ENVIRONMENTAL SAFEGUARD IN GEOTHERMAL ACTIVITIES: THE ITALIAN EXPERIENCES

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ABSTRACT

Rules and regulation issued in Italy *for* the entry into force of EEC Directive 85/337 about the environmental impact assessment do not apply to operations for geothermal activities.
The new specific law regarding geothermal exploration and production (896/1986) has established detailed provisions for the protection of environment, different from those stated by the EEC Directive and by EIA general law for other works (349/1986), both during the administrative procedures of the application and when the activities are performed.
The. main innovation is in the assessment of geothermal project [mining activities and plant construction) as a whole; another aspect to be pointed out is that the environmental impact assessment procedure! involving the participation of several environmental authorities, is coordinated by the same mining authority responsible for the control of mining operatinn.
In this paper are described the state of things before, the mining activity specific stages and the general and specific mining laws.
In the past few years many geothemal project have been evaluated, for the exploration phasc and tor the exploitation plants, obtaining interesting results; thr Italian experience is here discussed.
An international inquiry is proposed with a view to experiences in this field known in other countries where such procedures for geothermal activities are being applied.

1. THE ENVIRONMENTAL IMPACT ASSESSMENT PROCEDURE

'I'hc complex of problems concerning the Environmental Impact Statement (E.I.S.) manifests itself in the framework of the correlation between industrial development and the environment. From the point of view of a correct utilization of the resources, correlation should not mean conflict, but compatibility among different interests, many of which are protected by the Constitution.
Within this general scheme, the EEC Directive 85/337 was introduced as one of the Community initiatives on the matter of environmental protection, with the aim of supporting the harmonic development of the various national regulations on the subject.
The adoption of the above-mentioned Community Directive (while waiting for a complete legislative enactment, which shall be realized by means of a code of guidelines on the E.I.S.) has been carried out within the Italian regulation system with Government Decrees on 10/08/1988, n.337, and 27/12/1988. Both decrees have been issued in fulfillment of An. 6 of Law 349/86, which established the Ministry lor the Environment, and has been completed by scveral ministerial circulars.
Such decrees demand that any industrial project of the kind specified in the D.P.C.M. 377/88 is subjected to the E.I.S. procedure.
The procedure requires that the Ministry for the Environment (after consultation with the concerned Region) shall prepare a statement about the project compatibility with the environment, in agreement wirh the Ministry for Cultural and Environmental Goods, within 90 days from the date the Report (a Study of Environmental Impact. E.I.A.) has been submined by the proponent (Art. 6 ot Law 349/86), once the puhlic inquiry (which consists of depositing a copy of the E.I.A. by the Region and in the publication of a non-technical advertisement in the newspaper) has been completed.
Such a statement is founded on technical regulations issued by the above-mentioned D.P.C.M. decrees, in particular the 27/12/88 decree, which establishes the E.I.A. content.
Therefore, the E.I.S. becomes an Act about the environmental compatibility, which, in the negative cast, blocks the bureaucratic path of the project, except for the possibility of direct submission of the case to the Government.

