

**NATIONAL PROGRAMME
FOR THE MITIGATION OF CLIMATE CHANGE**

---O---

INTRODUCTION

I - INVENTORY OF EMISSIONS OF GREENHOUSE GASES (p.4)

Preamble

1.1 CO₂ emissions (p.4)

1.2 Emissions of CH₄ (methane) (p.6)

1.3 Emissions of N₂O (nitrous oxide) (p.6)

1.4 Gases with indirect effects: precursors of ozone in the troposphere (p.6)

II - POLICIES AND MEASURES AIMED AT REDUCING EMISSIONS OF GREENHOUSE GASES (p.7)

II - 1. EMISSIONS OF CO₂ (SOURCES AND SINKS) (p.7)

II - 1.1 BUILDINGS (p.8)

1.1.1 New buildings (p.8)

1.1.1.1 New housing (p.9)

1.1.1.2 New buildings in the tertiary sector (p.9)

1.1.2 Existing buildings (p.10)

1.1.2.1 Informing users (p.11)

1.1.2.2 Regulation and standardisation of new equipment performance (p.11)

1.1.2.3 Incentives for energy management developments (p.12)

1.1.2.4 Government buildings (p.12)

1.1.2.5 Excise on fuels in the residential/tertiary sector with regard to the greenhouse effect (p.13)

1.1.3 Development of the use of wood in construction (p.13)

II - 1.2 INDUSTRY (p.16)

1.2.1 Voluntary commitments (p.16)

1.2.2 Subsidiary measures (p.17)

II - 1.3 TRANSPORT (p.18)

1.3.1 Transport of goods (excluding light utility vehicles) (p.19)**1.3.1.1 Technical measures concerning HGVs (p.20)****1.3.1.2 Organisation of goods transport by road (p.21)****1.3.1.3 Economic measures (p.22)****1.3.1.4 Development of the intermodal transport of goods (p.22)****1.3.2 Passenger transport and light goods vehicles (p.25)****1.3.2.1 Optimising the technical design of vehicles (p.26)****1.3.2.1.1 Reducing the specific consumption of new vehicles (p.26)****1.3.2.1.2 Technical inspection of vehicles in service (p.28)****1.3.2.1.3 Cash payment when vehicles over ten years old are retired (p.28)****1.3.2.1.4 Aids to economic driving (p.29)****1.3.2.1.5 Development of a specifically urban vehicle (p.29)****1.3.2.1.6 Promotion of the electric vehicle and other alternatives (p.30)****1.3.2.2 Urban journeys (p.31)****1.3.2.2.1 Investment in urban public transport (p.32)****1.3.2.2.2 Management of motor traffic (p.33)****1.3.2.3. Management of suburban traffic (p.33)****1.3.2.4 Development of the High Speed Train (TGV) network (p.34)****II - 1.4 ELECTRICITY(p.35)****1.4.1. Investment in new nuclear power plants (p.36)****1.4.2 Electricity exports (p.36)****1.4.3 Reducing load peaks (p.36)****1.4.4 Replacement of fossil fuels by electricity for the final consumer (p.37)****1.4.5 The equalisation of low voltage electricity prices throughout the country (p.37)****II - 1.5 DEVELOPMENT OF FOREST-RELATED STOCKS OF CARBON (p.38)****II - 1.6 CARBON EMISSIONS RELATED TO CHANGES IN LAND USE (p.42)****II - 1.7 NEW AND RENEWABLE ENERGIES (p.43)**

1.7.1 The ADEME and Electricité de France (p.43)

1.7.2 Development of the use of wood for energy production (p.44)

1.7.3 Development of the production of agricultural biomass for energy production (p.46)

1.7.4 The use of wastes for energy production (p.48)

1.7.5 Hydro power (p.48)

II - 2 METHANE EMISSIONS (p.49)

II - 2.1. METHANE EMISSIONS FROM AGRICULTURE (p.49)

II - 2.2 METHANE EMISSIONS FROM LANDFILLS (p.52)

2.2.1 Stopping the dumping of ordinary waste (p.52)

2.2.1.1 Effects of the measure (p.53)

2.2.1.2 Costs of implementing the measure (p.54)

2.2.2 Recovery of methane from existing dumps (p.54)

II - 2.3 LEAKAGES FROM NATURAL GAS SYSTEMS (p.54)

II - 2.4 PRODUCTION OF METHANE FROM COAL MINING (p.55)

II - 3 EMISSIONS OF NITROUS OXIDE (p.55)

II - 3.1 MEASURES TO REDUCE EMISSIONS IN INDUSTRY PRODUCING ADIPIC ACID, NITRIC ACID AND GLIOXYLIC ACID (p.55)

3.1.1 Adipic acid (p.55)

3.1.2 Nitric acid (p.56)

3.1.3 Glioxylic acid and glyoxal (p.56)

II - 3.2 EMISSIONS OF NITROUS OXIDE FROM AGRICULTURE (p.58)

II - 4 OZONE IN THE TROPOSPHERE - CONTROL OF PRECURSOR GASES (p.57)

II - 4.1 MEASURES TO REDUCE VOC EMISSIONS (p.59)

4.1.1 Transport (p.59)

4.1.2 Use of solvents (p.60)

4.1.3 Industrial processes (p.60)

4.1.4 Extraction and distribution of petroleum products (p.60)

4.1.5 Other sectors (p.61)

4.1.6 Balance sheet (p.61)

II - 4.2 REDUCTION IN NO_x EMISSIONS (p.61)

4.2.1 Transport (p.61)

4.2.2 Generation of electricity (p.62)

4.2.3 Industry(p.62)

II - 4.3 REDUCTION OF CO EMISSIONS (p.62)

III - INTERNATIONAL CO-OPERATION AND FINANCIAL MECHANISMS (p.63)

III - 1 CO-OPERATION WITH DEVELOPING COUNTRIES (p63)

III - 1.1 BILATERAL AID (p.63)

1.1.1 Aid to projects (p.64)

1.1.2 Debt servicing (p.65)

1.1.3 Scientific and technical co-operation (p.66)

III - 1.2 MULTILATERAL AID (p.68)

III - 2 CO-OPERATION WITH THE COUNTRIES IN TRANSITION TO THE MARKET ECONOMY (PECO AND CIS) (p.69)

III - 2.1 ENHANCING NUCLEAR SAFETY IN THE EAST (p.69)

III - 2.2 ENERGY SAVINGS (p.70)

III - 2.3 REDUCTION OF LEAKS OF NATURAL GAS (p.71)

IV - FRENCH CONTRIBUTION TO RESEARCH ON GLOBAL CLIMATE CHANGE (p.72)

IV - 1 GLOBAL CLIMATE CHANGE (p.72)

IV - 1.1 AS REGARDS THE FRENCH IGBP (p.72)

IV - 1.2 THE "ECONOMY, SOCIETY AND GLOBAL CHANGE" PROGRAMME (p.73)

IV - 1.3 BUDGETS AND MANPOWER (p.73)

IV - 2 RESEARCH ON REDUCING EMISSIONS (p.74)

IV - 2.1 ADEME PROGRAMMES (p.74)

IV - 2.2 RESEARCH INTO THE MITIGATION OF CLIMATE CHANGE IN THE RURAL SECTOR (p.76)

INTRODUCTION

Awareness of the threat to the climate owing to the rising emissions of greenhouse gases, particularly CO₂, led the French government to undertake a policy of controlling the emissions of greenhouse gases, as a precautionary measure.

This commitment by the French authorities was reflected in active participation in international projects, particularly the negotiation of the Convention on Climate Change, which was ratified by France on 25/3/1994.

This commitment to adopt policies and measures aimed at limiting the emissions of CO₂ and other greenhouse gases not regulated by the Montreal protocol, which figures in article 4 paragraph 2 of the Convention, will be applied throughout the European Union, with the Union and its member states acting according to their respective competence. The initiatives now being taken by the Community are in fact particularly important and effective in many fields such as transport, duty on fuels, miscellaneous regulations (notably as regards the environment) and the Common Agricultural Policy.

The French authorities recall that the energy policy they have followed since the first oil shock has already made it possible appreciably to reduce CO₂ emissions and hence the contribution of France to the greenhouse effect. This policy has been based in particular on the following:

- the formulation of strict regulations aimed at encouraging energy savings. A typical example is the regulation of heating in dwellings;
- the use of fiscal instruments. The high level of duty on fuels, higher than those levied by most countries listed in Annex 1, has contributed substantially in the past to limiting CO₂ emissions. Also a number of fiscal incentives aimed at improving energy efficiency have been introduced since 1974, notably for industry and households;
- a substantial programme of enhancing public awareness of energy savings and energy efficiency. Since 1974, to implement these actions, France has had an Energy Savings Agency which has acted to control final demand and in conjunction with industry, constituting a centre of skills and expertise over the years;
- the development of a large nuclear generating system which has made it possible to reduce CO₂ emissions not only in France but also in the other member states of the European Union.

The scope and extent of this policy has enabled France to reduce its CO₂ emissions per head of population between 1980 and 1990 more than any other member state of the European Union (-26.5% compared with a Community average of -19.3%); of the OECD countries, only Sweden has reduced this ratio by a greater amount.

All in all, the emission levels due to the use of fossil energy, per head of population and per point of GDP, were less in 1990 by 22% and 35% respectively than the average levels of the European Community and by 44% and 36% respectively than the mean levels of the OECD countries.

Owing to the extent of the efforts already made and the results obtained, the cost of new measures liable to be taken in France will often be higher than in the other countries of the European Union or the OECD. For this reason France believes it is essential that the cost - per tonne of carbon emission avoided - of actions to reduce emissions adopted in national programmes should be of a comparable level for the various countries shown in Annex I so as to abide by the principle of economic efficiency and with the Polluter-Pays principle.

France has always believed that the most effective and equitable way of sharing the effort of reducing CO₂ emissions between the developed countries was to introduce, in all these countries, all emission reductions whose cost is below a common reference level. The simplest and cheapest way of achieving this result, and the one most transparent for all concerned, in terms of administrative costs, is to institute progressive CO₂ taxation at co-ordinated rates in these different countries within their fiscal regimes.

This approach is also the one which minimises the cost of reducing CO₂ emissions within each country.

This kind of fiscal approach, established in a sufficiently wide context to take into account the competitive nature of the activities to which it applies, will be essential if the objectives the world has adopted are to be achieved. If the necessary initiatives for reducing emissions of greenhouse gases can be decentralised - in an optimal manner - then the cost of preventing climate change will not be excessive in absolute terms. However, this cost will nevertheless place an unacceptable burden on certain enterprises if it is not adopted under the same conditions by all our partners. The methods applied for organising the world-wide effort should be defined with a view to preserving fair competition between firms in the framework of international trade and in that of the internal market of the European Union.

One of the priorities in organising international trade should be to ensure that the rules governing this trade do not constitute an insurmountable obstacle to the protection of the world's environment. It would be appropriate for the framing Convention on Climate to be amended to include provisions similar to those of article 4 of the Montreal Protocol on CFCs to ensure that non-signatory countries do not benefit unjustifiably, in international trade, from the fact that they are not involved in the joint efforts to protect the atmosphere.

As things stand, in Community discussions about a fiscal approach, France has suggested to its partners in the European Union that a CO₂ tax should be progressively introduced solely in those energy consuming sectors whose international competitiveness cannot be affected by the tax to the extent of engendering a risk of delocalisation; such delocalisations would in fact be both inequitable and inefficient, if not even harmful, as regards the prevention of climate change. In this context, France has therefore suggested that the existing minimum rates of excise duty should progressively be raised and that such minimum rates should be levied on fuels to which at present they do not apply, apart from industrial fuels.

It is also essential to stress how important it is for every country to eliminate the subsidies which encourage consumption of fossil fuels; these subsidies may for example take the form of domestic fuel prices decoupled from world prices, they may involve electricity being sold below its cost price, or the subsidising of certain activities that consume large amounts of fossil energy.

At national level, in order to introduce a degree of cohesion essential to the measures that are to be taken, throughout the economy, and with respect to the various greenhouse gases, France has set itself the objective of reviewing all the actions whose cost is equivalent to or less than a reference level expressed in ECUs per tonne of equivalent carbon the emission of which can be avoided.

The unit cost of possible preventive actions will be evaluated as the ratio between the necessary net expenditure (less, as appropriate, financial receipts and other quantifiable advantages concerning aspects other than the greenhouse effect), discounted to 8%, and the reductions in emissions obtained, discounted by the same amount. For gases other than CO₂, the equivalence coefficients recommended by the IPCC will be adopted (see Annex N°2).

A level of 70 ECUs per tonne of carbon not emitted was proposed in the draft directive of 30 June 1992: if the European Union considers this necessary to stabilise emissions, and if its partners' national programmes have an equivalent aim, France will adopt this reference level in designing its preventive actions; in such circumstances France will do its utmost to undertake gradually, by the year 2000, those actions whose reference cost will be less than 70 ECUs per tonne of carbon not emitted, whenever this is possible without adversely affecting the competitiveness of the economic activities concerned, having regard to measures actually applied by the other countries, notably those of the OECD.

I -INVENTORY OF EMISSIONS OF GREENHOUSE GASES

Preamble

In order to meet the specific concerns of the Climate Convention, these data are set out according to the recommendations of the GIEC, with only a few exceptions, in line with the decisions adopted at the 9th session of the Intergovernmental Negotiation Committee (February 1994)¹.

The detailed inventory is given in Annex I of this document. It will be provided to any authorities that request it. In particular, it aims to provide all useful data to the Executive and Subsidiary Bodies of United Nations Conventions, concerning French atmospheric discharges.

The following table gives the emissions of all gases:

	1990 Emissions (in Mt)	1993 Emissions (in Mt)
CO₂		
Emissions (all sectors)	367	365 (-0.5 %)
Use of energy	350	351 (+ 0.3 %)
Industrial processes	17	14 (- 15.0 %)
CO₂ - Absorption by the ground and forests	-32.2	- 37.2 (- 15.5 %)
CO₂ - Total net emissions	334.8	327.8 (-2.1 %)
(International bunkering - <i>pro mem</i>)	(8.6)	(8.9) (+ 3.5 %)
CH₄ (equivalent CO₂)	2.9 (72.5)	2.83 (70.7)
N₂O (equivalent CO₂)	0.177 (47,7)	0.171 (46.1)
NOx	1.725	1.675
	.	.
COV	2.425	2.3
	.	.
CO	11.0	10.0
	.	.

1.1 CO₂ emissions

Total net emissions of carbon dioxide per head of population and per point of GDP are particularly low for an industrialised country: 5.92 tonnes per head and 0.31 tonnes per billion 1990 dollars, as pointed out in the introduction.

¹ The information provided in earlier French publications were based upon different conventions:

- with regard to CO₂ emissions, earlier data referred to metropolitan France exclusively, and gave the carbon emissions resulting from the use of fossil fuels: here emissions from the overseas départements and territories have been taken into account;
- the carbon emissions evaluated previously were corrected for climate variations. The present inventory gives the gross emissions exclusive of any climatic correction.

The 1990 distribution of these emissions by sector was as follows (in millions of tonnes of CO₂):

Emitting sector	Gross emissions	Proportion of total emissions
Energy (production and conversion)	61 Mt	16.5 %
Industry	88 Mt	24 %
Transport	128 Mt	35 %
Residential /tertiary	82 Mt	22.5 %
Agriculture	8 Mt	2 %
TOTAL	367 Mt	100 %

The change in emissions due to energy use between 1990 and 1993 is analysed in Annex 3.

The very slight increase in emissions from the use of fossil fuels between 1990 and 1993 is mainly the result of fluctuations in climate. The winter of 1990 was mild, while that of 1993 was very close to the norm; the winter severity indicator, which equals 1 for a normal winter, was 0.88 in 1990 and 0.97 in 1993. This fact alone led to a relative increase of 10% in energy consumption for heating purposes. If the winter of 1993 had had the same characteristics as that of 1990, the emissions would have shown a fall of more than 25 Mt of CO₂.

Two changes independent of the severity of the winter should also be noted:

- CO₂ emissions from the overseas départements and territories rose continuously between 1990 and 1993 by over 20 % or + 1.5 Mt;
- CO₂ emissions from the transport sector rose steadily between 1990 and 1993, showing an overall increase of 5.5 % or 7.1 Mt; the following table shows changes in carbon emissions by sector between 1980 and 1993. It shows that the changes in the transport sector are merely a continuation of the increase in CO₂ emissions noted throughout the last decade.

CO₂ emissions in metropolitan France (1980-1993)

(emissions resulting from the use of fossil fuels
corrected for climatic conditions - in millions of tonnes of CO₂)

	1980	1993	Change
Transport (1)	95	132	+ 39 %
Residential and tertiary	114	99	- 13 %
Industry & agriculture	154	97	- 37 %
Power stations	106	25	- 76 %
TOTAL	469	353	- 25 %

(1) Excluding international bunkering.

1.2 Emissions of CH₄ (methane)

The data given for emissions of methane and nitrous oxide are very imprecise, owing particularly to uncertainties in the techniques used to evaluate these emissions in agriculture and from dumps.

In 1990, methane emissions amounted to about **2.90 million tonnes**, more than 55% coming from farming, 25% from waste disposal activities, especially dumping, over 10% from emissions occurring during the extraction and distribution of fuels, the remainder arising from their use. Methane emissions account for approximately 16% of direct greenhouse gas emissions, expressed as equivalent CO₂.

Since 1970, France has reduced its emissions due to coal production and gas distribution, owing to the closure of a large number of mines in the intervening period and to investment in improvements to gas distribution systems.

On the other hand, the increase in the quantity of putrefiable matter placed on dumps certainly led during the 1980s to a significant increase in methane emissions from dumps. The policy of eliminating dumps, decided upon in 1992, has not yet produced its effects.

1.3 Emissions of N₂O (nitrous oxide)

In 1990, emissions of N₂O amounted to about **177,000 tonnes**, 60% from industrial processes and 35% from the use of agricultural fertilisers. There is some marginal emission from energy production in fossil-fired power stations and from motor vehicles.

After the emissions of carbon dioxide (11%), nitrous oxide is the gas French emissions of which have the largest direct impact on the greenhouse effect. However, in the absence of indirect effects, their overall impact is lower than that of methane emissions.

As for methane, few data for this pollutant are available over time. It is possible to emphasise the relative stagnation of emissions from industry, due mainly to the stability of the main activities involved, except for the production of nitric acid, where reduced production has generally been compensated by higher emissions from denitrification installations.

1.4 Gases with indirect effects: precursors of ozone in the troposphere

Emissions of nitrogen oxides, volatile organic compounds and carbon monoxide are estimated at about 1.7, 2.4 and 11 million tonnes respectively for 1990.

The use of fossil fuels is by far the main source of emissions of these gases with indirect effects, except for the emissions of VOCs, where an equally important part of the emissions stems from the use of solvents.

The introduction of the catalytic converter in new motor vehicles, put on the market as from 1 January 1993, began in that year to reduce the emissions of these three pollutants from the new vehicles so equipped.

II - POLICIES AND MEASURES AIMED AT REDUCING EMISSIONS OF GREENHOUSE GASES

II - 1. EMISSIONS OF CO₂ (SOURCES AND SINKS)

The measures set out below concern partly the reduction in emissions related to the use of fossil fuels and also the management of stocks of carbon related to biomass and organic material in the ground. All the quantitative data for these emissions or changes in stocks are expressed as tonnes of carbon.

Annex 3 details the changes in emissions of CO₂ of fossil origin in metropolitan France related to energy use since 1973, and analyses the prospects for changes in these emissions up to the year 2000.

Following a minimum reached in 1987 due to the effect of the oil shocks and to the French energy policy described in the introduction, CO₂ emissions are at present rising, due notably to the world fossil energy price context and to a specific feature of the French energy situation: the nuclear programme begun in 1974 led to considerable overcapacity which resulted in conventional thermal power stations being temporarily under-used; this overcapacity is now declining although it will not disappear until the beginning of next century.

Because of the present programme, the increase in CO₂ emissions should nevertheless be limited after the exemplary fall achieved during the 1980s. Emissions from metropolitan France due to energy use could increase from 104.5 million tonnes of carbon in 1990 ⁽¹⁾ to 112 million tonnes in 2000, with a range of uncertainty, independent of the programme adopted, of about 20 million tonnes. The uncertainty is related to contingencies concerning economic growth, oil prices, the availability of nuclear plant and the weather.

Current policies pertaining to forestry and farming could improve the stocks of carbon in biomass and the ground by 2 million tonnes of carbon a year.

(1) after correction for the effect of the weather on the requirements for space heating.

II - 1.1 BUILDINGS

In 1993, emissions from the residential and tertiary sector arising from the direct use of fossil fuels accounted for 26.9 million tonnes of carbon, i.e., 28% of total French emissions. To this figure must be added virtually all the emissions from thermal power stations, 6.9 million tonnes of carbon or 7.2% of the total, due essentially to seasonal requirements for electric heating. Hence the construction sector accounts for more than one third of CO₂ emissions in France.

Since the first oil shock, France has applied a vigorous energy management policy in this sector based upon regulations governing new buildings and incentive measures for existing buildings.

1.1.1. New buildings

As early as 1974 France took the initiative of introducing regulations requiring new buildings to be thermally insulated, in close association with the building trades. These regulations have been regularly reinforced and they have been broadened, in the residential sector, towards a global approach to buildings taking into account both the thermal performance of the building itself and that of heating and domestic hot water systems.

As concerns dwellings, the original 1974 thermal regulations were revised in 1982, resulting in a 25% drop in energy consumption for heating, then again in 1988, producing a further drop of 25% in energy consumption for heating and domestic hot water.

As regards the non-residential sector, the initial regulations were applied in 1976 and revised in 1988, producing a 25% fall in energy consumption for heating and air conditioning.

As from 1980, a "label" policy together with financial incentives was introduced to encourage the construction of buildings with higher thermal efficiency than required by the current regulations (the High Energy Performance - HPE - label and the solar label).

