Control Your Power Plant!
Or It Will Control You.
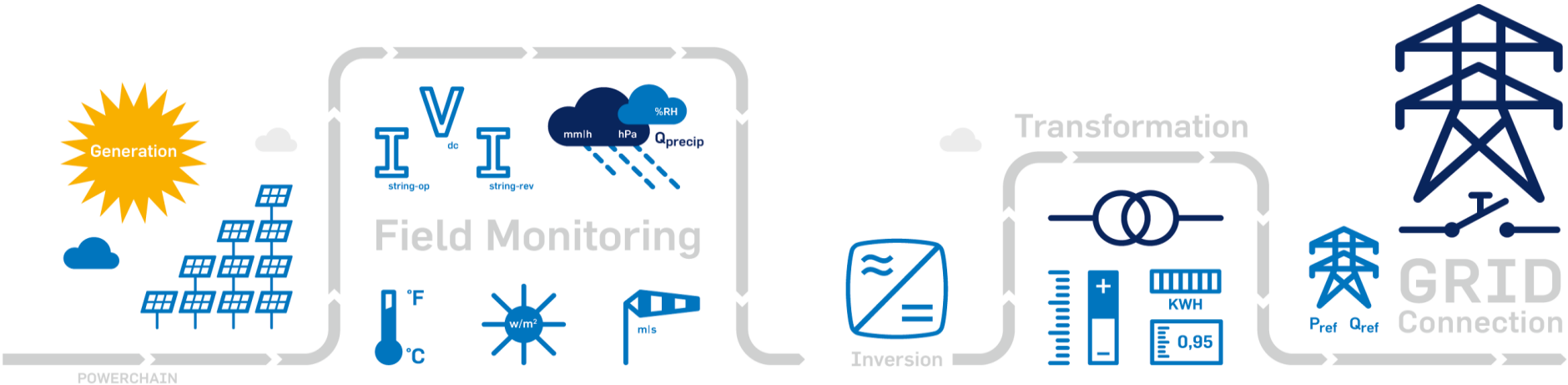
19/01/2007

Power Control and Power Dispatching
for Romania's Photovoltaic Power Plants

2013 Romanian Solar Summit, Bucharest, 19 November 2013

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Control
in a PV Plant?

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pioneers of energy

Measurement

Condition monitoring

Data acquisition

Data storage

Data computation

Data management

Visualisation

Evaluation

Closed-loop control

Monitoring, Control and Supervision
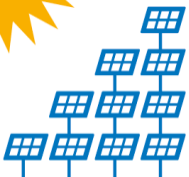
Measurement

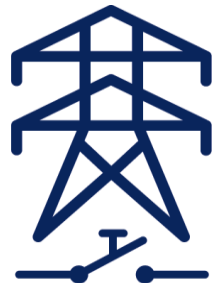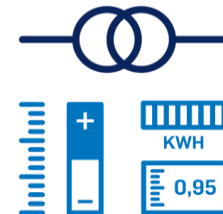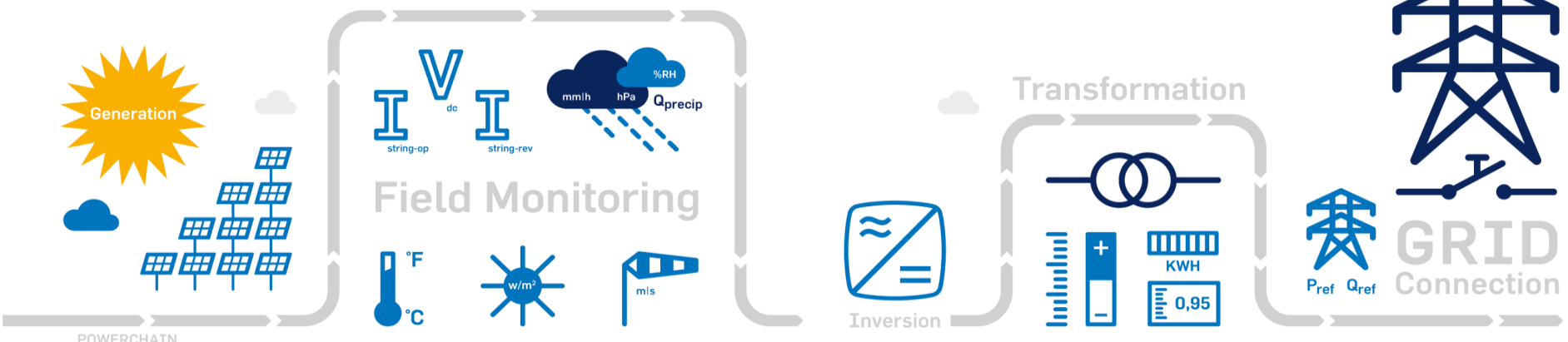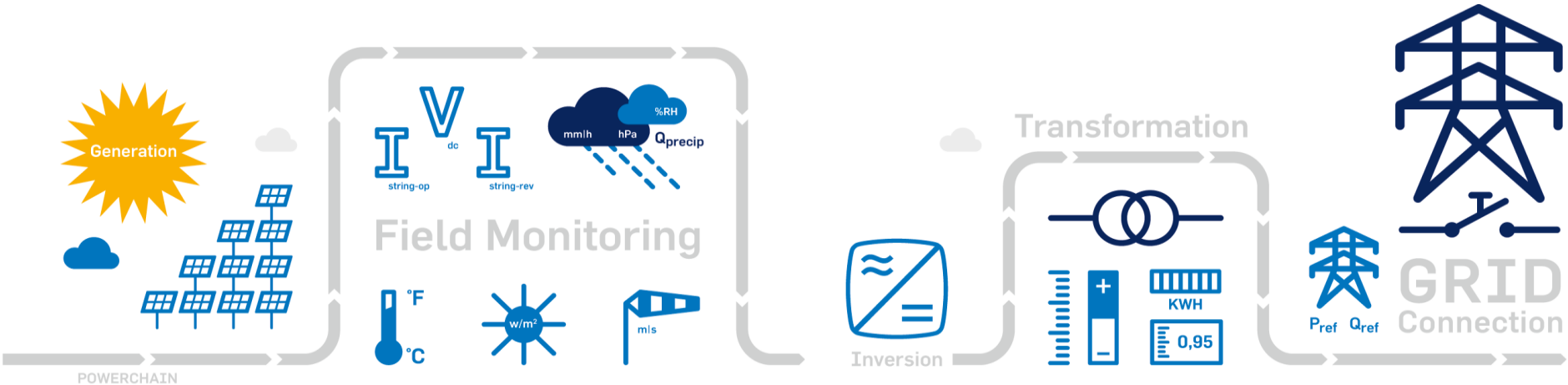Condition monitoring

