



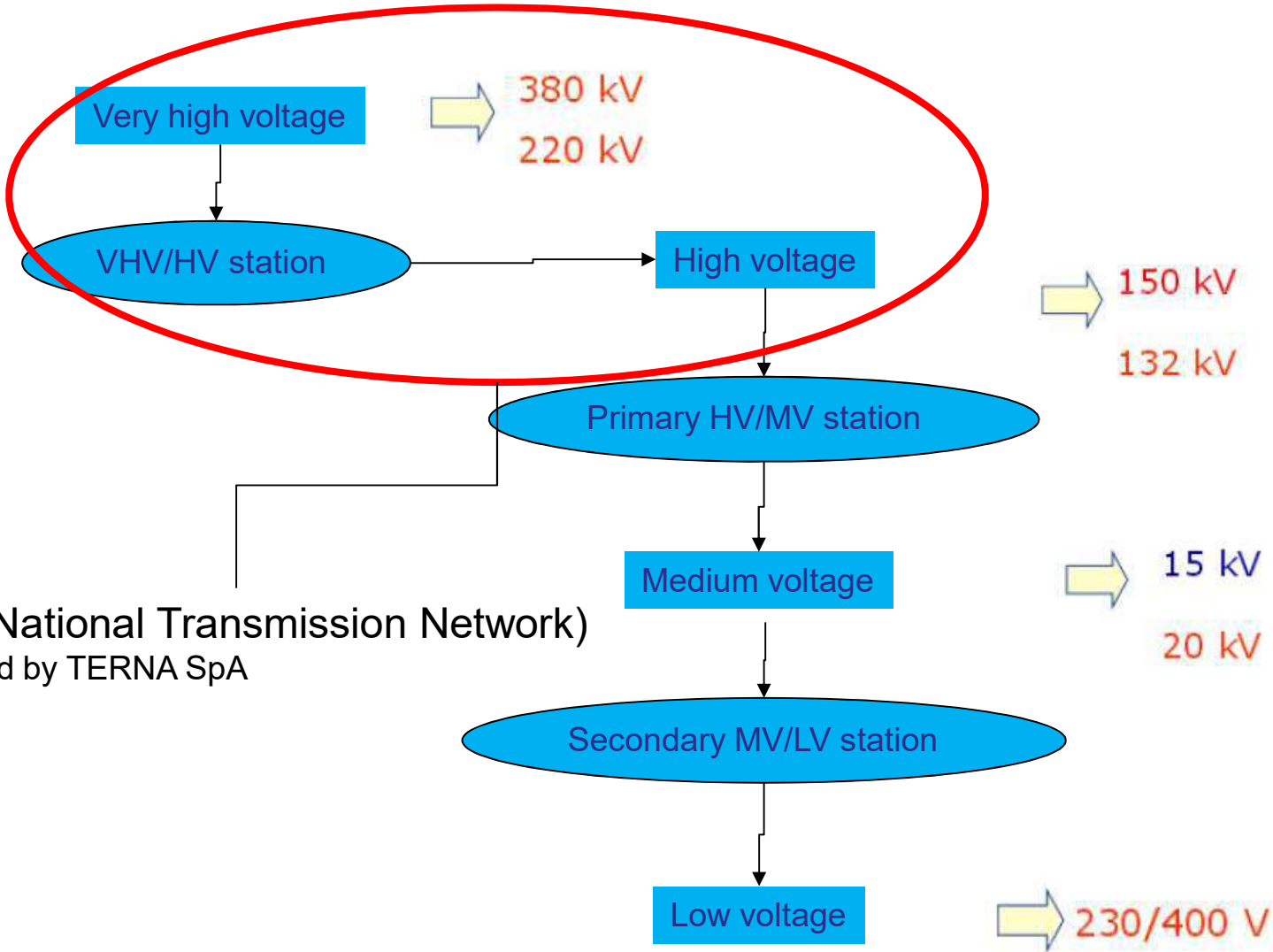
# **Report on the overall process of management on EMF induced from HVAC power lines projects**

Sara Adda, Chiara Pedroli



# THE ELECTRICAL AC NETWORK IN ITALY

Transmission network

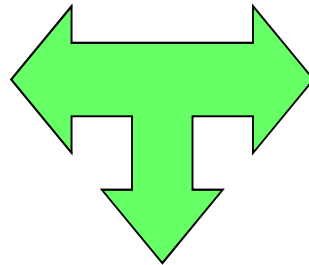


Distribution network

**RTN (National Transmission Network)**  
Operated by TERNA SpA

# ENVIRONMENTAL IMPACT OF HVAC POWER LINES

Landscape



Human health

Flora - Fauna

EMF exposure

# ENVIRONMENTAL IMPACT OF HVAC POWER LINES – procedure for new projects of National Transmission Network

## Strategic Environmental Assessment

Applied to the development plan of the electrical network

Competent authority: Ministry for the Environment  
Contribution of Piemonte Region (and Arpa Piemonte)

*Strategic environmental assessment (VAS) is a process aimed at integrating environmental considerations into development plans and programs, to improve overall decision-making quality*

## Environmental Impact Assessment

Applied to single projects before authorization

Competent authority: Ministry for the Environment  
Contribution of Piemonte Region (and Arpa Piemonte)

*The environmental impact assessment (VIA) is an administrative support procedure for the competent authority aimed at identifying, describing and assessing the environmental impacts of a project*

## Authorization procedure

Applied to single projects

Competent authority: Ministry for the Economic  
Development  
Contribution of Piemonte Region (and Arpa Piemonte)

*Aim of the authorization process is to obtain:*  
- authorization for construction and operation of the HVAC lines;  
- administrative measures required by law for the beginning of construction

# ENVIRONMENTAL IMPACT OF HVAC POWER LINES: EMF

## Italian regulations applied to the issue:

### FRAMEWORK LAW N.36/2001

fundamental principles aimed at ensuring the protection of health, the protection of the environment and the landscape and to promote scientific research for the evaluation of long-term effects of EMF.

### IMPLEMENTING DECREE 07/08/2003

Sets the EMF exposure limits, attention limit and quality goal

### REGIONAL LAW 19/2004

Regional regulation on protection against exposure to electric, magnetic and electromagnetic fields



## FRAMEWORK LAW N.36/2001

In relation to power lines, the state government has to:

1. Set the **exposure limits**, attention values, quality goals
2. Establish the **national registry** of EMF sources
3. Identify **measurement techniques** for emf exposure assessment
4. Define the layout of power lines with voltage  $> 150$  kV
5. Define the methods to calculate **compliance volumes** (inside these volumes, no building's end use that provides for people long stay, such as residential, scholastic, healthcare, is allowed)



## IMPLEMENTING DECREE 07/08/2003

### Exposure limits

$B = 100\mu\text{T}$   
 $E = 5000 \text{ V/m}$

Not to be exceeded in any point and time interval

### Attention values

$B = 10\mu\text{T}$  (24 hours median)

Not to be exceeded in playgrounds, in residential areas, schools and places where people can stay more than 4 hours/day

### Quality goal

$B = 3\mu\text{T}$  (24 hours median)

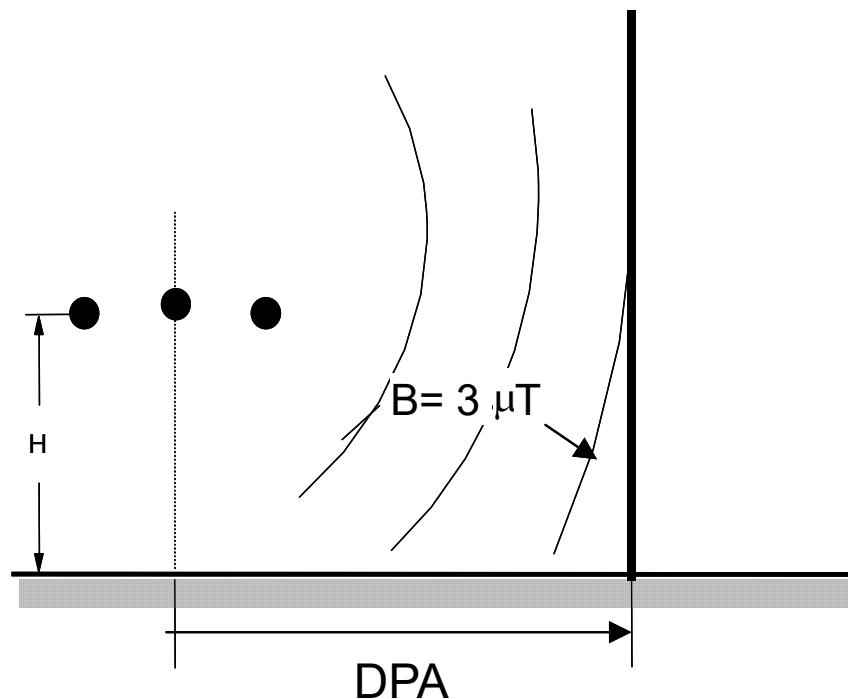
For the design of new power lines in the areas mentioned above (or new areas near electrical installations already present)



## COMPLIANCE VOLUMES: DECREE 05/29/2008

Compliance volume = the space surrounding a power line, which includes all the points characterized by a magnetic induction of intensity greater than or equal to the quality goal

First approximation distance (DPA): the distance, in plan on the ground level, from the projection of the line centre, that guarantees that every point whose projection to the ground is more than DPA is outside the compliance volume.





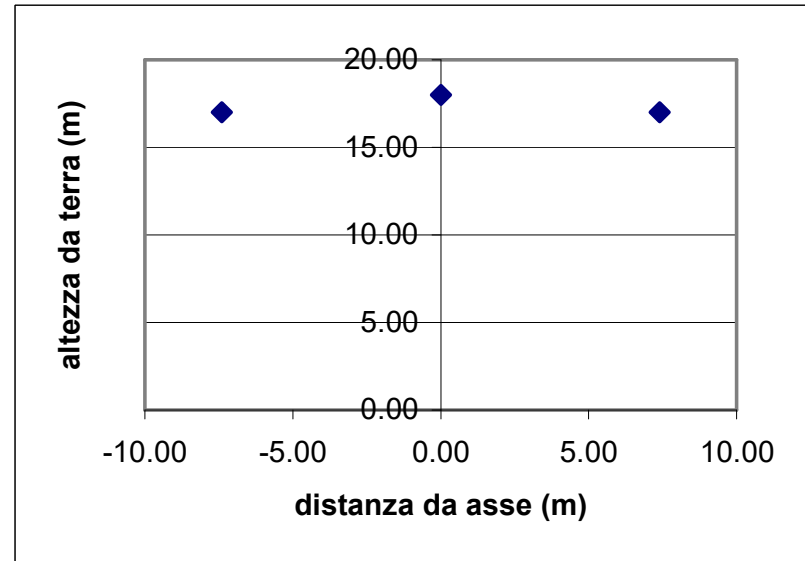


## COMPLIANCE VOLUMES: DECREE 05/29/2008

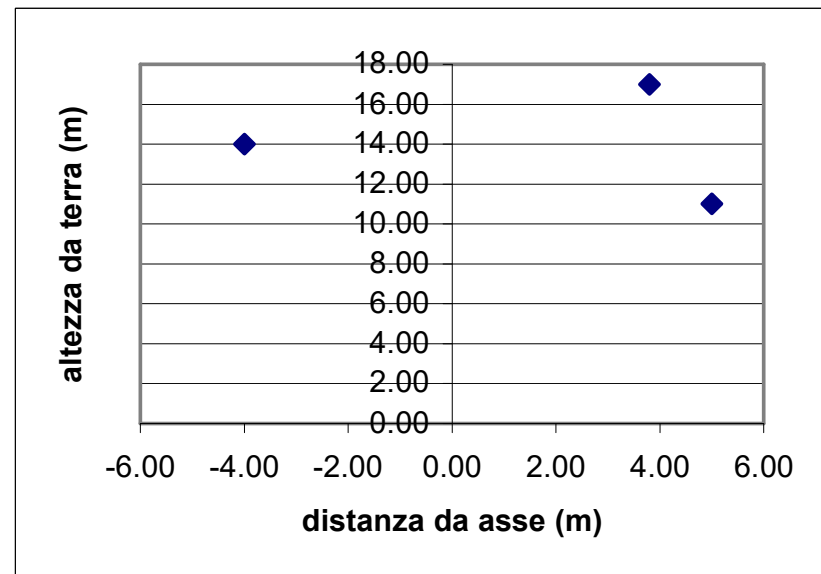
Compliance volumes and/or DPA are calculated using a current level corresponding to the current flow in normal service conditions of the power line (the maximum current level tolerated by the conductors for a prolonged period)

