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Enel Distribuzione

PV GRID

PV GRID – WP3

Technical Solutions for PV Integration

Existing Regulatory Barriers to Grid integration

Athens, July 4th, 2013

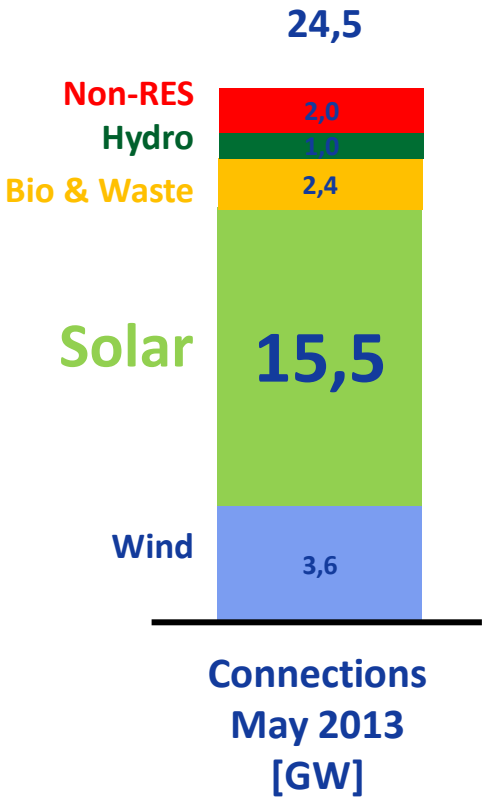
WWW.PVGRID.EU

Agenda

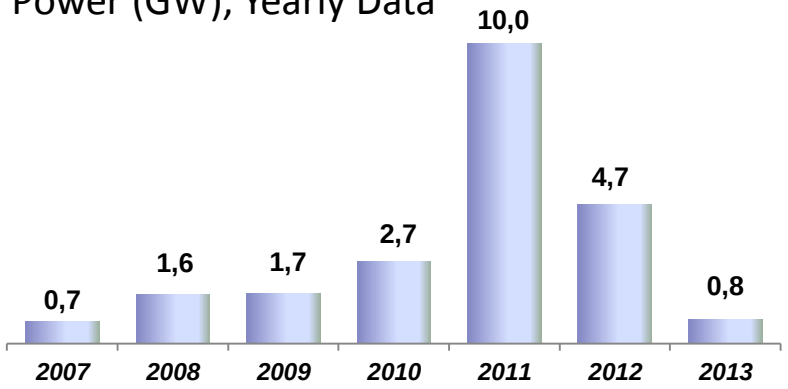
- DG and PV integration in the distribution network in Italy
  - Connection activities
  - Challenges for DSOs
- Identification of the relevant technical solutions in Italy
- Barriers
  - RES-Curtailment
  - Access to advanced inverter capabilities
  - Storage use
  - Self consumption
  - Control of passive loads by DSOs
  - Information exchange for Demand Response

