Renewable Energy roads:
a call for joint public-private effort

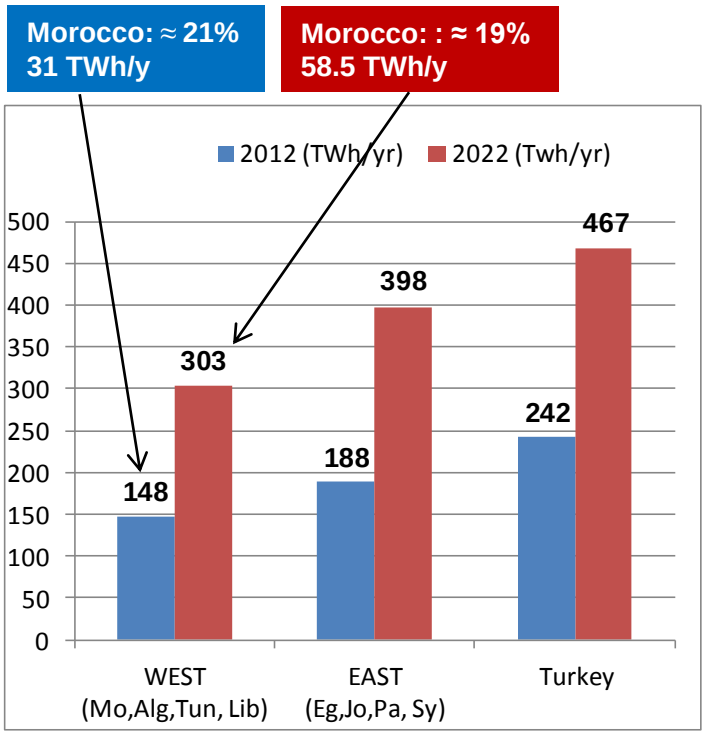
The TSOs contribution to market development and RES integration

March 9th, 2016
Rabat

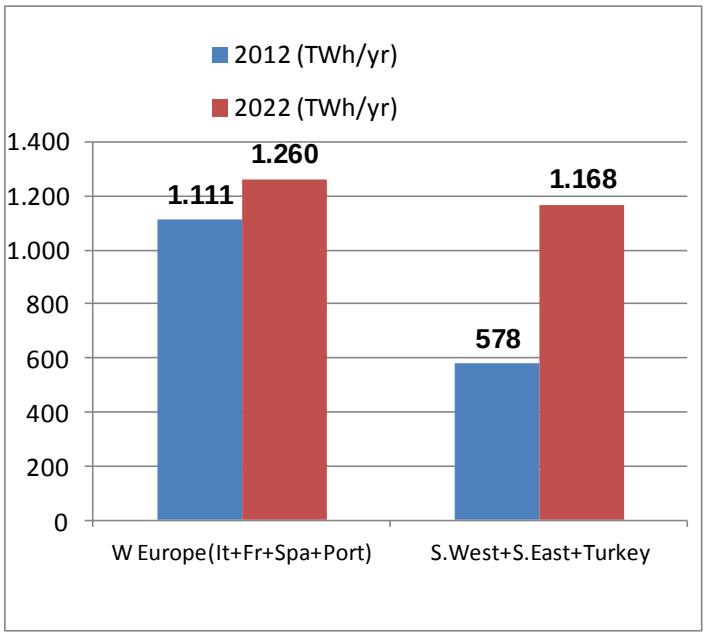
Electricity system in the Mediterranean Region: expected consumptions to 2022

Expected energy demand: doubling of energy demand up to 2022 in the South and West Mediterranean because of the demographic and GDP growth

Annual consumptions (TWh/y) at 2012 and at 2022



3 blocks: South West *(Morocco, Algeria, Tunisia, Libya),* ***South East*** *(Egypt, Jordan, Syria, Palestine) and* ***Turkey***



Western Europe *(Italy, France, Spain, Portugal) and the* ***3 blocks***

Source: MED-TSO Master Plan of the Mediterranean electricity interconnections, 2013

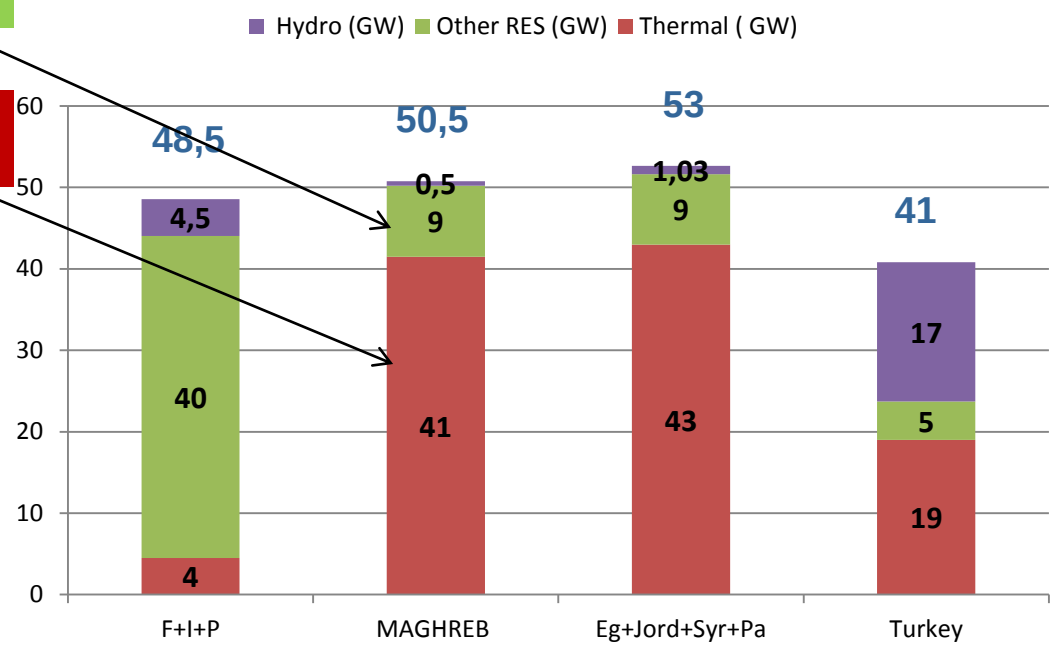
Electricity system in the Mediterranean Region: expected investments in generation to 2022

