A system of surveys in order to know the energy demand of the french commercial sector.

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1. SYNOPSIS :

This paper presents the system of statistical surveys set up in France in the tertiary sector, and their use in developing policies directed toward the improvment of energy efficiency.

2. ABSTRACT :

In order to define an energy policy aimed at energy efficiency and to evaluate its outcome, it is necessary to know exactly and in a detailed way energy consumptions in relation to the main factors explaining energy consumption levels and their evolution over time.

This knowledge can only be ensured validly through a system of permanent statistical surveys of energy users. This paper describes the work that has been carried out by CEREN on the commercial sector in France.

This sector as well as the transport sector are the most dynamic in terms of energy demand. Understanding these dynamics contributes to a better orientation of the energy policy. This understanding begins by the direct gathering of pieces of information and by gradually building up relevant structural characteristics :

- Breakdown total commercial sector use into relatively homogenous sub-branches.
- Breakdown sub-branch energy by end use.
- Breakdown annual energy demand changes into :
  - demand growth resulting from the sector's increase in output,
  - demand changes resulting from technical improvements reflecting the effects of energy efficiency changes.
- Unit consumption and standard deviation to evaluate the results of energy saving actions.

3. INTRODUCTION :

3.1. General :

A knowledge of energy use which is both precise (quantified) and detailed, in relation to the main explanatory variable, is needed both in order to develop and implement an effective energy policy and to monitor its consequences.

Such knowledge can only be obtained through a system of systematic statistical surveys conducted on energy users.

Such surveys are performed in France for all sectors (Residential, Tertiary and Industrial) by CEREN, in coordination with government surveys and with the support of Ademe.

In this paper, we present an overview of this work for the commercial (Tertiary) sector, including a discussion of objectives, methods and some principal results.

3.2. Importance, diversety and dynamism of the tertiary sector in France.

In 1992, there were 660 million square meters of heated floor space in tertiary sector, following an annual growth rate of 1,9% over the six previous years (1986-1992). The Tertiary sector accounted for 27% of the heated area in the combined Residential and Tertiary sectors and for 32% of their all energy consumption. This energy use amounts (1)

to 11% of France's total energy consumption as compared to 24% for the Residential, 33% for the Transportation and 28% for the Industrial and Agricultural sectors.

In addition to its importance in over all energy use, this sector as well as the transportation sector exibits the most dynamic energy demand and heterogeneity, due to the diversity of the associated activities (branches and sub-branches) such as Education, Health, Offices, Trade (2)... An understanding of energy use in this sector is therefore helpfull in developing better energy efficiency policies and programmes. Such an understanding depends on data collection and on data base structure achieved within the framework of the system of annual surveys in the field of energy.

3.3. Objective of the survey system

Through the performance of annual surveys, the goal is to:

- develop detailed data on annual energy end use and by plants in the Tertiary sector according to branches (3), types of energy, and precise end uses ;

- set up and update a data base, allowing the conduct of specific analytic studies on components of energy demand in the Tertiary sector:

  a) Knowledge of potential markets and evolution of market shares:
  - according to type of energy,
  - according to end use,
  - according to type of consumer.

  b) Analysis of the range of observed end-use estimates for the purpose of:
  - understanding the explanatory factors (i.e. : age of materials, insulation of buildings...),
  - estimating the energy savings potential,
  - measuring the evolution of this potential.

  c) Forecasting of energy use, taking into account different assumptions regarding the structural development of certain tertiary-sector activities, technologies, and behavioral changes.

4. METHODS

4.1. A structured system of surveys

The following describes the systematic survey approach used by CEREN to collect energy end use data.

- Performance of annual surveys according to a twofold approach:

  - A panel of energy consumers is monitored during two consecutive years (the sample is revised yearly) in all branches, to estimate the evolution of heated surface areas and of consumption according to energy type (sample size : 3 to 4 000 energy consumers).

  - Detailed survey of one branch, using a broad sample :
    --> provides estimate of energy use regarding a branch for the year considered (or a reappraisal of the preceding years).
    --> knowledge: equipment (heating pumps, central boilers...).
    (sample size : 2 to 4 000 energy consumers according to the branch surveyed).

  This twofold approach aims at ensuring a regular 5 year update for each branch, and allows for improvements in the quality of the results (i.e. : representativeness and adjustment in view of an reappraisal of consumption and its characteristics.

- Survey of new buildings :

  --> estimating the heated surface areas and comparison to authorized surface areas,
  --> forms of energy provided,
  to be added to the Existing Tertiary Appraisal.

