoltaic Power Systems Programm** (PVPS)
ist seit 1993 eines der Technologie-Kooperations-Programme
innerhalb der Internationalen Energie Agentur

29 members - 26 countries, European Commission, 2 sponsors

Task 19



Mission: *"To enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems"*

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Task 19 45+ Experts aus 18 Ländern + EU

China
5 NoPs

Austria
1 NoP

Spain
2 NoP

Malaysia
2 NoPs

Germany
1 TM
3 Inst.

France
4 NoPs

Portugal
3 NoPs
1 Task
Manager

Morocco
2 NoPs

EU-JRC-
Ispra
1 NoP

UK
1 Expert

Belgium
1 NoP

Italy
1 NoP

Denmark
1 NoP

Netherlands
3 NoPs

Switzerland
3 Inst.

Norway
2 NoPs

Japan
3 NoPs

Finland
2 NoPs

USA
1 NoP

EPRI
(USA &
Ireland)

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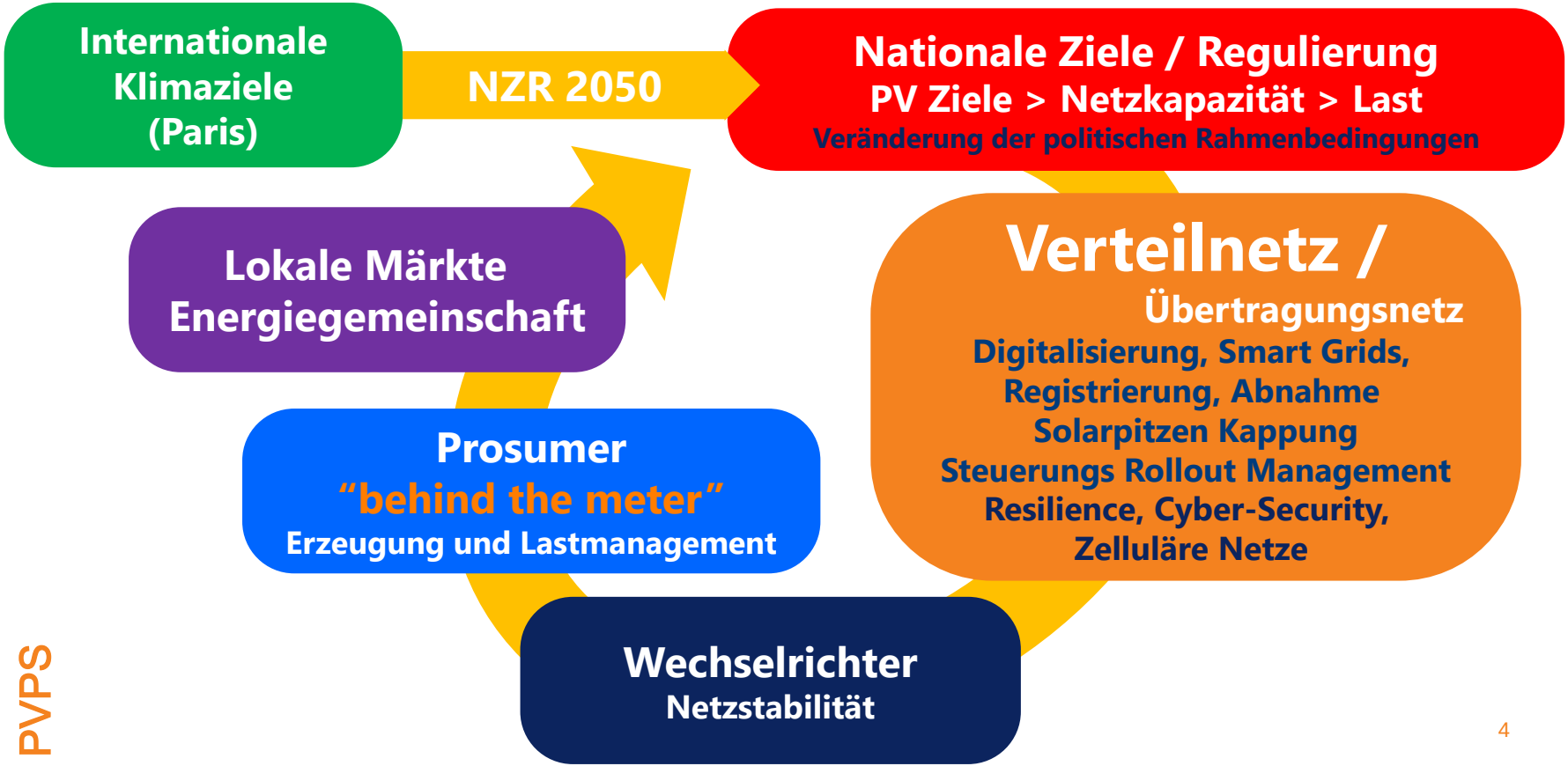
PV Integration in Stromnetze und Energiemärkte



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Task 19 - Neun Themen zur Photovoltaik -Netzintegration

1 **National PV Targets versus Grid Capacity**	**2** **Rights and Obligations of Prosumers**	**3** **PV in Smart Grids**
4 **Approval and Commissioning for Interconnection of PV Systems**	**5** **Curtailment Power Management**	**6** **New Inverter Capabilities**
7 **Aggregators, Local Markets and Energy Communities**	**8** **Local Energy Management**	**9** **Energy Economy in a 100% RES Based Power System**