New generation capacity installation of about 150 GW, 20% of which coming from RES. The relevant expected investment between 220 and 250 billion euro, depending on generation sources to be identified

Morocco RES: 4.6 GW (≈ 51%)

Morocco Thermal : 4.9 GW (≈ 12%)

New installed capacity (GW) decade 2013 - 2022



Western Europe** (Italy, France, Portugal) and the **3 blocks

Source: MED-TSO Master Plan of the Mediterranean electricity interconnections, 2013

Electricity system in the Mediterranean Region: expected investments in transmission to 2022

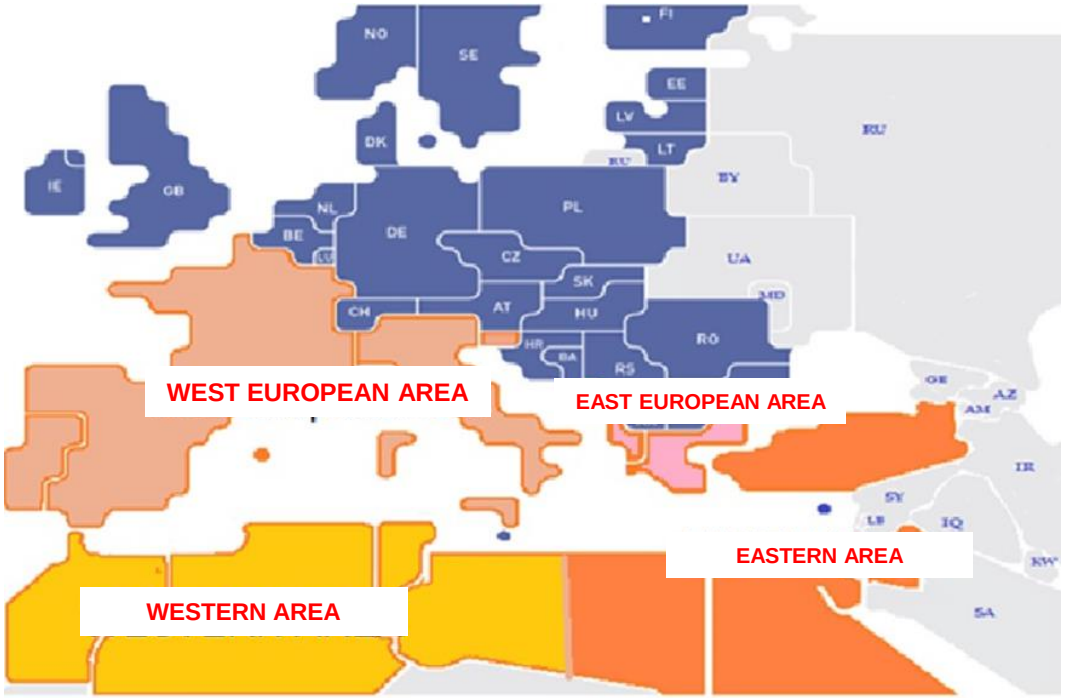
Investments in transmission mainly consider the energy demand trend.
During next years in the Mediterranean are expected total investments (new transmission lines and internal grid reinforcements) of about 30 billion euro.

90.000 km of new lines (220 kV e 400 kV + stations) + 2.000 MW (lowest scenario*) North-South Interconnections

WESTERN AREA

Exchange capacity at 2012: 1.500 MW
(Morocco - Tunisia axis)
Expected exchange capacity at 2022: 2500 - 3000 MW
(Morocco - Tunisia axis, taking into account criticalities in the Area, e.g. Libya).

Expected exchange capacity at 2022: Europe - Maghreb 2500 - 3000 MW



EASTERN AREA

Expected exchange capacity at 2016: 600 MW
(Turkey-Egypt axis, subject to the criticalities in the Area, e.g. Syria)

(*) 2000 – 6000 MW

Moroccan power sector: a snapshot (2014)

- Energy sold: 28,8 TWh
- Peak Load: 5.670 MW
- Total installed capacity: 7.993 MW
- RES installed capacity: 2.567 MW (1.770 MW Hydro – 797 MW Wind)
- Transmission network length: 23.332 km (400 to 60kV)
- Transformation Capacity (Transmission): 31.053 MVA (HV and MV)
- Distribution network length: 272.042 km
- Network losses (Transmission): ≈ 4% in 2014
- Energy imported and exported through international interconnections: 6.000 GWh
- Investments in Generation – Transmission – Distribution 2013 -14: ≈ 1,1 Billion Euro

Moroccan power sector: upcoming challenges

Morocco faces several **energy challenges**:

- ✓ It holds virtually **no conventional fossil fuel** resources
- ✓ It features an **increasing demand** for electricity,
- ✓ **Demand driver** primarily by Morocco's **increasing wealth**
- ✓ Steadily increasing **population growth** reaching 1.5% from 2012 to 2013

How is Morocco facing these challenges?

- **Transition towards a low-carbon electricity production:**

  - PV: In addition to one 20 MW concentrated solar power (CSP) plant that is incorporated into a combined cycle natural gas power station, the government is planning a large pipeline of CSP projects through 2020 to help meet its renewable targets. With its 160 MW Ouarzazate Noor I project, Morocco is home to one of the largest CSP projects in the world.
  - Wind*:* Morocco has planned to reach the ambitious goal of 2.3 GW coming from wind by 2020 (Integrated Wind Energy Programme).