- Annual "flow" survey on premicies :

Since 1990, a survey designed to develop detailed knowledge on the annual variations of the premicies (by fuel type) has been conducted. The results of this survey are integrated into the general scheme, and are used to help explain the annual changes in energy used on the premicies.

4.2. LAUNCHING SURVEYS AND EXTRAPOLATING RESULTS :

Energy users are selected for survey participation from the various operational and available files of energy consumers on the basis of a random stratified draw (according to the size and activity code specified).

The list of files used include :
- SIRET file (from "Institut National de la Statistique et des Etudes Economiques" : nationwide index of all energy consumers engaged in some form of economic activity)
- File of large energy consumers employing more than 100 people (F.G.E. at INSEE)
- Ministry of Health file (FINESS : computerized file of health and welfare institutions managed by the Ministry of Health) : updated quarterly
- Ministry of Education file: updated yearly
- Other files: from several specialized organisations and firms.

4.3. PROCESSING OF DATA COLLECTED :

In order to understand the important determinants of energy consumption and monitor annual changes, unit energy consumption must be estimated according to end uses. A model linking heating consumption to weather allows changes to be made to energy use corrected for changes in outside temperature..

4.3.1. Estimating energy end-use :

Since annual energy use surveys are performed by mail, the questions must be brief, clear and easy to answer. Also it is unreasonable to ask for a breakdown of energy consumption according to uses and forms of energy; most consumers are unable to answer.

Questions are formulated to determine the amount of energy consumed according to form of energy, as well as the end use (or the uses) of each form of energy.

The unit consumption approach which we have chosen, has borrowed methods of typological estimation from statistics ; since such methods are more suitable for large samples.

The following passage briefly describes and comments on the method adopted.

- Estimating unit consumption per use and per branch :

  Whatever the branch, the basic estimation method consists of applying multiple regressions to the data provided by the survey files. To avoid excess segmenting of populations and to obtain more reliable results, we did not distinguish between fuels. Fuel and electricity were treated separately.

  Results of this methodology:
  The national sample survey provided unit consumption (adjusted to the total surface area heated) per branch and per use.

- Introduction of unit consumptions for each region in France and balancing of consumptions to obtain whole observed consumptions for each form of energy :

  Each energy consumer will be assigned, based on reported statements from the survey on energy use, unit consumption, per use which, applied to the forms of energy used and to its heated surface area, determine a theoretical level of energy consumption.
  All this information is summed region by region, taking into account the weight of each observation through its coefficient of extrapolation and its surface area. This task is repeated branch by branch.

  Once this has been done, aggregate consumption must be balanced -- that is, for a given branch, region and form of energy. The consumptions defined for the four uses (heating, hot water, cooking and others) are summed and the total must balance with the recorded total energy use of the branch in each of the regions.

Some reflections on the method used:

The method used is limited by the type of information collected. However, the differences noted between unit consumptions introduced and unit consumptions finally obtained remain approximatively the same for the large branches, and thus consolidate the method used up to a certain point.

In any case, refocusing on the region rather than energy consumer by energy consumer has leveled out the size of the adjustments, by maintaining the explanatory weight of each observation within the region. The choice was made to maintain regional based consumption weights in order to minimize the effects of balancing behaviourial differences between individuals.

4.3.2. Adjustments of climate impact :

- General presentation:

This methodology relies on what is presumed to be a reliable knowledge of the buildings energy use, and of the correlation between this use and degree-days of heating.

Degree-days are calculated by branches for 126 weather observations points distributed throughout the territory of France, and on a specific basis for each branch, taking into account both the buildings use (days and times when they are open) and the different levels of comfort (the basis for the calculation of degree-days varies between 15 and 22 degrees Celsius).

- Average degree-days per branch;