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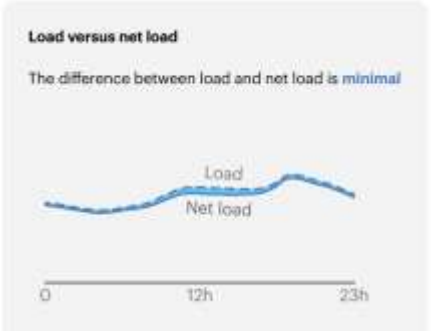
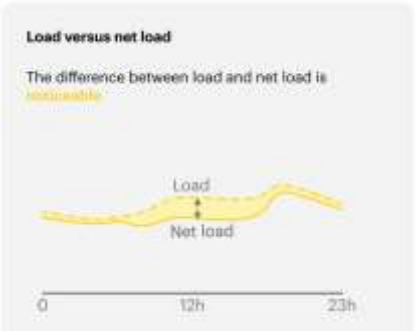
Sechs Phasen der Integration variabler regenerativer Energien (VRE)

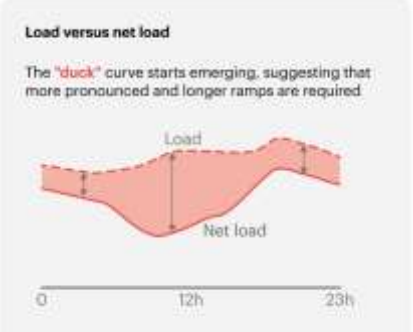
VRE hat keinen signifikanten Einfluss auf das Energiesystem



VRE hat geringen Einfluss auf das Energiesystem



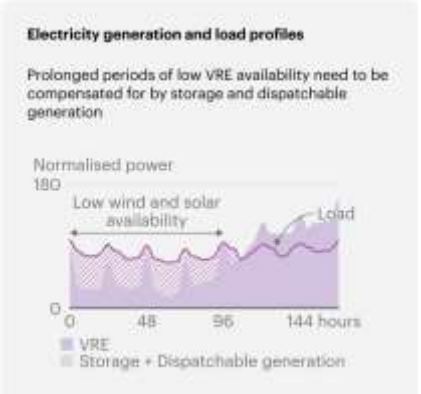
VRE bestimmt das Lastverhalten des Energiesystems



VRE deckt zu bestimmten Zeiten den gesamten Energiebedarf

Bedeutender Überschuss an VRE innerhalb eines Jahres

Sicherer Betrieb des Stromnetzes basiert auf VRE



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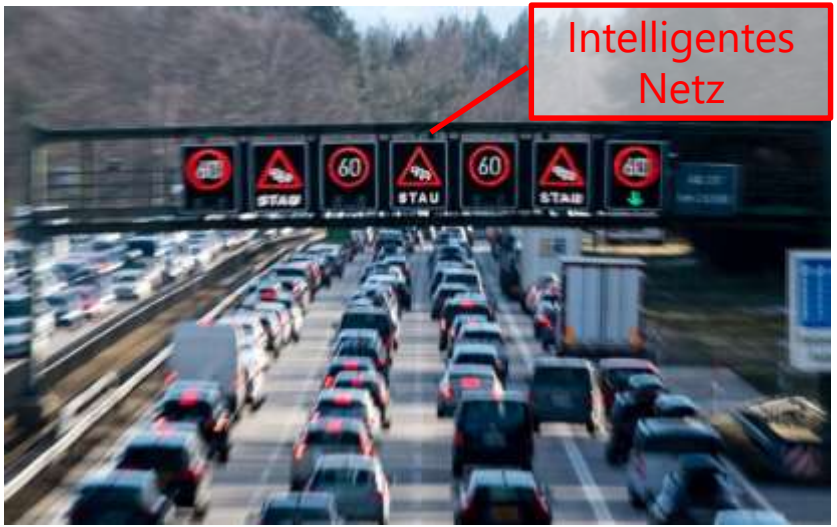
Baustelle - Netzintegration Photovoltaik

- Traumstraßen

- Albtraum Urlaub



- Verteilnetz bisher
- Übertragungsnetz heute – täglich

=> Verteilnetz morgen - stündlich

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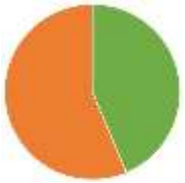
Start im Real-Labor... an einem sonnigen Tag

