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COMMUNICATION FROM THE COMMISSION TO THE COUNCIL  
CONCERNING THE REVIEW  
OF THE ENERGY RESEARCH AND DEVELOPMENT PROGRAMME  
ADOPTED IN THE COUNCIL DECISION OF  
11 SEPTEMBER 1979

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REVIEW OF THE SECOND  
ENERGY RESEARCH AND DEVELOPMENT PROGRAMME  
COVERING THE PERIOD 1979-83

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## INTRODUCTION

1. The energy research and development programme (1) (2) has provided support since 1975 for research carried out under contract concerning energy conservation, renewable energy sources (solar energy and geothermal energy) and the production and utilization of hydrogen. It also contains a subprogramme on energy systems analysis and strategy studies. As a result of this programme, and in conjunction with the programme of the Joint Research Centre (3) and the regulations on the granting of financial support for demonstration projects (4), the Community is contributing to the introduction and development of new energy technologies which are needed in order to pursue the Community's energy objectives.
  
2. In its Decision of 11 September 1979 the Council adopted the second energy research and development programme covering the period 1979-83 (105 million ECU) which follows on from the first programme covering the period 1975-1979 (59 million ECU).

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- (1) Council Decision 75/510/EEC of 22 August 1975 : OJ No 231 of 2 September 1975.
  - (2) Council Decision 79/785/EEC of 11 September 1979 : OJ No L 231 of 13 September 1979.
  - (3) Council Decision 77/488/EEC, Euratom of 18 July 1977 : LJ No L 200 of 8 August 1977  
and Council Decision 80/317/EEC, Euratom of 30 March 1980 : OJ No L 72 of 13 August 1980.
  - (4) Council Regulations (EEC) Nos 1302/78 and 1303/78 of 12 June 1978 : OJ No L 158 of 16 June 1978.

The table below gives the breakdown of the appropriations allocated to the five subprogrammes.

TABLE 1

Subprogramme	BUDGET (IN MILLION ECU) *	
	1975-1979	1979-1983
Energy conservation	11,4	27
Production and utilization of hydrogen	13,2	8
Solar energy	17,5	46
Geothermal energy	13,0	18
Energy systems analysis and strategy studies	3,9	6

Under Article 4 of this Decision the programme is to be reviewed in 1981 and possibly revised in the light of the final evaluation of the first programme. A report on this review and on the possible revision is to be drawn up for the European Parliament and the Council.

3. This review comes at a time when the Commission, in response to the mandate of 30 May 1980, is carrying out a general examination of possible ways of redirecting Community activities and is proposing to reinforce or adjust the policies in question in order to strengthen the internal cohesion of the Community and secure its position on the international scene.

The Commission has already made a number of proposals to this end.

4. In its energy strategy for the Community (1), the Commission presents a framework for action intended to allow the Community to respond more effectively to the challenge which the Community's energy dependence presents now and for the future.

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(\*) The following documents should be consulted for the Member States' research and development expenditure :

- 1) "Energy R, D and D programmes and expenditures of the Member States and the European Communities - Inventory of 1976-1978 prepared by CREST's Energy Subcommittee (XII/1000/79).
- 2) "Comparison of national and Community R+D policies - COPOL 81 (XII/1137/81 - COPOL/8/81).

(1) COM (81)540 final of 1 October 1981.

5. One of the main objectives of this strategy is to reduce dependence on oil as quickly as possible in order to enable the Community's economy to recover from the disruption caused by the energy crisis and to restore prospects of healthy, and therefore lasting, growth and an improvement in the employment situation.

To this end, there is a need for measures both on the demand side in the form of energy conservation and the rational use of energy and on the supply side by diversifying the sources of supply, in particular by making use of renewable energy sources.

6. Once the energy transition is under way it will offer prospects for the application of new technologies and therefore encourage the development of a modern and dynamic industry in Europe which is capable of competing internationally.(1)

7. In order to attain this objective the Commission has selected a number of priorities for Community action one of which concerns the strengthening of the common policies in the fields of research and development and demonstration.

8. The Commission has also proposed a second stage in its common strategy for research and development, (2) the main objective of which is to help to secure new prospects of growth and an improvement in the employment situation within the Communities by making the most of scientific research and technological development. This entails deriving maximum benefit from Community achievements by incorporating them in an overall strategy and taking advantage of the benefits provided by the scale of the Community.

9. In order to attain these objectives the first thing to do is to establish an overall approach instead of the pragmatic approach of undertaking successive research programmes in separate sectors.

This overall approach should make it possible to decide upon priorities as regards the direction and definition of activities and to make effective use of all the resources as the Community's disposal (finan-

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(1) COM(81)639/2 final of 29 October 1981.

(2) COM(81)574 final of 12 October 1981.

cial, fiscal, regulatory, support for innovation).

10. In order to implement this strategy it is planned to establish an overall framework programme which will reflect the main lines of approach and which will embrace the activities (whether under way or new) regarded as having priority.

The proposed approach is intended to make it possible to assess more efficiently the importance of the activities proposed, to coordinate them in order to ensure that they are consistent with each other, and to tighten any links that there may be with other Community activities (in the fields of energy, economic affairs, agriculture, industry, development and regional policy etc.). This process of adjustment will take into account the complementary nature of the activities of the JRC and the examination under way concerning future lines of approach.

11. The Council's initial reaction to the lines of approach presented by the Commission (1) was favourable, and the Commission now intends to prepare specific proposals to consolidate and reinforce some of the programmes already under way and carry out a more detailed examination in order to select lines of action for research and development in the longer term.

12. It has emerged from the review that although the programme was begun back in 1975 it would seem to be in line with the objectives of the energy strategy for the Community and the priorities set in the common research and development strategy.

That is why the Commission is proposing that, instead of revising a programme which is now almost two thirds completed, work should be begun as soon as possible on the definition and preparation of a new energy research and development programme to be included in the general framework of the strategies adopted, by including it in the Community's framework programme for research and development.

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(1) Council meetings of 27 October 1981 (Energy Ministers) and 9 November 1981 (Research Ministers).

13. This paper is the Commission's response to the request set out in Article 4 of the Council Decision that the programme should be reviewed, and it constitutes the report to the European Parliament and the Council provided for in that Article.

THE ENERGY RESEARCH AND DEVELOPMENT PROGRAMME'S OBJECTIVES AND ROLE

14. When the programme was conceived in 1974 the Commission's main concern was to stimulate and coordinate Community research in a number of new areas; since then, these factors have contributed to the Community's efforts to reduce its overall energy consumption and its excessive dependence on imported oil.
15. The research areas which the programme covers are such as to contribute to the attainment of the energy objectives.

Of all the "new energy sources" energy conservation technologies are the ones which offer the greatest potential for attaining these objectives rapidly. The economic efficiency of a significant number of new or improved technologies developed as a result of the programme is now assured, as regards both industrial processes and domestic applications.

