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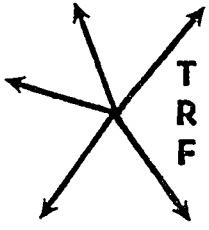

TRANSPORTATION RESEARCH FORUM

Transport and Mastery Of Energy in France

*by Bernard Jachimiak**

IN SPITE OF transient and cyclic variations, the energy crisis is still acute, and the energy saving policies of the countries of the industrialized world are now more necessary than ever.

I am even tempted to say that any analysis that might be made today would show that the implementation of these policies should be accelerated and their impact enhanced.

In this respect, the transport sector poses a special problem, because of its specifics characteristics.

I should now like to present this problem in greater detail, taking the situation in France as an example.

Since 1974, France has been setting up a major energy-saving programme covering all sectors of the country's economic life industry, agriculture, housing and the tertiary sector, and transport. This programme has resulted in the achievement of considerable savings, as is shown by figure 1. However, it should be noted that while the consumption of oil is declining in absolute value, like that of fuel oils as whole (heavy and domestic), it is clearly apparent that the consumption of automotive fuels is continuing to rise.

The available statistics for 1981 and 1982 show that there has been no slowing of this trend. It is already causing a serious disequilibrium of French refining capacity.

Now, the transport sector, which accounted for 22% of the country's total energy consumption in 1982, is already responsible for 46% of its oil imports (cf. figure 2).

If the observed trends continue, the transport sector will consume between 38 and 45 tons of oil equivalent in 1990, or between 50 and 70% of the country's total oil consumption. (These figures are based on two growth assumptions: 2.5 and 5% per year.) (Cf. figures 3 and 4.)

One of the basic causes of the continual growth of energy consumption is, naturally, the growing demand for mobility, especially on the part of households. Indeed, this demand grew 50% between 1970 and 1981 (cf. figure 5), counting all forms and types of transport for all domestic travel.

The evolution of the demand for mobility over the last ten years has resulted in growing consumption of transport by household consumption (cf. figure 6).

This expansion—and this is a highly significant characteristic—has occurred primarily in the form of road transport, both for passengers and for goods (cf. figures 7 and 8), in other words, in the worst possible form as judged by the single criterion of consumption of petroleum products, as shown by figure 9. (Rail transport, because of electrification and nuclear power stations, is consuming less and less oil per ton-kilometre carried.)

Mode of transport	1982 consumption (in millions of TOE)
—Automobile	17
—Road transport (goods and passengers)	10
—Rail	2.5
—Maritime and river	4.5
—Air	2

Within the category of road transport, the use of the private car holds a special place, since the growth of household ownership of motor vehicles has also been one of the most important social phenomena of the period in question: 70% of households have at least one vehicle. The automobile has thus become responsible for nearly half the energy consumption of the transport sector, as shown by the table above.

These few facts clearly show that the transport sector is henceforth the main difficulty to be overcome to assure the success of a policy of mastery of energy.

One might even say that for a country like France, dependent on import for 100% of its oil supply, reducing energy consumption in the transport sector is a strategic necessity.

The question then arises of how best to attain this objective, without for all that decreasing the availability of transport, which must, on the contrary, continue to develop and to offer optimum comfort, safety, cost, and protection of the environment.

A variety of courses of action can be

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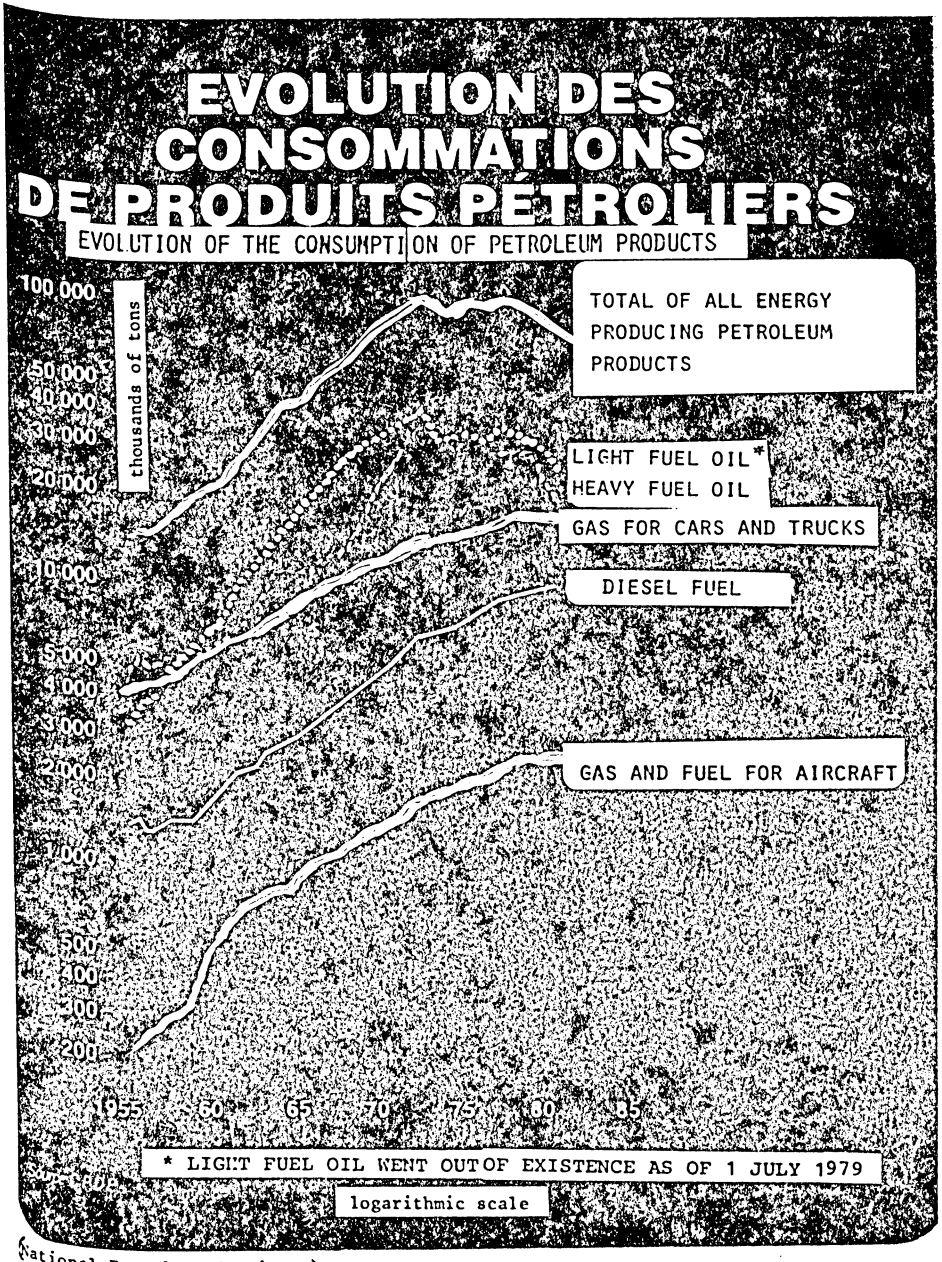