2. MINING LEGISLATION IN THE GEOTHERMAL SECTOR.

Based on the Italian regulation system in force, the mineral deposits belong to the State restricted patrimony. The Statc *can* grant on its territory, respectively for exploration and exploitation purposes, "permessi di ricerca" (exploration permits) and "concessioni di coltivazione" (mining leases) (R.D 1443/27, General Mining Law).
The mining activities connected with hydrocarbons (liquids and gases) and geothermal resources are subject io specific regulations. differentiated from the General Mining Law,
The granting and the use of exploration and exploitation of geothermal resources are subject to the dispositions of the law n. 896 9/12/1986, and the D.P.R. 395/91.
Ths existing titles are: the exploration permits (duration 4 years. renewable for two more years, on a maximum area of 1000 km^2) and the mining leases, (duration not over 30 years, later renewable for ten year periods).
I) *EXPLORATION PERMIT*
This represents the preliminary phase of exploration for the geological and mining assessment uf a promising area in view of industrial utilization of the existing resources.
In its framework the geological and geochemical investigations, the geophysical surveys, and the well dnlling *shall* be accomplished within the established terms. The party appointed has the right to obtain a renewal, if it complied with all the duties prescribed by the law and/or any duties agreed upon at the time of the bestowal.
Each operation is subject to a specific authorization by the mining authority (U.N.M.I.G.). In the event of positive results, the appointed party will be authorized to carry on the production tests on the exploratory wells. in order to assess the lield
2) *MINING LEASE*
The pany appointed in the exploration permit has the right to obtain a mining lease if the capacity of the well and the other available elements of geothermal assessment justify. from a technical and economical point of view, the developmenr of the filed
The appointed party is required by law to accomplish the developmentand exploitation works under the terms prescribed at the granting lime.

The work program foresees the dnlling of development wells aimed at the recovery of the mining resource and the construction of the power plants.

All the foreseen operations and modifications of the original program are authorized by rhe U.N.M.I.G. by means of *specific* provisions.

Finally, in the framework of the mining lease, the appointed party may carry out a contemporary program of further exploration, aimed at investigating other structures interesting from the mining point of view: such a program will be accomplished with procedures similar to those of the exploration permit.

The activities connected with exploration and exploitation of geothermal resources consist of operations that can be grouped in the following phases:

A. SURFACE EXPLORATION

The surface exploration is a set of operations aimed at the definition of rhe geological-structural characteristics of the area by means of surveys.

It involves geological studies, geochemical investigation. geophysical surveys *on* a wide scale (generally airborne gravimetric and magnetometric surveys). Seismic surveys *are* also carried out together with geoelectric surveys and thermometric measurements performed by means of shallow dnlling (gradient wells).

B. *DEEP EXPLORATION*

The deep exploration consists of drilling the wells in view of ascertaining the real mining value of the field discovered during the surface exploration phase.

C. DEVELOPMENT AND EXPLOITATION

The development and exploitation of a field *are* a set of operations to extract and to maintain the production nvtr time, in order to achieve the maximum possible recovery.

In particular, for a geothermal field suitable fnr the production of electric energy (high enthalpy), development and reinjection wells will be drilled and geothermal generating plants together with the relevant gathering system arid the electric substation will be built.

The gathering system includes steam pipelines to teed the power plants and water reinjection pipelines to dispose the waste water.

With reference to the environmental concerns, it is important to notice that the fundamental characteristics which differentiate exploration and exploitation, in terms of their impact on the environment, are the different time duration (temporary and permanent! respectively) and the different level of environmental risk (transitory or continuous) of the operations which are performed.

Moreover, it is worth stressing thar the exploration activities are operations for which the work sites am not known beforehand. For the exploitation, on the contrary, all the activities are localized in a place which is almost defined (the area of development).

3, THE ENVIRONMENTAL PROTECTION PROCEDURE FOR GEOTHERMAL ACTIVITIES

The adoption within the Italian regulation system of the EEC Directive can nor aim only at the objective of harmony among the national standards in Europe, but must also present itself as an unifying moment for the single national and regional initiatives on the matter of environmental protection.

It is very important then that the internal legislation provide a connection among the different standard levels instead of a contraddiction.

The E.I.S. attempts to establish a judgment procedure founded on the analysis of the concrete case and on social responsibility. Therefore, it does not aim to fix any abstract permission or prohibition, hut to establish an harmony between the regulation and the working reality. In consideration of this, a correct relationship bctwccn the demands of rigour and those of simplicity is required.

The law must play a role in strengthening the correct territorial planning. takcn in its widest meaning; the condition is that of succeeding in isolating the essential nucleus of those activitics which can damage the environment in order to obtain an adequate regulation.