ENEL DISTRIBUZIONE – DG CONNECTED

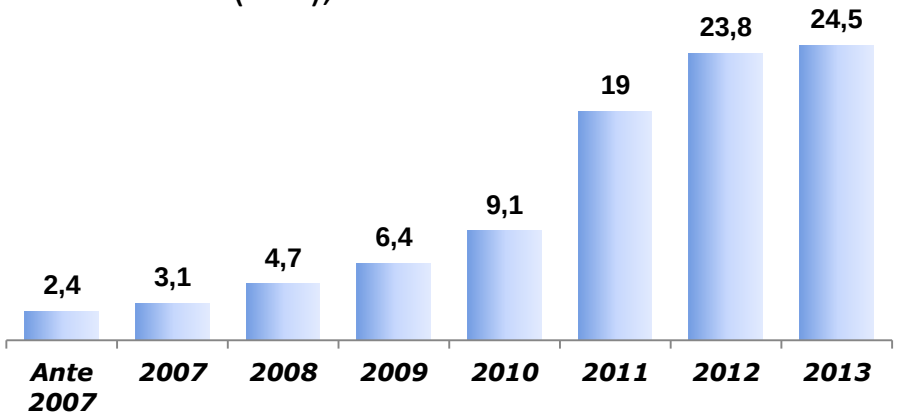
Up to May 2013



Connected Power (GW), Yearly Data



Connected Power (GW), Cumulative Data

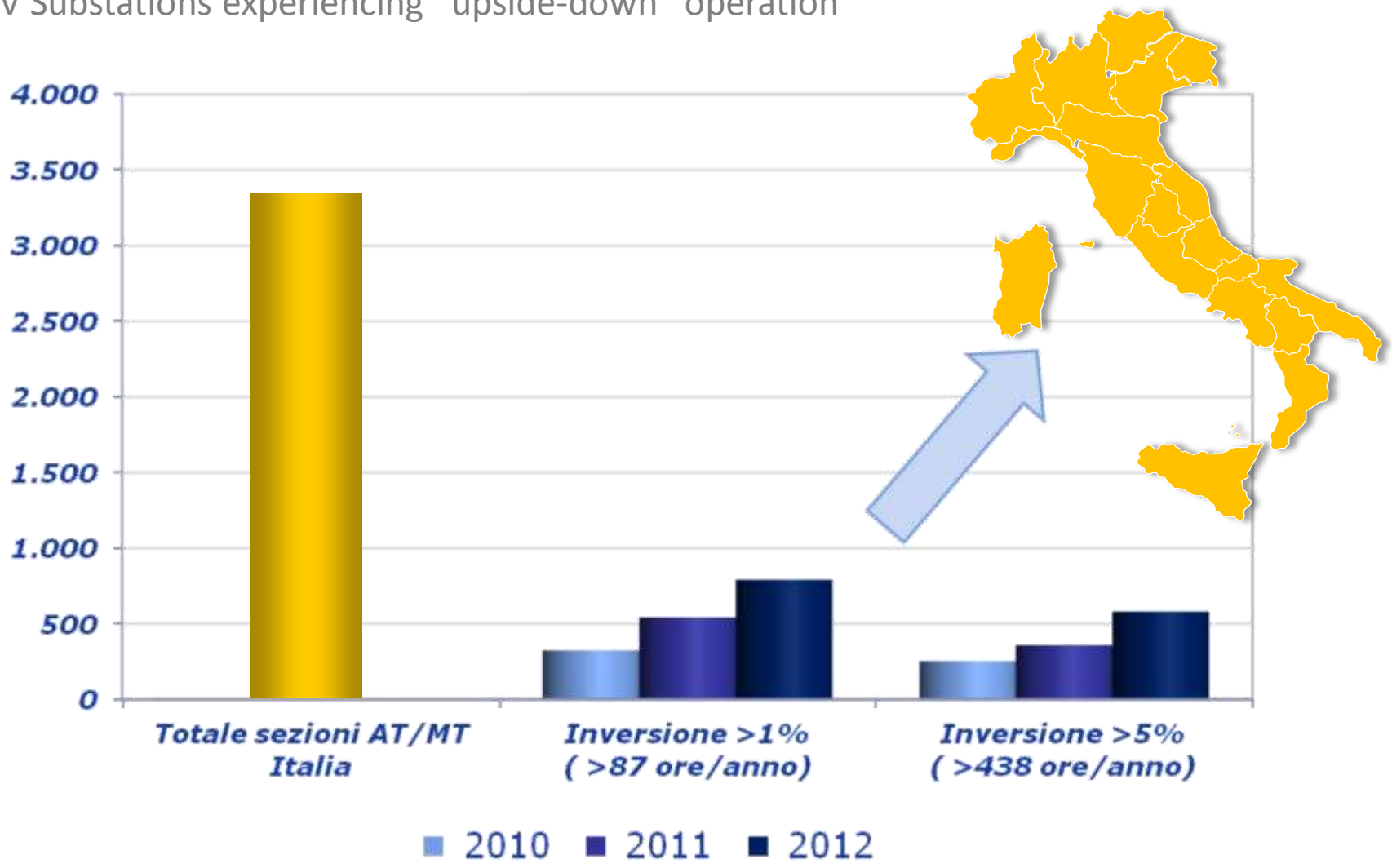


Cumulative connections (No.): 488.100