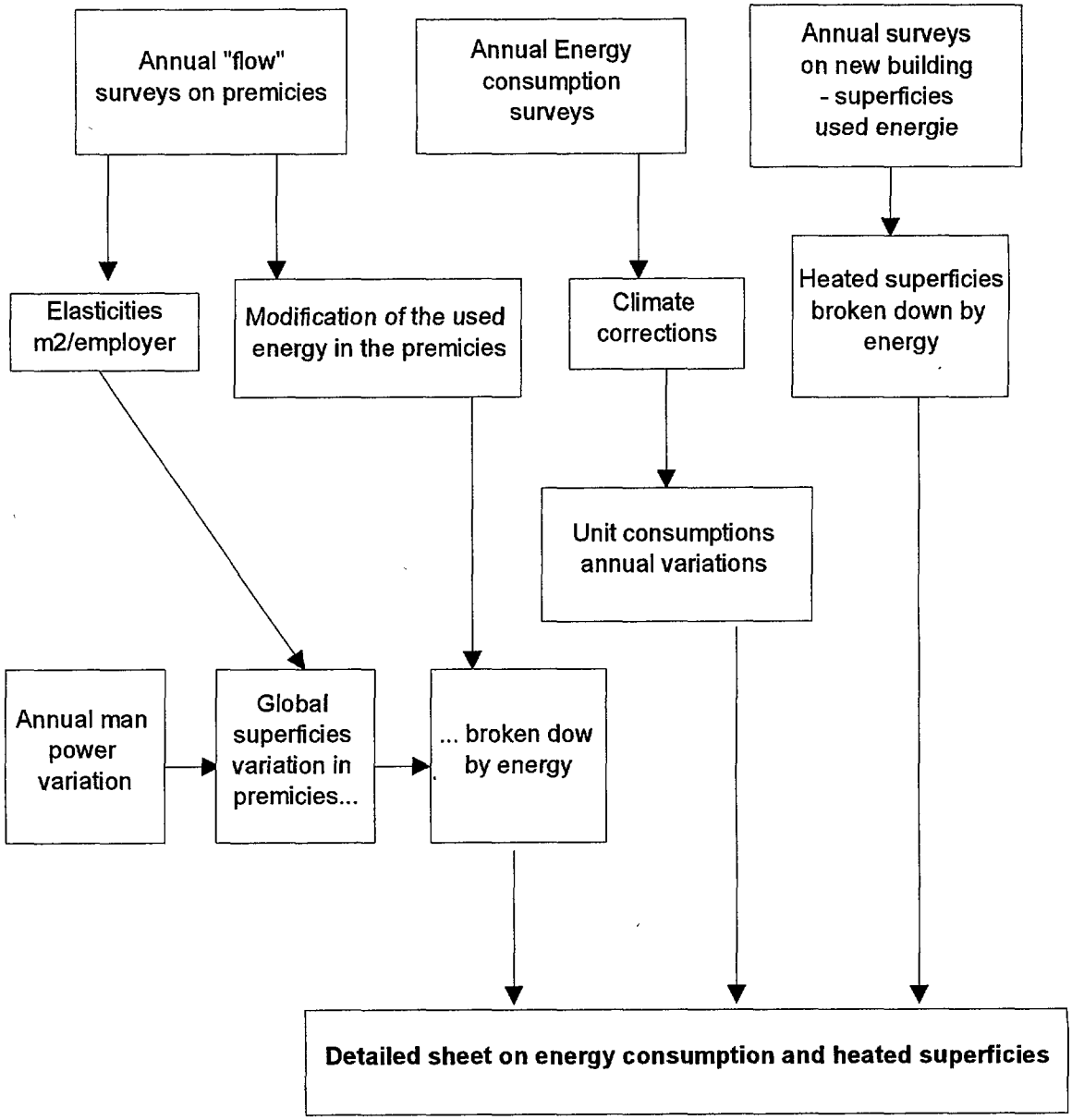
For each branch, average degree-days for all of France are determined by weighting the degree-days provided by the observatories against the corresponding tertiary sector populations as given by our files.

Results obtained : Evolution of climatic harshness coefficients (base 100 = thirty-year average, 1960-1990).

BRANCHES	Normal	1986	1987	1988	1989	1990	1991	1992
Cafes, hotels, restaurants	100	104,2	105,8	85,8	85,5	84,7	104,1	96,0
Community housing	100	102,7	108,9	89,4	98,6	86,1	103,0	94,5
Health, welfare	100	101,8	102,9	93,1	90,8	90,5	100,9	96,9
Education, research	100	94,0	94,0	74,6	73,5	85,3	104,7	95,4
Sports, leisure, culture...	100	103,7	107,4	85,5	85,5	84,4	103,7	97,5
Offices, administration	100	103,7	107,0	85,9	85,7	84,8	104,0	96,2
Trade	100	104,3	106,3	85,9	85,6	84,7	104,1	96,1
Transportation	100	103,5	106,8	86,0	101,3	84,5	103,8	95,8
Tertiary sector as a whole	100	102,3	104,5	86,4	86,2	86,1	103,4	96,2

4.4. INTERCONNECTION OF FILES :

In order to provide an annual estimation of heated surface space and consumption of energy in the Tertiary sector, we have developed a methodology adapted to the objectives of the study and which takes into account all the data available to us. Thus a connection has been established between the results of the annual consumption surveys and other external data (see the diagram below presenting the interconnection of our surveys)



- Annual progression of all floor space heated of one sub-branch is obtained by using annual progression of man power (source : public statistics form INSEE and UNEDIC) corrected with a coeficient representing the changes of squere meters occupied by on employee. This information is based on our annual surveys.
- The evolution of consumption in the establishments are calculated on the basis of a sample which remains constant throughout the two successive years (the sample responding in 1991 and 1992 for the last operation). The evolution of premicies is derived from the "Flow" survey and new buildings are integrated with specific unit consumptions.

