PV - Electromagnetic Impact Report

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Project for the construction of a photovoltaic plant of 7.17 MWp connected to the national grid in the town of Suvereto (LI), Tuscany Region, in Italy.

GENERAL

The electric and magnetic fields are two different physical quantities, however they are considered a single manifestation of a physical phenomenon: the electromagnetic field.
The magnetic field can be defined as a perturbation of a certain region of space determined by the presence of a distribution of electric current or magnetic mass, whose unit is the Ampere [A / m].
The electric field can be defined as a perturbation of a certain region of space determined by the presence of a distribution of electric charge, whose unit is the Volt [V/m].
The electrical field rather than the magnetic field, is easily shieldable by materials such as wood or metal, but also trees or buildings. These fields are cumulated together in space to determine the propagation of a field called electromagnetic (EMF).
The key features that distinguish the electromagnetic fields and determines their properties are the frequency [Hz] and the wavelength [m], which express, amongst others, the energy content of the field itself.

Depending on the power supply, you may distinguish different types of power line:

a) High-voltage power lines (380 kV): connect the power plants to the stations where the primary voltage is lowered by the value of transport to the distribution networks (regional super-field);

b) Distribution and sub-transmission high-voltage power lines (132 kV and 220 kV): departing from the primary power stations, these lines feed the large users or primary substations from which they create the Medium Voltage distribution lines;

c) Medium Voltage power lines (22 kV): start from the primary stations and feed the secondary substations and medium-sized industrial users;

d) Low Voltage power lines (220 - 380 V): depart from the secondary cabins and feed users of the area.

For the low frequency fields (power lines, electrical appliances), the intensity of the electric field is measured in Volt/mt [V/m] and the magnetic induction in Tesla (T).
The growing demand for electricity and communications has produced in the recent years a considerable increase of the number of power lines and base stations for mobile phones.
This led to an increase of EMF in our daily environment as well as a major exposure to electromagnetic radiation.

REGULATORY FRAMEWORK

In Europe the exposure limits and the values of attention for electric and magnetic fields at a frequency of 50 Hz and generated by power lines are defined by the law, such as article 5 paragraph 2 of the Prime Minister's Decree of July 8, 2003, in Italy
The article provides that in case of exposure to electric and magnetic fields at a frequency of 50 Hz generated by power lines, the exposure limit of 100 mT for magnetic induction and 5 V/m for the electric field should not be exceeded, understood as effective values.
The protection framework against the effects of exposures to environmental pollutants generally distinguishes:

• acute (or short) effects, based on a threshold, for which exposure limits are set to guarantee, with conservative margins, non-occurrence of these effects;

• effects of chronic (or long) effects, with no threshold, for which indicative operative limits are set to prevent the total damage.

In Italy, the law on the electromagnetic pollution, and specifically the field of non-ionizing radiation, is very fragmented.
The innovative aspect of the Italian framework law is the introduction of the "attention value" in order to consider the effects of long and medium term on the population; in law 36/01, they are in fact, defined as follows:

• Maximum exposure: values of electric, magnetic and electromagnetic fields (considered as the value of entry), to be considered as binding limits for the protection of human health from acute effects of exposure;

• Attention value: the value of electric, magnetic and electromagnetic fields defined in order to protect the population from the chronic effects of electromagnetic fields in the case of housing, schools and prolonged stays;

• Quality objectives: designed to foreshadow the progressive and gradual improvements in environmental quality, in a long term time horizon. They are divided into:

- locational criteria, planning standards, requirements and incentives for the use of BAT;

- Values of the electric, magnetic and electromagnetic field, determined by the State to achieve a progressive minimization of exposure to these fields.

It' s clear that the attention value (such as the 6 V/m of the Ministerial Decree on the spectrum) and quality objectives (such as the value of 0.2 mT of the Law of the Veneto Region) should not be considered as safety thresholds, but as references for the achievement of operational objectives for the protection from possible effects of long-term application of the "precautionary principle". The D.P.C.M. 23/04/92 on "Maximum exposure limits to electric and magnetic fields generated at the Industrial frequency (50 Hz) in homes and in the external environment "is limited to the population protection from the exposure as well as the exposure limits for the protection from its known effects in the short term.

The Decree also provides safe distances from power lines to ensure compliance with exposure limits.

Exposure Characteristics	**Electric Field Intensity [kV / m]**	**Magnetic Induction (μT)**	**High-Voltage lines Security Distances**

Areas in which exposure is reduced to a few hours a day	**10**	**1**	**132 kV lines ≥ 10 mt 220 kV lines ≥ 18 mt 380 kV lines ≥ 28 mt**
Areas where you spend a significant part of the day	**5**	**0,1**	

Table 1.1 - Values of magnetic flux density and security HV lines distance

The Prime Minister's Decree 28/09/95 on the "technical procedural rules for the implementation of the Prime Minister 23/04/92, limited to power lines, "restricted in a first phase, the measures to improve compliance with exposure limits and set a deadline for completion of rehabilitation of 31/12/04.
The references used are those of D.P.C.M. 23/04/92 for the values of magnetic induction and regulation on safety distances from the power line.