# calculation of the first approximation distances in some typical configurations

380kV single circuit  
 $I = 1500A$   
DPA: 36+36 m



220kV single circuit  
 $I = 1100A$   
DPA: 28+28 m

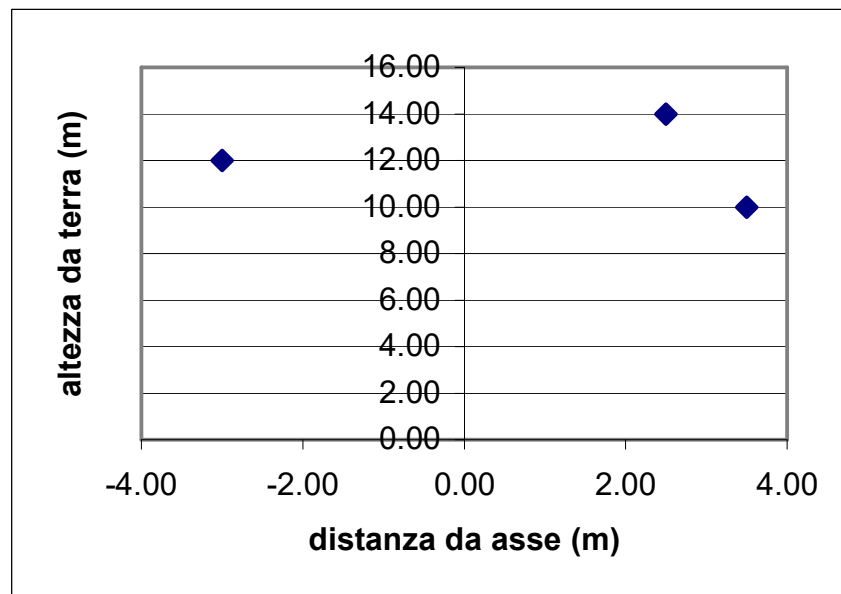


# calculation of the first approximation distances in some typical configurations

132kV single circuit

$I = 550\text{A}$

DPA: 16+16 m



# STRATEGIC ENVIRONMENTAL ASSESSMENT of development plan of national transmission network

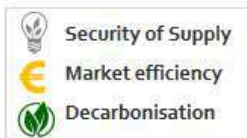
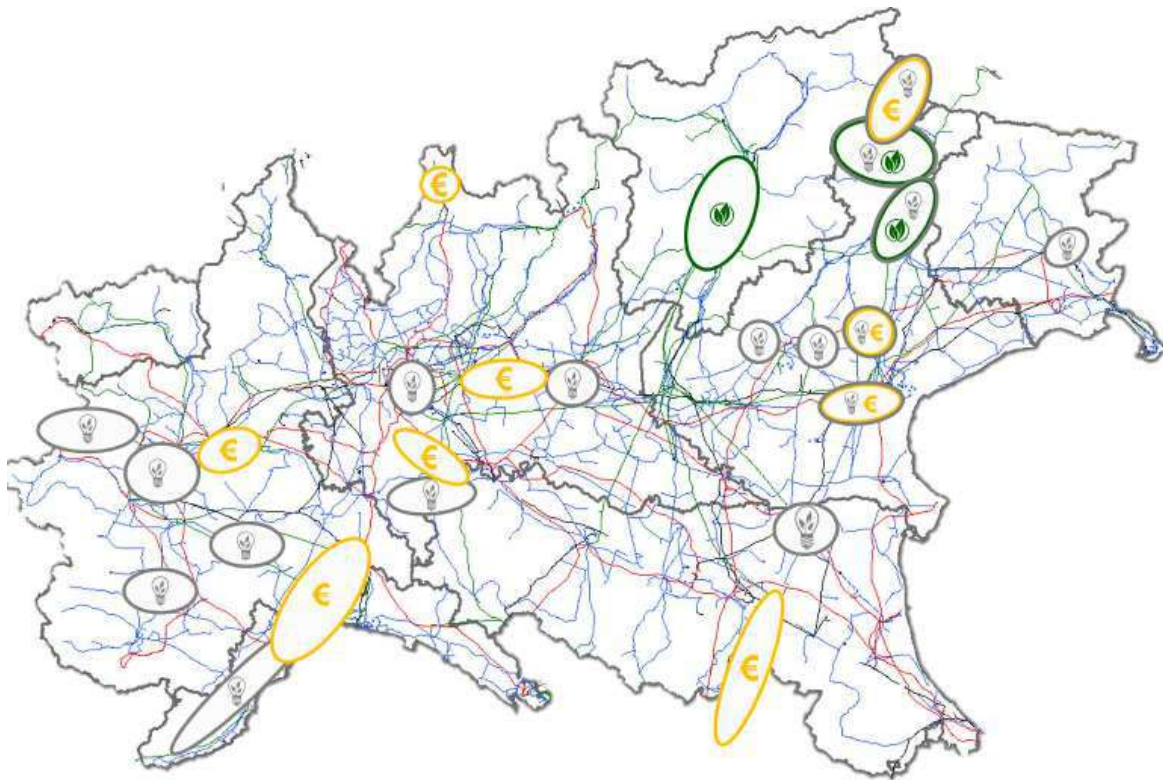
TERNA plan provides:

Analysis of critical issues of the national network

Proposals of development plans to reduce this critical issues

Assessment of the environmental impact of these plans by the use of specific indexes

Definition of feasibility corridors based on the research of minimum environmental impact



Arpa performs the examination of the documents provided by Terna, and verifies the impact of the various projects of the plan, through the analysis of the variation of the indexes connected to human exposure to EMF.

# STRATEGIC ENVIRONMENTAL ASSESSMENT: example

## 9.2.6 L'area della provincia di Novara: Intervento 155-N Stazione 132 kV Novara Est SE 132 kV Novara Est e raccordi 132 kV

Di seguito la scheda illustrativa dei risultati ottenuti dall'analisi degli effetti ambientali potenzialmente generati dall'azione relativa alla nuova SE e raccordi Novara Est, situata nell'area della provincia di Novara.

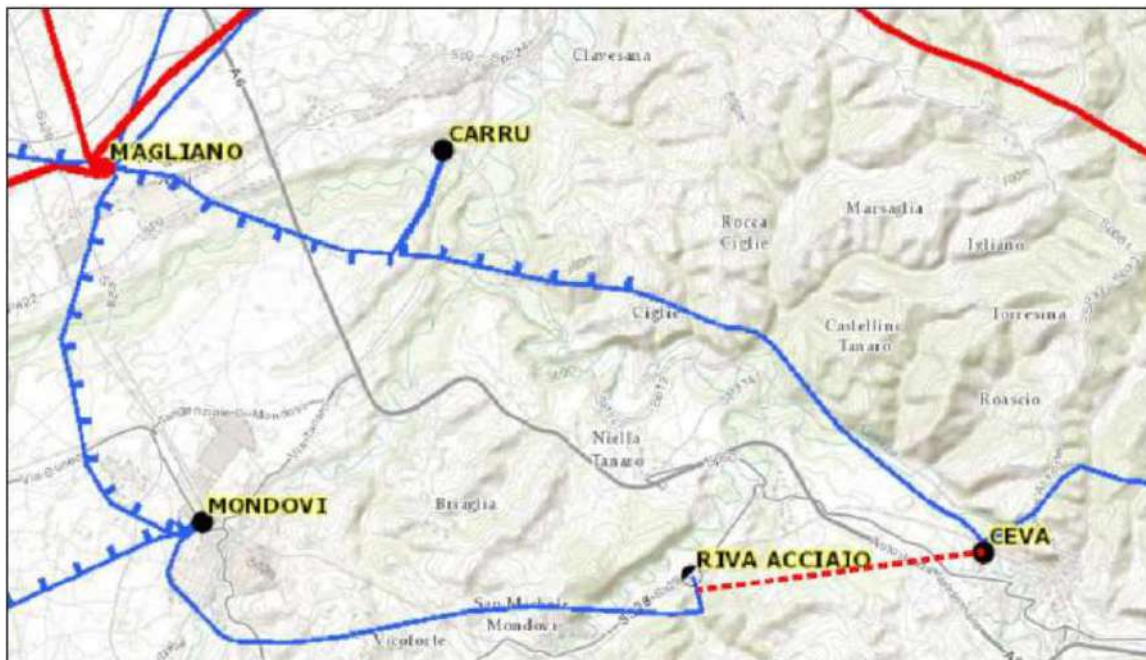
<b>Azione</b>	155-N_01	SE 132 kV Novara Est e raccordi 132 kV
<b>Intervento di riferimento</b>	155-N Stazione 132 kV Novara Est	
<b>Finalità dell'azione</b>	OTs4 - Qualità del servizio	
<b>Tipologia di azione</b>	Nuova infrastruttura	

<b>Area di studio</b>		
 <p>Legenda</p> <p>■ Stazione    ● Area di studio</p>	<b>Regione interessata</b>	Piemonte
	<b>Provincia interessata</b>	Novara
	<b>Comuni interessati</b>	Novara, Galliate
	<b>Dimensioni</b>	Area pari a circa 12,5 km <sup>2</sup> , in prossimità dell'esistente SE Novara Est.



<i>Indicatori di sostenibilità territoriale</i>			
<i>Cod.</i>	<i>Nome</i>	<i>Contenuti</i>	<i>Valore</i>
Ist04	Tutela delle reti ecologiche	Misura la frazione dell'area di indagine non occupata da reti ecologiche, di particolare interesse per l'avifauna	0,43
Ist05	Tutela aree agricole di pregio	Misura la frazione dell'area di indagine non occupata da aree agricole di pregio	1,00
Ist06	Promozione dei corridoi infrastrutturali preferenziali	Misura la frazione dell'area di indagine occupata da aree preferenziali	0,44
Ist07	Tutela delle aree per i beni culturali e i beni paesaggistici	Misura la frazione dell'area di indagine non occupata da aree di valore culturale e paesaggistico	0,00
Ist08	Tutela delle aree di riqualificazione paesaggistica	Misura la frazione dell'area di indagine la cui destinazione d'uso non è finalizzata alla riqualificazione paesaggistica	0,84
Ist09	Tutela delle aree caratterizzate da elementi culturali e paesaggistici tutelati per legge	Misura la frazione dell'area di indagine non occupata dalla presenza di beni culturali e paesaggistici	0,99
Ist10	Tutela delle aree a rischio paesaggistico	Misura la frazione dell'area di indagine non occupata da aree considerate ad elevato rischio paesaggistico	0,00
Ist11	Tutela delle aree di grande fruizione per interesse naturalistico, paesaggistico e culturale	Misura la frazione di area di studio non occupata da aree di fruizione turistica e di notevole interesse pubblico	0,00
Ist12	Preferenza per le aree con buone capacità di mascheramento	Quantifica la possibilità di sfruttare la morfologia del territorio e la copertura del suolo come mezzo per favorire l'assorbimento visivo	0,00
Ist13	Preferenza per le aree naturali con buone capacità di assorbimento visivo	Misura la frazione dell'area di indagine in cui l'inserimento di un'opera elettrica non comporta interferenze visive sul paesaggio visivo	0,00
Ist14	Preferenza per le aree abitative con buone capacità di assorbimento visivo	Misura la frazione dell'area per cui la visibilità dell'intervento dai centri abitati è minima	0,00
Ist15	Tutela delle aree ad alta percettibilità visuale	Misura la frazione di area occupata da corsi d'acqua	0,75
Ist16	Riduzione dell'interferenza con aree a pericolosità idrogeologica	Misura la frazione dell'area di indagine non occupata da aree a pericolosità idrogeologica elevata e molto elevata	1,00
Ist17	Riduzione dell'interferenza con aree a pericolosità antropica	Misura la frazione dell'area di indagine non occupata da aree a pericolosità antropica	1,00
Ist18	Ripartizione della pressione territoriale	Misura la porzione delle aree comunali coinvolte nell'intervento rispetto all'area complessiva di tali comuni	0,91
Ist19	Rispetto delle aree urbanizzate	Misura la frazione dell'area in esame non occupata da tessuto edificato	0,81
Ist20	Limitazione dell'esposizione ai CEM	Misura la frazione dell'area di indagine idonea ai sensi del rispetto dell'obiettivo di qualità di 3 µT (fissato dal DPCM 8 luglio 2003)	0,72

# ENVIRONMENTAL IMPACT ASSESSMENT and/or AUTHORIZATION PROCEDURE



TERNA projects:

Layout and technical characteristics of the power line

Analysis of environmental impacts (both during worksite activities, and post-operam)

For EMF: information about electric and magnetic field emissions, first approximation distances (DPA), exposure levels in specific receptors (houses, schools, etc.)