- **Private investments:** several international companies are currently involved in the big projects for RES development (ACWA power, Acciona, TSK, Enel, etc. ..)

- **RES and EE supporting policies:** Morocco has set up the Moroccan Agency for Solar Energy (MASEN), and the National Agency for the Development of Renewable Energy and Energy Efficiency (ADEREE) both responsible for all the issues related to RES development.

- **Interconnections with bordering countries:** Morocco is the founder and an active member of MEDTSO, the association of the Mediterranean TSOs aimed at strengthening the interconnection and the cooperation among the Mediterranean countries.
  A new 400 Kv interconnection between Morocco and Mauritania has been announced and it will impact on new development of the national grid in Morocco.

Source: ONEE Electricité Chiffres clés, 2014

Moroccan power sector: Network Development

Transmission lines (lines and cables):

- 2.673 km at 400 kV
- 8.732 km at 225 kV
- 147 km at 150 kV
- 11.780 km at 60 kV

➢ **Total: 23.332 KM**

Interconnections with bordering countries:

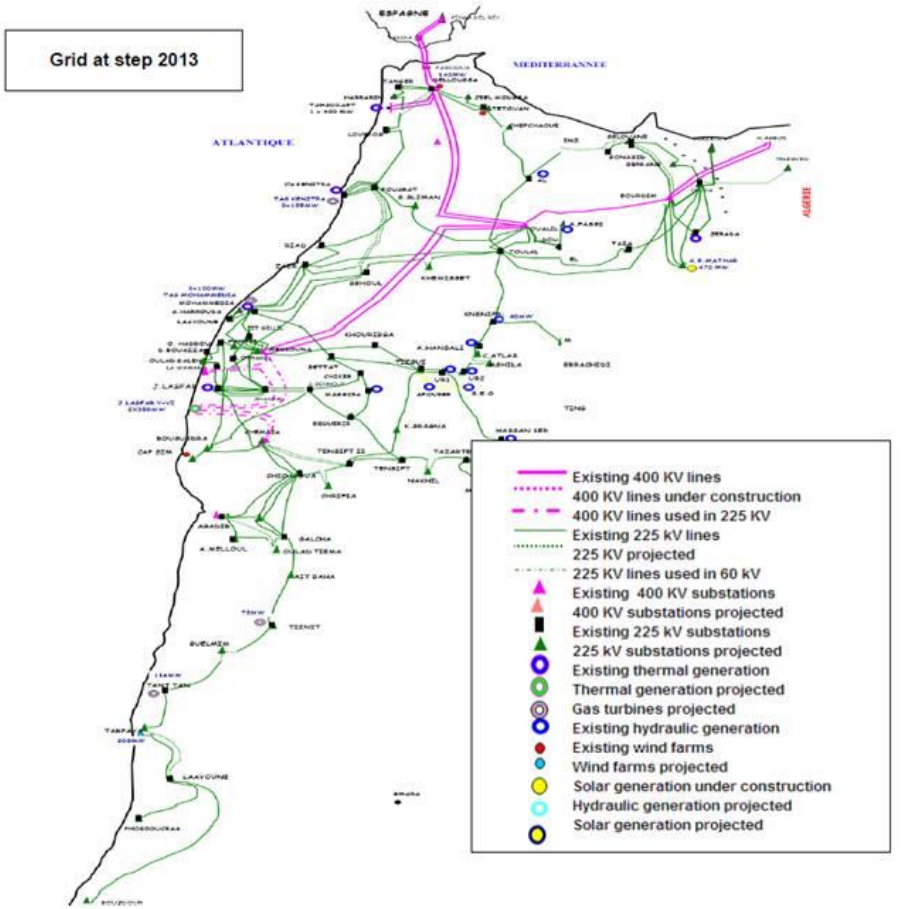
- Algeria 4 lines maximum transit capacity 1.000MW
- Spain: 2 HVDC cables, maximum transit capacity 1.400 MW (import 750 MW).

Transmission system development plan to 2017 (authorized and ongoing investments):

- **400 kV**: 2.520 km of new lines; 36 network connections; 6.000 MVA substations
- **220 kV**: 2.600 km of new lines; 98 network connections; 225/60 kV and 225/20 kV substations: 5.000 MVA
- **60 kV:** 1.200 km new lines; 90 network connections

Where the main investments will be located:

- Centre East: reinforcement of the interconnections with Algeria
- North: thermal power plants connection aimed at enhancing the interconnection with Spain (up to 2.100 MW)
- South: HV backbone enhancement to support the RES development national plan.
- Announced a new interconnection between Marocco and Mauritania



Source: Annual Report ONEE 2014

Electricity in the Mediterranean Region

- Italy, due to its geographical position is the ideal candidate to promote the integration of Euro-Mediterranean electricity markets. Italy is interconnected with 4 countries of the area: France, Slovenia, Greece, Malta and, in the coming years, Montenegro for more than a half of its total expected interconnection capacity.