Data acquisition

Data storage

Data computation

Data management

Visualisation

Evaluation

Closed-loop control

Monitoring,

and Supervision

Control

Data Base for
Power Plant Control

Data Base for Power Plant Control

skytron® pioneers of energy

Field information
Electrical quantities
(String currents, Voltages)
Ambient conditions (weather)

Inverter information

Grid and feed-in information
Electricity grid, energy meter, transformer, DNO requirements, medium-voltage switchgear, ...
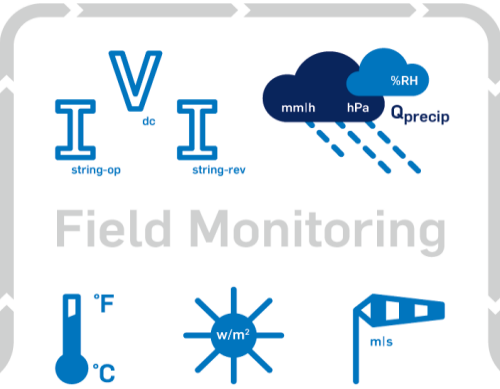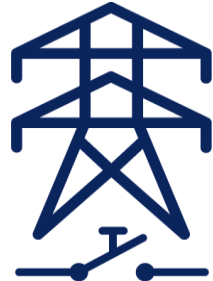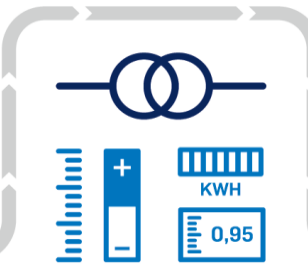
Data Base for Power Plant Control

Grid and feed-in information
Electricity grid, energy meter, transformer, DNO requirements, medium-voltage switchgear, ...

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(String currents, Voltages)
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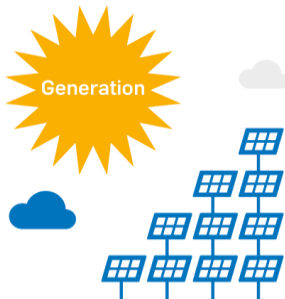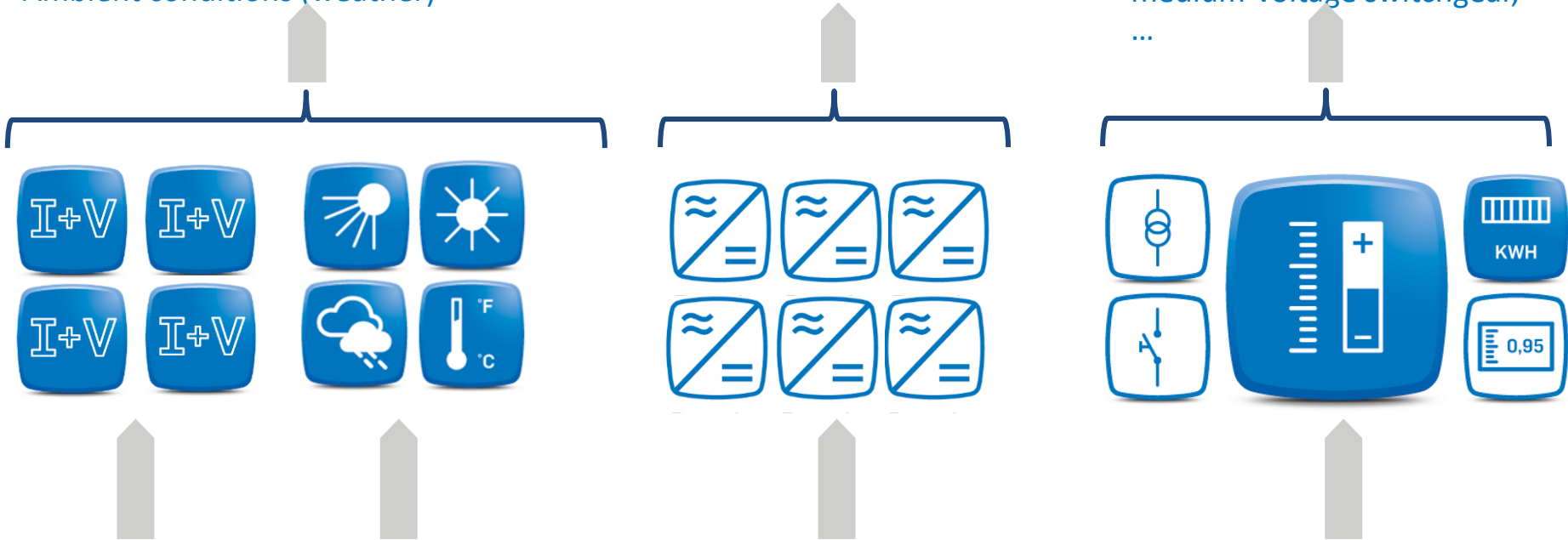
KWH