Finally, the E.I.S. has to be a mechanism capable of foreseeing the consequences for the environment of public and private projects of works and interventions to bc accomplished in the temtnry, with the purpose of preventing damaging effects: at least beyond a certain threshold. Therefore. concerning the mining activities connected with energy production, the legislature felt the need of modifying the approach of the traditional scheme (which held the work as a whole to be the object of the provision) considering. instead. the set of operations connected to a certain activity.

In fact, the environmental protection procedure, explicitly forcseen by Law 896/86, represents the first attempt of the national regulation (altnost contemporary with Law 349/86) to determine the procedures ad *hoc*, which in this casc are typical in comparison with those issued later by the D.P.C.M377/88 concerning rhe prescriptions of Art. 6 of Law 346/86.

Therefore, die procedure represents a particular example, to which (in fulfillment of Art. 2 of Law 9/91) the regulation of technical proceeding and rules for the E.I.S. in the hydrocarbons and industrial production sectors (which are subject as a whole, in its manifold and various expressions, to E I.S. procedure) will be added.

In this regard, it is important to observe thar the EEC Directive 85/337, when giving indications for the environmental impact assessment of the projects, refers to singlc works and particularly, in the enclosure II (works which the partner States are not required to subordinate to the E.I.S. procedure). Only "geothemal drilling and oil and natural gas extraction" are quoted in connection with the extraction industry. while within the national scclor legislation (Laws 896/86 for the geothermal activities and 9/91 for the hydrocarbons) the adoption of the EEC Directive has been madc by referring to the whole complex of activities.

Such an interpretation, even if it on one side represents a noticeable effort of coherence connected with the working reality of this sector as a whole, introduces, on the other side analysis difficulties and problems in formulating judgments in situations with no easy solution.

Tha E.I.A. is prepared on *the* basis of a tentative work programme. This programme map of course be modified? even in a significant way, during its progress: therefore the law considers the E.I.A. presented at the granting time as a provisional study, to be updated according to the actual progress of rhe works.

Fach modification and/or integration to the original E.I.A. should be approved by the U.N.M.I.G..as per D.P.R. 395/91 which conforms to the guidelines given in the Enclosure III of the EEC Directive

This has been done attempting also to define, in a manner mnre suitable to the trend of activities, the possibility of "graduaiing" during rhe progress of the work the "observations" of the competent U.N.M.I.G. which could not be expressed *at* the rime of the preliminary official environmental inquiry (authorization procedure for exploration wells).

But the most relevant and particular action of the procedure described in Arts. 4 and 11 of the quoted law, for exploration permits and mining leases, respectively, is to delegate to the M.I C.A., i.e., the mining authority, the task of coordinating, in the role of appointed authority for the main procedure within which the environmental protection is included,

In fact, the M.I.C.A transmits to the Ministries fur the Environment, of Agriculture and Forests, and for the Cultural and Environmental Goods, to the Region and to the Local administrations concerned, the E.I.A. submitted by the party that makes a request for a mining title.

The M.I.C.A. encourages meetings among Bureaus, investigations on the sites concerned by rhe request under *official* inquiry, ;hc advertisement of the interventions foreseen by the working program and the availability of the related environmental information by directly involving the local administrations.

The U.N.M.I.G. sends its observations (within 3 months for exploration permits) or expresscs a constrictive opinion (within 6 months for the mining lease] tu the M.I.C.A.

The M.I.C.A. takes into account the observations or the opinions concerning the environment before issuing the title panting decree.

Later on, during the progress of the activities included in the exploration permit at the time of the authorization for the well drilling, when the location of the work has been determined, the mining authority (having acquired the technical and environmental-mining information) starts a new environmental procedure, limited to the area of the wells, together with the competent state and regional administrations (Art. 16 of D.P.R. 395/91). This phase brings to an end the authorization path nf environmental character, which

gradually develops starring from a wide range of preliminary analysis and ending with a detailed, well-aimed analysis.

In the framework of the exploitation projects, the mining authority also supervises and coordinates the authorization of georhermal fluid reinjection and stablishes the relevant controls. Morcover the U.N.M.I.G. makes the controls demanded by the relevant bureau concerning gas emissions from the goothermal electric plants.

