Smart Tech, Stronger Grid - Terna’s Resilience Revolution

World Bank Webinar: European Climate Resilient Energy System: Integrating Climate Adaptation into Planning and Implementation

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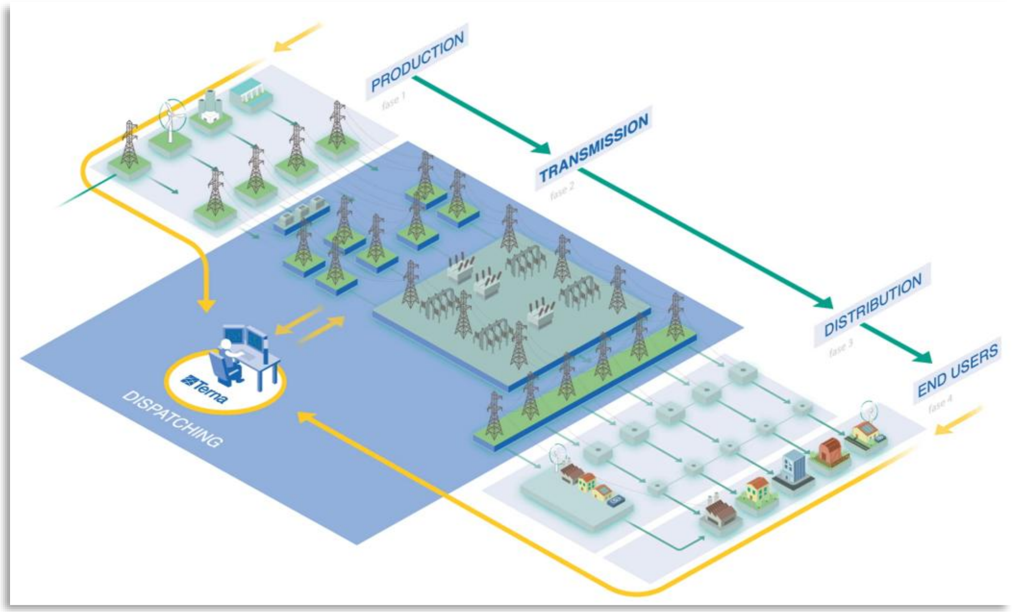
Terna Driving Energy

Terna in a Nutshell



- Responsible for the **planning, development and maintenance** of the national transmission grid (RTN) and for the management of the electricity flows.
- It operates under a **monopoly regime** according to the rules of the **Regulatory Authority for Energy, Networks and the Environment** and the guidelines of the **Ministry of the Environment and Energy Security**.
- **First independent operator** in Europe for km of lines managed.

More than 75.000 Km high voltage lines and 900 power stations managed

30 cross-border interconnection lines

36% of italian electricity demand met by renewable sources (2021)

17,7 bln € for 2024-2028 Terna Business Plan

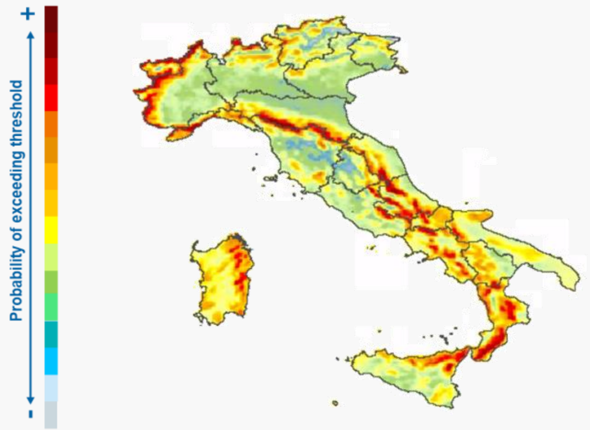
~ 2,4 bln for digitalization and innovation