0,95

Generation

%RH

mm/h   hPa Q_{precip}

V_{dc}

$I_{string-op}$ $I_{string-rev}$

Field Monitoring

°F

°C

w/m²

m/s

Transformation

KWH

0,95

Inversion

P_{ref} Q_{ref}

GRID
Connection

04 SUPERVISORY CONTROL LEVEL

03 CONTROL LEVEL

02 DATA ACQUISITION LEVEL

01 SENSOR LEVEL

PVGuard®
SUPERVISION
PLATFORM

BROADBAND

BROADBAND COMMUNICATION

BROADBAND COMMUNICATION

skycontrol + EnergyGuard
POWER PLANT CONTROLLER

KWH

0,95

ETHERNET PLANT NETWORK

skylog©
LOCAL DATA LOGGER

skylog© outdoor
LOCAL DATA LOGGER

skylog©
LOCAL DATA LOGGER

CANOPEN FIELDBUS

FIELDBUS

POWER
GENERATION

ArrayGuard®
COMBINER BOX

StringGuard®
CURRENT + VOLTAGE

skyCONNi
PYRANO

skyCONNi
TEMPERATURE

STRING
INVERTER

POWER
GENERATION

I+V

skyCONNi
WEATHER

skyCONNi
TRACKING

skyCONNi
RADIATION

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pioneers of energy
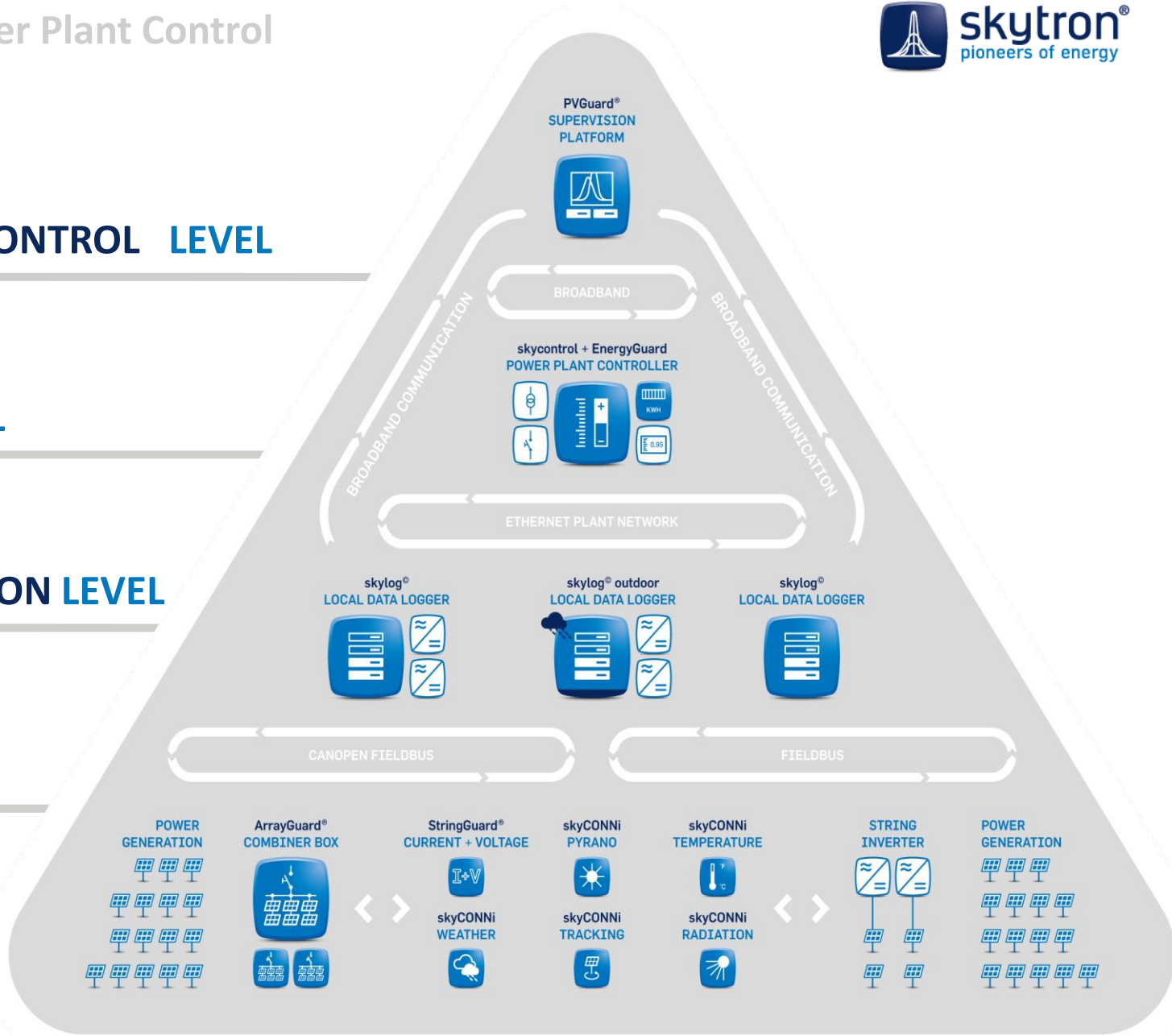
04 SUPERVISORY CONTROL LEVEL