(National Petroleum Committee)

FIGURE 1

considered, but four main directions can be identified based on the finding that true mastery of energy consumption in the transport sector can be achieved only by a combination of two approaches:

—improvement of the energy performance of each mode of transport, or a reduction of consumption per unit of transport;
—and improvement of the organiza-

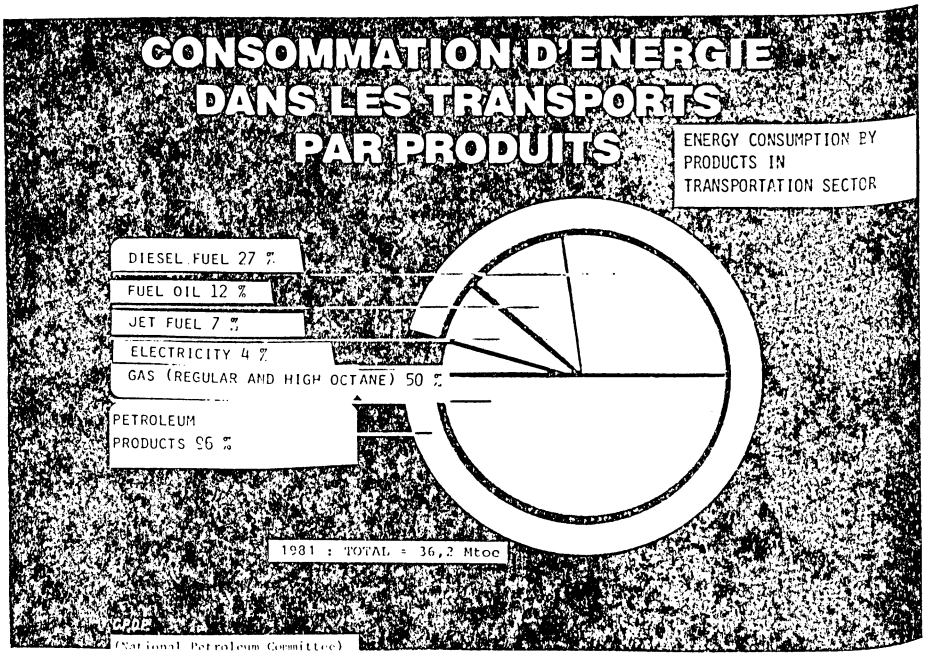


FIGURE 2

tion of the transport systems so that each will be used where most efficient in energy terms.

These four directions are:

- Encouraging and assisting the arrival on the market of new equipment and accessories that are energy-efficient or can be added to existing equipment to increase its energy efficiency. Concurrently, promoting the offer of reliable services capable of assuring the proper utilization and maintenance of the new products developed.
- Accelerating the distribution of these products and services to the various users concerned by active support of demand, in particular by offering suitable assistance with financing.
- Initiating studies and experiments aimed at laying the foundations for a policy to improve the energy performance of the overall organization of the transport system. This policy will aim at providing for each mode of transport conditions of use that minimize energy consumption. It will also encourage transfers from the least economical modes to modes having the lowest specific oil consumptions or to modes using alternative energies.
- Accompanying the above-mentioned actions by a major effort to train the various categories of transport users and professionals in, inform them about, and make them more aware of energy-related questions, so as to improve their behaviour patterns and to assure the setting up of better qualified and hence more reliable professional organizations.

PROMOTION OF THE SUPPLY OF HIGH-PERFORMANCE PRODUCTS AND SERVICES

In this field the first and essential step is the launching, by all of the industrial and scientific partners concerned (manufacturers, suppliers, subcontractors, laboratories, and engineering companies), of programmes of investigation, research, and development in the various areas where industrial fallout in the short and medium terms seems reasonably likely.

The example of the automotive sector can be studied more in detail.

In the course of the ongoing development and improvement of their products, French auto makers have already

