SOCIAL ACCEPTANCE OF GEOTHERMAL PROJECTS: PROBLEMS AND COSTS

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ABSTRACT
Almost everywhere on earth, a sine qua non to harness geothermal resources in the near future is to obtain the agreement, or at least the tolerance on the project works by the people residing in the project area: what can be called social acceptance, or social consensus of the project.
The three main conditions to gain such consensus are:
i) prevention of adverse effects on people's health;
ii) minimisation of environmental impact; and
iii) creation of direct benefits for the resident communities.
To this purpose, entrepreneurs should be prepared to increase the budget for the external costs of the project, and to meet specific expenses; however, by winning social acceptance and creating a favourable climate for the implementation of the project, such expenses result in external benefits for the project owner in the form of labour saving, reduction of passive interests on bank loans, and shortening of pay-back time.
After summarising the various aspects of the problem, estimations of the burdens are provided to gain the social consensus for groups of projects of different type and size.

1. INTRODUCTION

Table 1 shows a considerable increase in the world geothermal capacity 1950-2000, with total compounded average growth rates in the order of 7.7 % per year for electrical generation, and of 4.9 % per year for the whole of direct uses (excluding balneology).
Nonetheless, if we look at the increase trends by 5-years periods, we can note that:
- geothermal - electric capacity shows three different growth periods: the first between 1950-'70, the second between 1970-'85, and the third between 1985-2000, with average growth rates of 6.6 % , 13.4 % , and 3.6 % per year, respectively;
- thermal capacity displays four different growth periods: the first until 1980, the second between 1980-'85, the third between 1985-'95, and the fourth between 1995-2000, with average growth rates of 2.5 % , 10 % , 2.7 % , and 12.2 % per year, respectively. The notable increase occurred in the last 5 years is mainly due to the affirmation of heat pumps in a number of countries, whose use alone (6949 MWt) accounts for over 50 % of the world thermal capacity in the year 2000, except balneology (see Tab. 2 in Lund-Freeston, 2000).
Except the revival of direct uses due to heat pumps in the last few years, the marked decrease in annual growth rates occurred after 1985 for both geothermal-electrical and thermal capacity is attributable chiefly to:
i) reduced economic attractiveness of the natural heat resulting from low oil prices until late 1988 approx.;
ii) shortage of financial resources in many developing countries;
iii) constraints issuing from inadequate provisions in the energy sector; and
iv) Uncertain political situations in some countries with high geothermal potential.

However, in addition to those above (which are constraints at the global or country level), this writer thinks that other, and solely local, causes contributed from 1985 to 2000 to curb geothermal development in a number of areas with high-temperature resources. Significant examples in this regard are: Milos and Nisyros (Greece), Mt. Amiata and Latera (Italy), Ohaaki (New Zealand), and Puna (Hawaii, USA); here, geothermal projects had to face strong opposition by indigenous populations, concerned with impacts that project activities could have on environment, economy, tourism, and cultural traditions in their areas.

Table 1: World-wide Development of Geothermal Energy 1950 – 2000
Average annual growth rate by 5-years periods

Year (Dec.)	Installed Power Capacity MWe	%	Installed Thermal Capacity **(except balneology*)** MWt	%
1950	**200**(1, 2, and 3)	***6.2***	unknown	***?***
1955	**270**(1, 2, and 3)	***7.3***	unknown	***?***
1960	**386**(1,2, and 3)	***6.2***	unknown	***?***
1965	**520**(1 and 2)	***6.7***	**2,500**(4)	***2.3***
1970	**720**(1, 2, and 3)	***10.4***	**2,800**(4)	***2.7***
1975	**1,180**(1, 2, and 3)	***12.3***	**3,200**(4)	***2.4***
1980	**2,110**(1, 2, 3, and 5)	***17.7***	**3,600**(4)	***10.0***
1985	*c.* **4,764**(3, 5 and 6)	***4.1***	**5,800**(7)	***3.8***
1990	*c.* **5,834**(3, 5, and 6)	***3.1***	**7,000**(7)	***1.6***
1995	*c.* **6,800**(4, 5 and 6)	***3.6***	**7,579**(8)	***12.2***
2000	**8,100** est.(9)		**13,500** est. (10)	
Compounded average annual growth rate: 1950- 2000 (%)		*7.7*		*4.9*

(*) All other direct uses are included, regardless of inlet temperature.