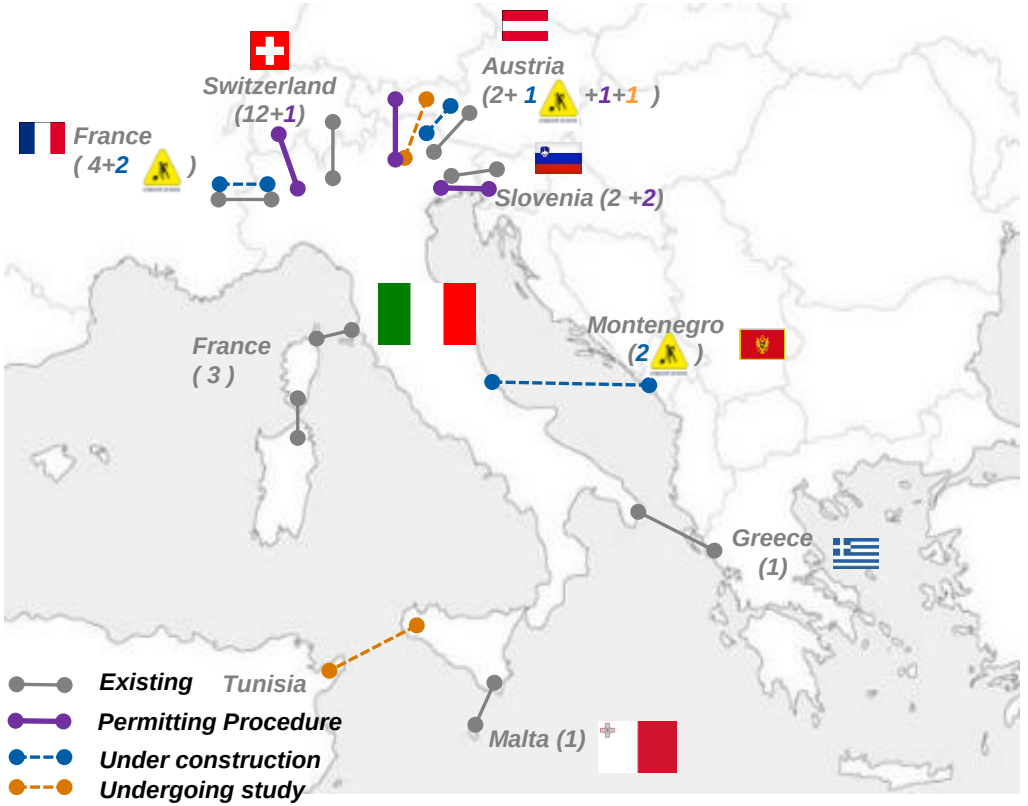
- An interconnected grid allows for more affordable prices in the market, through more competition and greater efficiency. A well interconnected grid is crucial also for sustainable development and resources diversification as it enables the grid to accommodate increasing levels of variable renewables, in a more secure and cost-efficient way, ensuring at the same time the environmental protection.

- Electricity interconnections will increase security of supply of Euro-Mediterranean countries, improving reliability of their electricity systems, reducing their import dependency and facilitating cooperation and solidarity between Transmission System Operators.

Italian cross-border interconnections

Existing, Under Costruction and Under Study

The geographical position makes Italy the natural hub in the Mediterranean Sea. Italy can also rely on a strong electrical frontier with 25[1] interconnections already in operation and further 5 under costruction



Opportunities from interconnection development:

Achieve pricing convergence and the integration of markets for the resources optimization (grid integration, coordination among TSOs, creation of a Single European Grid and, progressively, a single EU market)

Increase the huge potential resources and create synergies and fruitful cooperation with neighboring countries

1. *21 owned by Terna + 3 merchant lines operated (but not owned) by Terna + 1 (Italy-Malta) owned by Enemalta*

NOTE: double circuit transmission lines are accounted twice

Main changes in last years

Liberalization process

Up to 2000

- **Centralized system planning:**
  - *Generation and grid*
  - *Development and operation*
- **Generation capacity not sufficient to cover the demand:**
  - *High dependence from third countries*
  - *Prevailing thermal production (oil and fuel)*
- **Electricity demand in stable increase**

