

## **MODULE n°6**

# **NPP Siting, Design, Construction, Operation and Decommissioning**

## ***APPROACH TO SITE SELECTION UNICEN GUIDELINES DESCRIPTION***



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# THE OBJECTIVES

## OBJECTIVES OF THE PRESENTATION

**Present the guidelines produced by UNICEN GdL 1b (Task Group 1b) to support the NPP site selection process in Italy**

**UNICEN Commissione tecnologie nucleari e radioprotezione UNI  
(Ente nazionale italiano di unificazione)**

## **GdL 1b – Background**

- **Working period 2009 (March - September)**  
(document draft issued end of September 2009)
- **Nuclear option considered by the Italian Government**  
(Legge Delega N°99 del 23-7-2009)
- **11 organizations – about 30 experts involved**  
(ISPRA, MinSvEcon, ENEL, ACEA Electrabel, EDISON, EON, TERNA, SOGIN, ENEA, CESI/RSE, ANSALDO NUCLEARE)

## **GdL 1b – Scope of Work**

**Provide Guidelines and Plant Information to support the licensing process of new generation NPP to be built in Italy**

**1. Definition of site selection parameters and related criteria starting from the study done in 1977 by the Italian Safety Authority [CNEN-DISP DISP(1977)] and updating considering:**

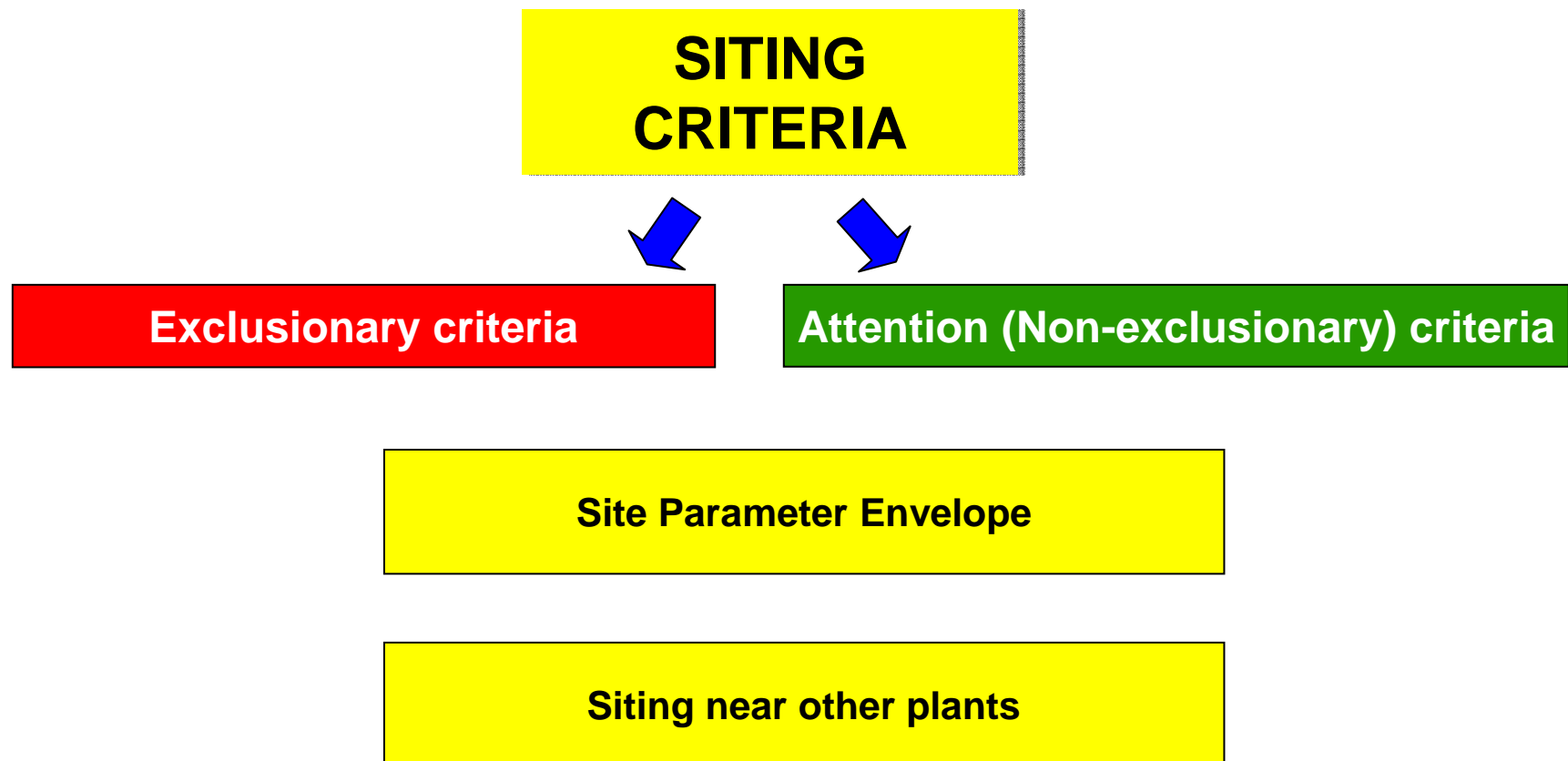
- The features of new NPP design (Generation III Reactors)
- IAEA more updating safety requirements