## 6.2 CARATTERISTICHE ELETTRICHE DELL'ELETTRODOTTO

Le caratteristiche elettriche dell'elettrodotto sono le seguenti:

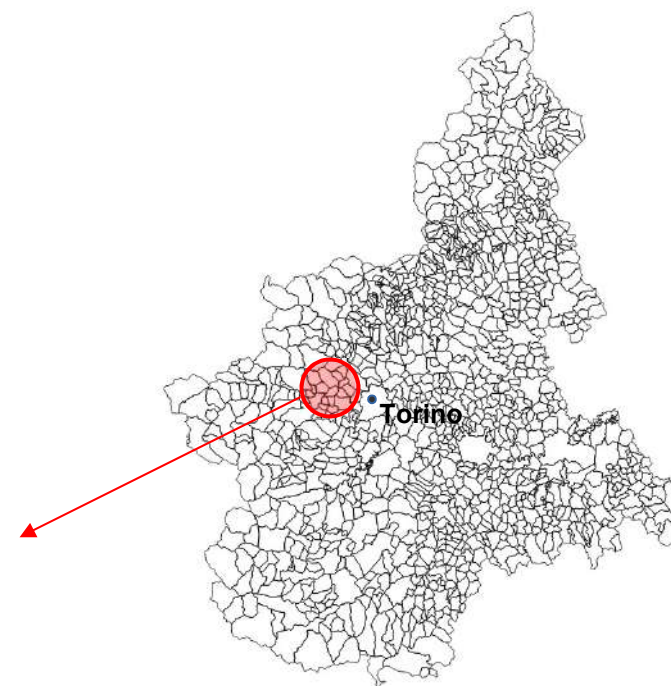
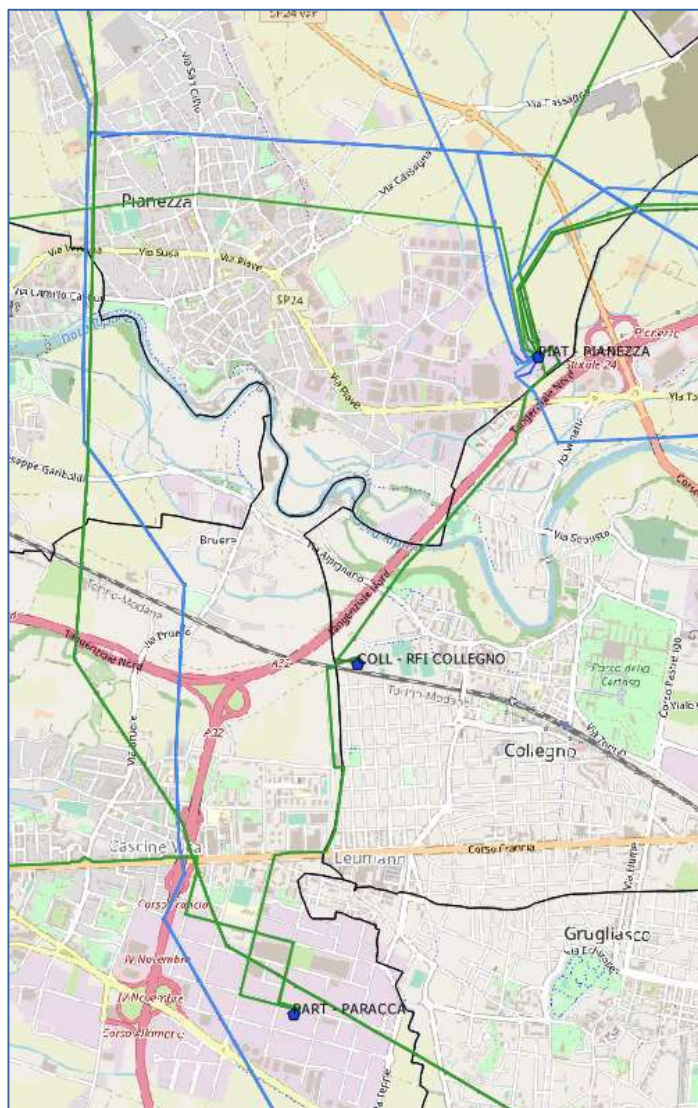
Frequenza nominale	50 Hz
Tensione nominale	132 kV
Corrente nominale	675 A
Potenza nominale	155 MVA

Tabella 2: Caratteristiche elettriche elettrodotto T.731

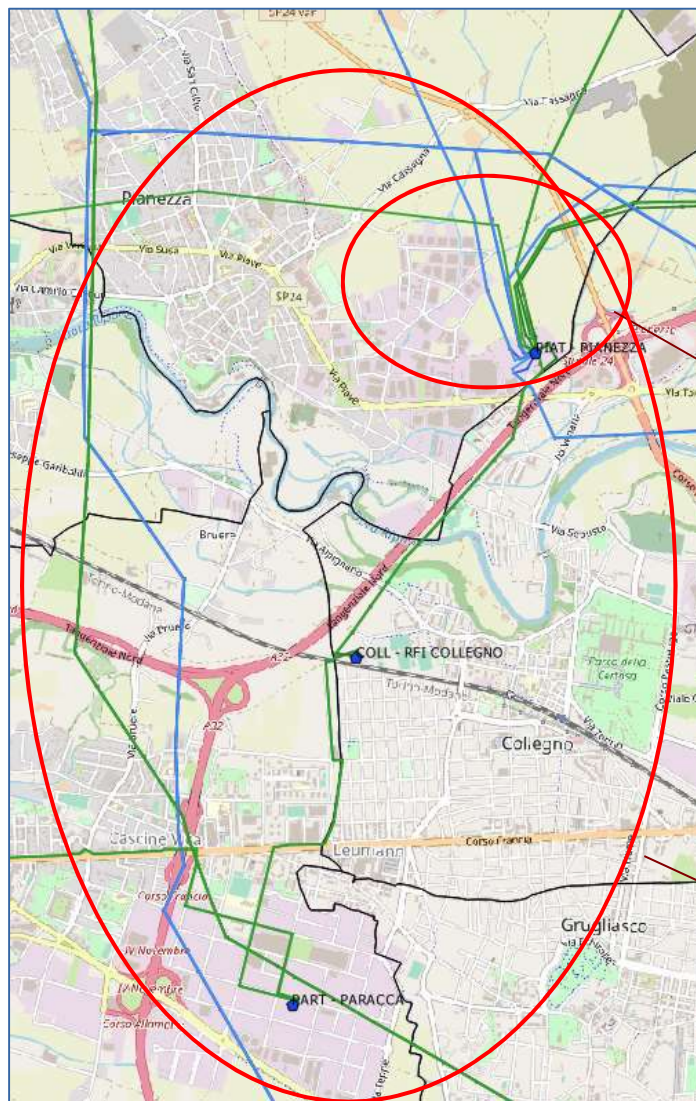
Arpa performs the examination of the documents provided by Terna, verifies the EMF modeling results, gives recommendations on how to improve the project to minimize EMF exposure.

# AUTHORIZATION PROCEDURE: a case study

Municipalities:  
Pianezza, Collegno,  
Rivoli, San Gillio







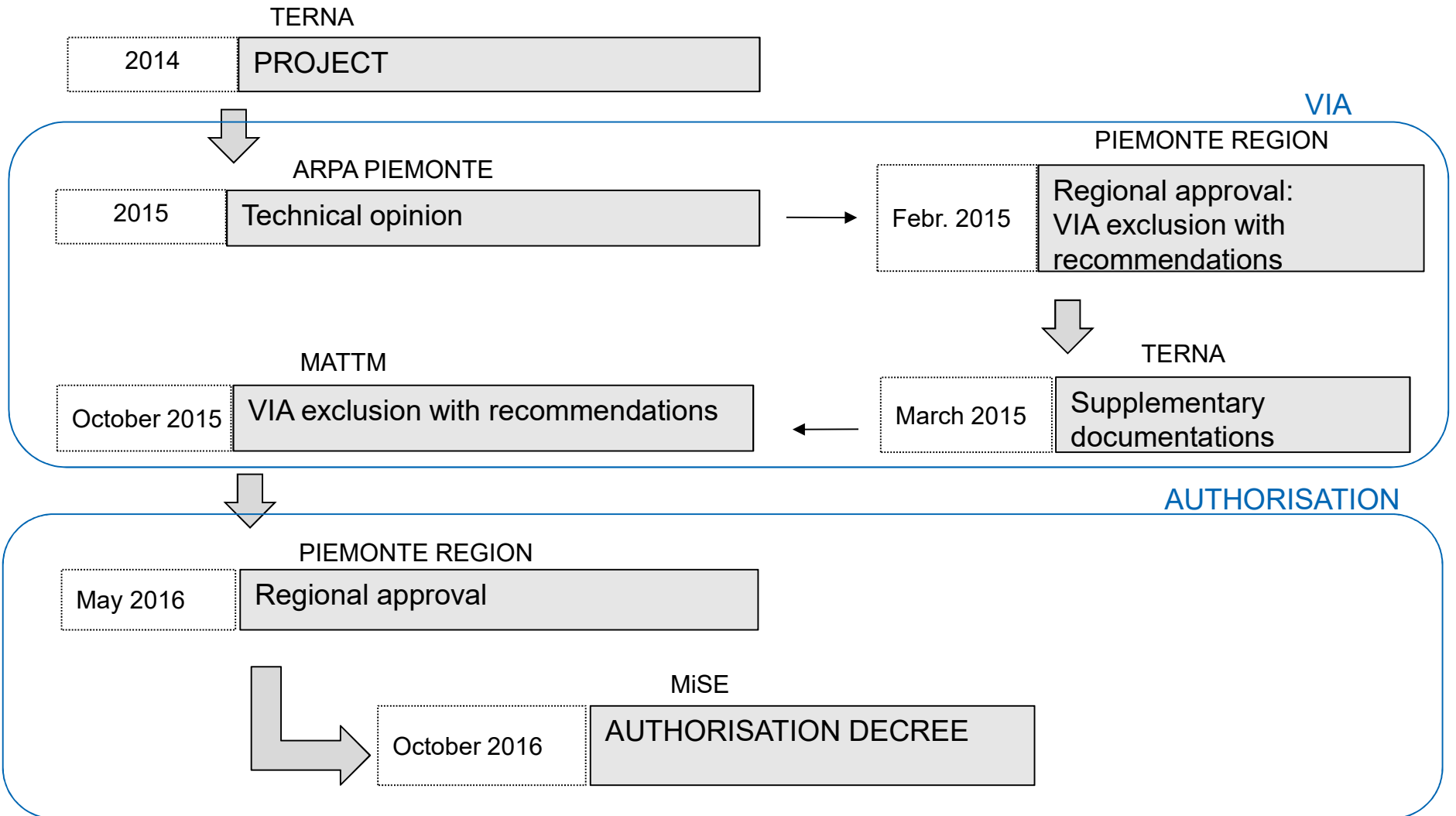
**The work**  
“Rationalization of the high voltage electricity grid in the city of Torino”

**Project 1**  
*Rearrangement of the 220 kV power lines T.217, T.231, T.233, T.254 coming into the Electrical Station of Pianezza in the municipalities of Pianezza and Collegno (TO)*

**Project 2**  
*220 kV underground power line T.213 and 220 kV overhead power lines T.216 and T.231 in input to E.S. of Pianezza*




# - Project 1 - Authorisation process








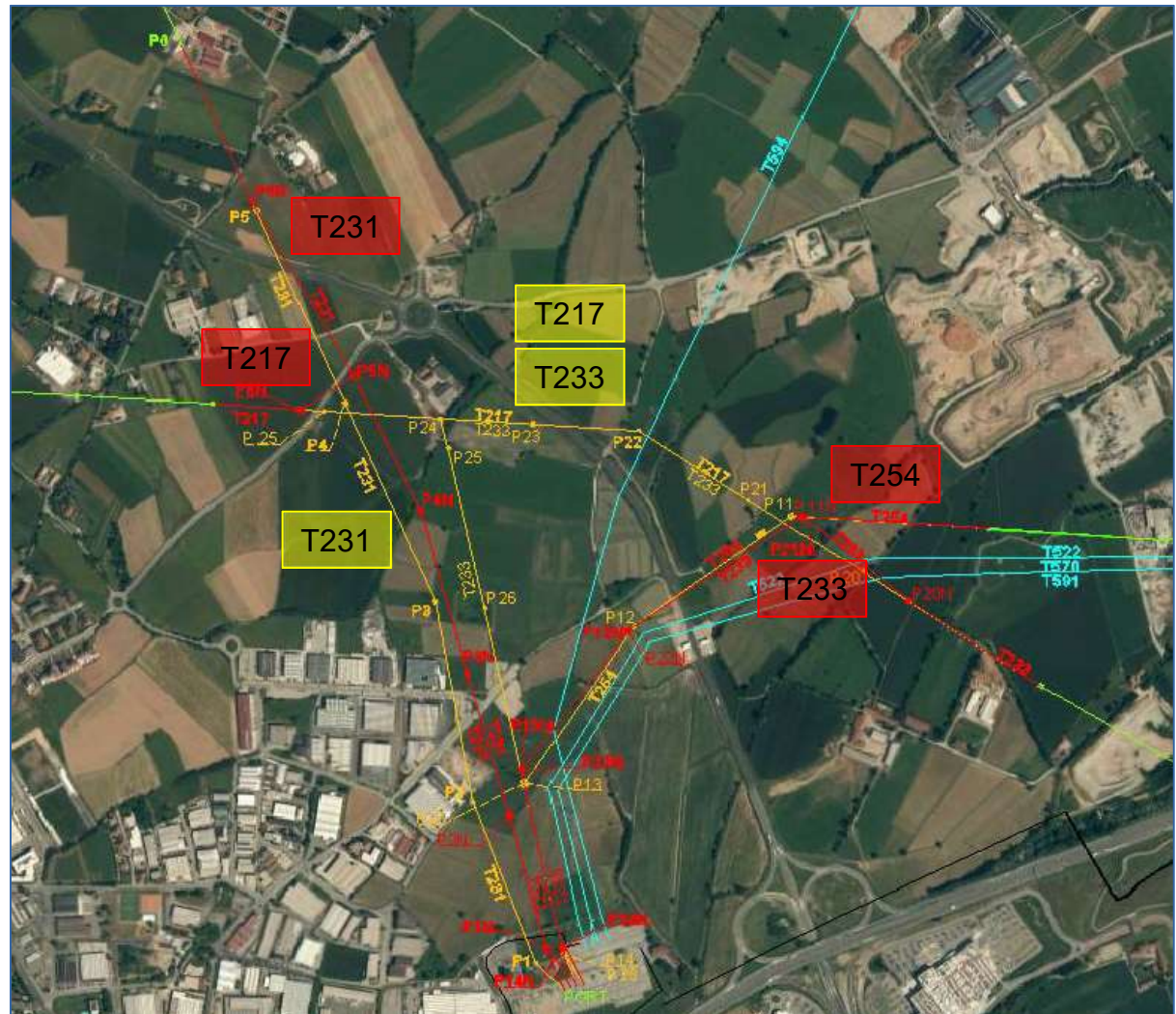
TERNA

2014 PROJECT

 Lines to be demolished

 New power lines

 Power lines to be demolished  
 New power lines  
 Existing power lines, not involved in the project