The adoption of these regulations resulted in a halving of the mean specific energy consumption of dwellings built as from 1975. In 1992, the energy savings on heating resulting from the implementation of the residential thermal regulations were evaluated at 4.5 million toe² (i.e., about 15% of total energy consumption for heating in the residential sector, 31 million toe a year³).

Because decisions affecting new construction are irreversible owing to the long life of buildings, and have a progressive and long-term impact on the rate of new building, France has progressed further and is already anticipating the gradual introduction of constraints to prevent the greenhouse effect.

²All the energy consumption figures quoted in this chapter are expressed as final energy and in equivalent terms (1 MWh = 0.086 toe for all forms of energy)

³Including 7.6 Mtoe for wood

1.1.1.1. New housing

The requirements of the existing thermal regulations have been applied since 1.1.1989. They were formulated in 1985 with a view to minimising the discounted overall cost of energy (with additional investment bringing about a reduction in energy consumption and hence in running costs).

A study carried out in 1987 for the Commission (DG XVII) showed that France was the leading EEC country as regards regulatory requirements in terms of both methodology and the requirements imposed. In 1993 France proposed that a comparative study of the overall requirements of regulations and practices in force in the different EEC countries should be undertaken at Community level. It reaffirms this proposal.

In the meantime, as from 1995, the technical approaches proposed to the different professions will incorporate the advances made with low-emission glazing; the French thermal regulations will be enhanced as from 1.1.1997 with a stiffening of their requirements corresponding to the energy saving obtained by replacing ordinary double glazing by low-emission double glazing; this saving is equivalent to 5 to 10% on heating requirements.

Expected effects

Assuming an annual rate of construction of 300,000 new dwellings and an average energy consumption for heating per dwelling, under existing regulations, of 0.7 toe a year, a saving of 7.5% (on average) on the heating requirements of new dwellings would lead to a saving of 16,000 toe a year for the buildings commissioned every year as from 1997. On this basis the estimated saving by the year 2000 is 64,000 toe a year, or about 40,000 tonnes of carbon a year. It should be noted that increasing the stringency of the regulatory requirements has a cumulative effect: its long-term impact is therefore much greater than its short term impact.

1.1.1.2. New buildings in the tertiary sector

The thermal regulations now in force in the new tertiary sector (buildings other than dwellings) are less stringent than those applying to new dwellings since 1.1.1989. They are now being revised with the objective of saving 25% in energy efficiency, but this is a difficult task in view of the great diversity of operating conditions related to the many different uses to which premises in the non-residential sector are put.

To provide immediate encouragement to professionals to design buildings with better energy performance than is required by the existing regulations, the ADEME and the Association of Air Conditioning, Ventilating and Cooling Engineers has embarked upon production of a series of sectoral guides. Four guides have so far been issued (hotels in 1992, offices in 1993, health and education in 1994) and the next four (shops, leisure premises, industry and agriculture) will appear in 1995.

Having regard to the progress made with the technical work, the new regulations for non-air conditioned buildings (77% of current projects) will be published before 1.7.1996 for

application as from 1.7.1997. The regulations concerning air conditioned buildings will be published before 1.1.1998 for application from 1.1.1999.

Expected effects

On the assumption that building starts continue at the present rate, it is estimated that a gain in unit consumption of 25% with respect to the current regulations will produce an energy saving of 60,000 toe a year for the buildings put into service each year as from 1998. This leads to the estimate that by the year 2000 the gain will be 180,000 toe, or about 120,000 tonnes of carbon, a year. As for new dwellings, this measure has a cumulative effect which increases with time.

1.1.2. Existing buildings

The residential and tertiary sector comprises 27 million dwellings, including 22 million main residences that are permanently occupied, and 720 million m² of tertiary premises that are heated. The major part of this stock, 75% of dwellings and about 65% in the tertiary sector, was built before the initial 1975 building thermal regulations came into force.

Following the first oil shock in 1973, France developed a vigorous energy management policy in the field of existing buildings and substantial improvements have thus been made. Three types of action were taken.

- aids to decision-making aimed at encouraging contractors to adopt energy saving measures. In particular, a thermal diagnostics tool was offered as early as 1982 together with financial assistance for its introduction;
- a policy of regulating and standardising components with, in particular, the regulation of boiler performance as from 1975;
- assistance with capital expenditure in a number of forms including direct subsidies and tax incentives.

It is estimated that investment in energy management in dwellings built prior to 1975, carried out as a result of these measures, amounts to 300 billion francs (1993 values) and has led to savings on energy used for heating of about 3.3 million toe a year in 1992 (i.e., about 11% of total energy consumption for the heating of dwellings) even though the amenity levels have been improved: for the housing stock concerned, the proportion of dwellings fitted with central heating has risen from 54% in 1975 to 80% in 1992.

However, viable energy management actions remain to be taken and the control of energy consumption and CO₂ emissions in the existing building sector will be developed in three directions:

- facilitating the dissemination of information on the improvement of energy efficiency, based upon an assessment of the viability of possible actions with the aim of improving cost transparency to users (1.1.2.1);

- regulating the performance of components that are significant for energy efficiency (1.1.2.2);
- providing financial incentives for energy management actions (1.1.2.3).

Current expenditure on energy management is today about 30 billion francs a year.

1.1.2.1. Informing users

A thermal diagnostic tool together with financial incentives for its introduction has existed since 1982. During 1993, the diagnostic procedure was applied to 110,000 dwellings and 16.5 million francs of public funds were devoted to this activity.

Under EEC directive 93/76 (the SAVE directive), the ADEME and the hot water central heating trade are introducing a simplified diagnostic procedure limited to heating installations only. This low cost procedure is aimed at alerting users and encouraging them either to have their installation adjusted, or replaced, or to have a regulating device installed. A pilot operation covering 3000 installations and intended to test the diagnostic methodology will take place during the 1994/95 winter period. If the results of the pilot operation are convincing, extension of the simplified voluntary diagnostic procedure to the entire country will be encouraged.

A compulsory thermal diagnostics procedure will be introduced for blocks of flats under joint ownership.

1.1.2.2. Regulation and standardisation of new equipment performance

The thermal regulations applying to new dwellings from 5 April 1988 have resulted in the installation in virtually all new buildings of boilers having an efficiency (LCV) of over 88% for gas and 86% for fuel oil.

In fact new boilers on the French market have an efficiency of over 89% (laboratory tests). Hence the requirements of EEC directive 92-42 which impose minimum efficiency values on new boilers are already in application and even exceeded in our country.

The tax reductions described in section 1.1.2.3 below are conditional, as regards glazing and insulation, on compliance with the CEKAL label (for double glazing) and the ACERMI label (for insulation). Compliance with a label is also required for other systems that may give entitlement to a tax reduction (windows and no longer double glazing only).

1.1.2.3. Incentives for energy management developments

Various financial incentives for improving existing dwellings will be introduced so as to encourage the most effective schemes in order to combat the greenhouse effect. The proportion of this public funding devoted to energy management can be evaluated at 2.5 billion francs in 1992. The incentives are the following:

- Tax reductions: reductions of income tax were available from 1.1.1990 to 31.12.1995 for thermal insulation, heating appliance control systems, the replacement of boilers or, in certain cases, the introduction of an insert for main residences built before 1/1/1982. This measure will be continued if an evaluation now in progress shows it to be effective.
- Grants for improving dwellings: this government subsidy is intended to help households with modest incomes to improve a dwelling over 20 years old which they own and which is their main residence.
- Grants from the Agence Nationale pour Amélioration de l'Habitat (ANAH): these grants are intended for improving dwellings let by private owners and over 15 years old.
- Grants for improving rented social housing (PALULOS): these grants are intended to assist organisations that contribute to providing housing for low income groups to improve the rented social housing over 15 years old which they own or manage.

1.1.2.4. Government buildings

Government buildings consume 2.25 million toe a year and spend 3 billion francs a year on energy.

In a Circular dated 24 January 1991, the Prime Minister requested each ministry to implement a programme of energy savings in buildings for which it was responsible. These actions are co-ordinated nationally by a group of senior civil servants responsible for energy questions in the different ministries.

The present objective is to give priority, between 1995 and 1997, to short-term investment (under 6 years) to ensure that government buildings set the standard in energy questions, this applying both to new buildings and to the refurbishment and operation of existing buildings.

This programme is a priority action of the ADEME which plans to spend 10 million francs on it in 1995.

In this way the energy consumption of existing government buildings could be reduced by about 12%, producing a reduction in carbon emissions of 200,000 tonnes a year by 2000.

1.1.2.5. Excise on fuels in the residential/tertiary sector with regard to the greenhouse effect

As part of the fiscal approach to controlling the greenhouse effect, France has proposed to its European Union partners that duty should be levied on fuels used in the residential and tertiary sector.

The minimum rate of duty already levied on domestic fuel oil should be progressively raised and a minimum duty levied on natural gas, LPG and coal intended for residential and tertiary use. Fuel used for generating electricity for residential and tertiary use should also be subject to minimum rates of duty.

Expected effects of the set of measures concerning existing buildings

For dwellings built before 1975, it is estimated that achievable energy savings, assuming an oil price of 20 dollars a barrel, a possible duty of 70 ECUS per tonne of carbon and a discount rate of 8%, would amount to 5.5 million toe a year in the residential sector and 2.4 million toe a year in the non-residential sector. The total investment necessary to achieve these 5.5 + 2.4 million toe a year is evaluated at 150 billion francs.

The group of measures listed in 1.1.2 is intended to tackle about 60% of this potential for energy management between 1990 and 2000. It will be noted that energy prices will play a decisive role in encouraging the accomplishment of this energy management investment.

The savings arising from this programme by the year 2000 are estimated at 3.3 million toe a year in the residential sector and 1.4 million toe a year in the non-residential sector, i.e., about 3.4 million tonnes of carbon a year. This is equivalent to 10% of present emissions by the sector.

1-1-3- Development of the use of wood in construction

In 1990, French consumption of wood in the form of sawn timber and panels amounted to 14.7 million m³ of equivalent standing timber (EBR), or about 0.27 m³ per head of population a year. Most of this wood came from French forests; in 1990, less than 10% of it was imported (most imported wood comes from managed forests).

Of the total of 14.7 million m³, some 12 million m³ are used for durable purposes (furniture and construction), representing the long-term immobilisation of 2 million tonnes of carbon a year, about 80% in construction and 20% in furniture.

A predictive analysis of French consumption of wood in the form of sawn timber and panels shows that there are significant prospects for development in construction.

France has decided to embark on a programme to develop the use of wood in the construction industry, with four aspects:

1. the development of actions to promote wood in the construction industry

This task has been entrusted to the National Wood Development Committee (CNDB), an interprofessional body set up in 1989, and which during the year 1993 devised an action programme under five headings:

- to provide information to decision-makers and influential groups;
- to take regional action to encourage prime contractors and clients concerned with particular projects to adopt approaches involving and making best use of wood;
- to promote wood products through partnership programmes with industry;
- to highlight the use of wood in construction at important relevant events, exhibitions, etc.;
- to provide training for present and future operators.

2. the elimination of obstacles to the wider use of wood in construction through programmes of research, development and ad hoc publicity; this action will be led by the Wood and Furnishings Research Centre (CTBA) which in 1993 adopted five priority topics: the creation of jobs concerned with the structural use of wood, the development of clean, high performance additives, the development of high performance and competitive semi-finished products, improving the competitiveness of raw materials supplied to factories, and improving understanding of the economic operation of the industry.

3. development of a strategy for the supply of industrial products and semi-finished products based upon the sawn timber sector.

4. the establishment of a permanent monitoring organisation to supply reliable data on markets and on trends in the use of wood in construction (financial data on wood products, monitoring of firms involved in wood construction).

Measures taken

Some of the public funds used to finance "demonstration products" in the rented social housing sector are dedicated to operations involving wood as a construction material and in which best use is made of its potential to meet the technical requirements of the industry (as regards speed, quality, site organisation, and so on).

New research programmes concerned with wood in the construction industry were already started between 1990 and 1994. It is planned to intensify these efforts by implementing a programme to structure research in this field over a period of years.

In 1993, these different programmes, covering the promotion of the use of wood as a construction material as well as research, received public funding amounting to 53 million francs.

Also, government regional authorities have been invited to ensure that wood is not unduly penalised, and in particular that:

- land-use planning does not involve any unjustified ban on wood as external cladding;
- specifications drawn up by public contractors take a balanced view of all possible technical approaches;
- wood is not rejected owing to its combustible properties so long as the provisions of the regulations governing the fire resistance of structures are respected.

Expected effects

Any significant development of the use of wood in construction will only be achieved in the long term: indeed it requires profound changes in consumer practices, and the establishment of a sector that is powerful enough to gain a foothold on a highly competitive market dominated by major industrial groups.

The policy which has been described has the following objectives for the year 2010:

- increasing the proportion of wood-framed buildings from 5% in 1990 to 15% in individual dwellings, from 0.5% to 5% in collective housing, from 1% to 10% in the tertiary sector and from 20% to 50% in agricultural buildings;
- the tripling of the use of laminated-bonded frame structures in industrial buildings, from 0.4 to 1.2 million m³ EBR;
- the tripling of the use of wood for decorative purposes and internal fittings (parquet floors, panelling, etc.) from 2.6 to 7.8 million m³ EBR;
- increasing the proportion of wood used in external fittings from 35% today to 45%.

The achievement of these objectives would make it possible to immobilise a further 0.35 million tonnes of carbon a year (of which 25% related to the development of wood as a structural material and 75% in decoration, fittings and so on) making an increase of 17.5% compared with the 1990 levels.

Also, the emission of a similar volume of fossil carbon could be avoided by reducing consumption of materials such as concrete, steel and PVC, the production of which consumes a great deal of fossil energy.

II -1.2. INDUSTRY

Since 1973, France has embarked on a process of managing energy consumption which has resulted in particular in a reduction of CO₂ emissions from industry of 38%, or 29 million tonnes of carbon in 1990 compared with 47 million tonnes of carbon in 1973 (1).

Fossil fuel savings exceed the observed reductions in emissions, because in the meantime the value added by industry went up by 24%, although the structure of production and business differs considerably between 1973 and 1990.

Some 80% of the reductions in industrial CO₂ emissions result from a considerable fall in emissions per manufactured unit. The remaining reductions in CO₂ emissions are due to changes in the country's industrial structure.

It should be noted that over three quarters of industrial CO₂ emissions are produced by a small number of sectors in which energy is a substantial factor in production cost: non-ferrous metals, iron and steel, construction materials, refining, paper and board, glass, agro-food, and chemicals. These sectors are themselves concentrated in about a thousand firms which account for 17% of industry's added value. Having regard to the risks of delocalisation, this justifies France's desire that actions concerning industry should be harmonised within a suitable geographical framework.

1-2-1. Voluntary commitments

In order to highlight the actions to be taken, ADEME has undertaken studies aimed at providing an initial systematic technical and economic approach to the potential for fossil energy savings in industrial applications, for each branch and type of action.

These studies are being validated in detail with the industries concerned and this process will continue during 1995.

The usual approaches, considering industry as it is and disregarding any changes it may undergo independently of energy matters, suggest potential savings of the order of 3% in industrial consumption that are achievable subject to short term investment (not exceeding 4 years).

The more ambitious approach described above has examined a range of actions representing up to 20% of potential reduction in CO₂ emissions through fossil energy savings or energy replacement, equivalent to about 5 million tonnes of carbon on the basis of 1990 levels.

(1) including emissions from the energy sector, although excluding those due to electricity generation

This potential is related to payoff times longer than those currently applied in industry - say, 2 to 3 years - and its exploitation would imply the grasping of all the opportunities that will arise as production facilities are progressively renewed, involving the adoption of new technologies whose technical and economic feasibility is not yet finally demonstrated in every case.

Again, although this potential is substantial, its complete exploitation will not be possible unless the conditions can be created at international level enabling it to be done without introducing distortions of competition: this difficult question should be dealt with in the spirit of article 4 of the Montreal Protocol on CFCs.

It is for this reason that France intends to exonerate specifically industrial fuels from duties in connection with the greenhouse effect at Community level only. However, as part of the voluntary commitment to progress, firms will be requested to invest in fossil energy savings, resulting in the same type of investment as would have been promoted by the duty.

In this context the aim is to achieve, by the year 2000, the progressive implementation of investment for which the payoff time may be 4 to 6 years with regard to production facilities that can be expected to remain in place for a sufficiently long time.

Consultations are being made with firms in the sectors that consume most energy with a view to signing voluntary undertakings in 1995 to enable the exploitation of a significant proportion of this potential.

1-2-2 Subsidiary measures

Since 1974 France has required industrial establishments consuming over 300 toe a year to undergo periodic energy audits by government-approved experts.

These arrangements, which anticipated the recommendations of the SAVE directive, are now being recast: the aim is to improve the effectiveness of the incentives for industry to grasp favourable opportunities, in order to achieve further progress in energy efficiency.

The different forms of aid for energy management in industry may now be summarised as follows:

a) Financial aid from the ADEME

- Support for research and development:

Projects for which assistance is provided mainly concern industrial processes (iron and steel, metalworking, non-ferrous metals, chemicals, paper), generic techniques (heat exchangers, radiant forms of energy, drying, grinding, heat pumps). The ADEME also allocates about a dozen research scholarships a year (leading to a doctorate) in these areas;

- Assistance with the decision-making process, notably in the form of grants to cover the use of external consultants, energy metering, or sectoral actions;

- Demonstration aids for investment projects that break new ground.

Between 1990 and 1993 these interventions totalled 398 million francs, including 132 MF for R & D and 45 MF from the regions.

b) Fiscal incentives

- A special 12-month depreciation period for various types of system intended to save energy or to produce electricity in a combined generation system, as from the time of commissioning.
- Reduction of 50% or 100% in the assessment basis of the trade tax or land tax on buildings for equipment which has been granted an exceptional depreciation period in accordance with the above measure.
- Exoneration from excise duty for gas and heavy oil used for combined generation purposes.
- The Approved Energy Saving Funding Companies (SOFERGIE) benefit in certain cases from tax relief on profits and capital gains made from leasing and renting equipment designed to save energy.

II.1.3. TRANSPORT

Transport (excluding maritime bunkering) accounts for over a third of French CO₂ emissions with 36.1 million tonnes of carbon emitted in 1993. Quite apart from measures aimed specifically at controlling the greenhouse effect, many government measures necessary under various aspects of transport policy also have the effect of reducing this contribution.

Fuel deliveries to the transport sector in France, expressed in terms of the carbon contained therein, are shown in the following table in million of tonnes of carbon a year.

	1985	1990	1992	total average carbon/year 85-92
goods traffic by road	8.02	11.67	12.40	+6,4%
of which emissions in France from French HGVs (> 5t payload)	3.84	4.84	5.01	+3,9%
of which emissions in France from foreign HGVs (> 5t payload)	0.55	0.83	0.86	+6,7%
of which emissions in France from French light goods vehicles (essentially in towns)	3.47	4.68	5.15	+5,8%
private cars	15.63	17.62	18.32	+2,3%
air transport	2.32	3.35	3.70	+6,9%
rail transport (SNCF - French Railways)	0.34	0.29	0.27	-3,2%
inland waterway transport	0.07	0.06	0.04	-7,7%
maritime transport	2.00	2.12	2.12	+0,8%
other	0.96	1.10	1.16	+2,7%
total	29.34	36.22	38.02	+3,8%

1.3.1. Transport of goods (excluding light utility vehicles)

The rapid growth of the road transport of goods mainly concerns long distance carriage and more particularly international transport. Although domestic traffic involving HGVs registered in France went up by 5.2% a year between 1985 and 1992, over the same period the proportion of this traffic involved in trade with other European countries rose at a rate of 10.2% a year, and it is estimated that HGV traffic in transit through our country rose by 12.3% a year.

These high rates of growth are partly explained by the widening of the European Community to embrace Spain and Portugal and then by the creation of the single market, developments which stimulated the goods trade between member countries.

Taking an average scenario (GDP rising by 2.7% a year), traffic is predicted to rise in the period 1990-2010 by an average rate of about 2.5% a year for internal road traffic of which 5% is for foreign HGVs in transit.

Technical advances in vehicle design have slowed down the increase in emissions arising from these changes in traffic; for 40-tonne semi-trailers, specific consumption has fallen by 0.8% a year since 1985, to reach 37.1 litres/100 km in 1992.

If no corrective action was taken, CO₂ emissions from goods transport would nevertheless continue to grow steadily. France has taken three kinds of action which will have a significant effect on CO₂ emissions from this sector:

- technical measures affecting vehicles in order to reduce the specific consumption of HGVs (1.3.1.1); it will be noted that these actions stem essentially from initiatives to be taken throughout the European Union;
- institutional actions pertaining to the organisation of the transport of goods by road, the observance of social regulations, and pricing (1.3.1.2 and 1.3.1.3);
- efforts to stabilise the modal breakdown of road transport, first by developing intermodal transport with a special effort devoted to combined rail-road transport and, secondly, through improvements to the inland waterways system (1.3.1.4).

1.3.1.1. Technical measures concerning HGVs

It is estimated that France has 1.75 million HGVs (over 3.5 tonnes), and buses. This stock includes old vehicles often doing a limited mileage (30,000 km a year), and more recent vehicles fitted with increasingly powerful engines and accumulating substantial mileage (100,000 km a year). Age and higher power are two factors that increase consumption.

Vehicles need adequate power to hold their own in road traffic and this contributes both to safety and to traffic fluidity. However, even though the average energy consumption (ratio of total consumption to the mileage covered) of heavy goods vehicles has fallen by nearly 20% since 1970, some power units today seem excessive. France recently established a working party involving representatives of the government and manufacturers and importers of heavy goods vehicles in order to examine the suitability of limiting the specific power of these vehicles. In the event of a positive outcome, France will propose consideration of a Community measure aimed at implementing such limits.

Also, as indicated in paragraph 1.3.2.1.2 concerning the technical inspection of vehicles in service, a recent Order (5 July 1994) extended the obligation to repair vehicles subjected to technical inspection (such as HGVs and buses) when they are faulty as regards pollutant emissions.

Expected effects

The measures described above should bring about a continued fall in the real specific consumption of buses and HGVs. A further reduction of the order of 20% in real specific consumption by the year 2015 seems achievable.

