COMMISSION OF THE EUROPEAN COMMUNITIES

COM(82) 324 final/2

Brussels, 11th June 1982

ASSESSMENT REPORT

on the Community Demonstration Programmes in the fields of Energy Saving and Alternative Energy Sources

This report contains the technical assessment of the Community Demonstration Programmes referred to in the Communication from the Commission to the Council (COM(82) 324)

Introductory Note

At its meeting of 22 and 23 February 1982, the Council asked the Commission to make a rapid assessment of the demonstration projects being financed through the Community Budget.
This report relates to Regulations 1302/78 and 1303/78 (1) which are intended to encourage industrial and commercial initiatives with a view to developing alternative energy sources and using energy more efficiently.

The Commission submitted a Preliminary Report[2] on this subject to Council and Parliament in July 1981.

The assessment made in this Report is a sector-by-sector analysis of this aspect of the Community's activities. Account is taken, in the analysis, of the state of the art in the sector of technology concerned, and of similar programmes under way at national level. A detailed description of the contracts now running is attached as Annex I.

The information relating to the national programmes was submitted by the Member States on the basis of a questionnaire drawn up by the Commission departments concerned.

The assessment was carried out with the help of a panel of independent experts, a list of whom is given in Annex II.
The Commission Directorates-General concerned also contributed.

The Community programmes have been assessed:

(a) on the basis of the results achieved in the case of projects that have been completed or are at an advanced stage of completion;

(b) in the light of the inter-relationships between the projects and the possibilities which are the most attractive from the technical and economic point of view in the sector to which they belong;

(c) taking into account previous national and Community research and development activities;

(d) in relation to the national demonstration programmes; and

(e) in the broader context of the Community's energy strategy.

Quantitative data relating to the Community demonstration programme are given in Annex III.

---

[1] OJ No L 158 of 16 June 1978.
[2] COM(81)397 final of 17 July 1981.

CONTENTS

Page

1. ENERGY SAVING

1.1 Buildings 1–5
1.2 Heat pumps 6–8
1.3 District heating, power stations and combined heat and power production 9–18
1.4 Industry 19–35
1.5 Fluidized beds 36–38
1.6 Energy from waste 39–43
1.7 Transport 44–46
1.8 Agriculture 47–48
1.9 Conclusions as regards energy saving 49–51

2. ALTERNATIVE ENERGY SOURCES

2.1 Solar energy

2.1.1 Introduction 52
2.1.2 Solar heating 52–57
2.1.3 Photovoltaic techniques 58–60
2.1.4 Biomass 61–64
2.1.5 Conclusions 65–66

2.2 Geothermal energy 67–73
2.3 Liquefaction and gasification of coal 74–84
2.4 Conclusions as regards alternative energy sources 85–87

3. NATIONAL PROGRAMMES 88–92

ANNEXES

I. Detailed description and assessment of the contracts now running

II. List of independent experts

III. Quantitative data relating to the Community demonstration programme

ENERGY SAVING

1.1 Buildings

I. Introduction

In 1980 the domestic and tertiary sector consumed 252 million toe, or in other words about 35% of the final consumption of primary energy within the Community. This energy was used first and foremost for space heating, ventilation and lighting. Since the potential energy saving for 1990 has been estimated at 20% i.e. 60 million toe, and for the year 2000 at 50% i.e. 160 million toe, the domestic and tertiary sector holds great energy-saving promise.

The steps at present being taken to reduce energy consumption in buildings may be divided into 3 categories:

- reduction of energy requirements (better insulation, less ventilation, temperature control, etc.);
- rational use of fuels (higher efficiencies, heat pumps, district heating, CHP, energy storage);
- use of renewable energy sources (active and passive solar energy, bio-climatic buildings, fermentation gas for CHP, geothermal energy).

The demonstrable techniques would make it possible (a) to reduce heat requirements to a minimum by means of suitable design of the structure itself and (b) to generate the necessary heat and light under conditions of optimum efficiency or by using so-called "free" sources.

The following is a list, for guidance purposes, of the fields within this category generally considered to be the most promising:

(a) Buildings in general

Improvements to the structure itself:

- insulation and condensation-control systems;
- elimination of thermal bridges;
- improvement of ventilation systems.

Heat generation

- improvements to existing systems (boilers, burners, insulation);
- replacement by high-efficiency boilers (condensation and low-temperature boilers);
- boiler regulation.

Heat distribution and emission systems:

- insulation, thermostats, optimizers, remote control, high-efficiency emission systems, domestic hot water (optimization of distribution).

(b) New heat-generation systems:

- heat pumps;
- solar collectors for heating domestic water;
- combined heat and power production;
- district heating.

(c) New buildings:
- bio-climatic buildings;
- radiant heating.

(d) Tertiary-sector buildings:
- artificial lighting;
- ventilation (control of fresh-air flow) and air conditioning;
- heat recovery.

II. Community action and national programmes

In order to spur activity pursuant to Regulation 1303/78, 32 projects concerning buildings, either directly or indirectly, have been adopted or are about to be so. The "building sector" comprises 16 projects (and also project EE/213/80, as yet unadopted) whose principal aim is to improve the thermal behaviour of the structure itself, although most of them also include techniques such as heat pumps and solar collectors.

A total of roughly 9 million ECU has been invested in these projects, including the measurement programmes, and support amounting to 3 100 000 ECU has been granted.

Most of the building projects cover new dwellings and various types of building within the tertiary sector (schools, office blocks), swimming pools, hospitals, etc. Two projects deal with new types of boiler. Where stress has been placed on a specific technology the remaining projects have been divided up into "heat pumps" (8 projects) and "CHP" (9 projects). The projects on low-energy dwellings involve the construction of 157 dwellings in 7 areas in 5 member countries. Two of these projects cover energy saving in existing buildings. It should be pointed out that only 2 projects have so far been completed.

When these projects were selected account was taken of the results and pointers arising from the "energy saving" R&D programme. The 16 projects adopted can be subdivided into 2 categories: residential sector (10 projects) and tertiary sector (6 projects).

(a) Projects involving the residential sector

Of the 10 projects in this sector, 9 are devoted to the construction of new low-energy houses and the tenth (EE/231/79) to a new high-efficiency boiler. Two of these projects also provide for the construction of flats (EE/323/79 and EE/290/80). These 2 projects are, moreover, the only ones also to include the renovation of existing buildings.

The construction or renovation of some 157 dwellings will enable well-insulated detached houses designed for the passive recovery of solar heat and equipped with heat pumps or solar collectors to be assessed systematically and uniformly.

The results obtained with the passive methods (heat insulation) and the various active methods (heat pumps) will be assessed separately. This distinction comes into its own when one remembers the potentially quite short pay-back period for the passive methods as compared with the much longer periods for the active methods.

The structures used in almost all of the projects are better insulated than their traditional forerunners. In addition, almost half of the projects include technical concepts promoting the passive recovery of solar energy.

The unconventional heating systems are mainly based on heat pumps or air-type solar collectors. Generally speaking systems of this type cannot meet a dwelling's full heating requirement and so back-up heating is provided whose nature varies quite widely, depending upon the project.

In most cases hot water is provided by water-type solar collectors (combined with the heating system of the building). Back-up heating is provided for sunless days.

Project EE/231/79 - high-efficiency boiler - is the only project completed in the residential sector. It has enabled the reliability of this type of boiler, yielding a seasonal efficiency of 91%, to be demonstrated.

Depending upon the project, the energy saving due to the introduction of new heating and hot-water equipment has been estimated at 30-65% of the consumption in equivalent, conventional buildings. The payback period on the extra investment needed for energy-saving techniques could vary between 6 and 37 years.

(b) Projects in the tertiary sector

There are 6 of these and they relate to such diverse types of building as offices, sports centres, hospitals, schools and commercial premises.

Generally speaking the purpose of these projects is to determine the effectivness of a number of energy-saving techniques i.e.:

- medium-power heat pump for heat recovery;
- heat exchangers for recovering heat from stale air;
- CHP;
- improvements to remote-control automatic regulation;
- recovery of incinerator heat;
- ozone treatment of swimming-pool water;
- improvements to artificial lighting systems;
- improvement to the seasonal efficiency of boilers by means of fuel-water emulsions.

Some of these projects combine various of these methods in order to obtain major energy savings as compared with traditional buildings.

One of the projects (EE/201/80) includes a large tank for the seasonal storage of hot or chilled water.

These projects will assess separately the various ways of saving energy under actual operating conditions and will determine just what overall savings can be gained from the integration of several energy-saving devices in the same building:

- the project dealing with improvements to the artificial lighting of an office block (EE/215/79) is almost completed and has yielded an energy saving of about 73% - an excellent result. This will provide some very interesting **feedback** and the Commission will distribute whatever information is useful in the near future;
- the project for improving the automatic regulation of school heating by remote control (EE/131/80) is likewise almost completed and should also produce tangible results;
- the project on boilers fired by fuel-water emulsions has been completed. It was a success and is now being exploited commercially. This technique can be applied to all existing boilers, whether private or industrial.

As the other 3 projects are still in preparation their results will not be available before 1983.

In conclusion, when compared with equivalent conventional equipment, these 6 projects should provide energy savings in buildings of 11 to 67%, while the payback period for the extra investment should be 3-31 years.

The building sector is included in all of the existing national programmes except in Luxembourg. Detailed information is contained in the table below.

Table A **Buildings**

	B	DK	D	F	GR	I	IRL	LUX	NL	UK	EEC (7)
1. Proposals received							58	18 3)			255
2. Proposals supported			6 1)	182	5		2	11		45 4)	36 5)
3. Total support (million ECU)			3.46	13.2	4.96 6)		0.16	0.035		4.3	6.4
4. Support per project (ECU)			577 000	72 500	992 000		80 000	3 200		95 500	178 000
5. Investment (million ECU)				25.8	14.7		2.9	0.19		10.2	17.4
6. Investment per project (ECU)				142 000	2 940 000		1.450 000	17 000		227 000	483 000
7. Contribution to investment (%)			68 2)	51	34		6	19		42	37
8. Projects completed				47	-			11		1	2

1) Of which 5 are "heat pump" projects.

2) Average support for the entire R, D + D programme in the "household and small consumer"sector.

3) "Heat pumps".

4) Industrial, commercial and domestic buildings.

5) Projects adopted by the Commission, of which 12 are heat pump projects and 2 are boiler projects.

6) Including research expenditure.

7) Community programme

France is the only country to have supplied assessment results in this sector and the energy saving achieved by the projects themselves amounted to a total of 247 000 toe between 1975 and 1980, whereas the energy saving spread over the entire residential and tertiary sector has been estimated at 5.4 million toe.

III. Conclusions

In view of the rate of building replacement (2% per annum on average) incorporation of the techniques being demonstrated both nationally and at Community level in all new buildings could cut household energy consumption by 1 800 000 toe per year.

The emphasis of the demonstrations should shift towards projects by the large tertiary investors, companies and cooperatives who manage numerous housing complexes and estates. This would offer several advantages, including the rapid, widespread appreciation of successful demonstrations and the centralization of decision making.

The following specific technologies deserve closer attention in future:

- building techniques enabling the heat requirements of large residential and tertiary buildings to be reduced;
- the use of micro-electronics to manage the energy requirements of existing or future residential and tertiary buildings.

1.2 HEAT PUMPS

I. Introduction

The requirement for low-temperature heat, both for heating premises and producing goods, accounts for more than 40% of total energy consumption in the Community. It is therefore essential that energy-saving techniques should be applied in this field.

Heat pumps are a particularly appropriate way of meeting the requirement for low-temperature heat.

The conditions specific to each installation are best met by a particular type of system, so that no single technique will be generally applicable.

The key factor determining the success or failure of a given technique is the degree to which the interaction between the different components of a complex installation can be controlled. In practical terms, this means that the source, production and distribution of the heat must be correctly adjusted. At the moment this is possible in a few cases only, although it is the prerequisite condition for reducing investment costs. Only experiment will provide the answer.

Low-output heat pumps are mostly fitted with electric motors, while high-output systems incorporate an internal combustion engine; electric motors can sometimes be economic in the latter case as well. The heat pumps themselves may often be more sophisticated than the auxiliary equipment (heat source, regulation system, hot-water distribution, etc.); it is this equipment, however, which governs correct operation of the installation as a whole.

II. Community and national action

In all, twelve projects have been signed in this field, representing a total investment of about 3 m ECU and receiving 1.2 m ECU in financial support.

None of the twelve had been completed prior to assessment. Seven are in progress, being run as demonstration units, when a detailed measurement programme is carried out; the measurement results are not yet available. The other five, are at the pre-project stage.

These twelve heat pump projects may be classified in any of the following ways:

(a) by the type of drive and the operating principle employed:
heat pumps with an electrically-driven compressor - 5 projects
heat pumps with an ICE-driven compressor - 6 projects
other heat-pump systems - 1 project;

(b) by type of use:
heating of premises and production of domestic hot water - 8 projects
industrial applications - 4 projects;

(c) by the temperature of the useful heat:
below 70°C - 8 projects
above 70°C - 4 projects.

Nearly every project is distinguished by one or other of the following innovations in installation/component design:

- heat extraction from the ground by large-area exchangers (approx. 9 000 m^2);
- recompression of steam by a compressor with an annular water-tube;
- low-output (20 kW) ICE heat pump;
- steam generation by a high-temperature heat pump (110°C).

Three projects are based on R&D work already carried out by a Member State and/or the Community: 00/035/79 - 171-77 EED; EE/011/81 - EE-A4-038D; EE/146/81 - 175-77EEUK, 369-78-EEUK, EE-B1-147-UK.

III. Conclusions

Most of the demonstration projects selected involve current heat-pump techniques and compare their results. The majority of these projects are already economic or about to become so; they are therefore likely to be put on the market.

Some of the projects are based on the results of work carried out under national and Community programmes; others have given rise to subsequent projects.

The Community's prime objective is to halve by the year 2000 the quantity of energy required to produce low- and medium-temperature heat - a reduction of about 20 to 30% in gross energy consumption (100 to 140 million toe/year). Heat pumps could help to save about a quarter of this amount (25-35 m toe).

The whole range of heat-pump possibilities having been highlighted in the first stage of the demonstration programme, efforts should now be concentrated on those systems which, in the light of the experience gained, are technically and economically the most attractive. The two areas which should receive most emphasis are :

- heat-pumps with a capacity of up to 200 kW in appartment blocks, and
- heat pumps in industry (paper, textiles, foodstuffs, etc.).

Several similar projects should be chosen, in each field, so that the most promising techniques in the Community can be compared and, in the medium term, costs reduced and the market developed by harmonizing technical specifications.

As it has been widely demonstrated that heat requirements in detached and semi-detached houses (10-20 kW) can be met by heat pumps with an electric motor, Community support should be limited in future to small ICE pumps and absorption pumps.

1.3 Remote heating systems (including heat storage, power stations and combined heat and power)

I. Introduction

This sector of technology brings together three subsectors which are often closely linked:

(a) Remote heating systems

The benefits of remote heating are:

- scope for energy-saving;
- scope for substituting other energy sources for oil;
- improved security of supply; and
- a considerable boost for employment, the balance of payments, the regional economy and certain industries now having a hard time.

As regards heat production for remote heating systems the emphasis is on:

- the recovery and use of industrial waste heat;
- the use of new energy sources (energy from waste, solar energy, nuclear power, etc.); and
- new techniques (large heat pumps, combined heat and power, fluidized-bed combustion, etc.).

Heat storage becomes necessary where production of heat and demand for it in heating systems are out of phase and is important chiefly as a way of taking advantage of intermittent sources of industrial waste heat and of heat also available outside heating periods.

Economic transport of heat over longer distances than at present is essential for the use of many industrial sources of waste heat and for cogeneration in large conventional or nuclear power stations. Any technique that can reduce the cost of heat transport has to be encouraged.

Distribution accounts for much of the capital cost of district heating systems. Further efforts will therefore be necessary to reduce its cost, e.g., by using new materials or new ways of laying pipelines.