03 CONTROL LEVEL

02 DATA ACQUISITION LEVEL

01 SENSOR LEVEL
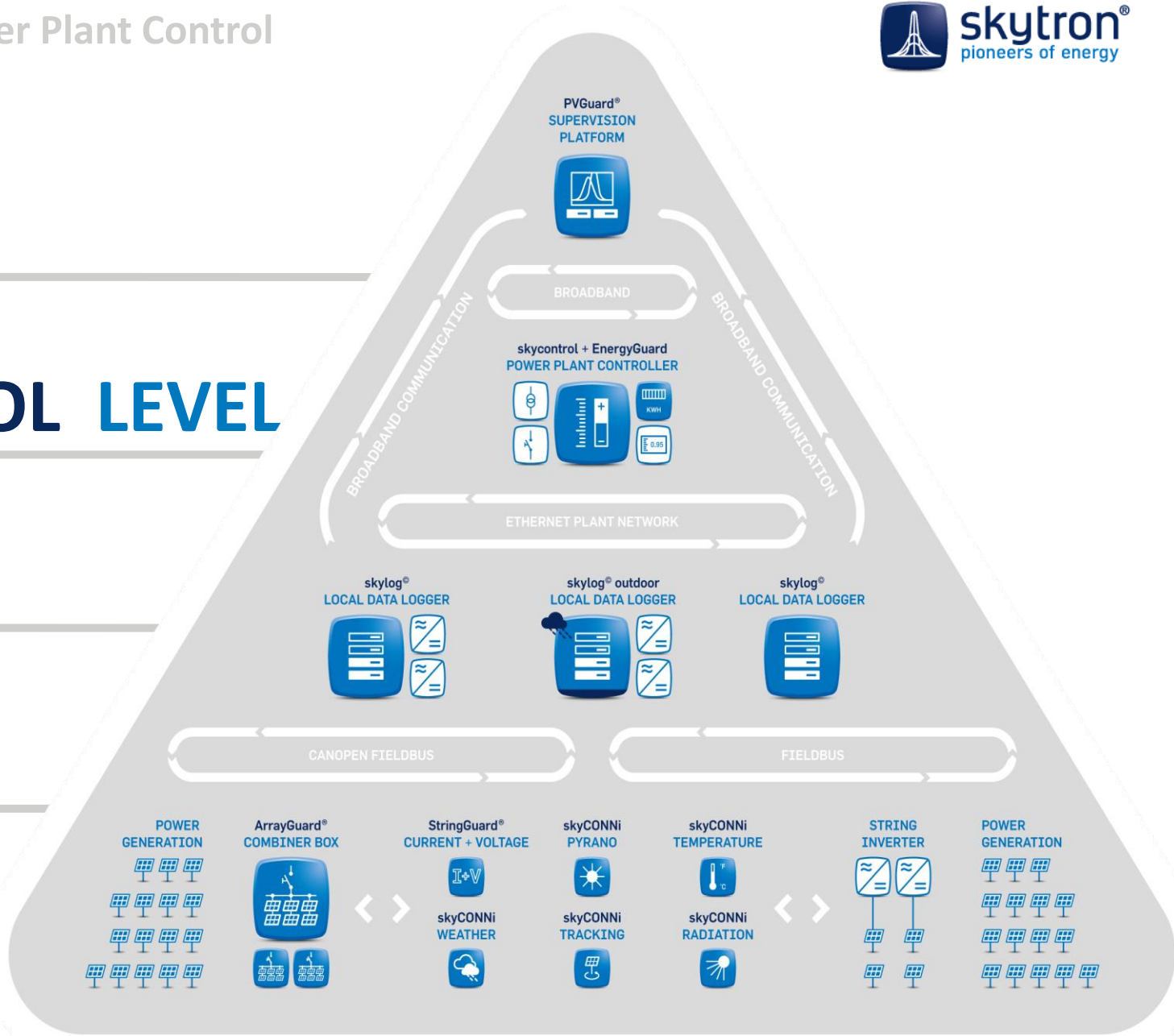
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Control Principle
for PV Power Plant Control