16. Although, to some extent, the renewable energy sources (geothermal energy and solar energy) involve technologies with very long lead times, they are undoubtedly potentially capable of making a medium-term contribution (about 5% by the turn of the century or thereabouts) and constitute a significant option for the 21st century. Certain technologies such as geothermal electricity and domestic heating, wind energy, solar heating and the utilization of biomass are already able to save considerable quantities of oil.

17. Hydrogen is an energy vector which is potentially suited for both transport and storage of energy. Although using it in this way is envisaged only as a comparatively long-term prospect, certain uses could assume importance in the shorter term. Hydrogen is already needed in many chemical processes, and it will have a role to play in the short and medium term in the production of synthetic fuels in particular.
  
18. Effective medium and long-term planning instruments are needed in order to establish energy research and development priorities and allocate energy resources. Such instruments are also of help in the preparation of energy policy decisions because they make forecasting possible. That is why it is useful, both for the Community as a whole and for the individual Member States, to develop methodologies and deploy multinational instruments in order to develop energy systems models for forecasting purposes and for the corresponding strategy studies.
  
19. As the programme has progressed it has also become apparent that, in addition to attaining its original aims, Community energy research can help resolve, to some extent at least, the economic and social problems now facing the Community : innovation, ability of industry to compete, employment, agriculture problems, aid to developing countries.



20. There is consultation on activities under the programme both within the Commission departments and with those outside.

For example, there is close coordination and collaboration between the energy R and D programme and the corresponding activities at the Joint Research Centre. In addition to the constant exchange of views during these activities, the review of the programme made it possible to hold a number of meetings with the competent JRC officials to discuss greater integration.

Collaboration has proved particularly beneficial not only in the programmes of indirect action for which there is a corresponding direct action, i.e. solar energy and hydrogen production, but also in the analysis of energy systems. The JRC is making a practical contribution to some categories of projects in the indirect action programme : solar heating and cooling, thermomechanical solar-power plants and the thermochemical production of hydrogen.

One practical example is the joint scheme to test solar collectors financed by indirect action (nineteen participants).

As regards the thermochemical production of hydrogen, almost all the contracts for indirect action are closely linked with the work conducted at Ispra.

21. In those fields where the Commission also grants financial aid to demonstration projects (energy conservation, solar energy, geothermal energy), account has been taken of the progress already achieved and the results already yielded by these projects.

Representatives of the departments involved in the management of R and D activities (DG XII) and the management of demonstration projects (DG XVIII) consult on all subjects of mutual interest and attend meetings of the advisory committees and the corresponding working parties.

Moreover, a considerable number of successful research activities have given rise to Community demonstration projects; this helps towards the essential industrial spin-off.

The status of the demonstration projects was described in the first periodic reports on implementation of Regulations No 1302/78 (alternative sources of energy) and No 1303/78 (energy saving), which have been forwarded to Parliament and the Council.

22. Finally, the activities and projects conducted under the programme have also led the Commission to collaborate outside the Community framework, either within the International Energy Agency (IEA) in which the Commission is participating in a number of implementing agreements or to back up the Communities' cooperation agreements with non-member countries such as Spain, Portugal, Mexico, Israel or India. Solar energy and, in some cases, geothermal energy are of the greatest interest in the Community's collaboration with the developing countries.
  
23. Where the relationship between Community research activities and research activities within the individual Member States is concerned, it should be emphasized that the energy research and development programme has helped to stimulate in certain fields the development of the corresponding national programmes and individual ventures within industrial firms and research teams.

24. The coordination of energy research and development efforts (in conjunction with the process of liaison between the implementation of the programme and the corresponding research and development work carried out in the Member States to which the ACPMs (1) contribute under their terms of reference) is one of the ways in which the Commission proposes to attain the objectives of the programme and of the research and development strategy. Duplication of effort is avoided, technical obstacles are overcome as a result of cooperation between researchers and transnational associations are set up (2).

The integration of Community-level and national-level activities has given rise to significant achievements, for example :

- the joint construction and operation in all the Member States of experimental facilities for the simulation of solar heating systems,
- the experiment on setting up vast heat exchange areas in a heat exchanger of the hot dry rock type,
- the industrial application of a family of advanced electrolysers developed in the programme,
- the study of the fundamental characteristics of low-cost housing with a view to reducing energy consumption for heating purposes, and to this end a study concerning the preparation of guidelines for architects.

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(1) ACPM : Advisory Committee on Programme Management

(2) This process of coordination established at the Commission's instigation can be illustrated by means of a number of examples : the European consortium bringing together four firms or bodies from three countries to build the EURELIOS solar power plant, the collaboration between 12 laboratories from four different countries for the development of advanced batteries, the assistance of 19 institutes in the Member States for the standardization and comparison of performance tests for solar collectors etc. Its influence is also apparent in the many references to the results obtained as a result of the pooling of efforts.

25. To encourage practical exploitation of the scientific and technical know-how obtained, the Commission makes every effort to ensure that research findings are disseminated and accessible as soon as they become available. It uses the methods best suited to see that they reach the right audience, whether it be individual researchers and scientific communities, or policy and decision-making bodies. It is constantly striving to improve its methods along the lines described in its communication to the Council on the exploitation and evaluation of research results (1).

Information, a subject of constant concern to the Commission, is disseminated in many ways : publication of final research reports, meetings of all the contractors working on a given subject or topic, organization of international conferences, seminars and symposia and publication of their proceedings, production of articles for scientific and technical journals, publication of regular status reports and works on specific subjects and even the organization of competitions and exhibitions and production of films illustrating results obtained under the programme.

A list of the main events organized by the Commission and of the most important publications is given in Annex III.

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(1) COM(80)889 final of 31 December 1980

26. As far as technological innovation is concerned, the programme is continually giving rise to the filing of patent applications or the development of non-patented inventions. In the course of the first programme, there were 107 inventions of this kind, some of which led to industrial applications such as a polytropic heat pump, a low-temperature water-air convector (Ecovecteur) and a geothermal probe for elevated temperatures and pressures.

To make the most of these inventions, the Commission maintains regular contacts with the contractors concerned to check whether their inventions are exploitable and, if so, whether they are later being exploited. If necessary, it provides support by, for example, seeking potential licence-holders.

#### EVALUATION OF THE FIRST PROGRAMME

27. The first energy R+D programme is now completed (1). Of course, it is not always possible to draw a clear demarcation line between the first programme and its successor, since projects such as the Eurelios solar power plant and the European energy models inevitably extend beyond a single programme. Nevertheless most of the projects have been completed or have begun to show results.

Full details of the results are given in the final reports published at the end of each project, in the summaries of the proceedings of the various seminars held to give progress reports, in the papers given at the conferences and symposia arranged and in the publication entitled "Achievements of the European Community First Energy R+D Programme". (2)

Some of the main results are reviewed in Annex I.

