

# Guidelines for the Conduct of Monitoring Campaigns: a Technological and Behavioural Approach

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## Synopsis

Guidelines for the conduct of end-use residential monitoring campaigns are presented which maximise the value of individual campaigns by developing comparable and exchangeable results.

## 1. Abstract

This paper proposes residential end-use appliance metering guidelines in order to produce generally comparable project outputs and common formats for data exchange as well as to minimise common problems associated with the campaign design. The vital need for results dissemination and co-operative actions is highlighted. Toward these ends, the European Commission is invited by the authors to develop a protocol for all the metering campaigns it supports which will satisfy the needs identified.

## 2. Introduction

An important limitation for the formation of energy efficiency policy has been a lack of consistent and reliable energy consumption end-use data. The probability of success of energy efficiency actions needs to be demonstrable prior to their implementation which is often only made possible through the assembly of credible end-use data. Estimations based on engineering data and questionnaires can give very variable values with low levels of confidence. In contrast dedicated metering campaigns (CIEL 1996, CCE 1996, NUTEK 1995) provide data with the required credibility giving results such as:

- energy consumption and load curves by end-use;
- information on behavioural and technical factors that influence energy consumption patterns;
- the identification of DSM opportunities;
- the evaluation of DSM measures.

## 3. The need for a common approach

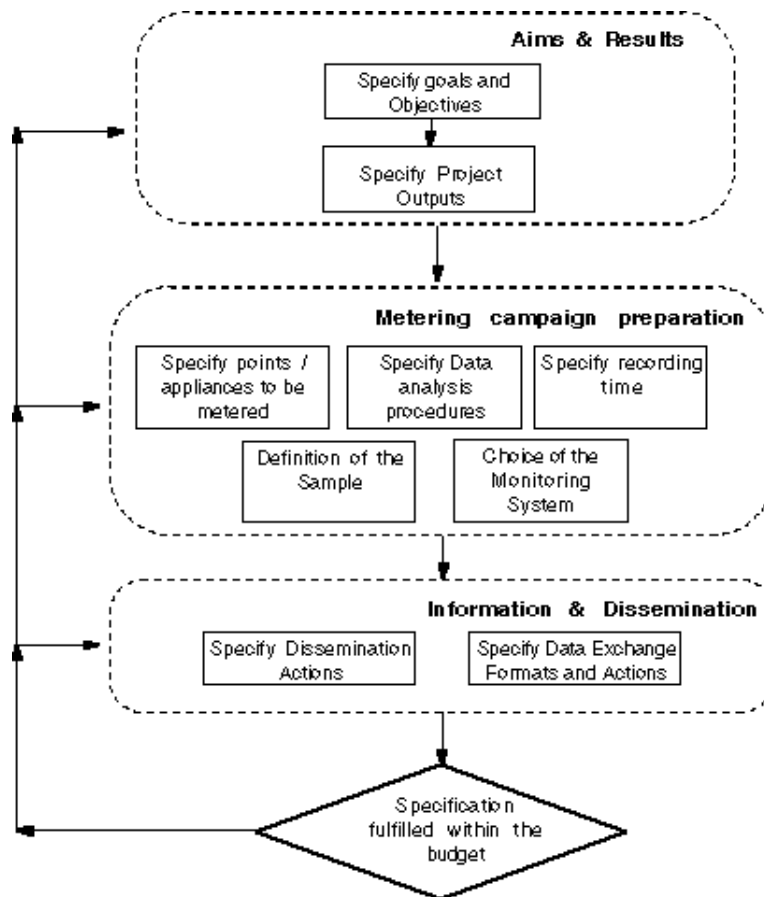
A central requirement of almost all metering campaigns is to be able to generalise the results from the sampled population to a much wider 'target' population. A frequently levied criticism of metering campaigns is that they only produce results of how electricity was consumed by the sample population at the time of metering, thus it is of great importance to take all available measures to ensure that the results can be of more general interest. As metering campaigns are expensive to conduct they can only involve small population samples that are usually drawn from the same locale. These small samples produce results which can be difficult to extrapolate from, thus, in order to raise the value of metering campaigns it is very important to:

- develop common efforts to produce consistent and comparable data in different metering campaigns and to pool the findings;
- design the campaign within the available constraints such that the scope to generalise from the findings is maximised.

Unfortunately, the results from metering campaigns have rarely been crossed or exchanged. This has been the case, not only in different countries but also in the same countries or even within the same agencies. Therefore, it is of crucial importance to agree on some guidelines to be followed in the production of results of metering projects in order to take advantage of the synergy among the individual campaigns.

#### 4. Methodology for the design and conduct of monitoring campaigns

Figure 1. Methodology for the design and conduct of monitoring campaigns



A monitoring project involves a large amount of manpower and money. Therefore, the project planning needs careful attention. An iterative approach is the most suitable to resolve the trade-off existing between resources (financial, human and temporal), scope, instrumentation available, type, level of detail, presentation and representativeness of results, and dissemination actions. In this section, a methodology for the project planning is proposed broken down into different steps, see Figure 1.

*Specify goals and objectives* Specify a statement to determine the scope of the project, the main outputs and the research questions to be answered. The planning of the overall project will depend on that statement.

Specify data products and project outputs to fulfil the objectives and to answer the research questions identified. This phase should provide a specification of the presentational form of the results to be delivered by the project: including the main tables, graphs and figures to be produced. Examples of the load curves are presented in the following figures.

Define the duration and season of the measurements. These will depend on the type of results or research questions to be investigated. Campaign designers need to be aware that for most end-uses, the time of year influences the energy consumption patterns, thus, the measurements should cover different seasons, in one period or two separate periods. If an evaluation of DSM measures is required, measurements should be made before the implementation of the measures and after e.g. when appliances are to substituted by more efficient ones (Before-After approach).

