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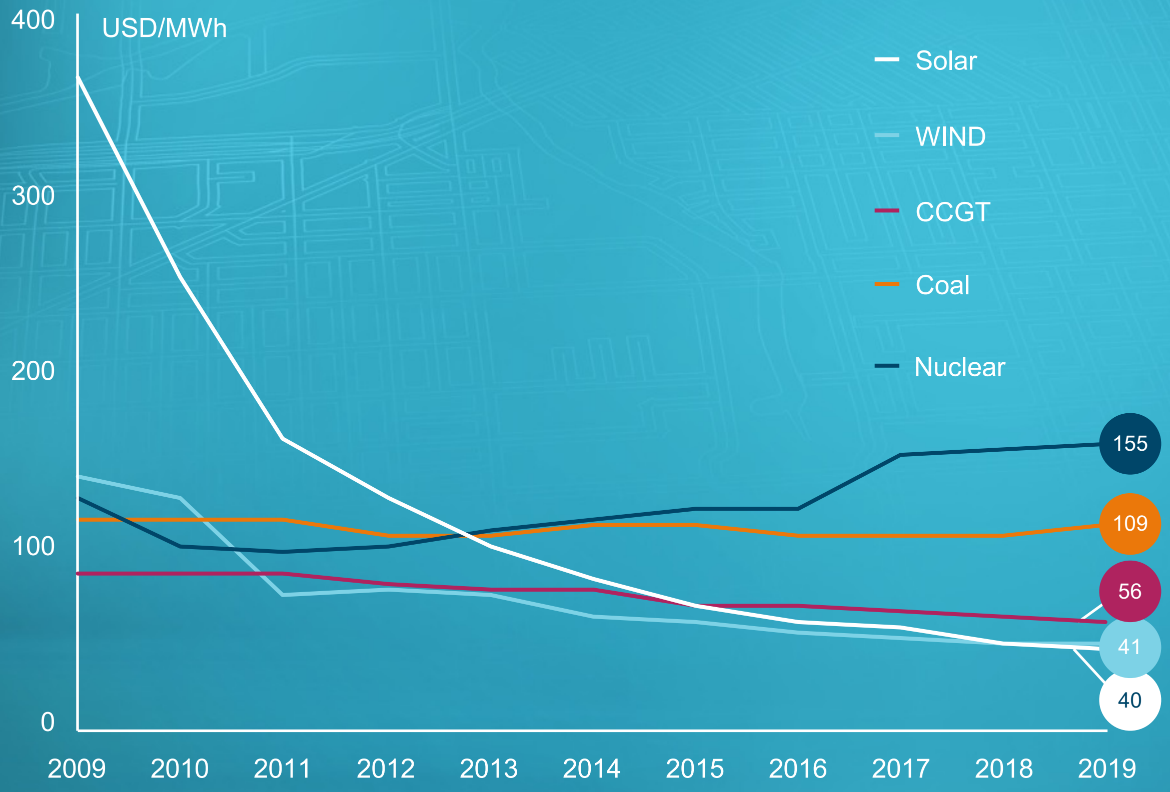
The evolving role of PV in future energy systems

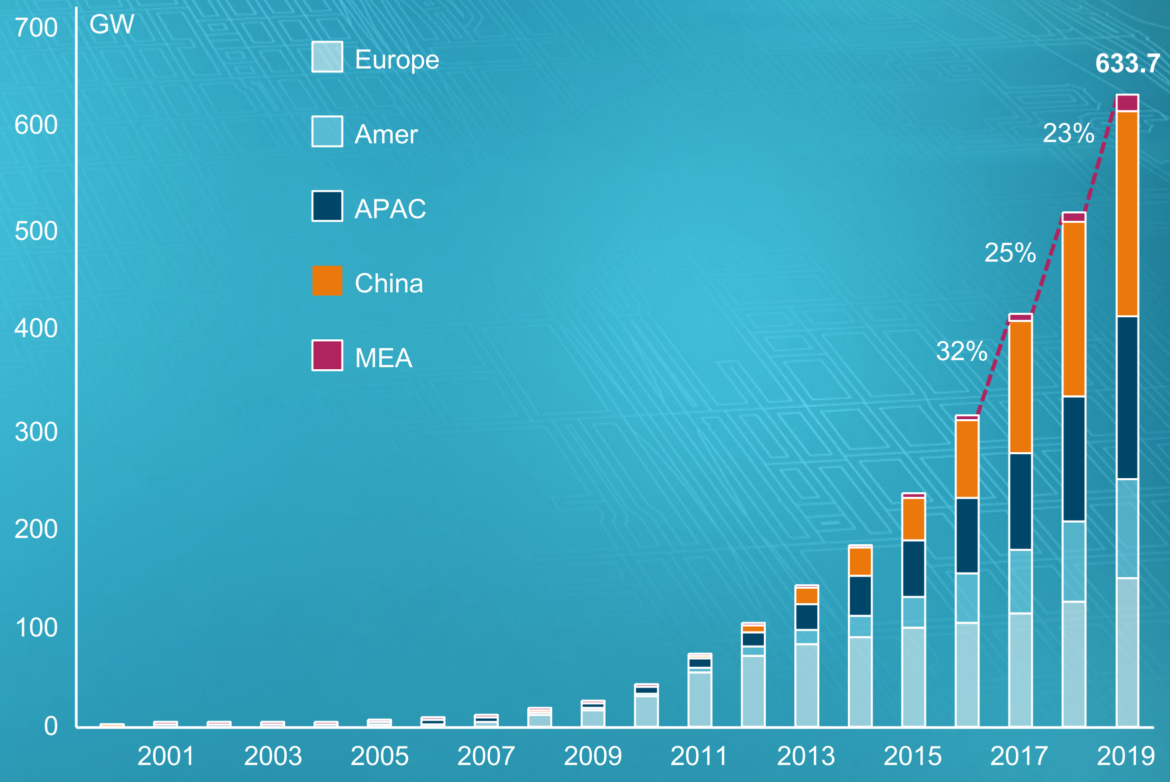
Use cases and enabling technologies – in front & behind the meter