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(1) The breakdown of the expenditure between the five subprogrammes is shown in table 2.

(2) Doc. EUR 7320.

28. Generally speaking, the projects completed fall into the following categories :

- . Appraisal and assessment of the potential of the Community's renewable energy sources, e.g. the geothermal atlas, the solar radiation atlas, studies on existing biomass resources and on their potential, and analyses of the potential for energy saving in certain industrial processes.
- . Improvement of energy technology, e.g. methods of storing heat, electrolytic production of hydrogen, solar cell production, instrumentation and measurement methods for geothermal boreholes, car engine design and advanced batteries.
- . Development of prototypes and of pilot plants, e.g. gasification plants for biomass, advanced electrolyzers and pilot plants for photovoltaic conversion and for recycling plastics.
- . Development and construction of large-scale units or of experimental plants, e.g. the 1 MWe solar power plant and experimental solar heating systems.
- . Coordinated development and application of measurement methods, e.g. methods of measuring the performance of heat pumps and of solar collectors.
- . Assistance for the Commission staff and national administrators responsible for preparing energy programmes and for taking decisions on energy policy, e.g. the construction of energy models and case studies.

29. It is fair to say that the first programme - although purely exploratory in many sectors - was satisfactory and, by and large, achieved its objectives, as the evaluations made by ERET have confirmed. (1)

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(1) Energy Research and Evaluation Team (see section 31).

STATUS REPORT ON THE SECOND PROGRAMME - PRIORITIES - LINES OF APPROACH

30. At this stage of progress in the programme, it is too early to obtain definitive results. Nevertheless, the review has highlighted what has been achieved and what work is outstanding enough to lead us to believe that the final results will be beneficial.

Review procedure

31. Commission staff and the ACPMs continuously monitored the work done in the course of the first and second programmes. Whenever necessary, the content and objectives of the programme were adjusted within the limits laid down by the Decision adopting the programme.

To fulfill the specific obligations laid down in Article 4, the Commission conducted a detailed review of the programme during the first half of 1981 and consulted the Committees and Groups of Experts listed below.

- Advisory Committees on Programme Management (ACPMs)

Using working papers as a basis, each of the five ACPMs discussed the programme review at one or more meetings. In some cases ACPM subcommittees were set up to prepare the working papers. All the ACPMs issued written opinions.

- CREST's Energy Subcommittee

This Committee regularly contributed towards the steering and the general completion of the programme. It gave opinions on several occasions, particularly when the first draft of this report was tabled at the CREST meeting of 25 April 1981.

- Energy Research Evaluation Team (ERET)

This independent team of outside experts commissioned to evaluate the first energy R+D programme submitted its verdict in two reports. (1) The Commission has taken account of most of the conclusions of this team in drafting the present review report and in the day-to-day management of the programme.

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(1) Doc. EUR 6902 - EUR 7350

However, it has not fully followed the advice given by the team in two of its conclusions : as regards abandoning the current form of the hydrogen subprogramme, because this opinion did not take the long-term development of the energy scenario into account, and as regards abandoning work on energy saving in urban transport, because various bodies have deplored the inadequacy of research on this subject.

### Developments, priorities and lines of approach

32. The major developments under the programme are reviewed in Annex II. The priorities and lines of approach emerging from the work are briefly outlined below for each of the five subprogrammes.

#### 33. Energy conservation

The contracts which have been negotiated show that in the second programme there is greater emphasis on research promising some hope of practical application in the short or medium term.

A number of promising results obtained from the first programme and then developed and exploited in the second (recovery of residual heat, industrial processes, sophisticated batteries), will have a direct effect on energy saving and on the diversification of energy resources.

The economic importance of the work done in this subprogramme, and the role of energy conservation in the energy and R+D strategies require that the research effort should be intensified in the future.



34. Production and utilization of hydrogen

The research has confirmed the interesting prospects held out by the use of hydrogen of outside origin for production of synthetic fuels. These fuels are extremely important in the effort to reduce the Commission's dependence on oil imports, research into this subject should be expanded considerably. Although some existing processes for producing synthetic fuels are being operated on a pilot scale (or even full scale), certain scientific and technical problems remain and the pay-back period is relatively long. It is feared that, without some stimulus from the Community, industry will not have sufficient incentive to devote the necessary effort to the development of "second-generation" processes, which are more efficient and ensure that indigenous natural resources (biomass and coal) or imported feedstock (coal) will be better used. Such research lends itself to a coordinated Community approach, since the benefit would accrue in the long term.

Synthetic fuels are such an important subject that a special subprogramme could be devoted to them in the next R+D programme.

35. Solar energy

Although the programme as a whole fulfills the objectives laid down for its implementation, it is now clear that there is something missing, namely that no reference is made to the needs of the developing countries.

Through the Lomé Convention and other international agreements, the European Community has very close links with the Third World. The solar energy potential of many of these countries is far greater than the Community's - not only because they have greater insolation but because their infrastructure lends itself easily to the rapid introduction of solar energy.

The Commission and the Member States have already tried to establish solar installations in Africa and elsewhere, especially for water-pumping stations.

Many of the Member States' projects have failed because they were not sufficiently well organized locally (institutional and social problems, adaptation and project management difficulties). The next programme, therefore, should contain topics relating to research into the adaptation of solar technologies to the specific requirements of the developing countries and the encouragement and support for industrial research in the Community with a view to developing these technologies.

36. Geothermal energy

The follow-up research now being carried out, or in view, should definitely increase the Community's geothermal reserves by developing new resources and by improving exploitation techniques. It should help to provide technology and know-how suited to the Community's own specific needs.

In the next programme work is to be done on the more systematic use of these technologies and know-how so that they can be applied in developing countries.

37. Energy systems analysis and strategy studies

Nowadays, energy covers a broad spectrum of the economy and analyzing the interaction between energy and the economy is now a specialized branch of planning.

Thus it is essential to intensify the work of achieving representation of the economy in the models which have been developed under the energy R+D programme.

In the longer term, priority should be given to two topics :

- (i) study of the effect of energy prices on economic equilibrium, the level of demand and the organization of energy supply;
- (ii) recognition of energy as a factor of production at sectoral level and its effect on industrial competitiveness in the Community and in the world.

These considerations must be taken into account when the next programme is prepared.

## MANAGEMENT

### 38. Budget

Table 2 gives an overall guide to the appropriations allocated under the first programme. It shows that the Community contributed 50 661 000 ECU to 683 projects, i.e. 51% of total research expenditure.

Table 3 shows the proposals received in reply to the call for tenders under the second programme, the proposals selected, the contracts concluded and the relevant financial situation at the time of writing.

One fact established by this review is that the funds allocated will not permit the second programme to be conducted without cuts.

Because of the large number of projects received in reply to the calls for tenders, some research projects which are recognized to be of interest and value cannot be given Community financial support through the conclusion of contracts; this applies particularly to the energy conservation and solar energy sectors.

