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CHOICE OF A SOLUTION FOR FEEDING C.P.C.U. NETWORK

A. Triboulet, *Technical Director*
Compagnie Parisienne de Chauffage Urbain (C.P.C.U.) Paris, France

INTRODUCTION

Through two hundred kilometers of steam pipes (1/6 of the total length of Paris streets), from eight plants of its own and from three other plants where is burnt garbage, C.P.C.U. (COMPAGNIE PARISIENNE DE CHAUFFAGE URBAIN) ensures the supply of steam to 3 400 buildings in Paris (out of nearly 20 000), and delivers 20 % of the heat consumption of central heated buildings (more than 40 % of buildings are not equipped of central heating).

Fifty years old, C.P.C.U. became the first district heating firm in Werstern Europe - and the second one in non socialist-world, after New-York-.

During the last twenty years, 140 Km of network were built ; yearly sales of heat grew up from one to eight.

During the last fifteen years, the total thermal power of the generators grew up, too, from 1 780 000 pounds/hour of steam (600 MW) to 6 500 Mlb/h (2 180 MW) :

- C.P.C.U. built 17 units (that is 5 000 Mlb/h altogether), one of which is coalburnt, while both of the other ones burn oil (less than 1 % sulphur oil)

- among its external suppliers :

  - Electricité de France, which sold C.P.C.U. 5 000 hours a year, 500 Mlb/h back pressure steam, from its old coalburnt power plant of Ivry, stopped its plant in 1974.

  - the total thermal power of the three " TIRU " refuse-burning plants reached 630 000 pounds/h.

In 1977, out of a heat production of 14 000 MMlb of steam, " TIRU " supplied 30 % ; and which is more significant in the point of view of energy-sparing , out of a theoretical peak-load of 5 200 Mlb/h, the part issued from combined production of electricity and steam (in TIRU plants) was of less than 500 Mlb/h (less than 10 % of the peak load).

Before 1973, C.P.C.U. intended to face the growth of heat demand (nearly 10 %/ year) with a program of development according which nine oil burnt kessels (of a total heat power of 2 800 Mlb/h) would have been progressively erected in the buildings or on the grounds of its eight plants - which would thus have been saturated in 6 or 7 years -.

Rather a new deal, since 1974 :

- Due to the raise of prices, reduction of 17 % of the specifical consumption of the customers ;

- Due to several causes, deceleration of the rate of expansion of the heat demand (from 10 % a year to 4,5 - 5 %).

So that the actual heat power will remain large enough to face heat demand until 1981-1982 winter. Heat peak load is reckoned to reach but 8 000 Mlb/h of steam in 1987- which induces the need of five standard 330 Mlb/h units, from 1981 to 1987.

- Oil became most costly - and is supposed to become more and more ; and less abundant, too - : whence the necessity of a new reflexion about the diversification of fuels.

Such are the bases of the new program that C.P.C.U. sent to French Ministery of Industry (" Délégation Générale à l'Energie "), on january 23 , 1978.

THE FIRST STEP OF THE STUDY : A THEORETICAL COMPARISON

In a first step, it was supposed C.P.C.U. had to choose among all the technical possible solutions, for a theoretical heat power of nearly 1 340 Mlb/h (400 MW). Why that power ? Because :

1°) it is the power of several C.P.C.U. plants, that is a correct size for a new one ;

2°) if generated by combined electric and thermal production, this power, with that of TIRU plants, would reach 30 % of the previous peak load of 1981-1982, that is a percentage convenient with a large annual utilization - so, then, that with a good admortizing -.

Costs of fuels were supposed to keep their present values all along the admortizing duration (20 years for nuclear solution and for gas-turbines ; 30 years for conventional boilers).

A calculated interest rate of 10 % was assumed.

All solutions referred to that one consisting into the installation of four standard oil burnt units, in existing plants.