More than 5000 employees

The Terna's Resilience Methodology

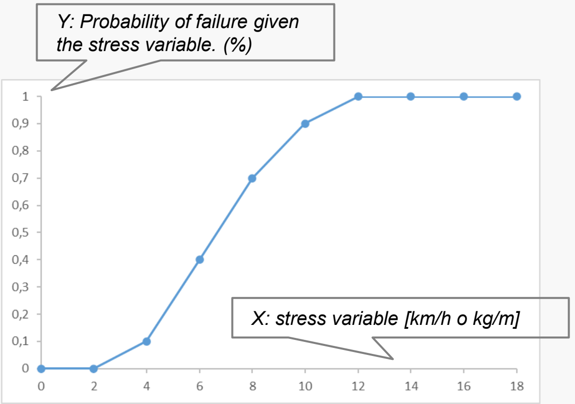
Terna has adopted the **Resilience Methodology,** a prospective, risk-based approach to identify the most vulnerable areas of NTG, calculate the risk of outage and quantify the benefit of resilience intervention. The methodology is characterized by the following key pillars:

PROSPECTIVE CLIMATE HAZARD



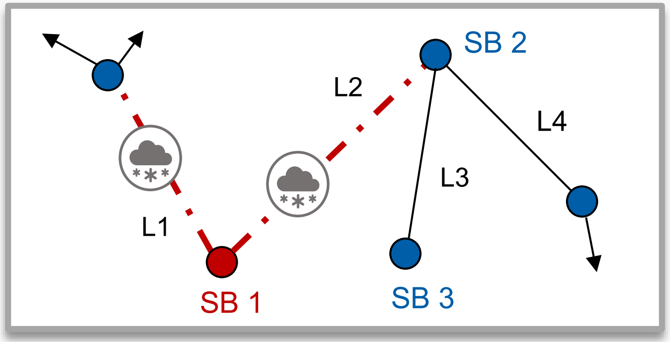
Use of specific **prospective climatological models** for each threat to determine the **probability of occurrence** of **severe weather events**, with high spatial resolution.

ASSETS VULNERABILITY



Vulnerability assessment of **OHLs** (failure probability): **vulnerability curves**, which are function of the **threat intensity**, are built by adopting an **engineering approach** based **on technical standards.**

CONTINGENCIES ANALYSIS



A **contingency analysis approach** to evaluate system resilience, quantifying **substations' outage Return Periods (RP)** and **EENS (Expected Energy Not Served)** after the simulation of **weather-induced multiple contingencies (N-k).**

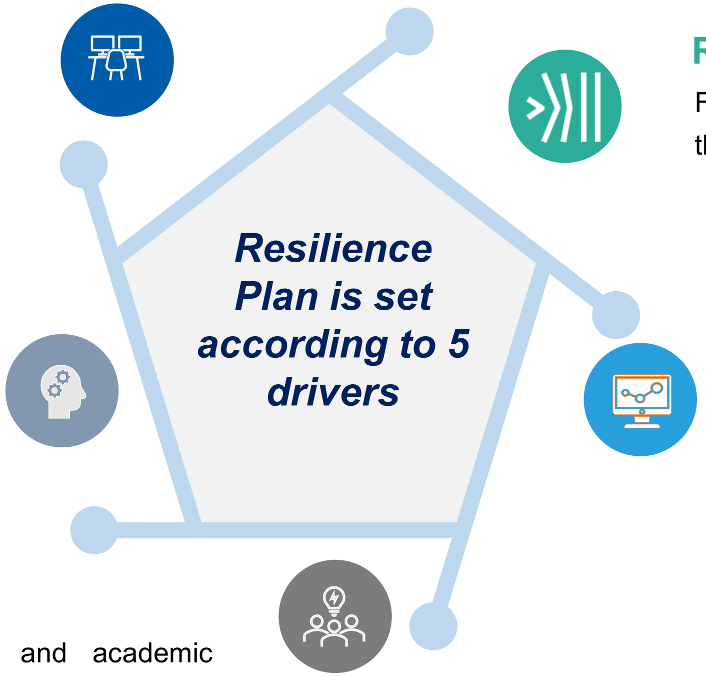
Resilience Methodology has been approved by the Italian Regulatory Authority (ARERA) with Resolution 9-2022 and is now part of National Grid Code (A76).

Terna's Resilience Plan – The Drivers

- All the intervention planned by Terna aimed at increasing the resilience of NTG are included in the **Resilience Plan**.
- **Investments** to enhance transmission grid's resilience are identified accordingly to **5 main drivers**;

Risk modelling

Development and consolidation of methodological approaches aimed at modelling meteorological and environmental phenomena with a significant impact on the NTG and assessing the associated risk of outage



Risk management

Further identify strengthening initiatives aimed at reducing the risk of outage due to extreme weather events

Technological innovation

Study of new technologies to further enrich the portfolio of solutions available to the TSO to increase grid resilience and thus have a diversified and efficient mix

Digitalization

Development and implementation of new tools and devices aimed at enhancing capabilities in terms of control, management, real-time monitoring of assets and short-term forecasting, to anticipate potential critical issues.