PV price becoming lower
PV plant installation increases

Solar Electricity Generation Cost in Comparison with other Power Sources (2009–2019)[1]



Total Solar PV Installed Capacity 2000–2019



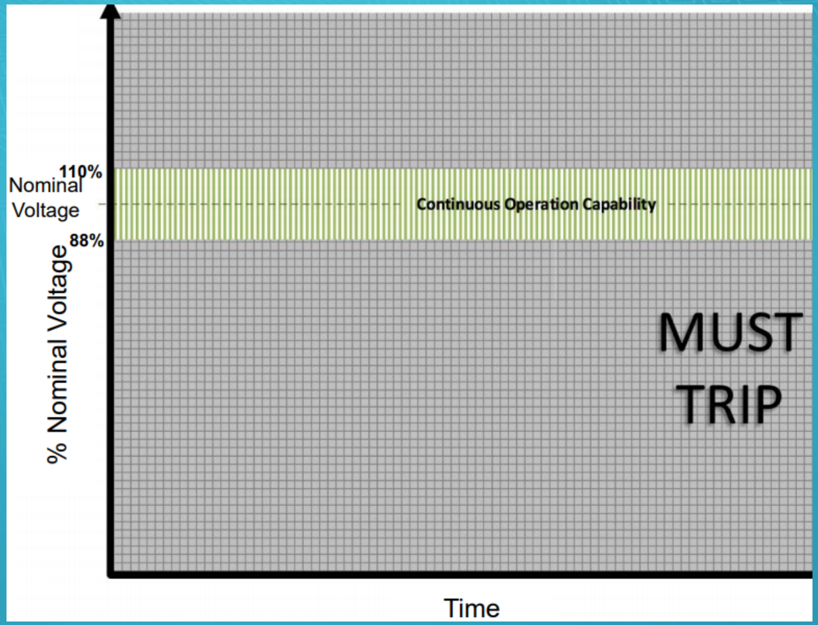
Source: Solar Power Europe 2020

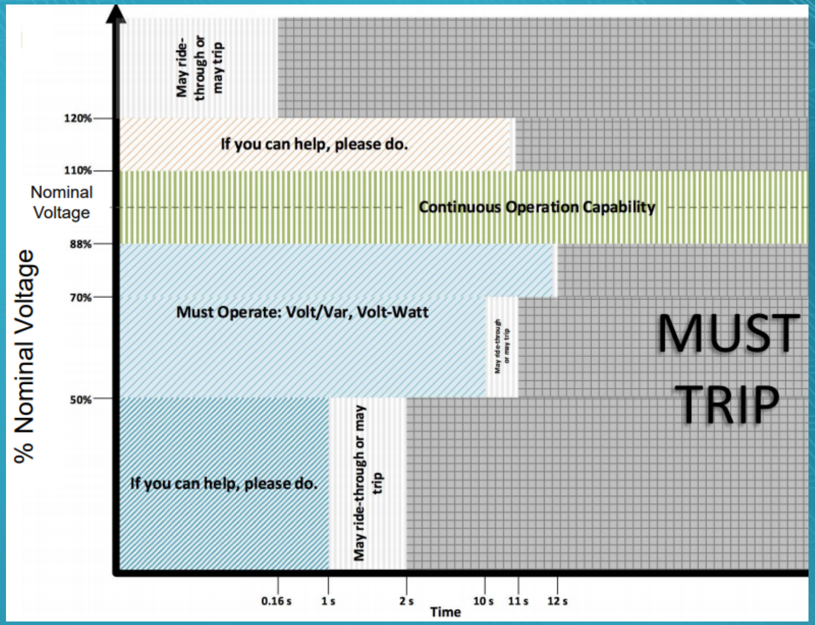
Grid codes getting more complex

Grid code criteria (extract)

- Reactive power support (Q(V)) and Voltage control
- Frequency response (P(f))
- Ride through abnormal Frequency and Voltage
- Power curtailment via interface to grid operator
- Generation forecast and scheduling
- Cybersecurity