1.3.1.2. Organisation of goods transport by road

The abolition in 1986 of a major part of the pricing regulations that had applied to goods transport by road for many years generated competition in the sector. In this situation, certain firms, finding themselves in difficulties, were tempted to disregard the rules concerning driving hours and rest times, speed limits, total weights, and so on.

This unfair competition proved unfavourable to the entire industry and resulted in an abnormal fall in prices which contributed to unbalancing the modal distribution to the detriment of the railways and inland waterways. Thus in France between 1985 and 1992, the price per tonne-km of goods carried by road fell by 3.4% a year in constant franc terms. Over the same period, the roads' share of the market (in tonne-km) went up from 58% to 69%.

With a view to restoring proper practices in the industry, a number of measures were decided in December 1993 in agreement with the industry:

- the requirements governing entry to the industry were made more severe;
- France took action to promote the production of an inviolable tachygraph at Community level;
- stiffer penalties were introduced for contraventions of the rules relating to driving time and rest periods, total weights and speeds.

The derestriction of cabotage planned for 1/1/1998 should be accompanied by more comprehensive harmonisation of working conditions in this sector throughout member states. France asked for the elimination of these distortions in competition in a memorandum lodged in 1989 intended to transform the regulations on driving hours into regulations on the working hours of HGV drivers.

Expected effects

The extent to which the regulations are observed has a substantial effect on the costs and prices of goods transport by road. The enhanced observance of the regulations to which the above measures should contribute could result in an average rise in the costs of goods transport by road of about 10%, the rise being certainly higher for the longest journeys for which European social regulations (especially as regards rest times) are the tightest. Having regard to a traffic price elasticity estimated at - 0.7 for long distance traffic (over 200 km), this should lead to a reduction of about 7% in CO₂ emissions from this traffic, or a gain of the order of 400,000 tonnes of carbon by the year 2000 compared with a situation in which there was no improvement in observance of the regulations.

1.3.1.3. Economic measures

The current minimum rates of excise duty on fuels, set throughout the EEC, should be progressively raised to cover the costs pertaining to climate change and, more generally, those related to the external effects of transport.

Several countries of the Union, including France, have done a great deal towards raising their excise duty: in France, excise duty on gas oil is today 31% higher than the minimum Community rate following action taken since 1990. It is important that the minimum Community rates should be increased so as to avoid introducing distortions of competition into the road transport sector or resulting in delocalised fuel purchases. These increases should also be clearly signalled beforehand to allow firms to adapt to the price changes in the medium and long term.

Expected effects

Assuming a value of - 0.2 for the price elasticity of fuel consumption for utility vehicles (short-term value), a rough estimate shows that each 10% increase in the real price of fuels (including taxes and duties) in France by the year 2000 would lead to a 2% reduction in CO₂ emissions from HGVs, or a gain of about 150,000 tonnes of carbon a year. This estimate disregards the reductions in emissions from private cars and light goods vehicles that would also result from this measure. In the long term, the price elasticity in fuel consumption is much higher, thus enhancing the effect of the price increases.

1.3.1.4. Development of the intermodal transport of goods

The aim is to develop intermodal forms of transport as an alternative to road carriage wherever this is appropriate, and more particularly:

- combined rail-road transport (containers and mobile enclosed pallets) for long routes;
- rail shuttle services on routes of high traffic density or to overcome geographical obstacles such as crossing the Alps.

The combined rail-road approach, despite the efforts made by European states and railway operators, still accounts for only a very small proportion of traffic. In France, combined rail-road traffic rose by about 3% a year between 1985 and 1992. Today, in terms of tonne-km, it represents 21% of the freight traffic carried by French railways, 5% of total goods traffic and 8% of traffic on journeys exceeding 150 km.

France is a country of transit and it is estimated that transit goods traffic will continue to increase at 5% a year, accounting for over a quarter of the rise in land goods traffic - all modes - in France between 1990 and 2000. Although it is on the longer routes, particularly for international traffic, that combined transport can be competitive, the situation of the different member states of the European Union shows how limited are the national policies applied: as regards the peripheral countries of the Union, 92% of Spanish and Portuguese goods sent overland to other Member states and 83% of Italian and Greek loads are sent by road.

The development of combined transport in France will be possible only if there is a co-ordinated European Union policy covering the institutional and pricing aspects, and investment.

Institutional aspects

With a view to encouraging combined rail-road transport for international traffic, EEC Community directive 91/440 provided for international combined transport to have access to Member states' railway infrastructures. France has investigated the effects the application of this directive has had in these Member states and has commenced the procedures for change it into French law. The necessary legislation will be promulgated during 1995.

It is equally important to ensure that Community systems are truly interoperable from the technical point of view. For this purpose France would like the European Union to develop powers to bring coherence into the rules, technical specifications and standards governing the infrastructure, rolling stock and other logistic facilities.

Research and development

Substantial assistance for research and development concerned with intermodal transport has been provided under the PREDIT programme (R & D programme for innovation and technology in terrestrial transport). During the period 1990-1994, the sum of 450 million francs was devoted to research covering the following in particular:

- development of automatic transshipment systems for containers and mobile enclosed pallets (the Commutor project);
- bimodal systems (the Kombirail project) whereby the road rig is converted into a rail wagon simply by adding bogies, thus obviating any need for loading gantries or lifting equipment;
- "moving roadways" or "rail highways", similar to those used in the Channel Tunnel.

These research and development programmes will be continued and extended.

Development of infrastructure

Conversion of the main freight lines to the B+ gauge is continuing. Since 1985, funding of 250 million francs has been devoted to the gauge change and a further 700 million francs have been earmarked for the period up to 2000.

New trading hubs will be introduced between 1994 and 2000 at four of the ten main sites that currently form part of the combined transport structure in France (Bordeaux, Lille, Lyon and Marseille). The government and the regions will contribute 100 million francs a year to the capital costs, which is a factor of 3 more than in the period 1989-1993 (30 million francs a year). In addition, the North-East Paris site will be completed and the other terminals involved in the network brought up to date.

A project to establish an automatic transshipment facility for containers and mobile enclosed pallets (the COMMUTOR project) is under consideration and a decision will be taken during 1995.

As regards "rail highways", the recent commissioning of the Channel Tunnel shows that the technologies are now available. The preliminary studies for the Lyon-Turin high speed line will also consider freight traffic. The introduction of a rail highway between Ambérieu and Turin and, initially, a shuttle service through the basic Franco-Italian tunnel will be investigated.

With regard to the development of the inland waterways system, the current projects (Niffer-Mulhouse, dredging of the Saône, Bray-Nogent) will allow the retention of some traffic which would otherwise have moved to the roads.

Assistance to carriers as concerns facilities

In accordance with the modified Community rule 1107/70, the government, the ADEME and Electricité de France in 1990 introduced a programme to encourage transport firms to acquire combinable systems. These arrangements are intended to facilitate access by small and medium-sized transport firms to the techniques of combined rail-road transport: road transport firms wishing to embark on combined transport or to increase their traffic in this field can obtain funding for the necessary equipment (rail-road semi-trailers, mobile rail-road enclosed pallets possibly coupled to a chassis, bimodal systems) through low-cost leasing arrangements in return for achieving certain objectives in combined transport traffic. A penalty system has been introduced whereby the leasing costs are raised if objectives are not reached. By the end of 1993, total funding dispersed amounted to 8.3 million francs.

This procedure will be continued with additional funding as necessary to meet carrier demand.

Expected effects

The actions taken in France, particularly as regards infrastructure development, will be effective only if they are backed up at Community level by a more balanced policy of transport cost charging (costs of infrastructure, congestion, safety and the environment), by better observance of social and safety rules and by increased investment assistance.

The objective for the year 2000 is to double the volume of combined transport compared with 1990 (+ 7 billion tonne-km). In particular, the efforts devoted to infrastructure development are intended to ensure that the development of combined transport is not hindered by a lack of capacity. Taking into account terminal journeys, and since there are no CO₂ emissions for generating the electricity needed for this type of demand, it is estimated that this gain of 7 billion tonne-km will avoid the emission of about 125,000 tonnes of carbon a year.

1.3.2. Passenger transport and light goods vehicles

CO₂ emissions from private cars rose by 2.3% a year between 1985 and 1992, and those from light goods vehicles by 5.8%. These rates of increase are lower than those for traffic (expressed as vehicle-km): 3.4% and 5.9% respectively. These figures reflect a fall in the average consumption of the vehicle stock owing to the lower consumption of new vehicles designed before the 1985 oil countershock.

The average conventional consumption of new gasoline and diesel-powered vehicles sold in France, which fell for a long period after the first oil shock and continued to do so up to the 1980s, is again rising.

	1989 (litres/100km)	1993 (litres/100km)	Rise 89-93
Gasoline	6.76	7.07	+ 4.7%
Diesel	5.90	6.09	+ 3.2%

The renewed rise in the mean specific consumption of new vehicles stems from two factors: first, new vehicles coming on the market in 1991 were designed after the oil countershock, consuming more fuel than the models they replaced; also, consumer choice is shifting to the higher consumption models on the market. These two trends are the result of the fall in fuel prices. Since fuel consumption and CO₂ emissions are directly proportional, it would appear important for this trend to be corrected.

The renewed rise is particularly marked in urban consumption, related to an increase in weight and average power of vehicles of about 10% during the period 1985-1993. It may be pointed out that vehicles are still being optimised for interurban use on motorways even though nearly 50% of the energy consumed by road transport is in urban areas and, in the last 15 years, energy consumption for transport in cities has increased four times faster than that of interurban transport.

France intends to take several types of measure which will have a significant effect on CO₂ emissions from passenger transport:

- as regards improving the technical design of private cars and light goods vehicles, it is a question of reducing specific vehicle consumption and encouraging drivers to choose economic vehicles (1.3.2.1.1 to 1.3.2.1.4), facilitating development of a specifically urban vehicle (1.3.2.1.5) and promoting electric vehicles (1.3.2.1.6). It should be noted that most of these measures are related to Community actions;
- as far as urban journeys are concerned, it is important to encourage local authorities to promote better planning of journeys (1.3.2.2);
- with regard to inter-regional journeys, it is a matter of developing the high-speed trains network whereby electric power replaces fossil energy (1.2.3.4).

1.3.2.1. Optimising the technical design of vehicles

1.3.2.1.1. Reducing the specific consumption of new vehicles

France believes it is necessary to reduce the average specific consumption of new vehicles throughout the Community. For example this average level could be set at 5 litres/100 km by the year 2005 following a Community evaluation of such an approach having regard to the economic constraints of the market, the technological state of the art and the various Community regulatory constraints.

The government is encouraging R & D programmes, notably through PREDIT. The sum of 1.2 billion francs has been allocated specifically to the "clean and economic" vehicle between 1990 and 1994. However financial incentives for research are unable to redirect the market in the absence of restrictive or incentive measures.

- *Fiscal measures*

An investigation has begun into the possibility of modifying the basic road tax ("vignette") paid by drivers each year. At present the tax is based on the characteristics of the vehicle's engine and transmission. These parameters do have an impact on energy consumption, but in view of recent technological developments the formula used for the calculation has become obsolete: the study is intended to determine whether it is possible, without changing the order of magnitude of the revenue, to make the tax more incentive by basing it on the carbon contained in the fuel needed to travel 100 km. This initiative, if adopted, will be at national level.

- *Tradeable permits*

The tradeable permit system⁴, the principle of which was proposed in 1992 by the United Kingdom, would have the objective of encouraging manufacturers and importers to design more economic vehicles and to give marketing priority to their lower consumption models. The feasibility of the proposal is worth examining by the European Union. For this reason France is already setting up a working group in order to take an active part in the Community effort, as and when appropriate.

- *Various regulations - or the lack of regulations - can have an impact on the specific consumption of the new vehicles bought each year. An example is the lack of any general speed limit on European Union motorways, and another is the changing regulations governing vehicle construction as regards passive safety.*

In France, the speed of private cars has been limited since 1973 to 130 km/h on motorways, 110 km/h on principal highways, 90 km/h on ordinary roads and, since 1990, 50 km/h in built-up areas. The absence of speed limits in certain states of the Community encourages manufacturers to develop increasingly powerful vehicles which are consequently not optimised for the controlled traffic speeds in the other states of the Union. If such generalised limits are not to be adopted soon, consideration should be given to physically limiting the speed of the vehicles marketed.

In the field of road safety, the emphasis in France in recent years has been focused on stricter checks on driving standards, particularly as regards speed, and on stiffening the penalties for contraventions. Thus a system of license points was introduced on 1 July 1992 and penalties for disregarding speed limits will be stiffened by creating a criminal offence for major excesses of speed (exceeding the maximum permitted speed by more than 50 km/h).

At European Union level, the actions mainly concern the intrinsic safety of the vehicle, the improvement of which could lead to making vehicles heavier and hence to increasing their fuel consumption. It will therefore be necessary in the future to keep a close eye on the compatibility of the aim of improving intrinsic safety and that of reducing energy consumption.

⁴Such a system could only be introduced throughout the European Union, so as not to introduce obstacles to the free circulation of goods within the single market. It would involve setting an objective and progressively decreasing level for the conventional emission of CO₂ per kilometre. This level would apply to all the annual sales of every manufacturer or importer of new vehicles within the European Union. When each vehicle is registered, it would be assigned a credit equal to the objective level of conventional CO₂ emission per kilometre. The manufacturers and importers would negotiate between themselves the credits they possess such that each, during a particular year, holds the number of credits corresponding to the conventional emissions from the vehicles it has sold. To prevent any blocking in the system European Union should be able to sell additional credits at a predetermined price.

Expected effects

At this stage it is not possible to evaluate the effects of the measures listed above.

1.3.2.1.2. Technical inspection of vehicles in service

It is estimated that 62.5% of the 24 million private and commercial vehicles in France are more than 4 years old.

On 31 December 1985, technical inspection was made compulsory whenever a vehicle under 3.5 tonnes and more than 5 years old changed hands. Since 1 January 1992, all these vehicles must undergo periodic technical inspection regardless of changes of ownership. This inspection is carried out in approved centres and covers 52 points defined by an Order of 18 June 1981, including a test of the carbon monoxide emissions (gasoline engines) and smoke (diesel engines).

As from 1 January 1995 the technical inspection will be carried out every two years for all vehicles over 4 years old, which anticipates the Community requirement planned for 1 January 1998. Under a recent Order of 5 July 1994, vehicles found to be defective during the technical inspection as regards pollutant emissions must be repaired as from:

- 1 October 1994 for petrol-engined vehicles without a catalytic converter;
- 1 January 1996 for diesel-powered vehicles;
- 1 January 1997 for petrol-engined vehicles with a catalytic converter.

Expected effects

The technical inspection procedure appears to have a positive effect on the tuning of petrol-engined vehicles since the failure rate, which exceeded 50% during the free test campaigns sponsored by ADEME in the early 1990s, is only 25% now that tests are compulsory.

Thus an average 10% reduction in consumption and pollutant emissions can be expected from the 50% of petrol-engined vehicles that failed the test in 1990, equivalent to 320,000 tonnes of carbon a year.

1.3.2.1.3. Cash payment when vehicles over ten years old are retired

Since February 1994, a cash sum of 5000 F has been paid for every vehicle over ten years old scrapped and replaced by a new one. This arrangement will continue to 30 June 1995.

Over and above the natural renewal of the vehicle stock, this payment should encourage the replacement of about 400,000 additional old vehicles during the period it is available. Its impact on CO₂ emissions is substantial in the short term (several tens of thousands of tonnes of carbon a year).

1.3.2.1.4. Aids to economic driving

The way in which a driver uses his vehicles has a considerable effect on its fuel consumption and hence its emissions. Two types of driver aids have been introduced:

- *Notifying the driver of his fuel consumption in real time*

In the early 1980s, several manufacturers fitted a fuel consumption indicator to their petrol-engined vehicles as standard. However the commonest of these sometimes proved unreliable and difficult to use in traffic.

The French government has invited manufacturers to promote a device that provides data not only on the instantaneous fuel consumption but also on the average consumption for both petrol and diesel-engined vehicles.

If 2 to 3 million private cars were so fitted by the year 2000, assuming an average efficiency of 3%, the annual saving by the year 2000 would be 40,000 to 60,000 tonnes of carbon.

- *Training users to drive economically*

ADEME has made a substantial financial contribution towards the development of a computer program for teaching economic driving which will be available for demonstration at the end of 1994.

Driving schools will be the first to receive this teaching aid, the aim being to equip 800 centres by the year 2000. By that time, some 120,000 new drivers could be trained in this way. A 10% saving on their average consumption would be equivalent to an annual saving of 10,000 tonnes of carbon.

1.3.2.1.5. Development of a specifically urban vehicle

Even though urban journeys account for an increasing share of motor traffic, vehicles are still being optimised to travel at 130 km/h on motorways; one third of the average annual mileage of 14,000 km for a light vehicle takes place in towns, accounting for half of all fuel consumption.

Traffic flow would be improved and pollutant emissions reduced by the use of a specifically urban vehicle characterised by small size, and low power, speed, pollutant emissions and noise, and a corresponding attenuation of the passive safety requirements currently necessitated by the speed of traffic on highways and motorways. The French government recently set up a working party involving representatives of all concerned with a view to defining the specification for this kind of vehicle.

The working party will look into the necessary regulatory measures at Community level, the appropriate national taxation regime and measures concerning urban traffic regulations to facilitate the creation of a big enough market for the price of such a vehicle to be competitive.

This vehicle could be a case for the special application not only of electricity but also of low-pollution substitute fuels such as LPG, natural gas, and so on (see 1.3.2.1.6 below).

Expected effects

In France, some 2 million new private cars are sold every year. It is not yet possible to determine what proportion of this market the specifically urban vehicle might take, since manufacturers will bring out such a product only when the conditions are such to ensure rapid development.

At best, an objective of about 1% of the market for the specifically urban vehicle by the year 2000 might be laid down. Such an outcome would be possible only if a deliberate policy is adopted simultaneously by all Community states, thus contributing to the creation of a true Community market for the specifically urban vehicle.

1.3.2.1.6. Promotion of the electric vehicle and other alternatives

France intends to promote the development of alternative vehicles (powered by electricity, natural gas and LPG). So far its efforts have been concentrated on the electric vehicle.

The electric vehicle is the only one with zero local emissions. In France, the average level of CO₂ emission is also very low because the base load electricity generating capacity is mostly nuclear and hydro; CO₂ emissions are even zero when batteries are charged at night.

However the electric vehicle is primarily a specifically urban vehicle and will probably remain so for many years to come.

Between 1990 and 1994, 500 million francs were allocated to research and development concerned with the electric vehicle, notably under the PREDIT programme mentioned earlier. This work has involved, *inter alia*, batteries, charging systems and fuel cells.

On 1 May 1991, a Fund was created to enable local authorities to purchase the first 1000 electric vehicles. In this way the purchase of 350 vehicles has been helped since 1992. As an additional measure, private firms buying electric private cars and batteries have been authorised exceptionally to depreciate these over a 12-month period as from 1 December 1991.

On 20 July 1992, a framing agreement on electric vehicles was concluded between the government and the Chairmen of Electricité de France, PSA and RENAULT. This concerns the development of infrastructure and repair and maintenance services necessary for making electric vehicles available to the public by 1995. So far 25 cities have acceded to this agreement on a pilot basis. Finally, Electricité de France has for a number of years been developing its own policy in favour of the electric vehicle and it now has a fleet of over 450. Between 1990 and 1994 Electricité de France invested more than 100 million francs on research and supplies.

At the same time, a number of international working groups have been established at the instigation of France with a view rapidly to achieving Community standardisation of the electric vehicle.

As regards alternative vehicles other than those powered by electricity, the first steps have been taken, notably the establishment of an association to promote natural gas for powering vehicles with the support of the authorities.

Expected effects

The French fleet of electric vehicles is still highly marginal, numbering less than 1000. The two major French manufacturers, in conjunction with the authorities and other partners, have adopted 1995 as the year in which sales to the public will begin. Hence there should be a substantial move forward after that date.

The objective is to have more than 100,000 vehicles on the road by the year 2000. The substitution of these vehicles for conventional vehicles powered by internal combustion engines should result in a saving of at least 40,000 tonnes of carbon by the year 2000.

1.3.2.2. Urban journeys

Between the years 1976-80 and 1985-92, the car's market share in urban journeys in terms of the number of journeys per day went up from 40 to 50% in the provinces and from 33 to 44% in the Ile de France region, while that of public transport remained stable around 10% in the provinces and 20% in the Ile de France, and that of non-motorised modes of transport fell substantially.

The rise in the market share of the private car is linked partly to its intrinsic advantages (the car is usually quicker than public transport, more comfortable, more available, and so on). However, even apart from the greenhouse effect, private car use in cities generates rapidly rising external costs of congestion but also external costs of insecurity, noise and local air pollution which are not covered by the various types of specific taxation levied on the car in its urban journeys. This implicit "subsidy" stimulates the expansion of private car use beyond its true social utility and encourages the development of increasingly sparse urbanisation generating increasingly long journeys which cannot be handled by public transport which is competitive only in fairly densely-populated areas (the home-employment commuting distance doubled between 1970 and 1994, from 7.4 to 14 km).

A desirable policy relative to urban journeys should lay down four additional objectives:

- it should take into account the interactions between urban development and transport in order to control the growing need for motorised journeys and to facilitate the use of modes of transport that save space and energy;

- it should selectively develop the type of transport best suited to the different urban configurations by interconnecting systems and making them complementary, and developing - whenever justified for the community - own-track public transport systems;
- it should institute regulatory and price mechanisms to control demand in congested zones;
- it should optimise the management of motor traffic.

These policies are matters for local authorities who will be made aware of their relevant responsibilities. The government, in addition to the investment assistance it provides to these authorities for developing public transport, intends to help them conduct the necessary research and provide them with up-to-date information, particularly through the network, transport, urbanisation and public building research centre (CERTU).