Most DG is connected to MV network

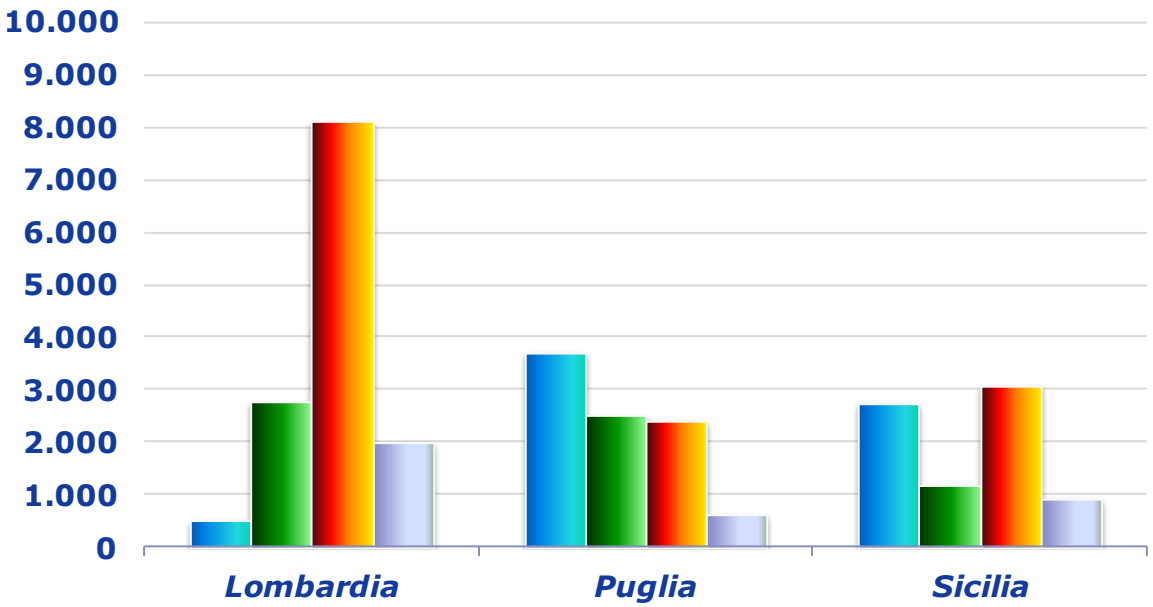
ENEL DISTRIBUZIONE – REVERSE ENERGY FLOWS

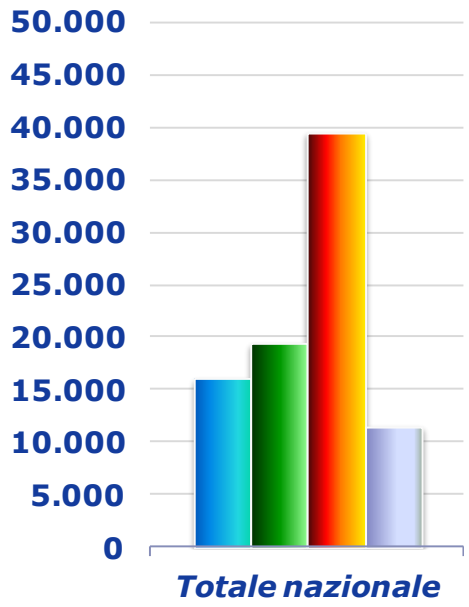
HV/MV Substations experiencing “upside-down” operation