Exemplary description





siemens.com/microgrids

Grid codes getting more complex examples around the world

Italy

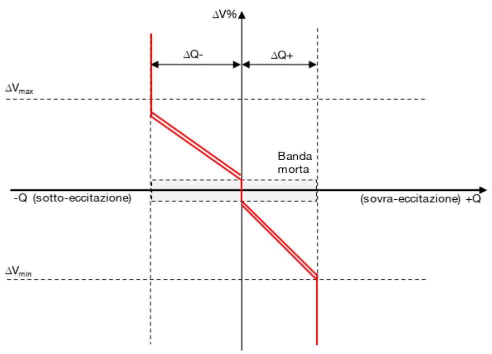


Fig. 6 – Curva caratteristica Q=f(ΔV)- Modalità base

Italy

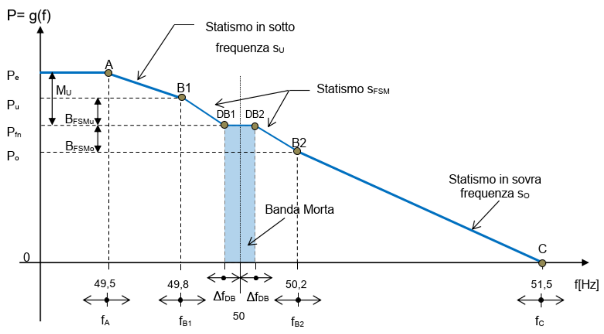


Fig. 9 – Curva P/f per una Centrale Fotovoltaica

SA

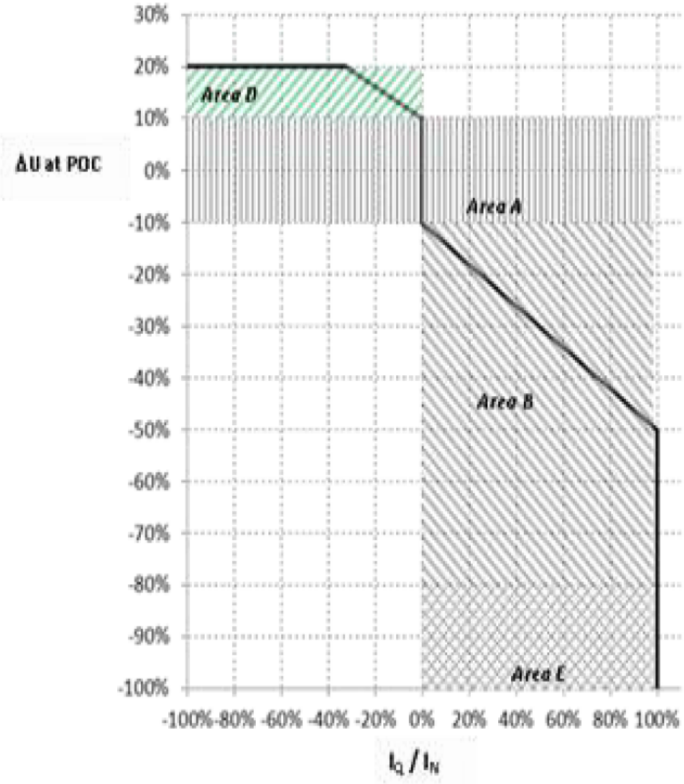


Figure 5: Requirements for Reactive Power Support, I_Q, during voltage drops or peaks at the *POC*