1.3.2.2.1. Investment in urban public transport

The government gives investment grants to local authorities for modernising urban transport and, since 1994, has modulated the sums granted in order to encourage a voluntary policy of sharing road capacity in favour of public transport. The relevant projects concern 32 conurbations with populations of over 100,000, not counting the Paris area itself.

Since 1990, the efforts to develop public transport infrastructure has been substantially reinforced. Thus the proportion of total expenditure on transport infrastructure (urban and interurban) going to urban public transport went up from 7.3% in 1990 to 13.8% in 1993.

During the period 1989-1993, the government contributed 1.3 billion francs a year towards the annual average investment in public transport of 5 billion francs, an increase compared with the period 1984-1988 (0.8 billion francs for investment of 3 billion francs). The annual government contribution will be maintained during the period 1994-1998; it should enable an annual capital expenditure of about 5.5 billion francs in public transport.

This investment in the development of public transport must be accompanied by the introduction of regulatory and price mechanisms to limit the use of the private car in congested areas. Studies has therefore been undertaken to determine whether the local authorities involved should be empowered to raise - if they so wish - new financial resources that would contribute to funding public transport; such resources could come from charging for the use of vehicles in the conurbation, insofar as such use is responsible for the high cost of public transport and as it benefits from the improvement in road traffic made possible by the development of this public transport.

The investment in urban public transport will have the result of slowing down the erosion of its market share. However it is very difficult to define a reference scenario and the impact of this investment in terms of CO₂ emissions cannot be quantified.

1.3.2.2.2. Management of motor traffic

Even outside periods of traffic congestion, poorly managed traffic lights result in excess fuel consumption owing to unnecessary stops. The correct phasing of traffic lights thus has a direct effect on fuel consumption.

About 20% of the 35,000 intersections presently controlled by traffic lights in France are co-ordinated. Experiments carried out in Caen showed that good co-ordination of traffic lights could result in a saving of up to 20% in fuel consumption in the town centre. Other experiments are in progress to confirm the hypothesis of a fuel saving of about 20% resulting from the co-ordination or management of lights.

Subject to this confirmation, the average saving in terms of CO₂ emissions, depending in the first place on the flow of vehicles concerned, would be between 20 and 30 tonnes of carbon a year per intersection. The total potential for savings from the co-ordination or management of the existing 28,000 intersections with non-coordinated traffic lights would therefore be between 0.6 and 0.9 million tonnes of carbon a year.

It will be noted that these measures are made worthwhile by the time savings they procure and that their cost to the greenhouse effect is zero. While the government is encouraging research and development in this field, the initiative for the appropriate actions belongs to the local authorities.

1.3.2.3. Management of suburban traffic

The network of fast urban and suburban roads in the major conurbations suffers from recurrent daily congestion resulting in particular from commuter traffic between home and employment.

The development of modern technologies for collecting, processing and displaying road information now makes it possible to limit the effects of road congestion by alerting users to traffic problems and suggesting that they travel at different times or use alternative routes. This information policy can be enhanced by a policy of adjusting motorway tolls as a function of congestion.

The reduction of congestion holds out hope for significant savings in terms of fuel consumption and pollutant emission.

In 1993 two suburban traffic management systems were introduced: the SIRIUS system in the Ile de France region and the CORALY system in the Lyon conurbation. These systems will be fully operational by 1998. Their capital costs are estimated to total 1200 million francs and they will cost 85 million francs a year to run. These costs are justified merely by the time saved by traffic management.

Experiments in modulating toll charges have also been progressively introduced since 1992.

Expected effects

Assuming that fuel consumption is 50% greater in slow-moving than in fluid traffic, it can be estimated that traffic management measures will make it possible to save up to one third of fuel consumption at certain times of day. As far as the SIRIUS operation is concerned (in the Ile de France region) the savings resulting from traffic management are estimated at about 40,000 hour-km a year (1 hour-kilometre: 1 hour of traffic jams over 1 kilometre). This leads to a saving of approximately 2600 tonnes of carbon a year. Similarly, it is estimated that the CORALY operation should lead to a saving of 8000 hour-km a year and 500 tonnes of carbon a year.

1.3.2.4. Development of the High Speed Train (TGV) network

Following the opening of the first TGV line in 1981, France decided to continue building a high speed rail network and in 1991 adopted the national master plan for high speed rail links.

This scheme includes about 4700 km of new high speed lines of which 1260 km were in service in 1994:

- TGV South-East between Paris and Valence
- TGV Atlantic
- TGV North Europe and the cross-Channel link.

By the year 2000, the TGV Mediterranean will be completed as far as Marseille and the first phase of the TGV East will come into service from Paris to the valley of the Moselle and from Sarrebourg to Strasbourg.

The government is also encouraging research and development, notably through the PREDIT programme. Some 445 million francs have been allocated specifically to high speed railways between 1990 and 1994 with, in particular, the programme for the new generation of TGV.

The development of the TGV network makes it possible to replace - for "high speed" traffic (by motorway, air or railway) - fossil fuels by electricity that of non-thermal origin (nuclear or hydro). Thus its effect on greenhouse gas emissions is favourable.

Expenditure on infrastructure for the high speed network rose (in constant 1993 francs) from 2.5 billion francs in 1980 to 7.1 billion francs in 1990. Over the last three years investment has averaged 7.8 billion francs. The cost of the future TGV Mediterranean and TGV East is estimated at 55 billion francs.

Expected effects

Traffic forecasts by French Railways suggest that the commissioning of TGV Mediterranean and TGV East should result in 1.8 billion and 0.6 billion passenger-km a year being diverted from air travel. Diversions from road traffic would be 0.7 and 0.3 billion passenger-km a year respectively.

It is estimated that by the year 2000 this will result in the substitution of electric power not contributing to the greenhouse effect for the 130,000 toe a year consumed by air traffic and 30,000 toe a year consumed on the roads. Hence the estimated savings in terms of CO₂ emissions is about 130,000 tonnes of carbon a year.

II -1.4 ELECTRICITY

The unique position of France as regards electricity generation substantially reduces its margin of manoeuvre for controlling changes in its future emissions.

CO₂ emissions linked to electricity generation account for less than 10% of French emissions compared with 30 to 45% in most industrialised countries.

Nuclear power, which has been introduced to a greater extent in France than in any other country, eliminates any CO₂ emission.

Other countries have considerable capability for reducing their CO₂ emissions in electricity generation which France no longer possesses: they can not only turn to nuclear generation, but also halve emissions from their electricity supply sector by replacing conventional coal-fired stations by combined cycle gas-fired plants or by developing combined generation. In France, the high proportion of nuclear generation no longer permits any savings through the replacement of energy sources and combined generation is unable to produce any further lasting reduction in CO₂ emissions unless coupled to seasonal demand for heating.

Although France has virtually no further possibility for reducing its CO₂ emissions through action on electricity generation itself, it does intend to further reduce its emissions through its electricity policy in two ways:

- by taking action on electricity demand to flatten the load curve;
- by further enhancing the penetration of electricity as a replacement for fossil energy wherever this can save CO₂.

1-4-1 Investment in new nuclear power plants

Six new 1300 MW PWR units were put into service between 1990 and 1994 and four 1450 MW PWR units are now under construction and expected to be commissioned before the year 2000. Thus the nuclear programme for 1990-2000 covers the installation of a total of 13,600 MW.

As an illustration, the base load operation of these ten units, with availability of 82% and a load factor of 85%, will generate about 84 TWh a year with no CO₂ emissions. Equivalent generation from power plants burning coal or from combined cycle stations burning gas would result in the emission of 25 and 12.5 million tonnes of carbon a year respectively.

Having regard to current forecasts of electricity consumption, the improved availability of French nuclear stations and the expected extent of our exports, it is not expected that further nuclear reactors will be ordered before the year 2000.

However, if the level of 70 ECU a tonne of carbon not emitted were to be regarded as necessary to stabilise emissions from the European Union, the French investment policy would be revised and this could lead to the construction of a further 3 GWe of nuclear plant; this would subsequently save 3 million tonnes of carbon a year.

1-4-2 Electricity exports

French exports of electricity contribute to reducing European CO₂ emissions because they replace electricity generated from fossil fuels. Under existing contracts, these exports will rise to 72 TWh by the year 2000, an increase of 26 TWh over 1990.

Having regard to existing European generating plant, these exports can be expected to replace electricity generated from coal, with a saving of 22 million tonnes of carbon a year (it is likely that a substantial proportion of future investment in generating plant, when this becomes necessary for our neighbours, will focus on the combined gas-burning cycle, which would reduce this CO₂ saving).

However France will not increase its investment in nuclear plant in order to provide its neighbours with energy that does not generate CO₂.

Any reduction in these exports at times when France is using its residual thermal plant would reduce French emissions but increase that of its neighbours.

1-4-3 Reducing load peaks

In most countries, every kWh saved reduces CO₂ emissions. In France, reducing base load electrical demand has no lasting effect on CO₂; however reducing demand peaks, particularly during the winter, is highly desirable because it will enable the operating time of the thermal plant to be reduced still further.

Steps will be taken to reduce peaks both to save electricity and to shift certain types of consumption in time.

Electricité de France has developed a sophisticated pricing system for this purpose, and in particular has introduced a low voltage tariff known as "TEMPO" which includes six differently-priced time periods during the year and will contribute to smoothing the annual load curve with a particular reduction in the winter peak.

Electricité de France plans to obtain 300,000 TEMPO subscribers by the end of 1996. In the medium term, market surveys suggest that the new pricing system could be of interest to about a million homes by the year 2000. In terms of consumption, the TEMPO tariff would then represent 5.4 TWh by the year 2000; the reduction in peak electricity consumption could reach 1.5 TWh, equivalent to a reduction of about 0.5 million tonnes of carbon emissions a year.

Quite apart from the specific impact of this new tariff, the introduction of a European Union CO₂ tax would further smooth the load curve by further differentiating the charges applicable at different times of the day and year.

Finally, besides these pricing changes, a co-operation agreement in the field of electricity demand management (MDE) was signed in February 1993 between Electricité de France and ADEME for a 3-year period. This agreement will focus on actions likely to reduce CO₂ emissions, i.e., mainly those affecting seasonal demand (lighting) or the demand for electricity in areas of the country not connected to the grid which is mainly supplied by nuclear plants (Corsica and the overseas départements). Emission reductions resulting from this policy would reach a maximum of 1.7 million tonnes of carbon a year by the year 2010.

1-4-4 Replacement of fossil fuels by electricity for the final consumer

Vigorous attempts will be made to introduce electricity for competing, non-seasonal applications in industry, wherever this will result in reduced CO₂ emissions at a cost below the reference cost mentioned in the introduction (induction furnaces, resistance furnaces, mechanical recompression of steam, and so on).

Electricité de France will concentrate on promoting investment for which the payoff time is under 6 years. Since industry does not spontaneously tend in this field to make investment with a payoff time longer than 3 years, Electricité de France will examine methods of pre-financing, repayable against electricity invoices, to facilitate the application of longer payoff times, while respecting fair pricing and free competition.

1-4-5 The equalisation of low voltage electricity prices throughout the country masks variations in the costs of generating and distributing electricity and has the result that electricity is sold below its true cost, first in isolated regions where power is essentially of fossil origin (Corsica and the overseas départements) and secondly in sparsely populated rural areas.

This situation leads to two effects which need to be corrected:

- first, electricity benefits from a natural advantage compared with new and renewable forms of energy which, in these sectors, would have viability situations such as to facilitate their effective development. The relevant new and renewable forms of energy are not only those which can produce electricity but also those which can replace it;
- secondly, the equalisation of electricity prices leads to excess consumption over and above what it would be if pricing reflected the real cost of supply. In isolated areas, not connected to the metropolitan grid supplied essentially by nuclear and hydro plants, this results in excess CO₂ emissions evaluated at 0.15 million tonnes of carbon.

While in no way questioning the expression of national solidarity in support of these areas where the cost of energy supplies is higher than elsewhere, solutions are being considered gradually to eliminate the two disadvantages mentioned above:

- the creation of local energy management funds will be encouraged so that the financial transfers corresponding to the equalisation of pricing can serve to finance energy approaches less costly than the development of electricity sales;
- experiments will be carried out in particular départements involving the départements themselves, Electricité de France and the ADEME, aimed at promoting electricity savings and the supply of alternative forms of energy.

The government has requested Electricité de France to devote 100 million francs a year to these actions.

II -1.5- DEVELOPMENT OF FOREST-RELATED STOCKS OF CARBON

Development of forestry policy

Extension of wooded areas in metropolitan France began at the beginning of last century. The rate of progress was initially fairly modest: from about 7 million hectares in 1830 the areas of woodland rose to 11 million hectares over a century later (1945) with stages of expansion followed by periods of consolidation (particularly between the two wars). The establishment of the National Forestry Fund (FFN) in 1947 gave new impetus to the development of woodland and its coverage rose to nearly 15 million hectares in 1990, giving an overall proportion of woodland of about 27%.

Thus since 1945 French forests have been extended by about 63,000 ha a year, this including natural extension (the spontaneous offshoot of saplings) and afforestation (planting of previously unforested areas). On the average FFN has assisted the afforestation of 21,000 ha a year over this period, declining from a high rate of planting during the 1950s (30,000 ha a year) to about 10,000 ha a year during the 1980s.

In 1993 France set itself the target of gradually increasing the annual rate of assisted afforestation to a level of 30,000 ha/year by 1998. This programme will be carried out without prejudice to other elements of environmental policy such as maintaining biological equilibria and the countryside. In 1994, 12,000 hectares were assisted in this way.

Measures adopted

The policy of government aid to forestry development covers not only the reafforestation of woodland (which is a form of encouragement to improving the quality of existing forests and reconstituting those destroyed by natural disasters) as well as extending the total area of woodland.

The system of providing aid for the initial investment was added to in 1994 by the payment of a grant intended to compensate farmers and landowners for loss of income. Of the expenditure involved, 50% is paid by the Community budget as auxiliary measures under the reform of the Common Agricultural Policy.

The system also involves a number of fiscal advantages (partial exoneration from the tax on unbuilt land and the inheritance tax).

Finally, in parallel with the enhancement of forestry resources, it was decided to promote applications of wood in the construction sector (see part II-1-1-3) and in the energy sector (see part II-1-7-2). Private investment in forestry developments will naturally be facilitated if there is a prospect of a good return; this return will be the higher once markets for forestry products can be assured and the impact on the greenhouse effect will be the greater the more wood is used for construction and energy purposes.

Impact in terms of carbon storage⁵

A growing forest is a durable store of carbon in the overhead and underground biomass of the trees. When the forest is planted on old agricultural land, carbon is also accumulated in the organic matter of the soil.

In 1990, the annual production of forest biomass was about 52 million tonnes of dry matter, corresponding to the fixation of 26 million tonnes of carbon. *Having regard to the amount of timber cut, the stock of carbon in the forest biomass went up by 10.3 million tonnes a year in 1990.*

⁵ The evaluations given in this section concern all "woods and forests" and "poplar plantations": they do not include any "wooded areas apart from forests" which represent only a small part of the annual output of forest biomass and for which little reliable data - especially as regards development - are available.

In parallel, there was an unknown increase in the carbon stored every year in the soil, probably between 1 and 2 million tonnes (current research will elucidate this point: see part IV-2-2).

In forests that already existed in 1990, annual production of forest biomass will continue to increase slightly (by a little under 2%) up to the year 2000 and decline thereafter⁶.

The change in the increase in the biomass contained in this forest depends upon changes in the amounts of timber cut.

In forests already existing in 1990, the net annual storage of carbon should fall from an annual rate of 10.3 million tonnes of carbon a year in 1990 to 9.75 million tonnes of carbon a year in the year 2000, since the increase in the annual production of biomass (+ 0.45 million tonnes of carbon a year) cannot compensate for the concomitant increase in timber cutting (an increase of 7%, or 1 million tonnes of carbon a year⁷. This is a natural trend for a relatively recent forest which is gradually reaching maturity.

Moreover, the deliberate afforestation policy described above will increase the area of woodland by 180,000 ha by the year 2000. The resulting annual rate of carbon fixation in forest biomass by the year 2000 will be 0.55 million tonnes a year, to which we should probably add between 0.1 and 0.2 million tonnes a year to take into account the storage of carbon in the soil⁸.

Additional afforestation between now and the year 2000 will result in a cumulative amount of 2.4 million tonnes of carbon being stored in standing timber during the decade; by the year 2040 this amount will be of the order of 12 million tonnes.

Continuation of this deliberate afforestation policy at the same rate over 50 years would have the result of storing about 50 million tonnes of carbon in standing timber over the period, storing a tonnage probably between 15 and 25 million tonnes of carbon in the soil and of producing, during clearance programmes, wood the use of which to replace fossil energy would make it possible to save about 14 million tonnes of fossil carbon.

⁶ The situation is that woodland established by afforestation and reforestation over the last 50 years will in general move from a phase during which the annual growth rose to a phase during which the annual growth will decline as the trees age.

⁷ However the increase in timber cutting, mostly producing timber for industry, will have two positive effects:

- * the proportion of this timber converted into panels will lead to durable storage of carbon outside the forest;

- * the rise in paper production will have a positive effect on the control of fossil energy consumption owing to the increased amounts of "old paper" burned in domestic refuse incinerators as a result.

⁸ This estimate disregards the impact of the natural extension of woodland, which could be regarded as taking place at a rate comparable with that observed in the recent past (+ 50,000 ha/year) which virtually makes up for the reverse trend from forest to fallow land, heath or artificial uses of the soil.

It is expected that the annual rate of storage of carbon in forest biomass between 1990 and 2000 will level out at 10.3 million tonnes of carbon a year; this is due to the fact that the effects of the deliberate afforestation policy between now and the year 2000 will compensate for the natural slowdown in the storage of carbon in woodlands that already existed in 1990.

The average cost of afforestation on agricultural land, expressed per tonne of carbon stored in the forest biomass and in the soil, is 370 F/tonne.

Protecting forests against fires

Over the last decade, an average of 5300 fires a year have affected 39,000 hectares of forest, heath, scrub and "garrigue". The south of the country bordering the Mediterranean is the most exposed area, experiencing two out of every three fires, but the risk is also high in the south-west and west of the country in years of low rainfall.

The policy for protecting forests against fires covers:

- * preventive actions under three headings:
 - raising public awareness about the dangers of bringing sources of heat into the forest;
 - keeping a lookout for incipient fires using fixed stations and patrols;
 - the construction and maintenance of suitable infrastructure as part of forest development: roadways, water sources, areas cleared of undergrowth, fire breaks, and so on.

The last two items account for the greater part of the budget.

- * the provision of firefighting facilities and their use by teams of firemen from the local authorities involved (totalling 27,000 men), supported by a national system including an air brigade (with 28 water bomber aircraft) and a land force of 1700 men.

The government's financial contribution was already at a high level in 1992 by comparison with the Community average (18.5 ECU/hectare/year for France compared with 6.5 ECU/hectare/year for the Community average). In a typical period this system can limit annual destruction to 1.05% of the wooded areas at risk compared with 1.55% for the Community average. The appreciable rise in funding allocated for this period since 1972 (1240 MF in 1994 compared with 712 MF in 1990) should improve this performance still further, although the precise extent is impossible to quantify.

II-1.6 CARBON EMISSIONS RELATED TO CHANGES IN LAND USE

Changes in land use

The strong trend away from agricultural land towards woodland, "unused" land such as heath or land lying fallow, and artificial uses of the soil, is expected to continue during the 1990s (- 120,000 ha/year in the long term).

Also, government incentives affecting the use of agricultural land have been modified.

Prior to 1993, the Common Agricultural Policy (CAP), notably through a mechanism of price support for farmers, strongly encouraged the intensification of agricultural production, as well as the conversion of pasture (permanent and temporary grasslands) to arable land and, to a lesser extent, of wooded areas (the depletion of wooded areas continued until recently in certain regions, even though there has been a substantial net increase in wooded areas in the country as a whole). Reform of the CAP should halt these trends:

- first, there is no longer any strong incentive to increase the areas put down to major crops (any such new areas would be unable to benefit from the hectare allowances paid for production of major crops that replace the former price support);
- secondly, there will be no further incentive for cattle breeders to intensify production by reducing areas under grass and replacing them by cultivated forage crops or other plant products (the subsidies paid, notably in the beef production sector, are capped according to the number of animals per hectare under forage crops).

It is therefore reasonable to assume that conversion of grassland or woodland into arable land will stop.

Finally, the Common Agricultural Policy at present incorporates a mechanism for the compulsory "set aside" of part of the area under major crops, which will affect the development of organic matter in the ground so affected.

Impact as regards emissions of greenhouse gases

As explained in Annex 4, the changes in land use which should take place by the year 2000 will reduce annual carbon emissions by 2 million tonnes compared with 1990.

This is a transient phenomenon related to a sudden change in land use occurring during the 1990s: its further effects after the year 2000 will be negligible.

II -1.7 NEW AND RENEWABLE FORMS OF ENERGY

In 1990 in France, renewable forms of energy accounted for 22% of national primary energy production, being 22.92 million toe, including 12.95 million toe of hydro power.

The development of these forms of energy is highly attractive in energy and economic terms, and in certain conditions in environmental terms, and is encouraged.

Various measures described in other sections concern these forms of energy.

The provisions include:

- not exposing these forms of energy to artificial competition by subsidising low voltage electricity in isolated or sparsely populated areas (§ 2-4-5);
- encouraging the development of energy markets for wood (§ 2-5-3) ;
- taking into account the value of recovering energy from the incineration of refuse (3-1-1) as part of the actions taken to control methane emissions from dumps (the Act of 13 July 1992).

Other specific actions have been taken in other areas.

1-7-1 The ADEME and Electricité de France have decided to co-ordinate their programmes aimed at facilitating the development of renewable forms of energy wherever these have specific industrial, technical and economic importance. Thus under an agreement dated 9 February 1993, in a research programme concerned with the potential for wind and water power in France, they have set up a study group and have implemented and funded a programme of projects. The estimated overall budget for the operations covered by this agreement has been set at 100 MF (with the possibility of an increase to 300 MF if the listed operations so justify) over a three-year period (1993 to 1995). This agreement has already resulted in a number of actions concerning wind power.

