AIEE Energy Symposium 2019

Grid security and new technologies

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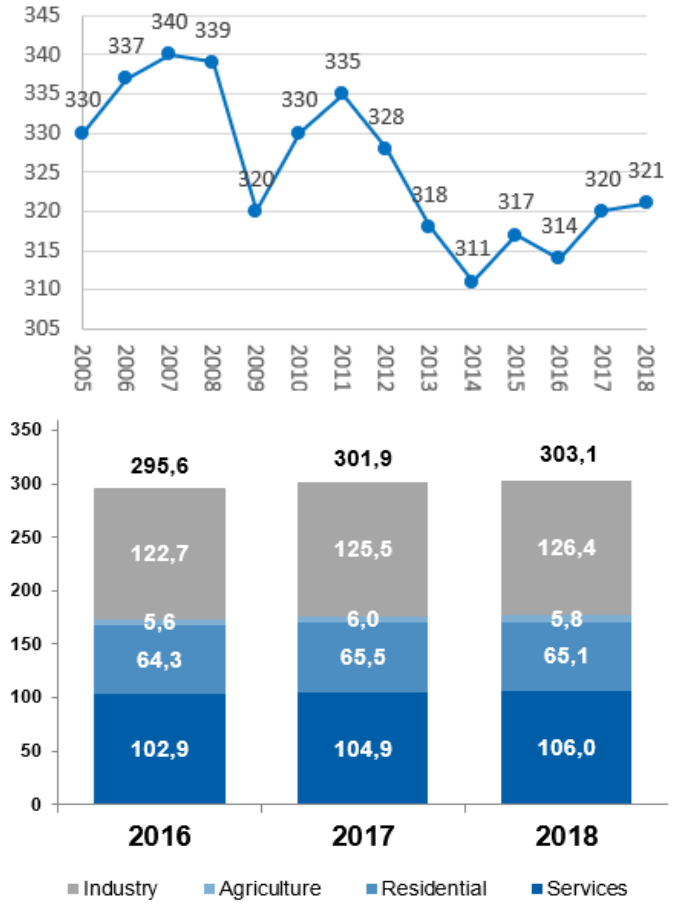
Electricity demand/ Final consumption annd GDP load relationship

Historical Data

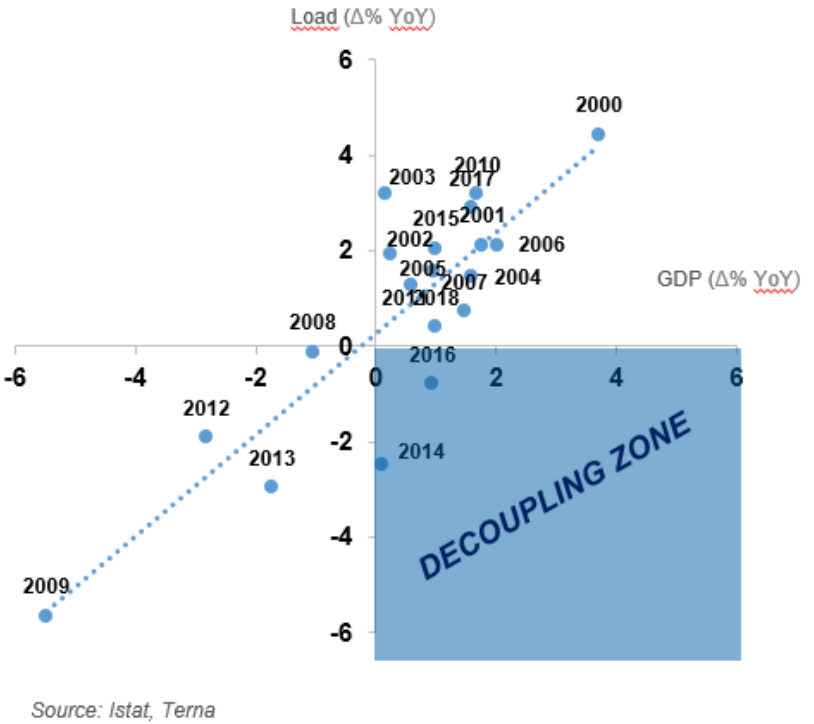
Electricity Demand* and consumption by sector (TWh)



Source: Terna

Electricity demand reached last year 321 TWh (-5% pre economic crisis level) with an average value in the last 13 years of 325 TWh