The same authority, on :he basis of the granting decree, verifies the correct accomplishment of the dispositions and controls with respect to the limits imposed on the operator concerning the environmental aspects.

For the exploration and exploitation projects submitted after the issuing of Law 896186. the above-mentioned procedure has been activated. To date, 6 official preliminary inquiries have been carried out for exploration permits, and 7 for mining lenses.

The experience thereof allows one to state that:

- the principle of gradual observation of the adopted procedures is quite adequate for the characteristics of mining operations, concerning the exploration permit and the related activities;
- a decisive qualitative improvement will be obtained in terms of simplicity of the procedure, if in the future, as foreseen by recent regulations, it will be possible to further simplify the procedure for the exploitation activities by anticipating all the interventions of environmental protecrion, authorizations and permits before the work begins, including all the latrer in the same granting decree of the miring title.

4. GEOTHERMAL ACTIVITIES IN ITALY

The past conjuncture, which stimulated (especially in the last ten year period) the research of alternative and, at least partially renewable, energy sources, brought, among other things. a new interest in the geothermal resources.

Italy, as is well known, is a country where the geothermal potential is high, relative: to tlic low strategic importance of such an energy source in the present situation, evaluared on the scale of the total energy budget of the country.

The Italian geothermal resources, exploited, at the present rime for the electric generation (and in conjunction with or as an alternative to thermal uses j are localized in well-defined areas on the peninsula, which have been known for a long time. In fact, they are mostly volcanic districts (Monti Vulsini, fmini and Monte Amiata area) or magmatic-intrusive zones (Larderello area).

Resides these areas, which, as mentioned. are under exploitation, rhere are other potentially interesting areas, from the geothermal point of view, still connected with the Apennine Range tectonics and tu the related Tertiary-Quaternary volcanism, distributed along the Tyrrhenian shore (islands and pre-Apennine hills).

Low enthalpy geothermal resources appear to be distributed on large areas of the national territory; among the latter those of the Po-Emilian area (objective of the "Ferrara Project") are particularly important because of the considerable flux of thermalized fluid available, and then there iie the more limited, but equally interesting ones of the Vicenza, Viterbo and Roma districts (Fig. 1).

In particular in 1993 (Table I), the yearly electric energy production from geothermal sources reached 3700 Gwh,

Table 1 - Geothermal activities in the years 1990-1994

			(high enthalpy)	
Year	Steam (k ton)	Electric Generation (GWh)	Number of Wells	Footage (m)
1990	29,090	3,222	14	15,254
1991	28,735	3,182	16	59,098
1992	30,832	3,459	25	61,832
1993	32.099	3,647	18	55,849
1994 (forecast)	31.000	3,500	20	60,200

Fig. 1 - Geothermal areas

supported by well drilling activities for exploration and development (about 56000 m).

In the same year, rhe direct utilization of geoheat for agricultural, district heating, balneology and industrial uses. reached 3,629 TJ.

The target given in the National Energy Plan of 300,000 OET of saving will not be achieved if this cnergy source is not sustained by Srate subsidies

Table 2 gives the picture of the geothermal situation in Italy before and after the entrance into force of the law 896/86.

Table 2. Comparison of the situation in the period 1986-1993

Situation	31 December 1986	31 December 1993
Installed electric capacity	460 MW	632 MW
Maximum capacity	370 MW	490 MW
Electric generation	2,760 GWh	3,667 GWh
Total dnlling footage	685,000 m	996,000 m
Total number of wells	723	850

856 MW of installed capacity are foreseen in Italy by the end of 1998 (680 MW of maximum capacity) and a generation of some 5,000 Gwh.

5. CONCLUDING REMARKS

Concerning the geothermal resources (distinguishing the high enthalpy from the low enthalpy ones) the techniques and the related

technologies for the exploration are equivalent and present a unitary picture of environmental concerns (even with differences due. to the different mining objectives under investigation). In the exploitation of the resources, even if tarried out with similar operations and technologies, the different geological conditions of the underground reservoirs and the peculiar characteristics of the product are predominant and therefore they condition in a meaningful way the whole activity.