Furthermore, the Commission has received from Greece several important high-quality proposals for pilot solar projects and geothermal exploration; the financial implications of these proposals could not be quantified when the budget for the second programme was adopted. Nevertheless, the Commission is endeavouring to achieve a proper balance between the proposals submitted in line with the funds available and in the best interests of the programme.

39. Day-to-day management

The most difficult and most time-consuming management task is to launch well-balanced projects and complete them within a reasonable period. This task requires consultation of a large number of technical and scientific experts from the entire Community (and sometimes from non-Community countries), the organization of procedures for soliciting proposals, involving resolution of the tricky problem of languages, and the final selection of projects.

Once the contracts are signed and work has begun, research can be monitored and coordinated most effectively by visits to the research scientists and above all by organizing meetings with the contractors during which the state of progress may be discussed on the basis of the documents they submit. These meetings are generally considered to be beneficial and stimulating as regards both the coordination of research and the dissemination of results. (See section 25)

## CONCLUSIONS

40. The implementation of the two energy R and D programmes - an evaluation of the achievements of the first and a review of the second constitute this communication - has yielded results and experience which the Commission will now have to use to the best effect. The review has also made it possible to identify priorities which will help the Commission, in collaboration with the Member States, to lay down the lines of approach for continuing these activities, while ensuring that they comply with the Community's energy and R and D strategies.
41. Because of the important developments currently under way for implementing these two strategies, the Commission does not believe that any attempt should be made in the course of this review to change the current programme in such a way that the text of the Council Decision would need to be amended. (1)  
Instead, it suggests that a new programme should be drawn up and developed from 1982.
42. To conclude, the Commission proposes :
- that the second programme be continued in its current form, both as regards the areas and sectors covered and as regards the overall budget, but that account should be taken, within the subprogrammes, of the lines of approach which are now emerging,
  - that proposals be made in the next few months to include in the framework programme of the common R and D strategy a third programme based on the priorities arising from the review and the abovementioned strategies, taking due account of the other activities in progress.
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- (1) It is also to be feared that the adoption procedure for intensifying the programme would not be completed in time in view of the date on which the programme finishes (30 June 1983).

**TABLE 2**  
**FIRST ENERGY R AND D PROGRAMME**  
**CONTRACTS**  
**GENERAL SITUATION**  
**1975-1979**

SUBPROGRAMME	NUMBER OF CONTRACTS	TOTAL COST ('000 ECU)	CEC CONTRIBUTION ('000 ECU)
Energy conservation	117	19.842	9.946
Production and utilization of hydrogen	83	14.757	8.033
Solar energy	289	35.163	17.379
Geothermal energy	140	24.323	11.605
Systems analysis	54	3.983	3.698
<b>T O T A L</b>	<b>683</b>	<b>98.068</b>	<b>50.661 (*)</b>

\* This sum covers only expenditure on research contracts, administrative expenditure (staff, missions, meetings of experts, organization of conferences, etc.) is excluded.

TABLE 3  
 SECOND ENERGY R AND D PROGRAMME  
 PROPOSALS AND CONTRACTS  
 GENERAL SITUATION  
 December 1981

SUB-PROGRAMME	P R O P O S A L S			C O N T R A C T S			
	Received	Selected	Total cost	Proposed CEC contribution	Concluded	Total cost	CEC contribution
Energy conservation	636	164	51.860	25.390	147	46.569	21.804
Hydrogen	89	44	18.239	9.465 (1)	41	15.854	8.087 (1)
Solar energy	555	181	124.737	35.343	290 (2)	52.551	23.543 (3)
Geothermal energy	165	78	81.245	15.260	76	38.818	12.623
Systems analysis		NO CALL	FOR TENDERS		53	2.935	2.463
T O T A L	1.445	467	276.081	85.458	607	156.727	68.520 (4)

- (1) Including appropriations outstanding from the end of the first programme
- (2) Including contracts concluded in continuation of the first programme and contracts for projects B, F, G and H for which there was no call for tenders
- (3) Contracts involving a Community contribution of 11 Mio ECU are under negotiation
- (4) This total does not include the Commission's staff and operating expenditure

ANNEX I

MAIN RESULTS

OF THE

FIRST PROGRAMME



MAIN RESULTS OF THE FIRST PROGRAMME

Energy conservation

1. Windows account for 10% of the wall surface of the average house. Approximately 35% of all the heat lost through the outer shell as a whole escapes through the windows. The research into improving window insulation, notably by applying coatings that reflect rays within the infra-red spectrum but allow visible rays to pass, led to the development of a specially treated plastic film, which costs only 1.5 ECU per square metre, is 60% transparent and has the same insulating effect as double glazing (i.e.  $3W/m^2K$ ).

It saves an estimated 100 kWh per  $m^2$  per year and pays for itself within about three months.

All the projects on insulation confirmed the advantages of reflective coatings. Calculations have shown that general application of reflective coatings could produce an energy saving of around 25%, as compared with conventional glass windows.

2. Twenty or so projects investigated - and demonstrated - how heat pumps can reduce the energy consumption of domestic heating systems. The research focussed on the usable sources of heat and on the development of heat pumps fitted with compressors, electric- or motor-driven heat pumps and absorption heat pumps. A study on the application of heat pumps in private houses and apartments (between 60 and 80 flats in all) showed that energy savings of up to 50% were possible as compared with conventional heating systems. Similar savings - between 50% and 56% - can be made by fitting district heating networks with 5 to 20 MW heat pumps which take their water from rivers, the sea, industrial processes and other sources.

One of the projects in this field has been taken as the starting point for a new Community demonstration project which is now being actively prepared.

3. Various methods of reducing the energy consumption of motor vehicle engines were developed and vehicle-tested. Thermal optimization of an existing engine, to give the 4-cylinder, 2-litre, 97kW TOP engine, reduced the energy consumption by around 30% as compared with the original version. Although the new engine retained all the features of a spark-ignition engine, its consumption during the standard ECE cycle matched that of a diesel engine with the same cylinder capacity. It has been tested in cars on a demonstration basis.
  
4. One project entailed developing a plant for treating the plastic fraction of the household refuse from a town of 120 000 (i.e. some 2400 tonnes of plastic per year). The studies proved that the recycling procedure developed by the project was economically viable and that each tonne of plastic recovered represented a saving of almost 5.25 t.o.e. The plant will be built in Liège as a Community demonstration project. In theory, the payback period should be three or four years.
  
5. Another development was a fluidized bed heat exchanger capable of operating at high temperatures (approximately 1000 °C) in atmospheres containing corrosive saline gases. Tests on the specially built experimental unit recorded a thermal conductivity of between 185 kW/m<sup>2</sup>K and 290 kW/m<sup>2</sup>K, depending on the particles used, and an efficiency of about 55%.  
The Community's demonstration programme also includes a project on the application of this type of heat exchanger in smelting furnaces.
  
