UNESCO Headquarters
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High-level Expert Meeting
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An Overview of the Status and Potential of Renewable Energy Sources in the European Community

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An Overview of the Status and Potential of Renewable Energy Sources in the European Community

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AN OVERVIEW OF THE STATUS AND POTENTIAL OF RENEWABLE ENERGY SOURCES IN THE EUROPEAN COMMUNITY.

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SUMMARY
The paper first describes the Community Energy Policy in favour of Renewable Energy Sources (RES), focusing on the ALTENER and THERMIE programmes.
It then considers in outline the present techno-economic and market status of each Renewable Energy Source in the European Community.
Finally, it ends with an overall estimation of the possible coverage of the Community energy needs by RES at the 2010 time horizon.

1. THE RENEWABLE ENERGY SOURCES AND THE EC ENERGY POLICY

As part of its general energy policy goals, the European Community has for years recommended to increase the role of the Renewable Energy Sources (RES) for the coverage of its energy needs. Let us for instance mention the June 1988 Recommendation of the Council of Ministers of the Community to the Member States (document COM/88/349/EEC) for priority actions for the development of the exploitation of RES.

More recently the Commission of the European Communities has adopted on 13 May 1992 on the initiative of the Directorate-General for Energy DG XVII the ALTENER programme for specific actions in favour of a larger penetration of RES (document COM/92/180 final) in the following area:

- promoting the market for RES and their integration into the internal energy market (harmonisation of regulations, definition of common norms and specifications);
- financ al and economic measures;
- training and information activities;
- co-operation with Third Countries.

This programme, which must still be adopted by the Council of Ministers, foresees a budget of 40 MECU on a 5 years' period (1993-1997). At the same time, the Commission of the European Communities CEC proposes to adopt the following objectives for 2005:

- to increase from about 4% in 1991 to 8% in 2005 the share of RES in the coverage of the Community energy needs (that is to say from 43 Mtoe to 109 Mtoe);
- this could be done notably by tripling the production of electricity by RES (excluding large hydro above 10MW);
- to secure a biofuels share of 5% of total fuel consumption by motor vehicles (this would imply a production of 11 Mtoe biofuels on an agricultural area of about 7 Mha).

ENERGY PRODUCTION FROM NEW AND RENEWABLE ENERGY SOURCES (RES)

(Following Eurostat's Statistical Conventions)

RES	*PRODUCTION 1991 (1)*			*OBJECTIVE 2005*		
			MTOE			MTOE
THERMAL USES						
• Fuel-Wood			20,0			50,0
• Other Biomass (Biogas, Waste, etc...)			2,7			8,0
Biomass Total			22,7			58,0
• Geothermal			0,4			3,0
• Solar			0,2			1,2
THERMAL USES - TOTAL			23,3			62,2
BIOFUELS			0,0			11,0
ELECTRICITY	GW	TWH		GW	TWH	
• Small Hydro-Power Plants (2)	5,0	15,0	1,3	10,0	30,0	2,6
• Geothermal	0,5	3,0	1,9	1,5	9,0	5,4
• Biomass and Waste	2,0	6,3	2,7	7,0	20,0	8,6
• Wind	0,5	0,9	0,1	8,0	20,0	1,7
• Photovoltaic	0,0	0,0	0,0	0,5	1,0	0,1
ELECTRICITY TOTAL (Excl. Large Hydro)	8,0	25,2	6,0	27,0	80,0	18,4
[TOTAL RES EXCL. LARGE HYDRO]			[29,3]			[91,6]
LARGE HYDRO (>10 MW) (2)	74,8	154,5	13,3	88,6	198,5	17,1
Including Pumping Stations	[26,0]			[27,9]		
ELECTRICITY - TOTAL	82,8	179,7	19,3	105,6	278,5	35,5
RES - TOTAL			42,6			108,7
TOTAL ENERGY CONSUMPTION (3)			1160,0			1400,0
PERCENTAGE SHARE OF RES			3,7			7,8

1.6.1992

(1) Based on Eurostat data and in-house estimates
(2) For a year of normal precipitation; electricity production is net, excl. pumping
(3) Estimates after taking account of RES not yet included in the statistics

Table 1 (1)


Thermie
THE OPET NETWORK
OPET
EC Energy Centre
Energy Information Centre
NORGE
OSLO
SVERIGE
DANMARK
EESTI
TALLINN
St Petersburg
LATVIJA
RIGA
LIETUVA
VILNIUS
MOSKVA
TYUMEN
ROSSIJA
BELARUS
MINSK
POLSKA
WARSZAWA
UKRAINA
KIEV
DEUTSCHLAND
BERLIN
Potsdam
Leipzig
Köln
Bad Homburg
Karlsruhe
Regensburg
NEDERLAND
BELG
LUX
Lille
Namur
DUBLIN
IRELAND
UNITED KINGDOM
Aberdeen
Manchester
Watford
Harwell
FRANCE
PARIS
Poitiers
Lyon
Valbonne
SUISSE
ITALIA
Milano
Bologna
ROMA
ESPAÑA
Bilbao
Barcelona
MADRID
Valencia
PORTUGAL
LISBOA
ČESKO
PRAHA
SLOVENSKO
BRATISLAVA
WIEN
OSTERREICH
BUDAPEST
MAGYARORSZÁG
SLOVENIJA
HRVATSKA
BOSNAI HERCEGOVINA
ROMÂNIA
MOLDOVA
BĂLGARIJA
SOFIA
SHQIPERIA
ΕΛΛΑΣ
ATHINAI
TURKIYE

Figure 1

Table 1 gives an estimation of the thermal and electrical production by RES in 1991 as well as an estimation of the corresponding figures for the 2005 objective. With the achievement of these objectives, a reduction by 180 Mt of CO_2 emissions could be obtained.

Another programme which has been launched on the initiative of DG XVII is the full-scale energy technology programme THERMIE. This programme has been designed to run for 5 years from 1990 to 1994 with a total budget of 700 MECU (roughly 900 M$) and it aims to promote innovative technologies in the fields of rational use of energy, renewable energy sources, solid fuels and hydrocarbons.