**2. Definition of new generation NPPs site parameter envelope data**

**3. Considerations on site related issues relevant for the Italian situation (e.g. Site sharing with existing NPPs under decommissioning o Power generation plants)**

**For the Environmental Protection Issue the guide reports only generic consideration because detailed analyses were allocated in another workgroup (GdL 22)**

## **GdL 1b – Scope of Work**



## ***Definition of site selection parameters and related criteria***

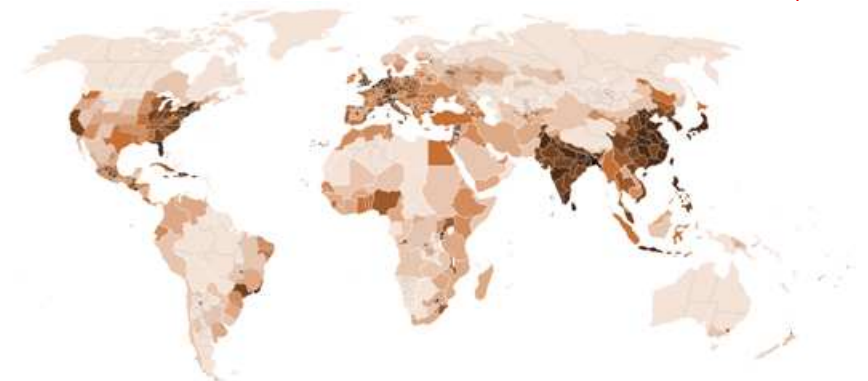
### ***Reference Nuclear Power Plant Design***

- **Generation III NPP (e.g. AP1000-1000MWe and EPR-1600 MWe)**
- **EUR document NPP design envelope as technical reference**
  - ❑ **European Utility Requirement document (EUR document) is a nuclear power plant specification written by a group of of European electricity producers willing to keep the nuclear option open (Enel and Sogin in the group).**
  - ❑ **EUR document common frame for development of next generation LWR NPPs.**
  - ❑ **Starting work in 1992**

## ***Definition of site selection parameters and related criteria***

### ***Exclusionary Criteria***

- 1. Population density and use characteristics of the site environs**
- 2. Seismology and geology**



## ***Exclusionary criteria***

### **Population density and use characteristics of the site environs**

**Area is acceptable for NPP installation if:**

**1.  $\leq 3$  km around NPP**

- Resident population density equivalent to the national average at km<sup>2</sup>
- No special large structures with people difficult to relocate (even temporary) - (e.g. Hospital, Prisons,)

**2. It is possible to put under nuclear operator control an Area  $\leq 800$  m around NPP**

**Preferential factors:**

**1. Distance of towns with 50.000 to 250.000 people  $\geq 5$  km**

**2. Distance of towns with more than 250.000 people  $\geq 10$  km**



## ***Exclusionary criteria***

### **Population density and use characteristics of the site environs**

#### **RATIONALE – ref. EUR Vol.2 Chapter 1 Safety Goals**

- **Significant reduction of the radiological impact on environment even in severe accident conditions**
- **Emergency Plan simplification**
- **Limited impact on local economy (i.e. restrictions on the consumption of foodstuff and crops limited in terms of timescale and ground area.)**

## ***Exclusionary criteria***

### **Population density and use characteristics of the site environs**

**RATIONALE – ref. EUR Vol.2 Chapter 1 Goals for Severe Accidents**

**“Three objectives related to direct PUBLIC INVOLVEMENT in case of accident:**

- **no Emergency Protection Action beyond 800 m from the reactor during releases from the containment;**
- **no Delayed Action at any time beyond about 3 km from the reactor;**
- **no Long Term Action at any distance beyond 800 m from the reactor.**

## ***Exclusionary criteria***

### ***Seismology and Geology***

#### **❑ General screening**

Area is acceptable for NPP installation if:

- Not affected by volcanism and active faults
- Earthquake peak ground acceleration  $\leq 0,3$  g with reference to rock soil and event return time of 2475 years (ref. D.M. 14-1-2008 NTC)