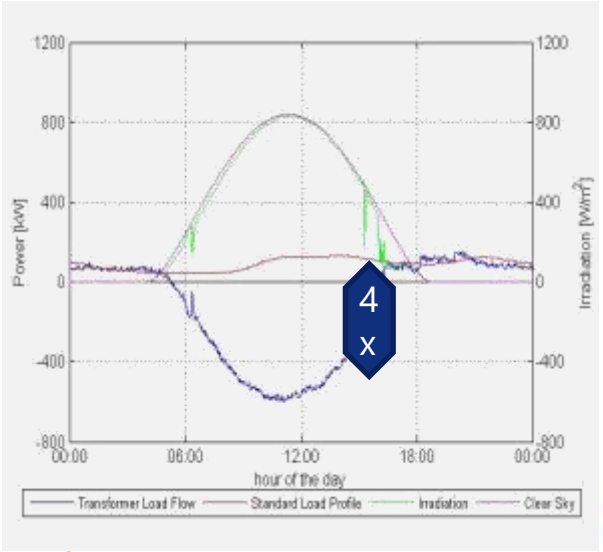


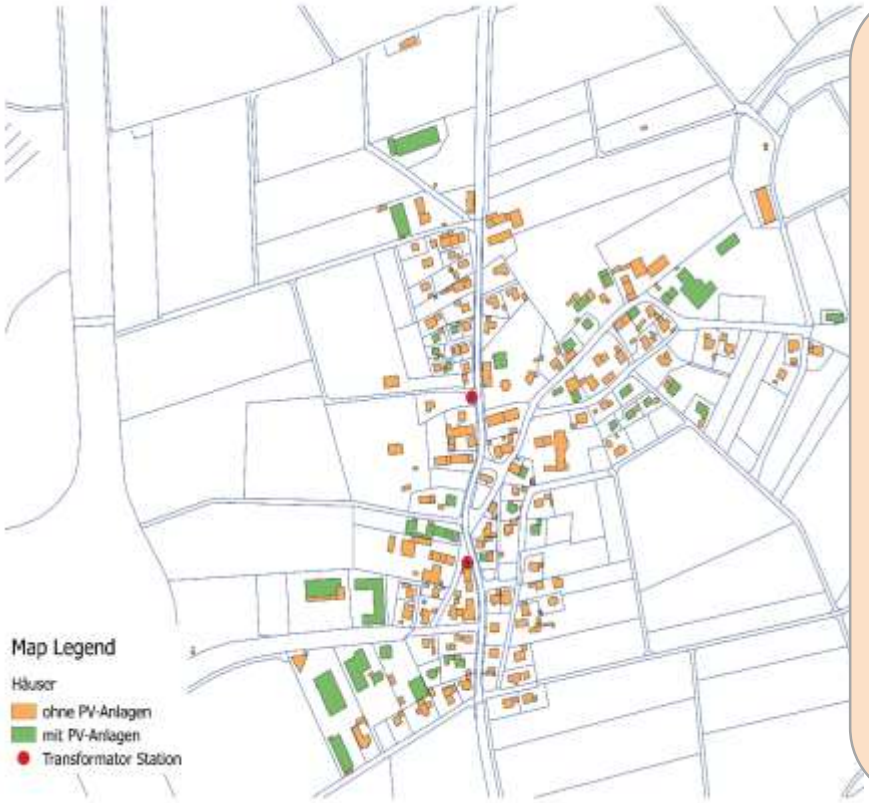
Hittistetten

85 PV-Anlagen

110 Hausanschlüsse

PV-Einspeisung > Last





Solardächer

200-300 % PV-Anteil am Jahresenergiebedarf

Rückspeisung 8-mal höher als Last

- Dachpotentialanalysen
- Netzberechnung
- Ausbaukosten
- Alternativen

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100 % PV Anteil am Jahresstrombedarf

Quellen| EU FP7-ORPHEUS-Projekt

Baustelle Verteilnetz - Niederspannung

28% - FuE

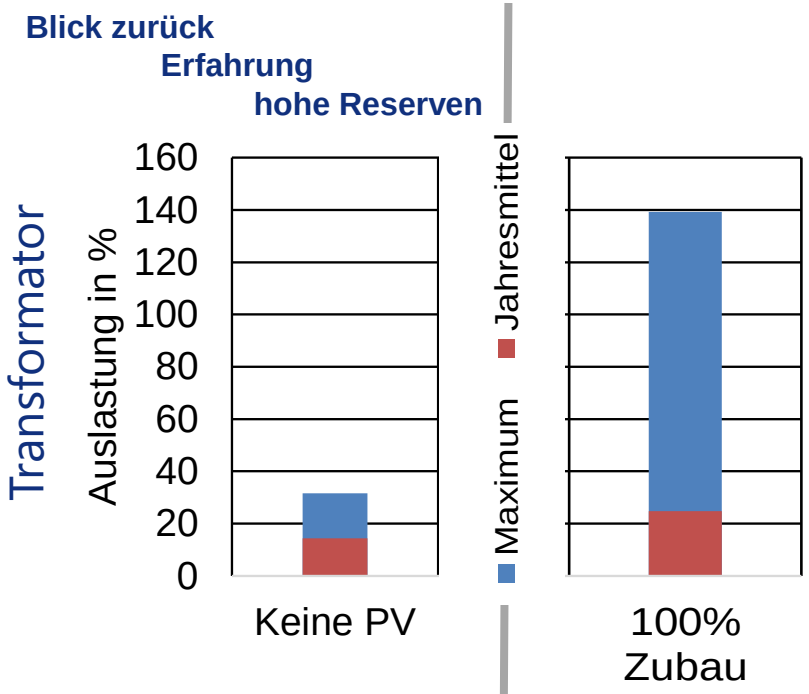
20%+ - 2021

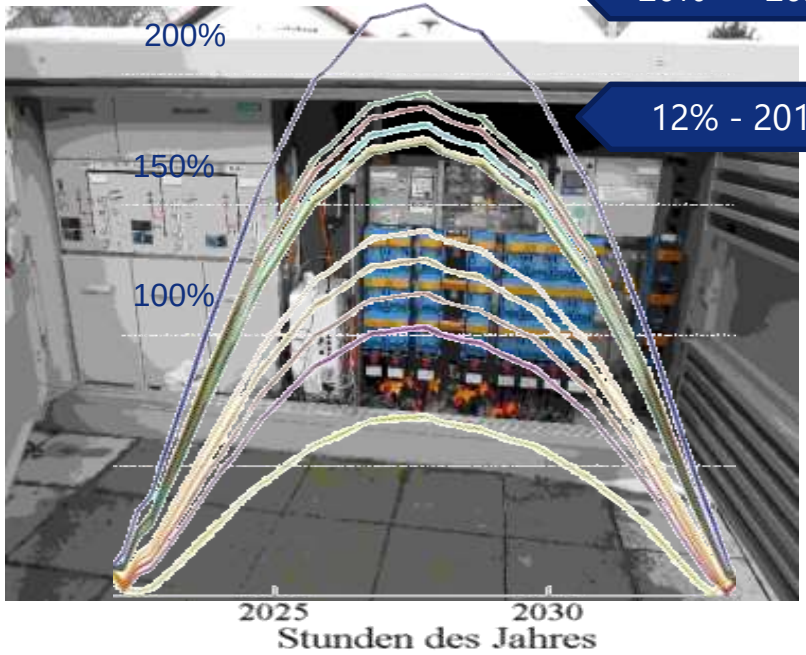
12% - 2013

Blick zurück

Erfahrung

hohe Reserven





Blick in die Zukunft - Auswahl von Alternativen
hohe Auslastung, mehr Information notwendig