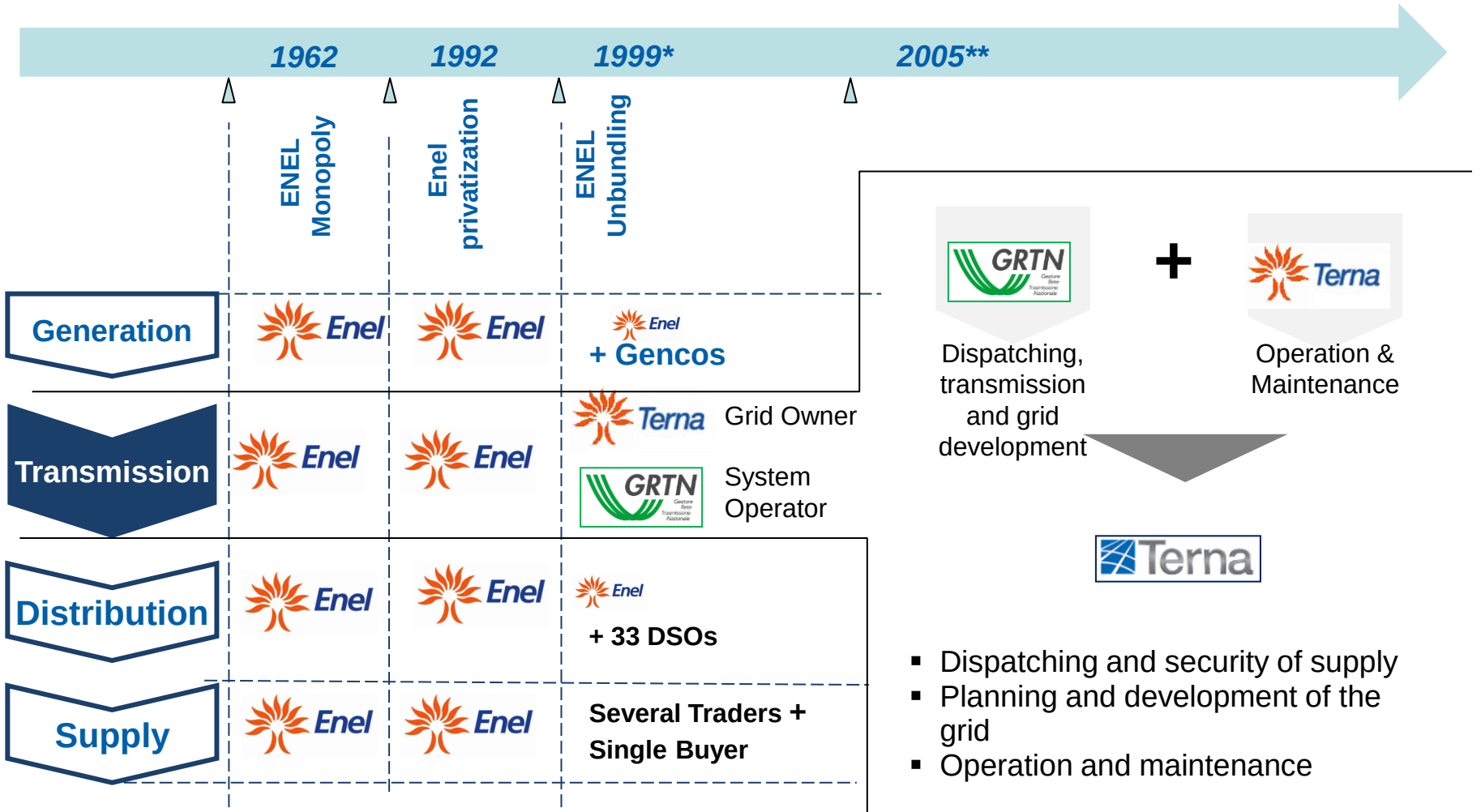
2000-2014

- **Liberalization of electricity generation**
- **Investments in generation activities and consequent energy operators increase:**
  - *Efficient thermal plants (CCGT): +22.000 MW*
  - *Renewables (wind and photovoltaic): +28.000 MW*
- **Electricity demand decrease:**
  - *Due to economic-financial crisis of 2008*

Transmission grid becomes crucial for the use of new efficient generation capacity

Main changes in last years

Liberalization process



Enel: listed on stock exchange since 1999

***Terna: listed on stock exchange since 2004*

Terna Group
A Long Growth Path

Liberalization/Unbundling

Brazilian and Italian M&A

Non Regulated Activities

- In 1999 Terna is incorporated following the liberalization of the electricity sector.
- In June 2004, Terna is listed on the Italian Stock Exchange

- Strategic guidelines characterized by organic growth and opportunistic approach:
  - ***2006 -*** *IPO Terna Participações S.A.*
  - ***2009 -****Sale of Terna Participações S.A.*
  - ***2009 -****Acquisition of ELAT*
  - ***2010/2011 -****Sale of PV Projects*

- In 2014 acquisition of Tamini Trasformatori
- In 2014 new Board of Directors has been appointed
- In 2015 acquisition of FS HV Grid (around 7510 Km of lines, 350 substations)

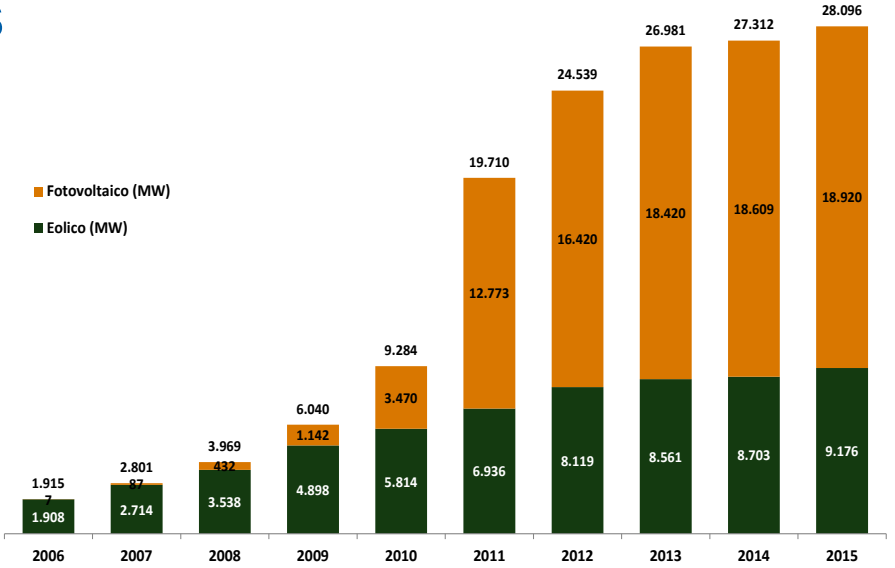
Main changes in last years

Investments in generation

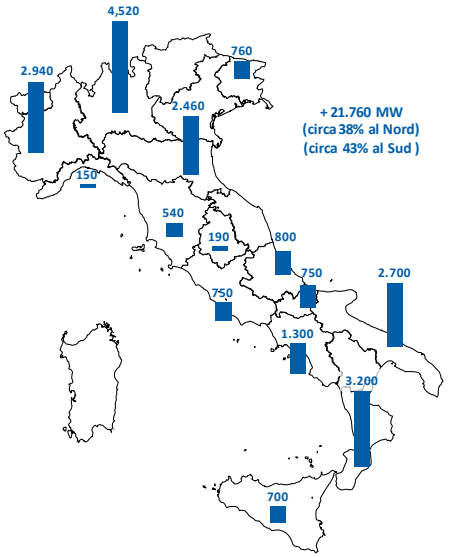
Boost to investments in generation since Market launch:

- Plants in South-Italy, far form big consumption centers
- Increase of generation capacity from gas combined cycles: **+22 GW**
- Increase of Renewables in 2005-15period: 17x (from 1,5 GW in 2005 to 28 GW in 2015)