#### **❑ More detailed screening for selected areas**

Verification if **geotechnical hazards** (i.e. soil liquefaction, behavior of foundation materials, slope instability, site surface collapse, subsidence or uplift) of selected areas cannot be managed by reasonable compensating engineering safeguards (risk of unproven design solutions or significant departure from NPP standard design)

## ***Definition of site selection parameters and related criteria***

### ***Attention (Not Exclusionary) Criteria***

- 1. Meteorology and hydrology**
- 2. Man-related hazards**
- 3. Infrastructures and site accessibility**

## ***Attention (Non Exclusionary) Criteria***

### ***Meteorology and Hydrology***

#### **Factors normally not critical for site selection**

- Reference plant addresses most of natural events even the extremes ones (e.g. tornadoes, raining storms)
- Where unfavorable physical characteristics exist, the site may be accepted if reasonable compensating engineering safeguards may be implemented avoiding risk of unproven design solutions or significant departure from NPP standard design

#### **The risk flooding can make unsuitable the selected areas**

Attention should be given to:

- Narrow valleys surmounted by: lakes, dikes, water basins
- Areas subject to: landslides, avalanches, snowslides (also induced only by earthquakes)
- Coastal areas subjected in the past to seaquakes

## **Attention (Non Exclusionary) Criteria**

### ***Man-related hazards***

Generation III reactors (EUR) are designed to withstand special external man-made events like: aircraft impact, pressure waves and toxic clouds.

#### **ATTENTION CRITERIA:**

##### **A. AIRPORTS**

1. Military Airports: 15 km from runways and 8 km from airport area
2. Commercial airports: 8 km from airport area (1/2 for small airports with aircraft velocity less than 250 km/h)

##### **B. MILITARY INSTALLATIONS: 8 km from area boundary of important firing grounds and military exercises area**

##### **C. INDUSTRIAL INSTALLATIONS: case-by-case evaluation of installation within 8 km**

## ***Attention (Non Exclusionary) Criteria***

### ***Infrastructures and site accessibility (1)***

- 1. WATER SOURCES**
- 2. AREAS REQUIRED FOR PLANT CONSTRUCTION**
- 3. SITE ACCESSIBILITY (Transportation of big equipment: weight and dimensions)**
- 4. ELECTRICAL GRID CONNECTION**

## ***Attention (Non Exclusionary) Criteria***

### ***Infrastructures and site accessibility (1)***

#### **1. WATER SOURCES**

- **Cooling water for main condenser and plant component cooling**

Roughly for 1000 MWe :  $35 \div 40 \text{ m}^3/\text{s}$

- **Potable and industrial water**

Roughly for 1000 MWe :  $5 \div 10 \text{ m}^3/\text{h}$  and  $20 \div 70 \text{ m}^3/\text{h}$  respectively

#### **2. AREAS REQUIRED FOR PLANT CONSTRUCTION**

**Plant area + Construction servicing areas: equipment temporary storage areas, workshops, offices, canteens ..**

- **Plant specific; roughly 16 to 33 hectares per unit**



## **Attention (Non Exclusionary) Criteria**

Examples for a 1000 MWe NPP

### **Infrastructures and site accessibility (2)**

#### **3. SITE ACCESSIBILITY (Transportation of big equipment: weight and dimensions)**

##### **WEIGHT**

▪ Spent Fuel Cask:	100 t
▪ Steam Generator:	640 t
▪ Turbine Rotor	150 t
▪ Turbine Stator	450 t

##### **DIMENSION**

▪ Vessel	7,3 x 12 m
▪ Steam generator	6,6 x 27 m
▪ Turbine Rotor	6 x 10 m
▪ Turbine Stator	6 x 13 m

## ***Attention (Non Exclusionary) Criteria***

### ***Infrastructures and site accessibility (3)***

- **ELECTRICAL GRID CONNECTION:** availability of suitable connections near the NPP
  - Power sources to the plant assured by at least two physically separated circuits in order to minimize the probability of concurrent failure occurrences.
  - Possibility to connect the plant at least to one circuit of 132/150 kV independent from the line used for electric power transmission by the plant (IAEA Safety Guide 50-SG-D7)

## ***Site sharing with other installations***

### **Shared Sites**

- **NPP sharing the site with NPP under decommissioning or other Nuclear Installation**
  - site already qualified for nuclear use
  - utilization of some existing structures and infrastructures (transportation roads grid connections)
  - Verification of the accomplishment of radiological commitments and accident consequences by adding a new installation
- **NPP sharing the site with conventional power plant**
  - utilization of some existing structures and infrastructures (transportation roads grid connections)
  - verification of the NPP radiological impacts on conventional activities both in normal and accident situations
  - plants separation for security reasons