Load vs GDP (Δ% YoY)



Source: Istat, Terna

Strong correlation between GDP growth and load

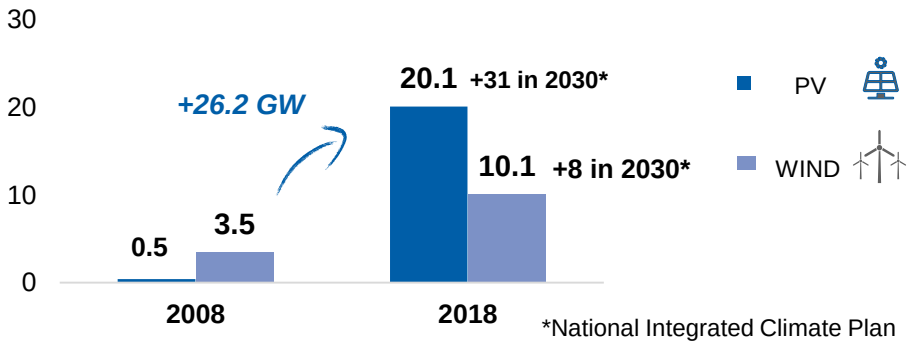
Lower right side still almost empty

*Losses included

Power System evolution in Italy

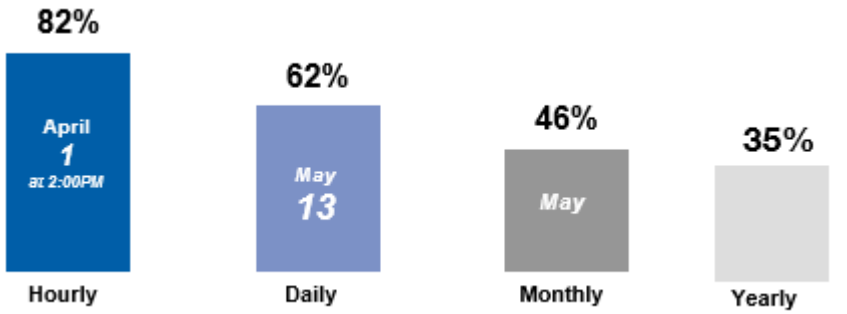
Renewables already pose great challenges

INSTALLED WIND AND PV CAPACITY (GW)



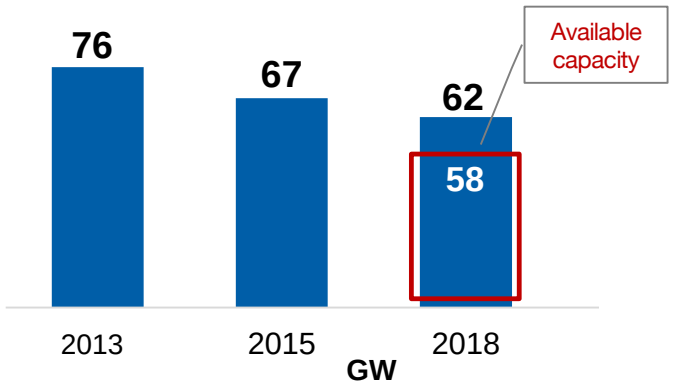
Strong **increase** in the installed capacity of RES.

DEMAND COVERED BY RES [1] (2018)



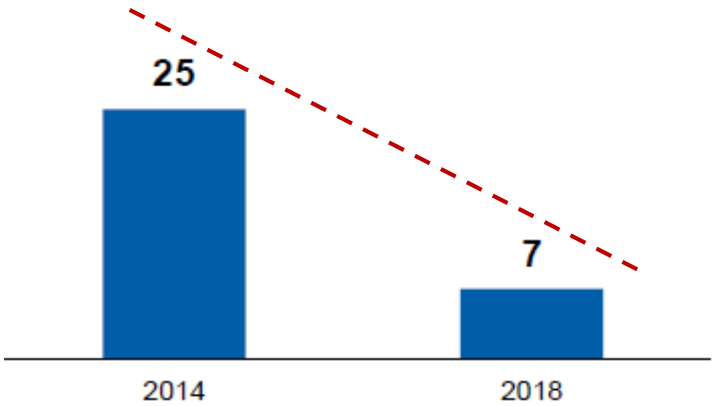
Peaks in the hourly needs **covered more and more** by RES.