Partnership and scientific research

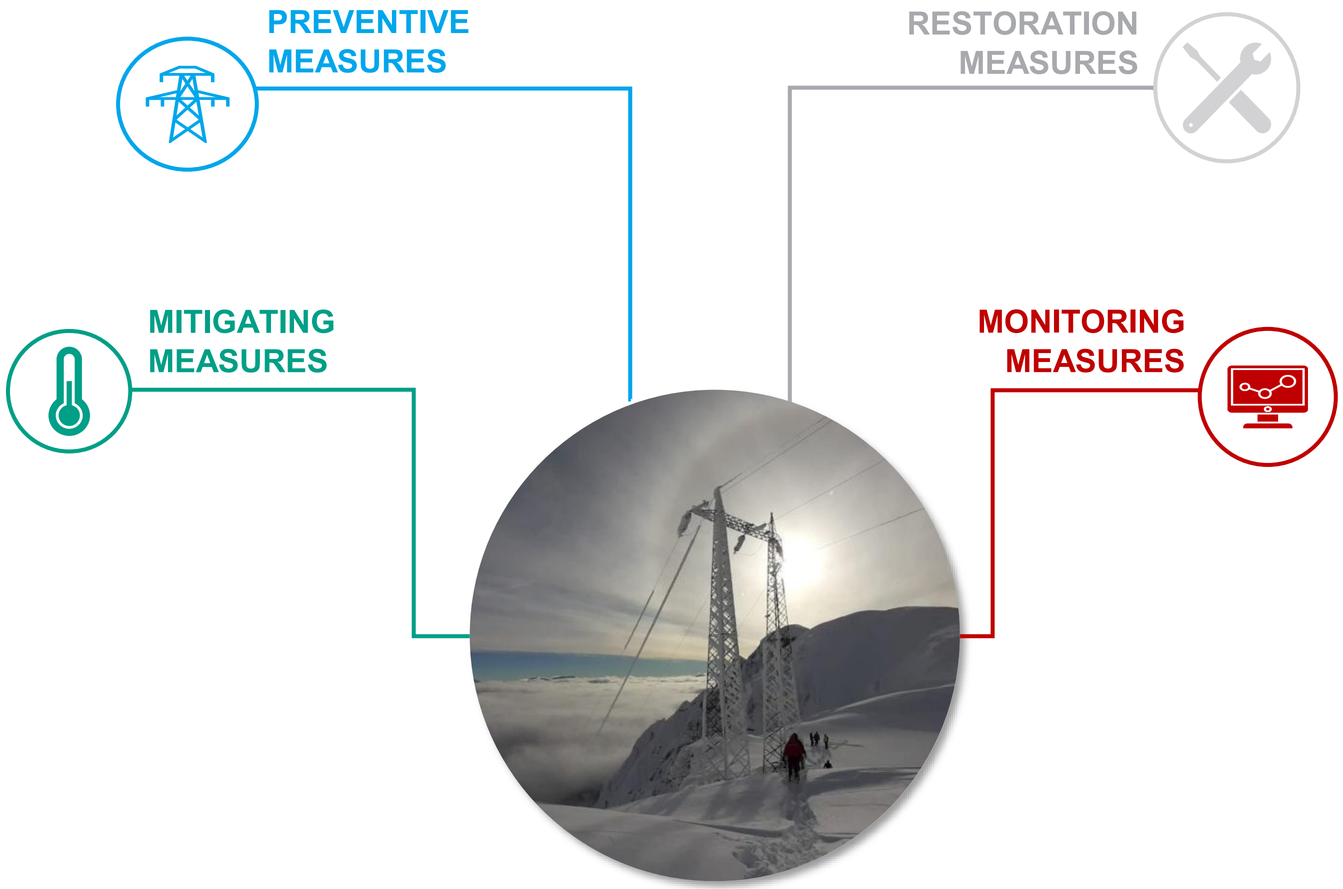
Strengthening collaboration with research institutes and academic institutions to combine multidisciplinary know-how and expertise essential for the study and modelling of complex phenomena such as extreme events, especially with regard to climate change.