## ***NPP site parameter envelope data***



***EUR DESIGN ENVELOPE***



***COLLECTION OF DATA FROM  
EUR DOCUMENT***

## ***NPP site parameter envelope data***

**Tabella 1 – Condizioni Standard di SITO (Rif. EUR par. 2.4.1.4)**

Parametro	Valori	Periodo
<b>Temperatura ed Umidità dell'Aria Esterna:</b>		
• Massime temperature		
- Lungo Periodo	32 °C	> 7 giorni
- Breve Periodo-Giornalmente	37 °C	da 6 h a 7 giorni
- Istantanea	42 °C	0 h
• Minime temperature		
- Lungo Periodo	- 25 °C	> 7 giorni
- Breve Periodo-Giornalmente	- 30 °C	da 6 h a 7 giorni
- Istantanea	- 35 °C	0 h
• Massima umidità di progetto		
- Estate	60 % a 37 °C (Bulbo Secco)	
- Inverno	100 % a - 25 °C	
<b>Vento :</b>		
	Maximum values	
• Base	43 m /s	
• Estremo	70 m /s	
<b>Sisma</b>		
Accelerazione riferita alla superficie indisturbata del terreno	0,25 g	
<b>Temperatura dell'Acqua di Raffreddamento</b>		
	Minimo	Massimo
• Sto marino	- 0,5 °C	33 °C
• Sto fluviale con torri di raffreddamento	0 °C	33 °C

**EUR – Site Parameter Envelope**

**Extract from GdL 1b**

**Draft document**

## ***Decreto Legislativo N°31 – 15/2/2010 - Art. 8: Parametri Esplicativi dei Criteri Tecnici Valutazione dei Siti***

### ***Parametri riferiti ai seguenti profili:***

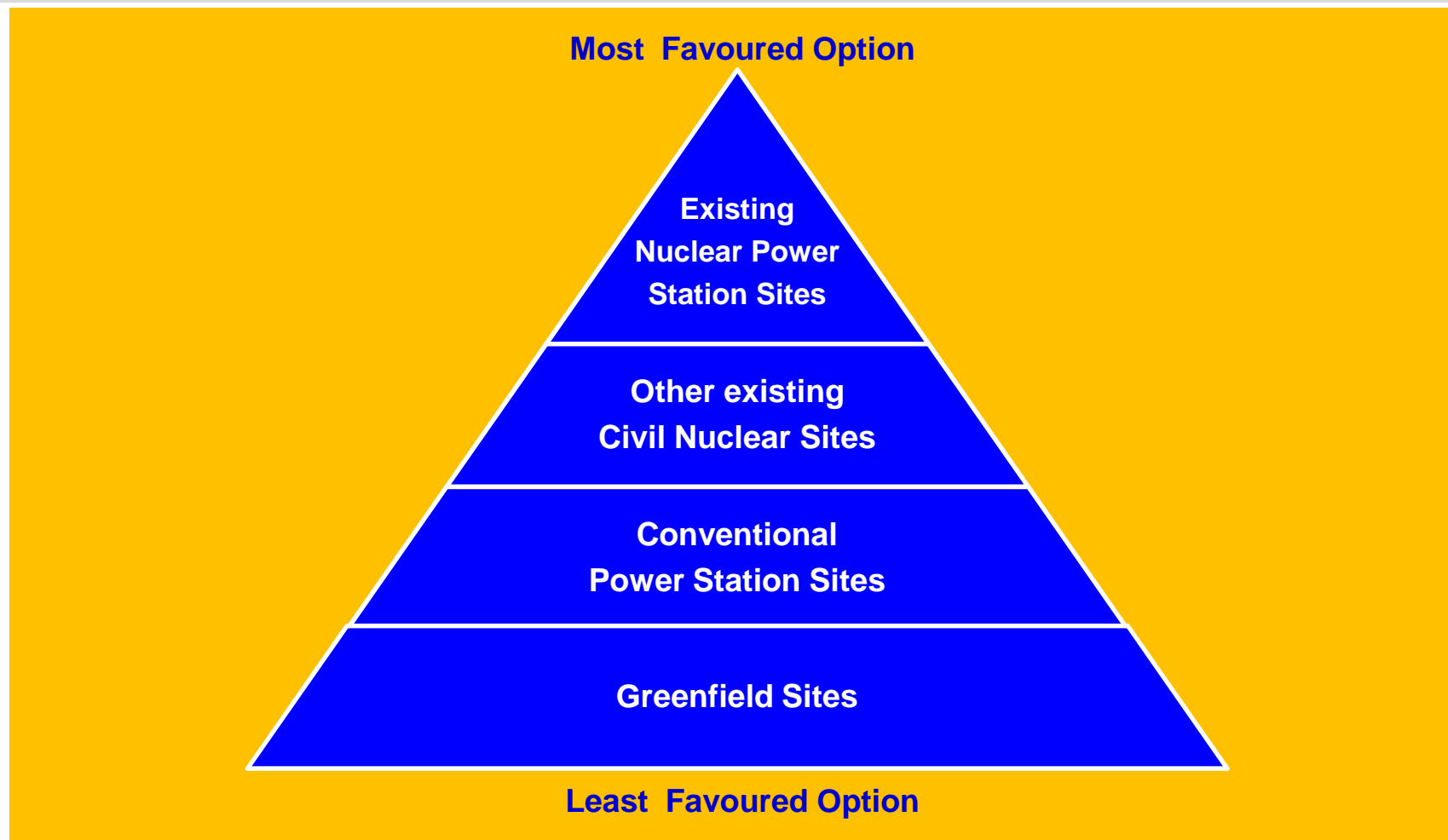
- ☛ Popolazione e fattori socio-economici
- ☛ Idrologia e risorse idriche
- ☛ Fattori meteorologici
- ☛ Biodiversità
- ☛ Geofisica e geologia
- ☛ Valore paesaggistico
- ☛ Valore architettonico – storico
- ☛ Accessibilità
- ☛ Sismo-tettonica
- ☛ Distanza da aree abitate e da infrastrutture di trasporto
- ☛ Strategicità dell'area per il sistema energetico e caratteristiche della rete elettrica
- ☛ Rischi potenziali indotti da attività umane nel territorio circostante