In 1993 and 1994, development of this energy source resulted in the construction of two wind power stations rated at 2.2 to 3 MW at Port la Nouvelle and Dunkirk which will save about 2000 tonnes of carbon a year.

Under the ADEME/EDF agreement, a programme supporting the development of wind generators connected to the EDF grid will be initiated following investigation of the available wind resources.

Research partly funded by the European Union is currently investigating the materials, components and systems for high power (1 MW) wind generators.

1-7-2- Development of the use of wood for energy purposes

Wood is in third place as regards national energy production, accounting for nearly 9 million toe.

Wood is essentially used for individual heating: nearly a quarter of private houses use it as a basic means of heating and another quarter as make-up heating. Total consumption of wood for heating in private housing is estimated to be 7.7 million toe. This traditional form of consumption, although not very well known (because it is mostly outside commercial circuits) appears to have been fairly stable over the last 10 years, although with fairly marked substitution between traditional modes of heating (solid fuel cookers and stoves in old houses) and new methods (enclosed fires in new houses, notably to supplement electric heating). With the present prices of fossil energy, this consumption is compromised in the longer term, as indicated by the fall in sales of wood-fired heating systems in recent years (- 45% over the period 1985/1990).

Consumption of wood for collective heating and in the tertiary sector is a recent development and accounts for about 0.1 million toe a year; it involves about 300 collective heating plants installed with the assistance of the ADEME during the last 10 years.

Finally the wood and papermaking industry consumes 1 million toe a year of wood, waste and by-products.

The available additional resource consists of the following:

- a cheap resource of at least 0.2 million toe in the form of wood by-products or waste;
- a more costly resource of wood to be collected in the forests capable of amounting to about 5 million toe (while respecting a sustainable form of management of the resource). This amount of wood, some of which could nevertheless be used for papermaking, should rise in the future owing to the accelerating rate of afforestation;
- wood resulting from fast-growing hedges and brushwood that can be grown close to the areas of consumption, notably on the "major crop" set aside land under the CAP.

In addition, the steady improvement in the energy performance of plant and equipment will gradually increase the actual contribution, in terms of fossil energy savings, of the resource now being exploited (by the year 2015, this process could release between 1 and 2 million toe of wood in dwellings heated with wood in 1990).

The competitiveness of wood for applications in the residential and tertiary sectors would be appreciably improved by the introduction of a CO₂ tax.

Also, two specific kinds of action have been decided upon to enhance the position of wood in French energy supplies:

- *It was agreed to correct the adverse effects on wood as an energy source arising from the underpricing (related to equalisation) of low voltage electricity in areas of low population density (see part II-1-4-5);*
- *An "Energy plan for wood" has been devised whereby the government and local authorities in a number of pilot regions will create the necessary conditions for structuring a supply system for wood for collective heating purposes, by taking action both on supply (procurement of wood, installation and maintenance of combustion systems) and demand (notably in the public housing stock).*

Measures taken

Under the energy plan for wood, development of the use of wood in collective heating plants will be encouraged with some or all of the following being financed wholly or in part from public funds (by government and local authorities, possibly also from the European budget):

- feasibility studies;
- facilities necessary for the procurement stream (collection, storage, conditioning);
- the additional capital cost of heating plants compared with competing approaches;
- supervision, training and evaluation.

The assistance provided will be provided on a case-by-case basis according to the local situation, with a view to making the biomass approach attractive compared with the competing fossil energy solution.

Public funds amounting to 148 million francs are earmarked for the period 1995-1998.

France is also requesting that wood as an energy source (non-manufactured products) should be included in the list of products attracting a reduced rate of VAT, annexed to the sixth European directive. This measure should first of all facilitate the development of wood as an energy source and, secondly, enable the supplies for individual heating to be introduced into commercial circuits. This would put some new life into an economic activity (felling, transport, and preparation of wood) which accounts for about 25,000 jobs in France.

Impact on emissions

Since French forests benefit from sustained management, the carbon emitted when wood is burned should not be taken into account. However the combustion of wood does generate greenhouse gases other than CO₂ which can reduce the positive contribution of wood use in terms of the greenhouse effect.

Improvements in the performance of combustion systems should appreciably increase the contribution of "wood as an energy source" to controlling the greenhouse effect in the future; however, in view of the long working life of systems, this trend will necessarily be slow.

An overall estimate suggests that the use of 9 million toe of wood would avoid the emission of 5 to 6 million tonnes of fossil carbon (the assumption is made that in private dwellings, wood replaces domestic fuel oil or electricity whose impact on CO₂ emissions is similar, and that the energy efficiency of wood-burning installations remains lower than that of those burning conventional fuels).

The measures described above should make it possible to maintain this level of wood consumption for individual heating up to the year 2000.

On completion of the 1995-1998 programme, the development of collective wood-burning heating plants will make it possible to save nearly 80,000 toe of fossil fuels a year, through the thirteen pilot projects adopted. This will avoid the emission of about 68,000 tonnes of fossil carbon, while creating over 300 jobs, mostly in rural areas.

However the principal issue is a long term one: this is the promotion of a structured wood supply system which would enable it to develop substantially in the event of any significant change in the energy situation. A prospective study has concluded that in view of the available resource and, particularly, its geographical distribution, and as a function of changes in the price (including taxes) of fossil energy, wood consumption in the collective housing and industrial sector is likely to triple by the year 2015, from 1 to 3 million toe a year.

1-7-3- Development of the production of agricultural biomass for energy purposes

The production of energy with a low fossil carbon content is one of the main approaches which, in the longer term, will make it possible to meet the ultimate objective of the Convention on climate. At the same time, France has a dynamic and efficient agricultural sector which is particularly badly affected by the contraction of world food markets.

In order to overcome this dual challenge, the Agriculture for Chemicals and Energy scientific group (AGRICE) has been established with the task of co-ordinating the various research programmes at national level. Its programme of work is organised under the following three headings:

- bio-fuels (with, in the short term, the approaches using methyl ester from rapeseed and ethanol from sugar factories and, in the medium term, those using ethanol cellulose hydrolysis and hydrocarbons produced by the flash pyrolysis hydrogenation of oils);
- the approach using woody cellulose plants (fast growing brushwood, herbaceous plants, "whole plant" cereals, leading to bio-fuels (this involves the direct burning of basic biomass in a boiler, possibly with more complex energy vectors such as suspensions of charcoal in oil or flash stabilised pyrolytic oils);

- approaches outside the foodstuff and energy sectors (bio-polymers, eco-products in the field of detergents, etc.), which will make it possible to displace some of the fossil carbon used in organic chemistry.

At the same time, France has begun experiments on an industrial scale into the production and distribution of bio-fuels:

- Ethanol produced from sugarbeet and cereals is used to produce ethyl tertio butyl ether (ETBE), a compound which increases the octane number and which can be used mixed with super grade gasoline in proportions up to 15%: in 1993, 27,000 tonnes of fuel ethanol were produced and by the year 2000, output should reach 110,000 tonnes a year;
- Rapeseed methyl ester is used first mixed in proportions up to 5% in diesel oil sold in service stations and in domestic fuel oil and, secondly, in higher proportions, in captive vehicle fleets such as municipal buses; ester production in 1993 amounted to 8000 tonnes and output is expected to be 400,000 tonnes a year by 2000.

Measures taken

For the year 1994, AGRICE disposes of 40 million francs of public incentive funding, together with 25 million francs from the professional farming organisations.

Since the cost of bio-fuels is much higher than that of petroleum fuels, at the current oil price, their sale has been made possible by exonerating them from the domestic duty on petroleum products.

The ceiling on the duty abatement is 230 F/hl for rapeseed methyl ester and 329.50 F/hl for ethanol, which would represent, by the year 2000, a loss of revenue to the government of 1500 million francs a year. The research undertaken by AGRICE should reduce this shortfall.

Steps will also be taken to assist the energy supplies to agro-food industries consuming large amounts of energy through the use of straw, other farming by-products or wastes and fast-growing wood planted on land set aside from major crop production.

Expected results

The experiments carried out in the motor fuel sector will avoid the emission of 270,000 tonnes of fossil carbon by the year 2000; this estimate takes into account the applications of fossil energy in the process of bio-fuel production.

This position can be further improved if the units producing rapeseed methyl ester burn bio-fuels. Attempts will be made to use bio-fuels for ester production whenever possible, and this approach should raise the annual saving of fossil carbon to 300,000 tonnes.

These measures have been undertaken essentially for reasons of agricultural policy; they are not viable merely from the standpoint of controlling the greenhouse effect. In fact if their cost was charged only to the control of the greenhouse effect, it would amount to 40,000 F/tonne of carbon avoided for the ethanol component and 3900 F/tonne of carbon for the ester component (this cost is especially high in the case of ethanol because the production process uses existing installations that are not optimised from the energy standpoint).

It is likely that by the year 2000 fuel biomass will be in production either for collective heating or for producing industrial steam (notably on the "major crop" land compulsorily set aside under the reform of the Common Agricultural Policy); however its quantitative impact at that time will still be limited. The cost of this action should be less than 500 F/tonne of carbon avoided.

1-7-4 The use of wastes for energy purposes

The Act of 13 July 1992 modifies waste management processes with enhanced promotion of recycling and re-use. Those wastes that will be neither recycled nor re-used in agriculture will mostly be preferentially incinerated with energy recovery.

In the future this sector should contribute 1 million tonnes of oil equivalent, since the amount of waste incinerated is expected to virtually triple between 1990 and 2003 (18.5 MT in 2003).

The application of this Act should also lead to a substantial increase in incineration with the recovery of ordinary industrial wastes whose energy potential exceeds 1 million toe although this is difficult to evaluate with precision.

Despite the advances made in cleaning up incineration gases - progress which eliminates any real hazard - substantial psychological difficulties are being encountered in getting public opinion to accept the installation of incinerators in the vicinity of urban areas so that the heat produced can be utilised directly as is desirable. Information campaigns will be organised with the local authorities concerned with a view to linking incinerators to district heating systems. When energy recovery is possible only by generating electricity, this reduces the need for nuclear power but has no effect on CO₂ emissions.

It can be estimated that by the year 2000 the total reductions in CO₂ emissions due to waste incineration will reach 300,000 tonnes of carbon a year at the most.

1-7-5 Hydro power

Hydro power, the most important of our current sources of renewable energy, is of great value with regard to the greenhouse effect, particularly when it is used to meet peak electricity demand instead of power generated using fossil fuels.

However hydro power is also under dispute owing to certain adverse effects it has on the environment or because it is in competition with other applications of water.

Between now and the year 2000, France will do its utmost to conserve the CO₂ savings arising from the use of hydro power, but has no hope of increasing them.

II - 2 - METHANE EMISSIONS

Having regard to the actions described hereunder, concerning agriculture, dumps of putrefiable wastes, gas distribution systems and collieries, emissions of methane, which are still not well known, should be about the same level in the year 2000 as they were in 1990.

II - 2.1 METHANE EMISSIONS FROM AGRICULTURE

Methane emissions from the agricultural sector arise mainly from two sources: enteric (internal) ruminant fermentation and the anaerobic fermentation of manure from various types of livestock raising.

The extent of these emissions is still not well known. We describe below the current trends affecting livestock production. No deliberate action to reduce specific emissions will be possible until current research is completed (see chapter V).

Changes in the livestock sector

The development of French agriculture between 1990 and 2000 will be marked by the reform of the Common Agricultural Policy (CAP), which will take place over the period 1993/1996, and the GATT agreements (the Uruguay Round) which will be introduced in the period 1995/2000 and which will reflect a reduction in subsidies on exports to world markets.

Predictions of animal production levels for the year 2000 have been made using the MAGALI simulation model for French agriculture, supplemented by expert advice; two contrasting hypotheses have been formulated as regards cattle production because of the difficulty of precisely determining the impact of the GATT agreements on French agriculture.

All in all it is possible to predict, for the period 1990/2000, the following annual average rates of change for the production of:

- milk: - 0.4 to 0%
- beef meat: - 0.5 to + 0.6%
- pig meat: + 1.9%
- poultry +2.6 %

Impact as regards emissions of greenhouse gases

a) Enteric ruminant fermentation:

* Emissions of methane due to milk production⁹ can be evaluated at 660,000 tonnes in 1990. Continued intensification of production will lead to a fall in specific emissions of methane per litre of milk produced compared with the 1990 level, estimated at 15%: emissions in the year 2000 will lie between 570,000 and 600,000 tonnes.

This estimate takes no account of any results of research into the factors determining the emissions due to ruminant enteric fermentation, described in chapter IV; emissions could therefore be less than the above figures.

* Emissions of methane due to the production of beef meat can be evaluated at 680,000 tonnes in 1990.

A degree of restructuring towards more extensive forms of production¹⁰, and a fall in the number of calves produced by dairy herds will result in an increase in the average specific emissions of methane (per kg of meat produced) of the order of 10%.

Total emissions in 2000 would be between 680,000 and 800,000 tonnes of methane.

** The overall 1990-2000 trend in methane emissions related to enteric cattle fermentation would lie between - 90,000 and + 60,000 tonnes of methane.*

b) Anaerobic fermentation of manure

Methane emissions from the anaerobic fermentation of animal manure in 1990 were estimated at 180,000 tonnes.

Continued improvements in animal product yields will naturally lead to a fall in the specific amounts of manure. The related methane production will depend on changes in the way this manure is handled.

At the beginning of 1994, a substantial programme for controlling local pollution of agricultural origin was introduced; its aim is to improve conditions in intensive livestock raising with regard to the local environment and in particular the protection of water (controlling nitrogen pollution). It will facilitate a number of capital investment projects on farms, particularly in order to increase the capacity for storing manure (by about + 50%) to permit better management of spreading.

⁹ Dairy cows plus pedigree heifers.

¹⁰ The negative effect (in terms of methane emissions) of more extensive production of beef meat is counterbalanced by a favourable trend in terms of carbon stored in the land producing forage for the dairy herd: a higher proportion of grassland and a lower proportion of land under cultivated crops; less intensive use of grassland. This factor is dealt with in part § II-1-6.

The foreseeable result of this development will be an increase of the order of 50% in the average storage time and a probably similar increase in methane emissions. Research is in progress to determine the technical basis necessary for this programme concerned with local pollution to incorporate a reduction in methane emissions (see chapter IV).

It is also likely that in areas where there is significant surplus production of manure compared with the absorption capacity of the soil, manure processing units will be built; the quantities involved, which have not yet been estimated, will no longer be stored for long periods; there would then be a reduction in methane emissions. The figures given below do not take into account this probable factor in the reduction of methane emissions, the extent of which has not been quantified.

Finally, the relative contraction of intensive beef meat production will reduce, as a matter of priority, the volume of manure whose methane production potential is the highest in this industry.

Changes in methane emissions due to manure from livestock raising are summarised in the following table: globally there is a possible 25% increase in these emissions between 1990 and 2000, or + 45,000 tonnes of methane.

	1990 methane emissions (thousands of tonnes)	Change in animal production (% over the decade)	Change in unit volume of manure (% over the decade)	Impact of method of managing manure (% over the decade)	Methane emissions in 2000 (thousands of tonnes)
Cattle, of which:	83				98
* <i>slurry</i>	37	-5	0	50	52
* <i>manure in field...</i>	46	0	0	0	46
pigs	72	21	-8	50	87
Poultry (of which eggs)	23	28	-10	50	38
total	178				223 (+ 25%)

c) Overall trend

The changes foreseeable in the livestock raising sector by the year 2000 could lead to a slight increase in methane emissions: the estimate of the extra emissions lies between - 45,000 and + 105,000 tonnes of methane depending on the effects of the GATT agreements.

methane emissions for livestock raising (thousands of tonnes)	1990	2000	change 1990 / 2000
enteric fermentation	1340	1250/ 1400	- 90 / + 60
fermentation of manure	180	225	+ 45
TOTAL	1520	1470 / 1620	- 45 / + 105

II -2.2 METHANE EMISSIONS FROM DUMPS

In 1990, a little over 50% of the approximately 20.5 million tonnes of household refuse produced were dumped, 9 million tonnes were incinerated and 1 million tonnes composted.

In 1990 the quantity of industrial wastes similar to domestic refuse was 40 million tonnes, of which 25% (9.5 million tonnes) went to public dumps with domestic refuse, and an unevaluated but low proportion was stored on internal dumps, most of the remainder of this waste being recycled or re-used, notably in agriculture.

It can be estimated that in 1990 a total of about 20 million tonnes of domestic refuse and similar wastes were dumped.

2.2.1. Stopping the dumping of ordinary waste

The Act of 13 July 1992 is intended completely to overturn this scenario. Although the main aim of the Act is radically to modify waste management, notably through enhanced promotion of recycling and re-use, the Act is also intended by the year 2002 to allow the dumping only of final wastes, i.e., those which have been recycled and re-used to the greatest possible extent using the best available technical processes at an economically acceptable cost. This means in particular:

- that dumped wastes contain little or no putrefiable matter, thus eliminating methane emissions at the source;
- that wherever new dumps for putrefiable wastes are established between now and the year 2002, the methane will be collected, recovered and incinerated;
- that one of the attractive processes to be adopted for limiting the quantity of final wastes will increasingly be the production of compost;

- that wastes not recycled for their material content or in agriculture will mostly be preferentially incinerated with energy recovery. Thus this sector which in 1992 provided over 600,000 tonnes of oil equivalent should supply 1 million tonnes of oil equivalent by the year 2000 (see § 1-7-4).

2.2.1.1 Effects of the measure

Using the GIEC methodology, methane emissions arising from the dumping of ordinary wastes (about 20 million tonnes in 1990) amount to 0.70 million tonnes. This methodology is based on the assumption that these gas emissions take place in the year when the wastes were dumped.

The evaluation given below uses a different methodology that assumes progressive decomposition of wastes over 30 years. In these circumstances, the "past" has an effect on current emissions, and any action to reduce the tonnages dumped will not have its full effects until after an equivalent period. With this approach, the estimate for changes in methane emissions in France over the period 1990-2000 is less favourable than with the GIEC approach (the methodology is described in Annex 5).

On this different basis, current emissions from all old and currently active dumps in France would amount to 0.5 million tonnes of methane in 1990 and rise rapidly to reach a maximum around the year 2000.

Impact on methane emissions

The introduction of the Act of 13 July 1992 should result in the elimination of methane emissions from newly produced wastes as from 1 July 2002.

The residual emissions of methane from existing dumps can be estimated to be 0.66 million tonnes in the year 2000, or an increase in emissions of 160,000 tonnes a year, despite a 40% drop in the wastes dumped each year since 1990. Subsequently, there would be a progressive fall to 0.44 million tonnes in 2010, and to 0.19 million tonnes in 2020. Virtually all these emissions would disappear by 2030 (see table below).

Summary table

(the results of evaluations done using the GIEC methodology are shown in brackets)

	Emissions 1990	Emissions 2000	Change 2000 - 2010	Change 2010 - 2020
CH₄ dumps	0.50 Mt (0.70 Mt)	0.66 Mt (0.42 Mt)	- 0.22 Mt	- 0.25 Mt

2.2.1.2 Costs of implementing the measure

The construction of incineration or composting units necessary for the application of the Act of 13 July 1992 are very expensive: as a first approximation (an evaluation is in progress as part of the revision of European Directives on Municipal Wastes), the capital cost of modernising and extending waste processing plants by the year 2002 would be between 40 and 50 billion francs.

This expenditure has to be undertaken by the local authorities involved. A waste management modernisation Fund has been set up to help these authorities implement the Act. This fund receives revenue from a tax of 20 F/tonne levied on the wastes dumped, amounting to 400 MF a year; the rate of this tax will shortly be increased.

2.2.2 Recovery of methane from existing dumps

An initial programme has the priority aim of recovering methane from abandoned dumps of area exceeding 5 hectares or containing over 250 m³ of waste, starting with the most recent. Its application depends on current work involving the *in situ* measurement of actual methane releases, in order to quantify its real effect on emissions; one hypothesis is that these actions will reduce the emissions evaluated in paragraph 2.2.1.1. by 10%, making 70,000 tonnes of methane a year, and reduce emissions in the year 2000 to 0.59 million tonnes a year (see the scenario described in § 2.2.1.1).

II -2.3 LEAKAGES FROM NATURAL GAS SYSTEMS

Generally speaking, leaks of natural gas are very slight, and it is practically impossible to quantify them with any precision, because they are below the detection threshold of meters.

These leaks therefore have to be estimated according to the method of transport or distribution used:

- Leaks from the transport of gas are regarded to be virtually zero;
- As regards leaks from distribution systems, the following assumptions are adopted, as orders of magnitude:
 - 350 m³/km/year for modern pipes (welded steel or polyethylene);
 - 3500 m³/km/year for old pipes in brittle cast iron which constitute the weak point of distribution networks.

In 1990 the distribution system had a total length of 114,000 km, including 17,000 km of cast iron pipes. Between 1990 and 1993, Gaz de France replaced 6000 km of these old pipes and intends to invest 1 billion francs a year to renew 1000 km of these old pipes every year up to 2000.

This programme is motivated primarily by the concern for improving safety, but it also makes a useful contribution to controlling the greenhouse effect.

Other things being equal, it can be estimated that replacing 12,000 km of cast iron pipes between 1990 and 2000 will have the result of avoiding the emission of 38 million m³ of CH₄ a year, or a reduction in emissions of 27,000 tonnes a year.

It is estimated that by the year 2000 the distribution system will comprise 140,000 km of modern pipes and 5000 km of cast iron pipes; the amounts of gas distributed will increase from 17 billion m³ in 1990 to 23 billion m³.

On the basis of these assumptions, total leakages will decline from 66,000 tonnes a year in 1990 to 47,000 tonnes a year in the year 2000.

II - 2.4 PRODUCTION OF METHANE BY COLLIERIES

CH₄ releases from colliery operations amounted to 362 million m³ in 1990. Collection systems enabled 124 million m³ to be re-used as fuel and emissions were 238 million m³ or 169,000 tonnes.

Having regard to changes in coal output and techniques for trapping fire damp, it can be estimated that emissions in the year 2000 will be of the order of 50,000 tonnes.