ENEL DISTRIBUZIONE – LOAD / DG BALANCE

Matching generation and load in MV-LV networks

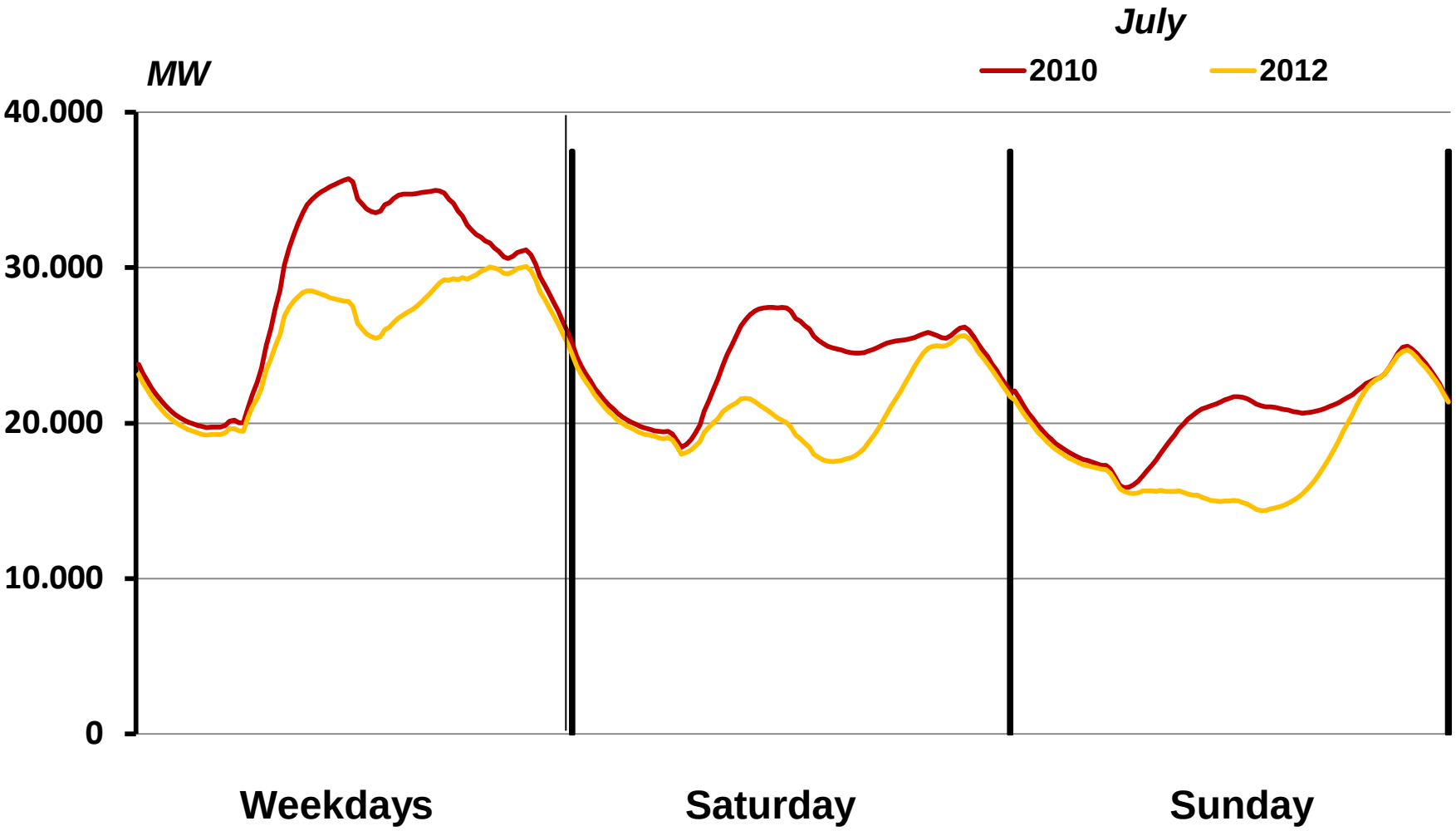




- *DG Connected to MV-LV Network*
- *Min MV+LV Load (2007)*
- *Max MV+LV Load (2007)*
- *Ongoing DG Requests*