THERMOELECTRIC INSTALLED CAPACITY (GW)



Reduction of installed capacity of thermal power plants.

RESERVE MARGINS AT THE PEAK [2] (GW)



Progressive reduction of the reserve margin at the peak.

[1] The hydroelectric source is included.
[2] Difference between the available production capacity and consumption (including the reserve) at the time of maximum load.

New challenge for the system: Decarbonisation

Tackling the global warming – ambitious targets and international cooperation

TARGET	2020		2030	
				PNIEC
GHG emission reduction	*- 20%*	*- 13%* [1]	*- 40%*	*-33%* (non ETS) *-43%* (ETS)
%RES on Final Consumption [2]	*≥20%*	*≥17%*	*≥ 32%* [3]	*30%* (all sectors) *55,4%* (Power sector)
Energy efficiency (vs scenario Business as Usual)	*+ 20%*	*+ 20%*	*+32,5%* [3]	*51,4 Mtoe* [4]

European and National guidelines aim to provide targets and policies in order to find measures for keeping the temperature within the Paris Agreement level.

Electricity will play a key role in this process

[1] Target defined by ESD (Effort Sharing Decision)
[2] Final Energy consumption (transport + electricity + heating & cooling)

New target «Clean Energy for All Europeans»
Cumulated Value of energy saved in 2021-2030

Managing the load profile with high RES penetration

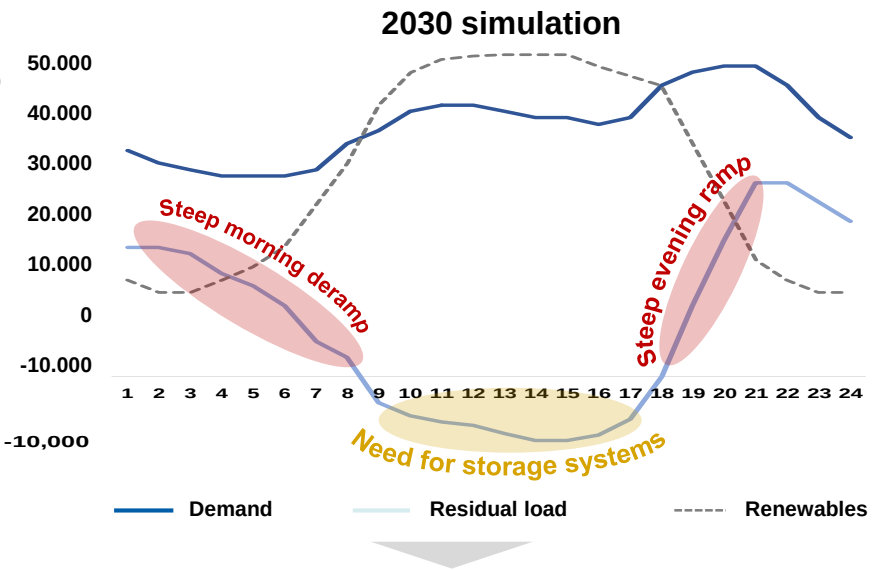
Main impacts on System Operations

The increasing penetration of **renewable energy sources** in the generation mix, combined with the simultaneous decommissioning of conventional **carbon-fired power plants** is posing new challenges for the security and cost-efficiency of grid operation

Major operational issues for TSOs

- Significant need of **ramping-up thermal generation** in the evening hours to balance the drastic output reduction by solar PV
- Poor **regulating capacity**, following the growing share of RES in the national generation mix
- Limited up-ward **reserve margins** to cover peak load, following the decommissioning of significant amount of thermal installed capacity
- **Grid congestions**, due to the non-homogeneous distribution of RES across the Country (most notably disseminated in the Southern areas)
- Increased periods of **over-generation** from non programmable and non dispatchable renewables
- Limited availability of sources providing **voltage regulation** (reactive power) and frequency regulation (rotational **inertia** against the loss of **system stability**)

Consumption and 'residual load' curves



Increased need of **flexible resources** (gas-fired turbines, pumped hydro storage and batteries, industrial & households demand response, interconnectors, active grid management, e-vehicles, power-to-gas, power-to-heat, etc.), **and market options** to unlock flexibility.