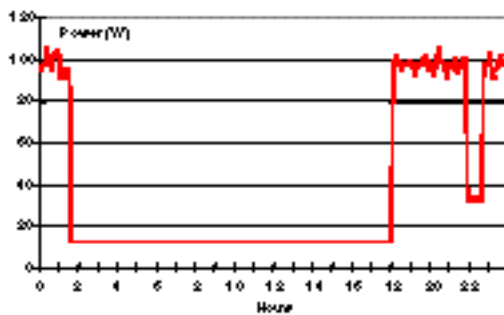


Figure 2. TV and VCR - Typical load curve - One piece - Consumer's viewpoint

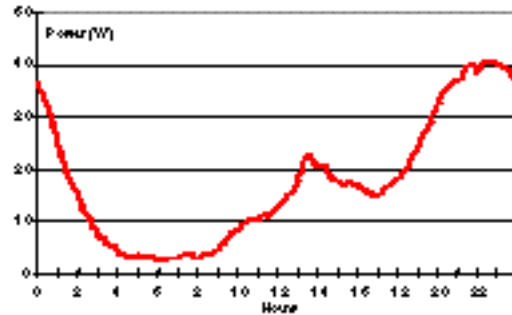


Figure 3. TV set - Average load curve of a sample Utility's viewpoint

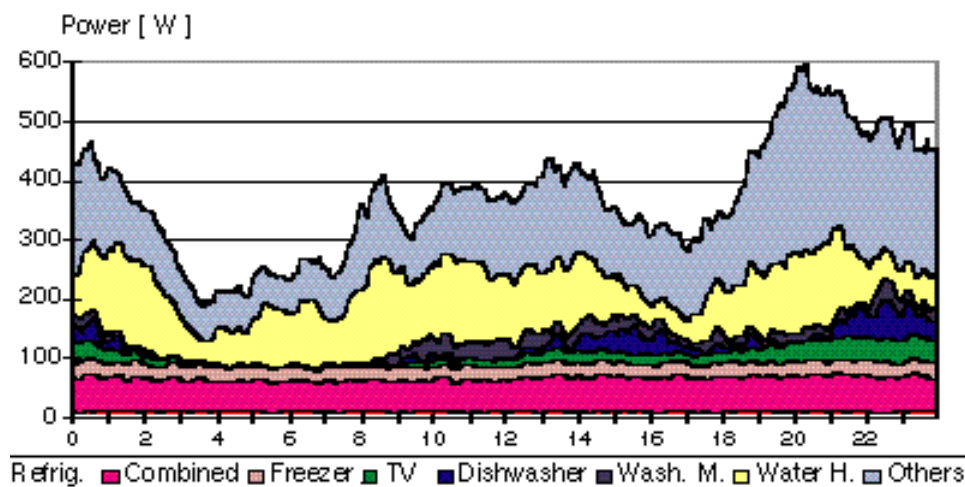


Figure 4. Average load curve of the sample by appliance

Time step - Scanning and recording intervals. The recording interval is the period of time between the storage of two integrated values of readings that have been made with a shorter period — scanning period. Care should be taken to ensure that the interval of the recording period is sufficiently short for the task in hand without generating unwieldy quantities of data. Between 5 to 10 minutes is sufficient to be able to analyse most appliance cycles but longer intervals can be used if only energy consumption or load curve data is required e.g. for wet appliances, the recording interval should allow the identification of the cycle type or temperature at least the distinction of three types: 30/40°C, 60°C and 90°C. Apart from the recording period used in the campaign, the analysis and the presentation of results should be done on an hourly basis. This period could be a common “standard” for the exchange of measurement files between different campaigns.

*Selection of the appliances to be monitored* Usually the main consuming appliances are selected to be monitored but designers should consider how to treat multiple ownership (e.g. second TVs) and how to measure lighting loads. Intelligent use of the consumer questionnaire can help with the prioritisation of the appliances to be metered.

*Definition of the population sample* Although the inevitable small sample size limits the potential for extrapolation, it is essential to make a careful definition. Often however it is not possible to select a properly stratified sample because of practical constraints which limit the sample available, thus great care should be given to considering how the use of a questionnaire and the metering of selected ancillary physical factors can enable the results from a poorly stratified sample to be generalised to the wider target population. Therefore, the sample definition should be preceded by a quick questionnaire where simple questions are made regarding both technical and practical issues. The advantages for the consumer should also be mentioned (individual report, recommendations for energy savings, rebates in appliances purchase, etc.).

*Design of the questionnaire* This should be designed to complement the information measured in three main fields:

- general information about the household;
- technical characteristics of appliances;
- behaviour and habits of the consumers.

*Choice of monitoring hardware systems* Mititious projects have failed due to the use of inadequate equipment. On the other hand, hardware-oriented orientated projects which do not involve a prior and appropriate definition of objectives are inevitably futile.

*Specify dissemination actions* Monitoring projects are expensive and will be under-utilised if there is an inadequate dissemination of their results. The dissemination actions should reach the six main targets of: utilities, policy makers, consumers, energy agencies, appliance manufacturers and appliance measurement standards agencies.

*Specify data exchange formats* Several monitoring campaigns have been carried out in the European Union without the results being merged. Therefore efforts have to be made to organise which requires *a priori* a common format for data exchange.

## 5. Conclusions

The European Commission has been supporting many monitoring projects, in different countries. We would like to request that the EC to develop a protocol helping to ensure that data from different EU sponsored projects are reasonably consistent, comparable and are pooled in a common database.

## References

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