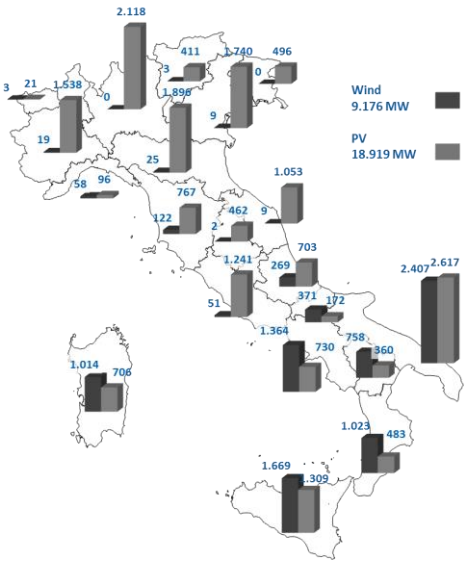
  - ✓ ***Wind*** *9,1 GW*
  - ✓ ***Photovoltaic*** *18,9 GW*



Thermal generation capacity



Renewables generation capacity *

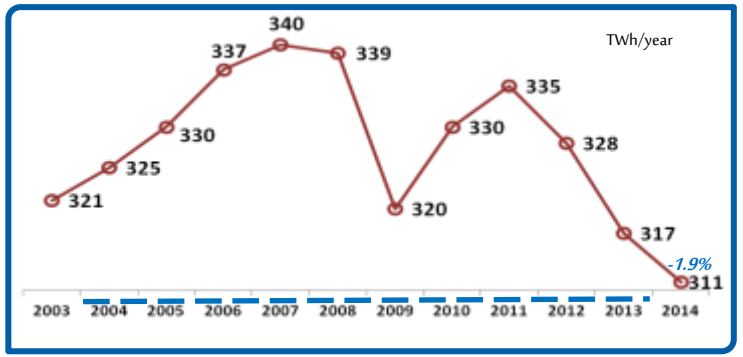


Main changes in the last years

Demand and Renewable trends

Demand crisis

- In 2014: **demand in reduction**

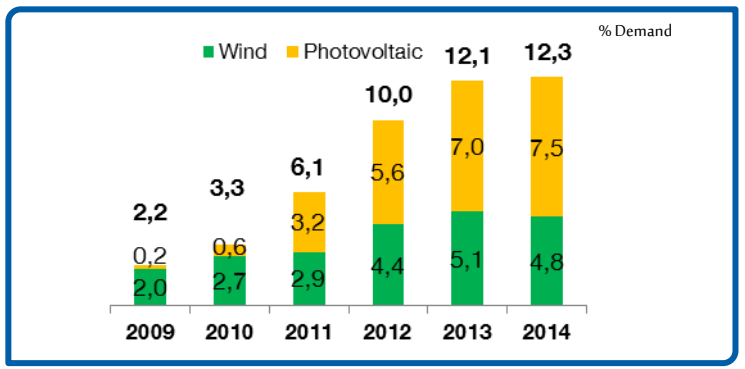


Demand crisis and **Renewable growth** make system operation more complex

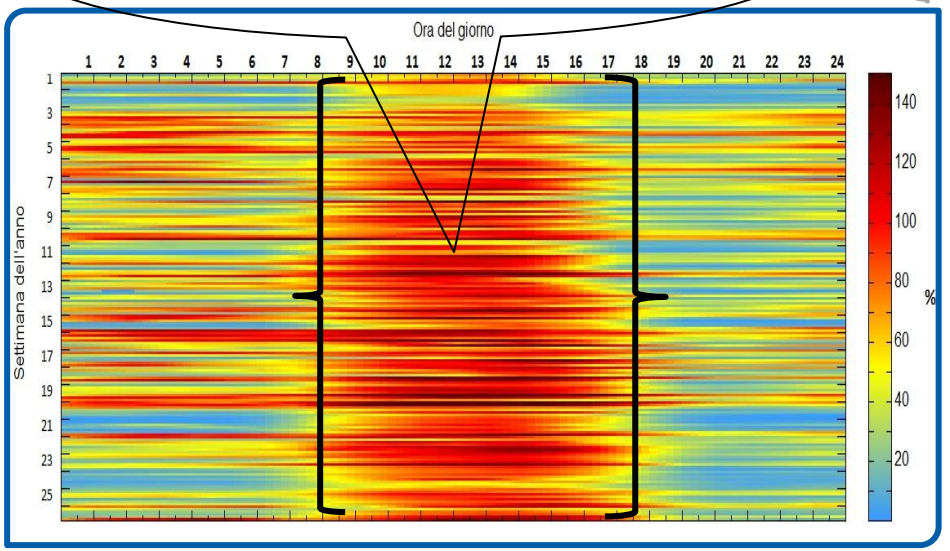
- More flexible dispatching resources are needed
- Less regulation resources are available

Renewable big growth

- In 2014: Demand significantly satisfied by Renewable: **12,3%** from Wind and Photovoltaic