So, the studies about five solutions were carried out :

1°) A nuclear plant :

The plant would have been equipped with a single purpose boiling water reactor with a thermal power of 500 MW, located in the zone of French " Centre d'Etudes Nucléaires " of SACLAY, within 20 kilometers from C.P.C.U.'s network.

The total additional investment cost was :

- 650 millions francs (130 millions $), for the reactor ;
- 250 millions francs (50 millions $), for the pipe and tunnel.

Oil burnt low pressure generators had to be built any wise, as spare units.

In spite of the light fuel cost of the nuclear plant, and of the large annual utilisation (6 000 hours), the actualized final result of the operation was a heavy loss, heavier than the cost of the whole transportation pipe - too much heavy for the operation to be saved by the consideration of the economy of fossil fuel : 230 000 tons a year -.

However, should all the fuel costs increase at a 2,4 % per year rate, the financial result would have been neither win nor loss.

Due to the well-known constraints about nuclear operations, this one was not attractive enough to be better than postponed. May be it will be born a new time in some years -.

2°) Cogeneration out of three oil burnt high pressure generators, with a back-pressure 60 MW turbine

Less promising than coal burning in the view point of diversification of fuels, this solution looked like generating no more actualized benefit than conventional low pressure boilers.

The annual primary energy saving (58 000 tons of oil) was not a strong enough incentive for this purpose to be registered into the some best ones.

It has to be pointed out that lay out problems eliminated the possibility of locating those high pressure generators but in a new suburban plant : 7 kilometers long only, the pipe from this plant to the network would have been worth, by itself, nearly 1/3 of the whole investment amount. The same thing, besides, for all of next solutions.

3°) Three coal burnt low pressure generators :

Almost as expensive as the precedent one, as to investments costs, generating no primary energy saving at all, this solution seemed to induce just the same actualized benefit as the reference solution, if the cost of coal was supposed as low as possible (that is 0,03 F/thermie, or nearly 42 $/ton, franco plant - cost to be compared with 0,045 F/thermie, or 63 $/ton franco plant, for low sulphur grade oil).

At this step, this purpose had to be repelled, but it has to be pointed out here that this conclusion was discussed at the second step.

4°) Three coal fired high pressure generators, with a 60 MW back-pressure turbine

Here appeared together three significant incentives :

- a lot of primary energy spared (45 000 tons of oil-equivalent- per year) ;
- the use of another fuel as oil ;
- a good financial result - but only with cheap coal, as laid out above.

5°) Gas-turbines

The project dealt with the installation of three 85 MW gas-turbines, equipped with heat exchangers used as recuperation generators of 400 Mlb/h of steam for each one. The same machines as for BERLIN (BEWAG) district heating net, except two differences : the use of natural gas, and not special oil ; and the assumption of the base load, with 5 000 hours annual utilization, which is not the case in BERLIN system.

Envisioning shortages of natural gas resources, Gaz de France denies gas supplying contracts with industrial users, but for their acceptance of the delivery of gas to be interrupted, at any moment, for any duration : Just like in the nuclear solution, oil fired low pressure generators had to be built, as spare units.

The economical result of this purpose was nevertheless the best of all.

THE SECOND STEP OF THE STUDY : A REALISTIC PROGRAM

It was then decided, in a second step, to carry out a realistic development program, no longer about a theoretical 1 300 Mlb/h plant like above, but based upon the matter of fact needs of the network, layout possibilities of existing plants, and financial resources of C.P.C.U.

- The first feature (needs of the network) lead to look after an operating site in the northern part of Paris : most of the steam output is generated in the southern part of the city ;

- Therefore, the choice of the first site to be equipped became rather easy : C.P.C.U. owns but one plant located in northern suburb, at SAINT-OUEN, with free place enough either for a gas turbine or for two coalburnt boilers. And this plant is especially favourable - in the viewpoint of noise, for instance - since laid out in an industrial zone : between a big EdF plant (two 250 MW groups, one of which is gas-fired) and one of the three TIRU garbage-burning plants.

- The third feature - financial resources - involved, too, a clear conclusion : the projects can be classed into either one or the other,out of two categories :

  . those that C.P.C.U. can assume

  . those that it cannot assume ...