II - 3. EMISSIONS OF NITROUS OXIDE

II - 3.1 MEASURES TO REDUCE EMISSIONS IN INDUSTRY PRODUCING ADIPIC ACID, NITRIC ACID AND GLIOXYLIC ACID

The sum total of the installations covered by this paragraph discharge relatively large amounts of nitrous oxide directly depending on the processes used; their emissions will be reduced by 75% by the year 2000 (- 77,000 tonnes).

However, at the same time, the efforts made to reduce emissions of NO_x in other installations are likely to produce an increase in their emissions of nitrous oxide. This phenomenon must be limited by suitable technologies. Such technologies however are already planned or even in service in the industries producing adipic acid. The expected effects on NO_x emissions are described in paragraph 4.

3.1.1 Adipic acid

The production of adipic acid is the activity giving off most nitrous oxide. It takes place on a single site in France. Emissions in 1990 are estimated at **55,400 tonnes**. In 1993, they could be evaluated at 50,000 tonnes.

Having regard to the elimination of N₂O discharges programmed by regulation for 31 December 1996, and the efficiency of the techniques used, there should be a reduction of about 55,000 tonnes by the year 2000 compared with 1990. There will be an accompanying significant reduction in NO_x emissions.

3.1.2 Nitric acid

On the basis of the emission factors recommended by the CORINAIR/GIEC methodologies, the emissions from nitric acid plants in 1990 apparently amounted to **38,100 tonnes of nitrous oxide and 16,800 tonnes of nitrogen oxides, excluding nitrous oxide.**

Owing to the economic situation of this activity, many units have since closed down. In 1993 the emissions of nitrous oxide from the existing units amounted to about 28,800 tonnes.

A ministerial Order of 1 March 1993, applying to most industrial installations, limited emissions of nitrogen dioxide, in new nitric acid production installations, to 1.3 kg per tonne of 100% nitric acid produced, and emissions of nitrous oxide to 7 kg per tonne of nitric acid produced. These standards reflect the best available technologies for simultaneously limiting emissions of nitrogen dioxide and nitrous oxide.

As regards the existing units, prefectural Orders will be issued by 1998, in application of this ministerial Order, and will specify the deadlines and objectives to be met by each in these prefectural Orders.

Effect of the measure

In the year 2000, nitric acid plants will emit **25,600 tonnes of nitrous oxide and 3,100 tonnes of nitrogen oxides excluding nitrous**, reductions of about **33% and 80%** respectively.

3.1.3 Glioxylic acid and glyoxal

These products are manufactured at two sites in France. The estimated 1990 emissions from these plants are **9,000 tonnes**. In 1993, these emissions amounted to about 8,500 tonnes.

The company operating these two sites has undertaken to introduce a technology for treating discharges by the year 2000 at the latest, and by the end of 1996 for the largest site, resulting in a reduction of its nitrous oxide emissions of 100%, with no additional emissions of nitrogen oxides.

Effect of the measure

Implementation of these measures will bring about a reduction of nitrous oxide emissions of **100%**, a reduction of **9,000 tonnes** between 1990 and 2000.

II - 3.2 EMISSIONS OF NITROUS OXIDE FROM AGRICULTURE

Since there is little understanding at present about the factors determining the diffuse emission of N₂O from agricultural land, it can only be assumed that emissions of N₂O change in proportion with the use of nitrogen fertilisers. The IPCC recommends that inorganic as well as organic fertilisers should be considered (the latter consists essentially of manure).

The use of nitrogen fertilisers will evolve under the combined effect of several factors:

- the introduction of the compulsory set aside arrangement for areas under major crops, under the reform of the Common Agricultural Policy, will lead to a natural fall in the use of fertilisers, resulting from the reduction in the area under cultivation. However it is reasonable to expect that by the year 2000 about a third of areas affected by set aside will be used for non-food products for which the needs for nitrogen fertilisation are similar to those of conventional crops;
- the trend towards less intensive production of major crops resulting from the partial decoupling between government assistance granted and the actual level of production achieved, is another expected result of the reform of the Common Agricultural Policy. This should result in a fall in the average specific amounts of nitrogen fertilisers used (per unit area) for major crops;
- the European directive on nitrates seeks an appreciable reduction in nitrogen pollution in so-called vulnerable areas, which in France should concern about 10 million hectares; it will result in particular in the usage of organic fertiliser being limited by regulation to 210 units per hectare before the end of the decade, then to 170 units per hectare after the year 2000 (in areas of intensive livestock raising, these levels are often exceeded). In many départements particularly affected by water pollution due to nitrates, local regulations based upon the national code of good practice are now being introduced, with the ultimate objective of aligning fertilizer spreading standards upon the absorption capacities of the crops in the different regions. For certain regions it has been estimated that total use of nitrogen fertilizers in 1990, 40% of which are inorganic, were nearly 35% above the potential exports of crops. This trend will be helped by the reduction in manure production per animal unit, of the order of 5% for pigs and poultry, resulting from the application of new feeding standards and from the resulting improved feed efficiency;
- the positive spin-off from the "fertimieux" [better fertilization] programme, set up in 1991, which aims to modify the attitudes of farmers and their advisers in order to prevent diffuse water pollution due to nitrates; this objective should be achieved through appropriate advice on optimal management of nitrogen (by optimising the amounts of fertilizer and the spreading of livestock slurry, management of intercropping, and so on).

In 1994, about 20,000 farmers working agricultural land of about 1 million hectares, mostly in vulnerable areas, were taking part in this programme.

All in all, there should be a significant reduction in the use of nitrogen fertilisers, especially in areas of livestock raising, primarily affecting inorganic fertilisers¹¹.

¹¹ Increased use of various by-products (notably sludge from sewage treatment plants) is also expected.

This downward trend in the consumption of inorganic nitrogen is already apparent in the statistics for 1990 onwards: it was particularly sudden in 1993 (- 15% compared with 1992, - 18% compared with 1990), while the as yet incomplete statistics for 1994 suggest that consumption stabilised in that year.

An estimate of what the quantitative effect of these different factors will be in the year 2000 is given in the table below. It is possible to count on a 14% reduction in total use of nitrogen fertilisers (inorganic and organic) which would lead to an equivalent fall in the percentage of N₂O emissions, or 7500 tonnes of N₂O.

Nitrogen fertilisers (millions of tonnes of N)	1990 level	Effect of set aside (2)	Effect of less intensive farming (3)	Effect of the nitrates Directive (4)	Effect of the "fertimieux" programme (5)	2000 level
Total inorganic nitrogen	2.65	-	-	-0.31	-0.02	2.11
Total organic nitrogen (1)	1.15	-	-	-	-	1.15
of which nitrogen on major crops (1)	1.7	-0.11	-0.1	-	-	
N₂O emissions (x 1000 t)	59.7					52.2 (-14%)

(1) estimate

(2) 10% set aside of which one third under energy crops

(3) price elasticity (relative elasticity of fertilizer compared with that of the agricultural product) for the use of fertilizer containing 0.2 nitrogen

(4) - 20% of total nitrogen in areas of intensive livestock raising (Brittany, the Loire, Lower Normandy) and - 10% in the other vulnerable areas.

(5) - 10% of total nitrogen (for 1 million hectares) in addition to effect (4).

II - 4 OZONE IN THE TROPOSPHERE - CONTROL OF PRECURSOR GASES

Tropospheric ozone is increasingly considered as the "third" greenhouse gas, in the order of contributions to climate warm-up, after carbon dioxide and methane.

The distribution of ozone in the troposphere in space and time is controlled by several processes, including photochemical production which results from the oxidation of precursor components of natural or human origin - methane, carbon monoxide, volatile organic compounds - in the presence of nitrogen oxides and solar radiation.

According to a report by the French Academy of Science ("Ozone and the oxidising properties of the troposphere", October 1993), ozone concentrations in the medium latitudes of the northern hemisphere have increased by a factor of more than 4 since the end of last century. Also at the same latitudes, the combination of increased basic concentrations, with more localised peaks, are causing concern about the effects of ozone both on health and on vegetation.

For this reason France has entered into a number of international commitments under the Convention concerning transfrontier atmospheric pollution within the United Nations Economic Commission for Europe:

- a 30% reduction in nitrogen oxide emissions between 1987 and 1998;
- a 30% reduction in emissions of volatile organic compounds between 1988 and 1999.

Reductions of the order of 30% will be achieved between 1990 and 2000. Reduction approaches already adopted or under consideration are described below.

II - 4.1 MEASURES TO REDUCE VOC EMISSIONS

4.1.1 - Transport

The provisions of the consolidated European Directive of 26 June 1991 impose new emission standards on all new gasoline-engined vehicles as from 1 January 1993. Meeting these standards led to the introduction of the catalytic converter and the small canister for recovering hydrocarbons that evaporate when the vehicle is in use. New provisions have recently been adopted for private cars and will apply as from 1997.

For vehicles over 3.5 tonnes, the "Clean truck" directive of 1 October 1991 sets values applicable to new trucks as from 1993. It reinforces the existing provisions. Small utility vehicles are regulated by a directive adopted on 28 June 1993 which applies to all new vehicles as from 1 October 1994.

The directives now being prepared for other mobile sources will provide for VOC emissions to be stabilised at their 1990 level.

In total, emissions from this sector should fall by 45% between 1990 and 2000.

4.1.2 - Use of solvents

A distinction is drawn between the industrial and domestic use of solvents.

Some industrial applications, such as printing, prepainting, motor manufacturing and dry cleaning, are covered by specific national regulations concerning the discharge of solvents into the atmosphere, these being the technical instructions of 5 April 1988, 25 August 1988, 11 June 1987 and the standard Order N° 251 respectively. As regards installations not yet covered by specific national regulations, the provisions applicable to the main emitting industrial installations are given by the ministerial Order of 1 March 1993 already referred to in paragraph 3.1.2. These measures should reduce emissions by about 38% by the year 2000.

Other uses of solvents are found mainly in paints for the construction industry, paints for use by the public, and domestic applications of solvents. It is expected that technical developments affecting paints will encourage the introduction of paints containing less solvents. As regards public use and the construction industry, water-based (emulsion) paints accounted for between 45 and 50% of total consumption in 1990. Incentive measures, notably of the "ecolabel" type, yet to be implemented, and a broad public information programme, suggest that their consumption will increase by the year 2000.

In total, VOC emissions due to solvents should fall by 30%.

4.1.3 - Industrial processes

The expected reduction in this sector has not been precisely quantified. However the application of the ministerial Order of 1 March 1993 to new installations as from 1994 and progressively over a 5-year period to existing installations when their discharges are substantial, should bring about a reduction of at least half VOC discharges in the chemicals and petroleum sectors and a reduction of the order of 20% in industry as a whole.

4.1.4 - Extraction and distribution of petroleum products

The application of the directives on the recovery of hydrocarbons throughout the gasoline distribution circuit will reduce VOC emissions in this sector. Having regard to the proposed Community timetable, most depots and service stations should be equipped for the recovery of gasoline vapours before the end of the century. This action should bring about a 32% fall in emissions.

4.1.5 - Other sectors

This includes the sectors of combustion, agriculture and waste processing. The contribution of the last two sectors to the overall level is low, and we shall assume that their emissions will stabilise by the year 2000; as regards combustion, the savings to be expected are difficult to quantify because the emissions will evolve according to the types of fuel burned; the increased use of gas is a favourable factor which should lead to a reduction in emissions. For all these other sectors it will be assumed that emissions will stabilise at the 1990 level, or 345,000 tonnes.

4.1.6 - Balance sheet

The measures described above should make it possible to reduce VOC emissions in France by about 30% (about 780,000 tonnes) between 1990 and 2000:

SECTOR	VOC EMISSIONS 1988 - 1990	VOC EMISSIONS 2000
Road transport	1 100 kt	550 kt (- 51 %)
Other mobile sources	100 kt	100 kt (=)
Industrial use of solvents	400 kt	250 kt (- 38 %)
Domestic application of solvents	240 kt	200 kt (- 17 %)
Industrial processes	85 kt	70 kt (- 20 %)
Extraction of oil and distribution of petroleum products	140 kt	100 kt (-32 %)
Miscellaneous	345 kt	345 kt (=)
TOTAL	2 400 kt	1 615 kt (- 32 %)

II - 4.2 REDUCTION IN NO_x EMISSIONS

NO_x emissions are a precursor of ozone production in the troposphere and as such have an indirect impact on the greenhouse effect. The measures described below were taken for reasons of local and regional pollution - notably the Geneva Convention. The indirect effects on emissions of nitrous oxide were dealt with in paragraph 3.

4.2.1. Transport

The European directives applicable to all new gasoline-engined vehicles, mentioned in the previous paragraph with regard to volatile organic compounds, are also intended to reduce emissions of nitrogen oxides. On the basis of these provisions, the expected reductions in nitrogen oxides will be of the order of 35%:

Road transport	
1990 NO _x emissions	2000 NO _x emissions
1 038 kt	671 kt - 35 %

4.2.2 Electricity generation

A programme to equip thermal power stations with low NO_x burners by the year 2000 is already programmed. Also, having regard to the expected changes in the load factor of French thermal stations by the year 2000, emissions can be expected to remain at their 1990 level.

4.2.3 - Industry

National regulations have already been brought in (ministerial Order of 1 March 1993, ministerial Order on "glassmaking", ministerial Order on "cementmaking") requiring emissions of nitrogen oxides to be reduced. Over and above this regulatory structure concerned with processes, it is planned to introduce provisions to reduce emissions from all combustion installations. The expected results are:

	1990 emissions	2000 emissions
Combustion in industry + district heating	77,700 tonnes	54,400 tonnes
Energy processes	83,500 tonnes	41,500 tonnes
Non-energy processes	30,800 tonnes	14,800 tonnes

The last line incorporates a reduction in NO_x emissions of 16,000 tonnes accompanying the introduction of processes to reduce emissions of nitrous oxide (see paragraph 3).

Other measures will be adopted, notably in the other two main emitting sectors: other mobile sources (aircraft, motor cycles, tractors, etc.) and private boilers in the residential and tertiary sectors which alone in 1990 emitted 218,000 tonnes of nitrogen dioxide, in order to obtain a further reduction of 70,000 tonnes to attain the objective set out in the SOFIA declaration.

II - 4.3 REDUCTION OF CO EMISSIONS

The principal emissions of carbon monoxide come from the sectors of transport and, to a lesser extent, from dwellings and the tertiary sector. The introduction of the 3-way catalytic converter on gasoline- engined vehicles, compulsory for all new vehicles since 1 January 1993, has reduced emissions of carbon monoxide by about 1 million tonnes, or 10%, with respect to total French emissions. In view of the scenario mentioned above, emissions of carbon monoxide from private cars, light utility vehicles and HGVs would be reduced by 65%, 40% and 40% respectively. Thus the expected reductions in CO emissions can be evaluated at 750,000 tonnes between 1990 and 2000, or again 60%, for the transport sector, which is today the principal emitting sector (accounting for over 70% of total emissions from human activities). A conservative estimate suggests that emissions in the other sectors will level out.

III - INTERNATIONAL CO-OPERATION AND FINANCIAL MECHANISMS

The prevention of the greenhouse effect calls for enhanced international co-operation and solidarity. We shall deal separately with French co-operation with developing countries and that with countries in transition to a market economy.

III -1. CO-OPERATION WITH DEVELOPING COUNTRIES

The rich countries should be encouraged to finance actions specifically intended to reducing emissions of greenhouse gases from poor countries, but it is certainly equally important to seek to speed up the process of development of these countries: in fact population growth is, in the very long term, the major factor in future emissions of greenhouse gases, and although development is not a sufficient condition for controlling population, it is nevertheless a necessary one.

In 1992, development aid from the French government amounted to nearly 44 billion francs. This contribution in terms of GDP (0.63% in 1992) places our country in fifth place of the OECD countries and in first place amongst the G7 countries. In absolute terms, France is the third donor of the OECD Development Aid Committee, after the United States and Japan.

France has also undertaken to increase its aid contribution to 0.7% of GDP by the end of the decade.

III -1.1 BILATERAL AID

Net payments by France as bilateral aid amounted to 33.4 billion francs in 1992, or the equivalent of 76% of its total aid.

A number of new priorities were recently defined for the distribution of this aid, in addition to the traditional sectoral orientations of France (agriculture, education, health, culture, and so on). These are in particular the environment, institutional development and the fight against poverty. Debt servicing remains an essential topic.

In the field of the environment, France intends actively to assist developing countries to discharge the commitments they entered into at the Rio conference, particularly those under the framing Convention on Climate.

French bilateral co-operation activities come under the ministries concerned and various public bodies - financial institutions such as the Caisse Française de Développement, research institutions such as CIRAD and ORSTOM - and the Environment and Energy Management Agency (ADEME) together with certain territorial authorities.

The actions under the aid umbrella that contribute to preventing the greenhouse effect involve a large number of operations and have so far not yet been systematically identified; the presentation given below is therefore more illustrative than complete.

In the future, aid actions that contribute to preventing the greenhouse effect will be systematically listed and the aid authorities will do their best to give priority to actions that are effective first and foremost in terms of development but which at the same time contribute to the prevention of climate change.

In parallel with the reconstitution of the World Environment Fund (see below), France has established the French Fund for the World Environment, with a budget of 0.44 billion francs for the period 1994-1998, in order to stimulate French aid efforts in the field of the world environment, by providing new ways and means. Through this mechanism, France will seek to fund exemplary projects within broader programmes of lasting development. This fund is managed by a steering committee made up of representatives of the main ministries concerned and the Caisse Française de Développement (CFD), with support from a scientific and technical council; it is managed by the CFD.

1.1.1 Aid to projects

Over the period 1992/1993, France will have devoted 25 billion francs to aid to projects. Some 35% of this aid was in the form of grants and 65% as loans on terms better than those available on the market.

Actions contributing to the prevention of climate change have been grouped under four headings:

* rural development projects, particularly intensification of crop production and the management of soil fertility with, as a positive impact in terms of the greenhouse effect, conservation of the carbon stocks in the soil and less pressure to clear new land, particularly in wooded areas.

About fifteen actions were taken in the period 1992/1993, essentially in sub-Saharan Africa, representing a financial commitment of 300 million francs.

* Projects for the sustained management of forest boundary zones and reforestation, which ensure the preservation and development of carbon stocks in the forest biomass.

In the period 1992/93, six projects were carried out in sub-Saharan Africa, representing a financial commitment of 42 million francs, together with participation in a wider project for the conservation of the Brazilian rain forest, to the extent of 35 million francs.

* projects to develop the utilisation of wastes, renewable forms of energy and natural gas, and projects to support improved management of the electricity sector, which enable energy requirements to be satisfied while limiting the related emissions of fossil carbon.

Thirteen such projects were carried out in the period 1992/93, in Africa and Asia, with a global government contribution of 890 million francs.

As an illustration, we may mention the funding of photovoltaic generators for rural electrification in Bangladesh, a power station using a geothermal resource in Indonesia, transmission lines for electricity generated in hydro plants in Ghana and work on the energy exploitation of biomass in West Africa.

* investment projects in railway transport and public transport in cities, which are the modes of transport having the least impact as regards greenhouse gas emissions for a given level of service.

In the period 1992/93, 5 projects were carried out in Africa, representing a financial commitment of 357 million francs.

The total commitment for these operations that are favourable to the prevention of the greenhouse effect is 1.2 billion francs, or of the order of 5% of aid commitments on projects.

1.1.2 Debt servicing

Reducing the debt of poor countries can be a favourable measure for preserving the environment in general and preventing the greenhouse effect in particular. Indeed when the conditions governing debt repayment are too restrictive, unduly high pressure is placed on exports which can lead, particularly for the less advanced countries, to an excessive rise in the rate of exploitation of natural resources (for example, tropical forest ecosystems).

Between 1988 and 1993, France undertook to cancel debts amounting to 16.2 billion francs owed by poor countries. In 1994, the cancellation of debts amounting to 25 billion francs owed by countries in the "franc" zone was announced as an auxiliary measure aimed at attenuating the effects of the 50% devaluation in the CFA franc.

Finally, in 1993 France established a "debt conversion fund for development" for the four intermediate income countries in the franc zone of sub-Saharan Africa, with the objective of converting debt to the benefit of sustained development. Projects to safeguard the environment is one of the categories into which these operations can fall. Thus the French government has agreed to cancel debts amounting to 0.85 billion francs in return for the execution of 17 projects, including land development in the cotton growing zone and wooded areas of Cameroon, and a forestry development project in Gabon.

1.1.3 Scientific and technical co-operation

In 1992, total aid in the form of scientific and technical co-operation amounted to over 7 billion francs.

The contribution in terms of research was 2.5 billion francs in 1992, most of this expenditure being used to fund specialist research organisations, CIRAD and ORSTOM.

*** the Centre for international co-operation in agricultural research for development (CIRAD)**

The CIRAD is a scientific organisation specialising in tropical and sub-tropical agriculture. Its budget in 1993 was 950 million francs, 66% of which was covered by government grants, and it employs 1800 people, nearly 40% of whom live abroad, in about fifty developing countries.

The research on annual crops and forestry (220 MF of public funds) is not directly related to controlling the greenhouse effect, but it does make a considerable contribution to preventing climate change by preserving or developing the carbon stocks in the soil and forest biomass in tropical countries.

This research is aimed in particular at:

- getting farmers to settle, particularly in West Africa and Madagascar;
- developing, protecting and exploiting forests with the aim of sustained production of wood;
- maintaining or restoring soil fertility.

There is also more concentrated research (10 MF in 1993) targeted on preventing the greenhouse effect:

- producing liquid fuels from vegetable oils and alcohols;
- utilising by-products of agriculture and agro-industry as fuels (combustion, pyrolysis, gasification, methane fermentation);
- research into the factors determining emissions of greenhouse gases from tropical ecosystems, notably the role of economic policy as it affects the agricultural sector.

*** The French institute for scientific research for development co-operation (ORSTOM)**

ORSTOM is a public scientific and technical establishment which conducts research on the tropical environments: land and marine ecosystems, agricultural systems, human societies, and so on. Its budget is 1 billion francs, nearly 95% of which comes in the form of government grants, and employs 820 researchers located at sites in some forty countries.

