
Operation of power systems under COVID-19

Experience and lessons learned from Terna

Enrico Maria Carlini - Terna Rete Italia S.p.A.

ROME – 17 APRIL 2020

SHORT BIO



Name

Enrico Maria Carlini

Contact

enricomaria.carlini@terna.it

Professional appointments

- ▶ Director of Dispatching and System Operations
- ▶ Leading roles in key international organizations and initiatives of the energy community: ENTSO-E, CIGRE, SEERC, IEC, CORESO Regional Security Coordinator, etc.
- ▶ Prior to joining the dispatching department, working as Director of Grid Planning and Interconnection

Core competences

Real-time control, HVDC links, energy storage, system protection and dynamics, emergency & restoration, system resilience, power quality, regional cooperation of TSOs, Italian National Energy Strategy, Eu Network Codes, resource adequacy, Ten-Year Network Development Plan, cost-benefit analysis, output-based approach

Agenda

Terna's quick facts



Context: Italy's energy trends to 2030



Coronavirus' effect on power system in Italy



Steps taken to ensure business continuity



> Terna is...

- Spin-off of Enel Group, by way of implementation of Italian Legislative Decree No. 79/99 which, within the context of the process for the deregulation of the Italian electricity sector, in 1999 sanctioned the separation between ownership and management of the national transmission grid
- The 1st independent electricity TSO in Europe and the 6th in the world
- The owner of around 99% of the Italian high voltage transmission grid
- In charge of dispatch, maintenance, grid planning, construction

> Grid

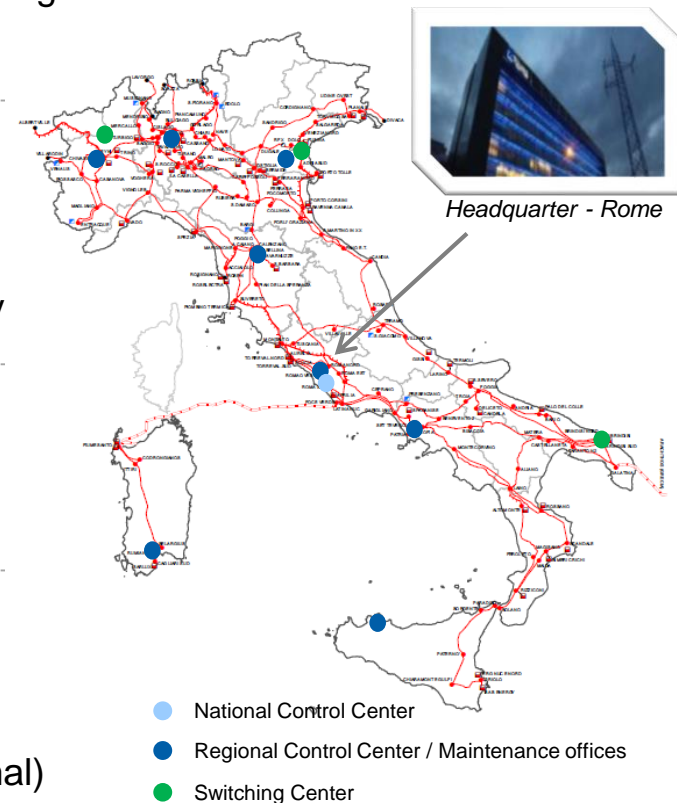
~74.440_{km} of transmission lines
26 interconnections with 7 neighbouring countries
884 substations connected to 380, 220, 132/150 kV

> Demand

320_{TWh} energy demand in 2019
60.4_{GW} peak load recorded on 21st July 2015

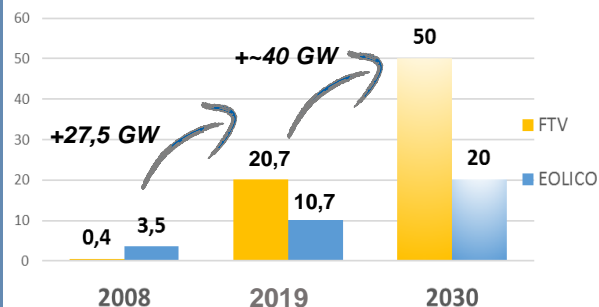
> Energy mix

35% Italian electricity needs covered by RES
61,9_{GW} conventional (gas, coal, oil)
54,1_{GW} RES (PV, wind, hydro, biomass, geothermal)

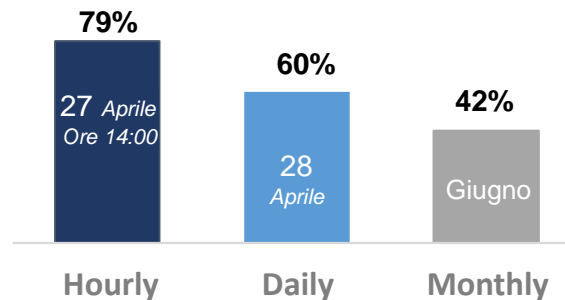


Italian Electricity System at a glance

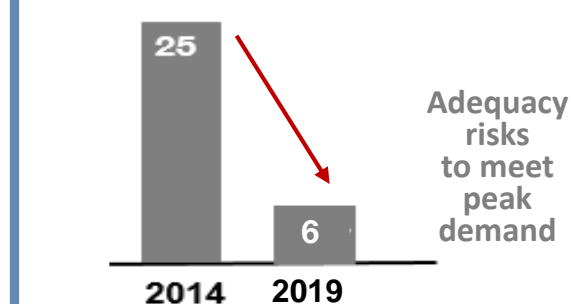
Installed wind and PV capacity (GW)



