"able financial terms.
In Other cases a direct agreement can be reached between the well owner and an interested party prior to abandonment(as occurred in Rodigo, Italy and Erding,Germany).
In solutions such as those above the project must be tailored to the resource and not vice-versa.
Compatible regulations,especially concerning well rights and data confidentiality are needed.
French and Italian legislation for example allow public availability of well information.

3.INVESTMENTS

Comparing a geothermal and Conventional heating project on equal basis,the high initial investment of the former may hamper competitivity or outweight the drastic reduction in production costs achievable during the life of the System.
Drilling costs increase more than proportionally with depth and vary considerably according to personnel cost and local rig market situation.
Fully equipped medium depth doublets cost ranges from around 1-1.5 M US 5 in Poland to 2.5-6 in Western Europe.
Geothermal plants generally include Surface equipment such as peak-load boilers,heat exchangers and sometime heat pumps which add to the costs (considerably in the latter case).
For example a possible geothermal heating Station in Denmark,producing G.3 M GJ/y,has been valued (DONG,1993) 12 M US $,of which 7.5 are for the surface facilities,including absorption heat pumps.The remainder is the Cost of a completed 1300 m depth doublet. In Pyrzyce(Poland)a 0.67M GJ/y geothermal plant under construction is costing 7 M US $(of which 2.1 for two 1700 m doublets and the rest for absorption heat pumps,boilers etc)(Meyer,1993).
These investments must be compared with those for conventional centralized heating stations,which are generally quite lower.
Outlays for the downstream(network and substations) part of a district heating System may range from 5 M US 5 for a small project to 15-25 for a larger size one. A6 example the Pyrzyce(a town with 16,000 people)network and related equipment will cost around 9 M US $,while connecting 13,000 housing units in Chevilly-Larue/L'Hay-les-Roses (France)costed around 25 M US $(Jaudin and Lemale, 1993).
The above data evidence the main disadvantage of medium-large centralized heating systems(indipendently from the energy used)compared to individual solutions:heavy investments With long pay-back.
Within this framework,while the largest Outlays are for the downstream part of any district heating system,geothermal upstream Costs have a relevant impact and should be closely monitored and constrained.
Sizable investments(up to some tens of million dollars)are also required for the larger geothermal greenhouse units,both for wells and for surface facilities,and should be carefully optimized.
A cost-reducing Option already mentioned is the use of existing non-geothermal wells.
Another is to concentrate efforts On fresh water resources requiring one well only(as in Aquitaine, France).
Drilling to shallow-medium depth targets will also reduce costs. While such approach limits expected temperature Of the geothermal water(and thus its heat content),productivity and chemical composition of the resource tend to improve substantially(flow rate can easily double and non-saline water could be available,eliminating in many cases the need for a reinjection well).
The interplay between the different factors can, from the economic point of view,compensate each other as Shown in Figure 1.
Optimization of equipment and Of drilling techniques as well as Standardization of materials and procedures can lower Costs significantly.
Substantial,often decisive,savings can be attained by careful planning and Shortening the time-span of project implementation,from the feasibility and preliminary agreements phase to drilling the first well and thence to delivery of heat to the end users. Handling Of all phases of the project by a single qualified Operator may be critical to this purpose.
Whenever possible maximization of utilisation period and/or of useful temperature drop improve substantially economics. The first target can be achieved by complementary uses like adding summer cooling to winter heating,like in Esso Begles offices,France(Haulbert et al.,1988);or coupling greenhouse heating with crop drying,as in Rodigo,Italy(Sordelli et al.,1991). The other approach implies cascaded uses(for example greenhouse heating and fish farming,again as in Rodigo). Sale for drinking of the cooled non-saline water after utilization Of available heat as planned in Erding,Germany(Bauernfeind et al., 1992)will upgrade the value of the geothermal Investment.

4.PRICES AND TAXATION

It is a well known fact that the continuing depressed energy prices have slowed the development of renewables,including geothermal.
However,while crude oil and natural gas prices at the border of the various EC countries are comparable,a diverse and often contrasting picture emerges when one looks at the final(after taxes)national product prices and considers the levies imposed. For instance light fuel oil is most heavily taxed in Italy and thus end-usem there pay a much higher price than in the rest of EC. Gas for industrial(including greenhouse heating)use in the Netherlands is much cheaper than in the rest of Europe. High taxes on oil, coal and electricity as compared to those on gas and renewables favor these last energies in Denmark. Italy has established a very rewarding price for power producers from renewables(including geothermal)and cogeneration,financed through a levy on electricity tariffs. Some similar incentive could be adopted for heat production from renewables(Austria applies a specific levy an electricity prices in favor of district heating of any type,including geothermal).
Low electricity prices in several Nordic countries have favoured heat pump applications,a sector where there is an interest for the geothermal industry.
From the above examples it appears that from the economic point of view geothermal energy stands on more favourable grounds in some country ra-

ther than in other.
Environmental taxes,imposed or under consideration by an increasing number of States,will benefit the less polluting energies,including low-medium temperature geothermal.
For a significant progress at the European level of this and other renewable resources,removal or drastic reduction of inconsistencies in final price and in taxation of energy is needed.