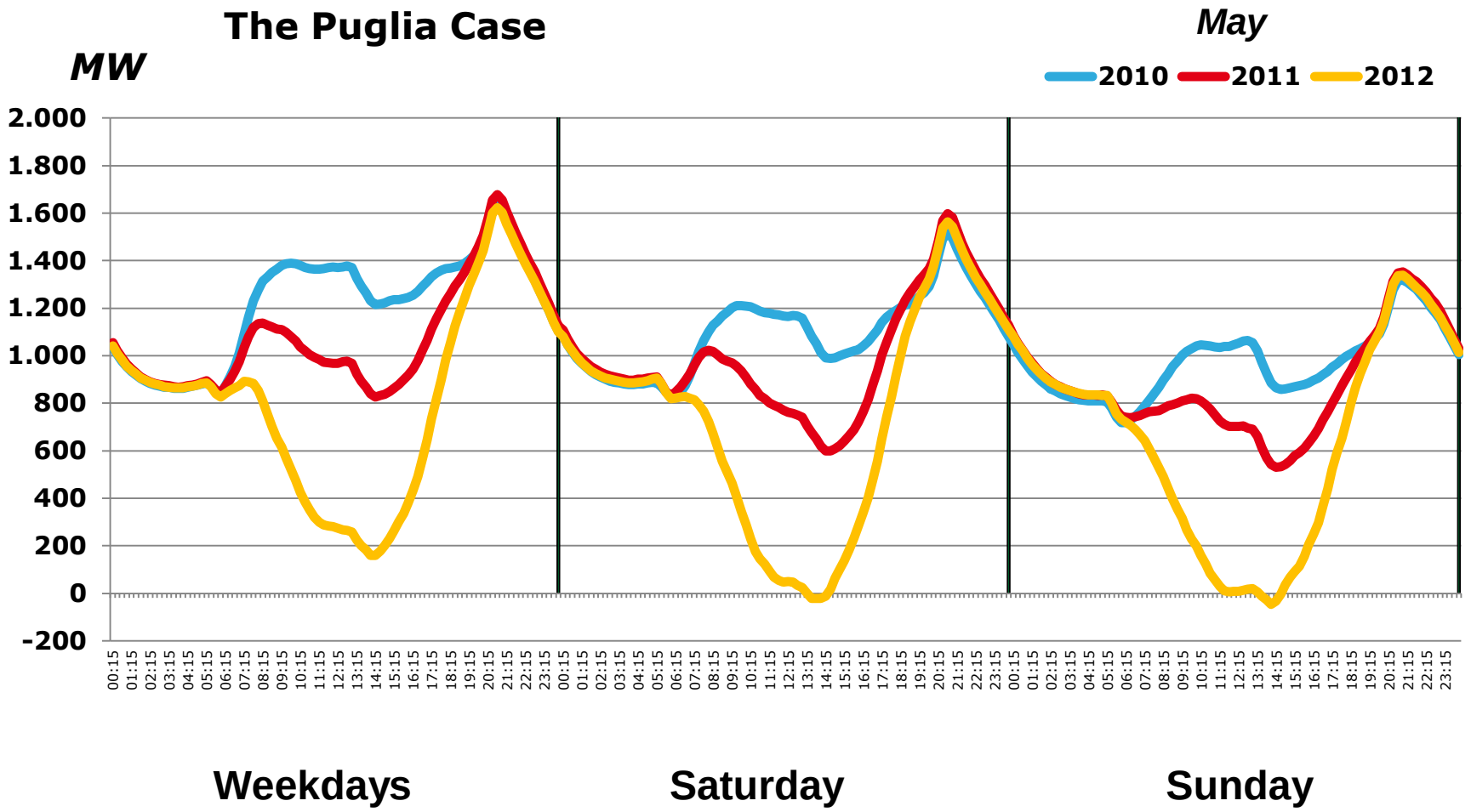
ENEL DISTRIBUZIONE – INTERFACE WITH HV GRID / 1