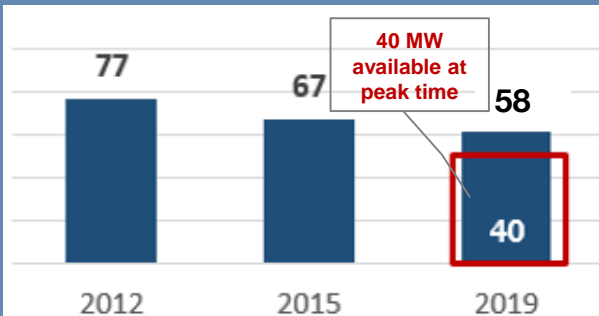
Share of demand covered by RES^{1,3} (%)



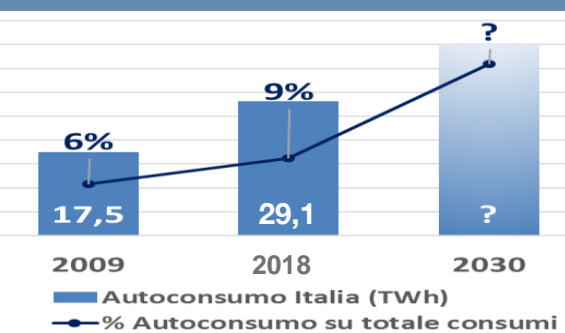
Minimum yearly reserve margin^{2,3} (GW)



Phase out thermal capacity (GW)



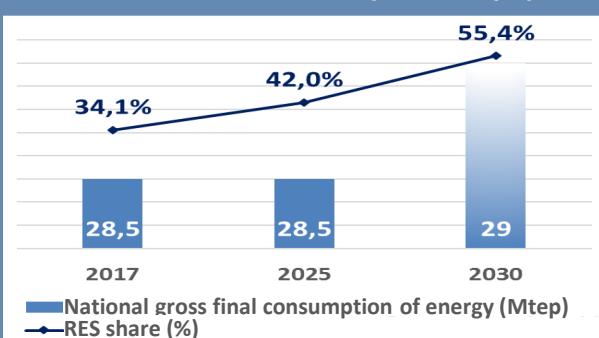
Self-consumption (TWh)



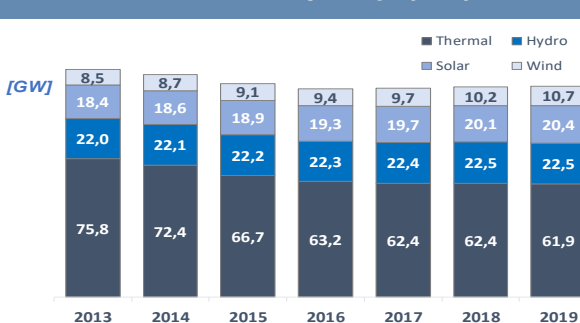
Target NECP

| | Obiettivi 2020 | | Obiettivi 2030 | |
|---|----------------|--------|----------------|---------------|
| | UE | ITALIA | UE | ITALIA (PNEC) |
| Share of energy from RES in gross final consumption of energy in 2030 | 20% | 17% | 32% | 30% |
| 2030 target for non-ETS GHG emissions under ESR compared to 2005 | -10% | -13% | -30% | -33% |

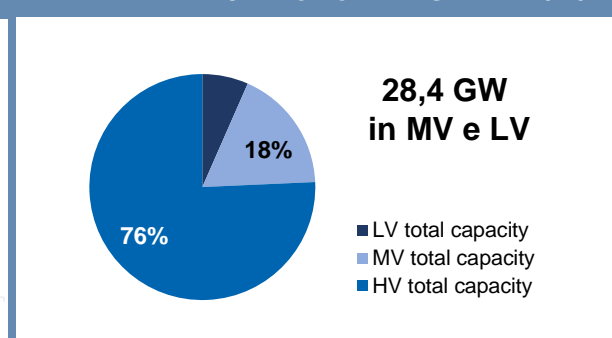
RES in the electricity sector (%)



Installed capacity (GW)



Installed capacity by voltage level (%)

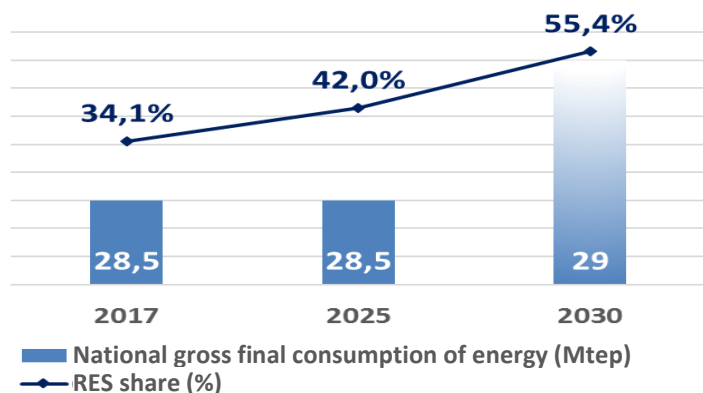


Decarbonization

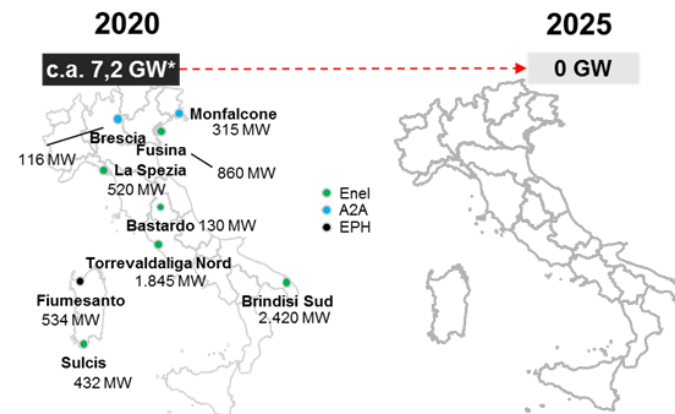
National Energy and Climate Plan (NECP): Italy by 2030