TERNA

March 2015

Supplementary documentations

## Conductors configuration

Phase

Voltage

Current

Conductor spacing

Diametro fune guardia  
11.500

Nome linea  
LINEA DT

Tensione [kV]  
220

Corrente [A]  
1420

Diametro conduttori [mm]  
31.50

N. sub condotto  
2

Spacing [mm]  
400

18.100

5.400

5.400

4.300

5.800

4.800

1.2

8

4

11.500

1.2

8

4

9.000

simmetrico - equilibrato

Ascissa asse linea

Sinistra: valori negati 0.000 Destra: valori

Mini Help

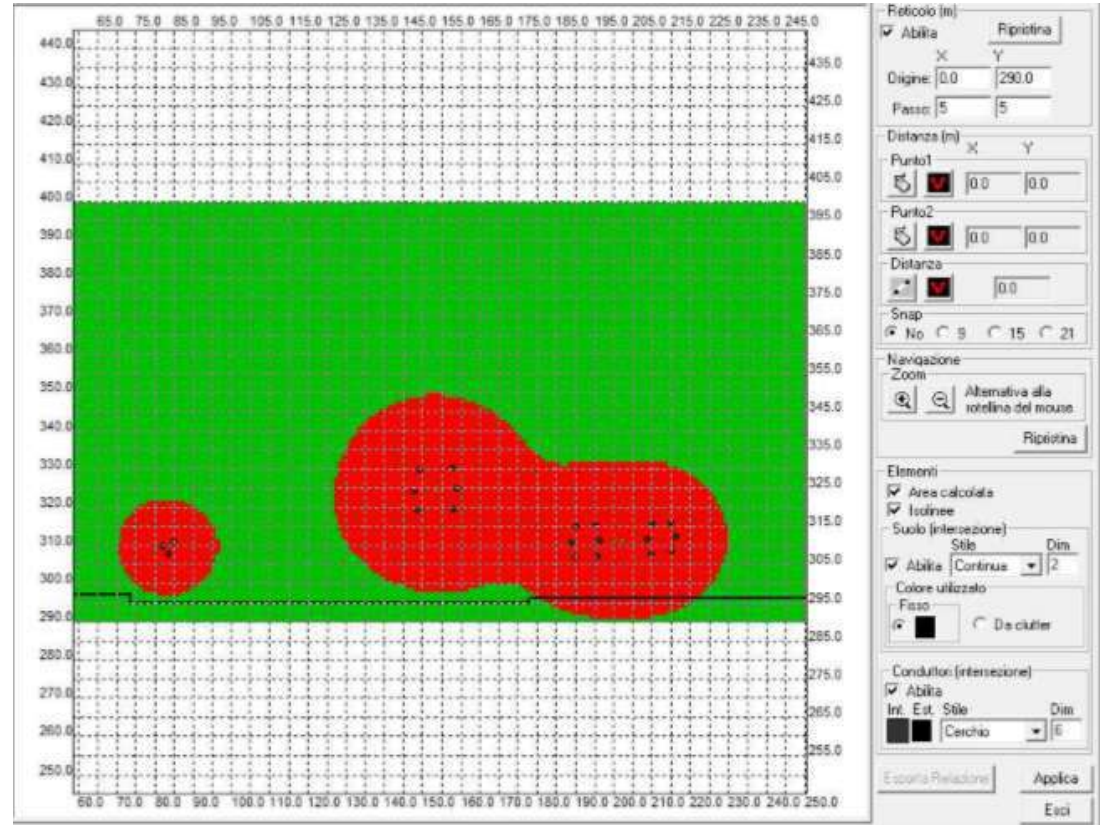
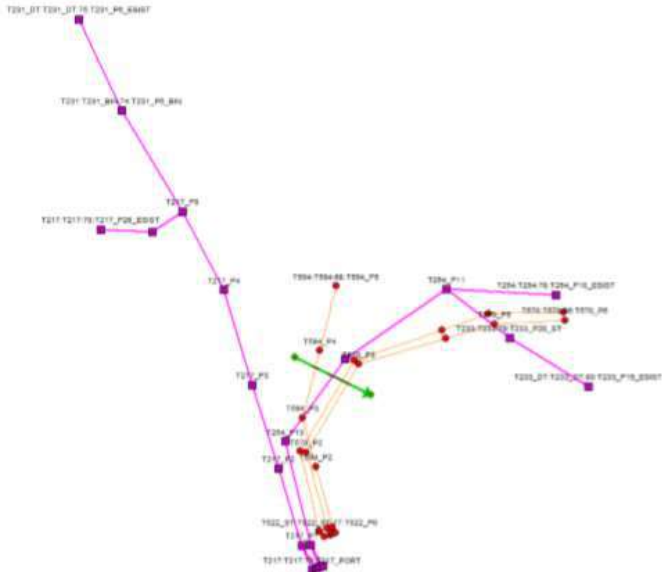
STAMPA Opzioni

CONTINUA ESC



# An example of pylons position and evaluation of the magnetic field emission

Power lines: T233-T254 + existing power lines 132kV



Vertical profile of the magnetic field. Red area:  $B > 3 \mu\text{T}$



MiSE

October 2016

AUTHORISATION DECREE

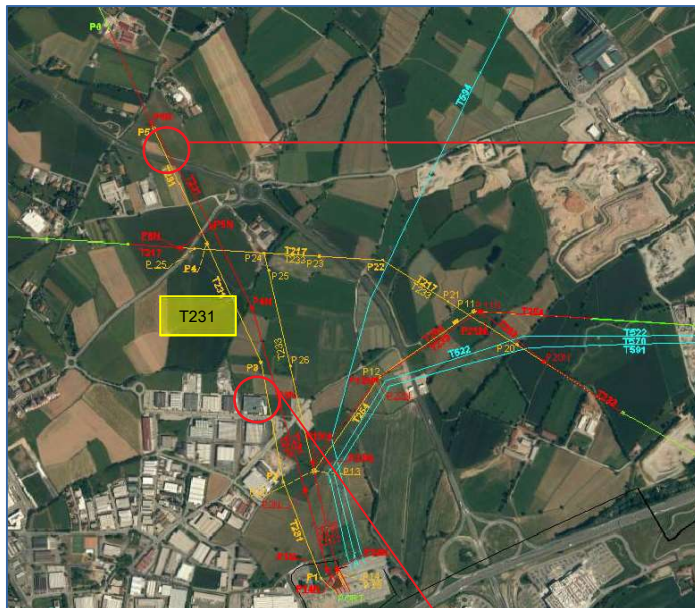
### **Main conclusions concerning the activity of Arpa Piemonte**

- The quality goal is met in any receptor where it can be applied
- Monitoring:
  - Ante-operam monitoring: measurements of electromagnetic field levels before the project starts
  - Post-operam monitoring: measurements of electromagnetic field levels before the project ends



Arpa Piemonte supports the proposer during the ante-operam and post-operam monitoring

**Ante – operam monitoring:** February 2019



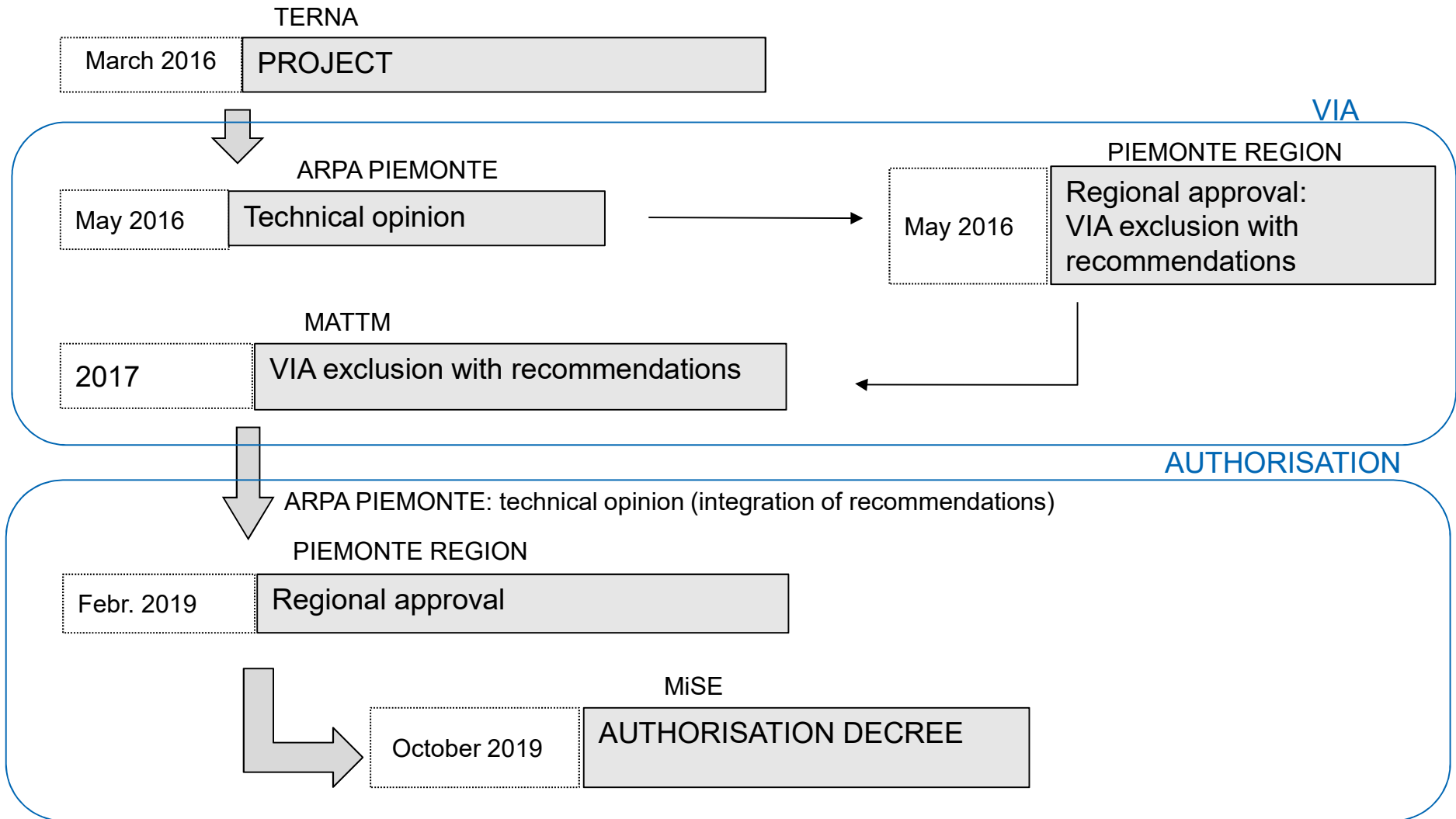
<i>Petrol station</i>	Magnetic field B
1° floor (café)	0.12 $\mu$ T

<i>Building</i>	Magnetic field B
2° floor (Reception)	0.22 $\mu$ T
3° floor (Office)	0.21 $\mu$ T