5.REGULATORY ASPECTS

A characteristic Of geothermal activity is the well known fact that upstream operations are quite similar to other mining activities like oil & gas exploration and production. Moreover,as already mentioned,there is a close relationship between the two activities because of the wealth of technical and geological data from oil & gas wells of interest for geothermal prospecting.
The legal aspects concerning geothermal exploration and production are different in the various European countries. The resource may be in the ownership of the State or of a private entity. It may be regulated by complex specific laws,as in Italy,or by a more manageable set Of rules(France).
Often no special legislation exists and provisions for groundwater apply.
It is important that the legal steps required to prospect and exploit geothermal resources be simple and necessary authorizations be granted without undue delays.
Confidentiality of oil & gas well data should be relaxed once the boreholes are abandoned,particularly as regards hydrological information(as in France and Italy).
Rules should be established on testing oil & gas wells prior to their abandonment.
Inventories,both Of resources and potential users, Should be provided for.Action of this type has already been taken by several countries and,at a more general level,by the EC. Inventories could include ad hoc research wells drilled by State agencies.
Concerning the downstream sector,fair and appropriate regulatory measures on geothermal heat use within the framework Of comparable renewables and/or district heating alternatives are needed.
Guidelines for a common legal framework,in Conformity with which member States may mantain or enact specific rules most suitable to them,could be issued by the EC.

6.MARKETING CONSIDERATIONS

Technologies related to direct uses of geothermal energy are in general well demonstrated. Several commercial plants with different operating schemes have been completed and are running in the medium to very low temperature range.
As regards the market,this fact represents an advantage over other renewables,some of which are still in the R & D stage.
One of the main assets medium to low temperature geothermal energy is its reduced impact on the environment when compared to oil and coal products.
A geothermal heating plant can achieve a reduction of 1.5 to 5 tans of CO_2 per each TOE subsituted, depending on the fuel(oil or coal)replaced. Most of the sulphur and nitric oxides as well as particulate emissions would be avoided.
When considering the future of geothermal non-electric business,it should be noted that the Size of an average heating plant Of this type corresponds to substitution of 700 to 5000 TOE/y. This plant dimension is well suited far a small-medium district heating project or for a large greenhouse complex of several hectares.
Geothermal heating operators can thus aim at a market niche of projects limited in size but rather numerous(given the different possible applications)and environmentally qualified.
Market Penetration problems however exist in the district heating sector which in many countries does not grow as planned because of the reluctance of end-users to abandon individual heating Systems.
Where the gas industry is pushing to develop a city-wide service network,it is a very tough competitor for m y alternative district heating system,be it Conventional or geothermal. For this reason several countries(Nordic,Austria) regulate the respective roles of gas and district heating in town heating.
The above considerations apply also to the agri-business sector,where especially low-priced fuel oil(Italy)or gas(Netherlands,with a greenhouse consuption of 4.5 billion cu.m/y)make alternative energy competition difficult.
A problem is also the rather large size of geothermal greenhouses which is still uncommon in the agricultural world.
Notwithstanding it6 potential,geothermal development is not progressing satisfactorily. Present day status is aptly described in the following statement by EC(DG XVII)in its 1988 evaluation report on energy demonstration programs:
"There is some evidence of replication but this is hindered by the fact that most of the contractors are municipalities who have no incentive to commercialise.Neither is there a well established geothermal industry because each project relies on bringing together the skills from Other industry sectors(drilling,engineering)whose main business is elsewhere.Development of such an industry is vital if the geothermal potential in the Community is to be fully exploited" EC,1988).
The same conclusions were reached in the 1993 evaluation report (EC,1993).
It is necessary that concerns other than local entities and individuals,not Structured or financially capable or qualified to grow beyond the Single project level,take the lead in developing a geothermal business. To be vital it should span the whole European market,given that activity in just one country would in many instances be too limited. One can think for example of heat or water distribution companies already operating on a national or better international scale Who could offer the geothermal resource as a non-polluting alternative "fuel" for heating systems,whenever conditions are right. Alternatively a special company could be established.