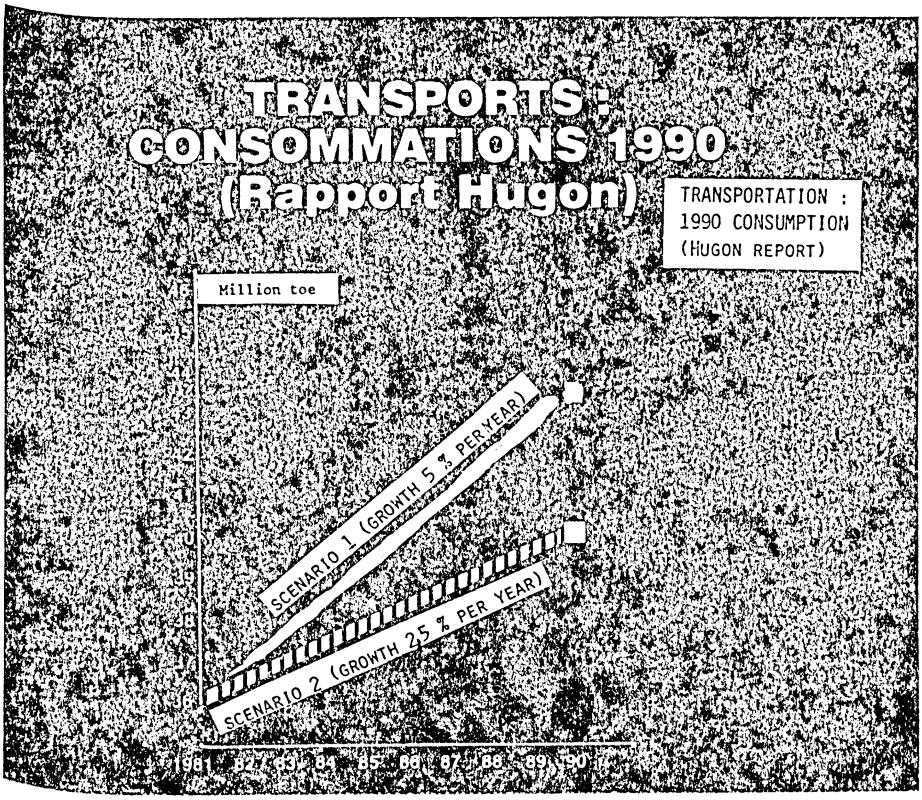


FIGURE 3

achieved significant savings in fuel consumption. From 1975 to 1981, the average consumption of new cars on the market was lowered from 8.5 to 7.1 litres per hundred kilometres. But this progress is slow, and is for the most part dependent on the evolution of the makers' lines for commercial reasons. To go farther and faster, an agreement was entered into with Renault and P.S.A. in 1978 that has led to the launching of two fuel-economy test vehicle programes (EVE and VERA, respectively) aimed at producing prototypes of middle-of-the-line automobiles derived from existing cars (the R 18 and the 305, respectively) but offering substantially improved mileage.

These two programmes have been uncontested technical successes, and even spectacular successes (I am thinking of the 2.52 litres per hundred kilometres achieved by the optimized VERA diesel on the Pau-Paris run, at an average speed of nearly 70 kph). But, beyond the actual performance, the success of these programmes lies in their demonstration of the feasibility of incorporating a large number of technological developments to reduced fuel consumption, in the not too distant future, without sacrificing the comfort, safety, and performance consumers demand.

For example, the petrol version of the VERA weighs 180 kg less than the 305 and its drag coefficient is 30% lower. This gain has been achieved through intensive work on structural design and the use of new materials. A major research effort aimed at optimizing the power plant has also contributed to better mileage.

The EVE vehicle, too, has been a laboratory for the development and testing of a number of innovations: a design that gives the lowest possible drag coefficient for a vehicle of this size class without sacrificing space or styling; microprocessor control of the engine for lower consumption for a given output power; investigation of the feasibility of recuperating and storing braking en-

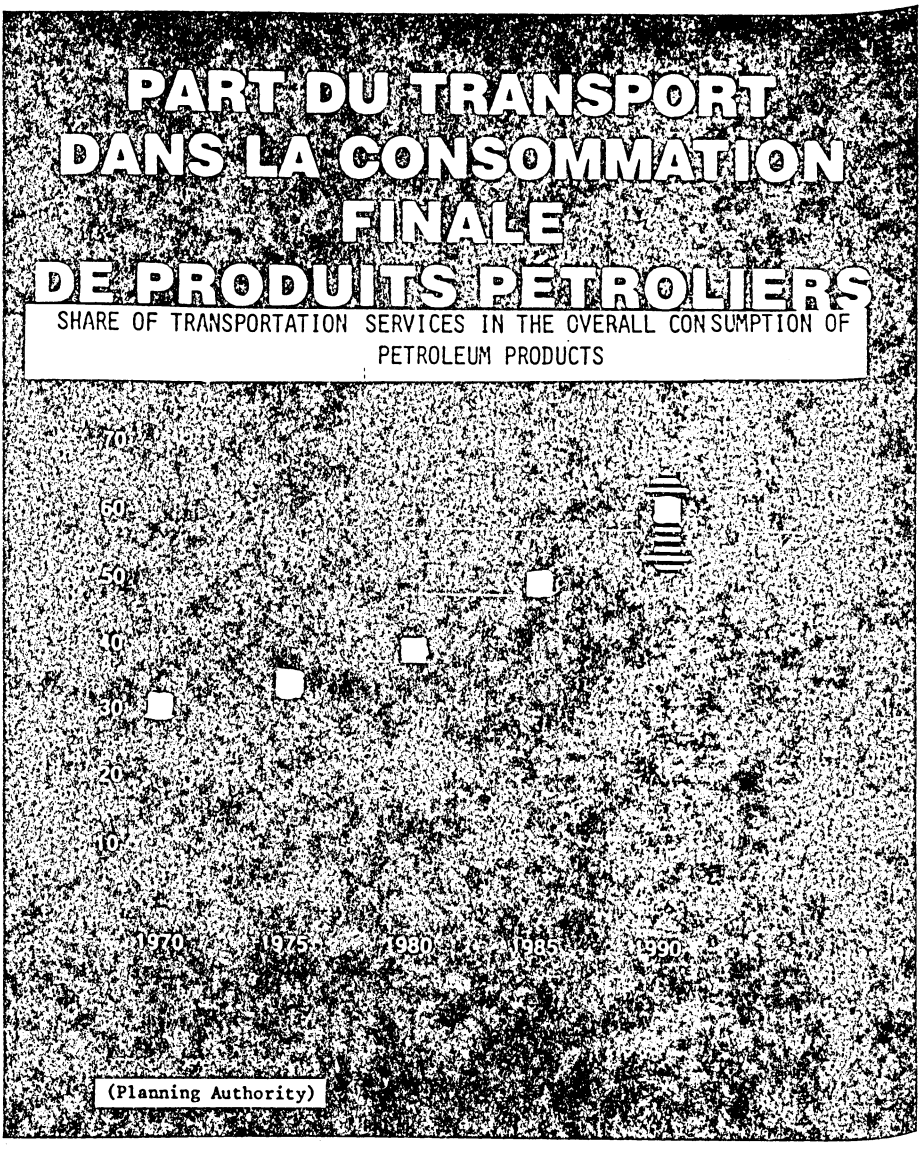


FIGURE 4

ergy by means of hybrid oil-air accumulators; testing direct injection in a small-displacement diesel engine; trying out the possibility of automating a conventional clutch and a conventional gearbox with discrete ratios, and so on.