At present heat-distribution networks supply only 2-3% of the Community's low-temperature heat requirements. These, however, are about 40% of gross energy consumption. The energy saved by reticulated heat-supply systems through the use of combined heat and power and industrial waste heat amounts to 3-4 million toe/year. Systematic development of reticulated heat-supply systems could result by the beginning of the next century in 25% of the Community's low-temperature heat requirements being supplied by this means. The potential energy saving is believed to be some 50 million toe/year.

(b) Power stations

Large power stations have now reached a high level of development; potential energy savings on an economic basis - leaving aside combined heat and power - are small. Endeavours to save energy must focus on special techniques chiefly relevant to industrial power plants of limited size.

Some examples are:

- combined cycles, i.e. a steam cycle with an upstream or downstream cycle using a different working fluid (heat-transfer medium);

- organic-fluid cycles; this is an important way of using relatively low-grade waste heat;

- advanced conversion systems (fuel cells);

- techniques for replacing oil and gas (e.g. gas turbines energized by solid fuels);

- reducing the energy consumed by certain ancillaries (e.g. stack gas desulphurization); and
- reducing the capital and operating costs of small hydroelectric plants in order to lower their minimum economic power level.

It is not easy to assess the potential energy savings that these technologies can provide; they will depend primarily on the technological advances achieved. In the medium term they will not exceed a few million toe/year.

(c) Combined heat and power (cogeneration)

Combined heat and power is a formidable means of saving energy:

as much as 30-40% less is consumed than with separate production of the same quantities of heat and power.

Conventional cogeneration techniques are based on:

- back-pressure or pass-out steam turbines; and
- diesel engines, gas turbines and gas engines with exhaust-heat recovery.

Recent years have seen the development of modular units, with internal combustion engines and integral heat recovery; these burn gaseous or liquid fuels or gas/liquid mixtures. The engines drive either alternators, or compressors (e.g. for heat pumps) or other mechanical devices, or a combination of the two. The fuel cell may in the future provide a static means of combined heat and power production.

Cogeneration has grown up chiefly in industry. The need for large quantities of heat and power at the same time and in the same place and at high annual load factors has made cogeneration an attractive proposition. In the early 1970s cogeneration in industry was saving 13-14 million toe/year in the Community. The fuels used were mostly hydrocarbons (heavy fuel oil in particular) because they give the lowest capital and operating costs. But the abrupt rise in the oil price, the slackening in industrial activity, the relative price stability of electricity produced by the utilities in large coal-fired and nuclear power stations, the high cost of new small and medium-sized coal-fired plants, high interest rates and a cloudy future for industry are all reasons why industry has found cogeneration less attractive.

Few new plants have been brought into service; existing ones are operating at reduced output or in some cases have actually been shut down. We are in a paradoxical situation where rising energy costs have caused a decline in interest in what is nevertheless one of the best ways of saving energy. Up to the year 2000 the potential for energy saving from cogeneration in industry is approximately 50 million toe/year, four or five times the present level. How far this potential can be realized will depend primarily on the economic and industrial climate. Meanwhile, industry must be encouraged to keep up its interest in cogeneration.

Cogeneration for district heating has developed somewhat in Germany and, to a lesser extent, in Denmark and France. Isolated systems, supplied by cogeneration plants are also to be found in Belgium, the Netherlands, the United Kingdom and Italy. The present energy saving is about 3 million toe/year. The potential for energy saving with cogeneration used for district heating is 30-40 million toe/year by the beginning of the next century (60-80% of total potential energy savings from heat-supply networks). Particularly as a result of the substantial aids in some Member States, the use of combined heat and power for district heating is enjoying steady growth.

Cogeneration has also made its debut in the domestic and tertiary sectors. Energy savings from cogeneration in these sectors are now about 50 million toe/year, 1.6% of gross energy consumption in the Community. The potential energy savings (all sectors) by the beginning of the next century will be 80-90 million toe.

II. Community action and national programmes

There are fourteen projects in preparation or in hand under the Community demonstration programme. These projects typically require heavy investment. Two of them are exceptionally large (EE/120/79 and EE/217/79) and will take several years to complete; Community finance has therefore had to be limited - initially - to the early stages.

Financial support for remote heating projects averages 21.4%; for power station projects 28.2%; and for cogeneration projects 34.5%. The sector average is 23%. This figure is relatively low because of the Commission's desire not to exclude big projects from a programme with limited resources behind it. Most projects, moreover, (with the exception of Italy's) receive national aid, which has enabled the Commission to reduce the level of its own contributions.

Most of these fourteen projects needed Community support if additional, national aids were also to be obtained; it also considerably eased the problem of financing that portion of the investment not covered by national and Community support.

At the time of writing none of the fourteen projects has been completed. Only three projects are in operation, and they are in the demonstration phase, during which a detailed data logging and analysis programme is carried out. The results are not yet available. Four projects are under construction. Six other projects are in the design stage or, if design is complete, construction has not yet begun. The contract for one project has still to be signed.

Remote heating, power stations and cogeneration largely rely on conventional, proven techniques. But the rise in energy prices dictates a review of some past approaches and the expedited development of remote heating as a way of saving energy and replacing oil. This has resulted in new priorities which can be summarized as follows:

(a) In large cogeneration facilities it is necessary:

- to reduce the use of oil products;
- to make more use of waste (both waste heat and waste substances) and alternative energy sources; and
- to adopt technologies with higher performance.

(b) The use of waste heat requires heat to be transported over longer distances and stored for extended periods. Economic ways of doing both must be found.

(c) The development of heat-supply systems and of industrial cogeneration depends to a great extent on the administrative and legal context within each Member State. New policies for the heat market are essential if these techniques are to achieve greater penetration. "Institutional", just as much as technological, innovation must be promoted.

Table I shows how the fourteen projects in this sector meet these priorities. Technological innovation in production is to be found in all but two of the fourteen. All fourteen meet the requirement of using waste and alternative sources of energy.

	Technological innovation in production	Non-oil fuels	Use of waste and alternative sources	Advances in heat storage, transmission and distribution	Innovations in the operation of the heat supply network	Incentives for installing new systems; "institutional" innovations
<u>District heating</u>						
EE/028/79 Reggio Emilia	X	(X)	X			X
EE/120/79 THERMOS	X	X	X			X
EE/121/79 Svendborg	X	X	X			
EE/174/79 Frederikshavn	X		X			
EE/217/79 Saarschiene	X	X	X	X		
EE/330/79 Brescia	-	-	-	-	X	
EE/003/80 Modena		X	X			X
EE/066/80 Plaisir	-	X	X	X	X	
EE/100/80 Milano			X			X
EE/163/80 Rouen	X	X	X			X
<u>Power stations</u>						
EE/118/79 Walter	X	X				
EE/134/81 Ruston	X	(X)				
<u>Combined heat and power</u>						
EE/156/80 MAN	X					
EE/014/81 CAMPBELL	X	X				

<u>Table 1</u>

Only one project is concerned with heat transport (EE/217/79) and only one with seasonal heat storage (EE/066/80).

Innovations in heat supply network operation are to be found in two projects, namely:

- demand modulation (EE/330/79); and
- matching of heat demand to production by means of storage (EE/066/80).

Five projects contribute to the setting up of new heat-supply networks or display "institutional" innovations.

Two Member States (F and D) have national demonstration programmes covering this sector. Greece has supported a project in the same field. Several Member States also provide aid for capital projects in this sector where they have no particular innovative character (F, D, NL, DK, IRL). Feasibility studies are also promoted in several Member States.

III. Conclusions

Energy savings currently made in the Community with all the methods and techniques falling within this sector are approximately 16 million toe, or 1.7% of gross inland energy consumption. The potential for energy saving by the beginning of the next century is in the order of 100 million toe (about 8% of gross energy consumption). Combined heat and power accounts for 80-90% of these potential savings. These figures justify the importance of this sector both in the national programmes and in the Community demonstration programme.

Energy saved or produced from alternative sources by these 14 projects amounts to 220 000 toe/year. A project-by-project estimate of the prospects for the construction of similar systems between now and the end of the century shows potential energy saving and production of approximately 2 million toe in the year 2000.

The projects selected for the Community programme have in general considerable demonstration value; most of them are world "firsts".

Lead times for projects in this sector are relatively long, so that few results are yet available. It is very difficult to make any assessment at the present stage.

Even with the small number of projects in this sector it has been possible to cover a fairly wide spectrum of new technologies and applications. The selected projects accord to a great extent with the development priorities for the sector.

Combined heat and power and waste incineration using conventional methods should no longer feature in demonstration programmes. Likewise the use of oil and/or natural gas should be confined to applications where no economic replacement is in view for them in the medium term.

A further effort will be needed, however, in the following areas:

- new technologies for using waste heat and for energy from waste (see also para. 1.6);

- use of nuclear plants for heat supply;

- new technologies for heat transport at lower cost; and

- new technologies for converting external and internal combustion engines to burn non-hydrocarbon fuels.

Projects in this sector are generally expensive. The innovatory portion often accounts for only a fraction of the investment. With a view to getting the best out of the funds available for the demonstration programme it would be of advantage - where possible - to confine Community financial support to the innovatory elements and direct the "investment" portion towards the other Community financial instruments. In its Communication to the Council [COM(82)24 final] on investment in the rational use of energy the Commission emphasizes the need to speed up investment in some sectors, in particular heat supply networks and proposes to that end that greater use should be made of the Community financial instruments.

Of the 14 projects in this sector included in the Community demonstration programme at least 10 :

- are based on R&D carried out on a national basis; or

- are part of a national demonstration or investment programme; or

- are in receipt of some other form of support from the Member State concerned.

This illustrates the close integration of national and Community programmes in this sector.

1.4 Industry

1.4.1 Introduction

Industry is "par excellence" the big energy-consuming sector. Leaving aside the energy content of raw materials, industry's energy consumption in 1980 was 227 million toe, equivalent to 35% of the Community's final energy consumption.

The possibilities for the more rational use of this energy are many and vary widely, depending on the industrial sectors involved. Nevertheless, two main categories may be identified:

(i) "horizontal" measures: these include improving the heating of buidings, optimizing the efficiency of industrial boilers, using more efficient equipment (e.g. pumps, electric motors, heat exchangers, etc.). The demonstration programme in respect of these measures covers a range of sectors;

(ii) "vertical" measures: these mainly concern improvements to manufacturing processes (using techniques to regulate and control energy flows, use of cascade heat) and the recovery of heat, at present lost, for CHP and/or district heating.

The potential energy savings to be made in the industrial sector may be put at 50-60 million toe, i.e. 20-25% of consumption in 1980.

1.4.2 Specific industrial sectors and Community action

(a) Iron and steel

I. Introduction

The iron and steel industry is the biggest energy consumer. In 1980, it accounted for 8% of the Community's primary energy consumption.

There is considerable scope for energy recovery in this industry because not only is the efficiency of modern integrated plants low (50-60%) but also the production of steel generates significant energy flows, basically in the form of heat. In view of the high process temperatures involved, these heat flows possess valuable thermodynamic properties which not only allow the heat to be recycled but also allow it to be used to generate electro-mechanical power.

The generally high cost of heat-recovery plant, however, meant that not even the most promising recovery systems seemed worth considering when energy was cheap. In addition, the steel makers felt a very understandable aversion to the idea of further complicating the main production operation which was already very complex and costly.

Today the situation is quite different and the potential savings from certain methods of energy recovery are beginning to persuade the steel industry to introduce the most promising techniques even if this means a slight reduction in the reliability of the production apparatus which is inevitable whenever auxiliary plant components are added to the main system.

There are currently 15 major energy-saving options open to steel firms (these options are followed by a + sign where they specifically relate to integrated-cycle steel works and by a ++ sign where they concern furnaces which use scrap):

- rationalization of energy use during the blowing operation (+),
- recovery of heat from the hot-blast stoves (+),
- recovery of energy from the blast furnace gas by means of a turbine (+),
- direct or indirect recovery of heat from the combustion products in the converters during blowing (+),
- recovery of heat from the shells (of the furnaces and converters) and from the steel treatment plants,
- improved operation of electric furnaces (++),
- recovery of heat from the combustion products in electric furnaces (++),

- pre-heating of scrap (++),
- recovery of heat during the warming-up of refractory materials used in casting ladles and other containers,
- conserving the heat from semi-finished products (ingots, slabs, billets, etc.),
- application of heat treatment to semi-finished products (e.g. wire rod) after rolling,
- application of unconventional methods of heat treatment,
- regulation of the rolling force,
- streamlining of the auxiliary services in order to save energy (heat, power and blowing plants; oxygen production, storage and supply installations; coking plants etc.),
- automatic or semi-automatic programming of the production and maintenance operations.

The above options may lead to practical results if use is made of the - often very different - range of technical alternatives available. The scope for action is thus very wide. In the short and medium term, the energy saving may be estimated at 10 or 15% of current energy consumption, i.e. 7-10 million toe/year.

II. Community action

Contracts for nine projects have been concluded or are shortly to be so, seven of which have been submitted by steel companies, one by a research institute and one by a mechanical engineering firm.

The total investment in these projects is about 26 million ECU and overall financial support 7 200 000 ECU.

In six of the nine cases the projects are in fields of general interest to all steelmakers, i.e.:
- recovery of heat from hot-blast stoves,
- installation of turbines to extract mechanical energy from the pressurized hot air at the furnace throat,
- recovery of heat from waste converter gases,
- pre-heating of the scrap charge to the electric furnaces by using the combustion products from the same furnaces.

Similar projects - all of great interest - are also being carried out or are planned in a number of other European steel firms.

The areas covered by the three other projects are more specific.

One aims to increase the power of electric furnaces and to achieve energy savings by making suitable alterations. The other two projects being run by firms with no connection with the steel industry and which are of interest to the metal-working industry as a whole, concern the heat treatment of steels by unconventional methods (fluidized bed or recovered heat). In six cases, the projects aim to optimize the efficiency of industrial processes: in the three others (EE/246/81; EE/074/80; EE/270/80) the aim is to recover fuel gas and/or generate electricity.

The research and development phase of project EE/074/80 has been partly financed from central government funds by the Energy Savings Agency.

III. Conclusions

The situation with regard to the nine projects is as follows:

- three are still at an initial stage and it is too early to make an assessment;
- five are in progress. No major problems have been encountered in their execution and, in at least three cases, there is every likelihood that the anticipated energy savings will be achieved;
- only one project has been completed (EE/251/79) and the results are far better than expected: the energy savings achieved are twice the forecast level.

The energy savings achieved by implementing these nine projects amount to about 147 000 toe/year.

(b) Non-ferrous metals

I. Introduction

In terms of energy consumption, this sector comprises mainly aluminium, copper, zinc and lead. The consumption of the non-ferrous metals sector represents almost 9% of the final energy consumed by industry.

The use of energy in this section can be subdivided into two distinct sections:-

(1) production of primary metal from raw materials. This process applies essentially to the aluminium and zinc industry and to a lesser degree to lead industry; virtually all European copper production is derived from scrap and imported refined copper.

(2) the melting, casting, rolling extrusion of metal into finished products.

In the aluminium industry, the total energy consumption is about 12 M toe/yr and for example, 70% of the energy demand (mainly electrical) is consumed for primary smelting, the specific energy demand of 30 to 50 GJ/tonne for the subsequent operation.

The energy conservation trend for the primary smelting operations is along the lines for improved furnace minor design changes by the control of electrolyte temperatures, using additives, re-arrangement of magnetic fields, etc., modern design of smelters yield consumptions of 16,000 kWh/tonne compared with older designs of 20,000 kWh/tonne.

In the secondary processes the main activity in energy conservation is involved in converting to continuous melting and processing from batch type operations. It can be shown that significant reductions in energy demand can be achieved resulting from reduced standing losses and better product qualities. Interest is also being shown in pre-heating furnace designs to reduce metal losses due to excessive oxidation.

II. Community action

In the non-ferrous metals sector three demonstration projects have been signed dealing with melting or smelting of aluminium, copper or non-ferrous alloys.