Power Plant Control: Principle of Operation

Setpoint

$+$ $P_{setpoint}$

$+$
$-$

Closed-loop control
with continuous
control correction

Setpoints from grid operator
> Active power curtailment P
> cos φ, Q - fixed setpoints, or
> Control characteristics cos φ(P), cos φ(V), Q(V)

Plant Controller

Plant controller
controls inverters of
different makes offering
differing control response

Actuating values

P_1

P_n

$+$
$-$

Controller

Controller

Controller

Inverters with integrated control

Inverter

Inverter

Inverter

Feedback
of actual values measured
at grid connection point

Passive power components

... acting as filters

Actual value

P_{actual}

Network analyser

Permanent actual value measurement
> P, Q
> Power factor cos φ
> Grid frequency, grid voltage

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Setpoints from grid operator ?

?

> **Active power curtailment P**
> **cos φ, Q - fixed setpoints, or**
> **Control characteristics cos φ(P), cos φ(V), Q(V)**

Setpoint

$+\ P_{setpoint}$
$-$

Plant Controller

Actuating values

P_1 P_n

Controller   Controller   Controller

Inverter   Inverter   Inverter

Inverters with integrated control

Passive power components   … acting as filters

Actual value

P_{actual}

Network analyser
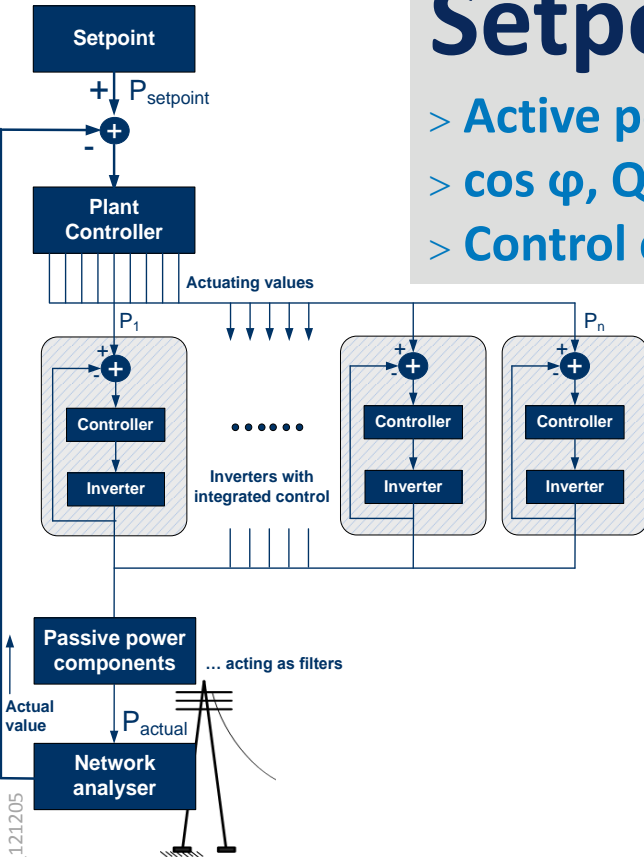
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Control Requirements
in Romania
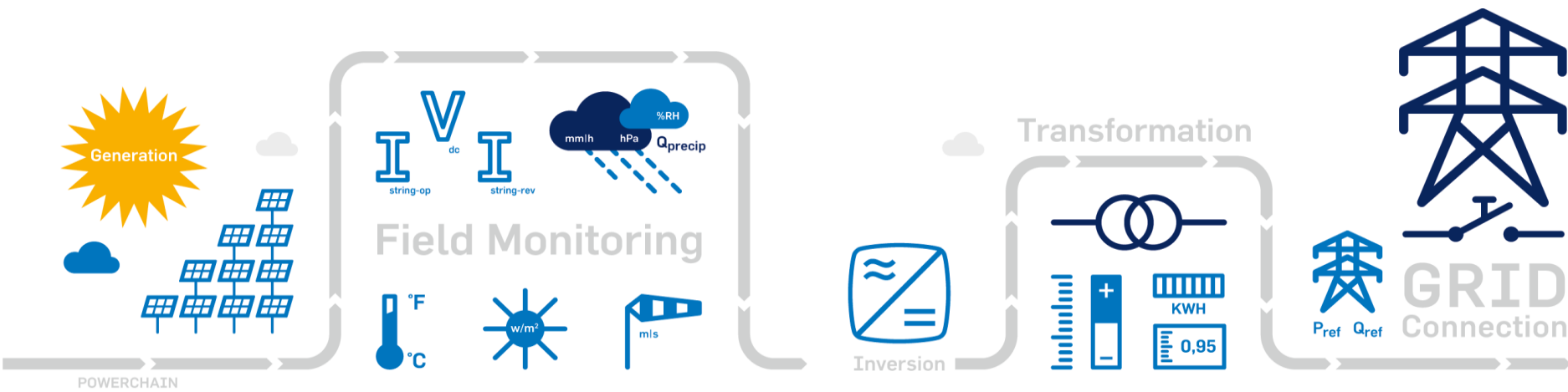
Power Generation