Net energy flows: Distribution network as seen by a TSO



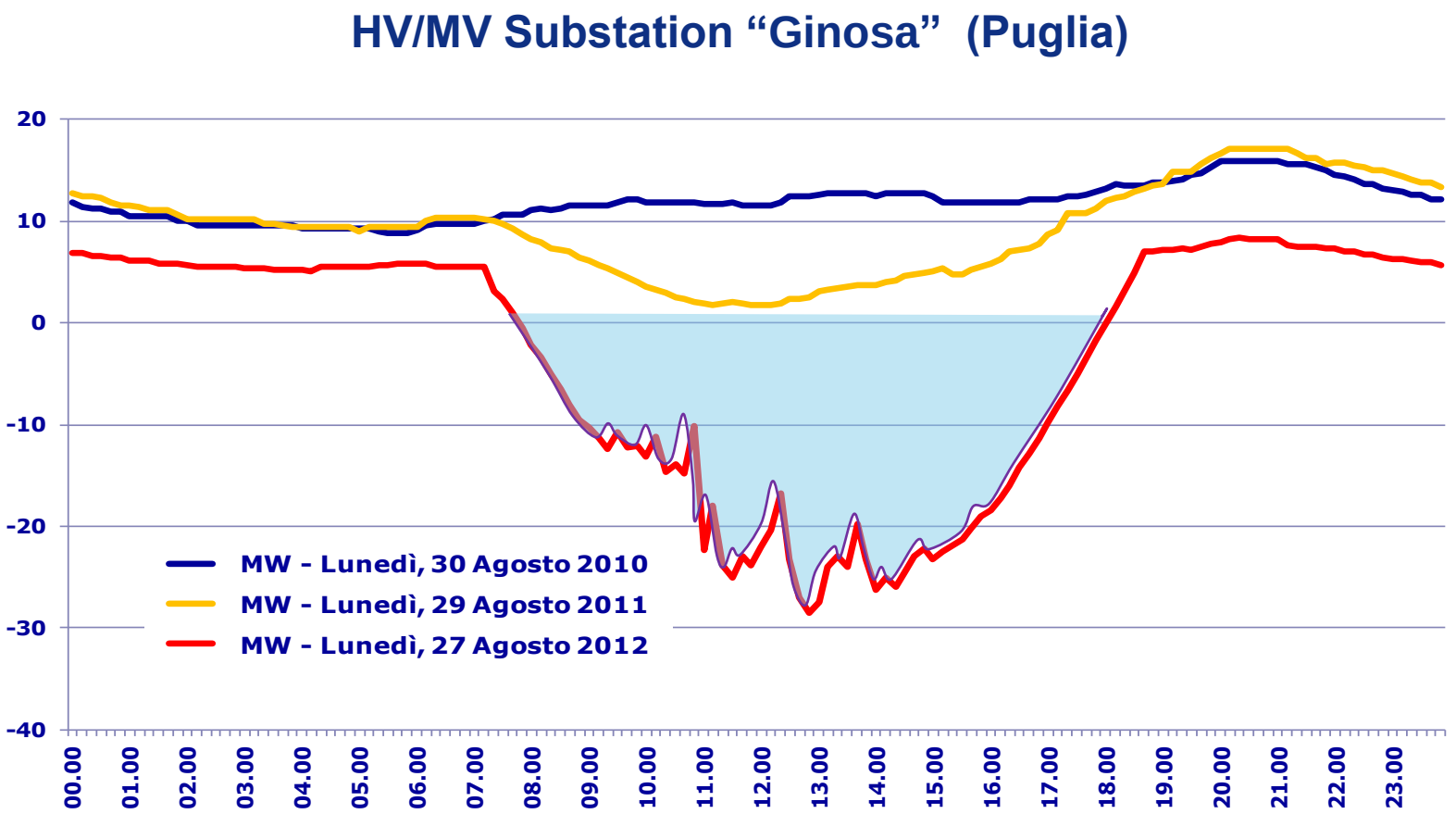
ENEL DISTRIBUZIONE – INTERFACE WITH HV GRID / 2