THERMIE is the natural follow-up of the previous Community Energy Demonstration Programme, but it differs significantly in the following respects, which derive from the conclusion that new initiatives were to be taken to bridge the observed "inertia gap" that existed between successful demonstration projects and the use of new technologies in the market place :

- much more importance is given to the active dissemination of projects and results. In particular, **financial support is given not only to actual innovative projects** (i.e. involving a new technology or a new application of a known technology) **but also to dissemination projects to encourage the wider use of a new technology or a new application in the Community** which has been successfully demonstrated;
- **financial support may also be granted to targeted projects**, fostered by the Commission to bridge observed gaps in the development of technology in some specific areas;
- where projects are of equal technical merit, preference is given to those which : involve collaboration between at least two independent organisations established in different Member States; are implemented in less-developed regions of the Community; are proposed by small and medium-sized enterprises; have a positive environmental impact;
- **in parallel to the support for projects, the associated measures are strengthened**. They include : evaluation of market potential and characteristics, dissemination of information on energy technology and project results, audits of approved projects and sectoral energy audits, technological co-operation forums such as seminars and workshops, promotion of industrial co-operation with third countries.

Besides their innovative content, the proposals submitted in answer to the annual call for tender of the THERMIE Programme should also meet the main following criteria : R&D almost (innovative projects) or totally (dissemination projects) completed, good prospect for technical and economic viability notwithstanding the technical and economic risks and high replication potential.

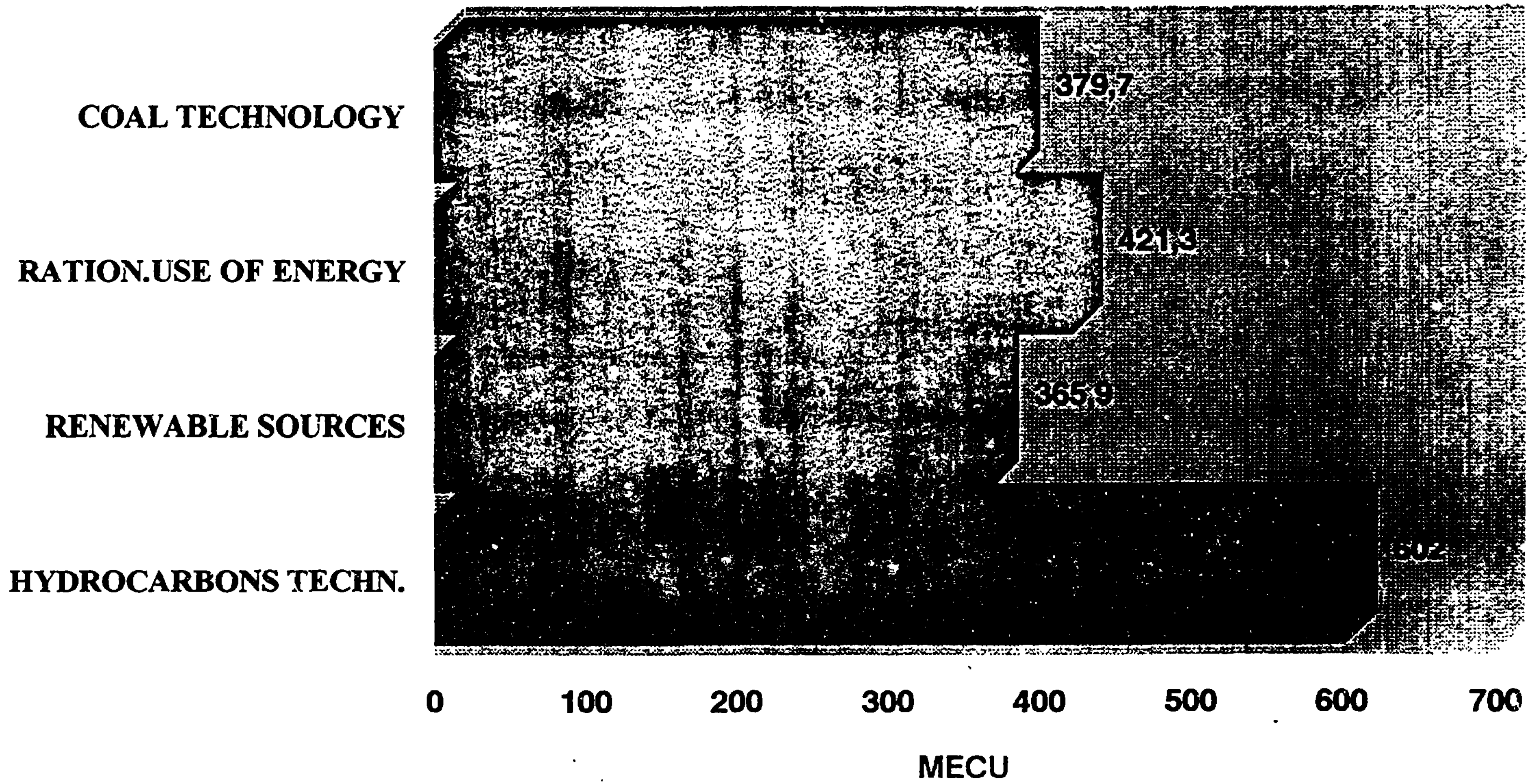
For the realisation of its dissemination strategy objectives, the Commission of the European communities has implemented **a network of 40 OPETs** (Organisation for the Promotion of Energy Technologies) (cfr. Figure 1). The OPETs are private or public institutions, working at national or regional level in Member States, which collaborate in dissemination activities with the Commission and among themselves.

In order to promote the co-operation with Third countries through technology transfer, the activities of the OPET network have been extended in countries outside the Community through the implementation of local Energy Centres and Energy Information Services (Central and Eastern Europe, C.I.S., Scandinavia, Austria, and possibly in the near future in non-Community Mediterranean countries, U.S.A. and Japan).