Italian Power System

Impacts on the Electricity System

Cluster	Impacts on Electricity System management
Technical characteristics of RES	Reduction of **system inertia** Reduction of resources providing **frequency and voltage regulation**
Intermittency of RES	Reduction of **adequacy margin** Growing periods of **over-generation** during noon hours Increasing steepness of **residual load evening ramp**
Location of RES	Increasing **grid congestions** due to geographical distance between RES supply and consumption centers Growing **system operation challenges**, due to the growing of Distributed Generation
Climate change	Increasing risk **of electricity network disruptions**

Changes in the context (the increasing penetration of RES, the continuous decommissioning of conventional thermal capacity an climate change) pose new challenges for TSOs

Italian Power System

Key enablers of the energy transition

1 Transmission grid development

- **Strengthening** of North-South **backbone** and **grid reinforcements** in the South of Italy and the Islands
- **Foreign interconnections** - **Reinforcement** and **meshing of national transmission grid**
- **Investments** in **voltage regulation and to increase the inertia** of the electricity system

2 Long-term price signals

- **Capacity Market** to deliver long-term price signals to encourage investments in new efficient and flexible generation
- **Power Purchase Agreements (PPAs)** long-term power purchase contracts for RES
- Long-term contracts for **competitive procurement of storage capacity**

3 Market evolution

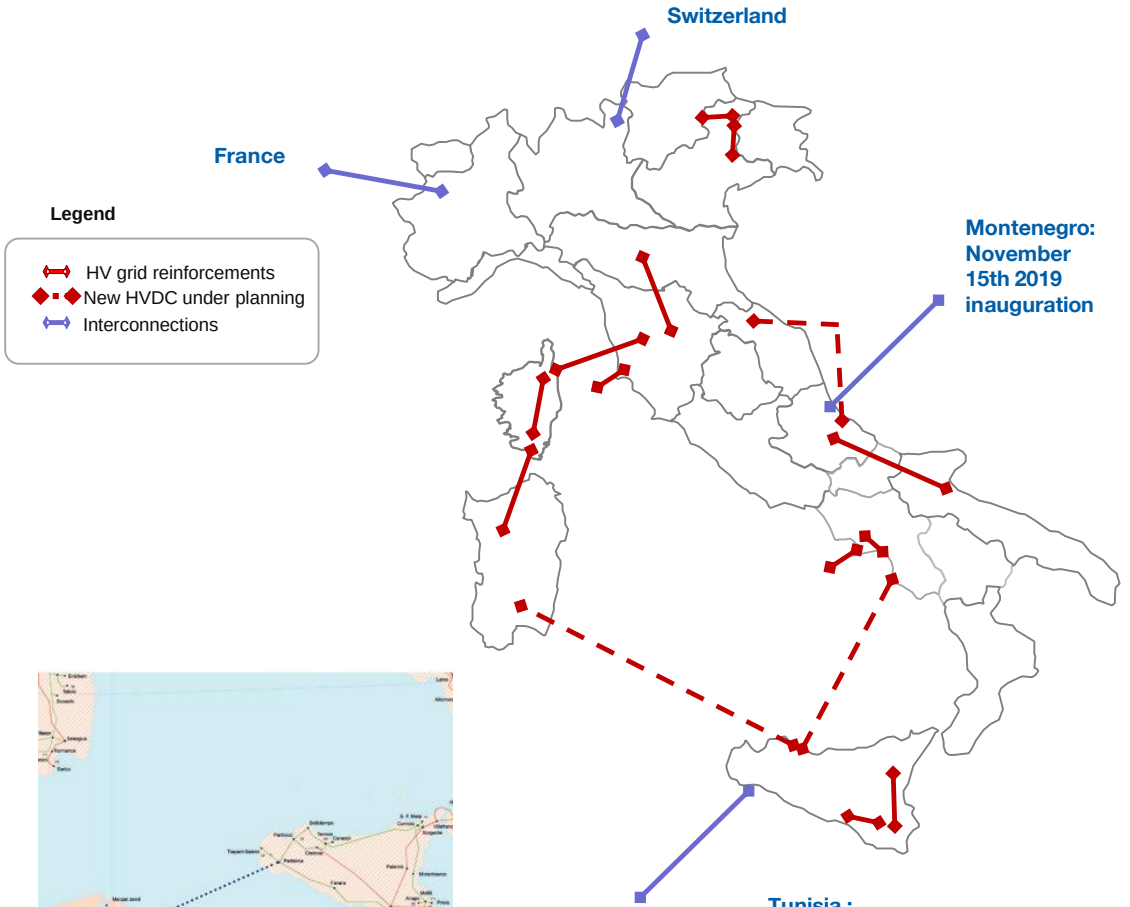
- **Participation of new flexible resources in ancillary services market,** i.e. demand, distributed generation, non-programmable renewable energy sources and storage, including electric vehicle-to grid
- **Evolution of the structure of the ancillary services market** to cope with new needs (voltage regulation, inertia,…)