Net energy flows: Distribution network as seen by a TSO

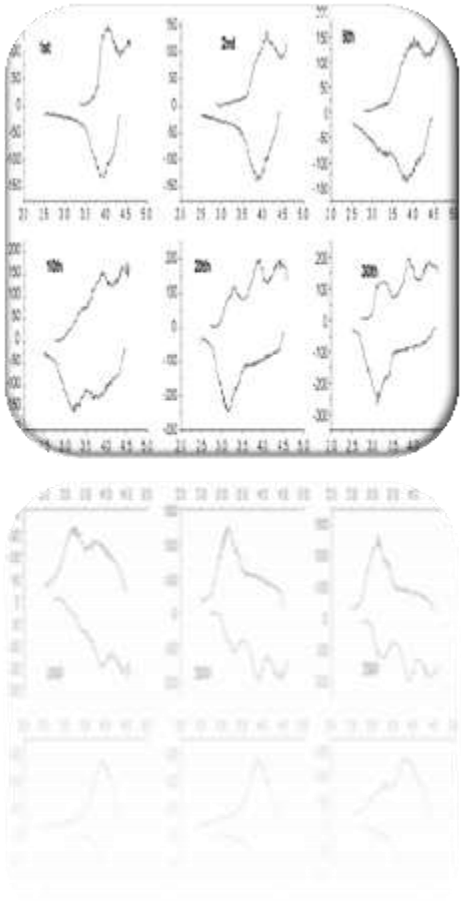


ENEL DISTRIBUZIONE – INTERFACE WITH HV GRID / 3

Net energy flows: Distribution network as seen by a TSO



MAIN CHALLENGES: VOLTAGE DEVIATIONS



- Slow Voltage Deviations

  Refer to the voltages in any given point in different load-generation conditions

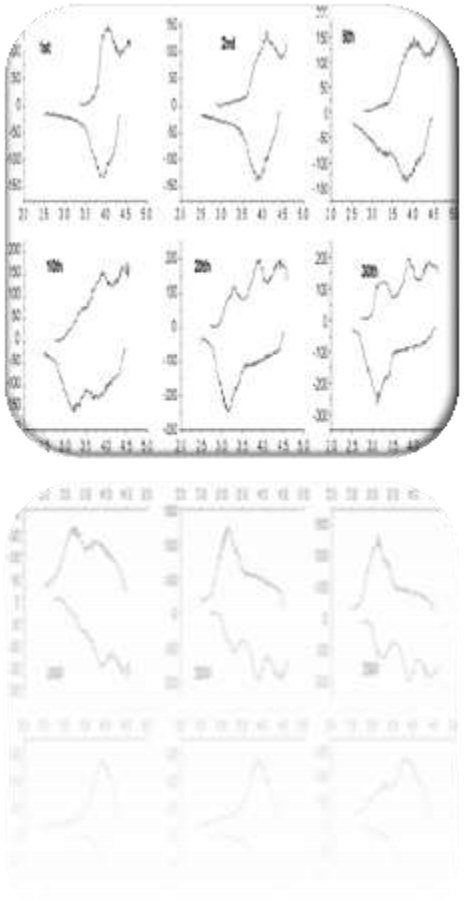
- Fast Voltage Deviations

  Refer to the voltage in the connection point of new DG in case of instantaneous disconnection

- Voltage Values

  In the most critical condition, voltage values in any point of the network must be kept within standards

MAIN CHALLENGES: CONGESTION



- Load Values

  In the most critical condition, load must be kept within standards

RELEVANT SOLUTIONS – THE CATALOGUE

SCADA + direct load control

SCADA + PV inverter control (Q and P)

Demand response by local price signals

Network Reconfiguration

On Load Tap Changer for MV/LV transformer

Wide area voltage control

Advanced Closed-Loop Operation

Prosumer storage

Reactive power control by PV inverter Q(U) Q(P)

Active power control by PV inverter P(U)

Static VAr Control

Self consumption by tariff incentives

Curtailment of power feed in at PCC

Network Reinforcement

DSO storage

Advanced voltage control for HV/MV transformer

Booster Transformer

Demand response by market price signals

RELEVANT SOLUTIONS FOR ITALY / 1

DSO-SIDE SOLUTIONS:

- Network Reconfiguration
- Network Reinforcement
- On Load Tap Changer for MV/LV transformer
- Advanced voltage control for HV/MV transformer
- Static VAr Control
- DSO storage
- Advanced Closed-Loop Operation.

Complementary solutions (no “killer application”)

RELEVANT SOLUTIONS FOR ITALY / 2

PV-SIDE SOLUTIONS:

- Reactive power control by PV inverter Q(U) Q(P)
- Active power control by PV inverter P(U)
- Curtailment of power feed in at PCC
- Prosumer storage.

Less limitations usually imply less effectiveness
Solutions must be chosen with graduality

RELEVANT SOLUTIONS FOR ITALY / 3

INTERACTIVE SOLUTIONS:

- SCADA + PV inverter control (Q and P)
- SCADA + direct load control
- Wide area voltage control
- Demand response by local price signals.

Solutions are complex and make sense only in case of massive deployment

NOT RELEVANT SOLUTIONS FOR ITALY

- Booster Transformer
- Demand response by market price signals
- Self consumption by tariff incentives.