Terna's Resilience Plan – Types of Intervention

TYPES OF MEASURES

In order to **fulfil an efficient mix between different technological solutions**, **Terna,** also through the application of the Resilience Methodology**, has identified different types of interventions** for the most critical areas:

- **Preventive Measures,** i.e. interventions implemented ex-ante to prevent the occurrence of failures
- **Mitigation Measures,** i.e. capital light interventions to contain risks on the electrical system and reduce damage due to critical event
- **Measures for restoration,** i.e. interventions implemented ex-post, in response to the actual occurrence of failures
- **Monitoring Measures,** i.e. innovative technological solutions aimed at anticipating critical situations



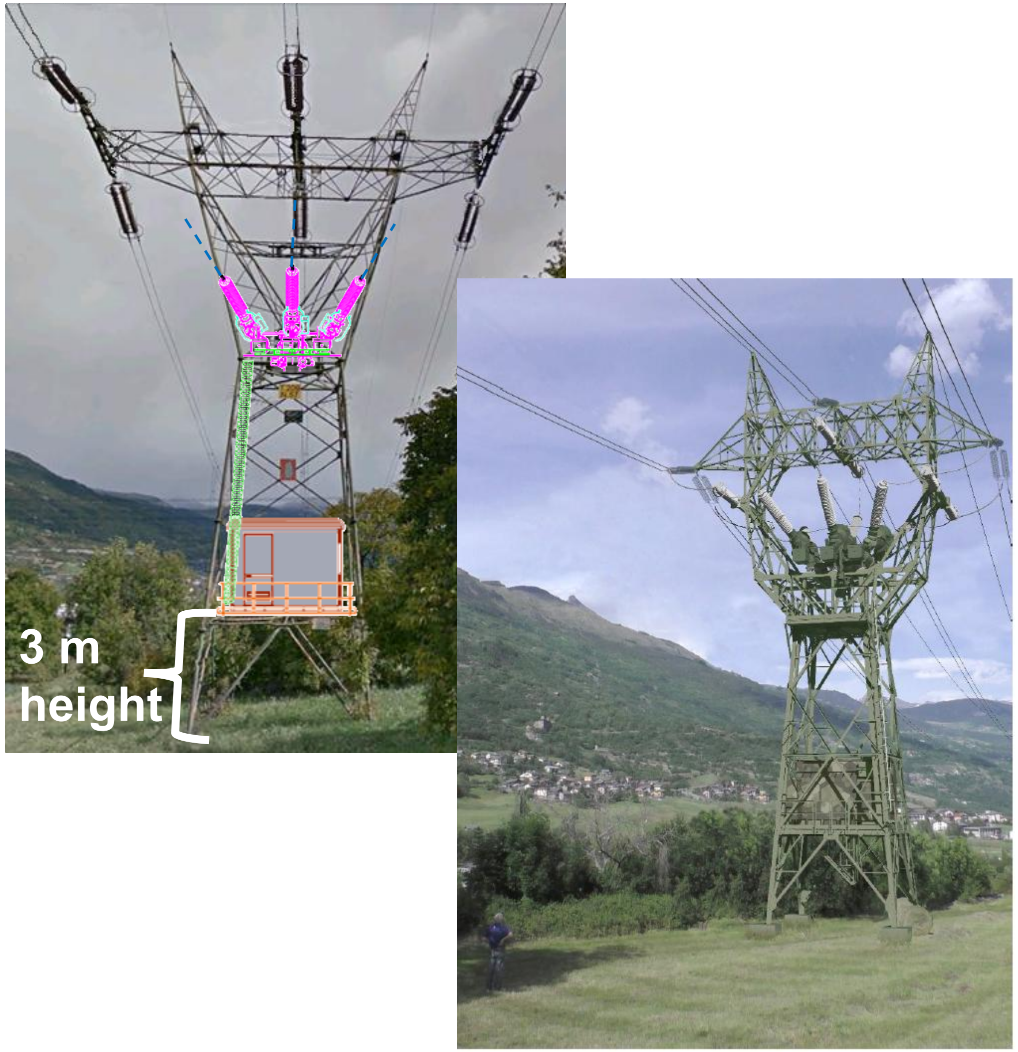
Innovative preventive solution: Pole-mounted Switching Equipment (OMP)