6. Other studies looked into ways of recovering the waste heat from the off-gases (at 250°C) from firing kilns for ceramics, with a view to using it to drive a 40 kWe turbo-alternator generating set operating on the organic Rankine cycle (ORC) principle and giving an efficiency of 11%. A pilot plant has been built. The estimated cost per installed kWe is 500 ECU and the project should break even in about three years. The ceramics industry has shown a keen interest in this type of unit.

7. Storing heat, mechanical energy or electricity is an important means of conserving energy whenever supply outstrips demand.

High-capacity batteries must be developed if the new methods of storing energy are to be applied in the transport sector (i.e. in electric vehicles).

In order to keep pace with the vigorous efforts being made in the United States and in Japan, 15 laboratories joined in the Community's R+D programme on sophisticated Na/S, LiAl/FeS and solid batteries.

Research within the industry succeeded, inter alia, in producing batteries with solid electrolytes (made of  $\beta$  alumina), which gave satisfactory reliability and performance when tested over more than 660 charge-discharge cycles at a current density of  $182\text{mA}/\text{cm}^2$ .

Li/S batteries with fused salt electrolytes were also developed and cheaper elements were produced along with new cells with a capacity of 200 Ah assuming a discharge of 20 A and a current density of 108 Wh/kg.

### Production and utilization of hydrogen

8. The research into electrolytic cells to produce hydrogen by splitting water brought about several improvements in the form of new diaphragm technologies and new catalysts for the electrode surfaces. The advanced cells based on these new technologies can halve the investment costs, while at the same time reducing the energy consumption of the electrolyzers by 30% at the equivalent current density. Industrial application of the new methods could soon bring the cost of electrolytic production of hydrogen down to that of hydrogen produced by other methods.
9. The studies and experiments on the safety aspects and on the construction materials to be selected, notably on special steels, demonstrated that the problems are clearly defined and that solutions can be found. Specially adapted methods of producing special steels have been developed.
10. A feasibility study conducted on an industrial scale proved that storing hydrogen in hydride form was a competitive alternative to storage in pressurized tanks.
11. The work on specially adapted processes to use non-fossil-derived hydrogen to convert coal into synthetic fuels such as liquid hydrocarbons and methane provided evidence that hydrogen is more economic, increases the energy output and, above all, makes better use of the available coal resources. The hydrogen required would be supplied by electrolyzers running on nuclear power rather than on electricity from coal-fired stations.

### Solar Energy

- 12.. Perhaps the most striking achievement was the design, development and construction of the 1 MWe EURELIOS solar power plant at Adrano in Sicily, the first such plant in the world to be connected to the conventional grid.

13. However, photovoltaic conversion generated the most activity. Together, the improvements made to the basic cells, the automation of panel production and the development of integrated systems helped to cut the cost of silicon panels to about one fifth of the 1973 level, whilst extending their service life at the same time.

Progress was also achieved in the work on alternative cells made of amorphous silicon or cadmium sulphide, which advanced from the basic research stage to the further development phase.

14. The Community's research on biomass concentrated on identifying the most promising ways of producing energy from biomass, on improving the conversion processes and on short rotation forestry. Several Member States have stepped up their activities in these fields as a result.

The programme also included a number of studies to assess Europe's biomass resources. They showed that the agricultural and forestry waste lying unused in the Community's tips could provide 200 million t.o.e. per year and that in theory the energy derived from biomass could satisfy about 10% of the Community's energy requirements between now and the year 2000.

15. The solar radiation data collected at 56 stations throughout the Community were used to compile an atlas showing the number of hours of sunshine recorded on a horizontal surface in each of the Community countries.

16. The Community research on the application of solar energy in the home played its part in the development of solar-powered heating and cooling systems. Twenty laboratories helped to prepare standard procedures for testing solar collectors, and these have now been finalized and field-tested. Eight pilot test units for simulating the heat load on a solar heating system as such (i.e. on the entire system and not just on the collector) have now been set up in the Member States with a view to assessing their performance under field conditions.

#### Geothermal energy

17. An extensive project on the acquisition and collation of geothermal data culminated in the publication of an "Atlas of Subsurface Temperatures in the European Community".
18. Substantial progress was made on the development of downhole instrumentation. Recent advances in electronics and welding techniques have made it possible to produce probes capable of measuring temperatures of up to 250°C and pressures of 250 bars as well as devices for measuring the heat flow.
19. The studies on the economics of geothermal heating cast light on the problems involved in assessing the real costs. However, some of the problems can be overcome by confirming the findings of feasibility studies by experimental data gathered in the field. It is therefore fair to conclude, at this stage, that geothermal heating is an economic alternative to conventional forms of heating in large housing complexes.

It would be much more competitive if mining costs were kept to a minimum and one applied new technologies such as water-water heat pumps and floor convectors capable of operating at relatively low temperatures (i.e. approximately 40°C).

20. Deep wells were drilled to explore high-enthalpy reservoirs in hot rock formations. In Italy one borehole through hot rocks (350°C) reached a depth of 4100 m, where geothermal water was found; 420°C was recorded at the bottom of another well in the same country. Those are the current records for the industry as a whole.
21. The technology applied to hot dry rocks entails extracting the heat captured in deep deposits by fracturing them artificially and circulating water through them. One project in that field succeeded in interconnecting three shallow (i.e. 300 m) wells in crystalline rocks by an array of passages created by a new method of stimulating the basement rocks. The experiment will pave the way for further research into methods of prospecting deeplying hot dry rocks.

Systems analysis : development of models

22. The most notable results of this subprogramme were the medium-term (EURECA, EXPLOR and EDM) and long-term models (MEDEE/SLT and EFOM) - which provide a means of observing energy supply and demand in the Community in the light of scenarios constructed by the users themselves and the establishment of a coordinated network of energy modelling experts throughout the Community.  
Considerable effort was also put into setting up the data bases required.
23. EURECA, EXPLOR and EDM were developed to provide medium-term forecasts of the likely energy demand, the main aim being to calculate the demand in each country in the light of the macro-economic and sectoral activities there and of the interaction between the economies of the different Member States.  
EURECA is a multinational macro-economic model for calculating the actual growth rate for the GDP of each Member State and for carrying out multinational case studies.

EXPLOR is a sectoral model for calculating the activity in each sector of the economy in each country from the aggregate totals calculated by EURECA. It also calculates the ultimate demand price and thereby provides a means of assessing the impact of energy costs on inflation. The demand prices are then fed back into EURECA. Converging results can be produced by such iteration between the two models.

EDM gives projections of the demand for each type of energy in each sector of the economy in each country, taking EXPLOR's data on the demand prices and on the activity in the individual sectors as its starting point.