## Process for NPP site selection



## Process for NPP site selection

### 2. Process for NPP site selection

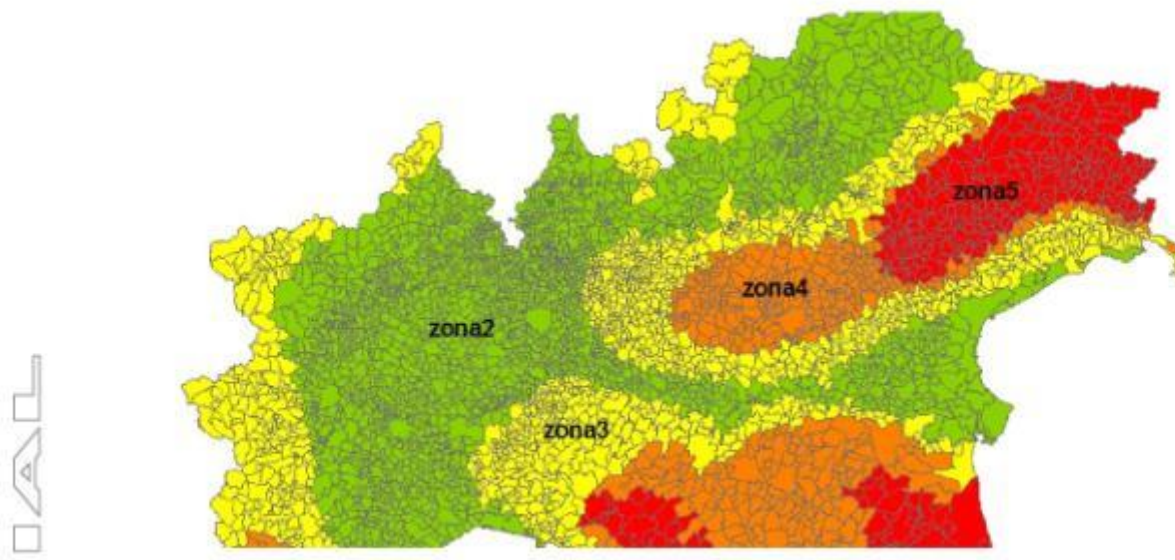




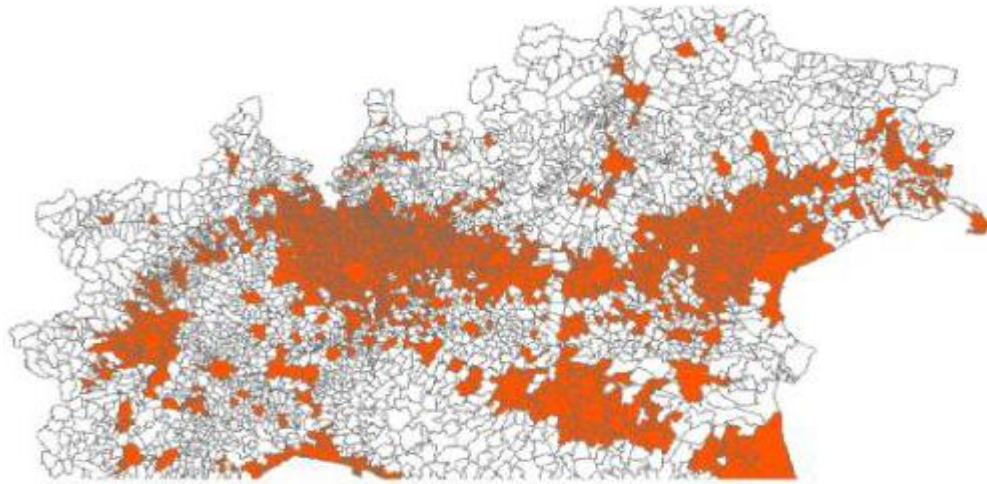
## Process for NPP site selection

ZONE	ACCELERAZIONE DI PICCO (ag)
1	$ag < 0,05g$
2	$0,15g > ag \geq 0,05g$
3	$0,25g > ag \geq 0,15g$
4	$0,3g > ag \geq 0,25g$
5	$ag > 0,3g$