ENERGY TECHNOLOGY SUPPORT PROGRAMMES

1975-1992

SUPPORT IN MILLIONS OF ECUS

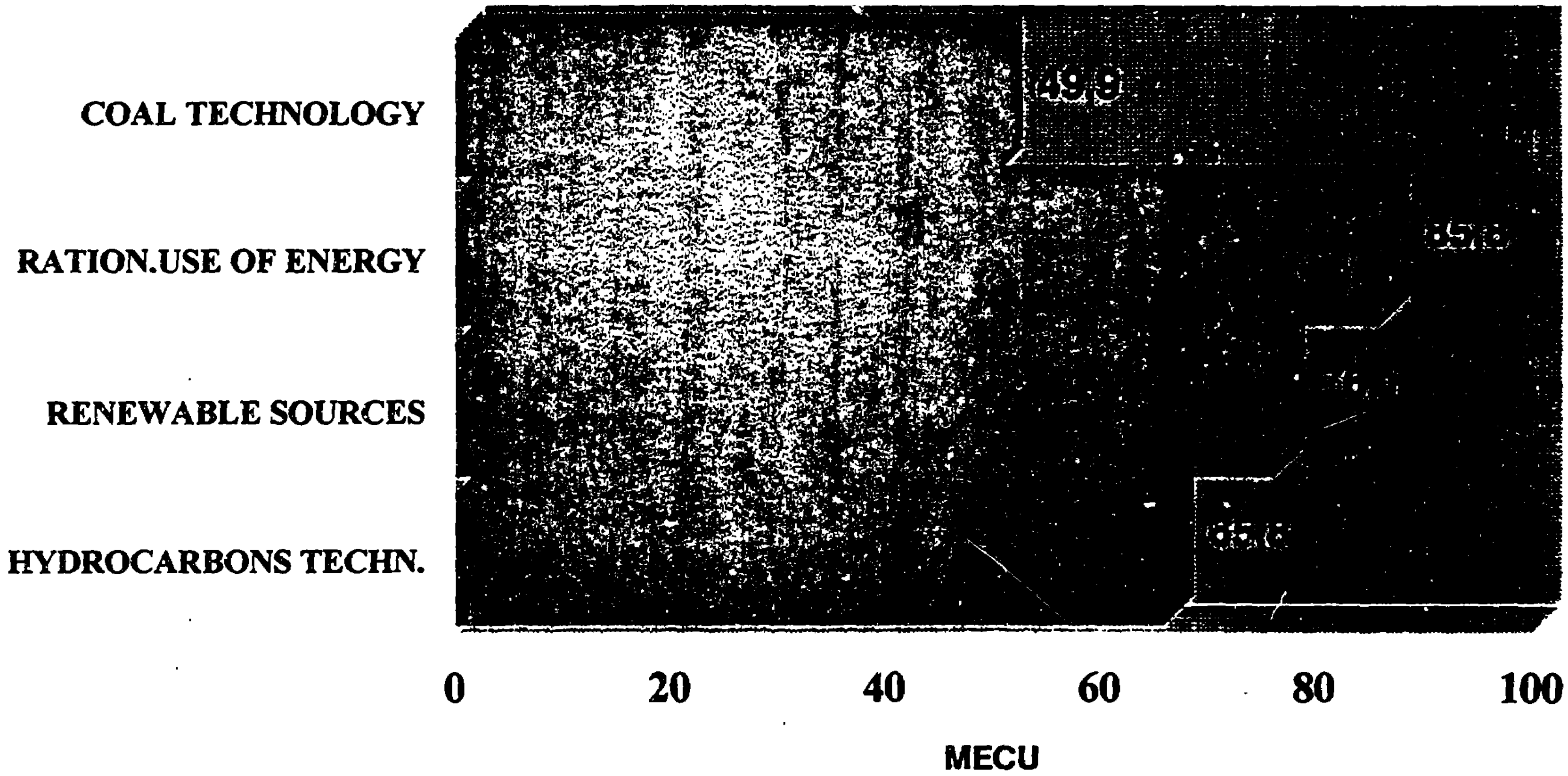


TOTAL ACCEPTED: 2885 PROJECTS
FOR AN AMOUNT OF 1768.9 MECU

Figure 2

THERMIE 1990-1992

SUPPORT IN MILLIONS OF ECUS

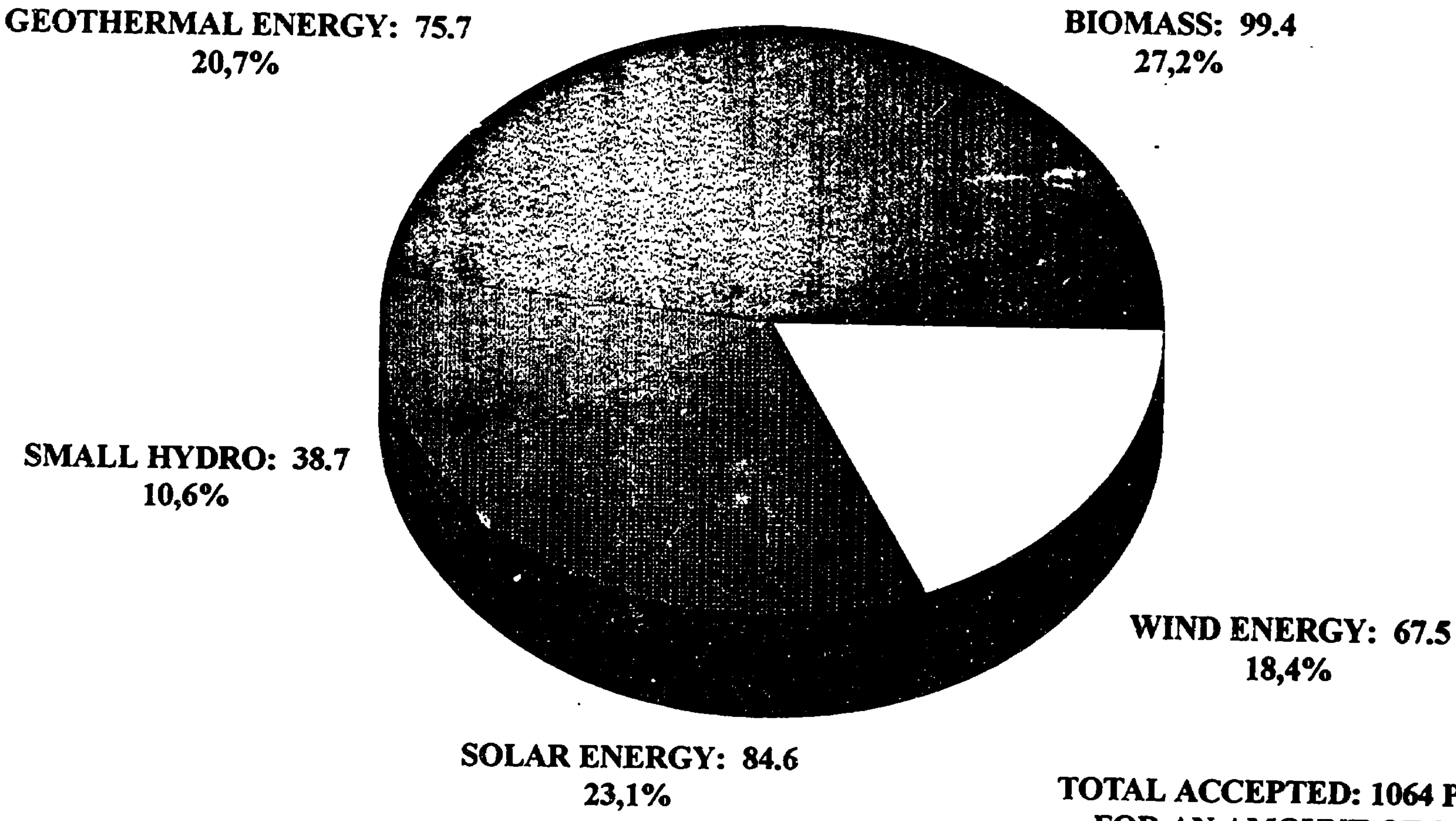


TOTAL ACCEPTED: 373 PROJECTS
FOR AN AMOUNT OF 277.6 MECU

Figure 3

RENEWABLE ENERGY SOURCES

1975-1992
SUPPORT IN MILLIONS OF ECUS



TOTAL ACCEPTED: 1064 PROJECTS FOR AN AMOUNT OF 365.9 MECU

Figure 4

Between 10 % and 15 % of the total THERMIE budget is devoted to the dissemination activities.

The figures 2 and 3 show the importance of the financial support that has been given by the CEC for energy technology projects in the 4 abovementioned sectors, respectively for the 1975-1992 period covering the previous demonstration programme and the present THERMIE programme and for the 1990-1992 period of the THERMIE programme. As can be seen, **the share of the support for RES** has increased since the start of the THERMIE programme and **represents approximately 25% of the total financial support. In terms of number of projects, the percentage is higher** for the RES, i.e. **37%**, since the RES projects are in average of a smaller size than in other sectors.

The splitting of the financial support by type of RES for the 1064 projects selected in the period 1975-1992 is illustrated by figure 4. Apart from mini-hydro which is limited to plants of less than 5MW, the other RES have received more or less the same level of support, with a little bit more means devoted to the "Energy from Biomass and Waste " sub-sector, which is also the RES with the highest energy potential. However, it is worth noting that, due to the limited immediate prospects for further innovative and dissemination projects in the Community, the geothermal and mini-hydro sub-sectors have been excluded from the 1993 THERMIE call for submission of projects proposals.

Other Community programmes or initiatives have a positive impact on the development of RES exploitation, which are impossible to describe here into details. Let us however specially mention the R&D JOULE programme which run on a 5 years' period from 1990 to 1994 with a total budget of 285 MECU, of which roughly 50% is devoted to RES, and the regional VALOREN programme, whose main aim was to help certain less-favoured regions in the Community to further develop while exploiting indigenous energy potential.

Similarly, some Member States have also implemented programmes for the support of RES at national level, which will not be described here. However, at the end of the paper, some figures will be given for countries which have fixed specific targets for some RES.

2. THE TECHNO-ECONOMIC AND MARKET STATUS OF RES IN THE EC