Two projects come from the same proposer, the Electricity Council Research Centre, one from the first call for tender in 1979 and the other from the third call in 1981. Both are follow-up of R & D work done by the proposer and the applications at demonstration level take place in industrial enterprises. Due to the limited investments involved, the EEC financial support is 40% for each of them. The third one is a joint effort by companies from Belgium and Germany who joined their R & D effort and decided to invest in a large industrial demonstration with a 30% financial support from the Community. For this project only, the energy savings foreseen are 5 000 toe/yr.
For these projects, the EEC support represents about 2.1 MECU for a total investment of 6.76 MECU.

(c) Cement & Building materials (bricks, lime)

I. Introduction

Since the processes require high temperatures, the cement, lime and building brick industries are necessarily energy intensive. The raw materials used in these industries are cheap and the major cost of production is the energy used in the high temperature process. Consequently, any energy saving is also a significant cost saving.

(a) Cement & lime

Both production processes involve calcining at temperatures up to 1400°C. In cement clinker manufacture, this is carried out in rotary kilns. Lime is manufactured in rotary kilns or vertical retorts depending on the lime quality required and the production rate. On large installations the principle fuels are pulverised coal and heavy fuel oil, smaller units producing high quality lime use premium fuels such as natural gas and distillate oils.

In the manufacture of cement almost 90% (6.5 GJ/tonne cement) of the energy used to produce the final product is consumed in kilns to produce cement clinker. It is not surprising therefore, to find that close attention is given to improving the design and operation of these kilns by more efficient firing, recovery of exhausted heat and improved insulation refractory material. With such an energy intensive area of the industry a small improvement in kiln performance represents a significant primary energy saving.

In cement manufacture the following energy conservation measures are currently being pursued :

i) wet to drier process conversions
ii) waste heat utilisation (improved clinker cooling)
iii) insulating refractories development
iv) blended cements (p.f.a. and blast furnace slag)
v) slurry moisture additives development
vi) specification changes (gypsum blending)
vii) improved grinding techniques and use of grinding aids
viii) fixation of alkalis in kiln dust
ix) use of refuse derived fuels.

The potential energy saving from the above is of the order of 40%. In lime manufacture the potential for energy conservation is more varied due to the wider variety of equipment in use.

The main areas being investigated are :

i) combustion systems development
ii) waste heat utilisation
iii) insulating refractories development
iv) fuel substitution (use of coal gasifiers etc.)

The potential for energy saving is of the order of 30%.

(b) Building Brick Manufacturers

The manufacture of bricks and other earthenware products involves materials preparation, low temperature drying at approximately 120°C and final firing at 800°C-1 000°C.
If hot air from the firing kiln is used in the drier, 80/90% (1.8/2.0 GJ/tonne bricks) of the total primary energy consumed to produce bricks can be used in the kiln. Main areas of interest in energy conservation include the use of carbonaceous wastes as an additive to some clays before firing, the recovery of heat from kiln exhaust and improvement in firing equipment.

The main area for energy conservation is in the final firing which is generally carried out in tunnel kilns.
The main areas being investigated are :

i) recovery of heat from exhaust gas from continuous kilns
ii) addition of carbonaceous wastes to raw materials before firing.

The potential for energy saving is of the order of 30%.

II. Community action

In this sector, 3 projects have been signed, one for the brick industry, where by using pulverised coal energy saving up to 60% can be expected. Normally, fuel substitution from oil to coal leads to penalties in terms of primary energy consumption. In this case, by using the latest technology for burning coal, it is possible to switch away from heavy fuel oil and still obtain significant energy savings. The replication potential is large and many parties have already visited the site of the demonstration project.

The second is in the lime industry and the demonstration is on a vertical lime. Because of the quality requirements of the finished product, many lime kilns use natural gas. A new annular ring burner will be demonstrated on an existing vertical kiln. If successful, the replication potential is large since this type of burner can be used on the existing vertical kilns of the Community.

The last project is in the cement industry and will be demonstrated on an existing cement clinker kiln. For the project, the energy saving envisaged amounts to 1 500 toe/year. With a total production of cement in the EEC of the order of 140 m tonnes, a replication of only 10% of the existing capacity could lead to energy saving of 42 000 toe/year.

For this sector, the EEC support represents almost 500 000 ECU for a total investment of 1 190 000 ECU.

(d) Chemical industry

I. Introduction

The chemical industry in the Community consumed 127.4 million toe in 1979[1]; this is equivalent to 40% of the final energy consumption of all Community industry[2]. In 1975 the chemical industry accounted for only 36.5% of final industrial energy consumption[3]. One of the reasons why the chemical industry is a major energy consumer is that the energy products it uses as raw materials account for over half of all those consumed in the chemical sector. In 1979, for example, its consumption of energy raw materials (oil products, natural gas and coal) made up 54% of the total energy consumption in the chemical industry.

[1] European Council of Chemical Manufactuers' Federations - January 1982.
[2] 311.2 million toe. (COM(81)64 final of 23 February 1981).
[3] European Council of Chemical Manufacturers' Federations - December 1980.

The chemical industry's efforts to reduce energy consumption since the first oil crisis have matched those of the rest of the industrial sector. CEFIC puts the energy savings per product unit during the period 1973-1978 at 8%[4]. Savings are probably higher in the important petrochemical sub-sector where drastic energy-saving measures have been taken and consistent investment made since the beginning of the crisis, and in the oil refining sector which is the source of most intermediate products.

As in other industrial sectors, energy savings have been secured in the chemical industry by reducing losses of materials and steam and by means of recycling and heat recovery. There is, however, now, after the remarkable progress made in the last ten years, little prospect of reducing consumption very much further by means of these techniques which have been applied to the energy required in the product manufacture.

Further substantial reductions may be made in unit energy consumption by reducing the specific losses of intermediate energy products. These can be achieved by improving process efficiency or by introducing new chemical reaction systems.

To achieve these objectives there must be an adequate R&D basis and, once this has been established, a large volume of funds to invest in new plant.

The largest potential energy savings can of course be made in the heavy chemicals industry which consumes a vast amount of energy in product manufacture and as a raw material. The main areas are fertilizers, chlorine, soda and ethylene-derived intermediates used in the manufacture of plastics, fibres and elastomers.

There is a substantial potential for energy saving in other sectors of the chemical industry, including the fine chemicals industry, but this is more difficult to quantify because of the large variety of products concerned, belonging to the following main categories:

[4]European Council of Chemical Manufacturers' Federations - July 1980.

cleaning products for various materials (wood, leather, metals)
adhesives and gelatines
explosives
medicines
cosmetics
pesticides
printing inks
photographic products.

It is particularly difficult to analyse the energy consumption of these categories of products and of the chemical sector as a whole because:

(a) the same product may be obtained from different raw materials;
(b) several manufacturing processes may be used to make the same product from the same raw material;
(c) the energy characteristics for the same process may differ according to the design of the production unit;
(d) the products marketed are intermediate products which will be used in further energy-consuming processes.

II. Community action

In view of the scale of the energy requirements of the chemical sector, in particular that of the heavy chemicals industry, the Commission has decided to concentrate on three projects in this sector. The Commission is also providing support for two projects concerned with oil refining which is an important source of chemical feedstock.

The total investment in these projects, of which a detailed breakdown is appended, amounts to 4.4 million ECU of which the Commission is providing 1.3 million ECU.

The first three of these projects which concern the heavy chemicals industry involve:

(a) a new method of manufacturing urea, which is the main constituent of nitrogen fertilizers;
(b) the recovery of heat from ash and gaseous emissions produced in the concentration and reduction of hematite;
(c) a new synthesis process for ammonium nitrate which is also used in the preparation of fertilizers.

The first project has been concluded, the second is still running and the third (which commenced at the end of last year) is scheduled to run until October 1983. The two projects in the refining sector have been successfully completed and are near the marketing phase. The first concerns the recovery of hydrocarbons in liquid effluent from refineries and the second the reduction of evaporation losses during the filling of tanks in petrol stations or tankers.

As a result, three of the five projects supported by the Commission have been completed and have every chance of commercial success. The five projects will lead to savings of 11 700 toe per year in plants and replication will give a potential of 750 000 toe per year for the Community as a whole. For total Community urea production project EE 274/75 alone could lead to savings of the order of 350 000 toe per year.

Any further Community demonstration projects in the chemical industry should concentrate on other products of the heavy chemicals industry such as ammonia, chlorine, soda, nitric and sulphuric acid and the petrochemicals sector.

(e) Glass industry

I. Introduction

The glass industry is one of the energy-intensive industrial sectors in the Community. It can be divided into three main areas of production:

(a) sheet glass
(b) glass bottles and containers and insulation fibres
(c) more specialized glass manufacture such as laboratory and instrument glass
(d) artistic glassware.

Community production in the soda silica glass (waterglass) sector is slightly more than 1 million tonnes per year and energy consumption is over 170 million m^3 gas per year.

The main measures which can be taken to achieve energy (heat) savings in the glass industry are:

(a) structural modifications to furnaces to obtain heat curves which will reduce the temperature of exhaust gases from the chamber but maintain the quality of the product;
(b) modification to furnace design and management to increase productivity (and hence reduce the specific losses) for the same chamber surface area;
(c) waste heat recovery making it possible to transfer a large proportion of the sensible heat from the furnace gases to the combustion air;
(d) improving furnace insulation;
(e) conserving heat from any intermediate products.

II. Community action

The Commission has signed a contract involving a total investment of 0.8 million ECU; the Community contribution is 0.3 million ECU. This project (EE/246/80) concerns a melting furnace. The melting furnaces normally used to manufacture glass from silica sand, powdered soda and potash are "same-way" flow furnaces.

In the demonstration project the firm has used a counter-flow furnace with a daily capacity of 80 tonnes in which the feedstock is introduced on the opposite side to that of the burners. The project is extremely interesting and the experimental furnace is in use.

An experimental furnace was started up in September of last year. There have, however, been a number of hitches and the consumption of natural gas had been higher than expected (140 to 150 m^3 instead of 124 m^3 per tonne). A saving of 15% instead of 27.5% has been achieved - as compared with 171 m^3/t - but this is still of interest.

The demonstration project has been practically completed and the energy savings achieved are around half the initial target. Further measures which may not necessarily be very costly should enable this target to be reached.

The results of this experiment may be of wide application in view of the saving of 47 m^3 of natural gas per tonne achieved (which could be extended to all furnaces). This would mean a reduction of 47 million m^3 of natural gas per year.

(f) Textiles

I. Introduction

The textiles sector has some very specific features. It is easy to define the action areas for saving heat:

- use, for air conditioning purposes, of heat emitted by textile machinery;
- rationalization of steam and air drying operations in sizing machines and similar equipment;
- recovery of heat from the smoke in the stenters (in which fuel is burned) to preheat the combustion air;
- recovery, for use in processes or services, of heat given off by stenters fed by steam or pressurized water;
- use for heating or other purposes of the heat in gaseous emissions;
- using heat pumps or self-cleansing heat exchangers to recover heat from dyeing effluents;
- possibly, the recovery of energy from waste; and
- efficient process management.

It is possible to save electricity; this depends on replacement of the textile machinery stock.

II. Community action

So far the Commission has signed two contracts in the textile sector. The investment involved was some 0.3 million ECU and financial support amounted to some 0.1 million ECU.

The first project (EE/016/79-LANEROSSI) is to recover heat in a dyebath system.

The construction phase had just been completed and the measurement programme had hardly ended and the process been started up than major departures from the forecasts were noted. This was due to poor organization, which has since been remedied. The second project (EE/133/79 - SHIRLEY INST.) sets out to demonstrate how efficient automated control of dyeing operations can give significant energy savings; it is still under way.

Of the two projects which have received support only the EE/016/79-LANEROSSI project includes an element of technological interest.

(g) Dairy industry

I. Introduction

The energy consumption of this sector can be evaluated at about 8-10 million of toe/year. The energy intensive areas of **milk** processing and the manufacture of milk products are mainly:

(i) pasteurization and sterilization (heat treatment)
(ii) evaporation
(iii) drying
(iv) refrigeration
(v) transportation.

The trends towards increased efficiency on energy utilization can be summarized as follows. Heat recovery from spray driers incorporating recovery of product which is presently lost from these devices. Heat recovery from effluent streams. Increasing number of effects in evaporators. Multistage driers. New processes such as reverse osmosis and mechanical vapour recompression to improve efficiency of water removal.

The **dairy** industry also keeps a keen interest in the developments in the solar heating and heat pump fields where improved performance of the units could prove to be useful.

The energy savings potential can be evaluated at 20-25% of energy consumption of **these** industrial services, i.e. 2-2.5 million toe/year.

II. Community action

The Commission has signed two contracts in this sector.

The aid granted was some 217 360 ECU and investments 543 381 ECU.

One of the two projects uses heat pipes to recover heat from the air in powdered milk dryers (EE/008/79). The second project (EE/008/80) uses inverse osmosis to concentrate milk.

Only one of the projects (EE/008/79) has been completed. Some 430 toe has been saved: 23% of the energy consumed by the dryers. The second project (EE/008/80) is under way and the early results are encouraging.

(h) Miscellaneous industries

I. Introduction

Three of the projects evaluated have been considered under this broad heading since their replication could be applied to any industry where relevant; the first applies to large gas users; the second to compressed air; the third to the utilization of mine gas in an industrial boiler.

II. Community action

In the 1st project (EE/314/79) a glass company wants to demonstrate that this energy can be recovered in an expansion motor to produce mechanical energy to drive a compressor.
The energy contained in the high pressure gas is normally lost during pressure reduction.
Industry uses almost 40% of natural gas consumed in the Community and large users are normally connected to the high pressure gas network.
On the other side, gas burners require pressures of a few bars.
The project is successful.
The potential for further applications concerns all large industrial gas users receiving gas at medium or high pressure.
The 2nd project (EE/167/80) has very wide applications since almost all industrial enterprises have needs for compressed air. The aim of the demonstration is to prove that part load capacity air compressors can be operated in an efficient way and save energy.
The 3rd project (EE/244/79) aims at the utilization of mine gas in a boiler whose burner had been modified. A regulation system for combustion control has also been developed. The project was successful.
The EEC support for these three projects is 240 000 ECU and the total investment is 600 000 ECU.

1.4.3 Industry Sector - Conclusions

With 27 projects receiving support, Industry accounts for a large proportion of the Community's action on energy saving. Total investment amounts to some 41.5 million ECU whilst 12.3 million ECU has been granted in financial support. Nine projects have been completed or are so far advanced that the results can be evaluated. The rest are not yet complete. Six of the nine have fulfilled the original forecasts of energy savings and reliability in operation. In almost all industrial subsectors the projects selected reflect the dominant technological trends.

Steel is foremost among the industries making an obvious technological effort, with many proposals of technological merit. In other sectors such as chemicals, glass, non-ferrous metals and cement, and in spite of some proposals of obvious value, the overall quality and number of projects are not commensurate with the opportunities waiting to be exploited.

There has not been much participation by other industries, probably because traditional technology is still widely used in them and this is a constraint on innovation. Another explanation might lie in the structure of the sectors concerned, which are characterized, inter alia, by a large number of small and medium-sized businesses which do not provide potential for major technological research and exchange little information.

Action in the steel sector must be pursued. In other industries that are big energy consumers, action should be stepped up and should demonstrate the viability and economic benefits of the following technologies in particular:

- cement: the dry process, use of derived fuels, use of waste heat, improvement of thermal insulation;
- non-ferrous metals: improvements to preheating and melting furnaces, greater use of electricity for heating, switching from batch to continuous processes;
- glass: raising furnace efficiency, waste heat as a source of low-grade heat, the recovery or elimination of heat losses in intermediate cooling;
- chemicals, particularly bulk chemicals: raising process efficiency and introduction of new chemical reaction systems;

- pulp and paper: better energy management and recovery of heat from effluents, particularly by means of heat pumps, and new paper drying techniques.