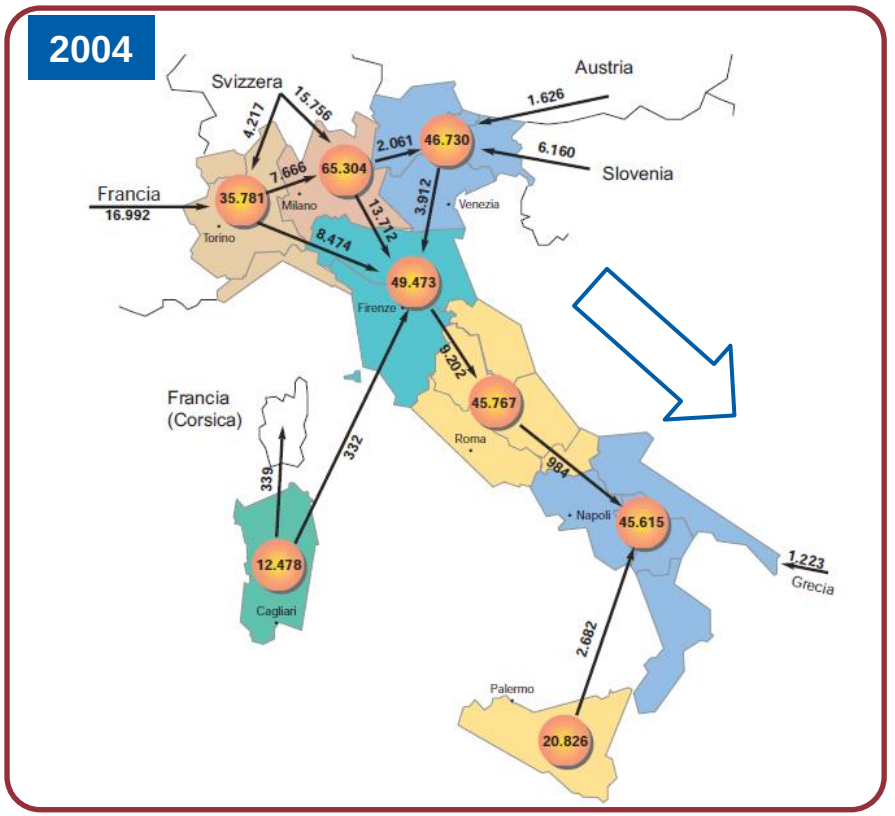
Wind and solar generation in the South of Italy more than 100% of the demand

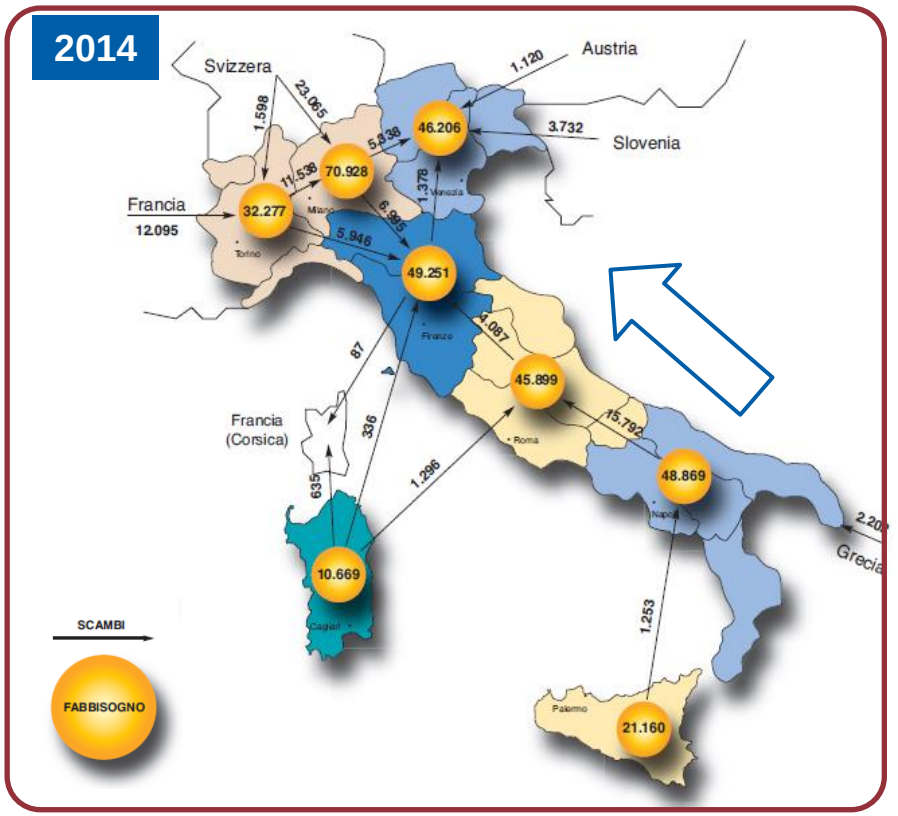


Model change after Renewables boom

Network energy flows

GWh = Mil of MWh



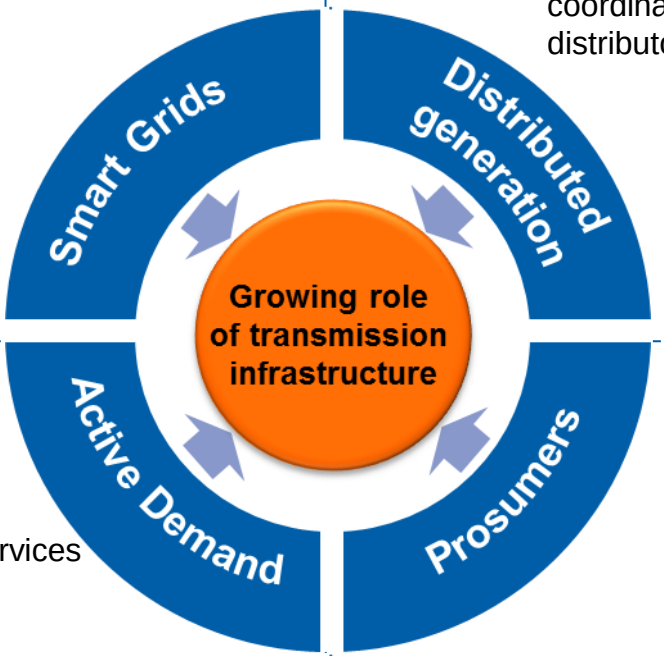


- Main flows from North to South (locationing in the North of efficient plants, import from the North)
- Big islands in export for security reasons