**Exclusionary criterion**  
**Areas Seismic classification**  
**Zone 5 Excluded**

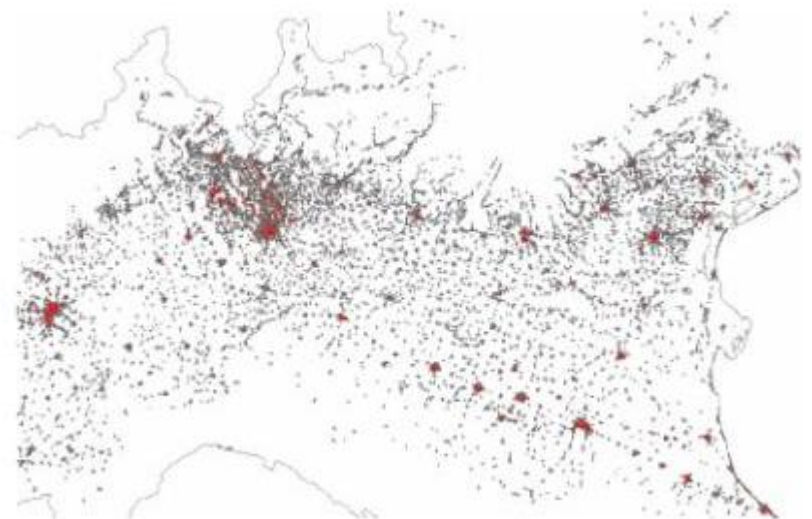


## Process for NPP site selection



*Figura 4- Comuni con densità superiore alla media nazionale*

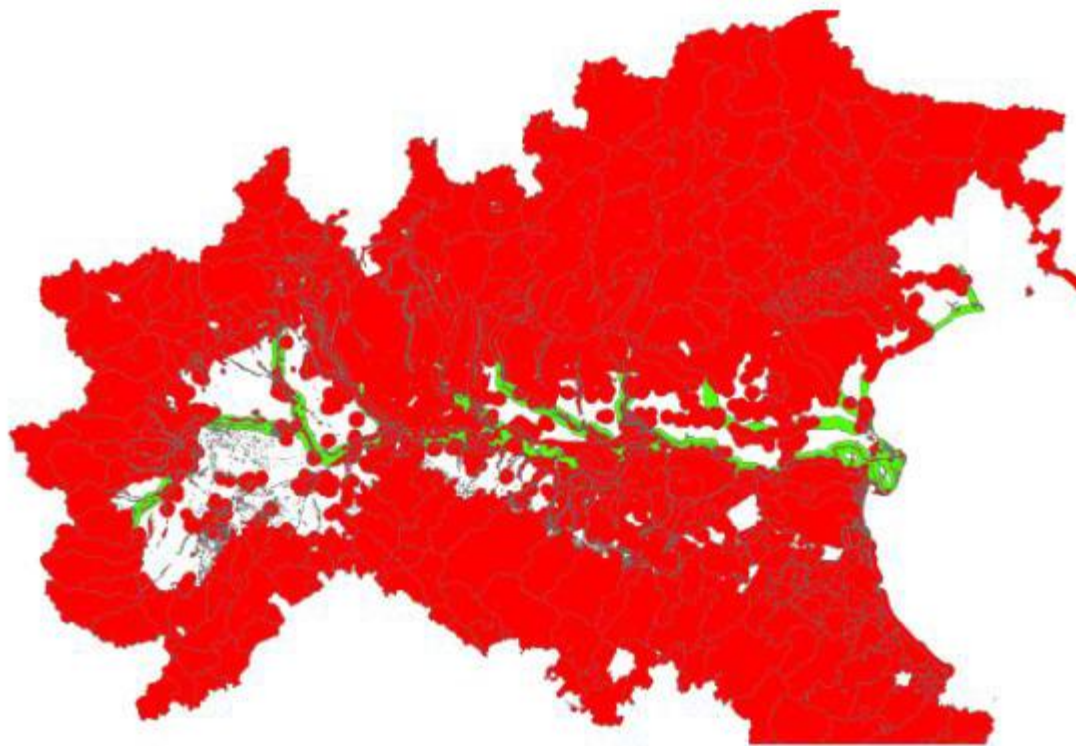
**Exclusionary Criterion**  
**Population Density**  
**higher than national average**