In all other industries - having regard to each one's limits and situation - Community action should continue. In addition further action by the Commission, such as the preparation of energy consumption budgets (or "balance sheets") and the dissemination of information, particularly by means of the "Energy Bus", should continue to be developed.

In dynamic sectors, and in those which have not so far been dynamic, these actions on their own cannot impart sufficient momentum to energy saving. A considerable increase in investment, dealt with in other Commission papers, is an essential precondition for achieving the Community's objectives for the efficient use of energy.

As the following table shows, industry is also a key factor in the Member States' demonstration programmes.

Table B

Industry

	B	DK	D	F	GR	I	IRL	LUX	NL	UK	EEC (4)
1. Proposals received				210[2]			24				367
2. Projects supported			12	127	-		7			110	90
3. Total financial support (m ECU)			39	148			0.29			13	43.6
4. Support per project (ECU)			3 250 000	116 500			42 000			118 000	484 000
5. Investments (m ECU)				61			7.09			61.7	135.3
6. Investment per project (ECU)				480 000			1 012 000			561 000	1 503 000
7. Percentage of investment supported			63[1]	24			4			21	32
8. Projects completed				80						13	9

[1]Average for all R&D in the sector.
[2]Including agriculture.
[3]Including projects on fluidized beds, boilers and industrial heat pumps.
[4]Community programme

1.5 Fluidised Bed Combustion (FBC)

I. Introduction

The quickest and cheapest way of making more oil available for premium use is to replace fuel oil by coal or by poor and waste fuels. In the medium term the largest growth market for coal is seen to be for industrial steam raising boilers.

In FBC boilers coal is burnt in a hot turbulent bed of ash or sand, fluidised by forcing combustion air up through the bed to maintain fluidity and to promote rapid mixing of coal and the hot refractory particles. It possesses the advantages associated with fluid liquid fuels - high efficiency and ease of control - and many significant advantages over conventional combustion methods. The advantages of fluidised bed systems are :

- High heat release and efficient transfer which allows smaller boilers to be constructed at less capital cost for a given heat output.
- Lower furnace temperatures effectively controlled below 1000°C which reduce corrosion, and fouling resulting in lower maintenance costs and greater boiler availability. Oxides of nitrogen levels are kept within most stringent emission regulations at no added cost. Non-sintered ash and less erosion of surfaces.
- Reduced Oxides of Sulphur are attained by using limestone injected with fuel in the furnace - this is much the cheapest way of desulphurisation.
- Burn poor and waste fuels, which enables useful heat to be gained from waste materials that would otherwise cost money to dispose of.
- Flexible systems matching oil burning equipment in control and performance allow coal representing 50% to 70% of oil costs on a thermal basis to be used in industrial applications to cope with quality variations without loss of efficiency and provide useful heat and/or power. The cost of FBC installations is greater by a factor of at least 2 but the pay back time can be as short as 2-3 years, after which there are cumulative savings.

All the systems which have reached the demonstration stage are of the admospheric "fluidised bed" type. A new generation of pressurised systems currently at the R + D stage could emerge during the next few years for industrial applications.

Wherever steam, hot water or hot gas are required, a compatible FBC installation is possible. Examples are : hot water boilers (for group domestic heating networks, the horticultural industry), steam boilers (of all types for general industry, electricity utilities, co-generation of steam/electricity), dryers (using hot gases for crop drying, clay industries, cement and chemical industries), waste disposal (noxious materials with safety and environmental protection, municipal waste and sewage) and combustion of low grade fuels with useful heat.

The economic returns vary with the application but, taking power generation from coal by FBC as an example, typical savings estimated are :

Costs of FBC of coal compared with pulverised fuel electricity generation	% saving on capital cost compared with a pulverised fuel (pf) station		% saving on operating costs compared with pf	
	with Sulphur Removal	without Sulphur Removal	S. Removal	No.S.Removal
	22	12	9	2

Development of the fluidized bed method depends on a number of technical factors.

First of all, it is essential that the fluid consisting of the mixture of inert particles and the particles of fuel is properly stable. In cases where the density of mixture is too variable to allow proper combustion, the required stability is achieved using a double flow of air or unsymmetrical flows of air so as to set up turbulence. Turbulence can also be created by giving the combustion chamber a special shape.

Careful attention then has to be given to problems of corrosion caused by the abrasive effect of extremely hot particles being projected at high speed against the walls of the boiler and the heat exchangers.

In order to ensure that the atmospheric pollutants remain fixed in the ash, combustion must take place at a relatively low temperature, in many cases near the point where the furnace will go out. Low temperatures also result in less fouling of the grates due to the formation of ash agglomerates.

The combustion will thus have to be controlled by a highly sophisticated regulation system which allows of very fine adjustments to the fluidization speed, the temperature and the charging rate.

There is obviously great scope for energy and revenue savings by using fluidized bed combustion for the wide range of applications outlined.

II. Community measures and national programmes

In this sector there are four contracts demonstrating the application of fluidized bed combustion to the rational use of energy in industrial processes with the objective of establishing their capability for energy saving and economic advantages. The total investment of these projects is 9.3 million ECU and the Community support 2.3 million ECU.

The first (EE/022/79) concerning combustion of waste acid tars, is the only contract completed. The second (EE/027/80) on combustion of shales in fluidized beds, has suffered some delay with the supply of equipment but start-up burning

Limburg shale is imminent, to be followed by a two years' test programme of various waste materials.

Technical and commercial demonstration under the last two contracts - (EE/190/80) atmospheric fluidized bed combustion for electricity production and (EE/126/80) fluidized bed combustion in a calcium silicate brick factory - is expected to take longer and, apart from confirming that they have every prospect of fulfilling the contract terms and proving the common economic and technical advantages of fluidized bed combustion in the rational use of energy, it is difficult at this stage to quantify the particular benefits they will provide.

The aim of the first contract (EE/022/79) is to eliminate acid tars left over from the regeneration of waste lubricants, without harm to the environment. The heat produced helps to generate the steam used in the plant. The other two contracts (EE/097/80 and EE/190/80) cover the burning of coal shales from spoil heaps or coal with a very low LCV containing a high percentage of ash and sulphur. Considerable savings can be made by substituting them for fuel oil for the generation of steam and electricity. The last contract (EE/176/80) deals with the generation of the energy required for the manufacture of building materials by burning coal with a low LCV using fluidized beds. This will save not only energy, as a result of the substitution, but also heat and transport costs, since the hot ashes are incorporated in the structure of the materials manufactured.

There is a district heating network in Denmark which uses the fluidized bed technique. In the Netherlands there are two projects supported by aid amounting to 0.93 million ECU out of an investment of 2.2 million ECU. The UK has recently increased its fund for conversion of boilers from oil to coal from 79 million ECU to 238 million ECU. Grants in aid amounting to 25% of the conversion cost have been available in France for this purpose.

III. Conclusions

The expected energy savings from these projects amount to 21 900 toe a year. If the techniques used in these four projects were applied throughout their various industries, more than 1.5 million toe could be saved in the Community each year - and this is only a small proportion of the possible applications. Further efforts should be made in this sector, particularly in respect of small industrial boilers and the burning of waste.

1.6 Energy from waste

1. Introduction

Urban, agricultural and industrial waste and agricultural by-products are potentially very good sources of energy. In theory, the contribution which this waste could make to the Community's energy supply is of the order of between 100 and 120 million toe a year. Obviously, however, only some of this waste can be exploited economically - possibly some 50 or 60 million toe a year.

The advantages of energy-from-waste techniques are that they make it possible to:

(i) produce energy (heat, electricity, biogas or alcohol) from materials whose discharge at present requires a large energy input if environmental constraints are to be respected;

(ii) obtain by-products which can be used as fertilizers or feedingstuffs (instead of importing them as now);

(iii) reduce the effect of these waste products on the environment;

(iv) improve the energy balance of agriculture.

The various technical options are examined below according to the type of waste involved.

Household waste and similar industrial waste

There are various methods of obtaining energy from waste of this kind:

(a) incineration with simple heat production or CHP.

This is a method very widely used in all the Member States and is the most cost-effective if there is a large-scale consumer (district heating network, industrial estate, etc.) to use the heat generated.

(b) Manufacture of refuse-derived fuels (RDF) from waste which is rich in combustible material but poor in fermentable material. There are several types of derived fuels:

(i) fuel obtained by using a hydraulic press to separate out the phases in order to increase calorific value;

(ii) American RDF - an unsophisticated fuel which can be burned in combination with coal in large boilers;

(iii) European RDF - more sophisticated since it makes separate use of the organic fraction (as compost) and the combustible fraction, which, once it has been dried and granulated or flocculated, can be stored and transported.

(c) Recovering biogas at the tip: the layers of waste on a controlled tip undergo anaerobic fermentation which produces biogas.

(d) Methane fermentation: the fraction of the waste which is rich in organic matter is first sorted and then may be mixed with the sludge. It can then undergo methane fermentation to produce biogas which can be used for simple (heat) or combined (heat and power) production. This process is complementary to the production of RDF.

(e) Alcoholic fermentation of the cellulosic fraction: after hydrolysis to free the sugars, the cellulosic fraction of household waste (basically paper and board) can be subjected to alcoholic fermentation.

(f) Pyrolysis: pyrolysis is a non-polluting process for the thermal conversion of household waste into fuel-oil or gas.

Currently, the only pyrolysis technique which can be used for demonstration purposes is pyrolysis of tyres.

Sewage sludge

The only way of obtaining energy from sewage sludge is by methane fermentation.

Although its use as a method of stabilization is well known, little has been done as yet to exploit the fermentation gas it produces.

Agricultural waste and by-products

(a) With waste and by-products, the most cost-effective method of obtaining energy is governed to a large extent by how wet they are. Dry matter should preferably be burned under boilers to produce heat or heat and power, whereas with extremely wet products the best methods are methane or alcoholic fermentation.

(b) Animal manure (from pigs, calves or poultry) accounts for a large proportion of farm waste. It may be fermented anaerobically to produce fermentation gas (50-75% methane) or may be mixed together, or with other urban or farm waste, before fermentation.

Industrial waste

Many industrial sectors produce waste from which energy can be extracted. Those offering the most potential are:

slaughter-houses:	stercoraceous matter, other waste and effluents
sugar refineries:	pulp and effluent
breweries:	effluent
canneries:	effluent
distilleries:	residuary and unfermented liquor
starch factories:	effluent
lumber yards:	waste
leather:	effluent

These are various methods of obtaining energy from this waste:

(i) combustion
(ii) gasification
(iii) methane fermentation
(iv) alcoholic fermentation

II. Community measures and national programmes

To date, the Commission has signed 10 energy-from-waste demonstration contracts for a total investment of 17.2 million ECU. The Community has granted support to the tune of 5.8 million ECU.

There are two other projects - one on the recovery of heat from a plant incinerating household and similar industrial waste (EE/003/80) and the other on the incineration of chaff (EE/121/79) - which are included in the section on "district heating".

The demonstration projects cover several areas:

(i) the recycling of plastics waste (EE/192/79)
(ii) the production of RDF from household waste (EE/260/80)
(iii) the recovery of fermentation gas from a controlled tip (EE/179/81)
(iv) the heating of an airport using fluidized bed combustion of waste (EE/033/80)
(v) the production of fermentation gas from agricultural waste (EE/260/80, EE/142/80, EE/285/79)
(vi) the production of alcohol and fermentation gas from rice chaff and maize cobs (EE/001/81)
(vii) the gasification of sawmill waste (EE/287/80)
(viii) the pyrolysis of discarded tyres (EE/235/79)
(ix) the incineration of urban waste and sewage sludge (EE/160/79)

All the different types of waste have been covered:

(i) urban waste (EE/192/79, EE/260/80, EE/179/81, EE/160/79)
(ii) agricultural waste (EE/001/81, EE/285/79, EE/142/80, EE/260/80)
(iii) industrial waste (EE/033/80, EE/287/80, EE/235/79)

Of all these projects, four are in their early stages, four are already in progress and one has been completed. This last (EE/142/80) involved setting up a reference and demonstration centre on anaerobic digestion. The following table shows the level of interest this sector has aroused, as indicated by the national programmes in France, Greece, Luxembourg and the United Kingdom.

Table C

Energy from waste

	B	DK	D	F	GR	I	IRL	LUX	NL	UK	EEC(2)
1. Proposals received								1			86
2. Projects supported		0		21	3			1		13	16
3. Total support (million ECU)				2,9	1,5[1]			0,107		2,4	9,3
4. Support per project				138.000	500.000			107.000		185.000	581.000
5. Investment (million ECU)				9,7	3,44			0,952		9,3	28,9
6. Investment per project (ECU)				462.000	1.146.000			952.000		715.000	1.806.000
7. Contribution to investment (%)				30	44			11		26	33
8. Projects completed								1		1	1

[1] Including research expenditure.

[2] Community programme

III. Conclusions

Much has already been achieved in this field with the help of the Community. The one project which has been completed (EE/142/80 on the setting up of a reference centre) meets a real need in Europe, particularly in respect of summarizing and evaluating the practical applications and research being carried out in the Member States and studying how to use biogas and digestion products - the most important factors which determine the viability of plants.

Community action will undoubtedly enable progress to be made in agriculture, which is often unreceptive towards promising technological innovations.

Exploiting all the resources offered by this sector will require extensive commitments to demonstration and investment projects.

Incineration of household waste and methane fermentation of sewage sludge can now be considered as proven technologies.

Future demonstration projects should concentrate on:

(i) efficient and cost-effective methane and alcoholic fermentation systems, in respect both of the fermentation process and the uses of fermentation products and by-products;

(ii) the recovery of fermentation gas from small and medium-sized controlled tips;

(iii) the institutional aspects of the use of fermentation products;

(iv) the use of industrial waste by industry itself;

(v) demonstration projects covering the best ways of incinerating agricultural and industrial waste and sewage sludge.

Demonstration projects will be required in respect of pyrolysis systems - apart from those for tyres - as soon as research has shown that plants of this kind are technically and economically feasible.

1.7. Transport

I. Introduction

Energy consumption in the transport sector represented in 1980, 24.5% (excluding maritime transport) of the Community's total energy consumption.

With the sole exception of rail traction, where there is a possibility of substitution by electricity, the operation of all transport is 98% dependent on oil.

In 1980 it still absorbed more than 44% of the oil consumed in the Community and forecasts for 1990 indicate that because of the reductions in oil impacts envisaged and because of the recourse that other sectors of the economy will have to alternative energy sources, transport will account for more than half of the oil consumed in the Community.

As far as energy consumption by sector is concerned, road transport represents 84.4% of the energy consumed by transport (58% for public and private passenger transport, and 26% for goods); air transport uses only 9.9% of the energy in this sector; railways 3.4%, and inland waterways 2.3%. Energy consumption for maritime transport in 1980 was about 26 million t.o.e., or about 16% of overall consumption.

The figures show the interest attached to paying closer attention to this sector which remains the one most vulnerable with regard to oil.

The necessity for and the importance of such efforts has been emphasised recently by the European Parliament in its Resolution of October 1981, and by the Council in December of the same year.

It should be underlined that the most significant energy savings can only result from a transport policy which lays down clearly the guidelines to be followed.

The main technical measures that can facilitate energy saving in the transport sector are as follows :

Road transport

Vehicles

- reduction of drag and rolling resistance (tyres);
- weight-saving without loss of active or passive safety;
- making clutch and gearbox systems more efficient and the introduction of new power transmission systems between the engine and wheels;
- recovering of braking energy, using flywheels or elastomers.

Engines

- reduction of mechanical losses;
- conversion of some vehicles to diesel power;
- combined cycle power plants; use of electric/hybrid propulsion;
- variable compression ratios
- automatic microprocessor control; stratified charge engines; electronic fuel injection in place of carburettors;
- electronic ignition; monitoring of fuel consumption under varying conditions;
- use of modular engines;
- new supercharging techniques.