The various studies undertaken under these programmes have naturally succeeded to varying degrees, but they have in all cases yielded very interesting results and have, as a whole, led to the development of prototype vehicles having mean consumptions on the order of 4.5 to 5.5 litres per hundred kilometers (the mean consumption is the average of the three conventional consumptions measured at 90 kph, at 120 kph, and in simulated urban driving).

The question that naturally arises is why such astonishingly energy-efficient

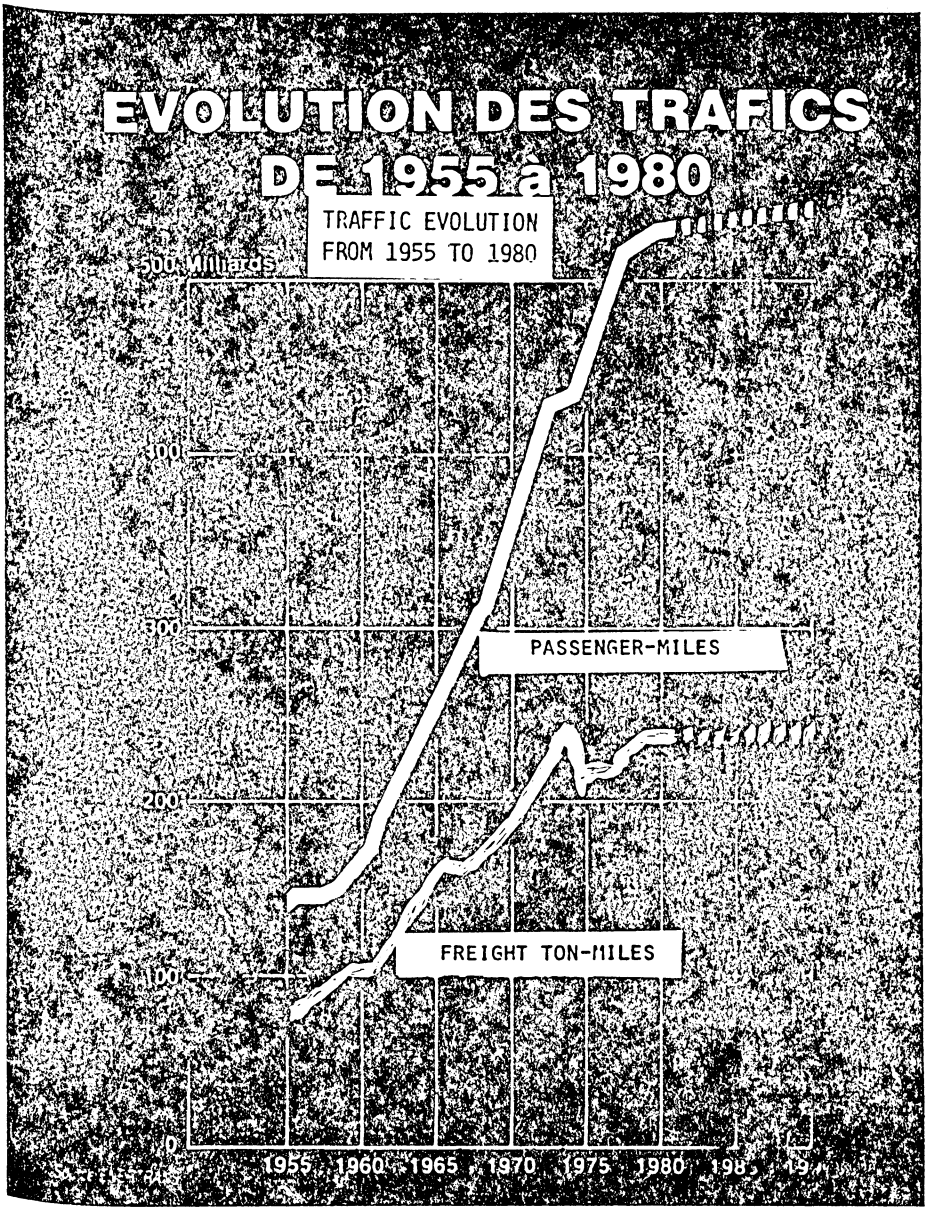
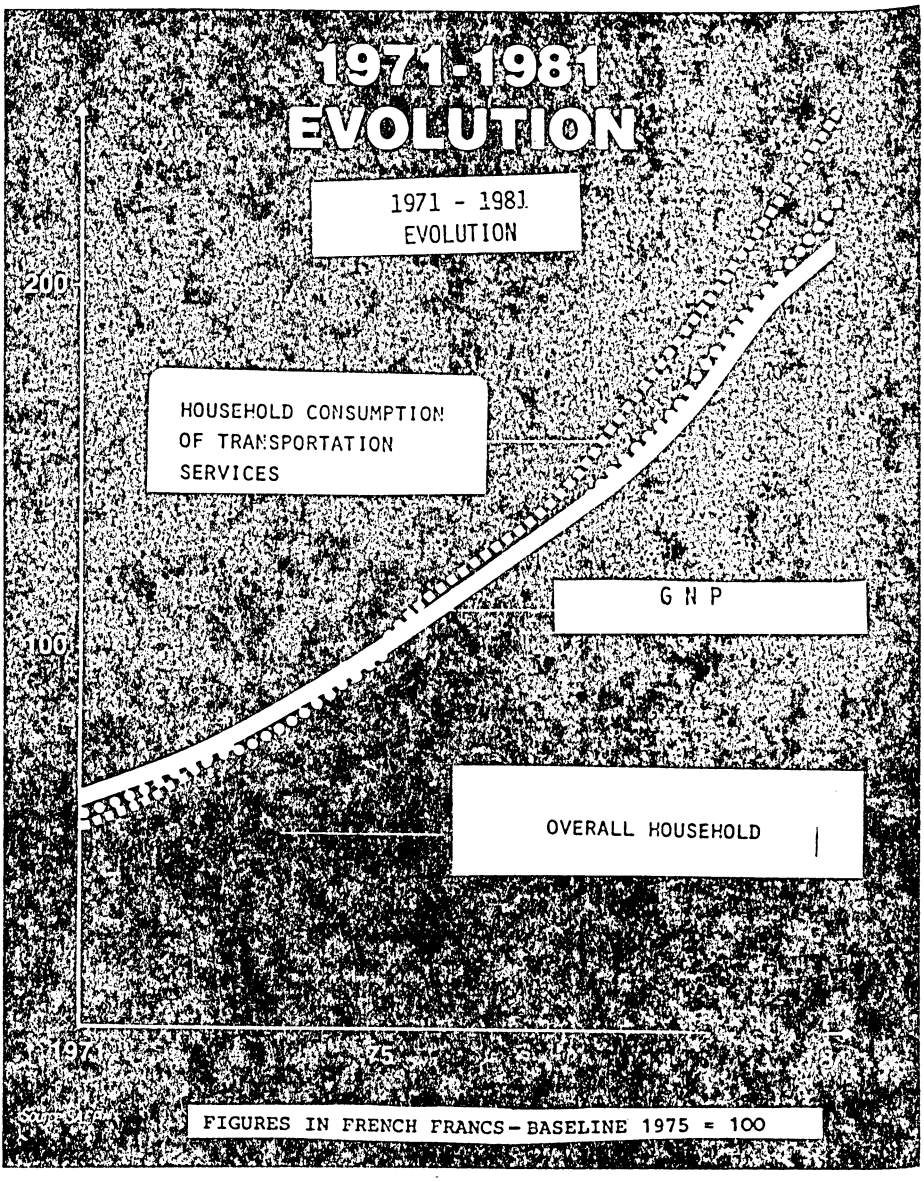