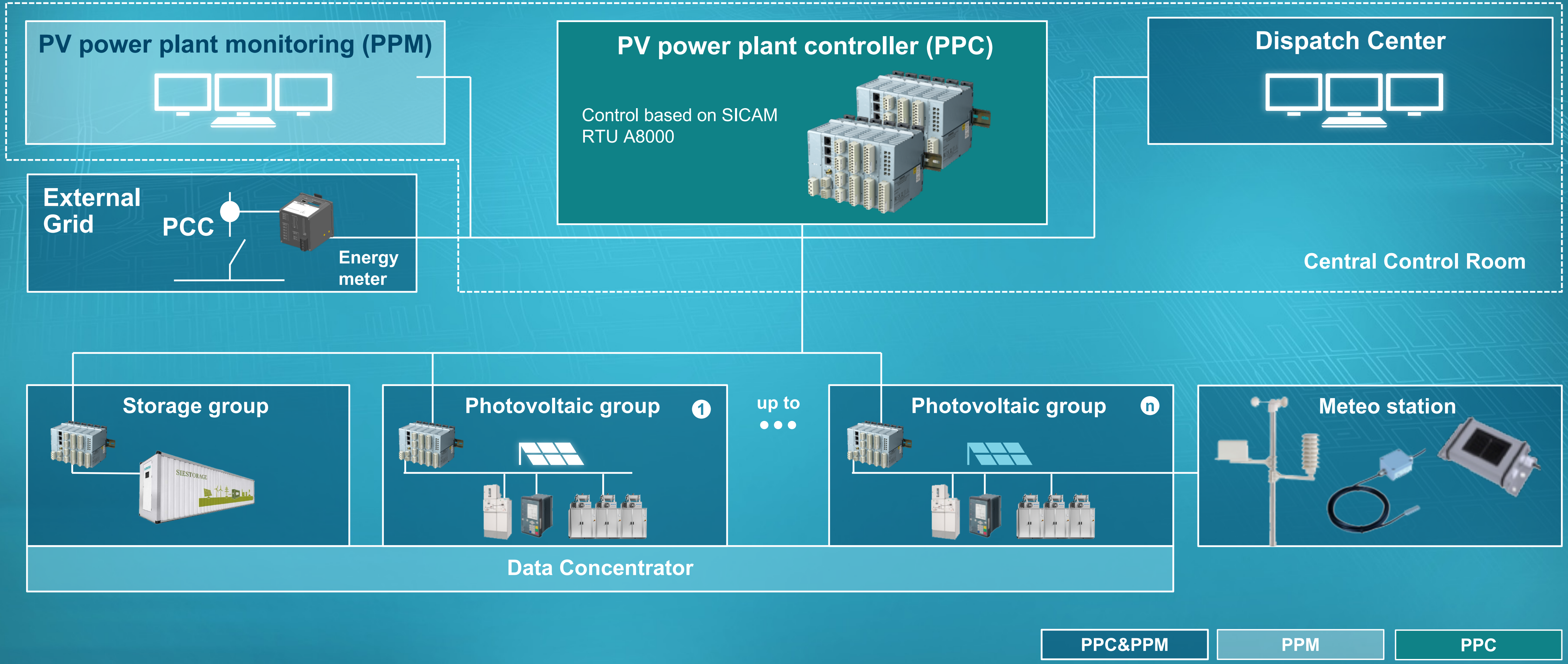
USA

Table 3—Minimum measurement and calculation accuracy requirements for manufacturers[a]

Time frame	Steady-state measurements			Transient measurements		
Parameter	Minimum measurement accuracy	Measure-ment window	Range	Minimum measurement accuracy	Measure-ment window	Range
Voltage, RMS	(± 1% V_{nom})	10 cycles	0.5 p.u. to 1.2 p.u.	(± 2% V_{nom})	5 cycles	0.5 p.u. to 1.2 p.u.
Frequency[b]	10 mHz	60 cycles	50 Hz to 66 Hz	100 mHz	5 cycles	50 Hz to 66 Hz
Active Power	(± 5% S_{rated})	10 cycles	0.2 p.u. < P < 1.0 p.u.	Not required	N/A	N/A
Reactive Power	(± 5% S_{rated})	10 cycles	0.2 p.u. < Q < 1.0 p.u.	Not required	N/A	N/A
Time	1% of measured duration	N/A	5 s to 600 s	2 cycles	N/A	100 ms < 5 s

[a]Measurement accuracy requirements specified in this table are applicable for voltage THD < 2.5% and individual voltage harmonics <1.5%.
[b]Accuracy requirements for frequency are applicable only when the fundamental voltage is greater than 30% of the nominal voltage.

Future proof – Enabled for co-location of PV and Storage, complex grid codes and adaptable functionalities