The ORSTOM programmes that can be related to preventing the greenhouse effect concern:

- the study of the methane fermentation of wastes from agro-industry, with the dual objective of energy production and the control of local pollution;
- the functioning of soils involved with various cropping systems with a view to preserving and sometimes restoring their fertility. This covers the biological functioning of soils, the storage of organic matter and methane emissions, notably from paddy fields;
- the dynamics of agricultural production systems. Analysis and understanding of production systems with regard to their biophysical, technical, economic and social aspects: this is one of the keys to sustained development, and is essential in guiding the decisions made by development managers. ORSTOM's work concerns Africa and Latin America;
- the study of forest ecosystems and desert environments. This approach seeks to preserve ecosystems and their diversity in the perspective of controllable exploitation (for example, programmes on agro-forestry and the management of land set aside).

These various research programmes involve about 150 researchers and receive public funding of around 200 million francs a year.

*** The environment and energy management agency (ADEME)**

The ADEME contributes to the national effort in technical, scientific and institutional co-operation with the countries of the south.

Its main topical programmes are the following:

- decentralised rural electrification: over the period 1992/93, execution of a pilot decentralised rural electrification programme in Morocco, photovoltaic projects in Tunisia and Senegal;
- making use of the energy potential of woody cellulose biomass: over the period 1992/93, joint funding of a regional research centre in Côte d'Ivoire, participation in the European programme on combined electricity generation in south-east Asia;
- clean technologies, including energy management in public buildings in Africa, management of urban transport systems in Latin America, and so on.

ADEME has devoted about 4 million francs a year to programmes on the rational use of energy and the development of renewable forms of energy in countries of the south during the period 1992/1993.

France is also proposing a transfer of knowledge concerning energy planning and energy management, based in particular on the experience of ADEME, which has served as a model or catalyst to the creation of local institutions charged specifically with these problems (Tunisia, Algeria, etc.). Co-operative ventures in the energy field are also involving the French network of technical research centres such as the CSTB, CETIAT, LNE, and the APAVEs on matters such as the conduct of tests, the practice of standardisation, and the preparation of regulations, the transfer of which is an important issue.

Other research organisations are playing a positive role in preventing the greenhouse effect. The national Agricultural Research Institute and the National College for Rural Engineering (water and forests) have activities in the field of tropical forests (developing forestry species that respect the major biological equilibria). Various teams from the National Centre for Scientific Research are assisting developing countries (Senegal, Côte d'Ivoire, Brazil, Thailand) in formulating national inventories of greenhouse gas emissions and defining national prevention strategies at the lowest cost.

France is also supporting research and projects concerned with combating the advance of the desert through the activities of the Sahara and Sahel observatory.

III - 1.2 MULTILATERAL AID

In 1992 France allocated funding of 10.4 billion Francs towards multilateral aid.

This aid is channelled principally through the United Nations, the European Commission and the international financial institutions, including the World Fund for the Environment.

In order to deal with the global threats to the planet such as global warming, damage to the ozone layer, the reduction of biodiversity and the pollution of international waters, France and Germany proposed in 1989, at the annual meetings of the International Monetary Fund and the World Bank, the creation of a special financial mechanism intended to assist developing countries face this new challenge. This mechanism was created in November 1990 and the sum of 1.1 billion dollars was made available for a 3-year pilot phase. During this period, France and Germany were the leading contributors with 0.81 billion francs, or 18% of the total contribution.

In March 1994, the resources of the World Fund for the Environment were reconstituted to the extent of 2 billion dollars for a further 4-year period; France continued its contribution of 0.81 billion francs. The different countries' contributions were based on a rule very similar to that of AID-10.

It is worth pointing out that since these contributions from the developed countries are intended to prevent global pollution, the distribution rule should evolve in the future so as to take into account both GDP and the damage done to the global environment (the level of CO₂ emissions) by the donor countries.

III - 2. CO-OPERATION WITH THE COUNTRIES IN TRANSITION TO A MARKET ECONOMY (EASTERN & CENTRAL EUROPE AND CIS)

Although reductions in emissions of greenhouse gases is not the prime motivation for the support given by France to these countries, it is a substantial spin-off from a number of the co-operative actions undertaken with them.

III - 2.1 ENHANCING NUCLEAR SAFETY IN THE EAST

Nuclear power accounts for a non-negligible proportion of electricity generation in these countries (15%).

France, in close conjunction with Germany, has played a leading role in the co-operation led by the international community for nearly four years with the aim of improving nuclear safety in the countries of central and eastern Europe and the former USSR: the primary objective is to prevent any nuclear accidents and the result is to limit the use of fossil fuels in electricity generation in these countries.

This co-operation involves the participation of French organisations (EDF and CEA) and firms in the discussions and other work carried out by the international institutions and associations (IAEA, NEA, RAMG, WANO, TPEG) and the activities of the international consortia (ENAC, CASSIOPEE, EFCC, RBMK).

Besides its share in the community effort, France has contributed the amount of 200 MF (for 1993 - 1994) to the international fund for nuclear safety in the east managed by the EBRD, and 150 MF for bilateral co-operative undertakings. In addition the country has made a voluntary contribution to the IAEA (4 MF in 1992 and 93) and has seconded French experts to the Agency.

France's bilateral actions mainly concern the three major topics in the multilateral programme adopted by G7 at the Munich Summit in 1992, but also the nuclear fuel cycle, radiation protection and the strengthening of the structures of the nuclear industry.

With regard to the safety of plant operations, the approach adopted has been on-site assistance and, particularly, the twinning of French nuclear plants with five plants in the countries concerned (Hungary, the Czech Republic, Slovakia and the Ukraine). These twinning arrangements seek to enhance the level of safety as well as plant availability. They permit exchanges of experience between operators, transfers of know-how and technologies and the provision of training sessions. In recent years, other activities aimed at improving operating safety have been carried out or are being carried out, including training in accident management and non-destructive testing (Ukraine) and producing an inventory of the principal plant systems on video disks (Slovakia, Ukraine).

Finally, French bilateral co-operation in this field has recently been reinforced by the introduction of compact simulators for training operators (Ukraine) and will be extended in 1994 with the extension of these actions to Ukraine and Bulgaria.

The improvement of technical systems in nuclear power stations, the second topic in the multilateral plan, is the subject first of bilateral agreements covering the supply of emergency equipment (agreement concluded with Bulgaria and being discussed with Ukraine), and secondly of training seminars on technical subjects such as analysis of the irradiation of pressure vessels (Russia) and of the transfer of design computer codes (Russia).

As regards the stiffening of regulatory regimes, this mainly takes the form of general co-operation between the French safety authority, its technical support agency which is the Institute for Radiation Protection and Nuclear Safety (IPSN) and their opposite numbers in the eastern countries, in addition to certain specific actions. These are projects to install compact simulators on the premises of the Bulgarian and Ukrainian safety authorities, the preliminary study of a safety analysis (Ukraine), and regional action involving the adaptation of the "Cathare" and "Escadre" computer codes to VVER reactors and the provision of relevant training sessions.

The nuclear fuel cycle has also led to a number of co-operative projects particularly with regard to cycle strategy (the former Czechoslovakia, Ukraine) and the organisation of and technical processes for the end of the cycle (the former Czechoslovakia).

Finally, bilateral actions have been taken or have just been decided with a view to developing a safety culture (Russia, Ukraine), in radiation protection and environmental monitoring (Belorus, Russia) and reinforcing the licensing and quality organisations (Russia).

Expected effects:

- to prevent any new accident with serious direct consequences which might hinder the development of nuclear power, even where its design and operation is reliable;
- to sustain this form of electricity generation that does not produce CO₂ and today avoids the emission of 60 million tonnes of carbon a year in the countries concerned.

III - 2.2 ENERGY SAVINGS

It is estimated that the potential for energy savings in all the eastern countries by introducing practices common in the west is about 30%.

The sum total of the actions initiated for improving energy efficiency in these countries have three positive effects:

- restoring the capability of the CIS to export fossil energy which is its main source of hard currency;
- improving the competitiveness of the economies of the eastern countries;
- reducing their CO₂ emissions.

Various initiatives have been taken in this field.

Bilateral actions funded by France are frequently the first stage of an arrangement which is subsequently taken over on a multilateral basis (by the World Bank, the EBRD, or the Community PHARE and TACIS programmes which have budgets of 1.5 billion Ecus).

Two public bodies play an important role in promoting these actions: The ADEME and Gaz de France.

Actions by the ADEME are focused upon:

- institutional support to countries in defining and implementing energy management policies and, in particular, the creation of energy management agencies;
- the development of university, scientific and technical co-operation;
- the creation of decentralised co-operative arrangements by putting local communities in the two countries in touch;
- demonstration *in situ* of what French industry can offer that is relevant to energy management.

Gaz de France has focused on demonstrating to the CIS that the best way of obtaining cheap gas is to save it, this being less expensive than developing new gas fields. For this purpose GDF has conducted a number of energy audits at the premises of industrial customers of GAZPROM and in the field of domestic heating in Moscow; GDF is also involved in the "Prague - Clean City" operation to determine ways and means of saving 25% of the energy necessary for heating. Finally we must draw attention to the participation of the French chemicals industry in the offer made by the professional group of European chemists (CEFIC): conducting, free of charge, the energy audits asked of them by the chemicals industry in countries "in transition".

If these various actions are to be really effective, the energy users in these countries must be made aware of energy management, and as far as Russia is concerned, priority in this process is given to bringing fuel prices rapidly into line with world levels.

III - 2.3 REDUCTION OF NATURAL GAS LEAKS

While the stakes relative to the greenhouse effect are lower than those of energy savings, active co-operation is also being developed in this field under the impetus of GDF which has attempted in particular since 1991 to convince its partners of the efficiency of using polyethylene pipes for gas distribution.

Various demonstrations have been given in Russia and Ukraine (using 1 to 3 km of pipe on each occasion) in Moscow, St Petersburg, Lvov and Jitomir.

MOSGAZ and GDF in partnership are preparing to establish in Moscow a centre for training in gas techniques using polyethylene pipes.

Finally, a polyethylene pipe production unit has been started in partnership between a Russian firm and a French firm.

Other co-operative arrangements concern the gas transport grid (audit of a 500 km section, cathodic protection, and so on).

IV - FRENCH CONTRIBUTION TO RESEARCH ON GLOBAL CLIMATE CHANGE

In the following we shall draw a distinction between research into the mechanisms of climate change and its effects, and technical research into how emissions can be reduced.

IV -1 GLOBAL CLIMATE CHANGE

At international level, research at present is structured in the field of the physical, chemical and biological aspects for investigating changes in climate arising from human activities, with the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP).

French research is organised along the lines of the international model although, in order to highlight the fact that changes in the climate and the global environment are the result of interactions between all components in the Earth system, it has been combined into a single programme, the French IGBP which therefore includes the national contribution to the WCRP and the IGBP.

Pending the introduction of effective international co-ordination of research in the field of social economics, research into the human aspects of climate change has been combined in the "Economy, society and global change" (ESCG) programme.

IV-1.1 AS REGARDS THE FRENCH IGBP, six national scientific programmes at present cover the essential areas of the study: the atmosphere, the seas and biomass. These are:

- the Programme National d'Étude de la Dynamique du Climat (PNEDC) [National Programme for Research into Climate Dynamics];
- the Programme Atmosphère Météorologique et Océan Superficiel (PAMOS) [Atmosphere, Meteorology, and the Ocean Surface] which in 1994 became the Programme National Atmosphère et Océan à Moyenne Échelle (PATOM) [the National Medium Scale Programme on the Atmosphere and the Seas];
- the Programme Flux Océanique (PFO) [the Ocean Currents Programme];
- the Programme Atmosphère moyenne (PAMOY) [the Intermediate Atmosphere Programme];
- the Programme Phase Atmosphérique des Cycles Biogéochimiques (PACB) [Programme on the Atmospheric Phase of Bio-geochemical Cycles];

- the Programme Écosystème (ÉCO Syst) [the Ecosystem Programme];

These programmes are described in Annex N° 6.

These national efforts are incorporated into international programmes through the participation of French scientists in the international bodies.

Besides these six programmes, there are more focused actions, and other programmes, some aspects of which are related to the subject of "global change". For example we may mention the study of erosion in the PIRAT programme, that of the continental shelves in the Dynamique et Bilan de la Terre [the Earth's Dynamics and Balance Sheet] programme, the study of the effects of pollution on forests (the DEFORPA programme), and the study of bio-geochemical cycles in the Programme National d'Océanographie Côtière (PNOC) [National Coastal Oceanography Programme] or investigations in paleohydrology in Africa (PALHYDAF). Certain programmes conducted by research organisations are also related to the subject of "changes in climate and the global environment". These research programmes are not detailed in the Annex but have been taken into account in drawing up the overall financial balance sheet.

IV - 1.2 THE "ECONOMY, SOCIETY AND GLOBAL CHANGE" PROGRAMME

co-ordinates the allocation of incentive funding (4 MF in 1994) for structuring research co-operation in economics and sociology on the organisation of the prevention of climate change. Its aim is to establish in France a durable research environment skilled in this field and capable of being integrated with the work done by the international scientific community under the international Human Dimension Programme (HDP) now commencing.

This programme covers the development of research into the socio-economic aspects of global changes related to the enhancement of the greenhouse effect, and particularly:

- the modelling of connections between the environment, resources and long-term development modes;
- the ability of fiscal incentives to direct technical change and changes in the organisation of space and transport; their macroeconomic impacts;
- institutions and the implementation of decisions pertaining to the international management of the global environment.

Some 20 teams, mostly working within a research group (GDR) are involved in this programme.

IV - 1.3 BUDGETS AND MANPOWER

The funding arrangements set up by the organisations can be broken down into research credits, covering intermediate-scale equipment, support for laboratories and incentives to research programmes on the one hand, and the consolidated budgets arising from the support for these programmes on the other hand, and which include the salaries of researchers and technicians.

The total budget for incentive research credits amounted to 180 MF in 1992. These credits are aimed at structuring research and generating a movement towards the programmes considered to deserve priority. All in all this funding is well balanced between actions related to climate (PNEDC, PAMOS), the chemistry of the atmosphere (PAMOY), ocean currents (PFO which in France corresponds to the international JGOFS programme), and ecosystems.

Funding from the EEC (EPOCH, MAST I and STEP of the Research and Development Framing Programme) reached an average of about 7.5 MF a year during the period 1988 - 1992. This should increase significantly with the Environment programmes (continuation of STEP and EPOCH) and MAST II.

The annual French contribution to the secretariat of the IGPB in Stockholm amounts to 0.5 MF.

The following table shows the breakdown of incentive and staff credits by programme for the year 1992. The consolidated total is obtained by adding together the incentive credits, and the financial charges corresponding to staff salaries in the budget for spatial operations. The budgets are expressed in millions of francs.

	PNEDC	PAMOS	PAMOY	PACB	PFO	ECOSyst	OTHERS	TOTAL
Incentive credits	86.56	17.58	10.3	18.27	8.6	20.14	18.34	179.79
Number of staff	244	88	25	89	62	125	207	840
Salary costs								558.50
Spatial facilities								529
Total expenditure								1 267.29

IV - 2 RESEARCH ON REDUCING EMISSIONS

The relevant research has already been pointed out in the presentation of the various actions, but two programmes deserve special mention.

IV - 2.1 ADEME PROGRAMMES

The ADEME has the task of directing and guiding technological research in the fields of new and renewable forms of energy.

The main lines of ADEME research are the following (with the credits included in the Agency's 1990 - 1994 budget):

- New and renewable forms of energy (246 MF)
 - decentralised electricity supply, essentially photovoltaic
 - biomass with research on the development of the resource (quick-growing brushwood), and on the conversion of biomass to energy vectors and the improvement of wood-burning boilers
 - geothermal energy, particularly in deep (4000 m), dry and hot rocks
- Energy management in industry (174 MF)
 - improvement of heat exchangers and boilers
 - high-performance applications of electricity, notably for high temperature heating or in the form of radiant energy
 - research into processes, notably in steelmaking (furnaces, galvanisation, recycling of casting sands, and so on), papermaking (drying) and the agro-food industries (liquid-solid separation)
- Energy management in transport (230 MF)
 - action concerning the demand for transport (understanding the factors determining mobility)
 - enhancing the attraction of the more efficient modes of transport, other than motor cars
 - improving traffic conditions and vehicle performance
 - developing the techniques of combined forms of transport
- Energy management in construction (149 MF)
 - improvements to materials
 - improvements to heating and air recycling systems
 - research into more efficient use of electricity in its specific applications (notably lighting).

Of these credits, 70% support private research, 30% public research with an average grant of 45%.

IV - 2.2 RESEARCH INTO THE PREVENTION OF THE GREENHOUSE EFFECT IN THE RURAL SECTOR

The conditions governing the emission (or storage) of greenhouse gases, and their levels, related to rural activities, are not well enough known for economically sound preventive measures to be organised in present.

A research programme has therefore been initiated on this topic, with particular emphasis on the following:

- storage of carbon in the soil as a function of how the soil is used and, in particular, the storage of carbon in forest soils, especially the changes occurring during the change from agricultural use to forestry use;
- methane emissions due to enteric ruminant fermentation: an empirical study of the general laws relating methane production to feed and animal factors, study of the effects of different known chemical and biological additives known to have a negative effect on methane generation, characterisation and impact of changes to the fauna in the rumen by means of mechanistic modelling and experimental *in vitro* and *in vivo* studies;
- methane emissions related to the management of manure, including measurement of emissions in different livestock raising systems and for different manure management methods, together with a technical and economic evaluation of the different strategies for reducing these emissions;
- study of the microbiology of the emission of methane by soils, stressing the characterisation, quantification and ecology of methanotropic microflora which are not well known;
- the rates of diffuse emissions of nitrous oxide and methane by soils, with the initial objective of developing reliable measuring techniques that are easy to use on a large scale (it has been agreed to give priority to micrometeorological methods which have proved their worth in related measurement fields).

Measures introduced

The National Agricultural Research Institute is co-ordinating this research programme, in which various public research bodies are involved. The programme began in 1992 and had incentive credits of 4.5 million francs for the period 1992/1994, which enabled some 17 million francs of overall public funds to be employed. It is envisaged that by the year 2000 some 9 million francs a year of public funding will be assigned to this programme.

Expected results

It is expected that the results supplied by this research programme will make it possible to introduce preventive measures in the rural sector that will limit basic emissions and significantly develop carbon storage, but their effects will mainly be felt after the year 2000.

EXECUTIVE SUMMARY

INTRODUCTION

Awareness of the threat to the climate owing to the rising emissions of greenhouse gases, particularly CO₂, led the French government to undertake a policy of controlling the emissions of greenhouse gases, as a precautionary measure.

This commitment by the French authorities was reflected in active participation in international projects, particularly the negotiation of the Convention on Climate Change, which was ratified by France on 25/3/1994.

This commitment to adopt policies and measures aimed at limiting the emissions of CO₂ and other greenhouse gases not regulated by the Montreal protocol, which figures in article 4 paragraph 2 of the Convention, will be applied throughout the European Union, with the Union and its member states acting according to their respective competence. The initiatives now being taken by the Community are in fact particularly important and effective in many fields such as transport, duty on fuels, miscellaneous regulations (notably as regards the environment) and the Common Agricultural Policy.

The energy policy operated by the French authorities since the first oil shock has already enabled them to reduce CO₂ emissions very considerably, and thus the contribution of France to the greenhouse effect. This policy has relied on the following in particular:

- The specification of strict regulations aiming to encourage energy saving. Thermal regulations for dwellings is a very significant example of this.
- The use of taxation. This high level of tax on fuels, which is above the levels practised in most developed countries, has contributed strongly in the past to limitation of carbon dioxide emissions. In addition, numerous fiscal encouragements aiming to improve energy efficiency have been put in place since 1974, especially in industry and in the home.
- A large programme of energy saving and energy efficiency, to develop and disseminate "clean and sensible" energy policies. Since 1974, France has run an Energy Saving Agency, which has dealt with energy consumption as final demand and in industrial activity, constituting a centre of skill and expertise over time.
- The development of a large nuclear power-generation pool, which has led to a reduction in CO₂ emissions not only in France but also in the neighbouring states.

Between 1980 and 1990, the magnitude of this policy has enabled France to reduce CO₂ emissions per inhabitant more than any other member state of the European Union (-26% against a European average of -19.3%). Within the OECD, only Sweden (now a member of the European Union) has achieved a better reduction than this. In total, the emission levels due to the use of fossil-fuel energy, per inhabitant and per unit of GDP, was less in 1990 by 22% and 35% respectively than the average of the 12 European nations, and 44% and 36% less than the average OECD levels.

I. INVENTORY OF GREENHOUSE-EFFECT GAS EMISSIONS

The following table summarises the emissions of all greenhouse-effect gases. This inventory was drawn up from the Corinair inventory and transposed into the IPCC format.

	Emissions in 1990 (in Mt)	Emissions in 1993 (in Mt) ¹²
CO ₂		
Emissions in all sectors	367	365
Energy use	350	351
Industrial processes	17	14
CO ₂ - Absorption by ground and forests	-32.2	-37.2
CO ₂ - Total net emissions	334.8	327.8
(International carriers - for ref.)	(8.6)	(8.9)
CH ₄	2.9	2.83
N ₂ O	0.177	0.171
NO _x	1.725	1.675
COV	2.425	2.3
CO	11	10

I.1. CO2 EMISSIONS

Shown in terms of inhabitant and unit of GDP, the total net emissions of carbon dioxide in France are particularly low for an industrialised country at 5.92 tonnes per inhabitant and 0.31 tonnes per billion dollars in 1990, as indicated in the introduction.

Their breakdown by sector was as follows in 1990:

Emitting sector	Gross emissions (Mt CO ₂)	Percentage in relation to total emissions
Energy (Production and transformation)	61	16.5 %
Industry	88	24 %
Transport	128	35 %
Residential/Tertiary	82	22.5 %
Agriculture	8	2 %
TOTAL	367	100 %

It should be emphasised that the winter of 1990 was mild. In average climatic conditions, the consumption of fossil-based energy (excepting electricity) for heating of buildings would have increased CO₂ emissions by 9.5 million tonnes, which is 3% of the gross emissions in 1990.