FIGURE 5

vehicles are not yet mass produced and on sale everywhere. The answer is, quite simply, that that is not what they were planned for. They are in fact only laboratory vehicles, developed with no thought of manufacturing constraints or the availability of the technologies at prices compatible with mass production.

Even so, the fallout from these programmes on the other vehicles being developed by the same maker can be considerable. For example, the 205 recently launched by P.S.A. incorporates a number of improvements developed and



(Economic & Planning Studies Department)

FIGURE 6

tested on VERA: the vehicle has been made much lighter, even lighter than a 104; the drag coefficient is 0.35, as against 0.40 for other existing vehicles of the same length; the improved engine is an industrial version of the engine developed for VERA, the rear suspension was developed on VERA; and so on.

But to meet the expectations of automobile users and further accelerate the appearance of fallout from the research undertaken, the authorities wished to encourage the auto makers to take yet another step. Thus was born in 1980 the

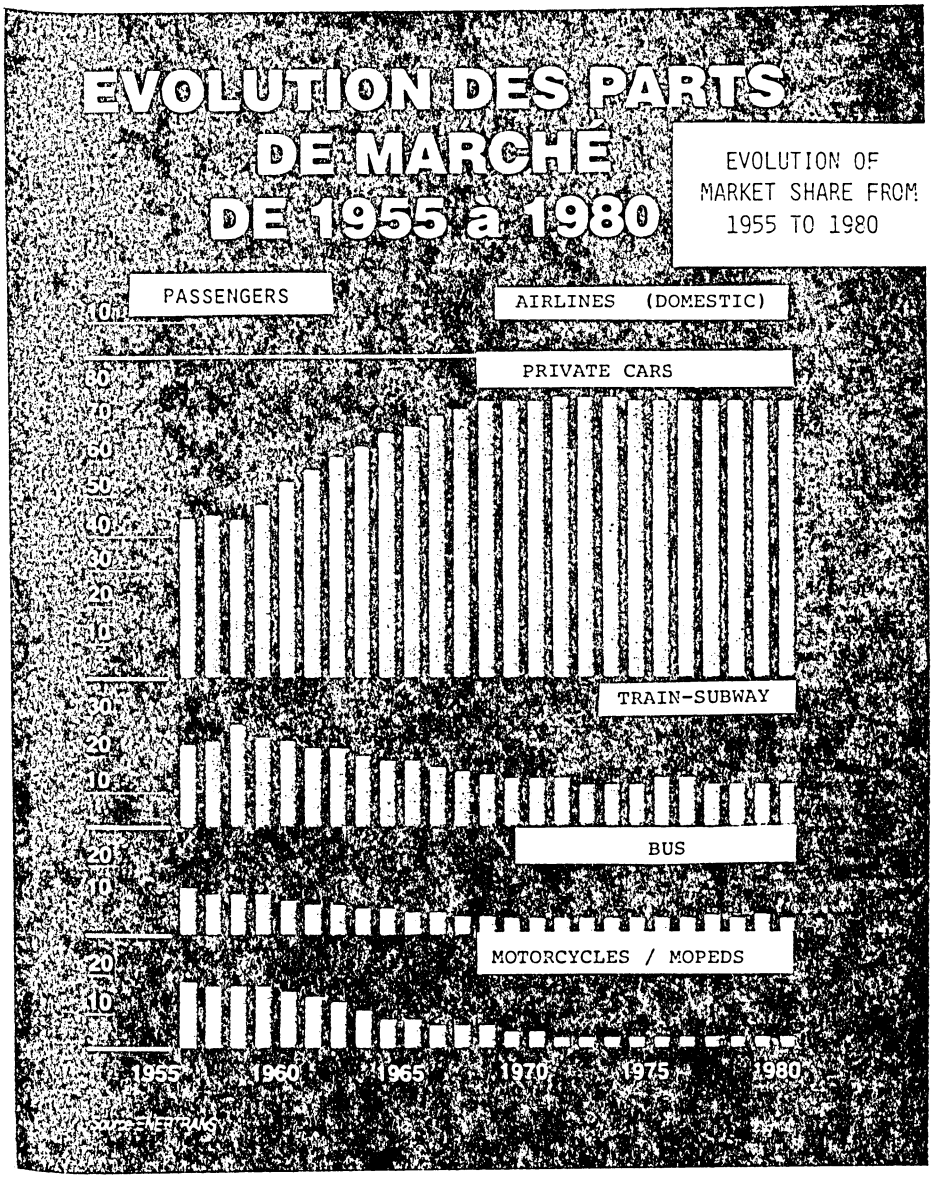


FIGURE 7