# - Project 2 - Authorisation process







TERNA

March 2016

PROJECT

## Overhead power lines

Power lines close to residential areas



critical areas





New power line

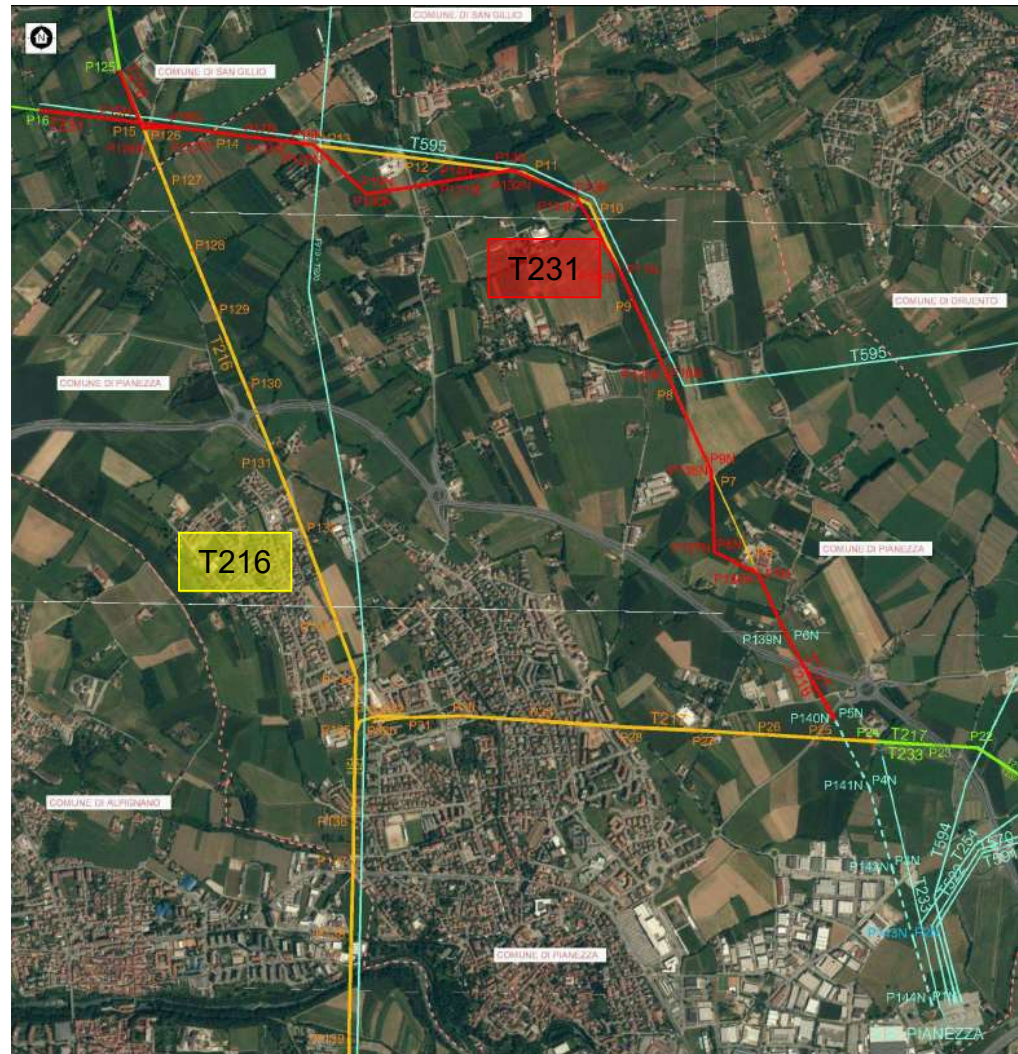
T231

Power lines to be demolished

T216

T216 – T217

-  Power lines to be demolished
-  New power lines
-  Line concerning the project 1
-  Existing power lines, not included in the project

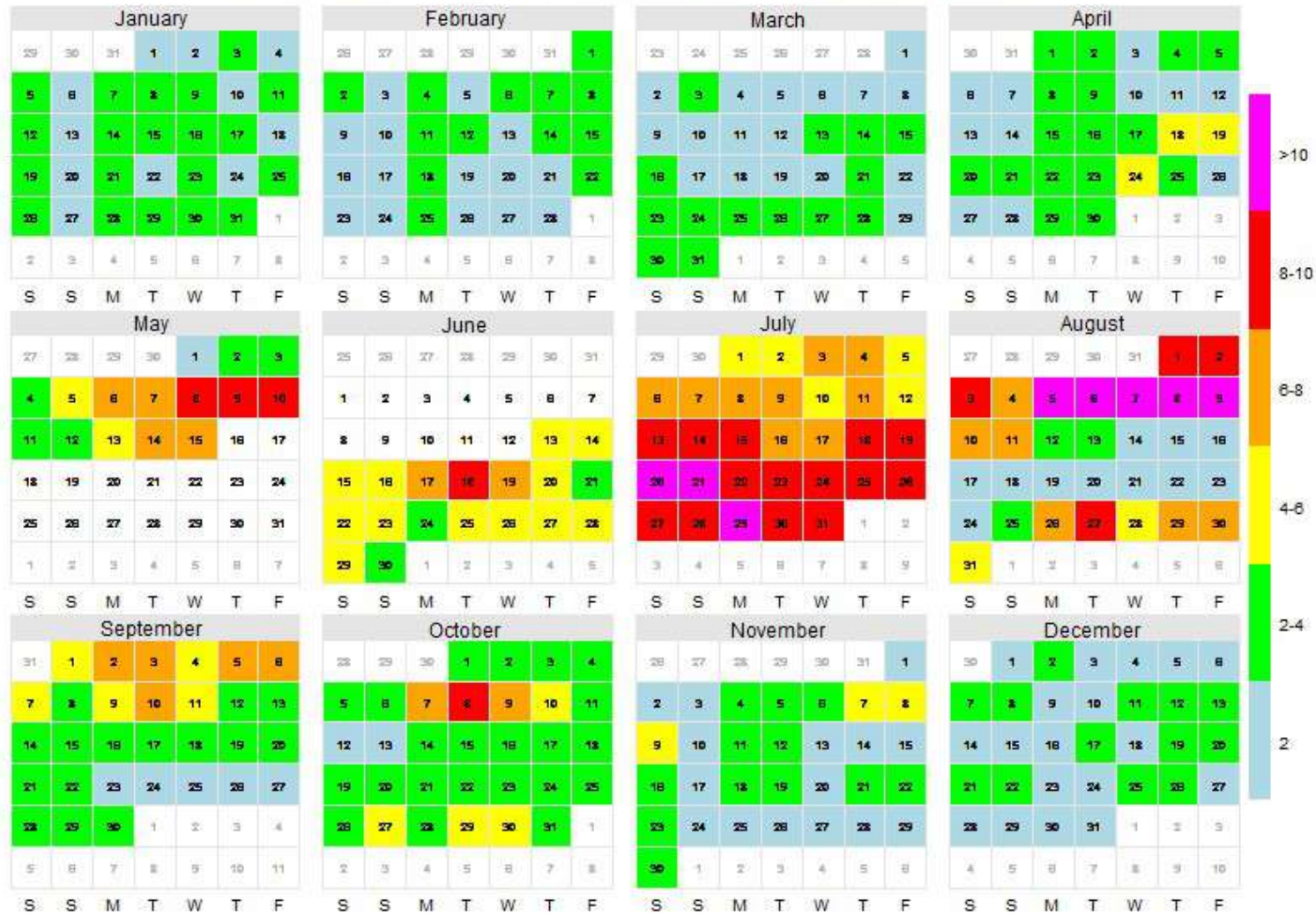


T216-T217



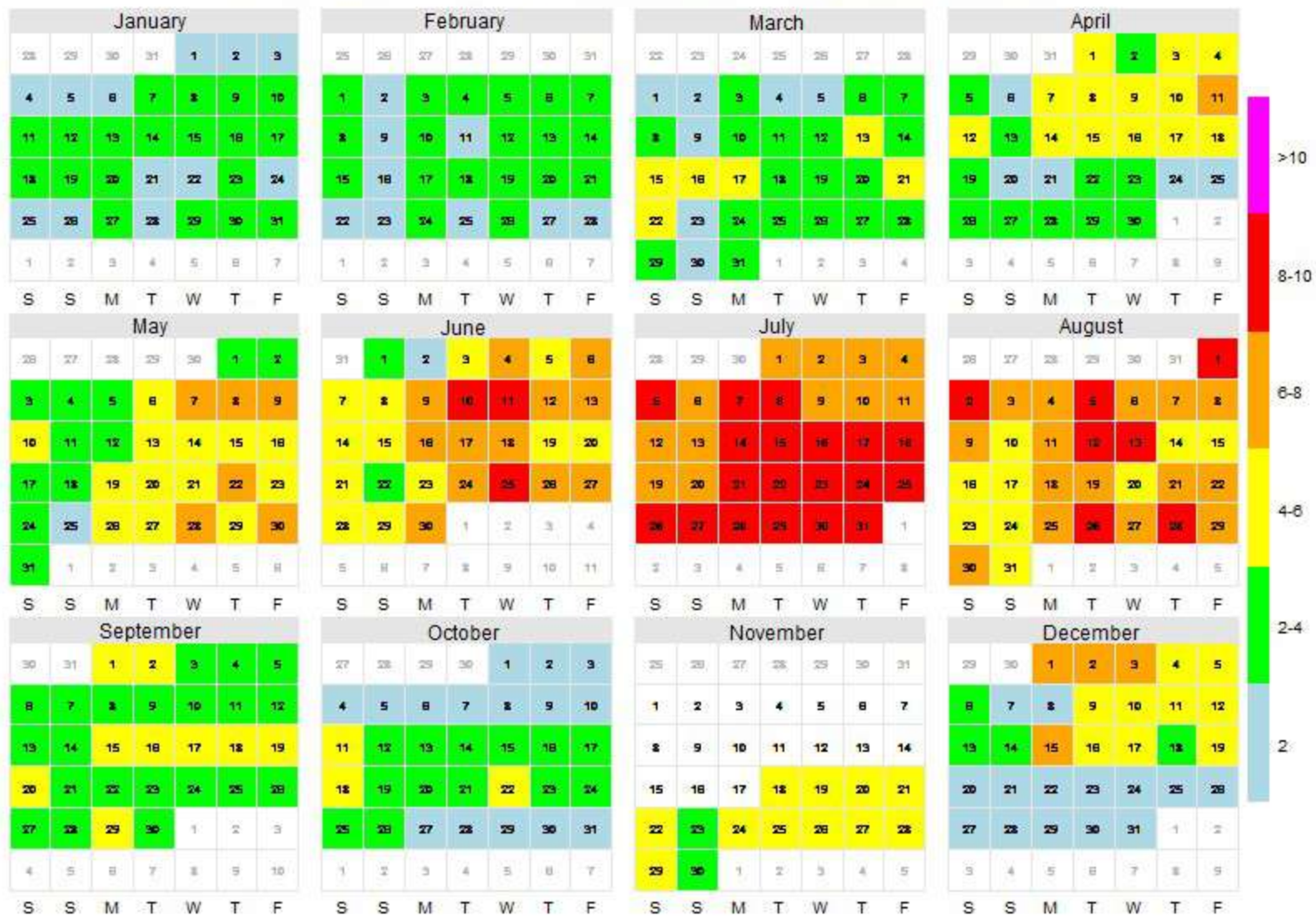
## A critical area: some results

Linea elettrica 220kV T216 - mediana giornaliera estrapolata( $\mu$ T) - anno 2013