Main target of NECP

Growing RES share

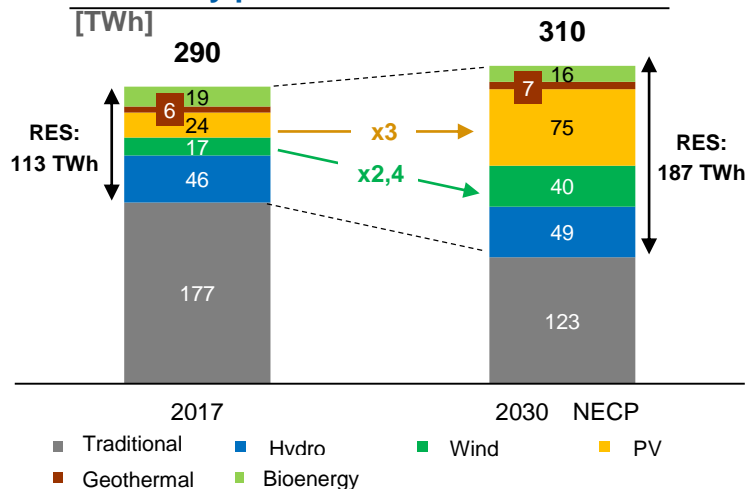


Coal phase-out by 2025

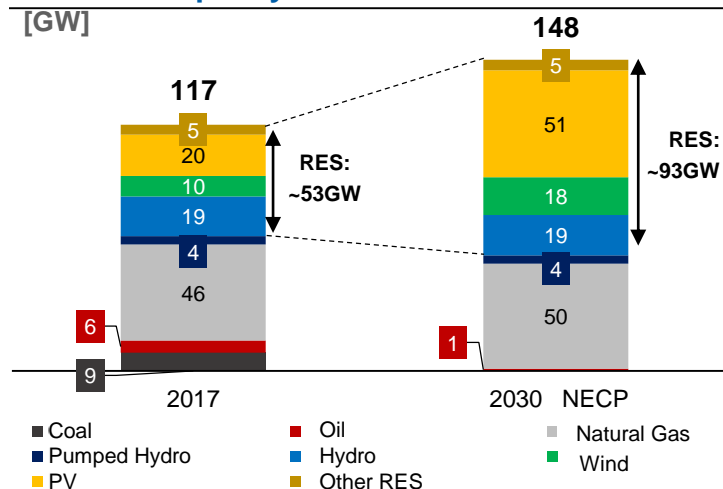


2030 Scenario

Electricity production



Installed capacity



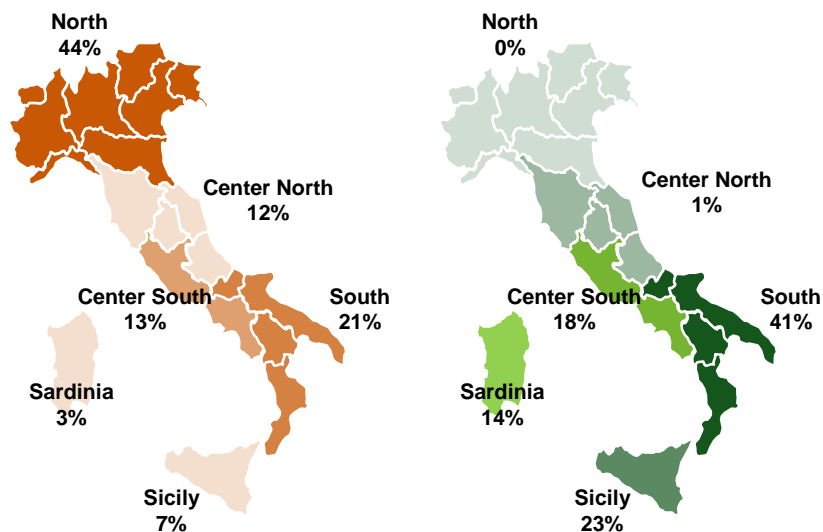
The NECP targets a complete coal phase-out by 2025 and a significant push towards RES

Geographical distribution of RES per Bidding Zone, 2018

[%]

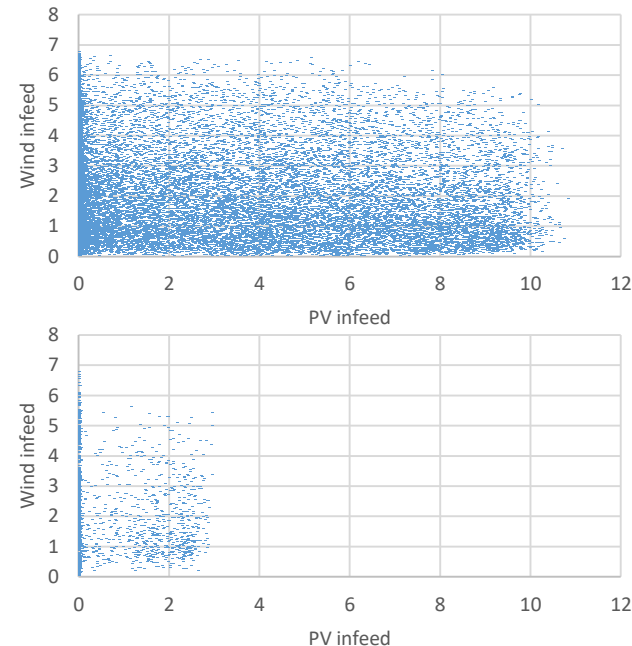
PV: 20.0 GW

Wind: 10.2 GW



Wind vs PV infeed 2015 – 18

[GW]



The Italian system is facing new challenges due to the nature of the intermittent RES:

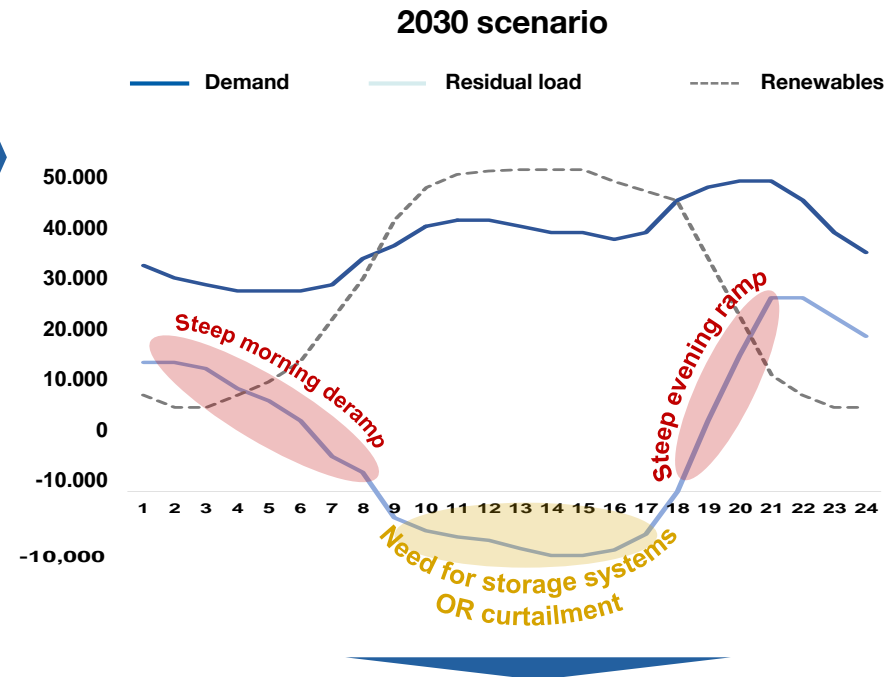
- **Congestion management:** Wind capacity is mostly installed in the Southern Bidding Zones (82%), which also host a relevant share (~40%) of the PV capacity. This leads to high electricity flows from South to North.
- **RES availability:** although the installed PV capacity is high, its production is low during the evening hours, when electricity demand can be peaky

The rise of renewable sources: challenges

OPERATIONAL ISSUES

- **SECURITY**. Not homogeneous distribution of RES across the Country (higher concentration in the South) causes **grid congestions**
- **OVER-GENERATION**. Increasing periods where non-dispatchable RES exceeds demand
- **ADEQUACY**. Limited up-ward **reserve margins** to cover the peak load following the decommissioning of a significant amount of installed thermal capacity
- **FLEXIBILITY**. Increasing steepness of the **residual load ramp** to be covered in the evening hours due to the significant reduction of PV production in the same hours
- **STABILITY**. Reduced **inertia** as less generation with rotating mass is in operation
- **POWER QUALITY**. Limited availability of resources which are able to provide **voltage regulation**

RESIDUAL LOAD GROWING ISSUE



Due to the Coronavirus lockdown, oversupply conditions are expected to occur more often

The increasing penetration of renewables in the generation mix, combined with the simultaneous decommissioning of carbon fleet is putting system operations at stress



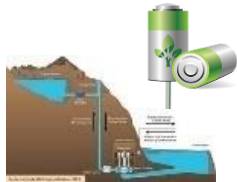
GRID EXPANSION

- To strengthen connections between **internal market zones** and **cross-border exchanges** with neighboring countries;
- **Synchronous condensers** for voltage regulation, inertia and short circuit level



MARKET DESIGN

- **Power Purchase Agreement and tenders** to finance **RES** investments
- **Capacity market** to give long-term price signals to 'peakers' unit
- **Aggregation** of demand, RES and storage to access Ancillary Services Market



STORAGE

- Additional **6 GW of storage** capacity by 2030 to meet **security, adequacy** and **flexibility*** needs



DIGITALIZATION

- **Data-exchange** between TSO-DSOs to allow **GD observability** and controllability
- ICT infrastructure to capture **distributed flexibilities**

* **Ramp up/ down** at the sunrise/ sunset, **downward regulation** to accommodate the excess of non-dispatchable generation

Agenda

 Terna's quick facts



Context: Italy's energy trends to 2030



Coronavirus' effect on power system in Italy



Steps taken to ensure business continuity



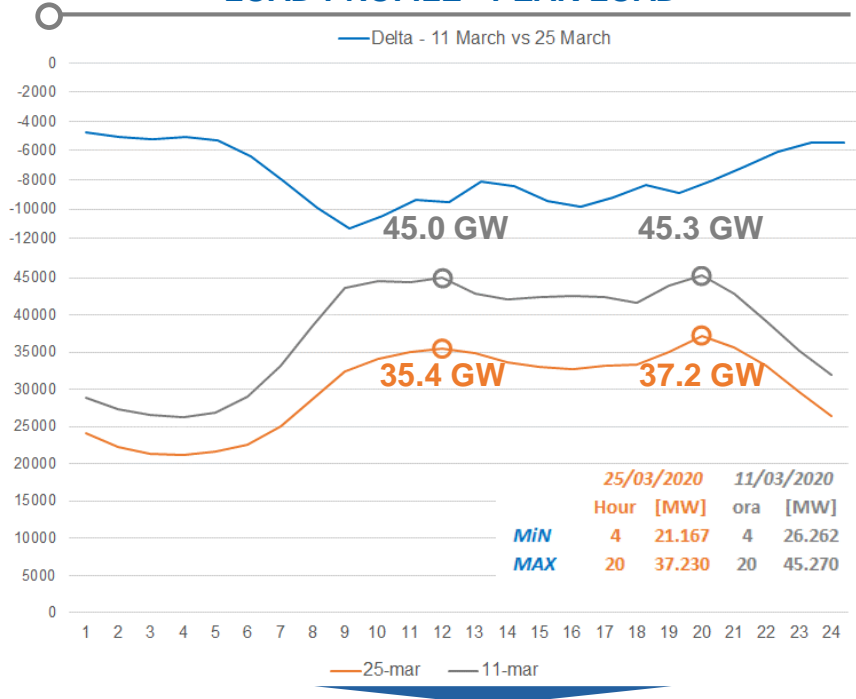
Coronavirus' effect on power system in Italy

Energy market and load profile

The measures currently being taken by the government to combat the spread of the COVID-19 are having a noticeable effect on Italy's electricity system.