It is of course impossible in the context of a limited synthesis paper to go into all the details related to each RES. Consequently, I shall concentrate on the main or most interesting aspects, voluntarily omitting solar thermal power plants and wave energy systems which are still in a development phase in the Community and tidal energy which is limited to some specific sites.

2.1 MINI-HYDRO (2)

The technology of small hydropower is well-established and reliable. However, modest advances in equipment and construction techniques are still possible and effectively done. This can be illustrated by:

- the increasing tendency for remote control of small plants using programmable logic controllers (PLCs) by means of micro-computers with increased memory storage, smaller size, increased reliability and lower cost;
- the use of air or water inflatable dams to increase water heads at low dams;
- electronic and electro-hydraulic means of governing turbine speed have replaced, to a considerable extent, the older mechanical-hydraulic governors in small plants;
- the use of modern steel penstocks without expansion joints thanks to improved welding techniques; and the use for piping of new materials like high-density PVC and polyethylene which are cheaper and lighter than steel.

The barriers to the expansion of mini-hydro are essentially of an administrative (length of procedure, opposition from the vicinity and from fishermen) and of a regulatory nature, in particular for what concerns the electricity buy-back tariffs.

These tariffs for the buy-back of auto-produced electricity of every kind, have traditionally been quite low in several Member States. However, the situation has changed in favour of RES in recent years in some Community countries, notably in Germany and Italy since January 1991 and in the UK since September 1990 with the initial non-fossil fuel obligation NFFO order for RES.

The buy-back tariffs for those countries are condensed in Table 2, however without going into the details of each country regulation.

COUNTRY	*BUY-BACK TARIFFS*
Germany	Since January 1991 SE and WE: 90% of the average selling prices Other RES: 75% reduced to 65% above 500kw
Italy (new installations)	Since January 1991 BM, GE, SE, WE: 170 lire/kWh HY up to 3 MW: 100 lire/kWh
U.K.	NFFO November 1991 WE: 11p/kWh Other RES: 5,7 - 6,55 p/kWh Scotland HY: 5p/kWh

Table 2 - Recent evolutions in buy-back electricity tariffs in some EC countries

BM = energy from biomass; GE = geothermal energy; HY = small hydraulic energy; SE = solar energy; WE = wind energy.
(100 lire : 0,055 ECU - 1 £ = 100 p = 1,27 ECU (May 1993))

Other Community countries apply buy-back tariffs favourable to RES: Ireland and, based on consumer's tariffs: Denmark, The Netherlands, Spain and Portugal.