7.INFORMATION AND TRAINING

For a Sizable market to develop for geothermal energy,information and promotion actions are

needed.
Dissemination of data and studies related to geothermal resources and their application potential must occur at the national and European level.
Transfer of know-how(including presentation of case histories on successful and failed projects) between countries should be promoted.
EC has recommended that a reference centre be established in the Community where interested parties could receive advice and assistance(EC,1993). A structure of this type has been created by ENEL (the Italian national utility)in Castelnuovo V.C.
Information,with Specific inputs tailored to meet different requirements,should be addressed to a wide audience. Political and administrative authorities involved in energy matters(especially at the local level)should be told of the interest of geothermal energy(impact on resource management, contribution to environment protection,etc.). Industries producing goods Which are needed in geothermal activities(well equipment,pipes,heat exchangers,heat pumps,etc.)should be aware of the potential market. Similar information should reach drilling and field maintenance firms,heat distribution and/or management companies,etc.
A very critical segment of the audience are end-users who must be adequately motivated.
Professional associations should work up and implement a program to promote at various levels geothermal energy. Many such organizations have been formed in recent years(in Germany,Poland, Slovakia,Switzerland and lastly in Italy). The International Geothermal Association(I.G.A.)has set up a European branch Which is quite active.
Finally,availability of qualified technicians is of great importance to a viable geothermal industry. Professional training programs,based on a reliable estimate of the human resources needed, will help provide expert personnel both for the geothermal field operations and the running and management of heating plants.

8.CONCLUSIONS

Greater use of geothermal resources and other renewables will contribute to improvement of the environment,diversity of energy supply and hard currency saving.
Medium to low temperature geothermal resources in Europe are readily available and geographically disseminated.
Even in times of low energy prices,geothermal heat costs are comparable and at times competitive with conventional fuels,the more so if external costs of energy are taken into account.
Widespread utilization of the resource is constrained by the risk factor and by legal and financial obstacles which need to be addressed to. Some possible actions to this purpose are discussed in the paper.
To conclude with the Words of the Madrid Declaration,outcome of the March 1994 Conference on Renewables,co-sponsored by the EC:
"Renewable Energy Sources are a vital energy resource capable of making a significant contribution to the security and sustainability of Current and future energy needs,whilst at the same time ensuring resources and environmental protection for future generations. They Should be developed by Europe in a coordinated way for the benefit of all its citizens.
Renewable Energy Sources face political,legislative,financial,technological,information, education and training barriers,and they face discrimination. These barriers should be tackled through urgent and coherent action.".

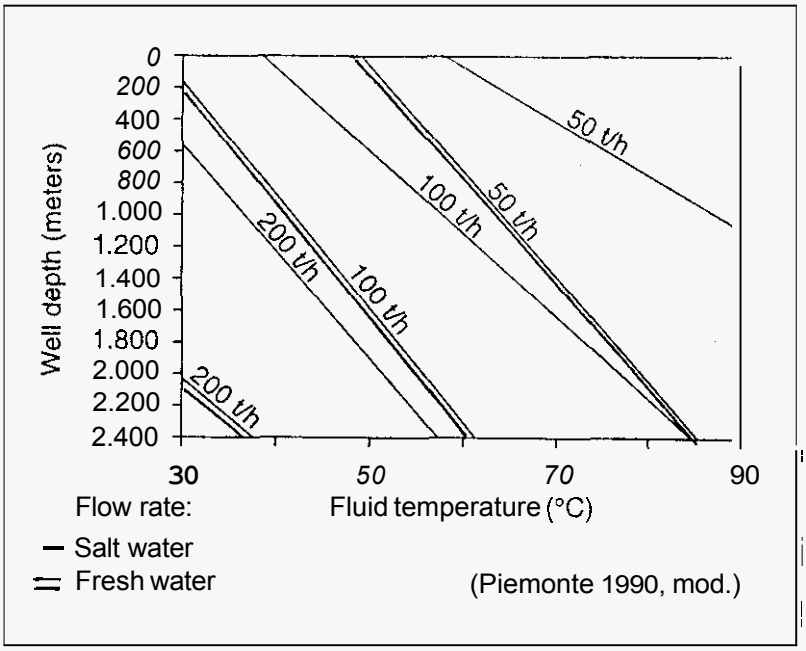

FIG. 1 - Economic limits for fresh and saline water geothermal systems (using gas-fueled heat pumps).

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