Maritime transport

- low-consumption diesel engines;
- use of low-grade fuel;
- slow-running propellors;
- propellors with thin, flexible blades;
- reduction of hull roughness;
- anti-fouling products;
- technical and economic flexibility of on-board electricity generation;
- use of sails as an auxiliary means of propulsion;
- stern design to improve flow of water towards the propellor;
- bow design for lower speeds (economic speed);
- use of shipboard computers to improve fuel consumption.

Railways

- general use of power electronics on traction vehicles;
- extension of recuperative electric braking;
- reduction of vehicle weight;
- improvement of aerodynamics;
- improvement of supply to the catenary;
- suppression of intersections;
- improved methods for regulating traffic flow.

Inland waterways

- reducing resistance to the movement of vessels;
- reducing the unloaded weight of vessels;

- improving the efficiency of the propulsion unit;
  . increased propellor diameter;
  . optimum speed reduction in the drive system;
  . propulsion by multiple propellors;
  . use of nozzles on propellors, in sofar as they do not already exist;
- recovery of residual energy by using exhaust gases to reheat fuel tanks, reheating heavy fuel oil where appropriate, and for the provision of hot water.

Air transport

- improved aerodynamics;
- improved engines;
- improved propellors;
- development of control equipment and use of computers to reduce unnecessary waiting time on the ground and in the air;
- substitute fuels.

II. Community action and national programmes

The Commission has concluded six contracts of which two are for cars, one is for lorries and three are for electric vehicles. The 6 projects represents a total investment of 5.5 Mio ECU and financial support of about 2.2 Mio ECU.

• Internal combustion engines

All three projects in this field are valid, their interest lying chiefly in their post-demonstration scope. Project EE/178/80 concerning a modular engine has now been completed, and the results - consistent with the forecasts - are very valuable. Project EE/262/79 on electronic cold-start systems is still in progress, while EE/221/81 (energy recovery with a Rankine cycle, for use in lorries) has just begun.

• Electric vehicles

All three projects concern electrically-powered vans for use as company vehicles in towns. Two projects (EE/85/80 and EE/130/80) will use the same vehicles in different climatic and traffic conditions, while the third (EE/161/80) will use vans with a higher payload (800-1 000 kg). All three are in their early implementation stages.

III. Conclusions

As pointed out above, transport consumes almost one-fourth of the Community's energy. Out of the approximately 990 proposals received in response to the three calls for projects, however, only 75 (less than 8%) were concerned with transport. Of the projects selected, the proportion is still lower - less than 4%.

National programmes show the same relative paucity, except for that of France, where a number of applications for heavy lorries are being demonstrated.

The disproportion between the significance of the transport sector in terms of energy consumption and the number of related projects is the more surprising since transport, in contrast to other sectors of the economy, has exhibited in recent years, a significant increase in oil consumption.

It would be necessary to discuss with the parties concerned the reasons behind this relative lack of interest in demonstration projects by the transport sector.

More particularly, it would be desirable to carry out an analysis with the professional bodies concerned, at the Community level, and particularly in the sector of land transport, related to ways of achieving energy savings that reflect the potential that exists in this sector, and which can reverse the current tendency.

1.8 Agriculture

I. Introduction

Agriculture accounts for nearly 8% of the Community's total primary energy consumption or approximately 76 million toe, broken down as follows: direct consumption 1.9%; indirect consumption (fertilizers and other agrochemicals) 3.7%; industrial processing of agricultural products 2.4%.

Although the opportunities for energy saving are modest in absolute terms, they are still significant in that they could ultimately represent 20% of the sector's total consumption.

From the energy standpoint, the agricultural sector has the advantage of being able to make productive use of low-grade waste heat scorned by industry, which often has difficulty disposing of it. The chief areas for energy saving are:

- drying of agricultural products (fodder, grain, etc.) using appropriate heat-recovery systems;
- improving the efficiency of industrial processing, and heat recovery e.g. in the dairy sector, sugar refining and brewing;
- generating electricity with biogas, in livestock rearing (pig units in particular);
- transfer of low-grade heat to farms, glasshouses, etc., by means of heat pumps; insulation and improved ventilation in the heating of farms and stock-rearing units in particular;
- heating of greenhouses or tunnel cloches with waste heat from industry.

II. Community action and national programmes

The Commission has signed three contracts so far. Investment totals 1 914 000 ECU, with financial support of approximately 703 400 ECU.

The aim of the first project (EE/278/79) is to use waste heat from thermo-electric power stations for agricultural purposes and that of the second (EE/209/79) to use the waste heat from a nuclear station in farming. The differences between them relate to climate, the source of heat and the production of different agricultural products.

The third (EE/002/80) - concerned with improvements to a fodder-drying plant - is more industrial than agricultural. It has been completed and has provided energy savings of 200 toe in the course of a fodder-drying campaign. The others are in progress and their value lies in exploiting waste heat.

Agriculture is represented in all the national programmes. The United Kingdom, for example, is supporting six projects and has provided aid totalling 0.7 million ECU, equivalent to 36% of a total investment of 1.8 million ECU. In Greece three projects with a total investment of 0.8 million ECU have received 100% support.

III. Conclusions

The three projects are in different countries and different sectors of agriculture.

One (EE/002/80) has been completed and is already making substantial energy savings, given its size. If the process were applied to all fodder drying throughout the Community it would save some 10 000 toe/year.

It is to be feared, however, that diffusion of the techniques demonstrated will not be easy because farms are scattered. The demonstration programme is therefore unlikely to bring all the expected benefits, so it is suggested to cut back the programme in this sector.
It would be emphasized, however, that many proven techniques may be extremely useful in this sector and also be eligible for support, and Community support in particular, from financial instruments better suited to the needs of farming enterprises.

1.9 Energy Saving - Conclusions

1. The potential energy savings in the Ten are very large. Estimated savings in 1990 are 60 million toe/year in the building sector; 50-60 million toe/year in industry; 30 million toe/year in the transport sector; and 10-15 million toe/year in agriculture. The potential savings from district heating and the combined heat and power can be put at 50 million toe/year, with a further 50-60 million toe/year for energy from waste. In total terms, bearing in mind a degree of overlapping between sectors, the savings may be estimated at 130-150 million toe/year for the Community in 1990 or 12-14% of gross energy consumption.

2. The anticipated energy saving from Community projects already approved is about 700 000 toe/year. Depending on the nature of the projects and on the efforts made to disseminate the results, an important multiplier factor could be expected.

   The characteristic feature of these projects is that the energy savings obtained vary depending on the technology which they employ. In the industrial sector, for example, one project alone (EE/074/80) will save a steelworks 100 000 toe/year; the nine projects in the residential building sector will achieve no more than 60 toe/year. This is due to the inherent differences between the sectors and the nature of the projects. In some sectors, such as building or transport (where each unit has a low energy consumption but is also representative of a large stock or fleet: one-family houses and motor vehicles) the amount of energy saved by a given project is small but potentially very high in terms of the number of similar applications possible.

   In other cases, for example project No EE/142/80, for the establishment of a European centre for the re-use of wastes, the importance of the project lies not so much in the potential direct energy savings as in its value as a demonstration and in promoting the diffusion of promising technologies.

3. The average investment and support for the 186 Community projects is 1.47 million ECU and 0.43 million ECU respectively.

Turning to the national programmes, a number of Member States (France and the United Kingdom in particular) tended to support a large number of fairly low-cost projects (914 in France, with an average level of support of 0.034 million ECU; 166 in the United Kingdom, with an average level of support of 0.11 million ECU). One Member State (the Federal Republic of Germany) selected only 30, with support averaging 4.9 million ECU.

As can be seen, Community action falls midway between these two extremes.

This is due to the Community's need (a) to offer - on a fairly limited budget - the same demonstration opportunities to the maximum number of economic operators throughout Europe and (b) to keep within the limits imposed by its ability to manage **projects** and its coordinating and incentive role.

4. Since the Community programme covered a fairly wide range of possible applications, a large number of proposals was received; this enabled the best to be selected.

The majority of the projects accepted are of a high technical standard. They reflect the predominant technological trends in their fields; often they are a follow-up to an R&D phase financed from national and/or Community sources. Of the 23 projects whose results can be assessed, 13 can be reckoned a complete success and their commercial exploitation assured; the other ten are a partial success; in the case of one project, (EE/022/79) concerning a fluidized bed, repayment of the Community's financial contribution has already begun.

5. Although the programme should offer a fairly broad range of applications, greater attention should be directed in future to industries which are big consumers of energy and to tertiary-sector buildings, to fluidized-bed technology and to energy from waste. In other sectors, such as transport, agriculture, residential buildings, specific industrial sectors and remote (e.g. district) heating, efforts should be pursued within the fairly tight limits imposed by the nature of the sectors, as mentioned in the assessment (evaluation) report.

6. To conclude, when Regulation No 1303/78 comes to be amended, it would be expedient to extend its scope to projects which, while offering a modest energy saving, are concerned with the replacement of oil by alternative and renewable energy sources or ones in secure and abundant supply.

Table D

Energy Saving Programmes

	B	DK	D	F	GR	I	IRL	LUX	NL	UK	EEC (8)
Start of programmes	1976[1]	1976[2]	1974[2]	1975	1979[2]		1981	1979	1977	1978	1979
1. Proposals received				(827)[4]			95	21	150		991
2. Projects supported			30	914	12		9	12	50	166	186[6]
3. Total amount of support (m ECU)			147.5	30.9	7.6[7]		0.46	0.14	5.4[5]	18.2	80.7[6]
4. Support per project (ECU)			4 917 000	33 800	633 000		51 000	12 000	108 000	110 000	434 000
5. Investment (m ECU)				88	19.5		10	1.14		74.5	273
6. Investment per project (ECU)				96 000	1 625 000		1 111 000	95 000		449 000	1 470 000
7. Support as a percentage of investment			63[3]	35	39		5	12		24	30
8. Completed projects				552	3			12			23

[1] Prototype development programme.
[2] RD&D programme.
[3] Average of all RD&D in the RUE sectors.
[4] Excluding Building sector.
[5] Budgets for 1977–81.
[6] Projects approved by the Commission. Projects withdrawn by proposers represent a total of 10.6 million ECU.
[7] Including research expenditure.
[8] Community programme

ALTERNATIVE SOURCES

2.1 Solar energy

I. Introduction

Solar energy is clean, inexhaustible and abundantly available; however, its density at the earth's surface is relatively low (a maximum of 1 kW/m^2) and varies considerably according to the time of day, the climate and the season. This energy source is therefore unfortunately only available to us in an extremely irregular fashion.

Although wind and wave energy are also considered to be forms of energy derived from the sun, this chapter discusses only projects for the use of solar energy proper.

Solar energy is used mainly via the following methods:

- the production of heat at different temperature levels;
- the direct generation of electricity by means of photovoltaic solar cells;
- the utilization of biomass.

R&D at both national and Community level have focused on these main lines of development. According to the resources that will be devoted to RD&D and other promotion activities, it can be estimated that the contribution of solar energy at the end of the century will amount to approximately 60 million toe, which represents 5% of the Community's estimated primary energy consumption at that date, namely 1 200 million toe. This figure, which depends largely on the way oil prices are assessed, could be broken down roughly as follows: heating applications: 3%, photovoltaic conversion: 0.5% and biomass: 1.5%.

For the purposes of this assessment, the projects supported by the Commission have been grouped together into three fields according to the extraction technologies applied:

- solar heating;
- photovoltaic conversion;
- biomass.

2.1.2 Solar heating

I. Introduction

The difficulty encountered in applying solar heating technologies resides in choosing the optimum solution from an energy standpoint. The following are the main areas in which such technologies are applied:

- buildings, with passive and active solar heating systems;
- swimming pools;
- agricultural applications;
- industrial applications.

a. Buildings

Passive solar heating systems fall rather within the scope of architectural design and microclimatic parameters. The most widely-used systems are greenhouses, storage walls (e.g. of the "Trombe" type), ventilation by temperature differential, direct gain through the windows, etc.

An active solar heating system requires technical components that enable the solar installation to operate with back-up from devices such as pumps or blowers.

The utilization problem is closely connected with that of storage (day/night, fine weather/bad weather and summer/winter), which normally applies only to small units (the heating of individual dwellings between 100 and 200 m^2 in area, of apartment complexes covering between 1 000 and 5 000 m^2, and the operation of water heaters providing between 300 and 5 000 litres of hot water at approximately 50°C per day).

b. Swimming pools

The conventional techniques used to reduce energy requirements essentially comprise covers for open-air pools and the recovery of energy extracted from indoor pools.

The following solar systems are in current use:
- simple unglazed collectors, from which the heated pool water is drawn;
- flat glazed collectors with heat exchangers for indoor pools and the production of hot water.

c. Solar energy applications in agriculture

The main applications in this area are:
- heating of greenhouses;
- crop drying;
- various other energy requirements (e.g. preparation of feedingstuffs).

d. Industrial or similar requirements

The systems to be demonstrated depend on the process temperatures required:

$30^{o}C - 50^{o}C$: ordinary flat collectors;
$50^{o}C - 120^{o}C$: evacuated parabolic trough collectors;
$80^{o}C - 300^{o}C$: concentrating collectors.

Increased use of solar energy in industry depends on certain factors such as the daily process heat requirements, the presence of competent technicians and profitability constraints.

II. Community action and national programmes

The Commission has selected 65 projects in this sector, of which 12 have been withdrawn by the proposers. The 53 projects represent a total investment of 32.5 million ECU and receive financial support amounting to 8.8 million ECU.

The contracts had not been signed for all of these projects when this evaluation took place. Consequently valuable results were only available from the projects from the first call for proposals (11 running contracts). Two of these 11 projects are completed, the others are well advanced.

The 53 projects receiving support can be divided into sub-sectors as follows:

1.

Sub-sector		Number of projects
Buildings		19
of which		
- hot water production	4	
- hot water + heating	8	
- heating	4	
- heating + air conditioning	1	
- heating, air conditioning and hot water production	2	
Agriculture		6
Industry		6
Swimming pools		22

According to the technology used, these 53 projects can be grouped as follows :

2.

Technology	Number of projects
Passive systems	3
flat plate collectors	39
concentrating collectors	7
Active systems	46
Active + passive systems	4

This distribution of projects indicates that all the sectors are covered. The high number of projects in the housing and building sector (see also 1.2.) underlines clearly the fact that this sector will be in future the most promising one from the viewpoint of replacing primary energy for heat and hot water supply. It is regrettable that not all the projects in this sector make sufficient use of passive energy conservation systems as a precondition for active systems. The technology used, mainly flat collectors, is mostly well proven. But in spite of this, only very few projects are economic or near the economic threshold.

The application of solar energy for swimming pool heating is the field where solar projects reach the best economic results. Due to the low temperature needed simple and cheap unglazed collectors are normally used for outdoor pools working with excellent thermal heat exchange efficiencies. Pay back periods down to 5-8 years are achieved. More expensive glazed collectors are used for indoor pools or, if used for outdoor pools, permit the extension of the bathing season. This sector covers 55 individual public pools, spread over all Member countries. The annual energy production by the solar installations of these pools is estimated at about 1500 toe. The results of the coordinated monitoring programme will stimulate a better design of future solar heated swimming pools. Besides the effect of oil-substitution by the solar collectors the big number of pools (and collectors) permits an industrial mass fabrication and the capability of solar energy is well demonstrated to a large public using the pools.

The agricultural and industrial sector are represented by some projects. The agricultural projects which use simple technologies (flat plate collectors) for the production of process heat at temperatures below 50°C could bring useful results for future economic plants. The industrial projects with temperatures above 200°C use sophisticated technologies which are far from being economic. The following table shows the demonstration projects in progress in the Member States.