In the EC, the total hydro-power plants installed capacity amounts to about 80 GW, while the total capacity for plants of less than 10 MW is only 5 GW. While the economic potential for large power plants is presently used to about 95%, the corresponding potential for the small hydro-plants of less than 10 MW is only used to the extent of 20% (1). Consequently, there is still some scope for further penetration in the EC, although this is expected to proceed slowly. The pace of expansion is considered to be significantly higher in developing countries.

Nevertheless, electricity production from RES in the EC is largely dominated by the hydraulic energy and will continue to be so. The production costs for hydro range from 0.016 ECU/kWh to 0.075 ECU/kWh (12).

2.2 GEOTHERMAL ENERGY (3)

Three types of geothermal energy sources are currently exploited in the EC:

- **high enthalpy** geothermal energy (temperatures above 150°C) for the production of electricity via steam turbines; the installed capacity amounted to 552 MWe in 1991 of which 545 MWe for Italy, where this form of energy has been exploited since the beginning of the century. Furthermore, ENEL, the Italian national utility, has recently decided to increase its capacity to 1500 MWe for the beginning of the next century.

The cost of electricity production from high enthalpy geothermal sources amounts to about 0,06 ECU/kWh.
In the range of high temperatures, the "hot dry rocks" concept is still under development and an industrial validation is not expected before the beginning of the next century

- **low enthalpy** geothermal energy (temperatures between 30°c and 90°C) for the direct heating of dwellings, greenhouses...

  The corresponding energy production in the Community was estimated to amount to 370 000 toe in 1990, essentially in France, Italy and Germany. An interesting potential also exists in Greece, Spain and Portugal;

- **very low enthalpy** geothermal energy for temperatures lower than 30°C. In Germany, more than 100 000 heat pumps functioning on low temperature - low depth aquifers have been counted, producing more than 50 000 tep.

For low enthalpy geothermal energy, the exploitation of the heat source is made by means of one single well or alternatively by the doublet concept, depending on the content of dissolved matter (salts, minerals and gas) in the water and on the related possibility to reject the used stream in surface without prejudice for the environment.

The technical problems encountered by the geothermal fluid exploitation are essentially related to corrosion (of different possible origins) or formation of deposits. These problems can be mostly overcome through the bottom hole injection of inhibitors.

Geothermal energy exploitation is, at least for what concerns the low enthalpy, a young industry: more than 90% of the low enthalpy plants in the Community have been realised during the preceding decade. Technical problems have inevitably arisen, most of which have been solved. However, the development of geothermal exploitation is also strongly influenced by non-technical factors, like of course the conventional energy prices levels, but also by background factors like the drilling risk coverage, the financing plan and the management structure.

2.3 WIND ENERGY (4) (5)

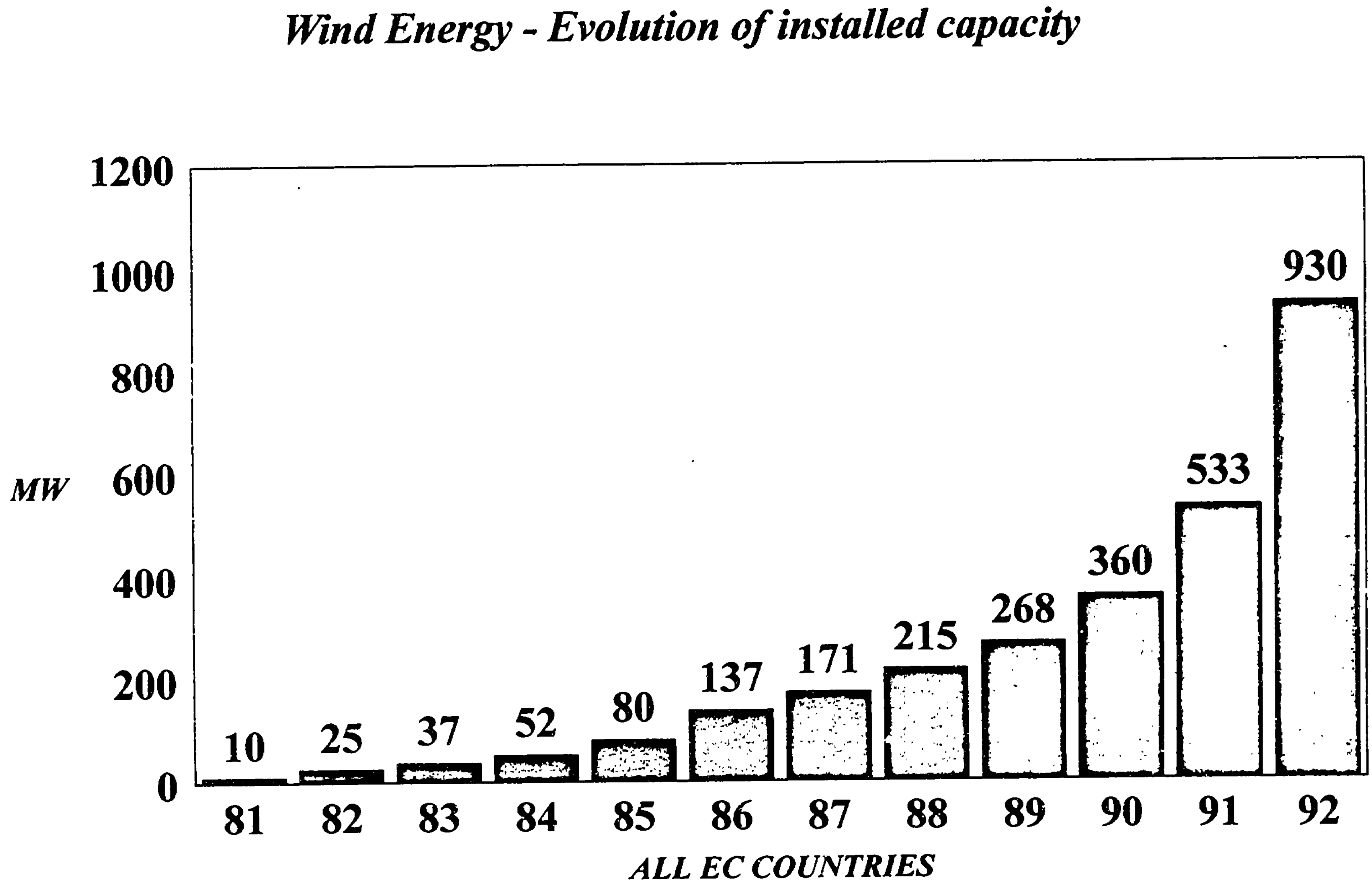
The European wind industry has gained considerable maturity over the last 10 years. At present, industry offers the market place intermediate sized wind turbines, in the 200 to 400 kWe range (i.e. 25 to 35 m rotor diameter), which are not only reliable but also cost competitive.