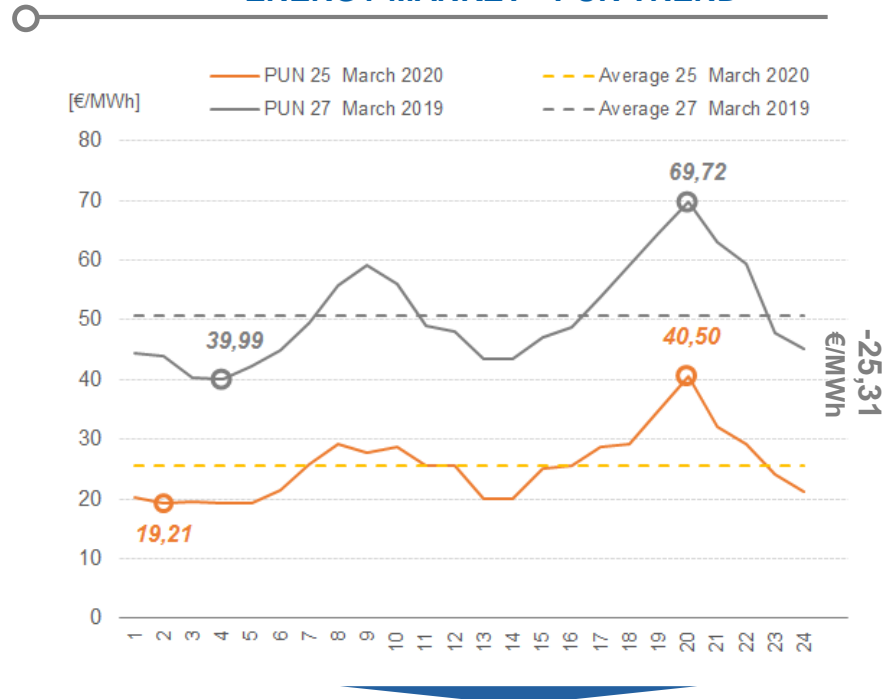
The decreases were gradual and punctuated by the announcements of government measures.

LOAD PROFILE - PEAK LOAD



- Since 11 March, the impact on industrial and residential loads is similar to what usually happens on weekends
- The gradual restriction on activities is leading to a sharp decrease in **peak electricity consumption** which is down from a previous year of **~9.4 GW**

ENERGY MARKET - PUN TREND

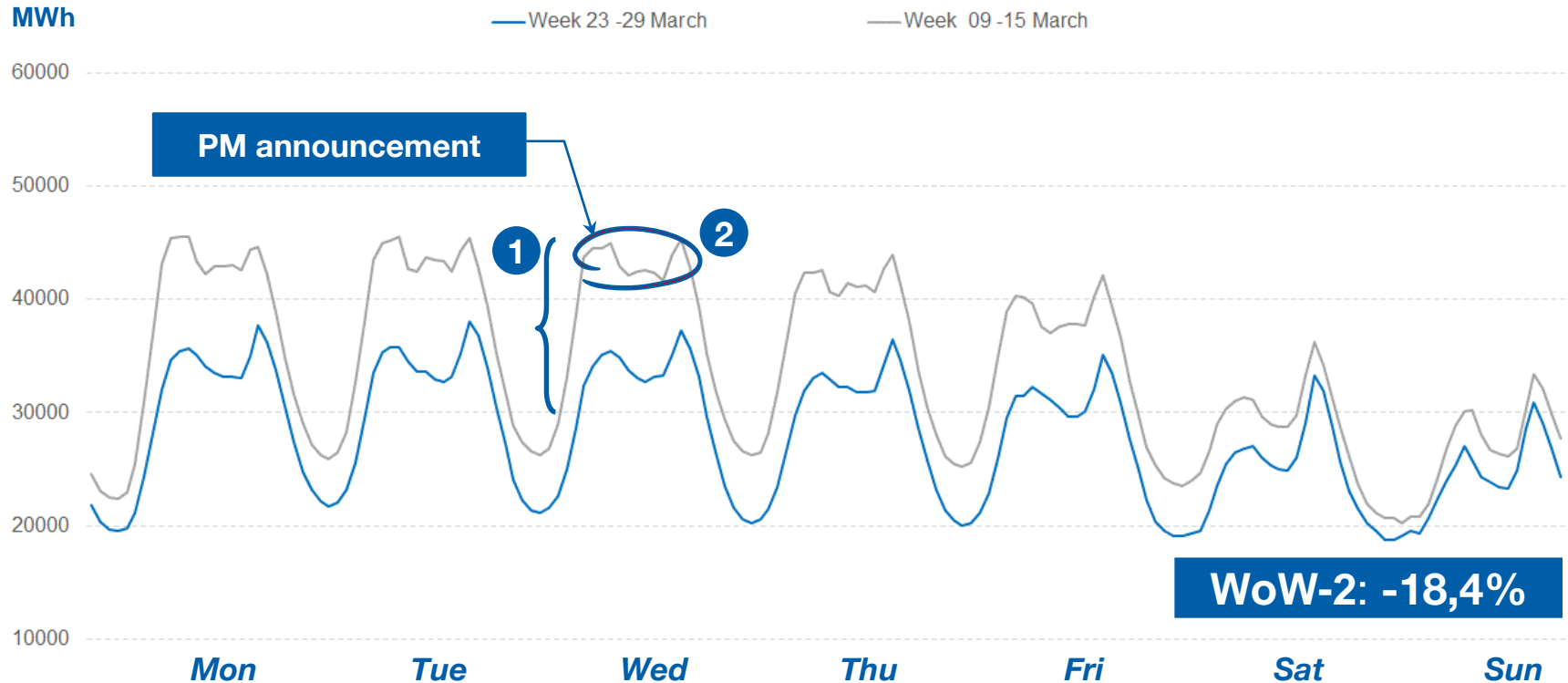


- The combination of lower demand, declining prices of gas/LNG, together with the seasonal increase in peninsular solar production has pushed the day-ahead power price down to **19 € per MWh**