References: (1) Cataldi-Sommaruga, 1986 ; (2) Baldi-Cataldi, 1986 ; (3) Barbier, 1998; (4) Coherent data are not available for the years 1965 through 1980: figures for these years are taken from Cataldi, 1997 (**), and Cataldi 1999/a (**), with revisions; (5) Lund, 2000 (Tab. 1) ; (6) Huttrer, 2000 (Tab. 2) ; (7) Cataldi, 1999/a (**) and 1999/b (**), with revisions; (8) Lund-Freeston, 2000 (Tab. 2), with subtraction of bathing and swimming ; (9) Projection to Dec. 2000 (from 7,974 MWe in Huttrer 2000, Tab. 2, based on country reports for the WGC2000, with data up until early 2000); (10) Projection to Dec. 2000 (from 15,133 MWt in Lund 2000, Tab. 2, with bathing and swiming subtracted as per data given by Lund-Freeston, 2000, Tab. 2).

(**) Thermal capacity figures in these papers are referred to inlet temperature > 35 °C; therefore, to account for temperatures < 35 °C considered in this paper, a few per cent increase has been applied to those figures, resulting in the revised values given above for the years from 1965 through 1990.

2. PUBLIC OPINION IN PROJECT AREAS

Most of the residents in areas with geothermal manifestations know that natural heat can be used for a number of practical applications. Many such residents also know that geothermal development may bring about important benefits in the project area, whereas others are concerned with the impact that large projects (especially those for electric generation) may cause on environment and economy of the area. Therefore, different positions form in the public opinion in areas where a geothermal project is about to start, with a number of people supporting, others encouraging in a conditional way, and still others opposing implementation of the project in their territory.

In each area, the different positions depend on several local factors, including socio-economic conditions, cultural background, and individual or group interests. Most frequently, though, when news spread on the possibility to have a geothermal project initiated in a given area, many of its residents eulogize natural heat with terms like clean, cheap, friendly, benign, green, sustainable, and the like, thus creating a favourable climate for the implementation of the project.

However, individual and collective attitude towards geothermal development usually changes with time as the project reaches the drilling stage, and works begin for installation of equipment and plants. Indeed, undesirable effects may result from these activities on: **i)** ecosystem (air, land, flora, fauna, and superficial and underground water); **ii)** human health (from water pollution, noise, and gas emission); and **iii)** economy (detrimental impact on some production actvities and tourism, and damages to crops and private properties). Moreover, **iv)** reaction often grows against landscape modifications and alteration of natural features of cultural or religious interest, caused by civil and industrial works, and by changes in the use of public areas resulting from project activities.

Depending on their nature and on the type of measures adopted to prevent their occurrence, such effects range from reversible and temporary to irreversible and permanent; moreover, their impact increases with the project size, and is notably higher in geothermal-electric projects than in projects for direct use. In general, however, adverse effects are minimal during Reconnaissance and Prefeasibility Studies, moderate during Feasibility Study, and relevant during field development, plant construction and production activities.

For all the above reasons, opposition by residents in the project area often increases as project proceeds, especially in areas with resources suitable for geothermal-electric generation; thus, the number of people also increase who charge geothermal energy with terms such as costly, polluting, and dangerous for people's health. Furthermore, in areas with different energy options, people's opposition to geothermal development can be enhanced by parties interested to foster the use of energy sources other than natural heat.

In short, people's opinion on the impact that geothermal development may have in a given area is a matter with economic and social aspects; it is a delicate issue that any geothermal operator should cope with much care, bearing in mind Principle 22 of the "Earth Charter (Rio Declaration, 1992)":

Indigenous people and other local communities have a vital role in environmental management and development.