Some characteristic technical developments identified in the last decade are listed below:

- the rated power of the commercial wind turbines from 55 kWe models in the early eighties was increased by almost six fold, while the first 450-500 kWe machines are due to become commercial;
- **wind turbine productivity has been improved dramatically**. From the rather poor outcome of 400 kWh per square meter of swept area per year, the present value is over 1,200 kWh per m2 per year at good windy sites;
- **the capacity factor is actually over 30%** for most wind turbines;
- **the availability figures for commercial machines is presently over 90%** with more and more wind turbines in the region of 95-98%;
- **noise levels have been reduced** thanks to design improvements of the blades and the other components used.

Considering the different existing design options it is easy to see that there **is not yet any consensus on any aspect of the design**, except that horizontal machines are to be preferred by the market where machines can be found with any number of blades, machines with different control philosophies or even none, with variable or fixed speed, concrete or steel, lattice or tubular towers, upwind or downwind. **And the question remains: is there an optimum size of wind turbines, if any?**

The cost of electricity production by means of wind turbines was drastically reduced up to 1988, while since then it has remained almost stable at around 0.04-0.07 ECU/kWh. **The number of wind turbine manufacturers has been strongly reduced from** the peak value of **approximately 200 manufacturers in the mid-eighties to about 30**, through the tough competition in the European and world-wide market (linked also to the 1986 drop of oil price which resulted in the temporary reduction of competitiveness of wind energy and in the bankruptcy of many manufacturers).


Wind Energy - Evolution of installed capacity
1200
1000
800
600
400
200
0
MW
10
25
37
52
80
137
171
215
268
360
533
930
81
82
83
84
85
86
87
88
89
90
91
92
ALL EC COUNTRIES

Fig''re 5

Figure 5 shows **the evolution of installed wind power capacity** in the EC from 1981 to 1992. The 'milestone' of 1000 MWe is considered to have been passed by now. Considering the world-wide situation in the field and the perspective to reach 4000 MWe by the year 2000 in the Community , one may say that the market lies mainly in Europe during this decade.

Following the results and observations of the first three THERMIE years, the major trends in the EC wind energy market can be summarised as follows:
- demand for bigger machines: range 400 - 1000 kWe;
- necessity of clearly defined financing schemes and certification procedures together with harmonised standards for wind turbine manufacturers;
- well performing and reliable wind farms;
- a market more and more competition led.

2.4 SOLAR ENERGY

2.4.1 SOLAR THERMAL AND PASSIVE ENERGY (6)

Passive solar concepts are attractive for all the the Community countries and are already commonly applied for domestic heating. Solar passive design should be further promoted for domestic cooling and non-domestic heating/cooling and lighting.

Table 3 illustrates the 1990 commercial situation of solar energy for water heating in the Community. Slightly more than 3,000,000 m2 of solar collectors were installed, representing a market value of 176.7 MECU and producing 452,100 toe.

Country	Population (millions)	Required energy for water heating (Mtoe)	Installed collectors (x 10^3 m^2)	Present productivity (x 10^3 tep)	Solar fraction (%)	Market value 1990 (MECU)
Belgium	9,9	2	10	1	-	-
Denmark	5,2	1	36	3	0,3	11,6
France	56	9,6	490	69	0,7	15,5
Gemany	77	15,5	284	40	0,3	33
Greece	10,2	1,4	1280	218	6,6	78
Ireland	3,6	0,7	-	-	-	-
Italy	57	9,8	350	49	0,5	6
Luxembourg	0,4	0,1	-	-	-	-,
Netherlands	15	3	89	7,1	0,2	4,8
Portugal	10,5	1,8	145	25	1,4	6,5
Spain	39	6,7	182	25	0,4	6
United Kingdom	57	11,5	185	15	0,1	15,3
TOTAL	**340,8**	**63,1**	**3051**	**452,1**	**0,8**	**176,7**

***Table 3** : Total surface of solar collectors installed in the European Community; year 1990 (6) (7)*

The **evolution of the situation varies greatly amongst the Member States**: solar collector production or installation has dropped significantly in Belgium, France and Italy in the second half of the 80's while installation of collectors for sanitary water heating reached a high score in 1990 (about 40000 m^2) and 1991 (about 60000 m^2) in Germany, however mainly to help protect the environment and with a strong regional financial support of up to 50% of the solar installation costs. Similarly, the production of solar collectors reached the high level of 18500 m2 in the first half of 1990 in the United Kingdom (of which 60% for export). Greece represents about half of the total EC market with the solar industry producing mainly thermosyphon domestic water heating units. Spain, which is also one of the sunniest EC countries, has surprisingly a small solar energy market for the time being.

The energy savings through the use of solar collectors may vary from 300-500 kWh/y in Northern Europe to up to 600-800 kWh/y for Mediterranean countries. Solar energy production costs are estimated to vary from 0.07 ECU/kWh for low cost systems in Southern Europe to 0.30 ECU/kWh for Northern Europe, where backup systems are needed (12).