  In the first class, just one project, that of coal-burnt low pressure boilers. It was accurately reckoned C.P.C.U. would be able to pay for all the investments and various costs, without overgoing a (tolerable) 66 % debt ratio.

The rentability rate of the first boiler would be nearly 20 % ; that of the second one would be still better (a quite different conclusion from that of the first step, inwhich this solution was handicapped by the choice of hypotheses - and for instance by the cost of the pipe -).

Without any external help, it is the direction C.P.C.U. will aim at, with, at it was said, the double consequence of :

- diversification of energy sources ;

- but not energy sparing at all.

And in the second class lies just one project too : it appeared the rentability of dual-purpose coal-burnt high pressure boilers was in fact rather poor ; it was not obvious at the first step because, here too, of the choice of hypotheses : it is self evident the economical results are quite different if you build three boilers together, with a 60 MW turbine, instead of building one after the other those boilers (or two of them only), each one with its little - and therefore expensive - 20 MW turbine-.

That is why there was no other alternative to low pressure coal burnt boilers as gas turbines.

Advantages of this alternative would be, as was said :

- diversification of energy sources (natural gas instead of oil) ;

- large energy spared, due to cogeneration (and delivery of electricity in the heart of a high consumption zone, which has not to be neglected) ;

- high rentability rate - more than 20 % -.

In front of this , two difficulties :

- Gaz de France, having limited resources, prefers to sell gas directly to heat dwellings, rather than selling it to industrials - and, so much the worse, to an industrial which is its competitor on the market of heat ... It is obvious this position cannot be changed but for decisions and actions of Administration.

- The total investment cost for turbine, boiler and pipe - approximately 140 millions francs, id. e. 28 millions $ - goes much further than what the financial surface of C.P.C.U. would authorize . Whence the need of a new society for building and operating the gas turbine plant - and the need of a strong help from Administration for this society to be borne.

All that was written hereabove, under the subtitle of the " second step ", only related about what was to be built in the site of SAINT-OUEN.

When this site will be saturated - with one gas turbine, or two coal fired boilers, that is in 1981 or 1983, the choice will remain easy : other coal burnt boilers or other gas turbines will not be able to be installed elsewhere than on the ground of an obsolete EdF plant, in south eastern suburb, at Ivry - close to a C.P.C.U. three oil burnt boilers plant. In this site, it will be possible to lay out from one to three units, so that the development program of C.P.C.U. is organized as follows :

- with no external help :

  . two coal fired boilers at St-Ouen, in 1981 an 1983

. then two other ones at Ivry, in 1984 an 1986

. and a third one at Ivry, or - according to the cost of fuels towards 1985 - an oil fired low pressure boiler in an existing plant.

- with external help :

. one gas turbine à Saint-Ouen in 1981 (and a reserve oil fired boiler in an existing plant, the same year)

. then two or three other ones at Ivry, in 1983, 1984 and 1986 (always with their spare units in existing plants).

. and, if the base load is enough largely taken by those machines, a standard oil fired boiler to achieve the program, in 1987.

- other solution, with external help :

. two coal fired boilers at St-Ouen in 1981 an 1983 (assumed by C.P.C.U.)

. then gas turbines at Ivry

or (if gas resource is really shorty) :

. one gas turbine at St-Ouen

. then coal burnt boilers at Ivry.

Such was the content of the proposals C.P.C.U. assessed to Administration in January.

As those lines are written, Administration asked for a complementary study - which is being carried out - about a gas or oil fired turbine, whose advantage would be to avoid the investment of spare units, since, if the source of gas was cut off, the machine could remain operated oil burning.

It will be interesting to see weither, finally, the governmental decision will be turned towards coal burning without energy spared, or towards gas (and oil ?) burning, with energy spared ; or, maybe, towards both of these solutions ...

And it will be interesting not only for C.P.C.U., but in the viewpoint of the future of district heating in France ...