3. SOCIAL ACCEPTANCE OF GEOTHERMAL PROJECTS, AND ACTIONS TO WIN IT

In modern society, no development initiative exists without a however slight possibility of impact on ecosystem and people of the area concerned: even less so when initiatives of wide interest are involved. This applies also to geothermal projects, especially those for electrical generation.

Indeed, when an important project is planned for implementation in a populated area, in most countries on earth, a debate begins among politicians, public administrators, economic lobbies, “green” groups, and indigenous communities, on whether or not, and in the affirmative on how, such project should be carried out. In brief, realization of any important project depends in many instances on its acceptance by the people residing in the project area.

Two definitions have been proposed in recent years for social acceptance of geothermal projects:

i) ***"Social acceptability is attained if the project activities do not result in drastic changes from the regular conditions of the area, and if the affected sectors can see some advantages issuing from the project "*** (De Jesus, 1995); and

ii) ***"Social acceptability of a profit - purported project is the condition upon which the technical and economical objectives of the project may be pursued in due time and with the consensus of the local communities; consensus to be gained by acting in consonance with the dynamic conditions of the environment, and in the respect of the people's health, welfare, and culture"*** (Cataldi, 1997).

The reader will recognize some significant differences between these two definitions; however, both of them stress that social consensus depends primarily on avoidance of detrimental impacts on environment and people in the project area.

As a consequence, to win social acceptance of their project, geothermal operators should carry out a number of "external" actions, among which (depending on the location, type, and size of the project) they may consider some or all of the actions mentioned in items 3.1 to 3.4 below.

3.1 Public relations and information campaign

This action may include:

a) During the planning stage of the intended project:

- Contacts with public administrators of the area concerned, not only to provide them with information on the project objectives, but also to start having an idea of the people's attitude towards the new initiative;
- Preparation of public opinion through a plain and timely information campaign;

- Presentation to regional authorities, public administrators, and important entities of the area, of a brochure outlining the project objectives, the environmental measures in program, and the social benefits that the project is expected to produce;

b) *During the implementation stage of the project:*

- Periodical dissemination of information on the activities already completed and in program through meetings with local administrators, and by means of media;
- Promotion of project - related scientific meetings in the work area;
- Guided visits to drilling sites and plants for local students and other interested people;
- Creation in the work area of a "demonstration facility", equipped with posters, models, photos, and leaflets of the project;
- Encouragement to implementation of territorial development plans and new economic or social initiatives that might have positive impacts onto the project objectives; and
- Consideration for traditions, culture, and modes of thinking of indigenous communities.

3.2 Prevention and minimisation of adverse effects on environment and people

Planning project activities according to a block structure for all main phases of work helps implementing a careful Environmental Impact Study (EIS) before the project is started. The EIS can be carried out following the block-structure approach suggested by Cataldi (1993), or according to the scheme called product-activity matrix (OLADE-IDB, 1994). Whatever its structure may be, however, the EIS should analyse all possible sources of impact during each phase of work, aimed at preparing a plan of measures to prevent the occurrence, or minimise the effects, of any undesirable impacts.

In many countries, the EIS is already a pre-requisite to obtain the authorisation for the project to start; however, in the form they have been carried out until now, most EIS have paid more attention to environment and people's health, than to possible detrimental impacts on economy and traditions in the project area. Therefore, in consideration of the fact that also these impacts may cause notable concern among the resident communities, they too should be considered in the EIS of any important geothermal project.

On the other hand, since socio-economic situations, infrastructures, and environmental conditions in the project area may change with time, and considering that the working schedule of the project often undergoes modifications as technical activities proceed, the EIS and the plan of environmental measures should be revised each time a new important work phase is about to begin.

The principal sources of possible impacts, and the measures and technologies that can be adopted to prevent, minimise, or remedy such impacts, are listed in Appendices I and II.