For active solar space heating systems, R&D on storage seems of paramount importance, since it represents nowadays the principal failure of most demonstration units.

The **further penetration** of solar thermal energy in the Community **could be encouraged** amongst others **by the enforcement of good standards** in order to improve the credibility of the technology and **by the extension of the concept of "guaranteed performance"** which has already been introduced in France, Greece and Spain.

2.4.2. SOLAR PHOTOVOLTAIC ENERGY (8)

The commercialisation of photovoltaic technologies for terrestrial applications began in the late 1970's and a worldwide PV industry became established during the 1980's. The growth of the European PV industry and confidence in its products have been helped amongst others by the energy technology programmes funded by the CEC. From 1978 to 1992, 140 projects were selected, the majority of them for rural electrification in isolated sites, leading to a total PV generating capacity in full-scale applications of 3.12 MWp.

In the less sunny parts of the Community the mean annual yield of PV systems lies between only 1 and 2 kWh/day.kWp, while in the sunnier regions, with hybrid PV/diesel systems or grid connected systems, then mean annual yields of more than 3 kWh/day.kWp may be achieved.

The costs of PV modules were seen to fall steadily in real terms during the early 1980's. However, since about 1987 it has been noticeable that module prices have more or less stabilised at around 7 ECU per Wp for typical small applications. Lower prices are available for large systems. There are good prospects for further long term cost reduction, especially in connection with new thin film technologies.

However, PV modules are not the only important element in the overall costs of a PV system. Typically, they now represent less than half of the costs of a stand-alone PV generator. In future years, more effort will also be needed to reduce the costs of batteries and other specialised equipment such as inverters.

PV technologies find natural applications as stand-alone electricity generators for remote sites. They are normally not competitive with grid power, although the electricity utilities are showing a growing interest in grid connected PV systems, particularly in Southern Europe.

Furthermore, in remote areas, it will probably be more expensive to extend the grid by several kilometers than to choose a stand alone PV generator (results from a French project suggest that PV systems of 400 Wp are cheaper than grid connection when their distance from the grid is more than 600 m, and that systems of 1200 Wp are cheaper when this distance is greater than about 1500 m).

2.5 ENERGY FROM BIOMASS AND WASTE

This sector is much less homogeneous than the preceeding ones **and covers in fact a broad range of different technology routes** which can be roughly grouped in three main categories:

- the production of raw fuels in the forms of energy crops and RDF;
- the thermal conversion routes with direct combustion, gasification and pyrolysis, carbonisation;
- the biological conversion routes with the production of biogas, landfill gas, compost, and biofuels for transport.

Furthermore several of these routes are directly influenced by non-energy factors:

- **the reform of the Common Agricultural Policy and the correlative search for new agricultural products outputs** like the reconversion of agricultural land into energy plantations or the production of biofuels for transport;
- **the interrelationship between energy and environment for all the "energy from waste projects"** which are in fact often primarily waste treatment projects with simultaneous energy valorisation. It is clear that the recent and proposed EC Directives on waste treatment will influence the technological routes to be chosen. However, it has been estimated that these new regulation trends have a global positive impact on direct or indirect (notably by recycling) energy recovery from waste.

All these technological routes have reached a different degree of techno-economic maturity which is impossible to describe here into the details. Nevertheless, some major trends can be highlighted as follows:

- In the field of biogas, **landfill gas has reached commercial maturity** in some Community countries like **Denmark, Germany, the Netherlands** and, last but not least the **United Kingdom**. It was estimated that the number of landfill gas exploitation works in the EC in 1990 amounted to 175, producing the equivalent of 351,500 toe (9) while the economic landfill gas energy potential for the whole Community has been roughly estimated at **1 Mtoe/y** (10).

  The methanisation of industrial effluents has also reached commercial maturity **in the agro-food and paper/pulp industries**. There is a slight tendency to extend this technology to other industrial segments, like the chemical/pharmaceutical industries.

  Small digesters on farm are rarely cost-competitive for the time being. In contrast, **the methanisation in large or collective digesters of animal manure** (a realistic energy potential can roughly be estimated at **1 Mtoe/y** for the EC), possibly complemented by industrial/urban solid organic waste **has reached technical maturity and reliability**, notably in countries like Denmark, Italy and the Netherlands. **It becomes also economically competitive** where a good market for the electricity/heat produced can be combined with fees for the treatment of the additional industrial/urban waste.

  The organic fraction of municipal solid waste (MSW) can also be anaerobically digested in large reactors, either in dry (about 30% dry solid content) phase or in wet phase after pulping. A clear recent trend is to **digest source-sorted organic MSW** which can then lead to an effluent valorised as compost, free of contaminants like glass, plastics or heavy metals. **This tendency also apply for the aerobic MSW composting plants.**

- **The percentage by weight of MSW which is treated by incineration amounts to slightly more than 20% in the Community** with a high disparity between the different countries (for instance 42% for France, 54% for Denmark and 50% for Belgium while about 90% of the MSW are disposed of in sanitary landfills in the U.K.). With the mean percentage of 20% in mind, one can roughly estimate that the economic energy recovery potential amounts to **1.5 Mtoe** while energy is presently recovered in about 200 incinerators in the Community.

  It is expected that every new large MSW incinerator in the EC will be built with energy recovery equipment in order to valorise the waste and lower the total waste treatment costs. Of course, as it is well known, it is more and more difficult to get the authorisation to build a new MSW incinerator in the Community, notably due to the NIMBY "Not in my Backyard" syndrome. The same applies for the opening of a new landfill site. Nevertheless, something is to be done with the waste that we produce and it seems that after having given the priority to waste prevention and recycling, it will still be necessary to adopt a pragmatic approach: at the Community level, a combination of the different MSW treatment methods will still be necessary, while at local level the final choice will notably be influenced by site specific conditions.

- Finally, there is in the "Energy from Biomass and Waste" sector a sub-sector which represents a **fairly large energy potential**, which is **the thermal conversion of wood, wood waste and agricultural solid waste**, presently essentially through combustion.