24. MEDEE, the demand model, and SLT, the simulation model, provide projections of the long-term demand. They operate as follows :

MEDEE - the long-term model - bases its calculations on the socio-economic scenarios for 1990 supplied by the medium-term models. It extrapolates the 1990 figures to give the long-term scenario for 2000. Model SLT then checks that the scenario is valid.

25. Two models of the energy supply system have also been constructed - namely, EFOM 12 C and EFOM 12 D. They are both designed to determine which system gives the best supply costs.

EFOM 12 C is based on a comprehensive interactive software system with its own international energy data base. The national data in the base have all been harmonized and are sometimes used to analyse the national policies. However, the prime objective of the model is to analyse the interaction between the national energy supply systems at the international level. The model is extremely complex and there are still a few problems to be solved.

EFOM 12 D is conciser and easier to use for multinational case studies since some of the national data have been simplified.



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26 . The first programme concentrated not so much on energy studies as such but rather on the instruments needed to conduct such studies. Nevertheless the first field studies have now been completed and have produced useful energy data as well as giving an idea of the improvements that can be made to the energy system during the second programme.

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ANNEX II

DEVELOPMENTS  
UNDER THE  
SECOND PROGRAMME

Developments under the second programme

1. Considering the aims, there have been some significant changes in the five subprogrammes as well as in the priorities and lines of approach evolved in the course of the work.

Energy conservation

2. Research in respect of the residential sector in the first programme covered techniques for conserving energy and for increasing the output of heating systems. Most of the research covered the improvement of the thermal insulation of buildings and the development of heat pumps. However some important matters were not covered during the programme at all, or were dealt with only superficially. Considerably more attention was therefore paid to them in the second programme.

Research into the insulation of outside walls, particularly windows and shutters, into draughts and into the ventilation of premises was intensified.

Several projects deal with the improvement of conventional heating systems and methods of controlling them.

A considerable research effort is still required to perfect heat pumps of an advanced type, particularly absorption heat pumps which have a high energy-saving potential; the work is being continued in the current programme. The heat pumps must be reliable, efficient and easy to maintain, and must be inexpensive. Similarly, work is being done on the most appropriate sources of heat and the constituent parts of compressor heat pumps.

3. The integrated application in a consistent and conform manner of the energy conservation techniques available has also been studied; the possibilities have been embodied in interpretative guidelines for the use of architects. With this same question in mind, a group of computer programme development specialists has developed methods to optimize the designing of low-cost housing by the use of data processing methods.

4. The industrial sector uses two thirds of the energy it consumes in the form of heat; large quantities of this heat are dissipated and simply lost. Despite considerable efforts to save energy over the last ten years there is still an enormous potential for improvement - up to 20% in many instances.
5. The utilization of energy in its final form by industry in terms of temperature exhibits two peaks, one in the temperature range 1000-1600°C and the other between 100 and 500°C.

Priority was given to research in the processing industries operating at the higher temperature range, e.g. glass, ceramics, cement and steel. In these industries there is a high potential for energy saving because of the high operating temperatures used. Heat recovery constitutes an important part of this potential; hence, in the second programme, the accent was on recovery techniques - high-temperature heat exchangers (ceramics, fluidized beds), organic fluid Rankine cycle engines, industrial heat pumps.

At the same time research is being done on the thermal stability and the physico-chemical characteristics of fluids and of the materials used in these machines with a view to their use at temperatures of around 300 to 400°C. Improvements in manufacturing processes are also being studied intensively.

In the low-temperature range, the work on industrial processes used in the textiles and food industries continues.

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- 6 . In the transport sector, and particularly in road transport, the internal combustion engine fuelled by petrol or synthetic fuel would seem to have many years of life ahead of it despite its low efficiency (at present 15 to 20%) .

Improvements to this type of engine have therefore been given a high priority in this second programme. The main aim of the research is to optimize the characteristics of the present petrol engine to the point where its fuel consumption does not exceed that of a diesel engine of the same cylinder capacity, whilst at the same time maintaining the petrol engine's advantage of a specific power output twice as high as that of the diesel engine. Work is also being done on methods of increasing the performance of diesel engines (low-temperature energy recovery); the possibility of making alcohol the main fuel for diesel engines is also being examined.

- 7 . In the longer term, with the spread of electric traction, the use of fuel in urban transport could be considerably more flexible and diversified; this would also reduce pollution problems in this sector. Besides further work to produce improved batteries, this objective requires a system for controlling battery charging and for regulating field controls. Systems of this type are being developed under the programme.

- 8 . In the energy transformation sector, it is appropriate to develop the techniques making use of coal in view of the fact that world coal resources are larger by one order of magnitude than those of oil and gas; fluidized bed combustion and gasification come under this heading. Various characteristics of the fluidized bed method, e.g. the burning of various types of coal,  $SO_2$  and ash content, and corrosion resulting from the heat exchange process, are being studied in a number of contracts. All parties are being vigorously encouraged to exchange information and coordinate research.

9. Industry wastes large quantities of poor quality gas. The possibility of using this gas or eliminating it by means of a special recovery burner is being investigated, with a view to saving energy and protecting the environment.
  
10. Where heat storage is concerned, it would seem that most applications would be in the domestic sector, where there is already a demand for inexpensive short-term storage facilities. Storing latent heat has proved to be very expensive, so that the second programme is concentrating on the much less costly aquifer systems. Possible applications for heat storage in industry are currently being evaluated.
  
11. Storage by chemical processes is being explored from both the technological and economic angles, since energy losses in such processes should be low.
  
12. Electricity storage using sophisticated batteries is being investigated, not merely because of its interest in the generation sector but also to ensure adequate use of alternative sources of energy (sun, wind, waves).  
  
It is absolutely essential that research on batteries should be coordinated. Under the first R+D programme close collaboration between 12 laboratories was organized; this is continuing. The aim of the current project is to perfect high-power or high-density energy flow batteries or cells.
  
13. Finally, two specific applications of steering wheels are being studied. One system will be used for travelling cranes and another for sets of commuter trains.

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Production and utilization of hydrogen

14. There is close cooperation with the JRC in respect of thermo-chemical production of hydrogen. This provides a contribution to Ispra's activities in this field by means of special surveys measuring the basic physico-chemical parameters and additional research into corrosion in the media characteristic of thermochemical processes. No new research is planned, and the measure will be terminated once present contracts have been completed.
15. As regards the electrolytic production of hydrogen, the promising results obtained earlier as regards electrodes and diaphragms are being confirmed by long-term trials. As for equipment, notably electrolyzers, the transition from laboratory tests to 100 kW prototype runs has begun and will be intensified as preparatory work is completed and a solution found to the transfer problems, especially the choice of appropriate construction materials. The operation and behaviour of these prototypes will then have to be analyzed. At a later stage, evaluation, measurement and further research will have to be undertaken to bring the process up to the industrial stage.

Compared with achievements elsewhere, progress in the Community's alkali electrolysis programme (under the aegis of the International Energy Agency) puts the programme carried out by the Commission in the forefront of current research. Everything is being done to maintain that lead, from which industry in the Community may benefit as soon as the new technologies are perfected.