Coronavirus' effect on power system in Italy

Energy demand

Comparison of electricity demand before and after the lockdown



DROP IN DEMAND

Prime minister Giuseppe Conte's lockdown announcement (on Wednesday 11 March) caused an immediate reduction in electrical demand:

- 20% as compared to normal times
- 18.4% as compared to 2 weeks ahead

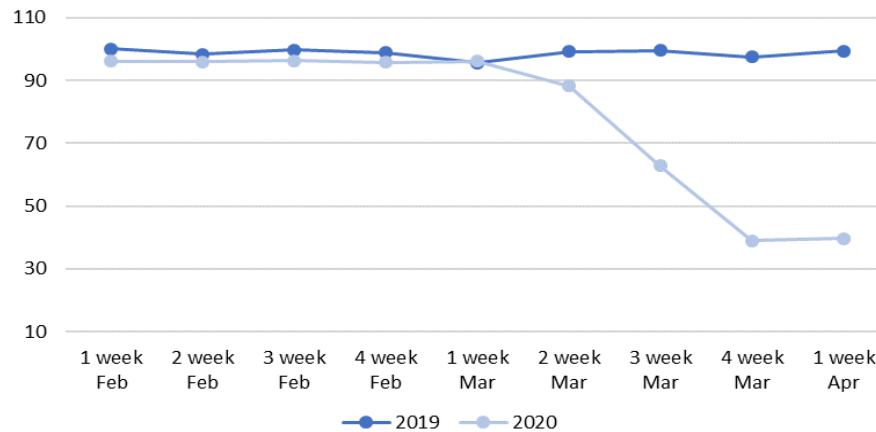
LOAD PROFILE

- With many people working from home and industries/ schools shut, people are less governed by routines and strict adherence to times
- This has caused the typical load profile and morning electricity "peak" to flatten out

Coronavirus' effect on power system in Italy

Industrial load

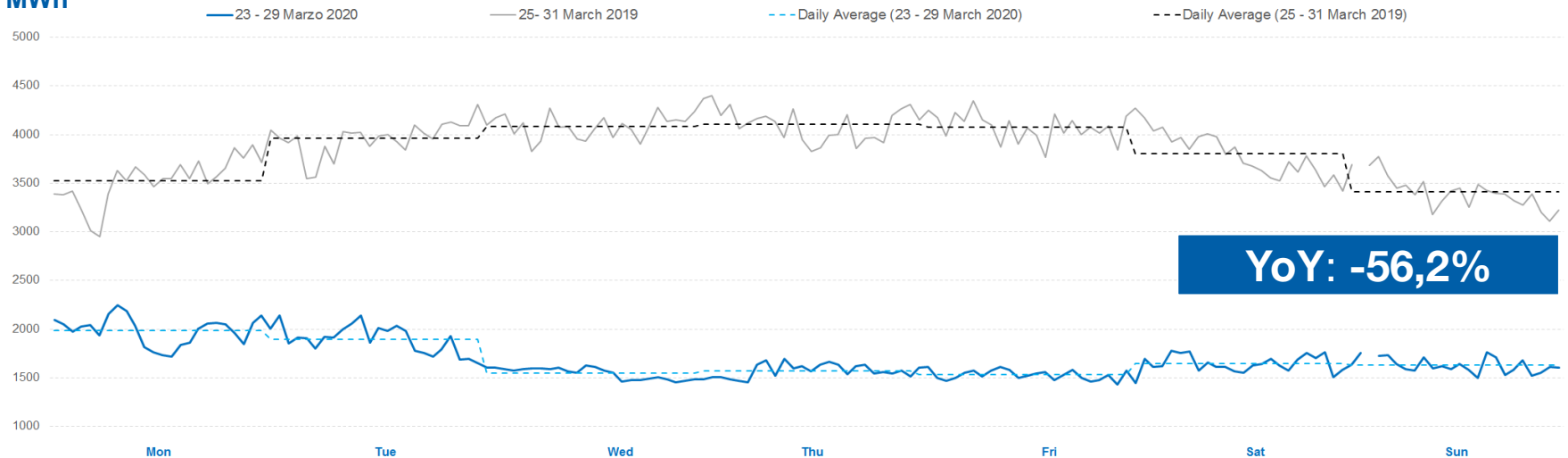
VARIATION OF CONSUMPTION INDEX IN ENERGY INTENSIVE CUSTOMER



- In total, there're **565** Industrial costumers with interruptible rates in Italy
- Interruptible loads available for defence system fell by **56%**