  20 Mtoe, i.e. 2% of the Community energy needs, are presently produced in the Community by wood/wood waste combustion, **of which 9 Mtoe in France** only which has carried out a detailed statistical evaluation on this point (corresponding statistics are generally not very reliable, since a relative high percentage of wood waste are not distributed through commercial channels).

  Wood as a fuel has a positive impact on the greenhouse effect compared to fossil fuels, especially when burned in medium to large installations where the combustion quality control is more rigorous. From an economic point of view, under the present conditions of low conventional energy prices, wood as a fuel is usually not competitive in industry while competitiveness against gasoil can be reached in the domestic heating market and against light heating fuel-oil in the collective heating market as soon as a sufficient boiler load is achieved (11).

  In connection with the expected increase in **energy plantations**, there are also good prospects for the development of **electricity production from wood/wood waste in centralised plants** in the coming years, either through combustion (in fact it is likely that in answer to the 1993 THERMIE call for proposals at least one project will be selected in this field, which would be the first of this type in the Community) or through gasification associated with a combined cycle which presents a higher efficiency for electricity production than combustion (in fact it is envisaged that the CEC will publish for the 1994 THERMIE budget round a call for tender for a full-scale targeted project, in the sense explained above, for the electricity production through wood/wood waste gasification in a combined cycle). Pyrolysis also shows interesting prospects for the future notably by the production of liquid fuels, namely pyrolytic oils, easier to transport, but further R,D&D seems still desirable to improve the conversion technologies and the quality of the products for practical use.

  Globally speaking, the energy potential from biomass and waste in the EC can be estimated at more than 100 Mtoe.

3. THE OVERALL FUTURE ENERGY POTENTIAL OF THE RES IN THE EC

What could now be the contribution of the RES in the coverage of the Community energy needs in the future?

A study (12) has been commissioned by the Directorate-General of Energy of the CEC from a consortium of 4 companies to estimate the possible penetration of RES technologies up to 2010, using the forecasts of overall energy demand and of electricity demand set out in "Energy in Europe. A View to the Future" (13)

4 different scenarios were considered which are summarised below:

- Base Case:	present policy actions of Member States.
- Existing Community Programmes:	additional effects of existing EC programmes related to energy and environment, notably: THERMIE, JOULE, SAVE, 5th Environmental Action Programme.
- Proposed Policies:	implementation of proposed energy policy framework including: ALTENER, Internal Energy Market, Carbon/Energy Tax.
- Full Social Cost:	Internalisation of all external costs. Full supporting measures to remove constraints on RES dissemination.

The results of the study indicate that significant growth in the penetration of renewables will not occur unless further policy measures are taken to assist the commercialisation of RES.

Growth in the EC under the "Existing Community Programmes" scenario is slow, from about 4% of primary energy needs in 1990 to 6.5% in 2010. In the "Proposed Policy" scenario more rapid growth is achieved, to 9.3% in 2010 (then meeting the general 8% objective set out in ALTENER for 2005). **In the "Full Social Cost" scenario**, accompanied by all the desirable supporting measures, **the RES penetration increases to 13.4% of primary energy needs in 2010.**
Simultaneously, the global EC CO_2 emissions would be reduced by 12% of their 1990 level (i.e. 2766 Mt) by 2010.

For all scenarios, **decentralised RES energy supply accounts for approximately 60%** of their total contribution. This clearly shows that great attention is to be paid to small systems for the promotion of RES.

Amongst the accompanying measures of various kinds which will be necessary to ensure the further penetration of RES, one may cite in particular:

- the dissemination by all means of relevant and reliable information to well targeted audiences, not only at Community but also and above all at national and regional levels. The main result of a study realised by the OPET network in the framework of the THERMIE programme on a "Strategy for the Promotion of Renewable Energy Technologies to Local Authorities" surprisingly showed that there was a rather general complaint about lack of sufficient and reliable information on RES. Furthermore, it is sometimes necessary to reverse the opinion in the public, based on some past bad experiences, that "RES cost a lot and do not work";
- the elaboration of favourable buy-back tariffs for the electricity produced by RES;
- the harmonisation of certification procedures and elaboration of standards;
- the preparation and harmonisation of guidelines for planning and project evaluation;
- the reinforcement of links between all the actors: public administrations and authorities, equipment manufacturers, professional/trade associations and final users for whom the needs are not always enough perceived.

RES National Targets in the EC

Country	National Plan	Target
Denmark	Energy 2000	2000 Wind : 800-1350 MWe 2005 Wind : 1500 MWe 2005 Biomass : 1 Mtoe
Germany		1995 Wind : 250 MWe 1995 PV : 2250 x 1-5 kWp units
Greece (2)		2000 Wind : 150 MWe 2000 Geo : 300 MWth 2000 Sol act : 30 % increase over 1990 area
Spain	PAEE 91 3.749 Mtoe by 2000 (not incl. large hydro) Technology targets as % thus	2000 Bio : 74.9 % 2000 MSW : 10.3 % 2000 Small HY : 8.8 % 2000 Wind : 2.9 % 2000 Sol act : 2.7 % 2000 Geo : 0.3 % 2000 PV : 0.1 %
Italy	PEN 17.5 Mtoe by 2000	1995 PV : 25 MWp 2000 Sol act : 0.2 Mtoe 2000 Wind : 300-600 MWe 2000 Hydro : 25 GWe 2000 Geo elec : 9 TWh 2000 Geo heat : 0.33 Mtoe
Netherlands	Elektriciteit Plan 1991-2000 & KWW study 5 % TPED (1) by 2010 & 25 % by 2050	2000 Wind : 1000 MWe 2010 Wind : 2000 MWe 2010 Sol act : 0.1 Mtoe 2010 PV : 0.1 Mtoe 2010 Geo : 0.1 Mtoe 2010 Bio : 2.0 Mtoe
Portugal PEN		10 % of TPED in medium term
UK		2000 All sources : 1500 MWe

(1) TPED : total primary energy demand

(2) Estimation of Future Use

Table 4 (12)

Besides the global targets proposed by the CEC for the penetration of RES in the Community, it would also be advisable that each Member State define targets for its country. These committment figures would help reassure industry about the foreseeable size of the RES markets. Several Member States have already detailed such targets which are presented in Table 4 (12).