- 16 . Promising results have been obtained in the storage and transport of hydrogen : upgrading steels to resist corrosion from hydrogen, preparation of evaluation trials for a prototype hydride storage plant studied under the first programme and production of a manual on the safe use of hydrogen.
  
- 17 . The most significant results as far as the utilization of hydrogen is concerned have been that the good prospects for producing synthetic fuels by new (or modified) processes from coal have been confirmed; the hydrogen needed for these processes would be supplied from outside. Such techniques should give higher overall energy yields at production costs lower than those for other existing industrial processes.

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### Solar energy

18. In view of the store set by solar energy and the interest it has aroused both in the public and among researchers and decision-makers, it is worth highlighting a few positive points before discussing the main features of the subprogramme sector by sector.

The implementation of the programme shows that cooperation on solar energy R+D is very profitable and can be conducted efficiently. Both completed and current projects have succeeded in filling the gaps and in making up the time lost in Community research and development in this field (especially in photovoltaic conversion) : they have in particular stimulated further activity in the national programmes and strengthened Europe's international competitive position by initiating and encouraging cooperation in many sectors between researchers, research centres and industrial firms; a wide field of discussion



has consequently been opened up for the latter. Groups of experts from the entire Community have formed to help provide researchers with the contacts they desire and need : thirteen committees and groups of experts have been set up, covering areas ranging from passive solar components to the experimental operation of the Eurelios power station, not to mention pilot projects in the fields of photovoltaic conversion and biomass.

19. The Community programme makes it possible to carry out an economically justified type of research from which all the Member States may acquire general benefits without necessarily having to cover the whole range of technologies in their own programme; duplication of effort, as for instance when several large-scale and always costly experimental projects are carried out, can thus be avoided.

The programme is designed to make rapid progress and achieve results which can be implemented as quickly as possible. This is why many contracts have been concluded with industry, represented by small and medium-sized firms as well as by large international consortia.

In view of the diversity of solar technology, however, an important part of the programme is devoted to fundamental research.

Altogether, the programme seems to preserve a balance between short-, medium- and long-term projects, between fundamental and applied research, and between research into components and the development of entire systems. However, the appropriations available did not allow all the valid proposals received in response to the calls for projects to be followed up and the scope of some projects has had to be restricted.

As has just been mentioned, the second programme is directed at accelerating those processes which will enable solar power to make a real contribution to the Community's energy supply. This is why emphasis has been given to carrying out pilot projects and to developing expertise on certain particularly important subjects.

20. Innovation in the field of solar energy involves building prototype systems, here termed pilot projects. These must include all the implementing stages from fundamental research to technological development and trials (usually on a reduced scale).

Such activity, therefore, does not just imply developing components, but includes the assembly of systems and subsystems as they will be used later possibly in operation. The aim is essentially an experimental one.

Three types of pilot project have been devised for this programme :

- the 1 mWe Eurelios thermo-mechanical solar power plant;
- photovoltaic installations with a capacity of between 30 and 300 kW;
- installations for producing synthetic fuel from biomass (chiefly wood), with a capacity of about 20 tonnes a day.

Unlike the demonstration projects, which involve systems whose industrial and commercial profitability is potentially high but has yet to be confirmed by trials (generally full-scale), pilot projects are concerned with the initial technical applications. Thus :

- Eurelios is a world "first";
- photovoltaic installations with a capacity of more than 30 kW have never yet been built in Europe,
- and installations for producing methanol from wood have never been constructed before.

It should also be pointed out that the pilot projects are carried out with every care to ensure European cooperation; the creation of transnational associations is very much encouraged, and the contracting parties meet frequently.

21. To evaluate the prospects which these projects hold out for the Community and to translate them into recommendations for further action, expert reports are drawn up in suitable sectors. The results are generally published. Evaluation covers :

- the performance and economy of solar energy applications in housing (in publication),
- the potential energy yield and, where appropriate, the economic potential of :
  - . photovoltaic conversion,
  - . biomass techniques, compared to its other uses (food, building materials, etc) (three publications between 1977 and 1980),
  - . biogas installations in the Community,
  - . solar architecture (in publication),
  - . wind power,
  - . solar radiation (atlas : first volume published),
  - . agricultural applications.
- the basic problems connected with improving the productivity of biomass crops.

Similarly, the results from operating the Eurelios power plant will be evaluated from mid-1982.

22. Taking each sector in turn, the following developments should be noted.

The Eurelios thermo-mechanical solar power plant has been completed. It was inaugurated and connected to the ENEL network on 26 May 1981, since when it has been operational. As to the future, cooperation with potential operators of other projects being developed elsewhere in the world (France, Spain, USA and Japan) is well worth considering, notably with a view to exchanging the results of experiments.

23. Some contracts for photovoltaic pilot projects have been concluded and others are being negotiated, so that, by the time the programme ends in mid-1983, eighteen installations with a total installed capacity of 1.3 MW will be operating in the Member States from Denmark to Sicily and from Ireland to Greece, supplying electricity for various purposes - an isolated village, dairy farm, school, telecommunication transmitter, airport, desalination plants, pumping, disinfecting water producing hydrogen.

All these developments will make the Community a world leader in this very promising field and will encourage its industry to assume its rightful place amid strong international competition. Firms of all sizes are engaged on these pilot projects, and the authorities in several Member States are contributing financially to their implementation.

There is a case, however, for conducting a fair amount of exploratory research later into photovoltaic conversion.

24. A major improvement in the Community-wide network of stations for measuring solar radiation has enabled significant progress to be made in the evaluation of solar energy as a usable resource.

25. As regards solar heating in housing, current activity is mostly concerned with passive systems and with developing "solar architecture", for which it is planned to draw up Community guidelines and standards. A Community competition for architects to design solar buildings was very successful.

In future, an effort is to be made to create better links between solar heating projects and the parallel activities in the energy-saving subprogramme and to include more research into systems which use air as the heat transfer fluid.

26. As stressed in the survey of the first programme (1) (of Section 14), biomass has considerable energy potential; hence, activities in this sector have an important place in the second programme. As well as basic research and feasibility studies, work is being carried out at the moment on the execution of the pilot projects mentioned in Section 20 (2). Subsequent measures will be directed at exploiting the processes and techniques for producing synthetic fuels developed, or to be developed, under the hydrogen subprogramme (see Section 34 of the main pages). In view of progress to date and of the prospects for this sector, the research and pilot project activities should be intensified in the next R+D programme, to enable maximum use to be made of biomass resources.

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(1) Annex I  
(2) Annex II

Geothermal Energy

27. As far as the exploration of geothermal reservoirs is concerned, trial borings near Southampton (in the United Kingdom) and around Naples (in Italy) have revealed new geothermal resources. These two discoveries should make it possible to develop geothermal energy commercially for district heating and in order to generate electricity.