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Quellen| BMBF FH-PROFUNT-NATHAN-PV Projekt

Herausforderung Integration Photovoltaik im Verteilnetz

Herausforderung

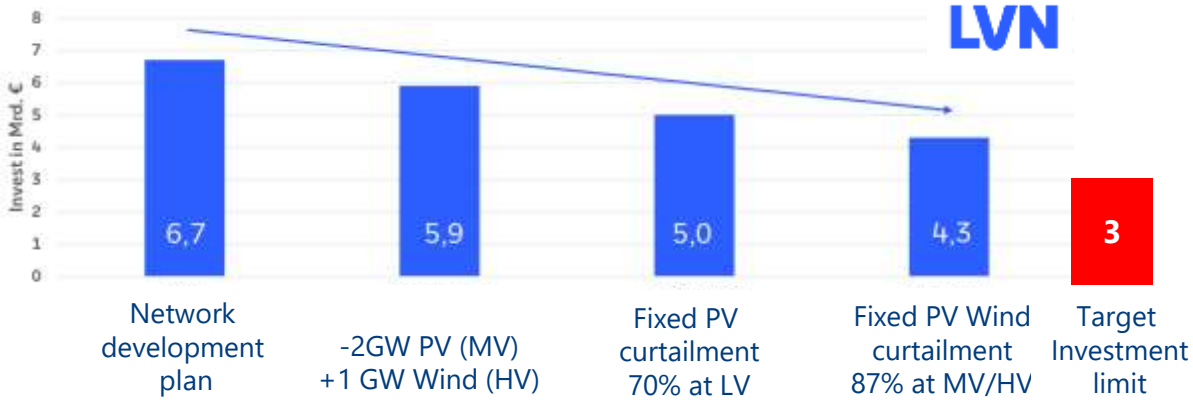
- Photovoltaik Ausbau-Ziele > Netzkapazität > Last
- Lösung Netzausbau ist nicht finanzierbar
- Netzgebühren im Blick behalten

Vorhandene Lösungen

- Netzausbau, Redispatch, Einspeisemanagement, Solarspitzenkappung

Innovative Lösungen – wissensbasierter Netzbetrieb

- Transparenz > Netzzustand > aktive Netzführung in der Niederspannung
- Höhere Ausnutzung der vorhandenen Netzkapazität
- Abschied vom fixer EEG-Vergütung > dynamische Tarife



Source (DE): Tagung zukünftige Stromnetze, Berlin 19.01.2025, Marco Wagler, LEW Verteilnetz GmbH

Task 19 Joint Research Activities:

- Definition of overpowered networks
- Grid hosting capacity rules
- Grid hosting capacity status

1 National PV Targets versus Grid Capacity	2 Rights and Obligations of Prosumers	3 PV in Smart Grids
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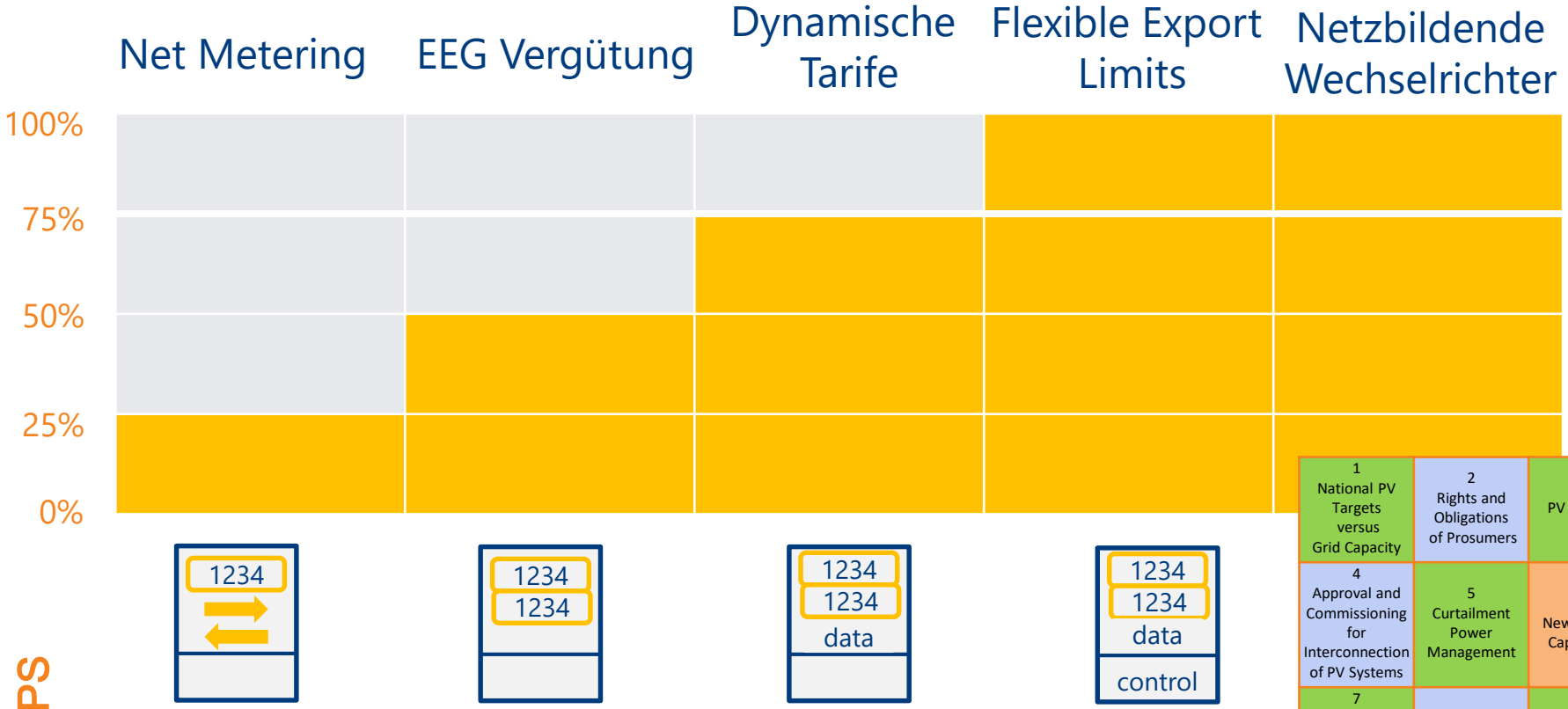
Warum braucht Netzintegration-Photovoltaik Smart Meter?