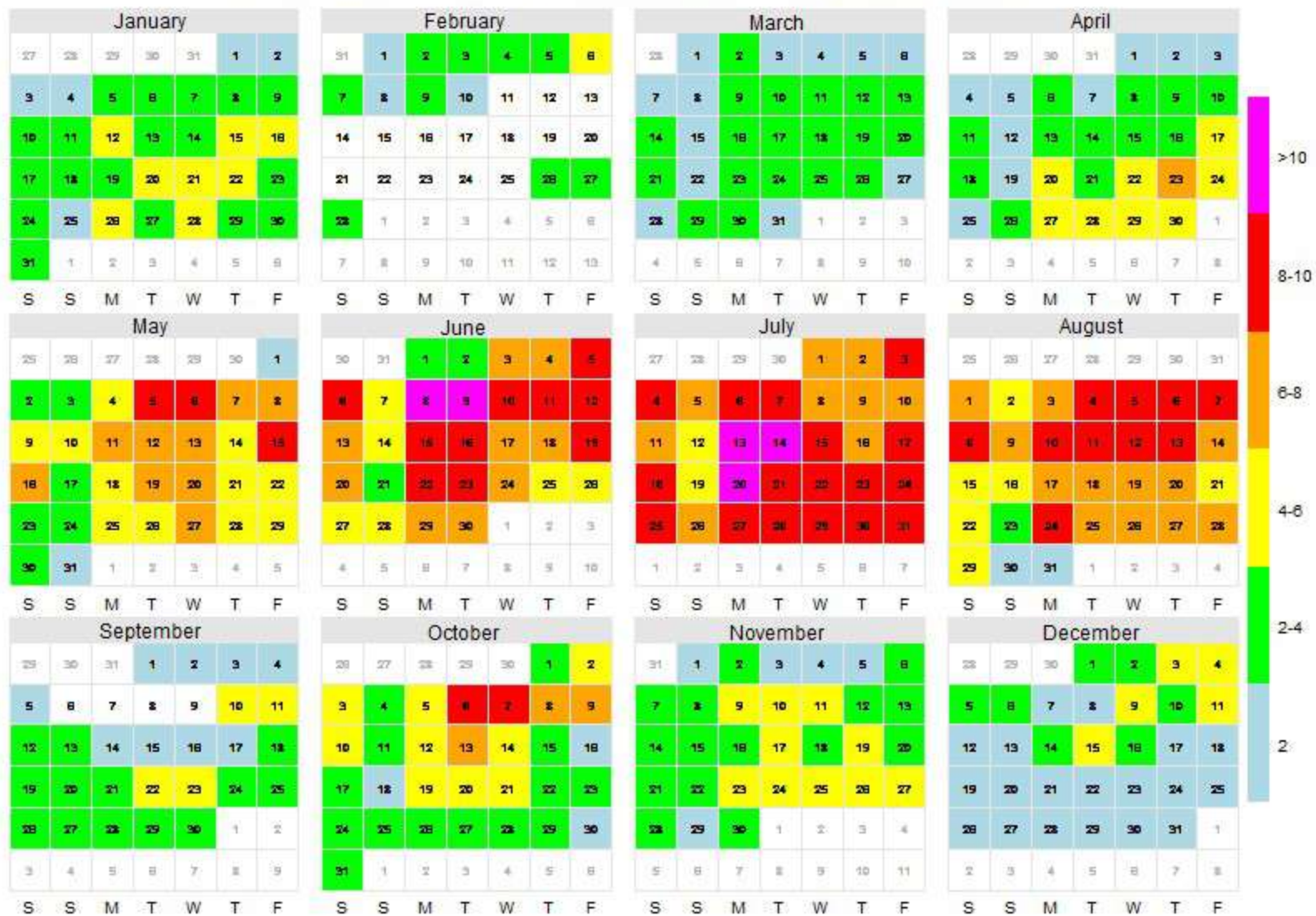


Linea elettrica 220kV T216 - mediana giornaliera estrapolata( $\mu$ T) - anno 2014



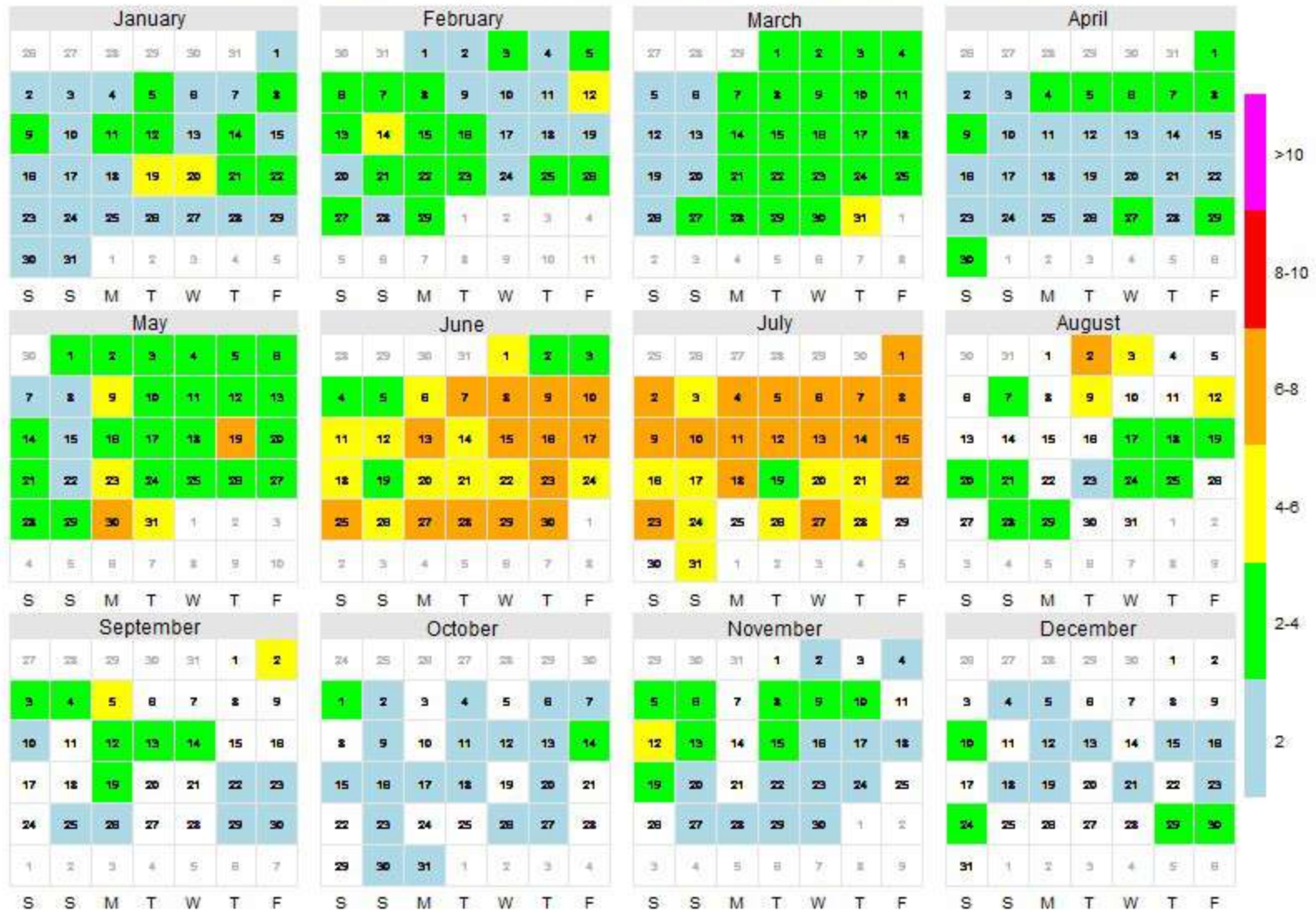


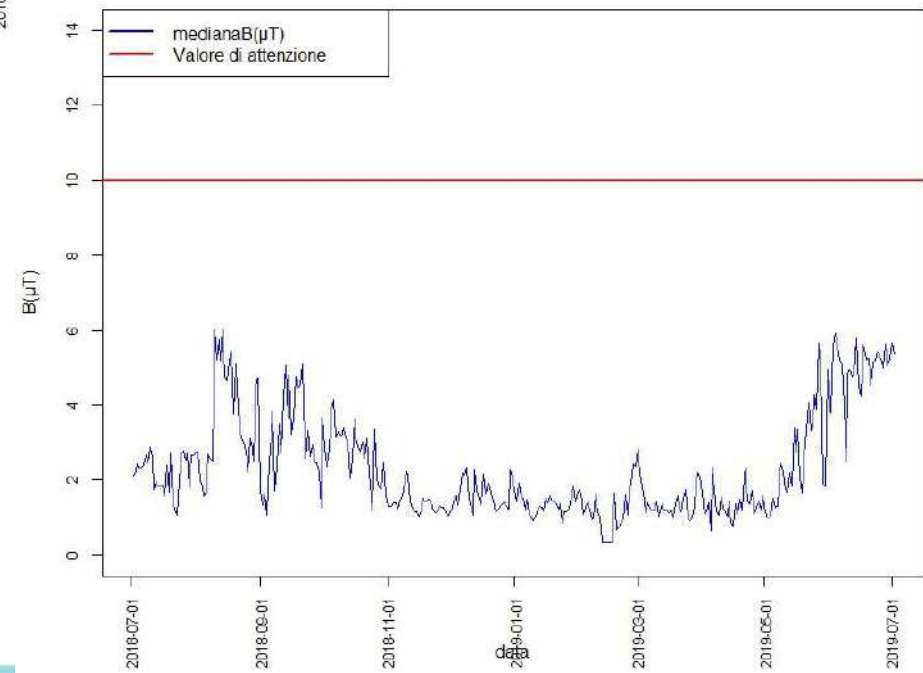
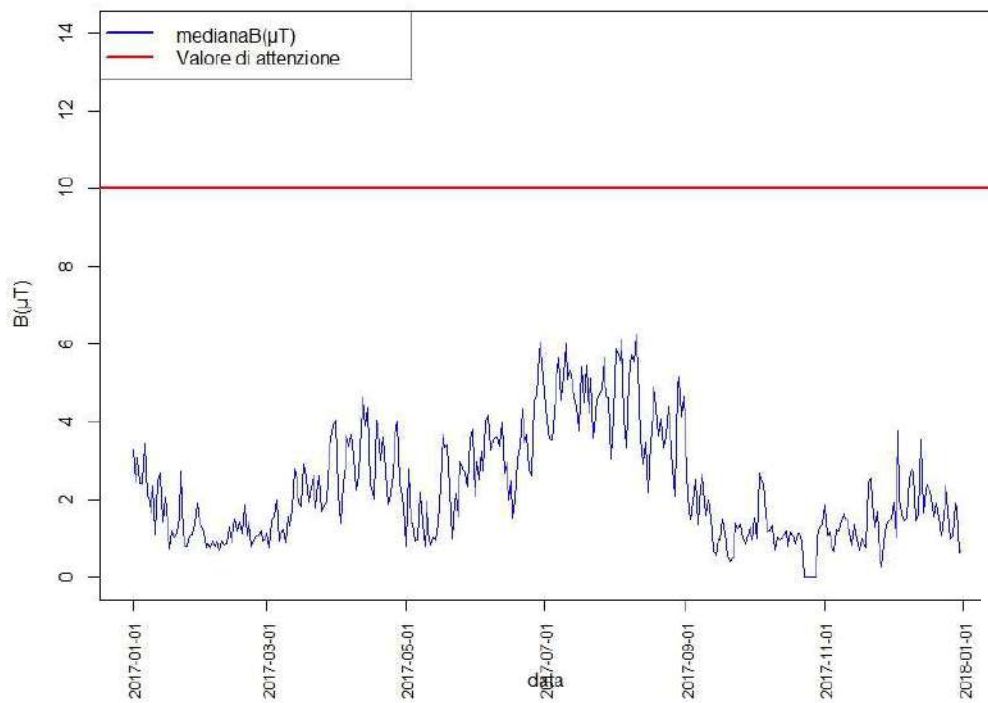
Linea elettrica 220kV T216 - mediana giornaliera estrapolata( $\mu$ T) - anno 2015





Linea elettrica 220kV T216 - mediana giornaliera estrapolata( $\mu$ T) - anno 2016







## Underground power line

New power line

T213



*Electrical Station of Pianezza*



## T213 – Layout



Vista dall'alto della zona dell'attraversamento fluviale



Immissione su via Aosta (comune di Pianezza)

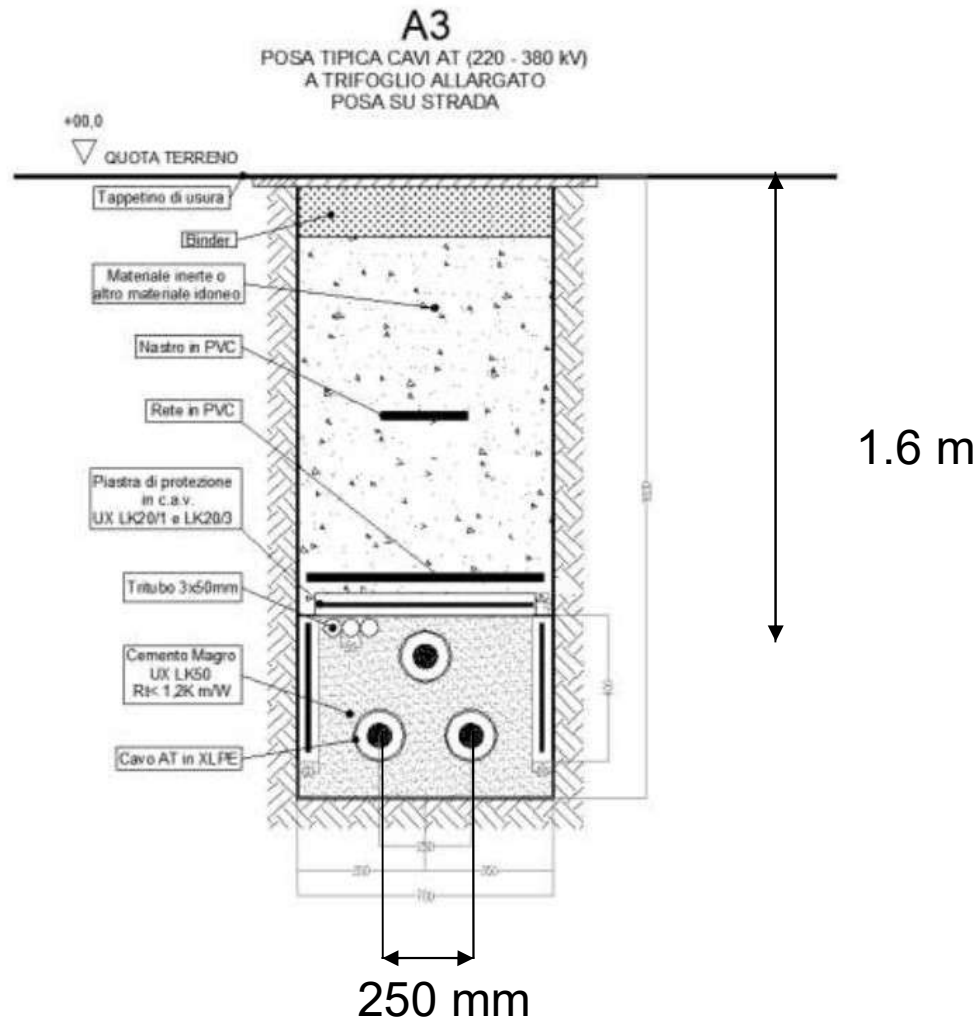


Imbocco di via Pavia da corso Francia / Strada Antica di Grugliasco (comune di Rivoli)