Solar Power
123 MV PV plant, Italy

Challenge

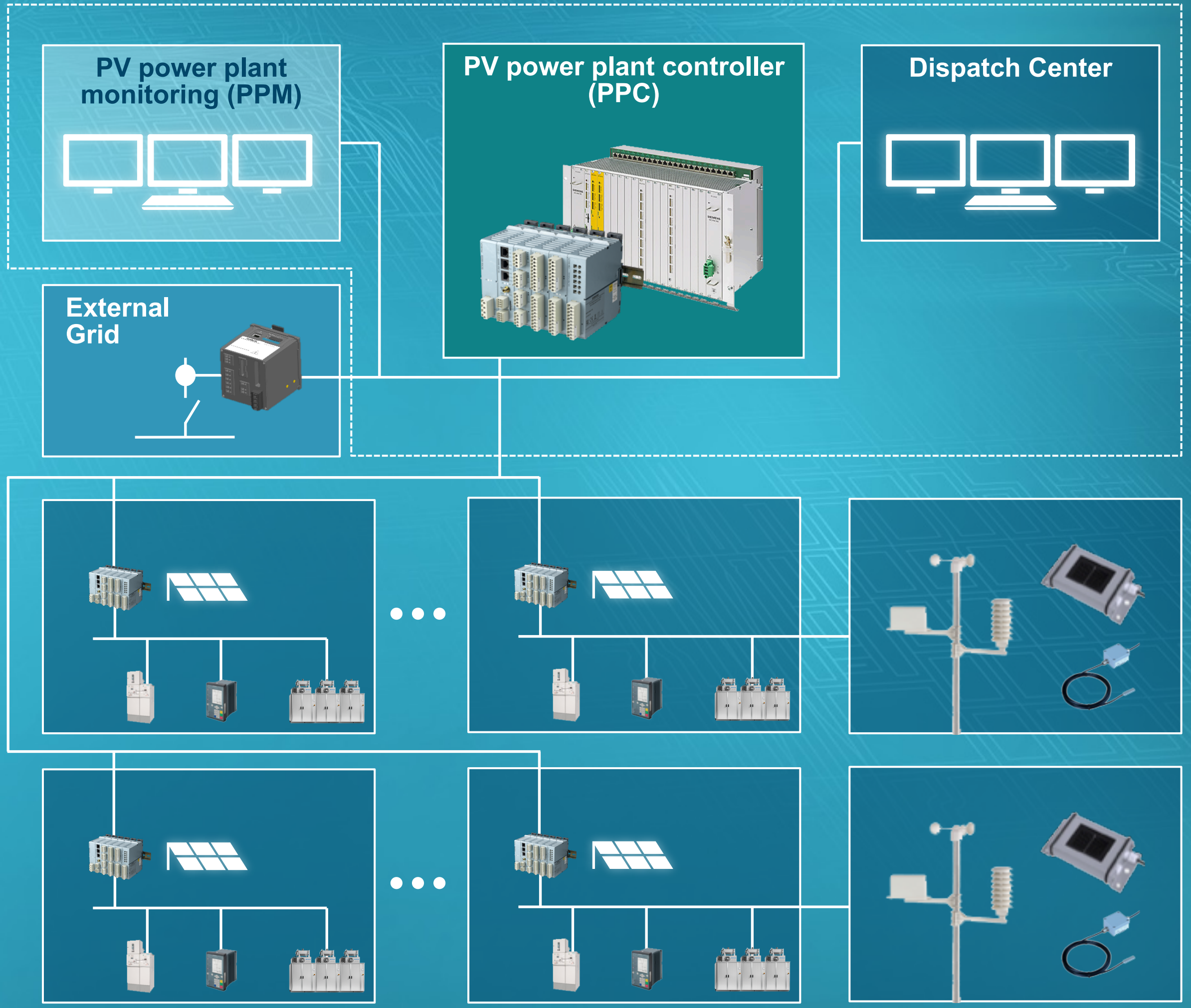
- Complex grid codes specification: P (f) and Q (V)
- Inverters on different areas with different tariff zones

Solution

- PPC & PPM control solution as a SICAM application

Benefits

- High precision closed loop controls
- High transparency of all inverters including error and warning reporting Stable and economical operation of the PV park