Table E

Solar heating

	B	DK	D	F	GR	I	IRL	LUX	NL	UK	EEC(4)
Start of programmes	1978	1976	1978[1]		1979		1980	1979	1978		
1. Proposals received			180				1	10	20		210
2. Projects supported			104	9[2]	4		1	3	15		55
3. Total support (million ECU)			21,1	0,4[2]	1,4[1]		0,29	0,14	1,1		9,5
4. Support per project (ECU)			203.000	45.000	350.000		290.000	47.000	75.000		173.000
5. Investment (million ECU)			21,1	0,8[2]	1,4			0,71	2,2		34,6
6. Investment per project (ECU)			203.000	90.000	350.000			235.000	147.000		629.000
7. Contribution to investment (%)			100	50	100			20	50		27
8. Projects completed			ca. 70	6	.-			1	5		3

[1] Demonstration programme conducted in public buildings (ZIP /forward-investment/ programme).
[2] AEE programme only; the COMES has a 1979–82 budget for the solar heating, photovoltaic conversion and wind power sectors of approximately 45 million ECU, of which 60% is devoted to demonstration.
[3] Including research expenditure.
[4] Community programme

III. Conclusions

In summary it can be said that for this sector the programme in its present conception has certainly helped and will still help the solar industry to find its orientation in the solar energy field, to get confidence in good promising applications and to abandon problematic issues.

Due to the high diversity of technologies applied in the different fields and taking into account the very early stage of many of the projects, it is extremely difficult to estimate on the basis of the results obtained with some projects the possible contribution of thermal solar technologies to the energy balance of the European Community.

The national distribution of the different projects indicates that priority is given in northern and middle regions of the Community to the housing sector mainly due to the high energy demand for heating. A greater interest for agricultural and industrial projects exists in the southern regions where higher daily and yearly periods of sunshine encourage such projects.

There is a high potential for export markets for most of the solar applications demonstrated.

It is a very positive aspect of the Programme that the size of tendering firms varies between very big companies and small private companies.

In future emphasis should be given to projects including :

- passive solar systems and combinations of passive and active solar systems,
- seasonal storage systems,
- solar greenhouses,
- solar drying processes.

- Industrial projects with high process temperature (> 200°C) should only be supported if simple technologies could be used. Present projects are often very sophisticated leading to very high capital costs which cannot be recuperated during the life-time of the plant by the amount of solar energy produced.

- Preceding R + D should better be integrated in the project design. The contractors should still more take into account and exploit results of R + D on national and international level.

- Taking into account the importance of the programme for solar-heated swimming pools presently carried out by the Commission and the state of commercialisation reached by the technologies applied in this field, it does not seem that there is any need for further demonstration projects in this field.

2.1.3. Photovoltaïc

I. INTRODUCTION

The direct conversion of solar energy to electricity by photovoltaïc solar cells is one of the most promising of the new solar technologies. Solar cells can make use of diffuse as well as direct sunlight and have the advantage of silence, cleanliness, simplicity, modularity, long life and easy maintenance. Although still expensive, they have become progressively cheaper over the past seven years and there is considerable scope for further cost reduction.

The photovoltaïc cell cost being today on the free market about 7-10 $/Wp, a cost reduction down to 1-2 $/Wp in the future might be achieved by using highly automised production lines for producing big numbers of cells (mass production effect) and by cheapening the presently used silicon as cell material. Further cost reduction underneath 1 $/Wp will require considerable effort in the development of the basic cell material and the application of thin film cell technology.

Solar cells are already economically viable for many remote stand-alone applications like telecommunications, remote instrumentation, navigation lights, radio beacons, cathodic protection of pipelines, highway warning signs, alarm systems, etc. There is a rapidly growing commercial market for such applications. Before 1990, photovoltaïcs may well begin to compete with diesel generators for such applications as water pumping, disinfection, desalination, irrigation and rural electrification, particularly in developing countries.

II. Community action and National Programmes

Out of a total of 25 proposals in photovoltaïcs received on the two first calls for tenders, 4 projects have been selected for financial aid. These 4 projects represent a total investment cost of 1.085 MUCE and receive a financial aid of 418 401 UCE.

ELF's micro-irrigation project (SE/77/79) is clearly the best of the four. Well conceived, executed and operated, the system has worked satisfactorily since 1979, providing valuable data and publicity which will no doubt help to promote the future optimisation and exploitation of solar irrigation. The involvement of agricultural research institutions has greatly contributed to the success of the project.

The other three projects all embody more advanced components, and therefore involve a much greater element of technological risk.

Galileo's project (SE/17/79) would have fared better had they, like ELF, chosen a fixed flat-plate array of proven modules and limited themselves to a demonstration of agricultural cooling. As it is, they have had to contend with serious technological problems in the concentrator system and are now faced with the almost impossible task of obtaining further supplies of the special solar cells.

Leuven (SE/29/79) have also encountered problems in the development and in house manufacture of their advanced low-cost solar cells and modules, which have delayed the construction of the generator for their electric car project. But they have learned a lot and hope to start operating and monitoring the system in June this year. With the elimination of battery changing and the choice of an energy-efficient car with regeneration braking, this could yet prove an interesting and successful demonstration. Economic viability, however, is further off than in the case of water pumping and irrigation and it depends, inter alia, on a marked improvement in the performance and range of electric vehicles.

It is perhaps too early to pass judgement on Gent's project (SE/147/81) but the conception is good and, if it is well executed, it should provide an excellent opportunity to study and demonstrate all aspects of a grid-connected solar generator. The importance of good public exposure has been realised and the co-operation of the local utility company should be of mutual benefit.

The Netherlands, Ireland and Luxembourg have each adopted a project in this field. The Netherlands envisage the carrying out of an investment of 0.75 m ECU with the help of financial support of 0.22 m ECU (30%); Ireland is in course of completing a project with financial aid of 1.16 m ECU, and Luxembourg has granted 0.1 m ECU to an investment project of 0.6 m ECU (18%). Greece has supported four investment projects of around 3 m ECU with a total of 0.84 m ECU (28%).

III. Conclusions

Already the fact that out of 240 solar proposals received, only about 10% were photovoltaic projects and that out of these 25 photovoltaic proposals only 4 i.e. less than 20% were selected, receiving a total financial aid of about 0.418 MUCE, i.e. less than 2% of the total sum of 22.5 MUCE provided for 84 projects selected, shows that the photovoltaic technology has not yet reached the same state of development and maturity as is the case in other fields of solar energy use.

In a short range, commercial application of photovoltaics will be limited to specific purposes and sites with low consumption like telecommunication, remote instrumentation, highway warning systems, alarm systems, electricity supply to remote houses or refuges in high mountains or other isolated areas etc. However this is a negligible energy supply and is without any tangible influence or consequence on the energy balance of the Community. The technology applied in this field in normally modest dimensions is well developed and needs no more substantial aid in the framework of the Commission's demonstration programme.

In a medium range, photovoltaics may be applied in the field of electricity supply for remote establishments like farms, mountain hotels or restaurants, small groups of remote houses etc., and this in Community countries, but also in developing countries. The demonstration of the operating behaviour (dynamic behaviour under different load conditions, behaviour under various meteorological and climatological conditions in different geographic areas) of well designed flat-plate module photovoltaic installations in the power range of some KW with adequate power conditioning systems should be the subject of future photovoltaic demonstration projects in the Commission's programme. However besides these technical considerations, a perceptible cost reduction of the cells available on the market is indispensable (necessary).

In the field of large scale electricity production, photovoltaics will have to compete with electricity produced by central power stations, the efficiency and economy of which have been brought to excellent values after a long period of technological development. Therefore large-scale photovoltaic electricity production should be considered as a long-range aim.

The efforts made in the framework of the photovoltaic pilot plant programme run by DG XII presently will make an important contribution to further development of photovoltaics towards the demonstration stage and even further. The results of these pilot projects will be an important help in the definition of future demonstration programmes in photovoltaics.

2.1.4. Energy from Biomass

I. Introduction

The subject of energy from biomass involves the conversion of renewable material of biological origin to useable energy obtained directly in the form of heat or through intermediate solid, gaseous or liquid fuels, and the generation of electricity.
In its treatment as a subject for R&D and demonstration programmes the techniques, which are essentially common to basic types of material, overlap into the subjects of energy conservation and waste treatment.
Though the basic technologies are understood, their feasibility in individual cases depends primarily on economic factors - the opportunity cost of the feedstock, the competitive cost of conventional fuels, and the cost of the equipment. The state of art of the main lines of development in terms of feasibility of different propositions can be summarised as follows :

- Combustion
  Many possibilities exist for the conversion of fossil fuel plant to use biomass material.
- Thermal gasification
  There are a number of developments of relatively small-scale equipment in Europe and elsewhere using new and improved designs. Some of these can be regarded as being commercial propositions. An optional subsequent stage to gasification-liquid fuel synthesis- is still essentially at the R&D stage, as is pyrolysis or direct liquefaction to form synthetic liquid fuels.
- Fermentation
  The technologies of alcohol production for the beverage industries are very well advanced and further advances in the synthesis of alcohol and other potential fuel chemicals are predicted as one of the main thrusts of biotechnology. However, lower value fuel alcohols may prove to be too costly to produce and in some the processes consume more energy than is contained in the alcohol produced.
- Anaerobic digestion
  This is recognised as being highly suitable for extension to demonstration phase from the very extensive R&D activity now underway on a variety of

materials, but particularly cattle waste. A key factor in economic feasibility is seen to be the size of digester or through-put of material.

- Energy crop production

  There are several prospects for these: catch-crops grown as part of established agricultural rotations; energy plantations of special energy crops grown on land dedicated in the long-term to this form of production, and including short rotation forestry; various sorts of aquaculture using micro-or macro-algae.

  Depending on the nature of the material produced either established combustion or digestion methods may be used for conversion.

Considerable R&D has been done and in the case of catch crops and energy plantations some schemes are clearly suitable for demonstration.

The above notes indicate the broad lines of major development potential. However, the wide variety of prospects and the relatively small scale of most projects means that there may be opportunities for individual cases of all kinds to stand on their own merits.

A key point is the often close integration of biomass energy schemes with the sectoral activities with which they are associated. In consequence it is not always possible to separate easily the costs of the energy-conservation components of a scheme from other parts of it. For instance the biomass energy route may be "built into" a waste disposal facility. Biomass routes may also be closely integrated with other renewable alternative energy systems and a number of the demonstration schemes dealt with here are of this kind.

II. Community action and National Programmes

Out of a total of 38 proposals in biomass received on the two first calls for tenders, 15 projects were selected for financial aid. These 15 projects represent a total investment cost of 32 MUCE and receive a financial aid of 10 6 MUCE.

For two of the projects selected it was decided not to proceed with the Commission's offer of support.

A wide range of project types is being demonstrated, broadly consistent with the main opportunities perceived and lines of technological development favoured in Europe :

- 7 out of 10 projects are concerned with digestion, 3 of these in association with other alternative energies like solar and wind energy;
- 3 are primarily concerned with combustion and this is a minor component in one other;
- 1 is concerned with gasification;
- 3 utilise cattle waste as the sole feedstock and this is a major component of 3 other schemes.
- 2 are wholy concerned with poultry waste and 1 with pig waste. These are components in 3 other schemes;
- 2 schemes utilise dry crop waste and this is a component in 1 other;
- 2 prospects deal with energy crops.

Energy contributions vary from a few tens of tonnes oil equivalent saved each year to 11,000 toe/y, and from small more or less continuous electricity supplies to 5MW main load provision. Successful projects will result in total or part self-sufficiency in energy and in 3 cases there is provision of electricity to the national networks, either arising as a surplus or as the main or major aim of the project.

On the criteria of project cost per toe saved and investment repayment times, projects show considerable differences. This is, however, partly due to the inclusion, in a number of cases, of substantial elements not directly or not fully attributable to the energy generation and supply systems. In some cases the energy-conservation elements are so integral to the system that they cannot be satisfactorily separated out and costed.

The projects are all supported by substantial R&D, usually from a variety of international sources, and, as demonstration projects, are primarily concerned with the new application of proved equipment and techniques in environments ranging from individual farms or agri-industries to communities and national utilities.

III. Conclusions

The importance of biomass in solar energy is underlined by the fact that some 40% of the solar budget is being used to support biomass demonstrations. Two of the demonstrations are particularly important - Bord na Mona and Société d'Energie Electrique de l'Est - and account for approximately 30% of the total solar budget. Although it is yet too early to judge whether or not these two major "energy plantation" projects will provide energy at economic cost, a certain optimism is justified.

Small scale technology is not neglected in the programme and demonstrations at the farm level e.g. Azienda Zooagricola il Prato S.p.a. (226/81) and A.I.R.D. (45/81) offer good prospects. Experience obtained in such demonstrations will allow the development of applications inside the Community and outside in the developing countries.

The biomass research programme of DG XII, particularly the biomass pilot projects, will make a useful contribution in the development of new techniques in the demonstration phase.

Commercial prospects arising from successfull demonstrations will be :

- Energy cost-saving in individual situations that are translatable to major agricultural and industrial sectors both inside and outside the Community.

- Direct contributions to public electricity supplies.

- The promotion of sales of a wide range of specialised and general purpose items of equipment resulting from the creation of substantial new markets, inside and outside the Community.

- Similar major prospects for system engineering expertise worldwide.

In the future, apart from guidelines given in the conclusion to chapter 1.6., demonstration in this area should concentrate mainly on energy crops, including short-rotation forestry and catch crops.

2.1.5. Conclusions of the "solar energy" sector

The Community programme has covered the main utilisations of solar energy; these are the thermal use, the photovoltaic use and the use of biomass. The thermal solar and the biomass technologies are more advanced than the photovoltaic technology, which is shown also by the number of projects proposed and selected in these three fields.

The thermal use of solar energy is at the moment most advanced, especially the application of low temperature collectors for the production of hot water and heating in the building and tertiary sector. Two thirds of the thermal projects of the Community programme cover this sector; the remainder concern agricultural and industrial applications (this latter with more advanced collectors for higher temperatures).

The shortest pay-back periods of 4-5 years are presently reached by very simple low temperature collector systems as they are used for swimming pool heating and for warm water purposes in agriculture.

Emphasis should be given inthe short term to the following solar projects :

- passive solar systems and combinations of passive and active solar systems
- seasonal storage systems
- solar greenhouses
- solar drying processes

Very few photovoltaic demonstration projects are supported by the Commission up to now, mainly due to the fact that this technology is still in full development. Only a considerable cost reduction in photovoltaic cells could bring such projects near the economic threshold. One should wait for the results of the pilot plants realised in the framework of national and Community R & D programmes before further demonstration projects should be started.

The use of biomass is very promising for the future in respect to the substitution of hydrocarbons. One fifth of all Commission solar projects with a financial volume of 40% of the total solar budget cover this sector; most of them produce biogas by anaerobic digestion of animal waste and some of them are based on combustion of solid agricultural waste or energy crops. The combustion and digestion technologies are already now economic or near the economic threshold. Further projects in these fields will be promoted but also those using other technologies (gasification etc.) when the R & D phase is finished.

The degree of utilisation of solar energy will result in future from the influence of the following main factors :

- cost of installations
- their reliability
- support to investment
- evolution of fuel prices.

The results of the Community demonstration programme will mainly influence the first two of these factors.

2.2 Geothermal energy

I. Introduction

Two types of geothermal energy source currently lend themselves to exploitation:

- "high-enthalpy" sources comprising reservoirs of steam or water/steam mixtures at temperatures exceeding 150-200°C, mainly tapped to produce electricity;
- "low-enthalpy" sources consisting mainly of reservoirs of water at temperatures lower than those quoted above, which are in the main tapped to provide space heating for dwellings or other premises and to heat greenhouses.

At the current state of the art within the Community the prospects for developing geothermal energy are attractive in several countries. Although in the short term prospects are brightest in France, Greece and Italy, where the exploitation of indigenous energy sources is of special importance in view of these countries' energy dependence, other countries, and in particular Belgium, Denmark, the Federal Republic of Germany, the Netherlands and the United Kingdom could derive medium-term benefit from this energy source.