FEATURES

The designed improvement is optimal in areas with **rigid “T” junctions** where **traditional connections or new stations are difficult to implement** and was based on the replacement of the existing support where control devices are not present or a simple manually operated disconnectors are present with **new switching equipment** suitably associated with a protection, command and control system, positioned in a shelter, all **integrated in** to the structure of a **lattice tower.**

- **Increase the flexibility of network operation**, thanks to the ability to interrupt rated and short circuit currents, in a selective manner
- **Interact with** neighbouring **substations and be remotely operated**
- **Being an expression of technological evolution**, resulting in:
  - ❑ a compact solution, a MCM (gas-insulated compact multifunction module) in the support, minimizing footprint and easing authorization.
  - ❑ Multi-hazard adaptation approach which includes especially extreme cold, floods, storms, landslides, and strong winds.
  - ❑ sustainable on the territory
- **Solution protected by patent**

THE DESIGN



How a OMP works

ADVANTAGES OF SCHEDULED MAINTENANCE

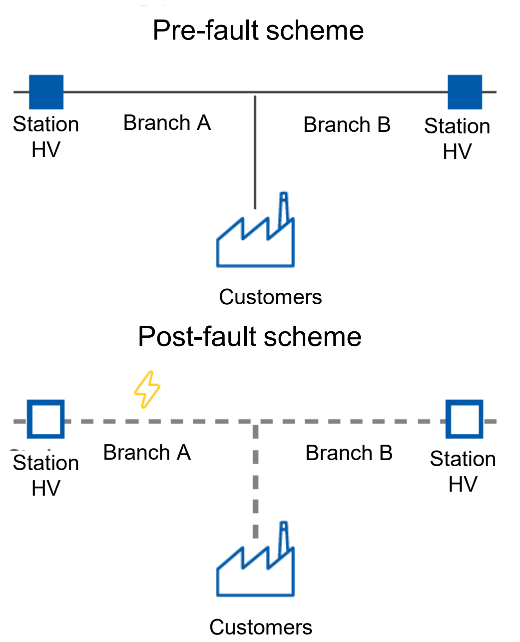
- **Operational flexibility**, thanks to the possibility of performing manoeuvres not only manually on site, but also remotely;
- **Speed and ease of manoeuvring**;
- **Instantaneous and remote network reconfiguration**;
- **No interruption** to the electricity service;
- **Flexible intervention scheduling**, independent of users' production cycles;
- **Maximization of the energy produced** by non-programmable systems;

ADVANTAGES IN THE EVENT OF A FAULT

- **Reduction in recovery times** following a out of service;
- **Selective and automatic elimination of faults** on the AT backbone;
- **Improvement in service qual**ity for connected users;
- **Minimization of economic losses** for users due to interruption of the production cycle;
- **Reduction in the risk of damage to industrial plants** due to prolonged power outages;
- **Suppression of short and medium interruptions** due to faults on the backbone and **consequent compensation by the operator;**