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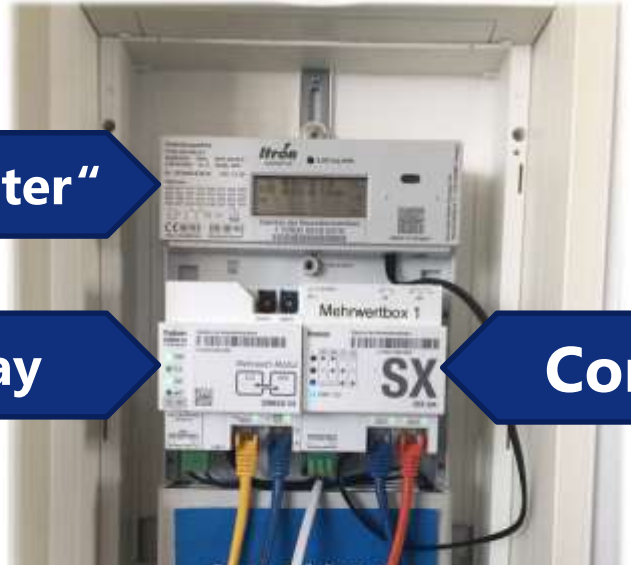
Warum braucht Netzintegration-Photovoltaik Smart Meter?

iMSys

intelligentes Mess-System
BSI-TR 03109 zertifiziert

„Smart Meter“

- Gateway



Control

FNN-Steuerbox

- Steuerung
- Bidirektionale Kommunikation
- IEC 61850 Datenmodel
- Einspeiser, Speicher, Ladesäulen Wärmepumpen

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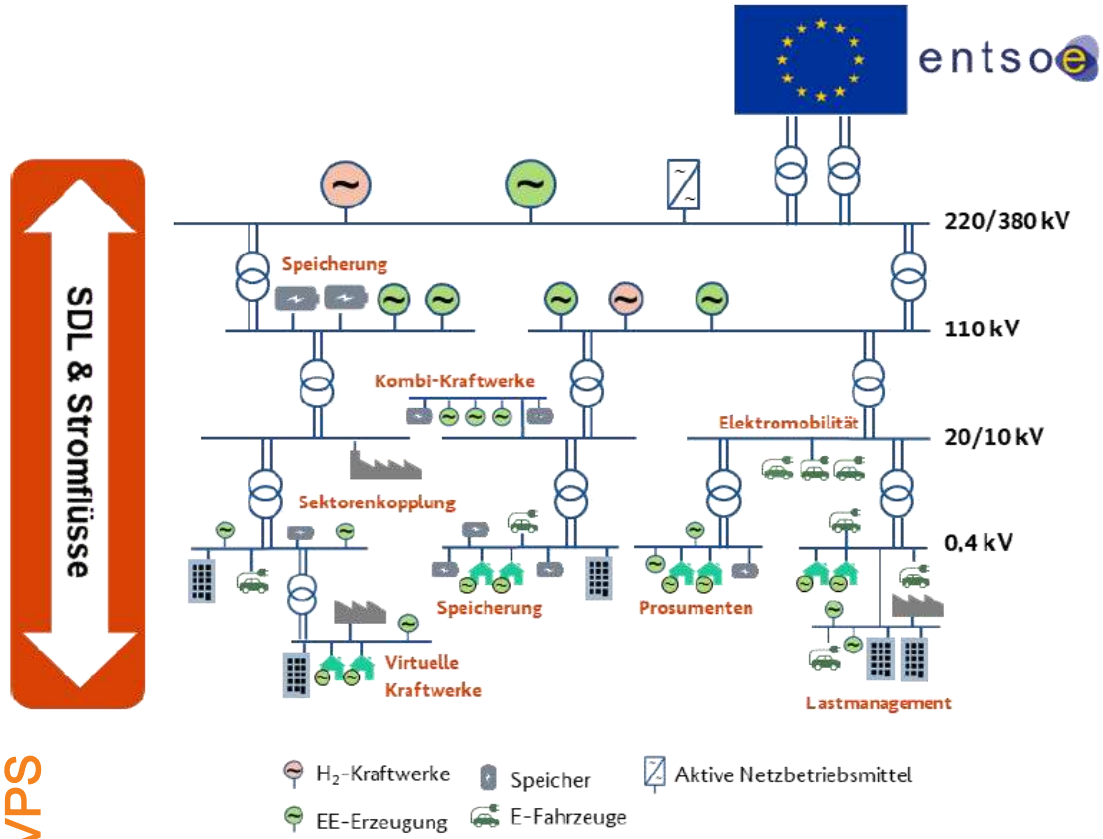
Systemführung mit netzbildenden Wechselrichtern