Grid Operator

Electricity Grid
110 kV, 220 kV.
400 kV, 750 kV

Power plant inherent control

Generation

POWER FEED INTO ELECTRICITY GRID

Closed-loop control: Feedback of actual values
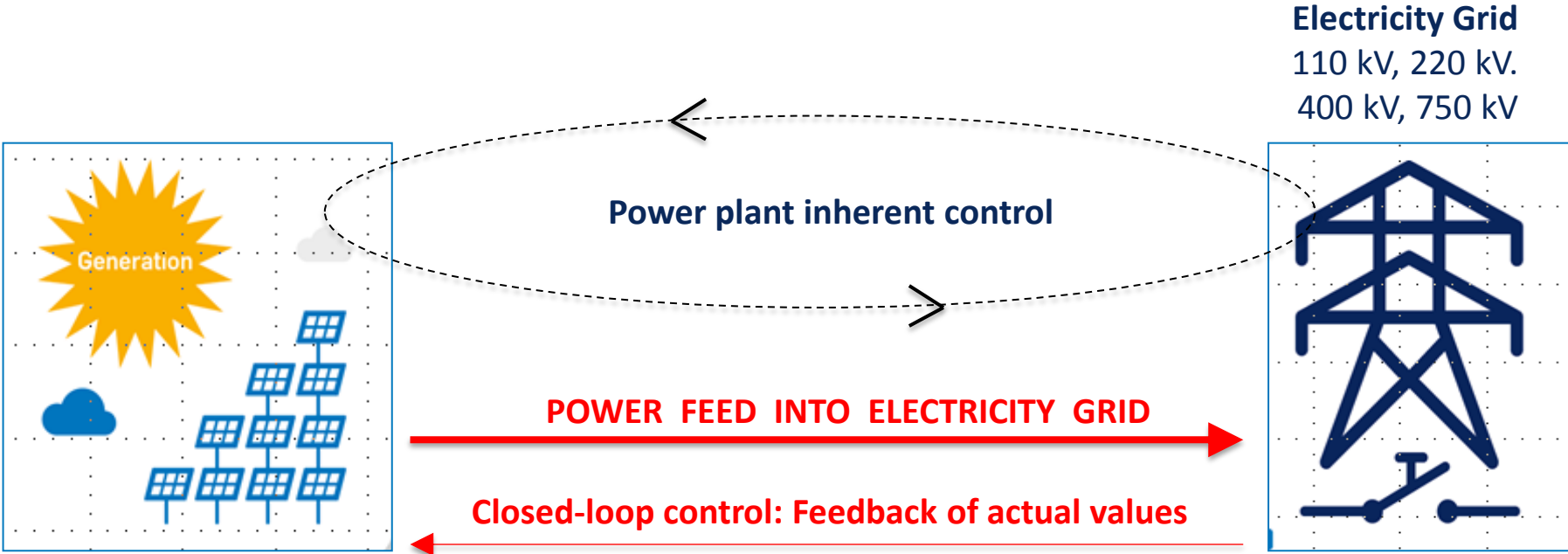
Control Requirements in Romania: Power Dispatching