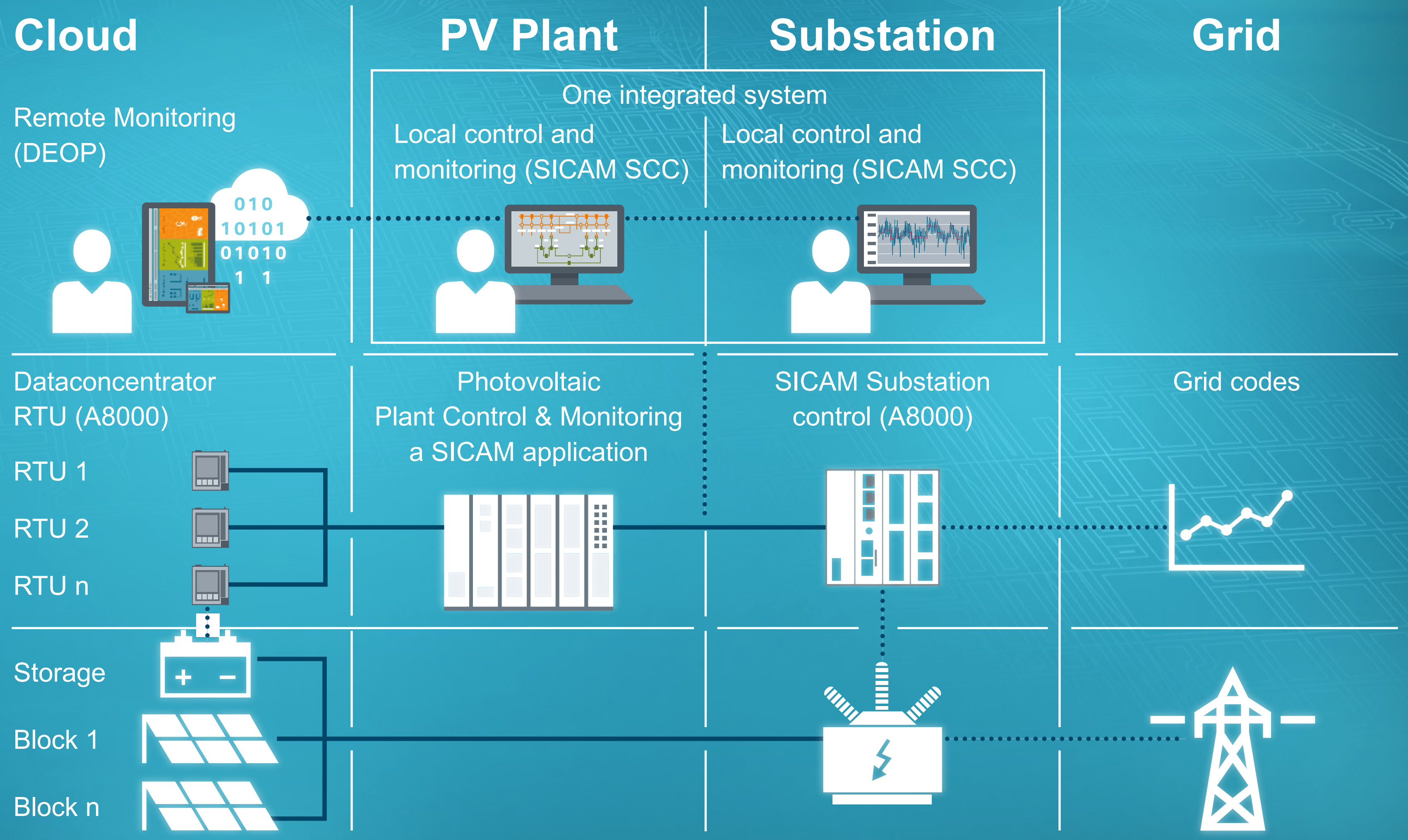
Take a look at our website

Example – PV power plants – End to end solution for monitoring, control and remote operations

Flexible, modular and scalable

Unprecedented fast cycle time (<100 ms)

Outstanding technology



Solar PV is at the heart of the Distributed Energy Transition

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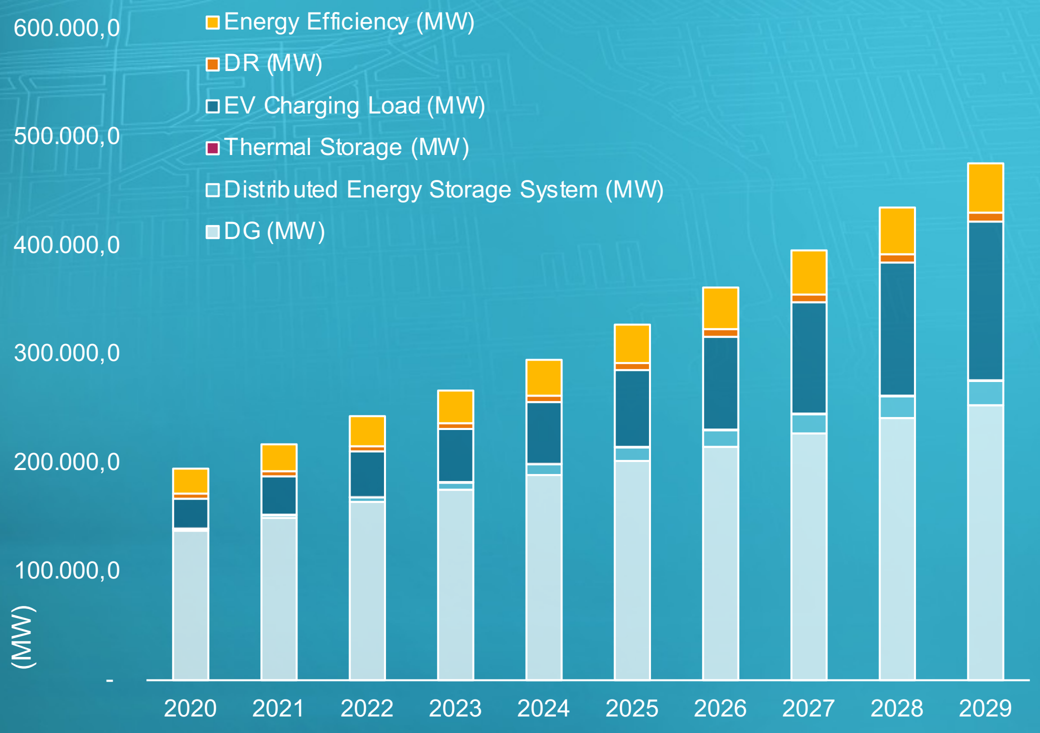
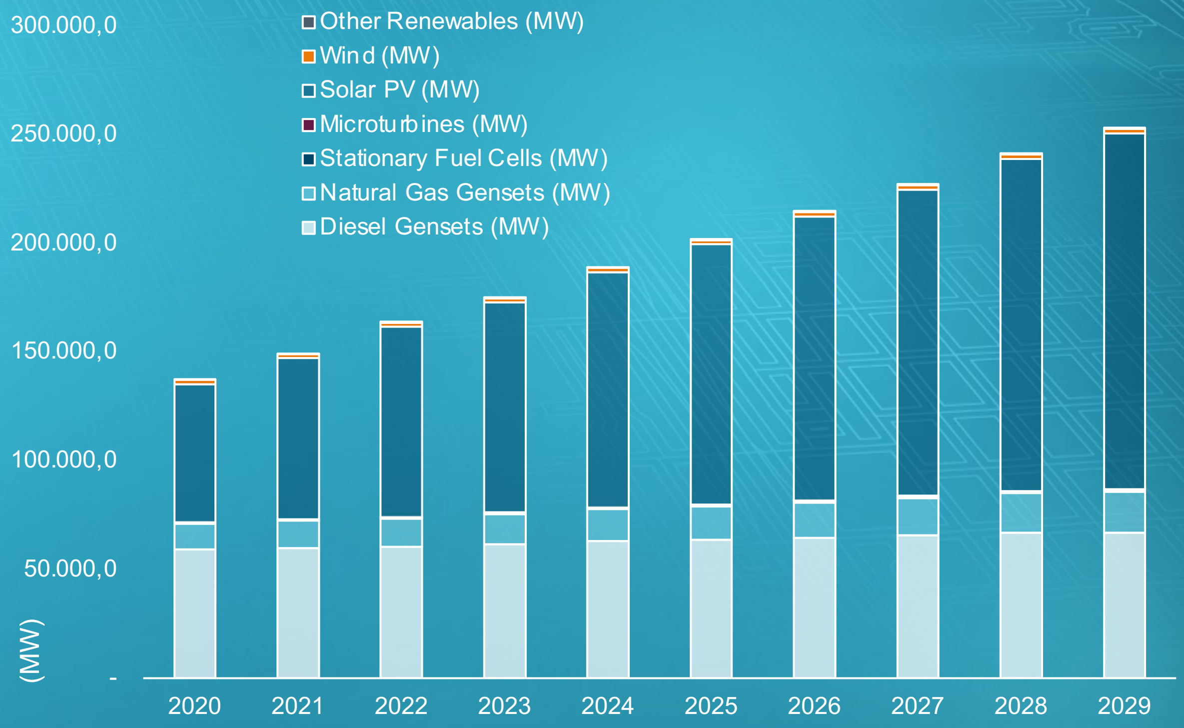
Annual Installed Total DER Power Capacity by Technology, World Markets: 2020–2029 Guidehouse Insights