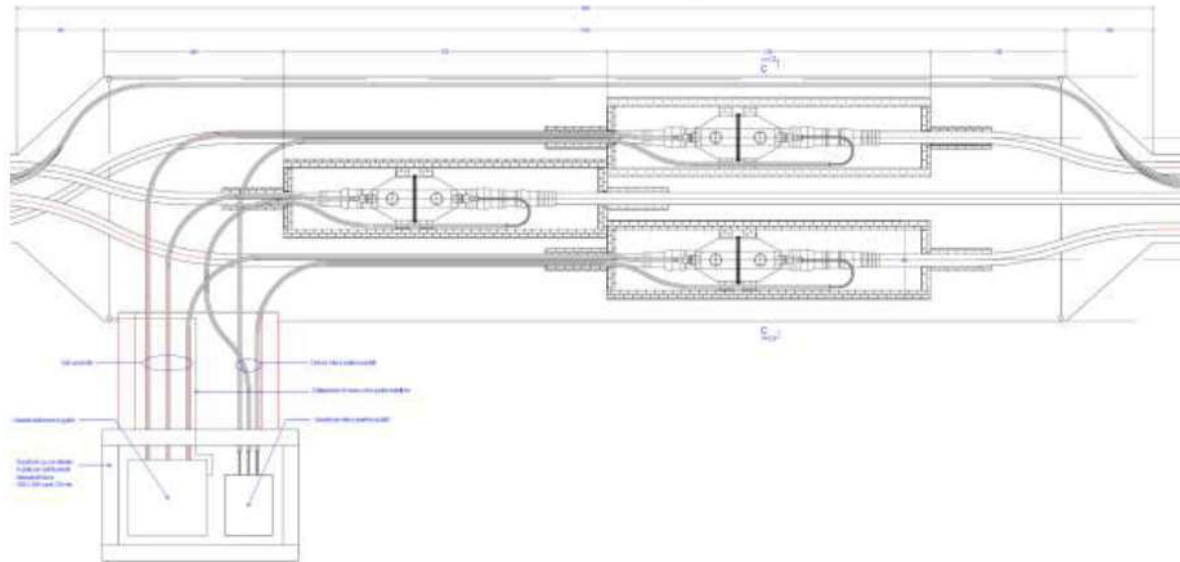


## T213 – example of underground cable placing



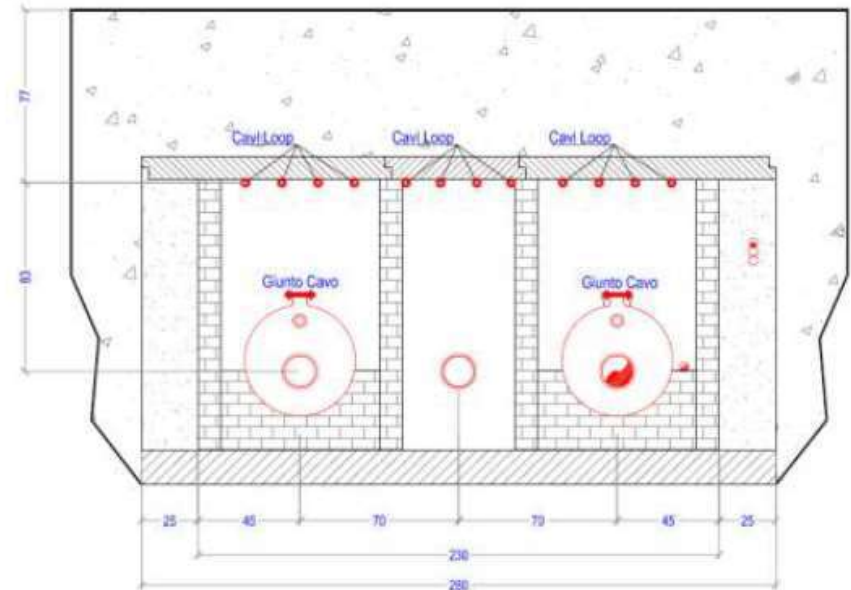
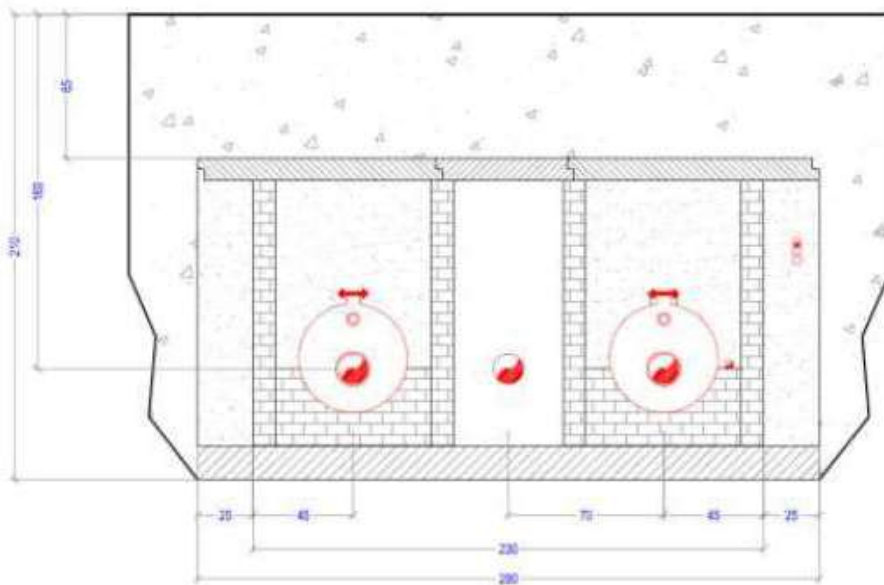


## T213 – example of cable placing in a junction



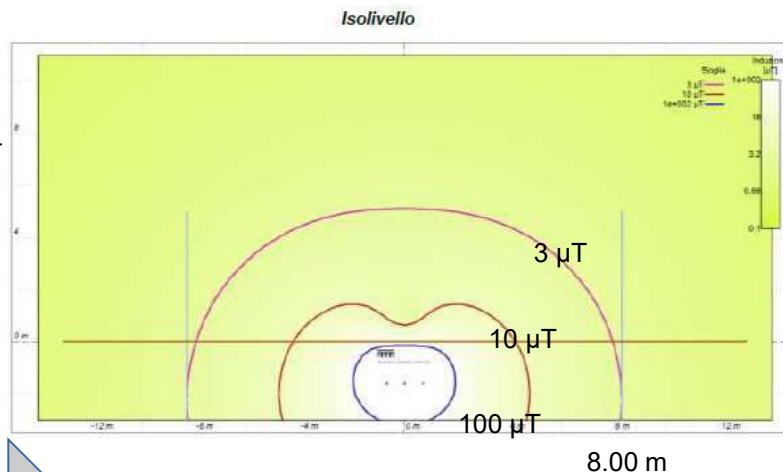
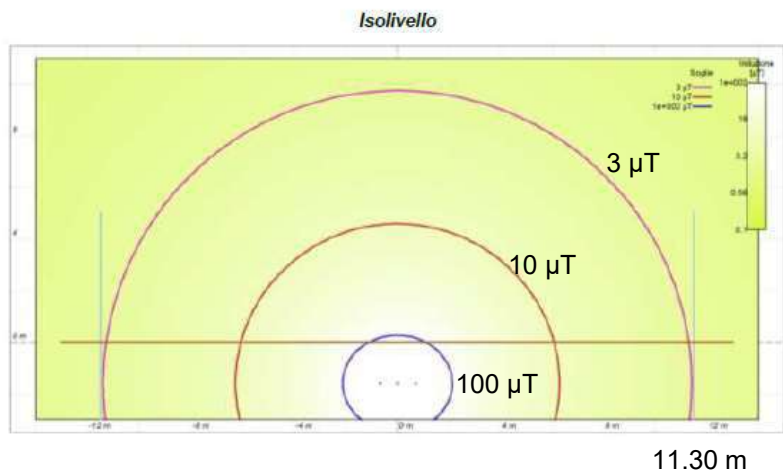
Without shielding

With shielding (loops with high magnetic coupling)

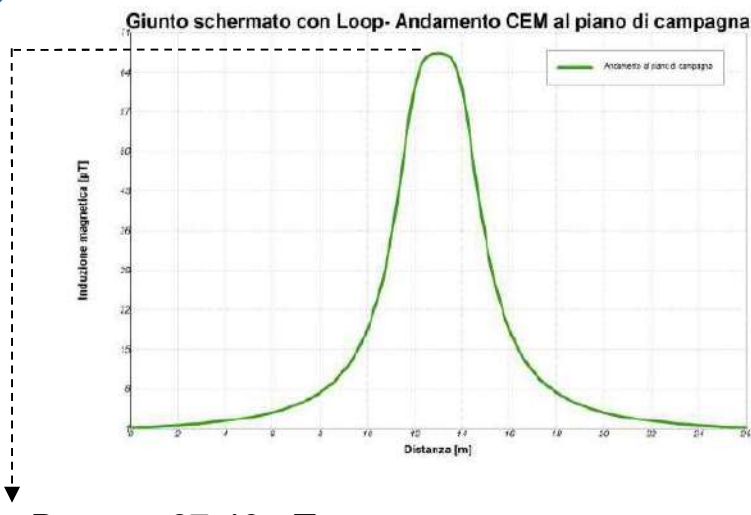
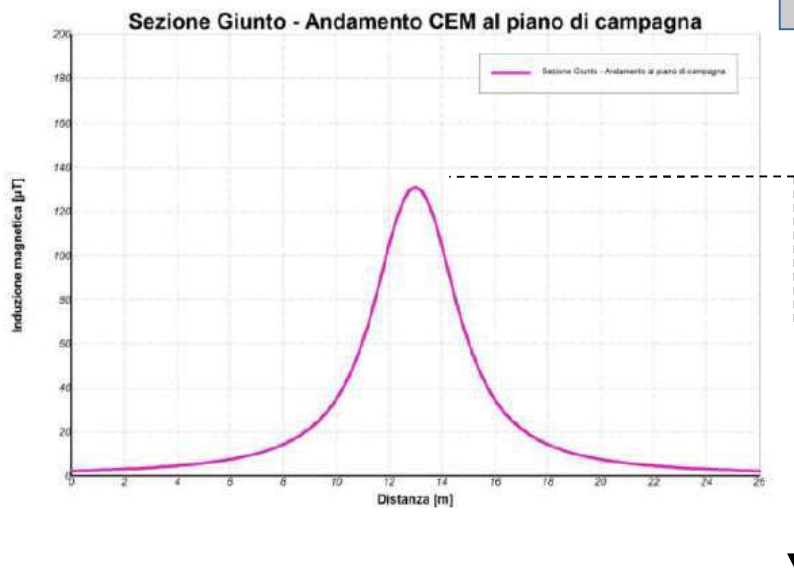