4 Innovation and digitalisation

- **Digitalization of the Transmission Grid** (assets and processes) and of its control systems (data management)
- **Full IoT, Energy Systems and Advanced Materials**
- **Sector Coupling**

Transmission grid development

Main projects under development



med-TSO
MEDITERRANEAN TRANSMISSION SYSTEM OPERATORS

DRIVER

- Decarbonisation
- Market Efficiency
- Security of supply and resiliency
- Sustainability

OBJECTIVES

- To solve congestions and limits of the grid
- To manage ancillary services optimally
- To increase security of supply and adequacy
- To increase RES integration
- To support a sustainable developing model

Long-term price signals

Capacity Market

Nowadays the Italian electricity system is facing **adequacy problems under stress conditions** (for example in case of extreme weather condition or unavailability of electricity import).

The Italian spot market, in the past years, was not able to **supply effective long-term price signals** in order to **encourage investments** in new generation capacity.

In every 2030 scenarios, **natural gas power plants continue to play a fundamental role** in providing **flexibility services** and **ensuring adequacy of the system** (around 50 GW of installed capacity).

Need for long-term price signals (Capacity Market) to support investments in efficient thermal generation

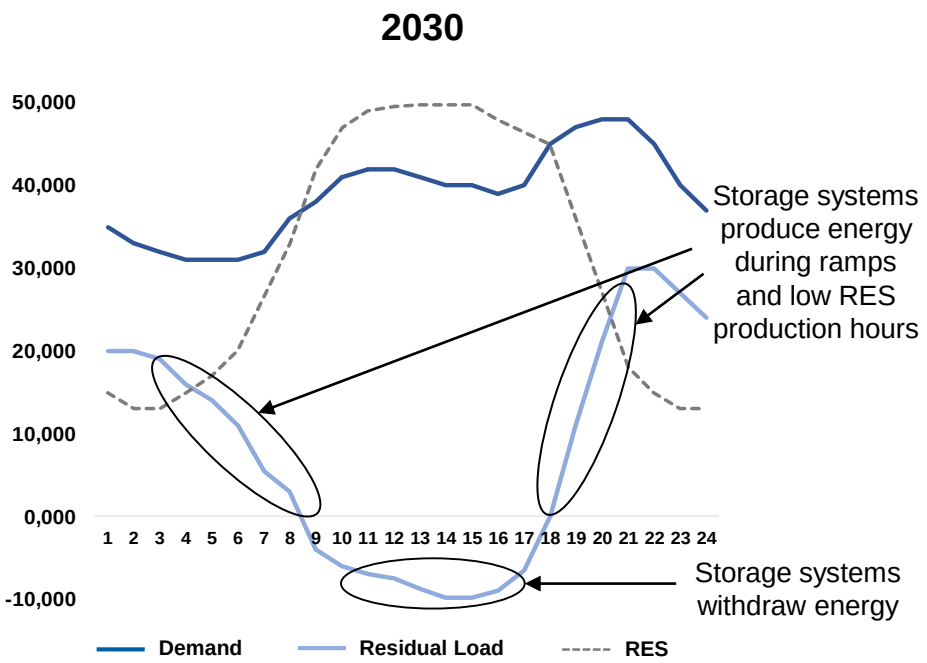
CAPACITY MARKET MAIN BENEFITS

- **To ensure adequacy of the electricity system through an effcient and sustainable generation mix**
- **To enable a fast renewable sources growth**
- **To allow the phase-out by coal**
- **To secure the final users against electricity price risk**

Storage system

Electricity system need by 2030

RESIDUAL LOAD CURVE WITH HIGH RES PENETRATION



Need for **6 GW** of centralized storage and **4,5 GW** of distributed storage system by 2030 (PNIEC)