Annual Installed Total Distributed Generation, World Markets: 2020–2029



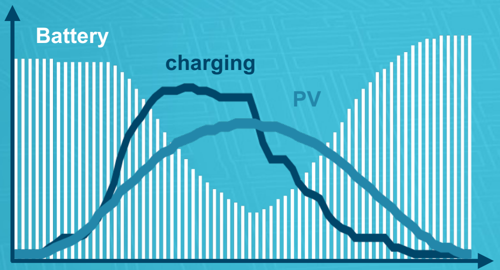
Source: Guidehouse Insights – Q2 2020

Solar PV’s contribution at the Grid Edge is application-driven

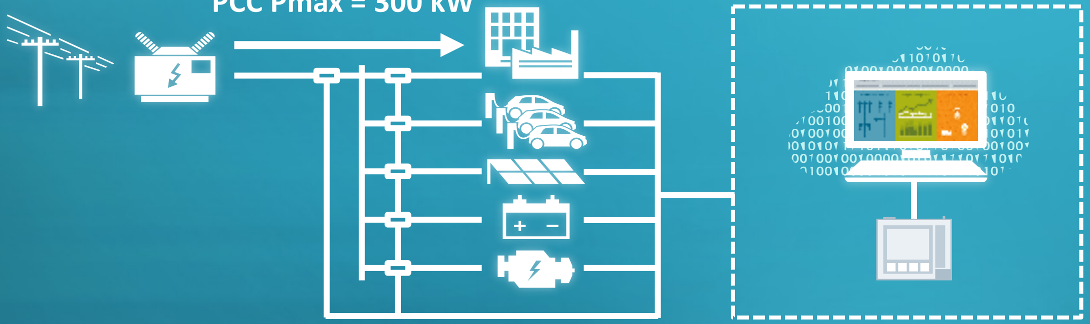
PV & Storage to support e-mobility charging