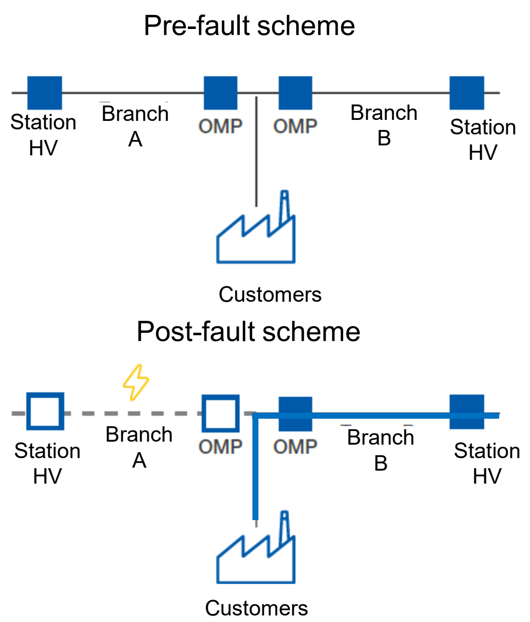
Benefits

Without OMP



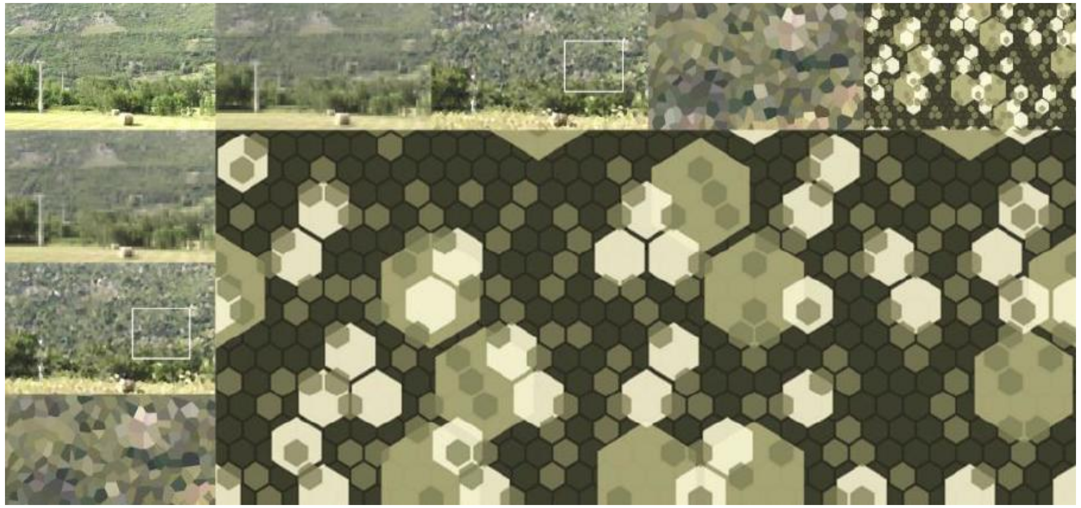
in the event of a fault or scheduled maintenance on a branch, the entire line goes out of service, with a power outage for the customers

With OMP

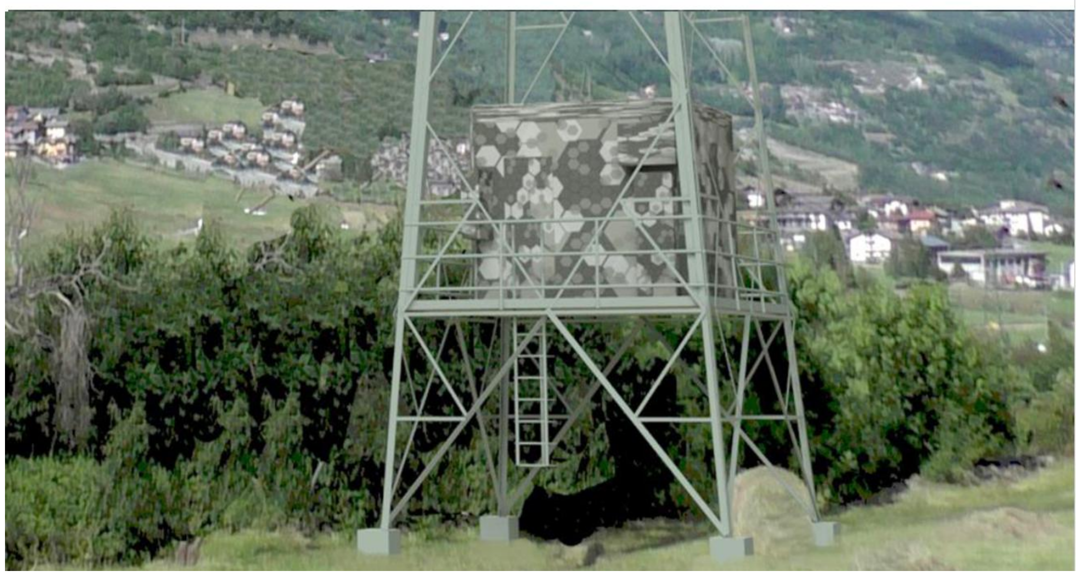


With OMP, in the event of a fault or scheduled maintenance, only the affected branch is taken out of service without power outage for the customers.