28. Follow-up action will have to be taken to step up exploration in those areas which have been assigned priority on the grounds that surface and subsurface prospecting has revealed good geothermal potential and there are good prospects for using the resource to benefit the locality and region economically.

The development of geophysical prospecting methods requires a further effort to be made to confirm the findings of experiments on the first test site (Travale) by trying out these methods on a second site of volcanic rock or sedimentary rock of volcanic origin.

29. As regards exploitation, a new experimental method for exploiting high-enthalpy fields consisting chiefly of hot water has been successfully tried out in the Campi Flegrei (Mofete). The development of a test line and of an experimental operational procedure allow an accurate assessment of the hydrodynamic and thermochemical problems connected with boring, completing and exploiting wells and with the surface exploitation and the reinjection of the separated liquid phase. Solving these problems should help to rationalize the management of these resources.

30. Efforts will now have to be concentrated on the physics of reservoirs which have high and very high temperatures, this being the only way of improving our understanding of the thermodynamics of geothermal fields, particularly as regards in-situ fluid expansion, scaling, distribution of salts between the liquid and gaseous phases and the production of supercritical fluids.

This research will combine laboratory tests under dynamic conditions - interaction between water and rock, solubilities, the physico-chemical theory and the mechanics of siltation - with studies on models.

In addition it will be necessary to develop a basic set of instruments, materials and proper drilling equipment and processes.

One immediate effect of this research covers the stimulation of dry and/or low-output geothermal wells; this calls for an increase in the number of on-the-spot and laboratory tests. The economic implications for the development of fields are considerable.

31. The research carried out into low-temperature geothermal heating processes has resulted in the successful development - although this is still at the stage of technical and economic feasibility studies - of a polytropic heat pump of the water/water type and the design and evaluation of a water/air convector with forced-draught ventilation and a very low inlet temperature. These processes extend the scope of geothermal heating to allow the use of fluids at temperatures of 40°C. They considerably increase the Community's energy reserves in the form of low-grade geothermal heat energy.

32. R+D efforts should now be made in two directions:

On-the-spot pilot experiments should be carried out to confirm that the results obtained with low-grade heat at the feasibility and prototype stages with heating processes at low and very low temperatures can be applied industrially.

With medium-enthalpy sources (hot brine), research should be continued and new research undertaken into processes for generating electricity using two-phase Pelton wheel turbines, binary cycles with direct contact heat exchange and by developing organic-steam turbines. These processes and machines are suitable for plant-generating between 0.5 and 5 MWe.

33. It should also be possible to recover minerals (boron, lithium, silicon, KCl, etc.) of economic or strategic value by means of thermochemical separation and other competing methods.
34. The first large-scale European field experiment on hot dry rocks, which was designed to assess the feasibility of extracting heat from hot dry rocks in situ, was carried out in Cornwall by drilling a pair of directional boreholes through solid granite to a depth of 2 000 metres.  
This subterranean heat exchanger is to be brought into operation in the first few months of 1982.
35. The experiment undertaken in the United Kingdom should lead to a pilot experiment at even greater depth if, and only if, it is justified by the results of present research into the technical and economic feasibility of the project. If this is the case, there is every likelihood that a site with different geological (metamorphic rock) and geodynamic (active tectonics) features will be chosen for the next series of tests.

There has already been considerable scientific spin-off from this project in multidisciplinary fields, involving areas connected with the stimulation of solid rocks and the prediction of earthquakes.

36. It is interesting that some of the present research has been combined with Community demonstration projects, e.g. the Strasbourg borehole has been combined with use of the fluid for domestic heating and the very deep boreholes of Sasso 22 at Larderello. Other demonstration projects are the direct result of previous research work supported by the Commission, e.g. the exploration of the Triassic formations in the Paris basin resulted in the greenhouse heating project in Melleray; similarly, the exploration of the Wessex basin and the Marchwood borehole led to the Southampton project for heating new buildings.



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Energy systems analysis and strategy studies

37. Energy models have been devised by the Commission in close cooperation with national working parties so as to make available to the national authorities concerned and to the Commission methods of analysis and evaluation which can make a real contribution to the formulation of energy policies.
- Hitherto, the work done under the second programme has concentrated on improving the models and developing new ways of representing the energy system.
38. The medium- and long-term improvement of the Community's energy models is to be achieved by maintaining and extending the data banks, introducing the models into national research centres and within the Commission, reassessing the parameters used in the models and developing new data-processing methods.
39. Developing new ways of representing the energy system will involve devising a multinational macro-sectoral model which will be better able to identify the relationships between the medium-term development of sectors of the European economy and the energy system. It will also include the application of a formalized instrument to determine priorities in respect of energy R+D (the best way of distributing the R+D budget over a whole range of new technologies).
- The representation of the energy supply system will also have to be improved by including gradual development mechanisms which will allow the new technologies to penetrate the market.

40 . Now that the models devised in the first programme are operational, the time has come to carry out a number of case studies based on :

- (i) medium-term energy demand models, which can be used to make economic and sectoral projections for all the Member States and to calculate the consumption of each energy product by the major consumer sectors;
- (ii) long-term energy demand models, which can also be applied to the major energy consumers in respect of different forms of energy and types of use;
- (iii) energy supply models which can be used to work out the best way of organizing supply in order to meet energy demand in accordance with different objectives such as, e.g. minimizing costs, minimizing investment, minimizing imports and applying the new technologies in both the supply and demand sectors.

41 . It is also necessary to determine the role of the new technologies in energy supply, to classify these technologies and to allocate budgetary resources to the various R+D sectors or topics.

42 . The modelling system will also have to be extended to apply to the latest Member State, Greece, and there will have to be discussions on the application of the methods used by the Commission in the prospective new Member States, Spain and Portugal.

43. Lastly, apart from the applications, the maintenance and the improvement of the existing models, work should be done on developing a new generation of models, particularly :

- (i) a dynamic multinational macro-sectoral energy demand model;
- (ii) an improved energy supply model;
- (iii) an energy R+D model to help towards a more rational allocation of budget.

44. If models are to be developed successfully and usefully, there must be full and permanent communication between the various national teams and experts and the Commission's departments. Preliminary contact has been established by the Commission with internal and external users and one of the important tasks for the future development of the programme will be to step up and extend this contact, especially in view of the wide interest already shown.

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ANNEX III

CONFERENCES AND PUBLICATIONS

CONFERENCES AND PUBLICATIONS RELATING TO THE ENERGY RESEARCH AND DEVELOPMENT  
PROGRAMME

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4. Hydrogen as an Energy Vector, Brussels, Oct. 1978  
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5. Solar Energy for Development, Varese, March 1979  
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Mars 1979  
  
Technique et Documentation, 11, rue Laboisier, Paris,  
ISBN 2-85206-047-4
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ISBN 0-86103-011.7
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Community  
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