e.g. 600 kWp PV
2 MWh battery storage

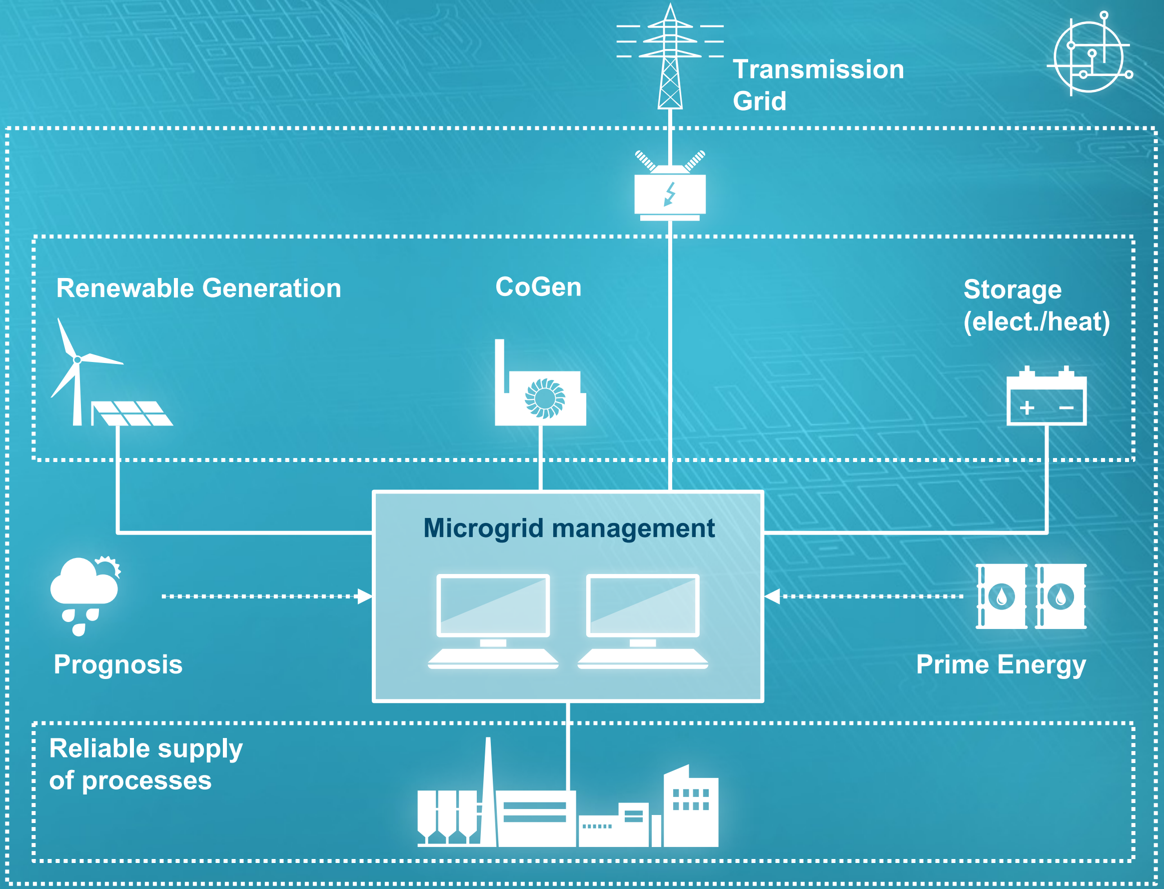
Grid independency



PV & Storage to defer CAPEX investments



Enhancing energy efficiency, power quality and resilience further through a Microgrid solution



There is not a one size fits all solution at the Grid Edge

External Factors

Growing electricity cost for building/facility operation

New peak loads, e.g.,
- New production lines
- Extended heating/cooling
- eVehicle charging

CO_2 – footprint target not achievable with current energy – consumption mix

Electricity from RES is the preferred energy carrier

Security of power supply and resilience is essential

Business Case Drivers

CAPEX/OPEX economic value and power grid feasibility

Variable power in-feed from renewables

Manage balance of generation and load

Autonomous backup alternative to keep power availability

New loads need flexible supply and compliance to network codes

Innovation at the Grid Edge (Products, Systems, Solutions)

Grid compliance and economic value feasibility study

Leveraging on excellent knowledge relation with grid operators and utilities

Distributed generation, participation in the energy market

Electrical equipment and power electronics

Energy automation and management, software

Storage solutions

Solar PV: A pillar for resiliency at the Grid Edge

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Challenge

- Week grid connection jeopardizing security of supply
- High CO_2 emmissions with diesel generation
- High Opex

Solution

- Grid Edge Solution with Microgrid Controller, PV, Battery Storage, and Building Load Management

Benefits

- Stable and economical operation of the industrial area
- Reduction of CO_2 emissions
- Reduction of peak load costs

Take a look at our website

Customer E-Charging

Microgrid Controller

Building Management

140 kWh

298 kWp

702 kWp

800 kW Diesel

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Commercial and Industrial String Inverters

BP 50 Series:

- Best for: large scale roofs and solar parks
- Robust and easy to install
- Highest technical + economical efficiency = lowest TCO

BP 87-110 Series:

- Best for: large scale roofs and medium-sized solar parks
- Highest efficieny (99.2 %) due to unique SiC power transistors
- Compact and light
- Full feed-in power at high ambient temperatures

KACO
new energy.

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Future Proof at the Grid Edge …

Products/Services

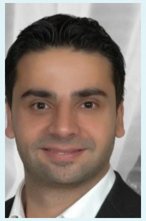
- Microgrids
- Building mgmt.
- Fire Safety
- KACO String Inverters
- Storage
- Financing
- Consulting

X as a Service Offerings

- Greater savings through holistic View
- Minimized risk for project execution
- No budget needed
- Faster in achieving sustainability goals
- Minimized risk for performance
- Cash-flow neutral

… with our Grid Edge Products, Systems, and X as a Service offerings

Any questions? Get in contact!



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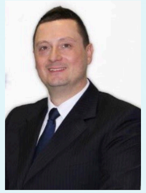

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