It is no easy matter to make a quantitative estimate of the likely uses of geothermal energy, in view of the hazards involved in discovering and tapping sources. Nevertheless, broad approximations can be made on the basis of the studies, research and projects under way. In 1990, roughly 2 000 MW of electricity could be derived from geothermal sources and by the end of the century the figure could reach 5 000 MW. Annual production would be about 40 TWh (≙ 9.2 million toe). The number of dwellings heated by geothermal energy could be about a million in 1990 and 4-5 million around the turn of the century, or in other words about 3% of all dwellings within the Community. If the equivalent fuel consumption per dwelling is 2 toe, geothermal energy could provide 8-10 million toe for space heating. Overall, therefore, geothermal energy could contribute about 20 million toe per year towards the Community's energy requirements by the turn of the century. These figures could be higher if the research into "hot rocks" could lead quickly to industrial-scale use.

Although this particular source cannot cover much of the energy requirement, it is nevertheless especially important at local level in certain regions of the Community and enables more rational use to be made of energy if only for transmission reasons. In addition, the development of a Community "geothermal industry" may have beneficial effects on industry and on the balance of payments in view of the potential extra-Community market.

II. Community action and national programmes

Since Regulation 1302/78 was adopted three calls for proposals in the geothermal energy field have been published. The 44 projects adopted[1] represent a total investment of 300 million ECU. Community financial support amounts to 28 million ECU.

It must be stated that a typical project is divided into three main operating stages:

- the drilling stage with the sinking of the production borehole or boreholes and, if needed, the reinjection boreholes. The results of this stage are decisive for the future of the project;
- the placing in service of the well or wells, installation of the pumping systems for distribution and reinjection as appropriate;
- the construction and placing in service of the surface facility intended to tap the geothermal energy sources.

In most cases Community support is granted on a stage-by-stage basis. Most of the projects are currently at the drilling stage, which is therefore receiving most support. It should be noted that several of the projects adopted for demonstration purposes had already received Community research support, thus providing a logical link between research and demonstration.

---

[1] Including the nine projects adopted on 16 November 1981 under the procedure provided for in Article 6(2) of Council Regulation 1302/78.

The state of progress of the projects adopted is as follows:

- exploitation begun	2 projects
- surface facility being built	2 projects
- drilling stage completed	14 projects
- drilling stage under way	7 projects
- in preparation[1]	14 projects

In view of the diversity of the projects and their state of advancement it is not easy to lay down rigid assessment criteria. The projects were firstly grouped together by field of application so that the level of exhaustiveness and representativeness of all the options explored could be appraised, as could the coordination and interaction between the various projects. Secondly, each project, depending upon its state of progress, was assessed from a technical/economic standpoint against the targets and the likelihood of obtaining practical results having general appeal.

The fields in question are as follows:

(a) space heating and the heating of buildings in the tertiary sector;
(b) greenhouse heating;
(c) energy production from brines;
(d) electricity production from endogenous steam;
(e) production of electricity in combination with other activities;
(f) use in industrial processes.

Field (a) comprises 31 projects, field (b) 8 projects - some of which also cover space heating - and field (c) comprises 5 projects, while the remainder consist of one project each.

Projects concerned with space heating and the heating of dwellings, tertiary-sector buildings or greenhouses are by far the most numerous. This is because it is possible to tap "low enthalpy" sources in most of the Community countries, whereas "high enthalpy" is only exploited in Greece and Italy.

Several projects demonstrating the heating of dwellings, tertiary-sector buildings and greenhouses have proved their worth by demonstrating the existence and potential use of sources in regions of the Community where geothermal energy had been unknown. This was particularly the case in certain regions of France (where, following the initial Community projects, others are now under way) of Northern Italy, of Northern Denmark and of South Western Germany.

There are other projects in "geothermally new" regions, but so far no results have been available. Where it has been possible to assess how far the energy sources in all of the projects in this sector can be tapped, one can say that about 60% of the estimated potential of the geothermal energy can be recovered to heat dwellings and tertiary-sector buildings and about 90% to heat greenhouses. These percentages must be interpreted with care since (a) the risk, mainly at the drilling stage, inherent in geothermal energy projects is always high and (b) there is always considerable uncertainty when estimating potential. It must also be stressed in general terms that even where a project is abandoned after the drilling stage, the geological and technical information and know-how acquired are always considerable.

Electricity generation from high-temperature brines holds great appeal. Indeed, this may prove to be a good way of extracting considerable quantities of energy from existing geothermal sources. The results so far obtained from demonstration projects allow it to be stated that about 50% of the estimated geothermal energy can be recovered. The progress made so far by the projects in the other electricity-generation sectors does not enable the recoverable resources to be assessed. The difficulties in exploiting such sources are considerable, but if positive results are obtained the prospects are so bright that the high risk factor can be considered acceptable.

Finally, it is regrettable that the use of geothermal energy for certain industrial processes has so far led to no demonstration projects. The only project adopted, which was highly promising and which involved heating and drying operations in a malting had to be withdrawn by the proposer because of administrative difficulties. In future special attention would have to be given to the promotion of projects of this type.

National action

Although the demonstration stage has now been reached in most Member States, an ad hoc funding programme for demonstration projects only exists in France. In the other Member States there are no special structures for demonstration projects and such projects are funded out of what are virtually R&D budgets. It is for this reason that the Community support scheme has proved of interest to project promoters and it has helped to spur and speed up several projects.

In Italy and Greece the most advanced projects concern electricity generation. This is because high-temperature sources exist in these countries. There are, however, also a number of projects concerned with the heating of residential buildings and greenhouses. It is in these two sectors that other Member States are concentrating. France has a large-scale support programme and Community funding plays an important back-up role. In the Federal Republic of Germany the number of projects is increasingly rapidly although funding problems have halted several projects. The Community funding scheme has been of great interest to local authorities and private promoters in this country. In the other Member States, particularly Belgium, Denmark, the Netherlands and the United Kingdom the demonstration stage has been reached with a number of preliminary projects. Practically all of these have been adopted for demonstration projects at Community level.

As far as geothermal energy is concerned, it should be noted that:

(a) with the exception of France, there are no special funding schemes for demonstration projects in the Community;

(b) in most Member States a system of financial support is needed for demonstration projects albeit at different levels and following prior research work;

(c) initial results have shown that the Community funding scheme acts as an important incentive.

III. Conclusions

At a general level it should be noted that the Community support scheme has promoted several practical projects to exploit geothermal energy sources. These have been confined in the past to the Paris region for space heating and central Italy for electricity generation. The emergence of projects in a number of regions in France and Italy, Belgium, Denmark, the Federal Republic of Germany, Greece, the Netherlands and the United Kingdom, is a welcome development.

Although the project leadtimes do not make it possible to make a full technical and economic assessment of Community action, it has been found from the study made that:

(a) for projects concerning the heating of residential and tertiary-sector buildings the recoverable geothermal energy is 60% of the estimated potential;

(b) for greenhouse heating projects it is nearly 90%;

(c) for projects concerning electricity generation from high-temperature brines it is 50%.

Geothermal projects entail high drilling risks. The volume of sources which can actually be exploited are often less than the potential estimated before drilling.

Although the number of demonstration projects for space heating may seem disproportionate compared with those for electricity generation this should be seen as a positive development. Low-enthalpy sources are more widely spread than high-enthalpy sources and the development of geothermal energy in the Community is dependent on their exploitation being demonstrated.

From the technical viewpoint, once the geothermal source has been located by drilling, some projects have been delayed by problems such as the clogging up of wells and scaling of surface facilities, corrosion, availability of equipment particularly submersible pumps which can work in contact with fluids which are often of high salinity and at a high temperature. This is due to the fact that oil technology has been used in the main and this is not always suitable for geothermal energy.

Finally, the preliminary results of the most advanced demonstration projects are encouraging and several of them have proved to be commercially exploitable.

The major share of Community support has been for the drilling stage to locate new geothermal reservoirs. This is a vital stage in the development of geothermal energy. Although this stage is well on its way it is not yet completed. There are still a large number of potential areas which have yet to be developed or explored in the Community. A large proportion of the funds available should, however, also be devoted to the development of techniques researched which might improve the exploitation of the sources discovered.

A special effort will have to be made in the future to promote projects concerning applications of geothermal energy to industrial processes such as heating and drying and its applications in agriculture (heating of greenhouses) for which low-temperature sources are particularly suitable.

2.3 Liquefaction and gasification of solid fuels

I. Introduction

Since 1973, there has been world-wide renewed interest in the conversion of solid fuels, particularly coal, into gaseous and liquid products to be used as substitutes for other energy carriers. The latter have become very expensive and their reserves are expected to decrease. This interest is being demonstrated by highly-intensified R&D work, within the Community and other countries, concentrated on the three technical routes of conversion.

I.1. Technology

Gasification of solid fuels

A first stage in nearly all current processes is to gasify coal or other fossil fuels by means of oxygen (or air) and steam to yield a medium (or low) calorific value gas, substantially a mixture of carbon monoxide and hydrogen (plus nitrogen when air is used) and generally called synthesis gas because after purification and catalytic treatment it can be converted into methane (equivalent to SNG), methanol, ammonia and other synthetic chemical entities.

Although the chemical processes for gasification are long established, there are two vital aspects which must be tackled to ensure that the transition to solid fuels is an orderly progression. These aspects which must be demonstrated to ensure success are:

- improved reliability, consistency and overall economics of the process;
- capability of dealing with a wider range of solid fuels and the high proportion of fine coal produced by modern mining methods.

Underground coal gasification

In Western Europe there is evidence that massive coal resources exist either in difficult conditions or deep below land and under the North Sea. Tapping these resources by conventional means is difficult and becomes increasingly more so as the resource base is extended. The idea of recovering the energy values by in situ processes without employing human effort underground and without bringing waste to the surface is one which has exceptional and universal appeal. The potential rewards, if satisfactory viable techniques can be developed, are enormous and make it desirable to analyse carefully the possibilities and regularly review them in the light of developing technology and economic circumstances. This requires reliable experimental and practical data - notably scarce and inconsistent in the past.

Liquefaction of solid fuels

Solid fuels can be converted to liquid fuels in two ways:

- indirectly by catalytic treatment of synthesis gas, i.e. by the Fischer-Tropsch process used commercially on a large scale by SASOL in South Africa;

- directly by reaction with coal dissolved in a solvent; this means hydrogenation and extraction techniques.

The indirect synthesis process now commercially available suffers the disadvantage of relatively low thermal efficiency and gives a spectrum of products that does not adequately match European market requirements. Thus, more selective processes are needed which make better use of the coal in the European context.

As far as extraction and hydrogenation are concerned, the advantages of these direct liquefaction routes in terms of improved efficiency and a more suitable product slate have to be demonstrated.

Generally, the requirements on coal quality (in particular the ash content) and process parameters (pressure) are much more rigid than for gasification. Thus, the technology of liquefaction is more difficult and sophisticated.

I.2. The potential of solid fuels conversion

The future rôle of solid fuels conversion is very difficult to evaluate, because :

- the technology is at present only taking its very first steps towards large-scale application, and

- its outlook depends largely on the overall future energy situation, and in particular on the evolution of prices for competing energy carriers, which is difficult to predict with precision.

In any event, there is certainly a long-term need for the conversion of solid fuels, the reasons for which are:

- the huge reserves of fossil fuels, particularly coal, which are used, at present, only to a disproportionate degree;

- the need to replace oil and, in the longer term, natural gas, for tactical and strategic reasons;

- the decreasing direct use of coal in households and industry requires an alternative energy carrier (gas or liquid);

- the conversion of solid fuels offers good prospects for technology export and job creation.

For all those reasons, the construction of large-scale plants is absolutely necessary to gain further know-how and experience, as well as to confirm the results obtained so far.

On the other hand, under today's conditions, which are highlighted by decreasing oil prices, redundancy of oil, budgetary cuts and the abandoning of certain projects, a feeling of reluctance seems to prevail. But, all this could very well be a temporary phenomenon and it would be very dangerous to interrupt promising, long-term development for such short-term reasons.

Therefore, a careful, step-by-step market introduction will be necessary, beginning with products which are already economically acceptable like synthesis gas for the chemical industry, fuel gas for power generation and methanol, whilst leaving the manufacture of higher-grade products like substitute natural gas (SNG) and gasoline for a later stage. A possible sequence of market developments is as follows:

Period	Raw materials	Products
1985-1990	Lignite and hard coal	Synthesis gas for chemical industry, fuel gas for electricity generation
1990-2000	Lignite and hard coal	First plants for substitute natural gas (SNG) and gasoline
after 2000	Lignite, hard coal other fuels	All products

Such a programme of demonstration or reference plants would permit a steady development of the technologies in the most economical fashion.

The projects selected for the Community's Demonstration Programme could fit very well into such a scheme and a careful estimation of their production potential showed that they could provide a production capacity of about 13 m. toe per year, after the completion of the demonstration phase.

II. Community and National Programmes

Of the 13 projects selected, one has been withdrawn by the applicant for unknown reasons.

Of the 12 contracts signed, 2 concern different stages of the French project on underground coal gasification (LG/02/2/78 and LG/02/1/80), and the two original parts of the British liquefaction programme (LG/03/1/78 and LG/03/1/80) have finally been merged into one project. Thus, the twelve contracts signed in fact cover only ten projects, the breakdown of which is:

Gasification	5
Underground gasification	2
Liquefaction	3

Furthermore, the financial aid granted so far covers only 14.2% of the total costs of the projects. This is a consequence of the fact that, for budgetary reasons, so far only the starting phases of the selected projects have been financed (with two exceptions).

The character of the projects is rather different frommost others carried out within the demonstration programme:

- The conversion projects need much more time for completion (the life-time goes up to 7 years). In general, they are broken down into three main phases: planning/engineering, construction and operation of the plant. The present situation is as follows:

  - five projects are still in the engineering phase
  - two are now commencing construction
  - two others have reached the operational phase, one of which is already producing very good results
  - one project has been terminated, but needs another demonstration step before commercialisation.

- The major part of the selected projects is not yet of a scale which would allow the direct transition to commercial use and, thus they need further development.

- The projects are very costly (in three cases, the total costs are in the region of 100 M ECU), mainly because of the high investment necessary for the construction of plants. However, no substantial benefit can be expected from the subsequent operation phase.

These factors have to be borne in mind when judging the programme and the individual projects.

II.2. General Evaluation of the Programme

The overall results obtained so far can be summarized as follows (see Annex 1 for details):

Gasification of solid fuels

The number of projects in this area reflects the concentration of efforts on coal gasification, which corresponds to the state of art and to economic aspects. The same is true for the nature of projects, whose aim is the production of synthesis or fuel gas with, in some cases, an option for SNG (Substitute Natural Gas).

Some of the projects are very well advanced, others are still in an early stage, but they all tackle the aspects outlined above, in their particular ways. At present, the most successful are probably the British Gas Corporation project on the slagging gasifier (LG/01/6/80), which offers excellent prospects for transforming the first generation Lurgi gasifier into a high-performance, flexible unit which can be used on a commercial basis quite soon. Besides this, Klöckner's project on molten iron bath gasification (LG/01/13/80) has shown very promising results, particularly with regard to gas purity and, hence, to environmental protection. However, the process has still to undergo further large-scale trials before commercialisation. For this second phase of demonstration, financial assistance will be sought in the framework of the German National Programme. The three other projects are still in the engineering phase. Therefore, a detailed evaluation is not yet possible, but it can be expected that they will reach their respective targets.

As far as economics are concerned, the cost estimates for commercialised plants shows that, particularly the process for the production of synthesis and fuel gas, have the chance of competing with similar products made from natural gas or oil, whilst the production of SNG still requires process improvements.

Underground gasification of coal

Two projects are underway using a similar basic technology but different methods for some specific process steps and working under different geological conditions.

The first part of the French project (LG/02/2/78) has been successfully terminated by establishing a linkage between two boreholes, but has now to be continued on a larger scale (LG/02/1/80). The Belgo-German project (LG/02/1/78) reached a decisive stage in April 1982 following a successful first ignition. Thus, more detailed results will be available soon.

In general, the results obtained so far should advance the development of the technology and allow the potential of the processes to be defined with greater accuracy, thus enabling better value judgements to be made.

But, in any case, a number of technical obstacles will still have to be overcome, particularly when increasing the distance between boreholes, the most important condition for economic operation.