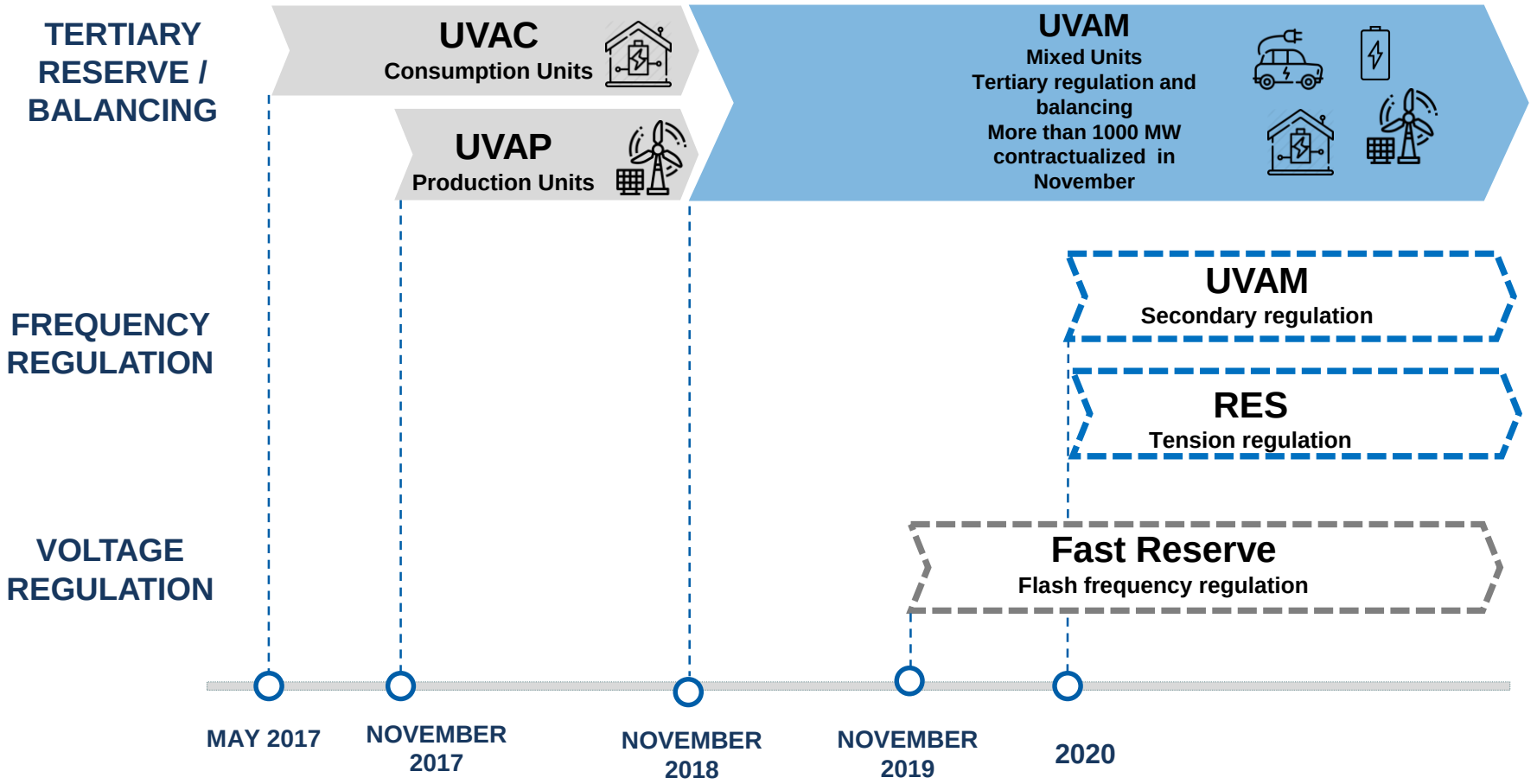
- In the future, storage power plants will withdraw energy during the central hours of the day (high RES production) and inject it when required by the system:
  - **Covering the expected demand** during peak hours and when PV/wind production is low
  - **Reducing grid congestions and overgeneration**
  - **Supplying frequency and voltage regulation services** and **increasing the short circuit power and the inertia of the system**

Storage systems must be located in the **Center**, in the **South** and in the Islands where RES concentration is higher and storage capacity is poorer.