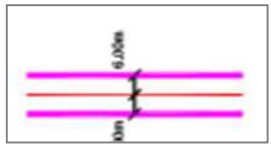
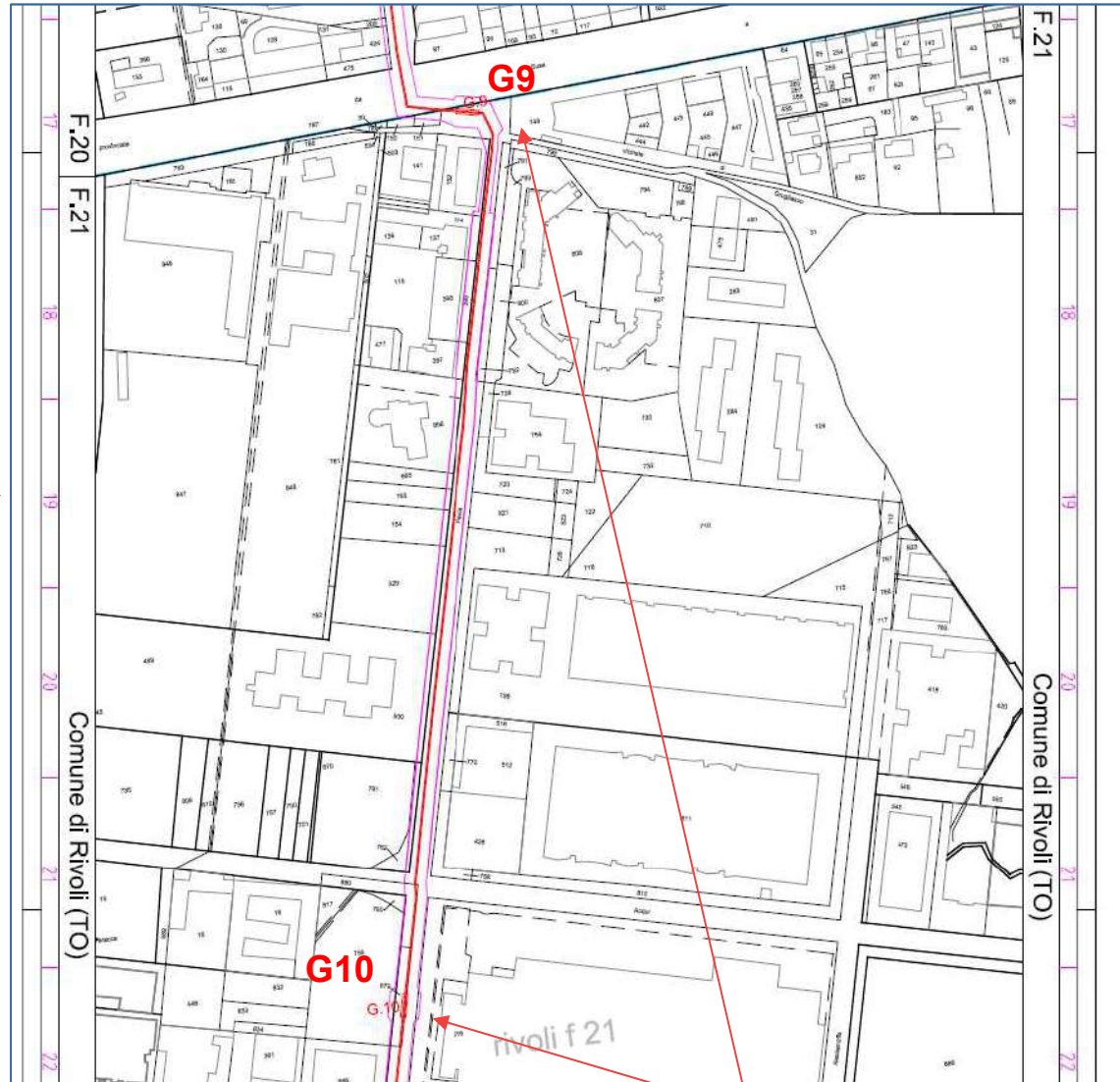
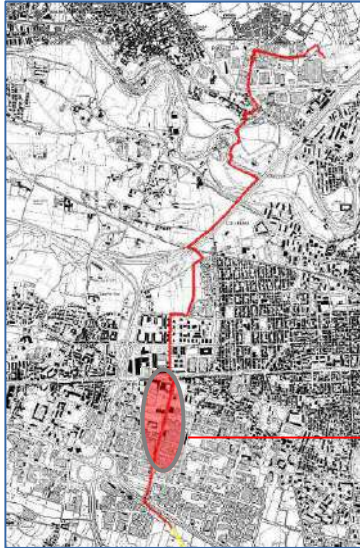
# T213 - Magnetic induction field emitted from a junction



Shielded junction



# T213 – DPA



DPA:  
power lines 6+6m  
shielded power lines: 3+3m  
junction: 8,5+8,5m

Junctions

## Overhead power lines

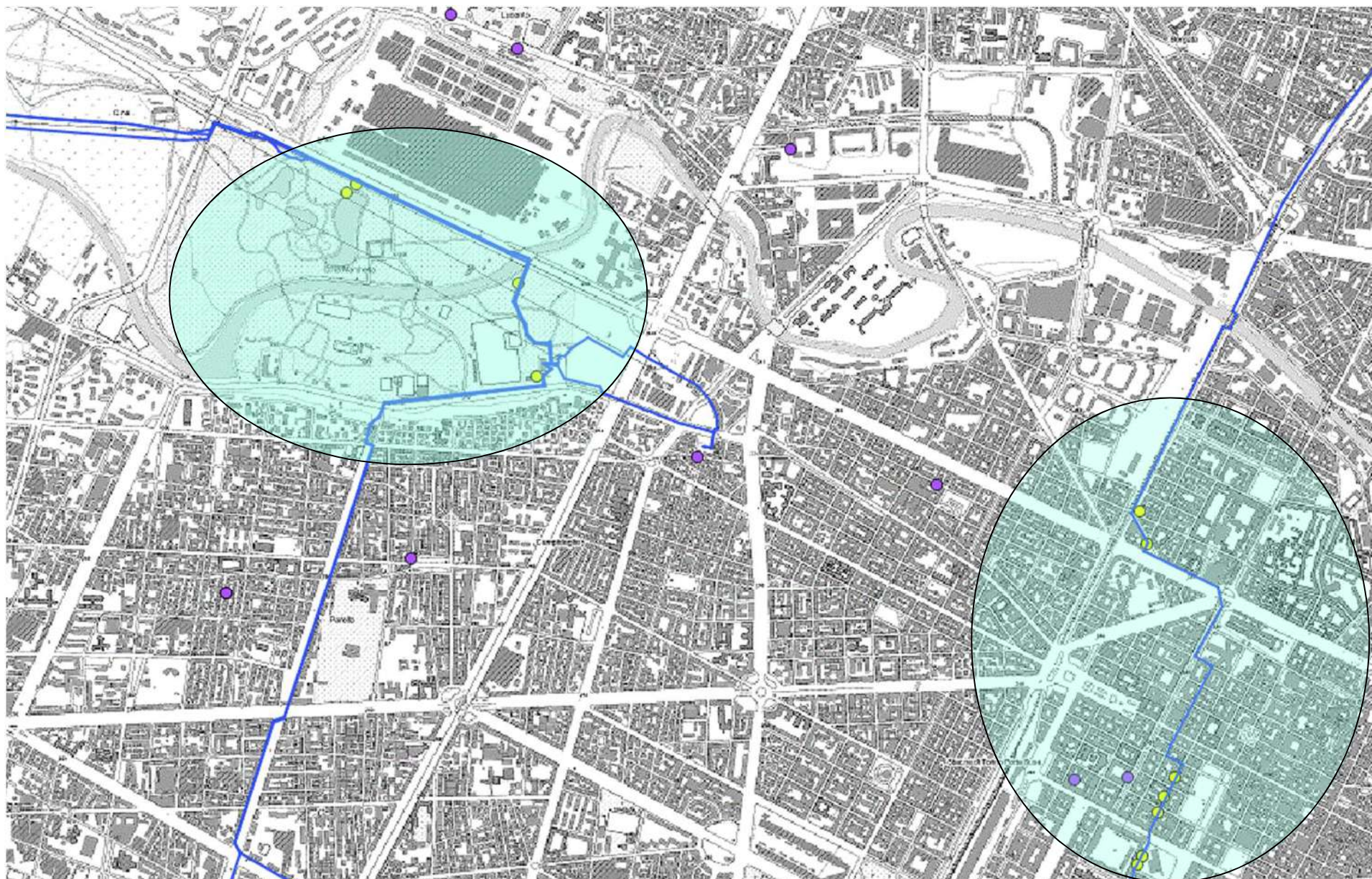
The project solves many critical issues about the EMF exposure

## Underground power lines

Requirements:

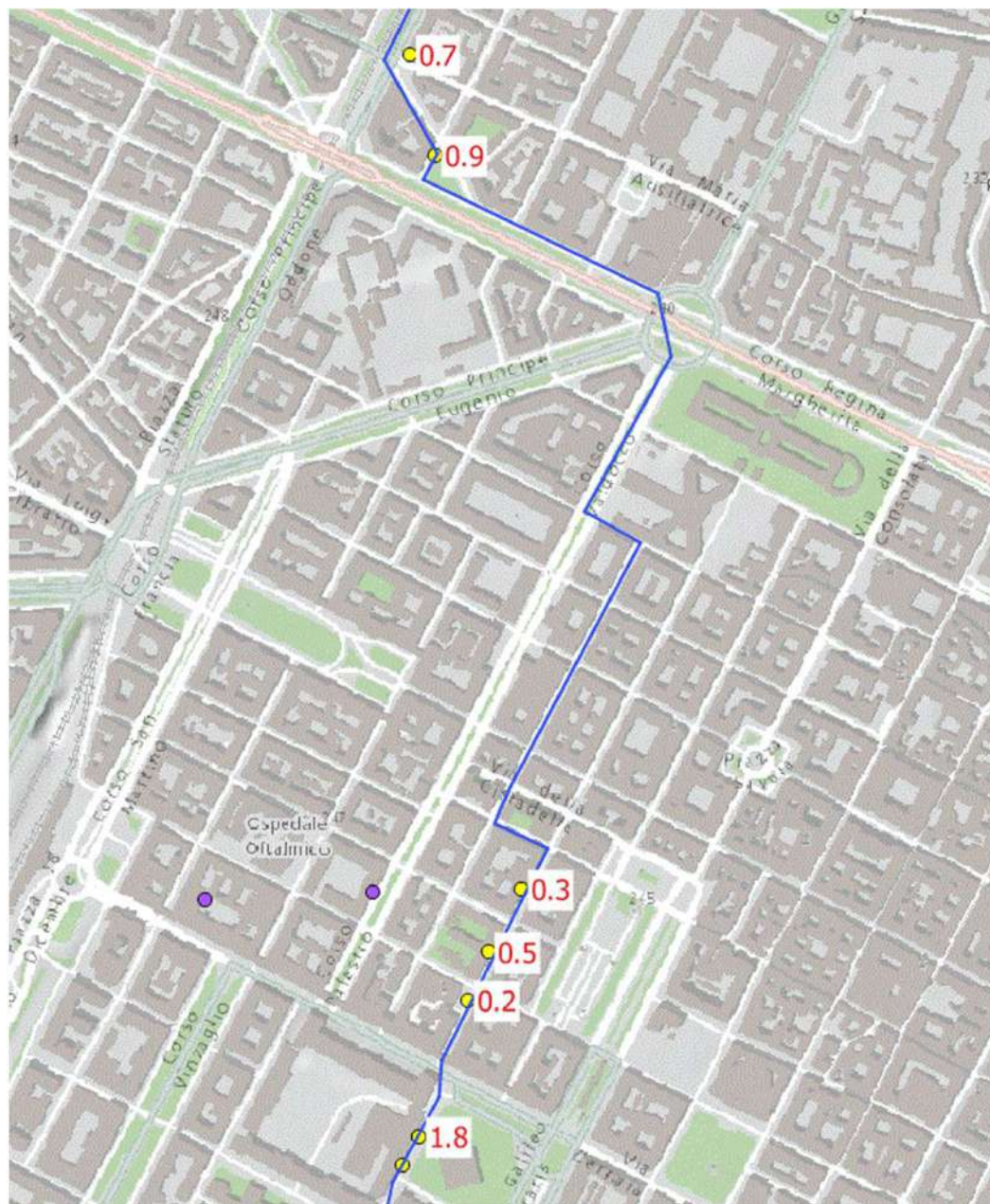
- Executive project: evaluate the exact location of the junctions in Rivoli, especially for the junctions N. G8 and G9, in order to locate them as far as possible from the buildings or any frequently used areas + consider the opportunity to increase their depth
- (Prudent avoidance principle) In via Pavia, in Rivoli: there are many buildings (café, shops, restaurants and a school) → insert a shielded section → it also protects people with medical devices who may be affected by any interference caused by the magnetic field
- Executive project: insert additional shielded sections, based on the actual position of the power line

# Results of this approach: examples of recently constructed cable power lines





Results of magnetic field measurements ( $\mu\text{T}$ ) after the line implementation





Before

Magnetic field levels from 0.5 to 2  $\mu\text{T}$   
below the conductors



After

Magnetic field levels from 0.4 (shielded  
cables) to 0.7  $\mu\text{T}$  (not shielded) above  
the cables





Results of magnetic field measurements ( $\mu\text{T}$ ) after the line implementation