- Wirkleistung
- Blindleistung
- Low Voltage Ride Through
- Inertia
- Low Voltage Ride Through
- Overvoltage
- RoCoF

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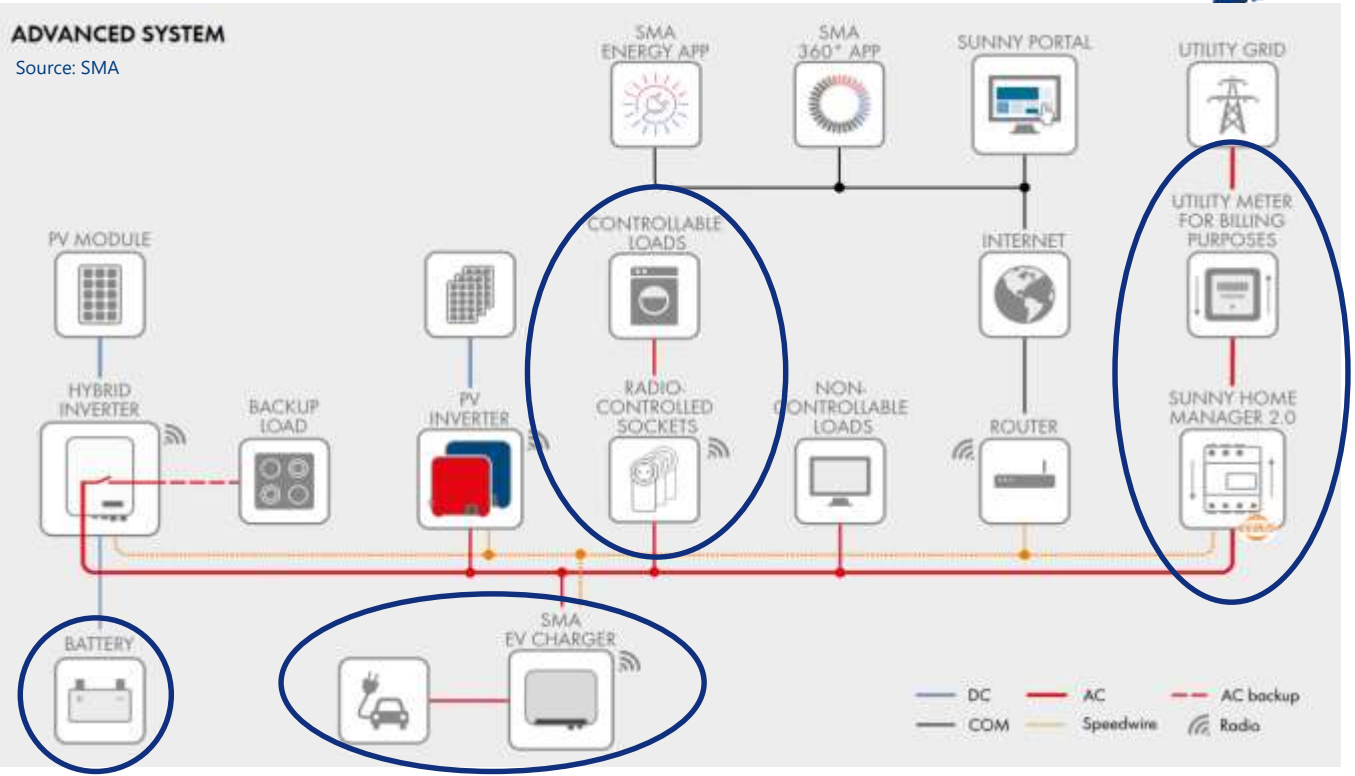
Source (DE): Tagung zukünftige Stromnetze, Berlin 19.01.2025, Alexander Folz, BMWK

Partizipation Prosumer < --- > Was passiert hinter dem Zähler?

Trend:
PV-Wechselrichter
“Herz” des Prosumer Energiesystems

Hybrid Wechselrichter
- Für PV und Speicher
- Steuerung von P2H
- Steuerung E-Ladung
- Integration Wetter-Prognose

Vendor Lock-in Standards?