*Figura 5- Aree urbanizzate con densità di popolazione superiore alla media nazionale per km quadrato*

## Process for NPP site selection

### Results of the application of the exclusionary criteria



*Figura 7- Aree idonee risultanti dai criteri di esclusione di riferimento*



## Process for NPP site selection

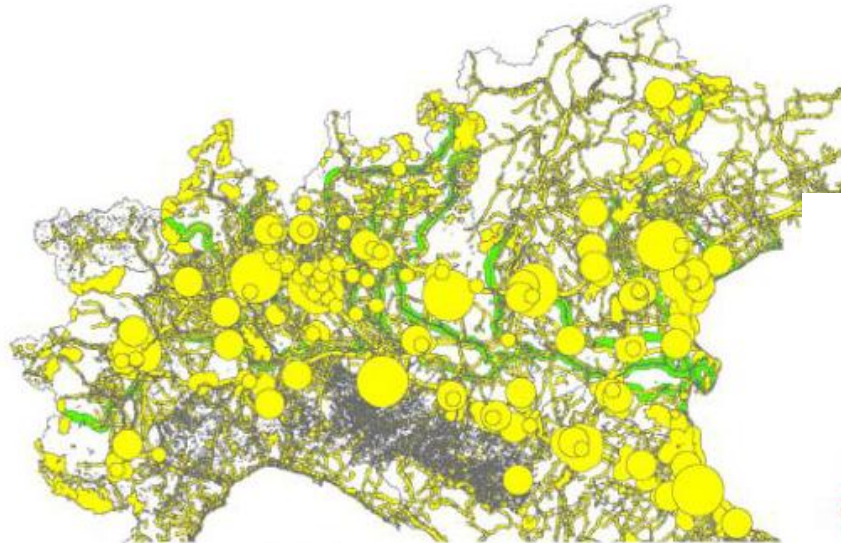


Figura 8- Aree idonee risultanti dai criteri di non esclusione di riferimento

**Suitable areas**

**Attention (non-exclusionary)  
criteria (less suitable areas in  
yellow)**

**Results of the application  
of the exclusionary and  
non-exclusionary criteria**

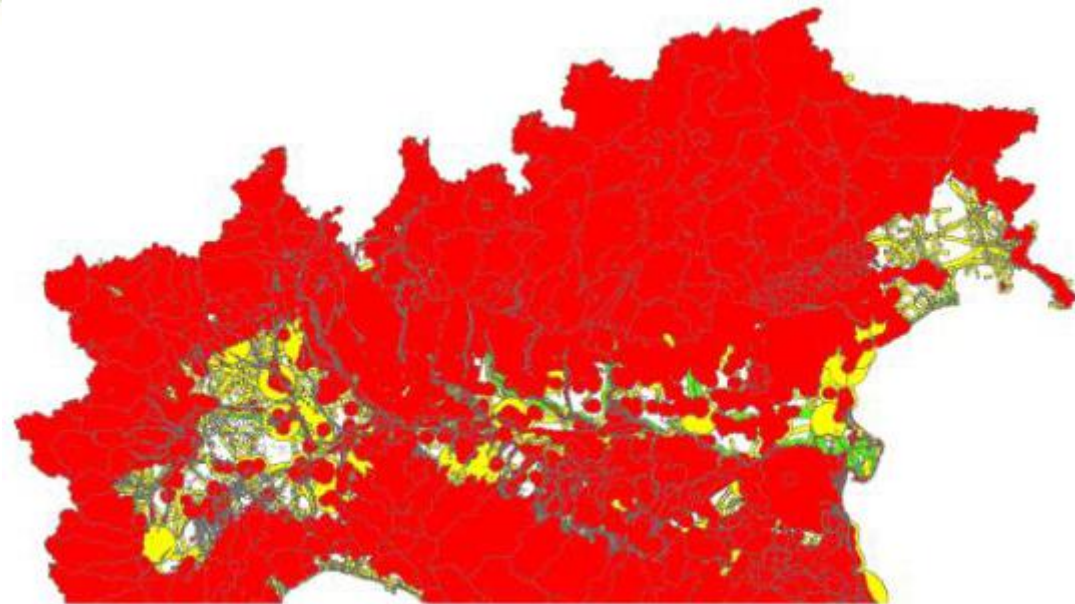


Figura 9- Aree idonee risultanti dai criteri di esclusione e non esclusione di riferimento