5. RESULTS

The statistical system described makes it possible to draw up detailed annual appraisal of energy use in the tertiary sector and to perform descriptive or explanatory studies of past energy consumption, and in particular to evaluate the potential for future energy savings. The following illustrates this type of assessment for the Health sub-sector.

5.1. ASSESSMENT AND FOLLOW UP OF ENERGY USE IN THE TERTIARY SECTOR :

This assessment includes:

- energy use breakdown according to sub-sector branches,
- energy use breakdown according to specific end uses,
- a breakdown of the sources of energy demand growth:
  - "areas" effects, which represent the general evolution of the sector,
  - "unit consumption" effects (efficiency), which give a better picture of the effects of the steps taken in order to improve energy efficiency,
  - "new building" effect.
- unit consumption ratios.

5.2. AN EVALUATION OF POTENTIAL ENERGY SAVINGS IN THE HEALTH SECTOR IN 1992 :

5.2.1. Objective :

Ademe asked CEREN to design and conduct a study of energy consumption in the Health and Welfare sector, in connection with variables regarding :

- the type of activity (i.e. : hospital, dispensary, day-care center...) ;
- the features of the building (i.e. : age, degree of insulation...) and the type of heating (i.e. : type of energy, make and model of boilers...) ;

The purpose of this study was, to identify the variables whose influence upon the degree of heating consumption appeared to be most important and to measure this influence so as to estimate the potential energy savings which would be possible, once the necessary investments had been carried out.

5.2.2. Scope of the study :

The scope covered is limited to health and welfare institutions ; retirement homes are excluded. The file used is the FINESS file (computerized file of health and welfare institutions) managed by the Ministry of Health.

5.2.3. Estimation of an energy savings potential :

- Definition :

"Energy savings potential" is defined as the energy savings which would be achieved if all the institutions concerned made investments so as to bring their "modifiable" variables up to optimal standards, e.g. high-performance or condensation boilers less than 10 years old, good insulation.

The premicies will be considered having good insulation if among the three conditions (insulation of the roof, of the walls or of the ground), two types are observed with insulation concerning more than eighty per cent of all the area and which have more than 4 cm of thickness.

We call the establishments which, for example, fulfill the three conditions mentioned "high-performance establishments", while other institutions are called "institutions which could perform better" (see whole distribution on p. 2).

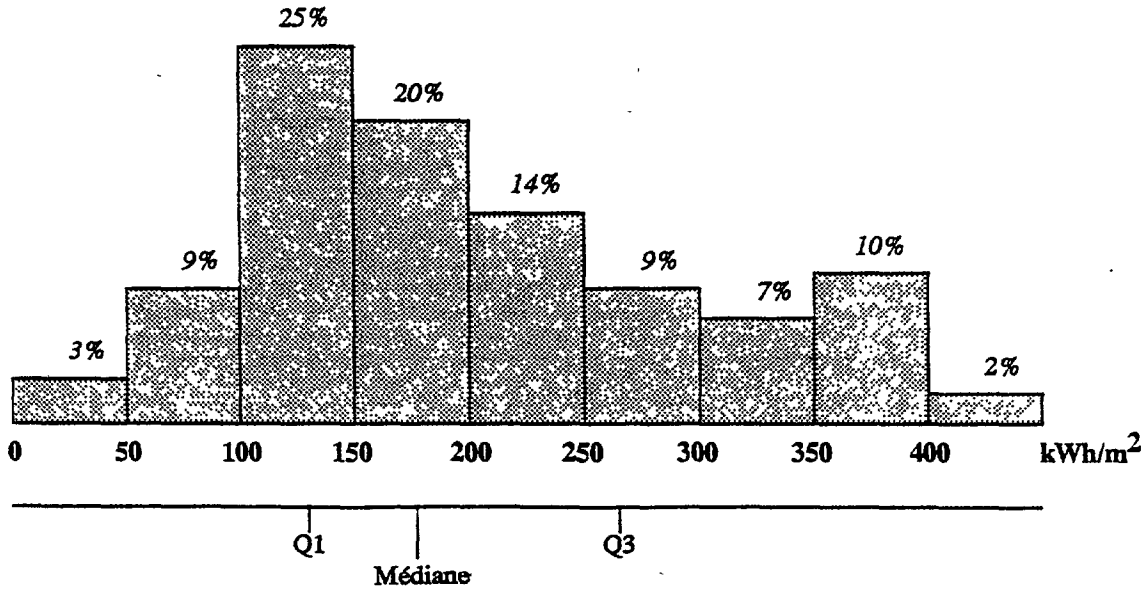
- Distribution according to unit consumption :