"3-litres programme"; the aim of which is to make it possible to market mass-produced vehicles comparable to those of the low-middle-of-the-line vehicles of today (such as the R5 and 104) by the beginning of the 1990s. This programme involves a research effort that is without precedent in its financial scale and in the ambition of its objectives.

It is being carried out by P.S.A. and Renault, which are working on two vehicles baptized "ECO 2000" and "VESTA" respectively. Following the feasibility studies of the first stage, in 1981, these vehicles have already reached the stage of working prototypes, and the first road tests have been highly satisfactory. The research effort covers

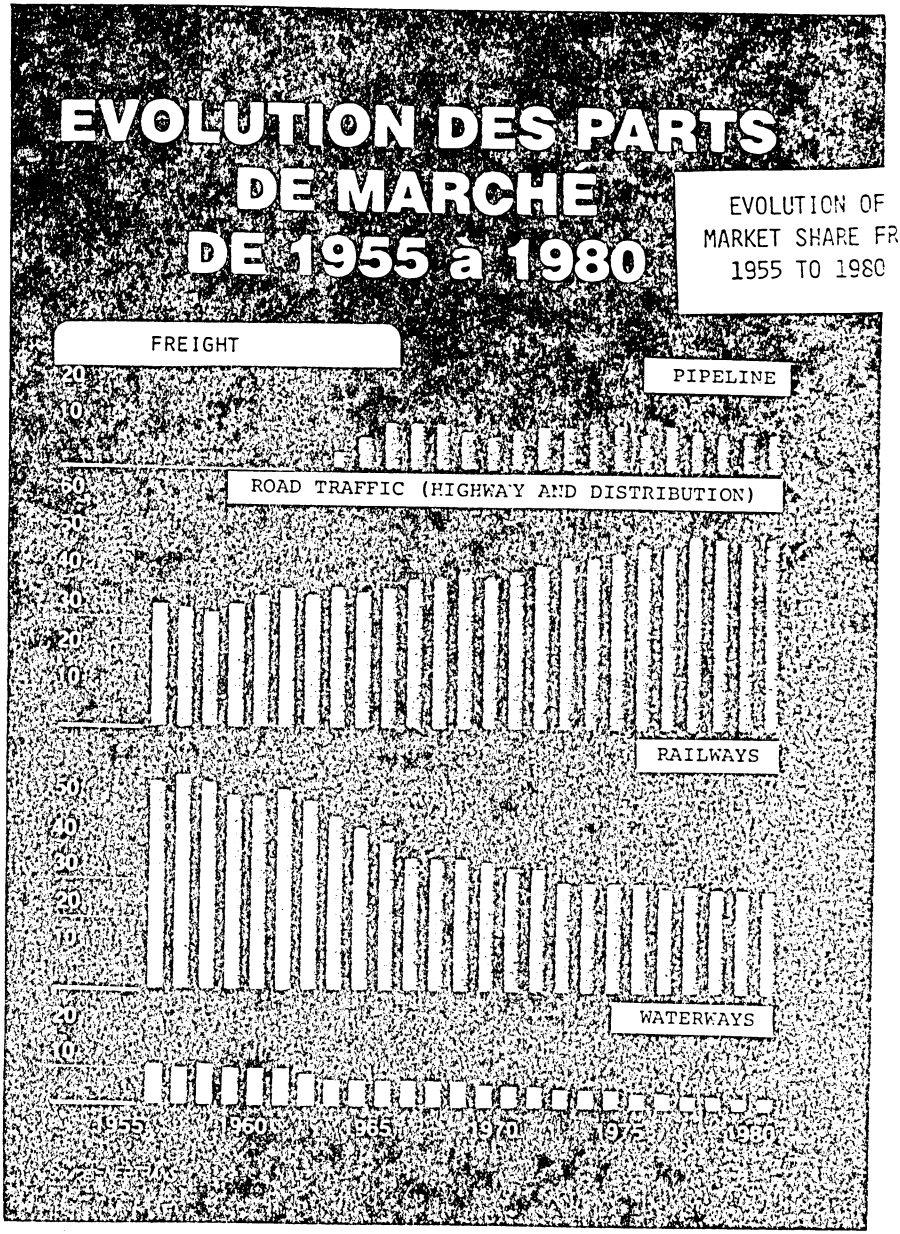


FIGURE 8

everything that might contribute to lower fuel consumption: better streamlining aimed at a drag coefficient close to 0.25; optimization of the structure to lower its weight; lightening of the main units; the use of new transmissions; the reduction of friction in the engines; the application of direct injection to passenger-car diesel engines; the introduction of new materials; and so on; while at the same time constantly striving to find technical approaches suitable for in-