Source: SMA

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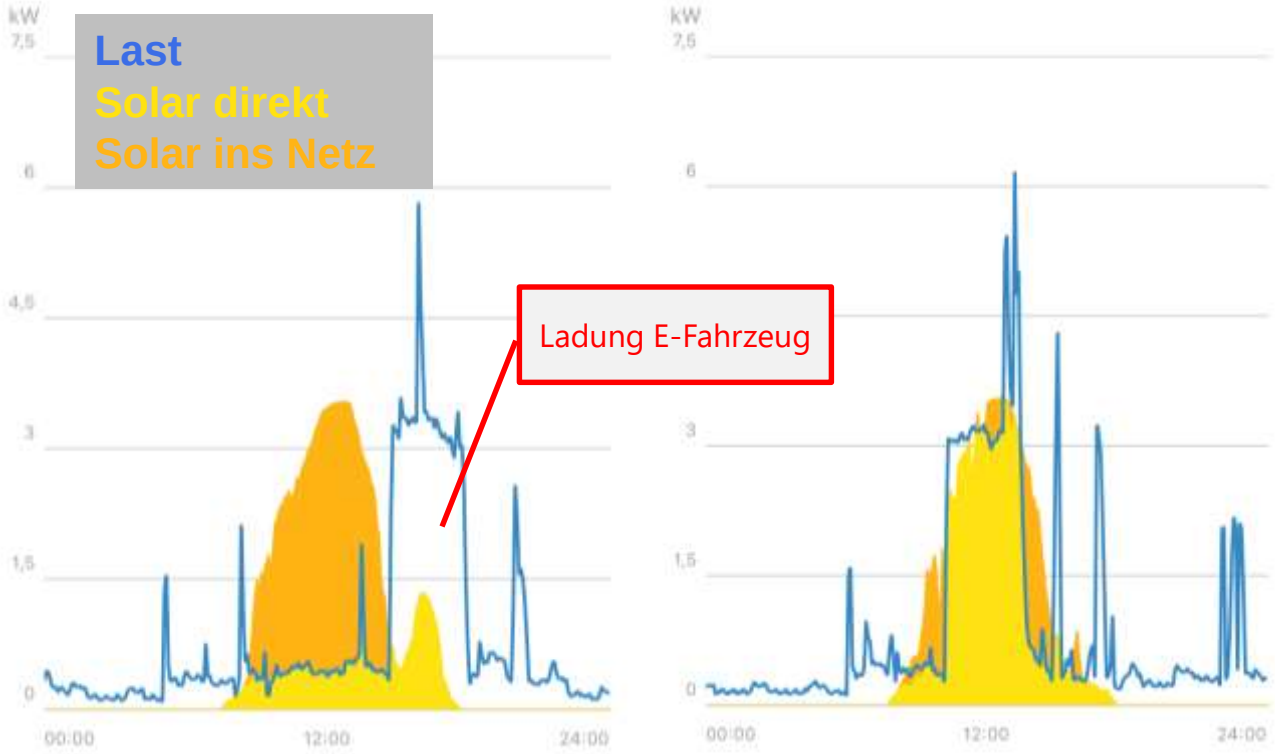
Gefördert durch: BMWK: PVin100RES-PS

Flexibilisierung der Last >> netzdienliche PV Integration



Source: Fronius Solar.web

Task 19 Joint Research Activities:

- Designing a new Social Contract for Customers to Grids Dominated by DER
- Overview on Capabilities of Local Energy Management Systems
- How do Countries deal with very high PV Penetration
- Control Strategies for Highly Overpowered Grids
- Talking to Inverters- Cybersecurity aspects

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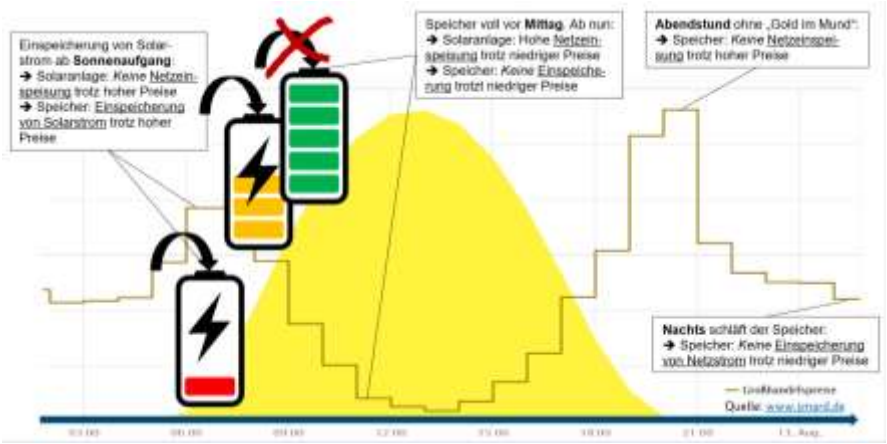
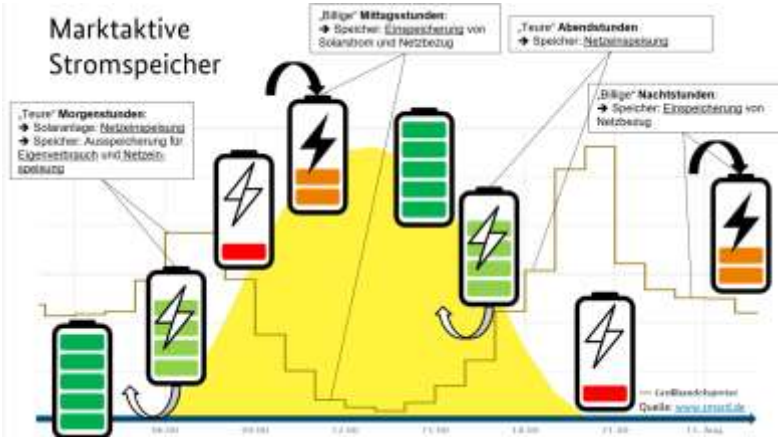
Gefördert durch: BMWK: PVin100RES-PS, eMpowerSYS

Marktintegration Photovoltaik und Batteriespeicher





Task 19 Joint Research Activities:

- Synergy Between EV and PV for PV Hosting Capacity in LV Grids
- Decentralized Storage Applications
- Role of PV in a Micro Grid Resilience Strategy

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Source (DE): Flexibilisierung und marktliche Nutzung von Stromspeichern – Sötebier, BNetzA.