Power Generation | **Dispatcher** | **Transelectrica**

IEC 60870

Confirmation

Setpoints

Gateway

Electricity Grid
110 kV, 220 kV.
400 kV, 750 kV

Generation
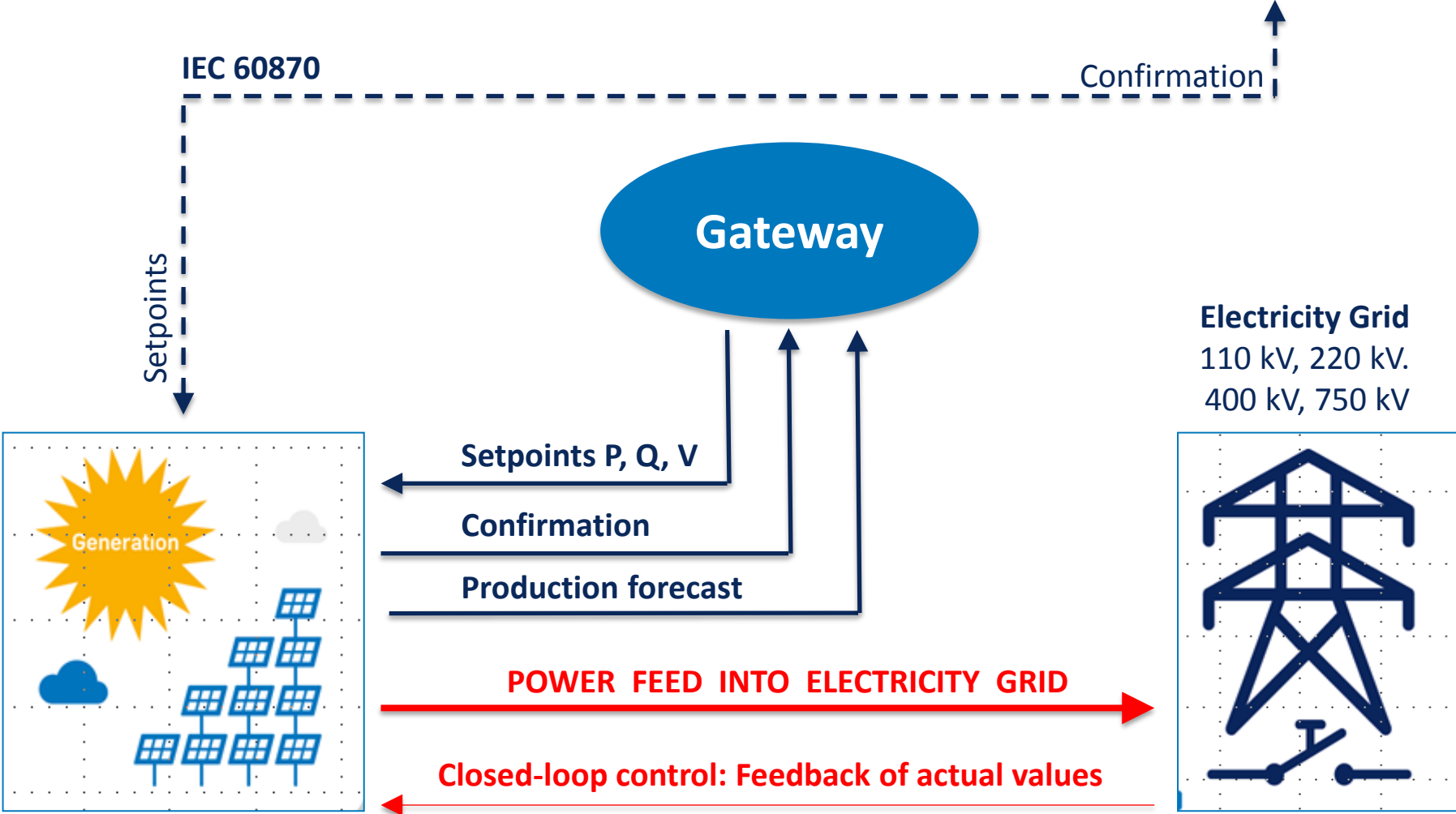
Setpoints P, Q, V

Confirmation

Production forecast

POWER FEED INTO ELECTRICITY GRID

Closed-loop control: Feedback of actual values

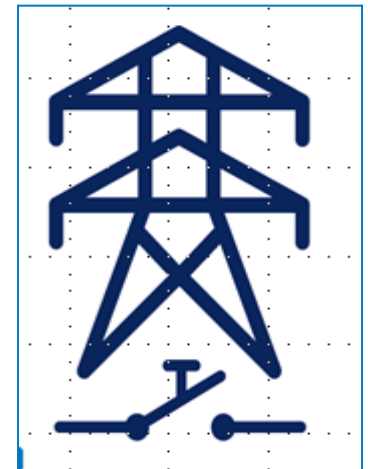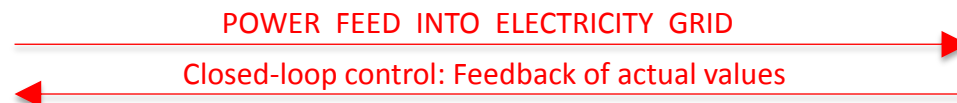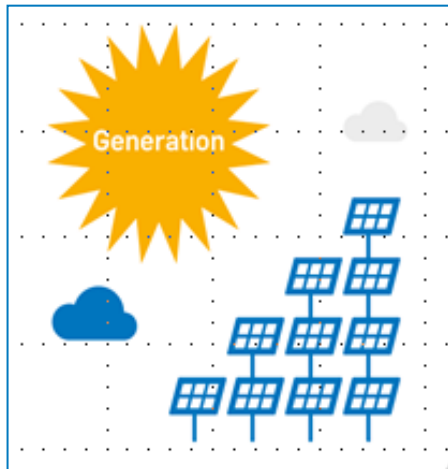**Special control functions**   (for plants > 10 MWp)

> Power feed controlled by **DISPATCHERS**   (... and not by the grid operator)

> Active power control P(f) in response to changes in grid frequency:
> → provide balancing power in the event of underfrequencies
> → enhances stabilization of grid frequency
> → can be enabled/disabled upon demand

> Reactive power control as a function of Q or V

Electricity Grid
110 kV, 220 kV,
400 kV, 750 kV

Generation

POWER FEED INTO ELECTRICITY GRID

Closed-loop control: Feedback of actual values

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Less demanding control functions for plants < 10 MWp

> Power feed controlled by **DISPATCHERS** (… and not by the grid operator)

> Active power control

> Reactive power control (cos phi)