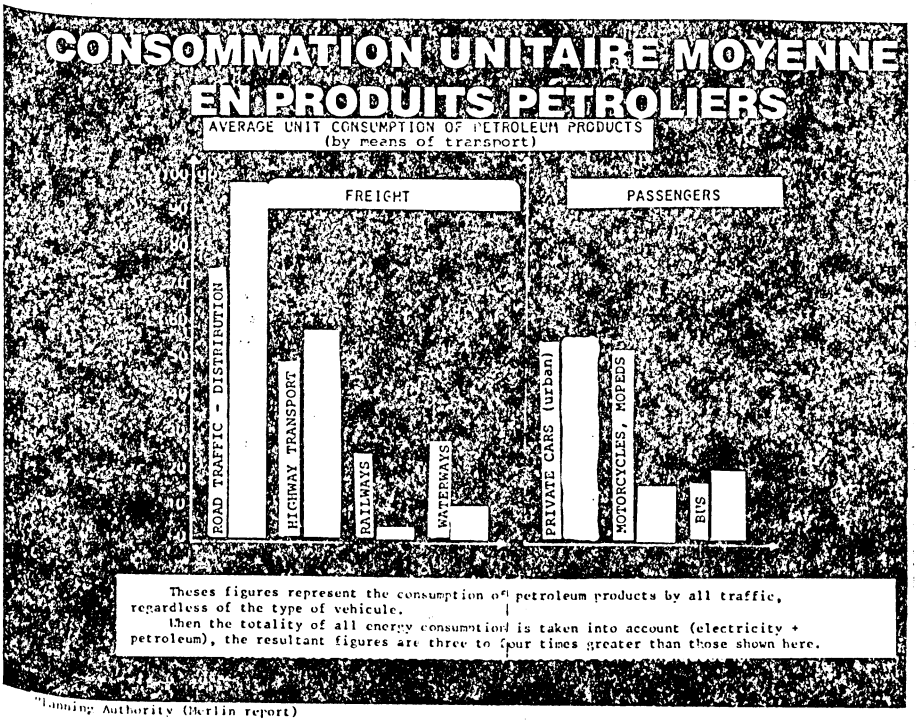


FIGURE 9

dustrial application, i.e., compatible with the constraints imposed by mass production.

Concurrently, companion research programmes have been entrusted to suppliers in the automotive sector, to complete the work of the auto makers through the optimization in terms of energy use of the various components not designed by Renault and P.S.A.

For example, there are research and development programmes aimed at the designing of new alternators and starters that are substantially more efficient, at perfecting lightweight automobile window materials, and at investigating the possibility of installing energy recuperation systems.

The considerable financial burden of this programme, estimated at 600 million francs over five years, is shared equally by the auto makers and government agencies.

In order to conclude this non-exhaustive look at the various approaches now being explored with a view to offering the motorists of tomorrow new products that are more energy-efficient, I would like only mention the other works undertaken in various fields such as studies on the recuperation of kinetic energy, consumption detectors and meters, systems for checking tyre pressures, development of electric vehicles, and so on.

SUPPORT OF DEMAND FOR HIGH-PERFORMANCE PRODUCTS AND SERVICES

The possibility will be thus offered, in the short or medium term, to the economic agents concerned in the area of transport, of obtaining new equipment and accessories, which may have gone through a standardization or approval procedure, if appropriate. But it is not enough. In view of the time that will be required for the complete replacement of the country's fleet of transport equipment, work to rationalize energy use in the transport sector must also deal with the existing equipment.

In the field of automobile, much remains to be done.

The first act, one that determines the consumption level for years to come, is the choice of a car: a vehicle's mileage

must henceforth be one of the buyer's main criteria.

After this, the condition of the some 20 million automobiles in France must be watched. Various surveys have shown that nearly 80% of all cars are being operated with the tuning of the ignition and fuel system quite far from the optimum range recommended by the makers. Now, yearly servicing can reduce a vehicle's fuel consumption by as much as 10%. This figure, applied to the total number of cars in France, gives an idea of how much is at stake: 1.5 MTOE (millions of tons of oil equivalent).

To attain this objective, car repair professionals have set up and are running an organization of several thousand diagnostic and consulting centres where motorists can have the ignition and fuel systems of their cars properly tuned.

Concurrently, economical driving is a factor in fuel economy that can yield savings ranging from 10 to 30%. Here, too, technological progress will in the next few years make it possible to offer motorists new systems and equipment to help them develop proper habits and a suitable driving style. Even so, the work will have to start with an effort to improve motorists' behaviour by making them more sensitive to what is at stake and by offering them campaigns of clear explanations.

Finally, something must also be done to promote the harmonious insertion of the automobile in the overall organization of the transport system. Persuading people not to use their cars when they are not the best way of getting somewhere can undoubtedly make a large contribution to reducing consumption. The use of alternative forms of transport (mass transit, walking, the bicycle), in the context of a rational organization of the transport system, optimized in terms of energy use, can be a major theme of the policy of mastery of energy, especially in towns where most trips are short. Even here, it will still be necessary to mobilize the partners most directly concerned (local officials, mass transit authorities, users' associations, etc.).

In the area of the mastery of consumption related to the automobile, progress is possible and the potential is vast. But exploiting this potential will require the combined efforts of all: motorists, auto makers, suppliers, auto repair specialists, and the authorities. It is henceforth a question of will and of motivation.

In the field of road transport, whether of goods or of passengers, substantial savings by comparison with current practices achieved here and now through the use of a certain number of appropriate means:

—The setting up of an in-house organization to encourage and coordinate measures to save energy;
—The setting up of analytical monitoring of consumption;
—Investment in equipment and accessories to measure and reduce consumption (the replacement of existing equipment by more economical equipment may be included);
—The setting up of methods and human and material resources aimed at improving the level of maintenance of the fleet;
—The organization of training for the personnel (in particular, the training of drivers in economical driving practices);
—The setting up of methods and equipment aimed at optimizing the use made of the transport equipment.