INDUSTRIAL CUSTOMERS CONNECTED TO HV LEVEL

MWh

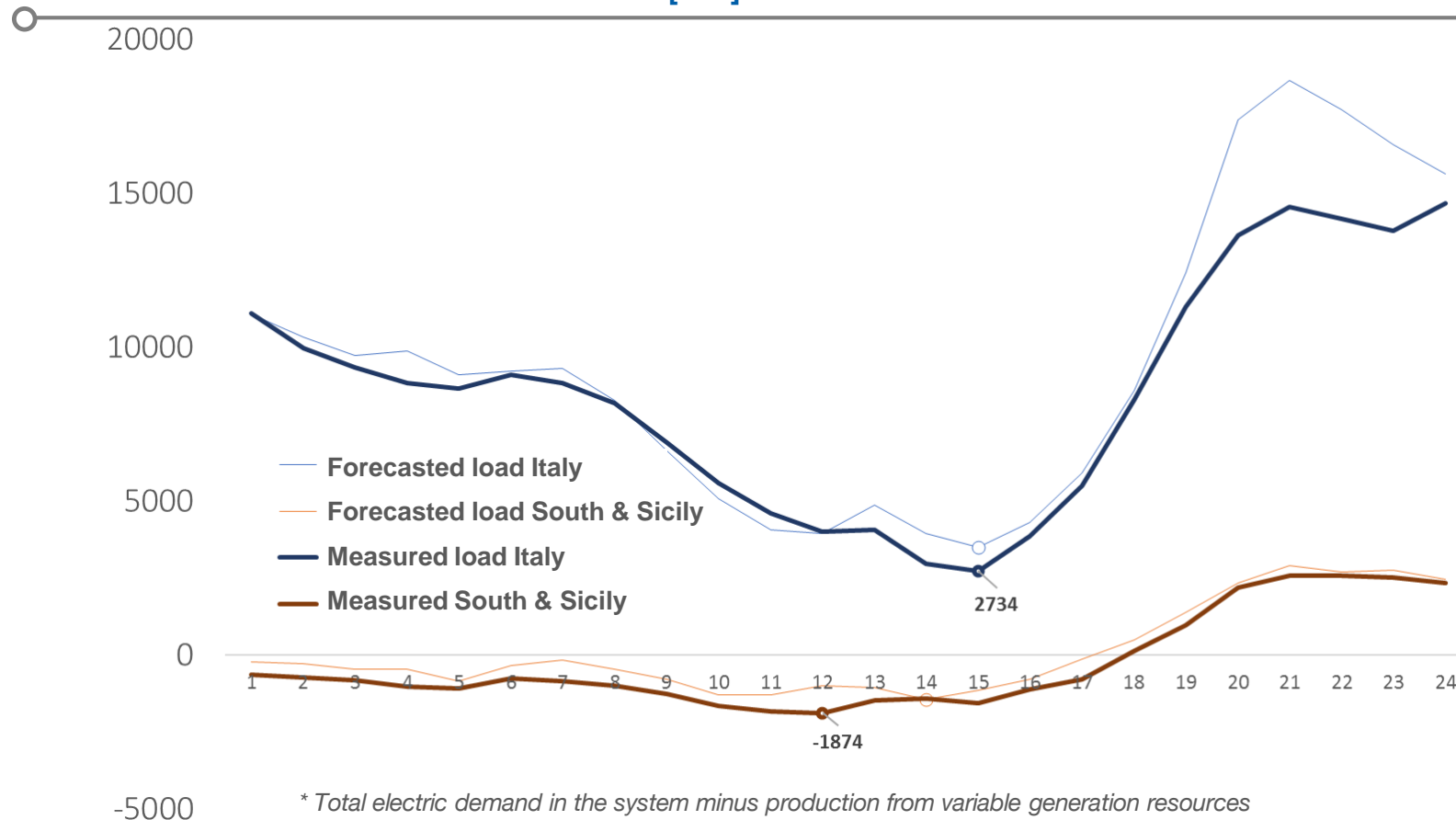


YoY: -56,2%

Coronavirus' effect on power system in Italy

Overgeneration

RESIDUAL* LOAD – SUNDAY 5 APRIL 2020 [MW]



High probability of encountering an **excess of inflexible generation** (i.e. hydro/ wind/ solar), especially during weekends and Easter period

In 'low consumption' days, we may need the following actions: **import reduction**, optimal use of **pumped storage**, disconnection of power lines/ tap staggering on transformers for **voltage regulation**, **curtail renewable** inflexible generation to balance the system (last resort)

Agenda

 Terna's quick facts



Context: Italy's energy trends to 2030



Coronavirus' effect on power system in Italy



Steps taken to ensure business continuity

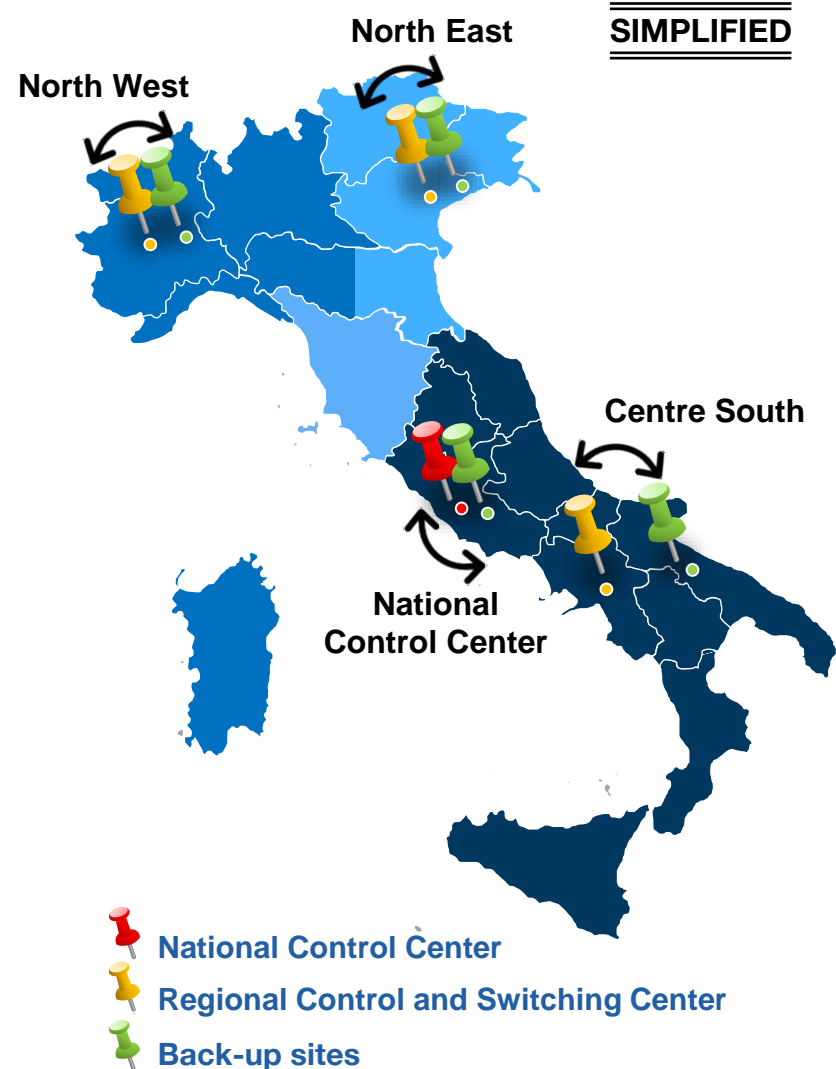


National Control Center

- Real Time control of the EHV transmission grid (400-220 kV) and interconnections
- Real Time Congestion Management (re-dispatching, counter-trading)
- Real-time balancing of consumption and generation
- Coordination of the Regional Centres