3.3 Indemnification measures

Even in areas with a climate initially favourable to the execution of a given project, when activities reach the drilling stage, or when construction of plants and infrastructures is about to start, a number of private land owners, and in some instances also entrepreneurs with other interests in the project area, always appear to warn the project operator on possible detrimental impacts on their properties or activities. Muttering then grows among people in the area, which gradually undermines the favourable climate mentioned above, and strenghten the position of those who had opposed the project since before its inception. This may cause additional operation difficulties, with consequent time delays and budget inflation for the project.

To reduce these difficulties, the project experts should be prepared to adopt technically-equivalent alternatives for the siting of major works such as drillings, gathering system, re-injection pipes, plants, and infrastructures; in this way, the project administrator will have a number of alternatives at hand during negotiations for rights of way, praedial servitudes, and purchase of portions of land, which are always necessary in any type of project. In all such cases, availability to pay fairly higher amounts for some commodities, and quick payments, result in saving delays to the project works. In particular instances, if disputes arise during negotiations for a given commodity, arbitration to settle issues in amicable way should be preferred to any legal action.

The same applies to indemnification of damages caused by the project works on private or public properties, such as cultivated fields, woods, livestock, rural facilities, buildings, roads, bridges, and infrastructures. In these cases, too, flexible attitude of the project administrator, payment of a bit litlle higher amounts in certain instances, adoption of compensatory measures, and quick conclusion of negotiations, are key factors to establish good relations with the resident communities, and to enjoy the social acceptance of the project.

3.4 Creation of local benefits

Especially (but not only) when large projects for geothermal - electric generation are involved, social acceptance depends on the public perception that the new initiative will bring direct benefits to the residents in the area concerned. To this end, some or all of the following measures can be taken.

- Steady or temporary hiring of native workers;
- Use of local firms for the execution of as many as possible parts of work;
- Training and steady hiring in the project firm of qualified natives (scientists, engineers and technicians);
- When the project is to be implemented in a remote area, the camp for personnel should be equipped with cafeteria and recreation facilities;
- Cession at low price (or at no cost, if possible) of residual steam or hot water for use in public buildings, social centres, and other facilities of public interest;
- Share of costs with, and logistic support to local institutions for the construction of parts of public infrastructures (road segments or junctions, bridges, green areas, and others), modified to allow for the installation of project facilities and plants;
- Sponsorship and/or “una tantum” cash contribution to cultural, sport, and folklore events held in the project area;
- Grants to native scholars and students for research, or publication of works on important aspects of development perspectives, history, traditions, and culture of the project area.
- In alternative to some of the measures above, the allocation of a fraction of the project profits may be negotiated with the local administrators for use in public works in the project area.

4. EXTERNALITIES ISSUING FROM SOCIAL ACCEPTABILITY IN GEOTHERMAL PROJECTS

4.1 General concepts

Externality is not a specific term of geothermal energy, but applies to any development initiative or project requiring notable capital investment, such as public works, large infrastructures, exploitation of natural resources, industrial processes, and similar. The term *externality* defines and includes activities, costs, and benefits <u>different</u> from those strictly related to the primary scope of the project, but that always appear during implementation of its works.

As a consequence, *external costs* should be considered separately in the project budget, namely, in addition to, and not in substitution of, the normal (technical, economic, and administrative) costs of the project. In particular, they include costs issuing from activities purportedly directed to prevent, minimize, or remedy possible adverse impacts caused by the project works on environment and people in the project area.

Externalities can be quantified economically and introduced in the cost-benefit analisys of each project according to the following two conceptual equations:

- ***TOTAL EXPENDITURES = COST OF TECHNICAL ACTIVITIES + EXTERNAL COSTS***
- ***TOTAL BENEFITS = ECONOMIC PROFITS + EXTERNAL BENEFITS.***

By comparing the results of the two equations, the project owner can draw an idea on whether or not his project has chances to gain the social consensus by the resident communities.

4.2 Costs of social acceptability of geothermal projects

Costs to gain social acceptance of geothermal projects (drawn from Cataldi, 2000) are shown in Tables 2 and 3, for direct use and multi-purpose projects (electrical generation + direct uses), respectively. To allow for a certain flexibility, a range of costs with their average are considered for each type of project, broken down into groups of different total construction costs.