By 2030, an installed storage capacity at least of 6 GW will be necessary in the Center/South of Italy and in the Islands in order to ensure security of supply, in the light of a considerable RES growth

Market evolution

New energy resources in ancillary services market

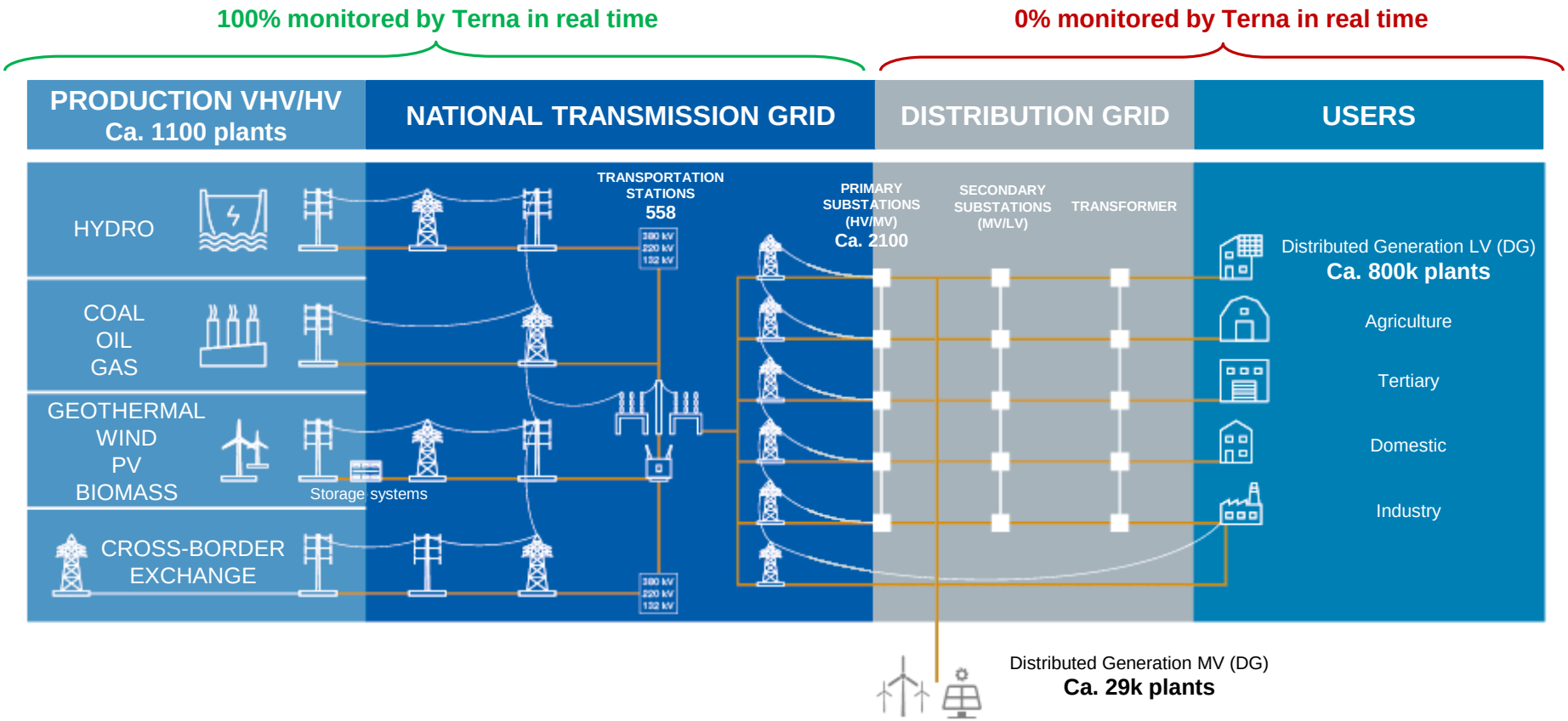


In 2017 Terna started testing pilot projects in order to extend the participation in ancillary services market to new resources

Observing the distributed energy resources

Direct observability and controllability of DER is fundamental for a safe operation

The term «observability» refers to the ability **to know in real time the main electrical data of the power system**, in order **to manage it correctly and safely**.



The strong growth of RES connected in MV/LV and the increasingly "active" role played by prosumers in the provision of flexibility, make the observability of resources connected to the distribution grids essential for the TSO to manage safely the power system.

Digitalisation & Innovation – System Operator