Liquefaction of solid fuels

Since liquefaction is generally considered as a more sophisticated and probably less economic technology than gasification, only three projects have been selected, but covering the three process routes of extraction, hydrogenation and synthesis.

At present, none of the three projects is in the operational phase. Thus, no results are available at the moment, which would allow a detailed evaluation. But it is expected that the project on synthesis (LG/03/3/80) will make the process more selective by demonstrating a new catalyst, while the two other projects on hydrogenation of lignite (LG/03/2/80) and extraction of hard coal (LG/03/1/80) will set out to demonstrate the advantages of the direct liquefaction route in terms of improved efficiency and a more suitable product slate.

II.3. Relationships between national or Community programmes

The relationships between the present programme and previous or running national and Community programmes are shown in the table below:

Contract No.	Contractor	Project	Relationship with national or Community Programmes
LG/01/2/80	FIAT-ANSALDO	Westinghouse gasifier for electricity production	unrelated
LG/01/5/80	AGIP	Texaco gasification	previous work in Germany on pilot scale
LG/01/6/80	British Gas Corp.	Slagging gasifier	previous work in Germany on Lurgi gasifier
LG/01/10/80	VEBA OEL	Gasification of residues from liquefaction	additional financing by German govt. anticipated
LG/01/13/80	Klöckner	Iron bath gasification	additional financing by German govt. anticipated
LG/02/1/78	IDGS	Underground gasification	co-financing Belgian/ German governments + EEC
LG/02/2/78 LG/02/1/80	GEGS	Underground gasification	co-financing French government + EEC
LG/03/1/78 LG/03/1/80	NCB	Coal liquefaction (solvent extraction)	Research financed by ECSC Demonstration project co-financing British govt. + EEC
LG/03/2/80	RBW	Lignite hydrogenation	Research financed by ECSC First phase of demo-projec financed by German govt.
LG/03/3/80	Haldor Topsøe	Coal synthesis	unrelated

The result is that:

- only two cases are unrelated to any other programme;
- two projects are based, to a certain extent, on previous pilot-scale work carried out in the Federal Republic of Germany;
- six projects are receiving or are awaiting co-financing by their respective national government and the Community, in two cases the previous research work was financed within the framework of the ECSC coal research programme.

This proves that the Community demonstration programme is not in conflict with, but is a complement to the national programmes.

III. Conclusions

Summing up, it can be said that the programme on liquefaction and gasification of solid fuels

- accords with the Community's Energy Policy, i.e. to replace imported energy carriers as far as possible by indigenous alternative sources;

- while limited in scope by the funds provided, the programme covers all areas of technology in the relevant fields and has been chosen so that the projects are complementary to the national programmes;

- will contribute to the further development and to better knowledge, particularly in the operation of larger-scale plants with the coals produced in and available to the Community.

On the other hand, at present, only one of the gasification projects offers good prospects for rapid commercialisation, while the others will still need considerable time before completion, or an additional step in scaling-up to industrial use. This is particularly true for the projects on underground gasification and liquefaction which have even more technical problems to overcome than exist for gasification.

In addition, it has to be emphasised that short-term viability and profitability cannot be expected in all cases. Particularly for the projects on underground gasification and liquefaction, this will depend upon further technical progress, problems of scaling-up and on the way oil prices move.

Naturally, this is only an intermediate evaluation based on the results obtained in the first phases of the projects. A comprehensive evaluation of the programme as a whole and of its repercussions on technology, economic and energy policy can only be undertaken when all projects have finished their operational phase.

Nevertheless, it can be concluded that all projects for gasification and liquefaction of solid fuels are large-scale, expensive and make heavy demands on resources and time. To enable them to reach a reasonable scale ready for the day when solid fuels conversion processes will be necessary to fill the gaps left by dwindling natural gas and oil, a continuous further development, at the appropriate technical level, . is an urgent necessity.

2.4 Conclusions on alternative sources

1. Alternative sources of energy have considerable potential in the Community. As we approach the year 2000, solar and geothermal energy could help to cover energy needs to the extent of some 100 million toe; gasification and liquefaction could add some 10 million toe.

2. Financial support by the Community has certainly acted as an incentive and utilization of these resources has begun or speeded up.

The demonstration projects selected currently number 126, including 12 projects on the liquefaction and gasification of solid fuels, 73 on solar energy and 41 on geothermal energy. Investments on these projects are of the order of 605 500 000 ECU.

Some 80 contracts are currently running, and thus an overall technico-economic evaluation of the Community programme is not feasible at the moment. Nonetheless, several projects have progressed sufficiently to allow an initial assessment.

3. In general, the projects selected for demonstration at Community level cover all the technologies envisaged, both in the sector of gasification and liquefaction of solid fuels and in the sectors of solar and geothermal energy. The projects were chosen to take account of Community and national research and demonstration programmes. In the sectors of gasification/liquefaction and geothermal energy, projects were often chosen to complement national programmes, this being facilitated by the limited number and scale of the projects in certain areas.

4. As regards gasification and liquefaction of solid fuels in particular, it must be stressed that these projects will help to develop Community technologies connected with the utilization of a major source of energy,

viz. coal, which is available and produced in the Community in considerable quantities.

However, if these technologies are to be operational when the time comes for coal to replace hydrocarbons on a large scale, financial support is absolutely essential.

Nevertheless, the projects have their own inherent features and are not comparable with those in other sectors, especially the high costs, the relatively long implementation periods and the uncertainty regarding utilization at commercial level.

Future projects of this type should be on an ad hoc basis.

It should also be noted that in the short term commercial viability is not always certain. For projects on underground gasification and liquefaction, for example, viability depends not only on technical progress and the levels reached, but also on the way oil prices develop.

5. In the solar energy sector, projects on the utilization of heat and biomass far outnumber photovoltaic projects, current applications being only in the low-temperature sectors, which reach the threshold of profitability with a payback period of four to five years. Longer payback periods are still an obstacle for those who base their decision to invest in a solar energy installation solely on economic considerations.

The degree of solar energy utilization in future will depend on the joint effects of various factors, especially subsequent R&D results, the cost and the reliability of the installations, financial support and developments in oil prices. It is on this positive development in costs and reliability that the results obtained in the Community demonstration projects must have their main impact.

The positive results already achieved and predicted are an encouragement for the continuation of the demonstration programme, combined with coordination with national programmes and projects.

6. In the geothermal energy sector, Community support and the results of R&D projects have led to numerous firm projects designed to utilize geothermal resources, hitherto limited to the heating of buildings in the Paris region and to the production of electricity in central Italy. The emergence of demonstration projects in several regions of France and Italy, in Greece, Germany, the United Kingdom, Denmark, the Netherlands and Belgium is a very encouraging sign.

The initial results of the most advanced demonstration projects are encouraging and for several of them utilization at commercial level is assured.

Part evaluation, based on the results currently available, indicates that the ratio between "toe figures located" after the drilling phase and "toe target figures" is acceptable and, on average, exceeds 60% in the different sectors.

7. Generally speaking, financial support from the Community has played a decisive role in the implementation of the first projects designed to utilize alternative sources of energy, although the technical and economic risks involved are still of a kind to hinder or prevent development.
The prospects for utilization of these resources are realistic as long as support for the different types of projects is continued and intensified.

3. National demonstration programmes

1. A summary review of the demonstration programmes on energy saving and alternative sources set up by the Member States is given below, classified under the major headings.

It is based on replies to a questionnaire sent to Member States by the Commission. It makes no claim to be exhaustive but facilitates an assessment of the situation in the individual Member States.

2. Today Member States have demonstration programmes but their scope varies enormously from one country to another.

In France, Denmark and Germany, these programmes play an important role in the national energy policy. In Germany, Denmark and Greece demonstration and research activities come under the same programme.

Ireland, the Netherlands and the United Kingdom also have extensive programmes but their financing is not always commensurate with the potential that could be exploited. In the United Kingdom, the emphasis is on energy saving, while in Ireland, the Netherlands and France more money goes to alternative sources.

In Belgium there are no real demonstration programmes, but a number of demonstration projects financed by different Ministries or by the regions. In Italy a low recently adopted provides for the introduction of demonstration programmes similar to the Community programmes with a budget of 15 million ECU in 1982.

3. In general, demonstration programmes were adopted only towards the end of the 1970s. Programmes that started earlier focused on work closer to the research stage. Support for demonstration projects on energy saving has increased in all countries more or less in step with the Community programme - in some cases because of its stimulus whereas many of the Member States launched their programmes on alternative sources some time after the Community programme (see Annex III, Table e).

National programmes are not normally for a limited period, but some of them have a multiannual plan (e.g. Germany, Denmark, Ireland and the Netherlands for alternative sources).

4. National funding for demonstration schemes differs from one country to another. The following table shows the scope of the national programmes in absolute and relative terms. Germany, France and the Netherlands have the highest budgets, but compared to total spending on energy research, the figures for Ireland and the Netherlands are high while those for the United Kingdom and France, which has a relatively high research budget, are low. A comparison of demonstration expenditure with total budgets shows that the proportion going to demonstration projects is small in the United Kingdom (no support for alternative sources), Luxembourg and Italy and relatively large in Ireland and the Netherlands.

It may be concluded that demonstration schemes receive fairly good financial support in France and Germany in the two sectors covered by this report. In Ireland and the Netherlands, this is only true of alternative sources (in the Netherlands mainly coal gasification), while in the United Kingdom energy saving projects predominate. Some special aid goes to both sectors in Denmark and Belgium.

Greece is also engaged on a substantial programme, but it is not possible to draw a clear line between the research and demonstration parts.

5. The level of aid differs from one Member State to another. Support can cover up to 100% of the capital cost in the Belgian schemes (for prototype development up to 80%), in Denmark, in Germany (only 40% for gasification), in the Netherlands (alternative sources only) and in Greece. In France, the investment grant may cover up to 50%, in Ireland up to 33.5% and in Luxembourg and the United Kingdom up to 25%.

In the Netherlands, support for energy-saving projects covers 50% of the costs, half being in the form of a non-repayable grant while the other half is repayable in the event of commercial success. The repayment condition also applies in the Netherlands for alternative sources, geothermal energy and coal liquefaction/gasification and in Ireland for alternative sources. In the United Kingdom a loan can be granted instead of a subsidy. In France there is also a repayable loan scheme (limited to geothermal energy but intended eventually to apply to energy saving as well). Belgian aid for the development of prototypes is repayable in the event of commercial exploitation and the Walloon Region in Belgium also intends to introduce repayment in the event of commercial success. In Germany, repayment is stipulated only for a small number of very profitable energy-saving projects and for coal gasification in the event of commercial success.

No information has been received that repayments have already been made, either because the repayment stage has not yet been reached (e.g. Ireland) or because a decision on repayment has not yet been taken (Netherlands). Apparently repayment does not figure very large in national aid schemes and is regarded as the exception rather than the rule.

6. The costs of measurements are paid in full by most of the programmes, e.g. in Germany, Denmark, France, the United Kingdom and Netherlands. The costs of feasibility studies are regarded as eligible for support in France, the United Kingdom, Denmark, Germany and Belgium.

The average size of the investment projects on energy saving that are receiving support appears on the whole to be fairly small. Some Member States (in particular France and the United Kingdom) prefer to support a large number of relatively inexpensive projects (in France an average of 34 000 ECU for 914 projects and in the United Kingdom 110 000 ECU for 166 projects), whereas one Member State (Germany) has selected only 30 projects receiving an average of 4.9 million ECU. Greece has also granted a relatively high average level of support (633 000 ECU) but research activities are included in this figure.

7. Under the heading of alternative sources, most countries have granted support for solar heating (Belgium, Denmark, Germany, France, Greece, Netherlands, Ireland and Luxembourg) and for wind power (Denmark, France, Greece, Ireland, Netherlands and United Kingdom). Biomass (Germany, France, Denmark, Ireland), geothermal energy (low enthalpy) (Belgium, Germany, Denmark, France, Greece, United Kingdom) and coal liquefaction and gasification (Belgium, Germany, France, Netherlands, United Kingdom) have also received support in some countries.

National programmes on energy saving concern different sectors, but concentrate mainly on industry and building; transport is also important in France and district heating in Germany.

8. The selection criteria for projects to be supported are virtually the same everywhere. Innovation potential, value as a model, potential energy savings, economic viability and technical feasibility are the main factors.

The main reasons for rejecting proposals are lack of novelty and low economic efficiency, but budget restrictions have also played an important part in the selection of projects (e.g. in Denmark and even Germany). A surprisingly large number of projects is rejected, especially in Ireland, the Netherlands and Luxembourg and to a lesser extent in France.

9. In all countries, the projects involve a series of measurements. Although in some countries many demonstration projects have been completed, results were only available for France, which has also embarked on their evaluation, although this is so far confined to energy saving in the services sector.

Denmark also states that it has carried out overall evaluations of its programme but does not give details.

The United Kingdom states that an evaluation will be completed in 1983. Germany has not made an overall evaluation of the energy saving programme, but in a few years it intends to evaluate the solar energy and coal gasification sections.

All the other countries think that it is too early for evaluation at the current stage in their programmes.

10. Views on the influence that demonstration projects have on the development of markets are generally favourable. In the Netherlands, for example, these projects are considered to have a substantial impact while in the United Kingdom it has been observed that after demonstrations other installations have been constructed. In France a quarter of the projects supported have had a widespread influence and it has been found valuable to support several demonstration projects of the same type so as to have a more effective impact on markets, especially those of a regional nature. Germany considers that insufficient time has elapsed since the start of the programmes to allow any great impact on markets.

11. Several countries provide support for the marketing of new products or processes, for example Denmark (10-20% subsidies for the purchase of systems using renewable energy), France (direct marketing aid of about 20%), the Netherlands, Germany (repayable aid of up to 50% to bring energy-saving products on to the market more quickly) or Belgium (aid for the development of prototypes for demonstration and marketing).

12. For dissemination of results, all countries use more or less the same information methods: exhibitions, visits to factories, reports, brochures, seminars, press releases, etc. Only the United Kingdom includes the results of Community projects in its national information system, which is well developed, while Germany has arrangements for the exchange of information between its coal gasification programme and the corresponding Community programme.

13. All the countries stated that the demonstration programmes formed an integral part of their national energy strategies and were regarded as essential to the success of their policies. Ireland and the United Kingdom also pointed out that their programmes had aroused great public interest and that the number of proposals was constantly increasing.

Tableau F

NATIONAL DEMONSTRATION SCHEMES 1982

	MIO ECU	B	DK	D	F	GR	IRL	LUX	IT	NL	UK
I.	BUDGET ENERGY SAVING		3,1 Dem. 2,5 Géo. 1,9 Col. systems	32 Energy Sav. (1) 8,8 Solar 1 Géo. (2)	13,7 (3)		0,5			1,9 Energy Sav. 2,2 Solar + Wind	8,1
II.	BUDGET ALTERN. SOURCES			16,4 Coal Gaseific.	20,3 (4)		2,0			37 Coal Gaseific.	
III.	TOTAL DEMONS. BUDGET I + II	9	7,5	58,2	37,5	(17,9)(6)	2,5	0,01	15	41,1	8,1 (without Altern.)
IV.	NON NUCLEAR R & D BUDGET (1981)	29		270	401		5			40	299
V.	III : IV (in %)	30	25-50	21	10		50			103	2,7
VI.	PUBLIC BUDGET : Total Current Uses (1982)	49.857	34.606	285.368	227.467	14.059	8.962	1.620	166.971	74.850	206.773
VII.	III : VI (in %)	0,018	0,021	0,020	0,016	(0,12)(7)	0,028	0,0006	0,009	0,055	0,004 0,009 (5)

Remarks :

(1) 50 % of R & D Budget.
(2) 20 % of R & D Budget.
(3) 1981 AEE Budget.
(4) 60% of COMES 1981 Budget only.
(5) Lower figure : without alternative sources.
Upper figure : two great projects in alternatives included in 1982.
(6) Including Research Expenditures