Table 2: Costs related to social acceptance of heat use projects

Project size	A) Total Construction Costs (*) (in **US$ x 10^6**)		B) Social Acceptance Costs (in **US$ x 10^3**)		C) Average Share **%**
	A_1) Range	A_2) Average	B_1) Range	B_2) Average	(B_2 / A_2 x 100)
Small	1 - 3	**2**	5 – 35	**20**	**1**
Medium	3 – 7	**5**	35 – 165	**100**	**2**
Large	7- 23	**15**	165 – 335	**250**	**1.7**

(*) Excluding costs for hot water distribution network in space heating projects.

Table 3: Costs related to social acceptance of multi-purpose projects (electric generation + direct use)

Project size	A) Total Construction Costs (**) (in **US$ x 10^6**)		B) Social Acceptance Costs (in **US$ x 10^3**)		C) Average Share **%**
	A_1) Range	A_2) Average	B_1) Range	B_2) Average	(B_2 / A_2 x 100)
Very small	10 – 20	**15**	200 – 400	**300**	**2**
Small	20 – 40	**30**	400 – 1,000	**700**	**2.3**
Medium	40 – 80	**60**	1,000 – 3,000	**2,000**	**3.3**
Large	80 – 200	**140**	3,000 – 7,000	**5,000**	**3.6**
Very large	200 – 400	**300**	7,000 – 9,000	**8,000**	**2.7**

(**) Excluding costs for electric network, and for hot water distribution network in space heating projects.

Values given in Tables 2 and 3 for different project sizes should be taken as indicative figures, not only because each real project is a specific case, but also because some measures that can be adopted to safeguard environment and people's health (as for instance re-injection of spent water, and pipe insulation in gathering systems) correspond in many projects to technical measures, which are needed to optimize field management and plant efficiency.

4.3 External benefits

Columns C) in Tables 2 and 3 evidence that the share of the social acceptability costs to the total construction costs in each project is rather modest in relative terms: up to 2% for heat use projects, and up to almost 4 % for multi-purpose projects, on the average. However, figures in columns B) in the same tables show that the actual costs are all but modest in cash terms, especially for medium- to very large multi-purpose projects.

Nonetheless, they are a necessary burden for the project owner because they enable prevention or minimization of detrimental impacts on environment and people, as well as creation of benefits for local communities, which are indispensable tools to obtain the social acceptance of the project.

This acceptance, in turn, allows for the project to proceed in the fastest way possible, and results eventually in considerable external benefits for the geothermal entrepreneur, consisting mainly of saving of labour, reduction of passive interests on bank loans, and shortening of pay-back time.

5. CONCLUSIONS

Social acceptance is an important requisite for the smooth implementation of geothermal projects, especially those for electrical generation. The three main conditions to win project acceptance by communities residing in the work area are: *i)* minimization of environmental impact; *ii)* avoidance of adverse effects on people's health; and *iii)* creation of direct benefits for local populations.

To meet these conditions, the project owner should be prepared to bear specific burdens in the form of external costs, whose amounts (depending on the site, type, and size of the project) range, on the average, between 1-2% and 2-4 % of the total construction cost, for direct use projects and multi-purpose projects, respectively.

Though modest in relative terms, these are sizeable amounts in cash terms. However, not only they enable attaining the objective of the social consensus, but also produce notable return benefits for the project owner. Therefore, this writer thinks that social acceptance is the mutual convenience of both resident communities and project developers.