Can inevitably help in very limited circumstances

SOLUTIONS' EVALUATION

Qualitative "holistic" evaluation for MV and LV grids

	Technical solution	CZ	DE	ES	IT
TOP PRIORITY SOLUTIONS	Curtailment of power feed-in at PCC				
	Network Reinforcement				
	Reactive power control by PV inverter Q(U) Q(P)				
	Active power control by PV inverter P(U)				
	Prosumer storage				
	On Load Tap Changer for MV/LV transformer				
MEDIUM PRIORITY SOLUTIONS	SCADA + direct load control				
	Network Reconfiguration				
	Self-consumption by tariff incentives				
	Wide area voltage control				
	Static VAr Control				
	Booster Transformer				
	SCADA + PV inverter control (Q and P)				
	DSO storage				
BOTTOM PRIORITY SOLUTIONS	Demand response by local price signals				
	Advanced voltage control for HV/MV transformer				
	Demand response by market price signals				
	Advanced Closed-Loop Operation				

Regulation is needed Technology is mature	Regulation is needed Technology not mature	No regulation needed Technology not mature	No regulation needed Technology is mature

Table 1 Summary of technical solutions for voltage quality and congestion problems, prioritization for the low voltage networks.

	Technical solution	CZ	DE	ES	IT
TOP PRIORITY SOLUTIONS	Network Reinforcement				
	Reactive power control by PV inverter Q(U) Q(P)				
	Curtailment of power feed-in at PCC				
	Active power control by PV inverter P(U)				
	Network Reconfiguration				
	SCADA + PV inverter control (Q and P)				
	Advanced voltage control for HV/MV transformer				
MEDIUM PRIORITY SOLUTIONS	Static VAr Control				
	SCADA + direct load control				
	Self-consumption by tariff incentives				
	Wide area voltage control				
	DSO storage				
	Prosumer storage				
BOTTOM PRIORITY SOLUTIONS	On Load Tap Changer for MV/LV transformer				
	Booster Transformer				
	Demand response by local price signals				
	Demand response by market price signals				
	Advanced Closed-Loop Operation				

Regulation is needed Technology is mature	Regulation is needed Technology not mature	No regulation needed Technology not mature	No regulation needed Technology is mature

Table 2 Summary of technical solutions for voltage quality and congestion problems, prioritization for the medium voltage networks.

MAIN REGULATORY BARRIERS / 1

RES-Curtailment

PROBLEM STATEMENT:

Curtailment only allowed for transmission system security reasons, not in case of local voltage or load constraints (Priority Dispatch).

No conditioned connection allowed -> connection solutions become more complicated

SOLUTION AFFECTED:

All solution implying limitations of RES-injection.

RECOMMENDATION:

Curtailment of RES must be allowed to DSOs in National Regulation.

Boundary conditions must be defined in technical standards (Transparency and No Discrimination).

MAIN REGULATORY BARRIERS / 2

Self consumption

PROBLEM STATEMENT:

No regulation exists prescribing self-consumption for distributed generation. Economical incentives have been defined for self-consumption, but they apply only to new installations and their effect cannot be granted, as it depends on individual behaviors of operators, on voluntary basis.

SOLUTION AFFECTED:

All solution implying self limitation of RES-injection.

RECOMMENDATION:

Define (reasonable) self-consumption obligations for newly-connected RES, in order to ensure transparent and non-discriminatory planning criteria.

MAIN REGULATORY BARRIERS / 3

Storage use

PROBLEM STATEMENT:

Present Regulation does not foresee DSOs making use of a storage system and does not provide any instruction about how storage energy must be treated within the electrical market structure.

SOLUTION AFFECTED:

All solution implying a DSO-owned storage.

RECOMMENDATION:

Roles, rights and limitations of DSOs in the use of storage must be clearly defined by NRA. It can be reasonably expected that local security-related capabilities should be made available to DSO.

MAIN REGULATORY BARRIERS / 4

Access to advanced inverter capabilities

PROBLEM STATEMENT:

Some Regulations do not allow DSOs to make use of available capabilities of inverters, even though they have already been included among mandatory requirements.

SOLUTION AFFECTED:

All solution implying control by DSO on PV-inverters.

RECOMMENDATION:

Access to inverters and control over their capabilities must be granted to DSOs.

Boundary conditions must be defined in technical standards (Transparency and No Discrimination).

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Thank you for your attention

Riccardo Lama

Standardization, Working Practices

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