## Process for NPP site selection

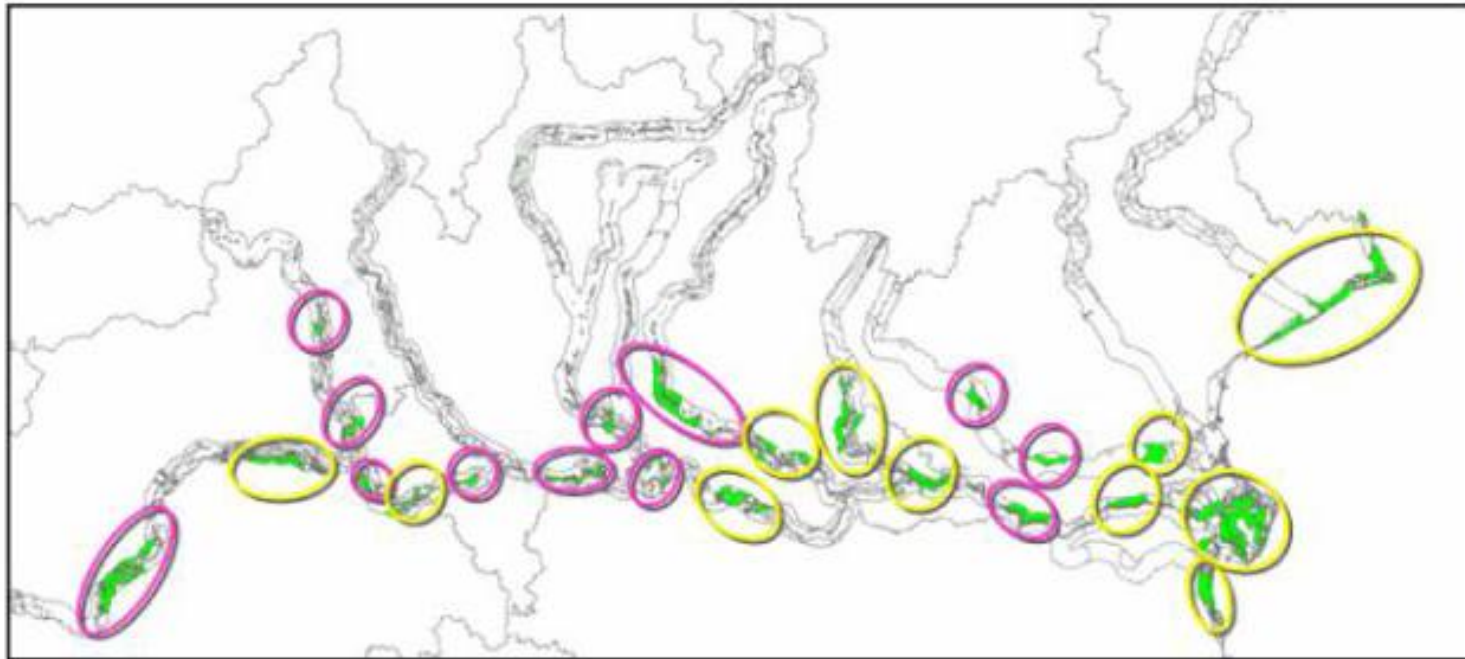


Figura 10- Aree idonee risultanti dai criteri di esclusione e opportunità (in giallo: aree già idonee nel '77- valutazione ENEC; in rosa: aree non previste dalla valutazione del '77)

**Selection results - Suitable areas**

## Process for NPP site selection



### EXCLUSIONARY CRITERIA

1. GeoHazards
2. Surface Faulting and potential liquefaction
3. Other natural Hazards
4. Cooling water source
5. Population density
6. -NA-
7. -NA-

1. GeoHazards
2. Surface Faulting and potential liquefaction
3. Other natural Hazards
4. Cooling water source
5. Population density
6. Restricted areas
7. Site size

1. GeoHazards
2. -NA-
3. Other natural Hazards
4. Cooling water source
5. Population density
6. -NA-
7. Site size

### NOT-EXCLUSIONARY CRITERIA

1. Extreme events from human activities
2. Transportation access
3. Grid system
4. Landscape and Ecological issues

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## Regulation comparison