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APPENDIX I

MAIN ISSUES OF POSSIBLE CONCERN IN GEOTHERMAL PROJECTS

- Restrictions in the use of areas and properties (*land occupation, crossing of fields, cutting of plants, digging of trenches, modification of paths, construction of roads and plants, etc.*);
- Levelling of working areas (*to construct drilling yards, store equipment and materials, and erect plants*);
- Noise (*due circulation of heavy trucks, drilling-rig motors, well testing, fluid production, and other field works*);
- Disposal of residual material during and upon completion of drilling (*mud, cuttings, oil drainings, and fluids of different nature*);
- Uncontrolled blowouts of wells;
- Craterization of drilling yards;
- Scaling in the drilling area and along pipes (*by leakages of hot water, water-steam mixtures, and condensate*);
- Percolation of polluting solutions into water streams and underground;
- Discharge of spent water into ground, water courses, lakes and lagoons, after their separation from steam;
- Injection of condensed steam and residual water into fresh aquifers;
- Release into the atmosphere of gas (H_2S, CO_2, etc) and plumes of saturated steam containing toxic elements (Hg, As, B, etc.);
- Acid rains in the areas of the power stations;
- Micro-earthquakes due to water injection;
- Ground subsidence due to lowering reservoir pressure as result of fluid production;
- Heat dispersion into the atmosphere, particularly in the vicinity of power stations;
- Visual impact on panorama and landscape (*due to trenches, clearings, platforms, drilling-rigs, barracks, sheds, water and steam pipes, plants, equipment, industrial buildings, power lines, etc.*).

APPENDIX II

MEASURES AND TECHNOLOGIES TO PREVENT AND MINIMISE ADVERSE ENVIRONMENTAL IMPACTS

- Sites for temporary works and permanent plants can be selected as much as possible in correspondence to unused or less fertile areas. The areas used for temporary works can be later restored (or even improved) by planting appropriate vegetal species.
- Drilling areas can be minimized by drilling two to five directional wells from the same yard.
- Major noise sources (steam venting, drilling-rig motors, plant machinery, etc.) can be greatly reduced by an adequate design and/or by acoustic insulation of the noisiest equipment.
- Residual waters are usually re-injected into the original reservoir, which enables not only to dispose of undesirable chemicals, but also to prevent or greatly reduce subsidence.
- Occurrence of micro-earthquakes due to injection of spent water can be prevented or greatly reduced by installing an appropriate seismic monitoring network, which makes it possible to keep the amount and pressure of injected water below a critical threshold to be established case by case according to the characteristics of the area.
- Craterization of drilling yards can be prevented by grouting the area around the well-head.
- Uncontrolled blow-outs of wells are prevented by a suitable design of the technical drilling profile, and by using adequately-sized blow-out preventers.
- Pollution of fresh water in shallow aquifers are avoided by casing and thoroughly cementing the wells in correspondence to water-bearing layers.
- Saline encrustations and residual materials from drilling and well production can be temporarily stored in watertight tanks, until they can be carried to sites with appropriate processing facilities.
- Condensable and non-condensable gases associated with fluid production can be carefully monitored in both nature and amount to establish whether any of them may generate undesirable effects on people and ecosystem if released into the atmosphere. When no economically-sound solution exists, than dispersing gases into the atmosphere, anemometric surveys are performed to determine the best dispersion method (ventilation or exhausting chimney) and its technical parameters.
- Several methods (Stratford process, BIOX process and others) are available for H_2S abatement, and are adopted in certain cases. In other cases, when for economic reasons one of these methods cannot be adopted and there is no other solution than discharging H_2S into the atmosphere, its noxious effects can be minimized by specially designing the generation plants and by locating them as much as possible in well-ventilated sites and/or scarcely populated areas.
- Abatement processes exist also for CO_2. However, in addition to their high cost , the by-products of these processes create a number of other environmental problems; therefore it is preferred to discharge CO_2 directly into the atmosphere through chimneys many tens of metres high.
- Acid rains and heat dispersion in the areas around the power stations can be minimized by installing the plants as much as possible in elevated and well-ventilated sites.
- To minimise their visual impact, water and steam pipes can be painted with the prevailing colour of the local vegetation.
- To accommodate in a harmonious way into the landscape the sky-line of permanent plants and facilities, a suitable architectonic design of the buildings can be made. Green areas with stairs, flower-beds, and fountains can also be created artificially around these buildings.