This approach is moreover very general and can also be applied to shipping and inland water transport companies.

IMPROVEMENT OF TRANSPORT ORGANIZATION

Any change in the organization of traffic and in its breakdown among the various means of transport (lightweight vehicles, mass transit, two-wheeled vehicles, walking, etc.) has a large effect on the energy consumption of the transport system.

It is possible to lower the average energy cost per trip in a local transit system by acting:

—on the conditions under which the trips are made, so as to lower the consumptions of each of the means of transport (changes to such parameters as average speed, the regulation of traffic lights, the availability of parking occupancy factors, etc.);
—and on the breakdown of travel among the various means, to divert a share of it towards more economical alternatives (for example, from the car to the bicycle or mass transit).

Let us mention, for example:

—measures to improve the speed and quality of service (special reserved lanes, bus call boxes, traffic control, etc.);
—measures aimed at making mass transit easier to use (parking facilities arranged to encourage use of

mass transit, etc.);
—the introduction of lighter new systems (lightweight metros, paratransits, lightweight rail cars, etc);
—the organization of group movements, for schoolchildren, company personnel, tourism, etc.);
—the organization of mass transit in suburban and low-density areas (research aimed at economical systems);
—the search for new forms of organization of travel between home and work (car and van pools, etc.);
—the use of electric traction (trams, trolleybuses, mixed systems, etc.);
—rationalization of the use of the automobile (parking policy, traffic plans, etc.);
—the promotion of two-wheeled vehicles (making a place for them in urban travel, the study of suitable infrastructure, etc.).

However, a precise determination of the actions and their follow-up so as to assure optimum efficiency presupposes a precise determination of methodological rules.

Any operation launched on a large scale must be implemented in accordance with very strict procedures to assure the possibility of a rigorous analysis of its impact on energy consumption.

In this aim, a good cooperation with the local governments appears absolutely necessary. A good example of what can be obtained in such a cooperation can be provided by the example of the experiment which was realised in a French medium town in order to test the traffic regulation system.

Urban traffic control systems have a significant impact on fuel consumption: traffic lights control to some extent the time spent in traffic, together with the number and duration of stoppages. The system that is currently the most widely used is the "green wave strategy with local microcontrol." The aim is to stagger changes of aspect along major itineraries to maintain an uninterrupted flow and, at the same time, to match the durations of the green and red phases to the needs of the traffic. An experiment has made it possible to calculate the energy impact of this control system. The city chosen was Caen, which has a sophisticated control system. The experiment covered the energy performance of ten vehicles over ten thousand kilometers in various traffic control situations. By comparison with normal operation, the suppression of the microcontrol caused only a slight decline in energy efficiency: from 1 to 3%, depending on the site. On the other hand, suppression of the green-wave coordination resulted in added consumption by the vehicles ranging from 4 to 25%, depending on whether the site was a highway, a service road, a bypass, or the centre of town.

The Caen experiment demonstrates the advantages in energy terms of traffic control during peak hours, when it favours mass transit, and during off-peak hours, when it increases the energy efficiency of motorized travel; altogether, it yields a saving of 2,000 tons oil equivalent per year.

TRAINING, INFORMATION, AND AWARENESS

In the course of the preceding paragraphs, the various actors concerned by the implementation of a policy for the mastery of energy in the various transport sectors have been mentioned.

The principal among these actors are: motorists, transport companies and firms owning captive fleets, service companies (garages, repair shops, and parts distributors), makers and equipment suppliers, and local governments.

It is clear that the set of actions planned with these partners in mind, described above, must be completed by the necessary additional training programmes, by the dissemination of the appropriate technical and economic information, and by measures to heighten awareness of energy-related questions.

a) In the area of training:
—checking that the supply of training offered on the market is adequate in both quantity and quality and, if necessary, encouraging the setting up of new training programmes;
—encouraging the attendance of training sessions by all components of the transport sector heads of companies, supervisory (heads of companies, supervisory personnel, operating personnel, transport managers of private firms or local governments, individual carriers, etc.).

b) In the area of information:
—the preparation and dissemination of training aids (books, pamphlets, films, audiovisual presentations) to deliver to the various targets the technical and economic information they need;
—holding discussions, seminars and conferences to take stock of the state of knowledge from time to time.

c) In the area of public awareness:
—preparing messages aimed at heightening the awareness of the

various publics concerned and disseminating them through the most effective channels;

—participating in local public awareness campaigns.

SUMMARY AND CONCLUSIONS

The oil crisis of 1973 brought about considerable changes in the methods of using energy in the country's various sectors of activity.

In the transport sector as in other sectors, but to a lesser degree, substantial fuel savings have been accomplished both through technological improvements in individual behaviour.

But the slow pace of these developments, aggravated by the persistence of certain social phenomena that have appeared in recent years, such as the growing demand for mobility on the part of households and the expansion of communications, are leading to a highly unbalanced energy supply and demand situation in the transport sector.

Moreover, the background of economic crisis, the heterogeneity of this sector, and the specific characteristics of its various components mean that free-market mechanisms alone cannot respond in time to the stated need to reduce energy consumption. Planning and incentives are therefore required.

It is in this context that it was decided in France to set up an agency to coordinate energy saving policy: the Agence Française pour la Maîtrise de l'Energie. (French Agency for Energy Mastery).

In the transport sector, its mission is to make possible the attainment of an energy-saving objective of 1 millions tons oil equivalent per year.

For this goal to be reached, the work done up to now must be continued and considerably extended along the lines of action to be explained in the course of this paper and based on the observation that a real control of energy consumption in the transport sector results from the conjunction of two phenomena:

On the one hand, the improvement of energy performances for each mode of transport, that is a decrease in specific consumption, and on the other hand, the improvement in the organization of transport systems with a view towards obtaining optimum conditions on the energy level in each transport mode. Considerable evolution has already taken place in both these fields. However, a major amplification of this effort is required in order to reach the indicated aim.