A new concept of sustainable design for the territory

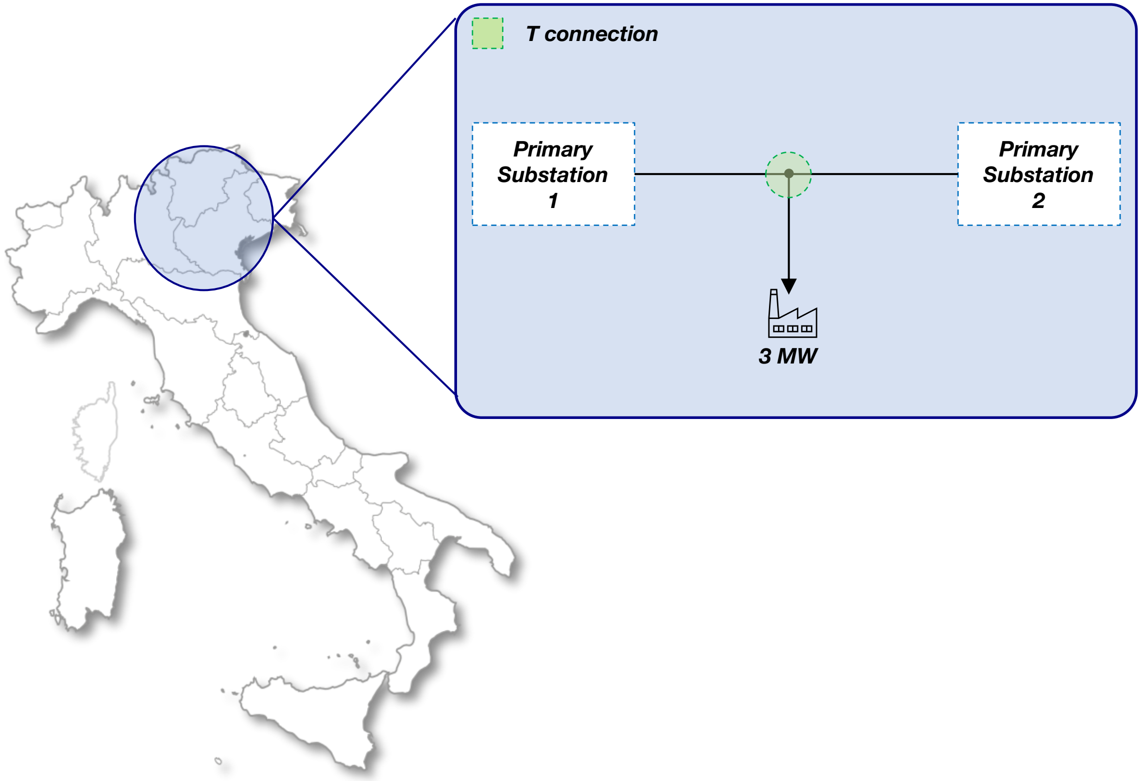


- Terna has paid close **attention to the visual integration of the infrastructure into the landscape**, and in particular, to avoid visual impact even at great distances.
- a **color scheme** which, together with **geometric shapes**, creates a **geometric honeycomb camouflage** that **blends in as well as possible with the surrounding landscape** was adopted.



Real case Analysis

- The **analysed portion of the grid** consists of an **MV substation** directly connected to the HV network with a **T-connection** and a **load of 3 MW.** The only T-connection feeding the utility crosses **areas in Alpi mountain**, making it particularly critical due to **wet snow sleeves, strong wind and falling vegetation**.
- **The area does not allow for the construction of a new station and new lines**



RESULTS

	Snow		*Wind*	
	Base Case (T connection)	*OMP connection*	*Base Case (T connection)*	*OMP connection*
EENS [MWh/year]	3	0	26	0,5
Outage RP [year]	22	Resilient	3	>100

- The **line-in line-out connection is the best solution to solve the criticalities**, ensuring power supply even when a branch is out of service.
- The **resilience benefit** in this case is:

$$\Delta EENS(Snow) = EENS_{PRE} - EENS_{POST} = 3 \text{ MWh/year}$$

$$\Delta EENS(Wind) = EENS_{PRE} - EENS_{POST} = 25{,}5 \text{ MWh/year}$$

- demonstrating the actual effectiveness of the installation of OMP in mitigate the power outage and in increasing the resilience of NTG.

Terna
Driving Energy