- Main flows from South to North, with more congestion risk (due to locationing in the South of efficient gas plants and renewables)
- Reduction of import from the North (due to prices alignment in the hours when RES supply is high)

The growing role of TSOs: new technologies

- **Phase Shift Transformers (PST):** to manage flows on critical interconnection
- **Synch compensators:** to ensure voltage quality
- **Storage systems:** to deal with local service needs



The **growth of Distributed Generation** (DG) - mainly photovoltaic - makes essential the coordination between TSOs and local distributors (DSOs)

- **System operators coordination:** TSO-DSO load management programs
- **Smart Meters** Residential load management

- **New "traders" and consumers:** Development of energy efficiency services and active demand management

- **Autoproducers**
- **Development of «energy islands»** producers/consumers scheme

The emerging new technologies requires TSOs to leverage and integrate them granting the grid to have a **"Backbone role"**

Terna's Storage Project 1/2

Confirming its commitment to guaranteeing safely and affordably managing the electricity grid, Terna is undertaking an **innovative storage system** project. This challenge includes the involvement of *Italian and foreign universities and research institutes*. The final product of this experimenting will be **revolutionary for electricity grid management** and will also provide **new opportunities for the storage system industry**

Key facts

- Ca **300 Mil€** capex plan starting in 2013 regarding 2 projects
    1. **35 MW** of NaS technology
    2. **40MW** of Sodium and Lithium technology

Project 1 (National Development Plan)

- Useful in guaranteeing greater flexibility in managing renewable plants and in increasing grid's capacity in accepting "green energy" through **"Energy Intensive"** storage systems

Project 2 (Defence Plan)

- Help in increasing the safety of the electricity systems in major islands through 40 MW of **"Power Intensive"** storage systems

Terna's Storage Project 2/2

Power Intensive

Scope: Safe management of the grid

Total Capacity: **40 MW**

Number of Sites: (Phase I) : **2**

Phase I: 16 MW Storage Lab

Codrongianos
Installed Power: ≈ 8 MW
Status: 5.4 MW completed

Ciminna
Installed Power: ≈ 8 MW
Status: 3.2 MW completed

Technology evaluation

Phase II: 24 MW

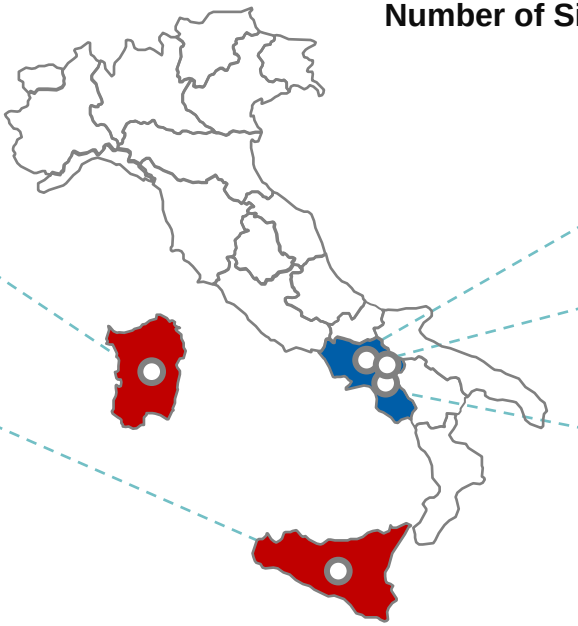
Casuzze and Codrongianos: to be started

Energy Intensive

Scope: Solve Grid congestion / bottlenecks

Total Capacity: **35 MW**

Number of Sites: **3**



Ginestra
Installed Power: ≈ 12 MW
Status: completed

Flumeri
Installed Power: ≈ 12 MW
Status: 6.0 MW completed

Scampitella
Installed Power: ≈ 12 MW
Status: building in progress

Ginestra and Flumeri among the biggest installations in Europe
Excellence in technological Know-how

TSO-DSO interactions

Operational issues

- Operational cooperation between TSOs and DSOs for system and overall network security:
  - ✓ TSOs and DSOs should **agree on requirements** for observability from RES/DSR;
  - ✓ TSO-DSO cooperation is needed to ensure **appropriate and timely implementation of NC requirements**
- TSOs and DSOs should **coordinate in solving congestions** at operation planning stage and before real time, and **share upfront information** about foreseen congestions
- TSOs and DSOs should cooperate to find the solution to **allow TSOs to access generation and demand services appropriately,** wherever its connection point, in alert and emergency system states
- TSOs and DSOs should work together to realize **efficient utilization of the capabilities of distribution connected generators and demand resources to provide system services**. TSOs should identify the requirements for system services and how these might be delivered by distribution connected service providers
- **Pilot projects** may be developed to test the implementation (e.g. coordinated voltage control from distribution connected RES to support transmission voltages, frequency response from RES)

Market interface

- TSOs consider that **DSOs should not create local and fragmented market** frameworks because this could lead to a lack of economic optimization
- **The market framework should define the roles and responsibilities of TSOs and DSOs following these criteria:** (1) resources should be used with the purpose of reaching an economic optimization, (2) competition rules need to be followed, (3) transparency of the rules, (4) confidentiality of the data collected and used and (5) cost allocation

What Terna expects

- **Institutional support** by Government and Regulatory Authority, in order to invest in projects presenting high strategic and political positive externalities

- **Clear and solid regulatory framework**: need of clear rules at national, regional and international level, that contribute to define a global reference **regulatory framework incentivizing investments**, which is predictable and in line with macroeconomic scenarios

- **Financial support**: by IFIs and by European Commission (i.e. ENI-European Neighborhood Instrument and other financial facilities) especially **for those projects which are not bankable under pure market conditions**