Neues Markt Design für ein Enerergiesystem mit 100% VRE

- **Transparenz der verfügbaren Verteilnetzkapazität für Marktteilnehmer**
- **Sichere und leichtgewichtige Teilnahme an Flexibilitätsmärkten: Präqualifikation als Markteintrittsbarriere**
- **Integration von Flexibilitätsmärkten**

Task 19 Joint Research Activities:

- JRA40-PV in Energy, Capacity and Balancing Markets
- CET Partnership Collaboration (demonstrate the market and grid integration of up to 100% VRE in European and extra-European scenarios

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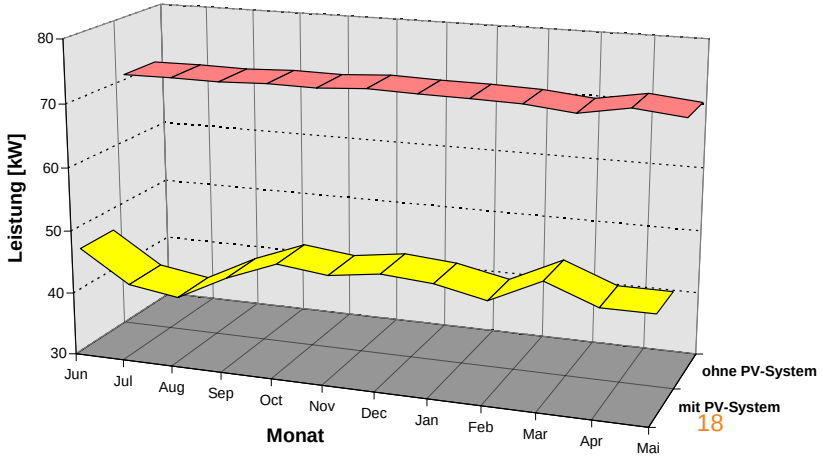
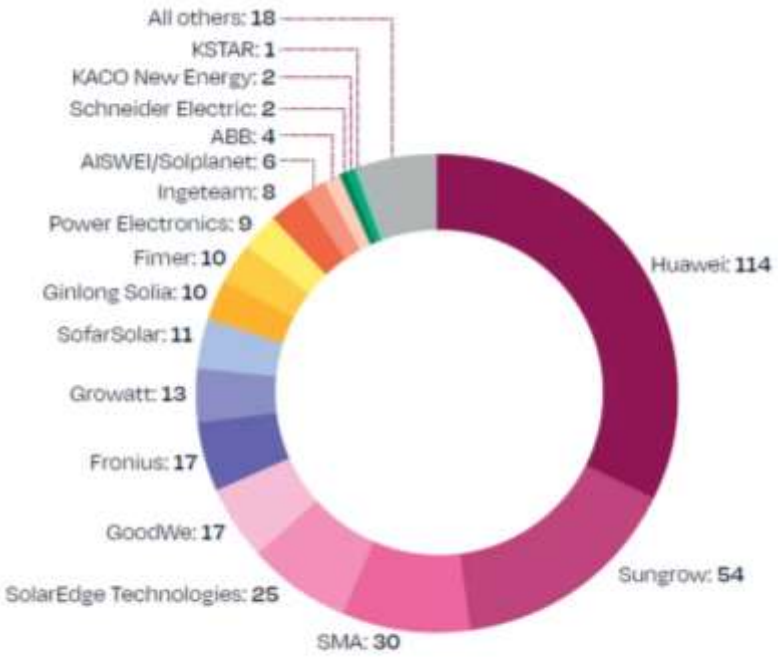
„Lastverschiebung mit Photovoltaik in der Industrie…….1995”

- Trautwein GmbH, Emmendingen
- Herstellung Badewannen
- mit Solarstrom

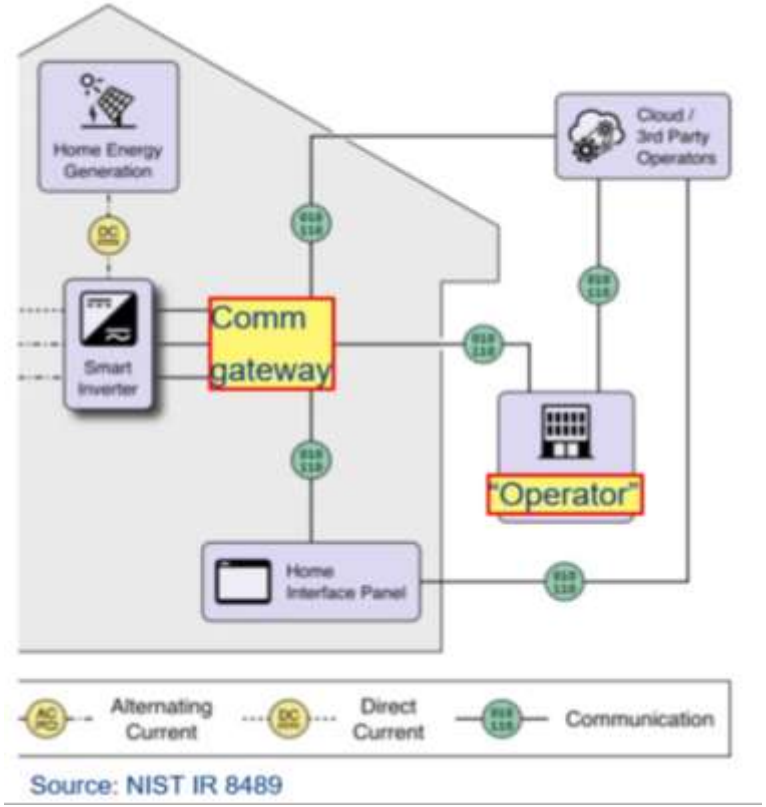


Cybersecurity für Photovoltaik Integration



PV inverter shipments to Europe from 2015 – 2023 in GW.
Source:Wood Mackenzie

- **Relevant providers must prove that sovereignty over inverter operations lies in the EU at all times.**



Source: NIST IR 8489

Smart Grids Forschungsgruppe an der THU

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