¹²Provisional estimate at 04/11/1994

The very slight increase seen between 1990 and 1993 of emissions due to the use of fossil-based energy resulted mainly from variations in climate, the winter of 1993 having been very close to normal. Nevertheless, two facts, independent of climatic changes, deserve to be emphasised:

- a continuous increase in CO₂ emissions in the overseas *départements* and territories (DOM-TOM) between 1990 and 1993 (over 20%),
- the regular increase in CO₂ emissions in the transport sector over the same period (5.5%).

The latter is an indication of an ongoing trend. From 1980 to 1993, CO₂ emissions related to the use of fossil-based energy in the various sectors in metropolitan France, after correction for climate variations, have evolved as follows:

Transport	+ 39 %
Residential and Tertiary	- 13 %
Industry and agriculture	- 37 %
Electric power stations	- 76 %
Weighted average.	- 25 %

I.2. METHANE EMISSIONS

The data given for methane and nitrous oxide emissions are very imprecise, particularly when account is taken of uncertainties applicable to the techniques used to measure these emissions in the agricultural and waste-dump areas.

Methane emissions amounted in 1990 to about 2.90 million tonnes, over 55% of which came from agricultural activities, 25% from waste disposal, and especially the consignment of waste to dumps, and 10% from fugitive emissions in the course of fuel extraction and distribution, the remainder occurring in the course of fuel consumption.

Since 1970, France has reduced its emissions due to coal production and gas distribution, with the closure of many mines and investments made for the purpose of improving the gas distribution networks.

On the other hand, the increase in the volume of waste breaking down in dumps certainly contributed in the Eighties to a significant growth in methane emissions from dumps. The policy of eliminating dumping, adopted in 1992, has not yet had time to produce any notable effects.

I.3. NITROUS OXIDE EMISSIONS

NO₂ emissions in 1990 came to about 177,000 tonnes, 60% of which came from industrial processes, and 35% from the use of fertilisers in agriculture. Marginally, some emissions also come from energy production in flame-powered thermal power stations or from motor vehicles.

I.4. GASES WITH AN INDIRECT EFFECT, TROPOSPHERIC OZONE PRECURSORS

Emissions of nitrogen oxides, volatile organic compounds, and carbon monoxide, are estimated respectively at about 1.7 million tonnes, 2.4 million tonnes and 11 million tonnes for 1990. The use of fossil-based energy is by far the main source of emission of these indirect-effect gases, with the exception of the VOC emissions, or an equally large part of emissions coming from the use of solvents.

II. DESCRIPTION OF THE POLICIES AND MEASURES FOR REDUCTION OF GREENHOUSE-EFFECT GAS EMISSIONS

II.1. REDUCTION OF CO₂ EMISSIONS

II.1.1. BUILDINGS

If account is taken of emissions due to flame-combustion power plants, which are due in essence to seasonal requirements for electric heating, the building sector represents over one third of CO₂ emissions in France. France conducted a vigorous energy conservation policy in this sector since the first oil shock, using regulatory measures governing new buildings and incentives aimed at existing buildings.

II.1.1.1. New buildings

From 1974 onward, France has taken the initiative, in close association with professionals in the building industry, of legislating requirements to be applied to the thermal insulation of new buildings. The fairly irreversible character of decisions made in the area of new construction encouraged France to go even further and to anticipate the progressive growth of the constraints which will be put in place to mitigate global warming.

- ***From 1/1/97, thermal standards for dwellings will be strengthened*** by raising the requirements in proportion to the energy gain obtained by substituting slightly emissive double glazing with ordinary double-glazing. This measure will result in a reduction of 5% to 10% of heating needs.
- ***Thermal standards of the tertiary sector, which was far behind that applicable to dwellings, will be reinforced with an objective of reducing energy consumption by 25%***. This will take effect before 1/7/1997 for non-air-conditioned buildings, and before 1/1/1999 for air-conditioned buildings.

These two measures will give a gain of 0.16 MtC in the year 2000. However they also have a cumulative effect which makes their long-term impact far greater than the short-term effect.

II.1.1.2. Existing buildings

Ever since the first oil shock in 1973, France has been developing a vigorous energy conservation policy in the area of existing buildings, and substantial improvements have been achieved here. Nevertheless, viable interventions in respect of energy conservation still remain to be effected, and this policy will be pursued through measures which depend upon information to users, regulation and standardisation of new equipments and incentives for investments leading to energy saving.

For state buildings, the government has set itself the objective of making energy conservation investments between 1995 and 1997 which have a 6 years payback time. This should result in a reduction of 12% in their energy consumption.

Finally with regard to the fiscal approach to prevent global warming, France has proposed to its partners in the European Union that a tax be levied on fuels used in the residential and tertiary areas.

In all, the measures concerning existing buildings should enable a gain of 3.4 MtC per annum to be achieved in the year 2000.

II.1.1.3. Development of the use of wood in construction

France has decided to develop the use of wood in construction, and this action can be divided into three components:

- the development of the promotion of wood in the construction industry,

- the removal of factors which are preventing wider use of wood in construction, through research, development, and ad hoc publicity,
- the development of a strategy for industrial products or semi-products based on the sawmill industry.

The aim is to store an additional 0.35 MtC/year by the year 2010, over and above the 1990 figure.

II.1.2. INDUSTRY

Cooperation with companies in the energy intensive sectors is being conducted with a view to achieving the signature of voluntary agreements which will lead to significant savings in fossil-based carbon emissions; potential emission reductions are estimated at 5 MtC a year in this field on the basis of 1990 activity.

In parallel with this, the policy of public aid in the control of energy use in industry, including financial aid (support for research and development, aid for demonstration of exemplary investment, etc.) and fiscal encouragements (exceptional depreciation, exoneration or reduction of various indirect taxation thresholds, etc.), will be pursued.

II.1.3. TRANSPORT

Transport (with the exception of maritime bunkers) represent over one third of French CO₂ emissions, and constitute the sector in which emission growth is fastest. In addition to specific measures adopted to mitigate global warming, many other public measures, necessary for various reasons within the transport policy, also have the effect of reducing this contribution. It should be noted that many of these actions originate from initiatives to be taken by the European Union.

II.1.3.1. Transport of merchandise (other than commercial vehicles)

- *With the aim of establishing the best conditions for exercising the profession of road transportation of goods*, various measures have been adopted in cooperation with the profession (strengthening of the conditions of access to the profession, imposition of sanctions if the regulations are not observed, etc.) These measures could achieve a reduction in emissions due to road transportation of goods of about 0.4 MtC per annum in the year 2000.
- Moreover, France is proposing to its partners in the European Union that *it should programme the progressive raising of the minimum rate of community excise on gasoil, in order to transfer to the transport industry all of the costs which they create for the general public*. An increase of 10% in the price of gasoil will lead to a reduction in carbon emissions of 0.15 MtC/yr.
- *It is intended to double combined road-rail traffic between 1990 and 2000*, and this will result in a carbon emission reduction of 0.13 MtC/yr. As soon as 1995 onward, credits available to such combined transportation were increased by 300 MF.
- Finally, *technical actions relating to the vehicles themselves* will be studied in a community context, with the objective of reducing unit consumption by 20% between now and 2015.

II.1.3.2. Passenger transportation and commercial vehicles

In 1994, the government adopted two measures to reduce polluting emissions from the existing car pool, which will also have an impact on CO₂ emissions.

- *The obligation to repair vehicles which have been declared defective in respect of pollutant emission when they are subjected to technical checks* should result in a gain of 0.32 MtC per year.

- ***A payment of 5000 F for the replacement by a new vehicle of one which is over 10 years old, and due to be scrapped,*** should lead to a short-term reduction of tens of thousands of tonnes of carbon in French emissions.

Furthermore, France has the intention to promote the following:

- ***reduction in the European Union of the level of specific consumption of new vehicles.*** This average level could be set, for example, to 5L/100km by 2005. To this end, France is proposing that the feasibility of a system of negotiable permits should be studied at the European Union level. France has also undertaken a study at national level on a possible change in the road tax payable annually by motorists, to act as motivation
- ***the development of vehicles specifically for town use,***
- ***the development of electric vehicles and other alternative vehicle types (GPL/GNV).***

Policies relating to urban transportation will have a considerable impact on CO₂ emissions, and should set themselves the objective of controlling the growth of motorised transportation and facilitating the use of more economical modes of transport in terms of space and energy. Though these policies are the prerogative of local authorities, these authorities will be made aware of their responsibilities in the matter. In addition to ***the investment capital which it allocates to local authorities for public transport, to the value of 5.5 GF per year,*** the State also intends to assist them in the conducting of the necessary studies and in their documentation.

Finally, the development of high-speed trains for inter-city travel is leading to an energy-efficient alternative to the use of cars or aircraft. It also substitutes electrical energy for fossil-fuel energy. The estimated gain in respect of CO₂ emissions is 0.13 MtC/yr by the year 2000.

II.1.4. ELECTRICITY GENERATION

The special character of France in electricity production, related to the magnitude of the nuclear contribution to electricity generation, is considerably reducing its margin of manoeuvre in the future development of its emissions in this sector. ***Only reduction of the peak of electricity demand and substitution of electricity for fossil fuels for non-seasonal uses will lead to reductions in CO₂ emissions.*** To this end:

- ***EDF is proposing a new price structure which is modulated with time*** (the "Tempo" charging system, which includes 6 time zones with different charges throughout the year), and this should lead to a reduction in peak electricity consumption, with a consequent emission gain of 0.5 MtC/yr in 2000.
- ***Demand side management action started in 1993 and affecting seasonal demand and demand in "départements" not connected to the metropolitan network in particular*** (Corsica and DOM-TOM), should lead to additional emission reductions of 1.7 MtC per annum by the year 2010.
- ***EDF also will promote the penetration of electricity into the area of non-seasonal uses in industry.*** The use of investment with a return period of under 6 years can lead to emission reductions of up to 1.8 Mt/yr by 2000.
- ***Equalization of low voltage electricity prices over the whole country leads to over-consumption of electricity,*** both in isolated regions where electricity is frequently fossil-fuel based, or in sparsely-inhabited rural zones where it can artificially replace renewable energy sources. EDF will invest 100 MF/year in operations designed to prevent this.

II.1.5. DEVELOPMENT OF THE CARBON SINKS RELATED TO FOREST

France decided to develop its policy of public support to forestry (aid toward plantation, to which was added a bonus for revenue compensation), setting itself the objective for increasing the rate of supported afforested land from 10,000 hectares per year over the decade of the Eighties, to 30,000 hectares per year from 1998 onward. This policy will enable it to maintain the rate of increase in carbon stocks in the forest by the year 2000 at its 1990 level, compensating for the natural slowing of carbon storage in the forest already existing in 1990, and which is progressively reaching maturity.

II.1.6. CHANGES IN LAND USE

Reform of the Common Agricultural Policy in 1992 should put a brake on the movement of grassland or woodland conversion into arable land, which was a result of the agricultural policy followed since the Sixties. This will result in a reduction of carbon emissions from the soil estimated at 2 MtC per year by 2000.

II.1.7. RENEWABLE ENERGY

The measures adopted in this area (development of wind and hydro power; development of wood as an energy source, in particular by the launch of the "Wood Energy Plan" which was aimed at the structuring, in a certain number of pilot regions, of a veritable wood-energy chain for collective heating; development of the agricultural biomass for energy uses; use of energy generated from waste) should lead to savings of some 0.64 MtC/year by 2000.

II.2. OTHER GREENHOUSE-EFFECT GASES (METHANE, NITROUS OXIDE PRECURSORS OF TROPOSPHERIC OZONE)

Changes in the emission of these gases will come in the main from measures adopted for a variety of reasons in the context of environmental policy (the law on waste, which forbids the dumping of normal waste, regulatory actions concerning automobile pollution, protection of waterways against pollution by nitrates, etc.) or of sectorial policies (agricultural policy in particular).

Special regulatory measures will nevertheless be implemented with a view to limiting CH₄ emissions from existing dumps and N₂O emissions from the main industrial emitters. Investments to be made in adipic acid, nitric acid and glyoxylic acid plants, should reduce emissions of N₂O on the industrial sector by 72 thousand tonnes between now and the year 2000. The reduction in N₂O emissions in the agricultural area is estimated to be 7.5 thousand tonnes of N₂O per year between 1990 and 2000.

III. GREENHOUSE-EFFECT GAS EMISSION SCENARIOS

Given the present programme, *the emissions in metropolitan France due to energy use may increase from 104.5 million tonnes of carbon (MtC) in 1990¹³, to 108.5 MtC in 2000*, though this includes a range of uncertainty of some 20 MtC. This uncertainty is related to contingencies concerning growth, oil prices, the availability of nuclear power plant, and the climate.

Where other greenhouse-effect gases are concerned, the actions set in train *should enable emissions of methane to be stabilised in the year 2000 at their 1990 levels, with nitrous oxide emissions reducing by half and those of nitrogen oxides and volatile organic gases reducing by a third.*

¹³Carriers included, and after correction of the effect of climate on the heating requirements of buildings.

By weighting the emissions of methane and of nitrous oxide by their global warming power over 100 years, as indicated by the IPCC in 1994 (24.5 for CH₄ and 320 for N₂O), we arrive at the following figures for net emissions, expressed in millions of equivalent tonnes of carbon, in accordance with the IPCC methodology (that is not corrected for climate, and including DOM-TOMs but not carriers).

Mt C equivalent	1990	2000	Growth 1990/2000
CO ₂	91.3	98	7%
CH ₄	19.4	19.4	0%
N ₂ O	15.4	8.1	- 47%
Total	126.1	125.5	0%

One should however keep in mind the considerable uncertainty affecting these emission forecasts for reasons which are independent of the national climate change mitigation programme.

IV. INTERNATIONAL COOPERATION AND FINANCIAL MECHANISMS

IV.1. COOPERATION WITH DEVELOPING COUNTRIES

In 1992, the amount of official development assistance (ODA) from the French government was almost 44 billion francs. Its ODA rate in relation to gross domestic product (0.63% in 1992) places France in the number five position in the OECD. In absolute figures, France is the third largest contributor to the Development Aid Committee of the OECD, after the United States and Japan.

France is also committed to increasing its ODA rate to 0.7% of GDP between now and the end of the century.

IV.1.1. BILATERAL AID

In parallel with the re-constitution of funds for the global environment facility (GEF), France has also put in place the French global environment facility, consisting of 0.44 billion francs over the period 1994-1998, in order to stimulate the French aid effort in the area of global environment, providing it with new intervention resources. France thus intends to finance exemplary projects forming part of wider programmes of sustainable development.

In addition, numerous projects undertaken in the context of the ODA also contribute to the mitigation of the greenhouse effect in the receiving countries.

- of the 25 billion francs devoted to project oriented assistance during the 1992/1993 period, in the form of subsidies or loans with conditions which are more advantageous than those of the open market, about 5% relate to operations favouring the mitigation of the greenhouse effect (some 1.2 billion francs). These are inter alia: rural development projects; sustainable management projects of forest areas; projects aiming at increasing the use of waste, renewable energy and natural gas; projects in support of better management of the electricity sector; investment projects in the rail-transport area or public transport in conurbations.
- France considers that reducing the debts of poor countries is also a measure which favours preservation of the environment in general and mitigation of the greenhouse effect in particular. The commitments of France for this purpose, between 1988 and 1993, amounted to 16.2 billion francs. In 1994, cancellation of payments to the value of 25 billion francs in respect of countries in the 'Franc Zone' was announced as a measure aimed at softening the effect for a 50% devaluation of the CFA (African Financial Community) franc. Finally, in 1993 France established a "debt conversion fund for development" for the four intermediate income countries in the franc zone of sub-Saharan Africa, with the objective of converting debt to the benefit of sustained development. Projects to

safeguard the environment is one of the categories into which these operations can fall.

- The contribution in the research area was 2.5 billion francs in 1992, this being devoted mainly to financing specialised research bodies, the CIRAD and the ORSTOM, which run many programmes in the agricultural and forestry areas in particular. These programmes contribute widely to the mitigation of climate change in the developing countries.

IV.1.2. MULTILATERAL AID

In order to deal with the global threats to the planet such as global warming, damage to the ozone layer, the reduction of biodiversity and the pollution of international waters, France and Germany proposed in 1989, at the annual meetings of the International Monetary Fund and the World Bank, the creation of a special financial mechanism intended to assist developing countries face this new challenge. This mechanism was created in November 1990 and the sum of 1.1 billion dollars was made available for a 3-year pilot phase. During this period, France and Germany were the leading contributors with 0.81 billion francs, or 18% of the total contribution.

In March 1994, the resources of the GEF were reconstituted to the extent of 2 billion dollars for a further 4-year period; France continued its contribution of 0.81 billion francs. The different countries' contributions were based on a rule very similar to that of IDA-10.

France is of the opinion that since these contributions from the developed countries are intended to prevent global pollution, the distribution rule should evolve in the future so as to take into account both GDP and the damage done to the global environment (the level of CO₂ emissions) by the donor countries.

IV.2. COOPERATION WITH COUNTRIES IN TRANSITION TO MARKET ECONOMIES

IV.2.1. SAFETY OF THE NUCLEAR INDUSTRY

In close cooperation with Germany, France has played a leading role in the cooperation exercised by the international community for almost four years now, in favour of improving nuclear safety in the countries of central and eastern Europe, and of the former USSR. France thus agrees a financial effort of 200 MF (for 1993/94) to international funds for nuclear safety in the east, controlled by the EBRD, and 150 MF for bilateral operations. To this has been added a voluntary contribution to the IAEA (4 MF in 1992 and 1993) and the placing of France experts at the disposal of the Agency.

This cooperation mainly concerns safety in control of the process, an improvement in the technical arrangements, and the strengthening of regulatory regimes for nuclear power stations.

The objective of these actions is to avoid any new accident with direct serious consequences, which could hinder nuclear development, even where the industry is designed and run in a reliable manner, and to preserve a means of a carbon free electricity production scheme, avoiding the emission of some 60 MtC per year in the countries concerned.

IV.2.2. ENERGY SAVING AND REDUCTION OF NATURAL GAS LEAKS

In all of the countries of Eastern Europe, it is estimated that 30% of the energy used could be saved by introducing practices common in the West.

Actions financed by French and bilateral funding are frequently the first stage of a project which is then continued by multilateral financing (World Bank, BERD, the Phare and Tacis Community programmes, etc.).

If these various actions are to be really effective, the energy users in these countries must be made aware of energy management, and as far as Russia is concerned, priority in this process is given to bringing fuel prices rapidly into line with world levels.

Active cooperation is also developing in the area of natural gas, under the leadership of Gaz de France, which has applied itself since 1991 to convincing its partners, through various projects (training, demonstrations, etc.), of the effectiveness of distribution techniques using polyethylene pipe networks.

V. RESEARCH

V.1. GLOBAL CLIMATIC CHANGES

At international level, research at present is structured in the field of the physical, chemical and biological aspects for investigating changes in climate arising from human activities, with the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP).

French research is organised along the lines of the international model although, in order to highlight the fact that changes in the climate and the global environment are the result of interactions between all components in the Earth system, it has been combined into a single programme, the French IGBP which therefore includes the national contribution to the WCRP and the IGBP.

Pending the introduction of effective international co-ordination of research in the field of social economics, research into the human aspects of climate change has been combined in the "Economy, society and global change" (ESCG) programme.

The total budget for motivational research credits came to 180 MF in 1992.

V.2. RESEARCH INTO THE REDUCTION OF EMISSIONS

The purpose of the ADEME is to lead and orientate technological research into the areas of renewable energy, and energy efficiency in industry, transportation, and construction. Eight hundred million francs of credits were devoted to the budget of this Agency from 1990 to 1994.

In addition, the National Institute for Agronomic Research provides coordination of the programme of research into the magnitude and conditions of emissions (or storage) of greenhouse gases within the rural sector, in which various public research organisations take part. Over the period from 1992 to 1994, this programme has enabled public resources to the amount of 17 million francs to be brought into play.

VI. FUTURE PROSPECTS

National communications presented by the Annex 1 Countries at this stage, are build on a set of policies and measures which will be implemented with the aim of returning the greenhouse gas emissions of these countries to their 1990 levels by the year 2000. This is only a first step towards the ultimate objective of the Convention.

The cost of the new measures to be taken in a second step will differ greatly from one country to another, mainly with respect to the efforts which have already been put in, and of the results achieved in the area of energy policy. When introducing new commitments, full account should be taken of these differences in the Parties' starting points.

France considers that the most effective and equitable way of sharing the effort of reducing CO₂ emissions between the developed countries was to introduce, in all these countries, all emission reductions whose cost is below a common reference level. The simplest and cheapest way of achieving this result, and the one most transparent for all concerned, in terms of administrative costs, is to institute progressive CO₂ taxation at co-ordinated rates in these different countries within their fiscal regimes. This approach is also the one which minimises the cost of reducing CO₂ emissions within each country.

This kind of fiscal approach, established in a sufficiently wide context to take into account the competitive nature of the activities to which it applies, will be essential in reaching the ultimate objective of the Convention. In parallel with this, it is necessary to emphasise the importance which must be attached to removing all subsidies in all of these countries which encourage the consumption of fossil fuels. These subsidies may take the form of internal prices for fuels or oils which are less than world prices; it may also consist of selling electricity at prices below production cost or of subsidising certain activities which are very large consumers of fossil-based energy.

The methods applied for organising the world-wide effort should be defined with a view to preserving fair competition between firms in the framework of international trade and in that of the internal market of the European Union. One of the priorities in organising international trade should be to ensure that the rules governing this trade do not constitute an insurmountable obstacle to the protection of the world's environment. It would be appropriate for the Framework Convention on Climate to be amended to include provisions similar to those of article 4 of the Montreal Protocol on CFCs to ensure that non-signatory countries do not benefit unjustifiably, in international trade, from the fact that they are not involved in the joint efforts to protect the atmosphere.