> Reactive power compensation at night,
possibly making use of compensator banks

Electricity Grid
typically: 20 kV

POWER FEED INTO ELECTRICITY GRID

Closed-loop control: Feedback of actual values
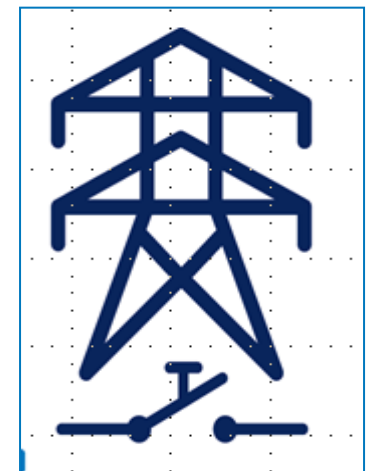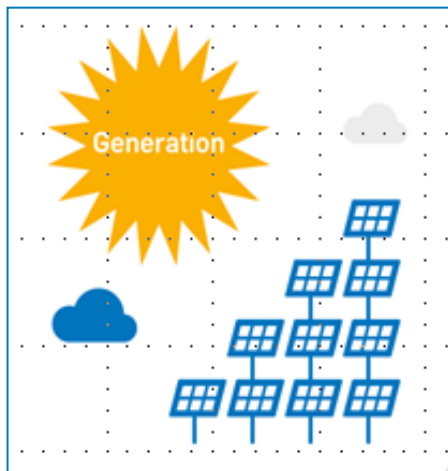
Flexible power plant control according to Romanian grid requirements

NEW
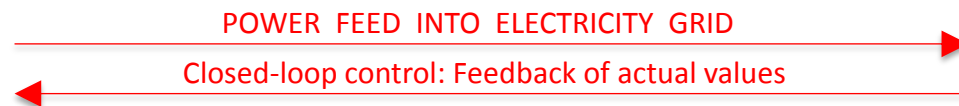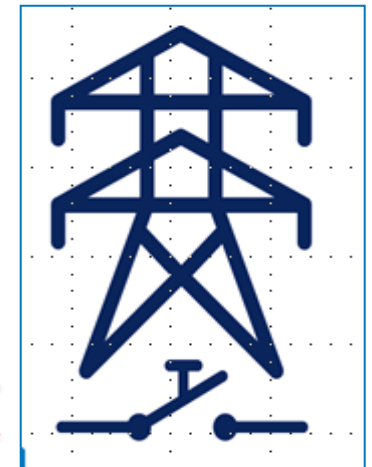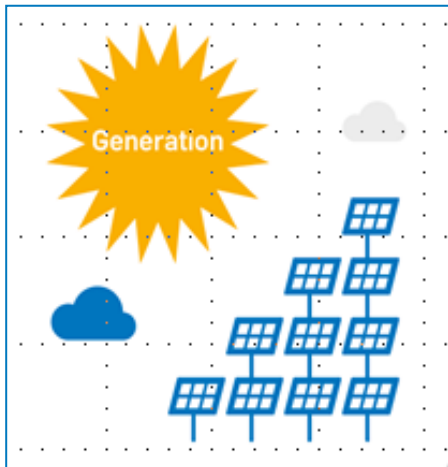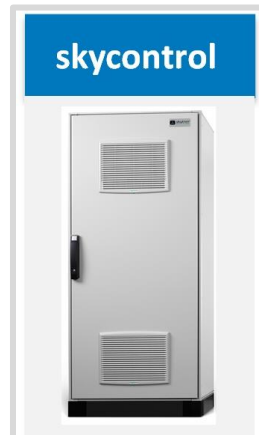## PV power plants

> 110 MWp completed or to be commissioned by the end of 2013

> In Giurgiu District with EPC partner LSG Building Solutions

RETROFIT
PV power plants

> 16 MWp currently being retrofitted in order to integrate required power plant control

Power Plant Control

skycontrol

Generation

POWER FEED INTO ELECTRICITY GRID

Closed-loop control: Feedback of actual values

4.5 GWp worldwide relies on skytron® energy

... thereof: More than 2 GWp with skycontrol - Power Plant Controller

CANADA 67.9 MWp

USA 5.8 MWp

BELGIUM 10.4 MWp

UNITED KINGDOM 26.5 MWp

GERMANY 2 441.1 MWp

FRANCE 280.9 MWp

CZECH REPUBLIC 72.1 MWp

UKRAINE 763.5 MWp

RUSSIA 1 MWp

SPAIN 72 MWp

ROMANIA 78.7 MWp

INDIA 304.4 MWp

ITALY 272.5 MWp

ISRAEL 4.1 MWp

MALAYSIA 6.2 MWp

SLOVAKIA 2 MWp

THAILAND 18.1 MWp

BULGARIA 8.2 MWp

URUGUAY 1.8 MWp

GREECE 7.2 MWp

KUWAIT 0.2 MWp

TONGA 1 MWp

CHILE 10.1 MWp

SAUDI ARABIA 4 MWp

QATAR 0.7 MWp

MAURITIUS 15 MWp

AUSTRALIA 1 MWp

OFFICES: DALLAS / SANTIAGO DE CHILE / BERLIN / CAPE TOWN / BANGALORE / SINGAPORE / BEIJING

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Together
Let's Put the Sun into Our Power Plants

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Meet the PV market

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