The complex geologic-structural and tectonic evolution of the Italian territory, mostly related with the manifestation and the duration of the phases of the alpine dystrophism, which on one side determined favurable conditions far the formation of considerable and useful geothermal resources, on the other side exposed the region to the serious effects of endogenic dynamics and therefore io high seismic risk. subsidence, spontaneous uplift of natural gases and thermalized arid mineralized fluids. The attention felt by society toward those activities which involve the extraction of geothermal fluids, the draining of the deep acquifers and the related changes of the underground thermal and hydrostatic equilibrium is therefore justified.

Moreover. the peculiar characteristics of the Italian territory, where the beauty of both the natural and the historical-architectural landscape represents a resource of undeniable value to be effectively protected, cannot be forgotten.

The introduction of the environmental protection procedures also in the sector of geothermal activities. answered general expectations and specific needs of control and management of the environment and of the territory, revealing itself as an appreciated instrument and of great utility for the attention dedicated to the mitigation of the effects of the exploitation of geothermal fields, both in the exploration and in the production phases.

The problems of the introduction of the power plants in the natural environment and in the landscape are tested, under both the historical-artistic aspects and the archeological architectural ones.

Also the problems of the introduction of the yuwer planrs in the territory, with regard io the aspects of irs management and collective use and of safeguarding the stability conditions of slopes and of the. hydrogeological equilibrium, are attentively evaluated.

Concerning the drilling activities and the construction of the plants, the greatest attention is required because of the possible consequences of the inflow in the water, on the surface and underground, of polluting substances and of the interference with the underground acquifers.

The mission in the air (gases, steam and liquid drift) as well as the fall-out on *the* ground of substances contained in the extracted fluids, are carefully tested for toxic or damaging elements or compounds.

Particular attention has been dedicated to the analysis of extraction-reinjection cycles aimed at the protection of the underground acquifers of general utility and ai the control of the phenomena of subsidence and/or induced seismic activity.

During the production tests and during the exploitation phase is usually foreseen the monitoring of the environmental concentration levels of certain substances, sclected within the E.I.A., and/or certain physical or chemical parameters in order to ascertain variations or changes of the pre-existing environmental conditions beyond certain limit values. The monitoring is particularly necessary for the control of specific geodynamical phenomena (subsidence and induced seismic activity). hydrologic and hydrogeological phenomena, and of the emission levels of harmful gases in the atmosphere.

6. INQUIRY QUESTIONNAIRE

The necessity of testing the functionality of the present regulations concerning the environmental impact assessment procedures and of analyzing the problems related with their application in Italy,induced the authors of the present paper to suggest a comparative analysis of the procedure adopted also in other counmes where studies of environmental impact have been already introduced.

It is worth stressing that the context of the Italian public organization is very complex and different powers (for interests and competencies) and different levels of powers (central and local) are involved in rhe decisional path.

For this purpose, the fundamental elements which characterize the analysis and environmental impact assessment process of the exploration and exploitation activities of the geothermal resources have been individuated. The subjects engaged in this activity havt also been identified together with the subjects and the institutions involved in the information or authorization procedure and/or in the opinions.

The phases and the times of the activities aiming at the discovery and the exploitation of the resource k e n individuated, as well as the phases and times of the authorizing procedures. Also the subjects active in the environmental monitoring and the quality standard of the monitoring have Been identified together with the most common types of the encountered effects on the environment.

Therefore, a questionnaire bas been prepared and submitted to the attention of whoever is interested in the procedures of environmental impact study and assessment in various countries, All of them w e warmly invited to fill out the questionnaire completely and to mail it to the given address before the end of the current year, which will allow the beginning of the gathering of the information necessary in order to carry out a comparative inquiry at the international level about the criteria and the environmental impact assessment procedures adopted in various countries. It is worthwhile to underline again the general and particular utility of such an inquiry, whose result, after an adequate elaboration, analysis and exposition, will be communicated to any participant in the inquiry itself, and, if possible, published in a conclusive paper.