We shall assume that in any large enough group of observations the unit consumption for heating will follow a normal distribution (Gauss' law) whose features (mean and standard deviation) depend on the characteristics of the particular group of institutions.

This hypothesis has been validated by the fact that, for all the groups of observations whose consumption-histogram which have been analysed, the Kolmogorov-Smirnof test has been used to show that the sample studied could derive from a population whose unit consumption followed a normal distribution with, the mean and standard deviation of that distribution being the mean and standard deviation noted in the sample.

Consumption in kWh/m2 under actual climate conditions of 1992
Health and Social action
- Heating + hot water -
Sub-sector : General

Average	201	Q1	131
Interval of confidence	+ 5	Medium	178
Concentration index	0.28	Q3	264



If all those establishments were to carry out the investments necessary in order to become high-performance institutions, their unit consumptions would follow a normal distribution whose mean and standard deviation are those noted in our sample of "high-performance".

- Brief presentation of the method :

The calculation consisted of comparing for each observation which could perform better, the unit consumption following investments in relation to its initial unit consumption, and in such a way that the unit consumptions following investments, taken together, show the normal distribution of "high-performance institutions".

This method attempts to take into account the behavioral variable (or other parameters unknown to us) which may have a non-negligible effect on the level of unit consumption. We therefore presuppose that the reduction in consumption will not affect all institutions in the same way.

- Results :

The technical (and economical) energy savings potential obtained using this method amounts to 2 300 GWh, that is, 198 ktoe, which is equal to nearly 14 % of the heating consumption of the sector.

- Limits of the study :

The scatter of unit energy consumption noted for categories which in principle are homogeneous tends to show that behavior (or other unknown factors) play a major role. However, the method proposed for evaluating the energy savings potential implicitly takes this into account, since the reduction in unit consumption which results from the proposed model does not affect all the establishments in the same way. This analyse may be completed by financial evaluation on the cost of these improvements.

6. ENDNOTES

1. Consumption calculated by using consumption equivalents in order to evaluate electrical consumption, that is, 1 kWh = 0.86 x 10-4 toe.

2. The term "commerces" covers both the retail trade and wholesaling.

3. According to a previously established classification of activities specifying the content of the branches and sub-branches.

7. REFERENCES

The text of this communication was drawn up from the following CEREN reports :

- Consommation d'énergie du secteur Tertiaire en 1986 par région de programme (Energy consumption in the Tertiary sector in 1986 according to program regions)
  (A study performed for EDF, GDF and Ademe - published in March 1988).

- Secteur Tertiaire - Suivi du parc et des consommations d'énergie : évolution de 1986 à 1992 (The Tertiary sector - Monitoring the premicies and energy consumption : the evolution from 1986 to 1992
  (A study performed for EDF, GDF, Ademe and Observatoire de l'Energie - published in November 1992).

- Gisement d'économie d'énergie (Energy savings potential)
  (A study performed for Ademe - published in January 1995).

8. CEREN'S PRESENTATION

A complete information system about energy.

CEREN was formed in 1958 as a joint venture (G.I.E.), in order to collect and analyse information about national and regional energy market evolution.

On energy supply in France, CEREN obtains high quality statistical data from its founding members, energy producers and/or distributors :
- Charbonnages de France (CdF, France's national coal company),
- Electricité de France (EDF, France's national electric utility),
- Gaz de France (GDF, France's national gas utility),
- Agence De l'Environnement et de la Maîtrise de l'Energie (Ademe, french energy and environmental management agency).

CEREN's energy demand information system is built with statistical surveys and end-use models in the Industrial, Residential and Commercial sectors. The highly efficient survey system is supplemanted by CEREN's partnership with the France's National Statistics Institute (INSEE) and the Housing Ministry. INSEE and the Energy Observatory (l'Observatoire de l'Energie which is an interdepartmental energy information body) are both members of CEREN's board of Directors (INSEE since its formation, the observatory since 1983).

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