Regional Control Centers & Switching

- Real control of the sub-transmission grid (≤ 150 -132 kV)
- Voltage regulation in coordination with CNC
- Coordination with the DSOs (management of flows coming from distribution grids, coordination during emergency situations or restoration, etc.)
- Topology modification (switching circuit breakers, putting in safety)



Business continuity plans for system operations

Steps to protect control room operations

7

As a 'last resort' containment measure for a worst-case scenario, currently only hypothetical, it will be necessary to **segregate shift operators**



CAMPER IN THE PARKING LOTS

HOTEL NEARBY



6

Intensified **tests of disaster recovery** procedures to enable fully functional command and control capability of back-up sites in case a primary Control Center becomes inoperable

1

Infrared thermometer to measure the body temperature of all employees at the entrance of each Control Center

2

Deep cleaning of critical surfaces in the Control Room (e.g. telephones, desks...)

3

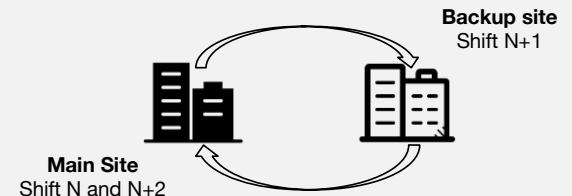
Dispatcher are equipped with **facial masks** and disposable latex gloves

4

Organization of shifts with **stable crew**

5

- For each Control Room, the nearby back up site has been activated
- **Personnel rotates** at each shift from the **main site** to the **back up** one (and vice versa), leaving the elapsed time of a shift for sanitizing the site not in use
- This strategy also seeks to reduce contact between real time Operators
- Relay of shift is conducted through non face-to-face way such as teleconferencing



Business continuity plans for system operations

Steps to protect general employee population and business continuity

1 Smart Working

Smart working for 'non-essential' office staff (>70%)

2 Guidelines for Producers

- Ministry issued recommendations to the relevant national Producers to make sure they will be able to staff and operate power plants
- Optimized maintenance plans

3 Maintenance works and construction sites

Construction sites and of maintenance activities limited to unavoidable activities: urgent and non-delayable maintenance, urgent cutting of vegetation, legal inspections, prompt intervention, oversight of non-interruptible construction sites, tasks related to emergency management

4 Protection of general employee population

- Ban on physical training sessions and non-essential business travels
- Sanitization and new protocols for intensified cleaning of critical surfaces in office spaces (door handles, buttons on the elevator, telephones, desks...)
- Installations of distributors of sanitizing products
- Obligation of quarantine in case of symptoms or contacts with infected people
- Respect of interpersonal distance of 1 meter
- Continuous exchange of information with employees and the Trade Unions

5 Crisis Committee

- Activation of a dedicated Task Force on Board level, assisted by the company top managers (members: CEO, Safety, ICT, Dispatching, O&M, HR)
- One member of the Crisis Committee is permanently seconded to the Civil Protection Department Operating Committee

6 System Operations report

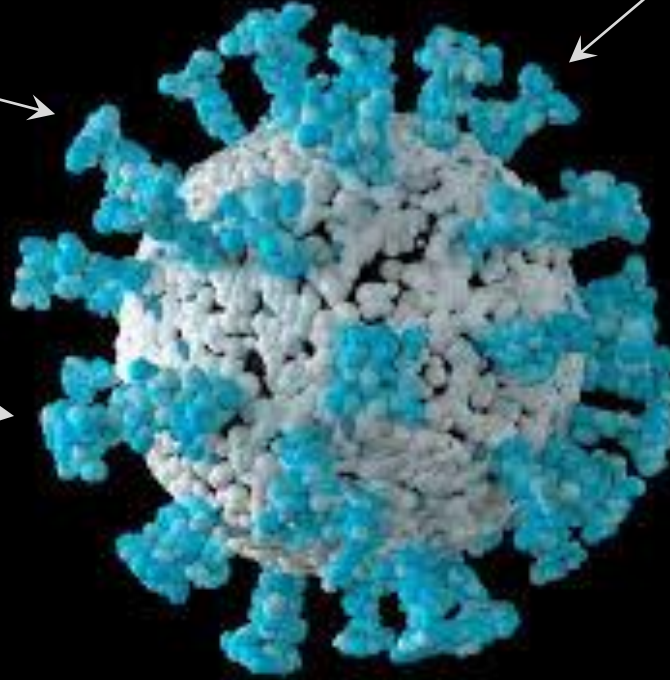
- Daily report shared with BoD, the Ministry of Economic Development (MISE) and the National Regulator (ARERA) to ensure maximum transparency and continuous flow of information
- Contents: load consumption, outages of thermal plants and transmission grid elements, interruptible customers, import

7 Neighboring TSOs

Extraordinary daily calls are organized with neighboring TSOs to early detect potential critical situations

8 Health Insurance

Special COVID-19 insurance coverage for all employees valid until end 2020



An aerial photograph of a white, angular, crystalline structure, possibly a piece of art or a natural formation, set against a dark, textured background. The structure is composed of numerous sharp, geometric facets and is surrounded by a dark, irregular, and textured material that resembles a rough surface or a dark liquid. The overall composition is abstract and dramatic, with high contrast between the bright white structure and the dark background.

THANK YOU

QUESTIONS

enricomaria.carlini@terna