QUESTIONNAIRE

Please answer all the questions and ***then mail to*** Zng. ***Antonio Martini - Ministero dell'Industria, del Commercio e dell'Artigianato, Ufficio Nazionale per gli Idrocarburi*** e ***la Geotermia, Divisione V, via Molise, 2 - 00187 ROMA (ITALY).***

1) Which are the public administrations competent to authorize exploration and exploitation activities at a national and a local level (Ministry, Region, City Council, etc.)?

2) Is different authorization issued in the different phases of the activities (exploration, exploirarion, or other phases)?

3) On rhe matter of geothermal resources, is the general regulation for mineral deposits applied or is there instead a specific regulation for geothermal resources?

4) Are the subjects active in exploration and exploitation of geothermal resources private panics (with adequate technical and economical capacity) or public institutions or both!

5) Which is the genetic type of the principal geothermal deposits (volcanism, magmatic intrusion, radioactive decay, etc.)?

6) Which are, in order of importance, the main utilization of geothermal resources (electricity production, district heating, industrial activities, etc.)?

7) Which percentage of the total national energy production is obtained from genthermial resources?

8) How many and of what capacity are the geothermoelectric plants in operation or planned?

9) Does a specific regulation, different from the general one valid for different activities and works, exist for the environmental impact assessment *in* the case of geothermal activitics'!

10) Does the environmental impact assessment procedure include also a phase of publication, distribution of information and participation of the public?

11) What is the degree of public acceptance of geothermal exploitation acdvities?

12) Havc rules and/or guidelines spread for completing environmental impact studies of activities and works, in general, and for the geothermal exploitation activities, in particular?

13) Is the environmental impact assessment procedure required by law before the exploration phasc, before the exploitation phasc or before both of them, or is it directed by different criteria?

14) Does *the* regulation concerning environmental impact studies prescribe the type and the quality of the data to be shown, the organization of the studies to be carried out? In the affirmative casc, please give such indications.

IS) Which are the most important effects which are required by law to be shown in the environmental impact studies (landscape modifications, emission in the atmosphere, surface or underground water pollution. solid and liquid waste production. acoustic pollution, etc.)?

16) Concerning the effects indicated in question 15, which are the mitigation measures required in the different activity phases (exploration, exploitation, etc.), iniand or on the sea? Which works have to be carried out and constructions have to be built (survey, aqueducts, steam-ducts, power plants! etc.)?

17) Do specific regulations exist for fluid reinjection'!

18) Must specific authorizations for landscape modification emissions in the atmosphere and discharge in the rivers be issued by various public Bureaus'!

19) Have effects of the activities for geothermal resource utilization in their different phases (exploration, exploitation, etc.) and in the different operations [production: emission in the atmosphere, reinjection, etc.), on h u m s , on fauna, on plants, on the watrr, on the seismic activity, on the subsidence, etc., been observed?

20) Concerning the effects described in question 19, have monitoring networks for systematic observations been set up? In which caws is the monitoring required by law?

(The questionnaire has been elaborated by Architect Carmela Balanzone, Servizio V.I.A - Ministero dell'Ambiente).

Acronym list and definitions:

E.I.A. = Environmental Impact **Assessment:** *the specialized studies and researches projects required to evaluate the impact of a* **work;**
EEC = European Economic Community;
D.P.C.M. =Government Decree,
E.I.S. = **Environmental** Impact Statement: *administrative act after the consultation among the various parties involved in the evaluation of the* **impact** *of a work:*
R.D. = **Royal** Decree;
D.P.R. = Decree of **the** President of the Republic;
U.N.M.I.G. = **National** Mining Bureau **for** Hydrocarbons and Geothermal Activities;
M.I.C.A. = Ministry for **Industry, Commerce** and Handicraft.