Regulations	**Limits**	**Field B (mT)**	**Field E (kV/m)**
DPCM 08/07/2003	**Exposure Limit**	**100**	**5**
	Attention Value (24 hour of exposure)	**10**	**-**
	Objective Quality (Planning new power lines)	**3**	**-**
DPCM 23/04/1992	**Limit exposure to whole day**	**100**	**5**
	Limit exposure for a few hours	**1000**	**10**
1999/512/EC	**Reference levels**	**100**	**5**

Table 1.2 - procedural technical rules of implementation

ELECTROMAGNETIC FIELD SOURCES IN THE ELECTRICAL SYSTEMS

The electrical power systems (consisting in central stations and power lines) are particular sources of electromagnetic fields, which depending on their operating frequency (50 Hz), are defined as Elf sources (Extremely Low Frequency).
The photovoltaic power plants comprise of subsystems with different operating voltages:

- **Extremely High Voltage HHV (220 kV to 380 kV);**
- **High Voltage HV (30 kV to 150 kV);**
- **Medium Voltage MV (1 kV to 30 kV);**

• **Low Voltage LV (400 V).**

The HHV will not be present on new developments in Kleinbegin.

Tables 2.1 and 2.2 show the indicative values of the electric and magnetic fields observed below the power lines.

Utility voltage (kV)	Electric field to the ground (Maximum values) (V/m)
380 *	5000 - 6000
220	2000 - 2500
130-150	1000 - 1500
22	100 - 300

Table 2.1 Electric field under the HV and MV lines areas (at 1 m above the ground)

Utility voltage [kV / m]	Magnetic induction (Maximum values) (µT)
380 (1500 A) *	16 to 21
220 (550 A)	7
130 (300 A)	5
22 (150 A)	0,3

Table 2.2 Magnetic field under the HV and MV lines areas (at 1 m above the ground)

* **The 380 kV utility voltage, will not be present on new developments in Kleinbegin.**

ELECTROMAGNETIC FIELD SOURCES IN THE PROJECT

The proposed project consists in setting up a PV plant for the production of electricity which comprises elements that are able to generate the emission of electromagnetic waves:

- Overhead power line for the connection of the pv cabin to the plant cabin (132 kV cables). **In Kleinbegin, this was already present before development.**
- Power line, laid underground, for the connection of the plant cabin to the delivery cabin (22 kV cables);
- Plant and delivery cabin: the plant cabin, made of reinforced concrete, receive all the cables coming from the pv panels. The plant cabin contains the MV module and the MV cells (receiving line, interfaces and counters) and the LV power panel of the cabin as well as the computerized management system. The plant cabin is then connected to the delivery cabin through the power line.

The high voltage cabins (plant cabins) are characterized by values of electric field and magnetic induction depending from both the intensity of the CC electricity and the specific components (disconnectors, switches, transformers, etc..) located in the cabin.

PROBABILITY OF IMPACT

Higher values of the electric field is attributable to the operation of the disconnectors (1.2-5.0 kV/m) while the highest value of magnetic induction is adjustable at the processor (6.0-15.0μT1). The high voltage cabins, therefore, are characterized by values of magnetic induction and electric field below current regulatory limits.

Underground Cables: the network connection between the various equipment of the plant consists in MV cables (22 kV) to connect the plant cabins to the delivery cabin.
The maximum value of electric field and magnetic induction measured next to a 22 kV overhead line, one meter from the ground, are respectively of 0.4 kV / m and 0.4 mT.
No more than three 22 kV power lines of converge to the connection and delivery cabins, and, in the case of air power lines, the value of the electric field at one meter distance is 1 kV/m and 1 mT for the magnetic induction.

Based on available information, the considerations reported above can also be valid for the electromagnetic fields generated from 132 kV overhead power lines.
The probability of impact is considered negligible. In fact the electromagnetic frequencies are extremely low (50-300 Hz) and absolutely harmless.

IMPACT EXTENSION
The study of electromagnetic impact of these plants can prevent the already low emissions, to interfere with human activities. Much attention is therefore paid to the respect of the limits

imposed by law regarding both the electromagnetic influence of the plant and the power lines. Eventually, the spatial limits of the impact are confined to a very small area around the cabin connection.

REVERSIBILITY OF THE IMPACT

The time limit of the possible impact is due to the life of the plant, amounting to usually 20 years.

The impact is completely reversible.