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Using Typical Consumption Profiles to Stablish the Consumption Level for Short Time Periods

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Abstract

The current practices in the consumption metering by electricity utilities is currently largely based on monthly consumption reading. The consumption metering device is always calculating the cumulative consumption. Then, it is possible to calculate the difference between the actual and the previous consumption evaluation in order to estimate the monthly consumption. The power systems planning needs in many aspects to handle consumption data obtained for shorter periods, namely in the Demand Response programs planning. The work presented in this paper is based on the application of typical consumption profiles that are previously defined for a certain power system area. Such profiles are then used in order to estimate the 15 minutes consumption for a certain consumer or consumer type.

Keywords: Consumption estimation, Demand response, Typical consumption profiles.

1. Definition of Consumption Profiles

The definition of consumption profiles has been largely studied in the literature [1]. Several methods and approaches can be identified, namely: the Profile Administrator (PrA) [1]; the modified follow the leader [2-4], the self-organizing map (SOM) [3, 4, 5], the k-means [4, 5], the average e Ward hierarchical methods [5, 6] and the fuzzy k-means [6–8]. The work here presented is based on the typical consumption profiles definition currently in use in Portugal, as implemented by the regulatory authority ERSE [9].

ERSE publish annually consumption profiles concerning regular low voltage consumers (BTN), special low voltage consumers (BTE), and medium voltage consumers (MT) in order to be possible to once having the monthly consumption being possible to estimate the consumption for each 15 minutes period in consumers without metering capabilities able to measure this period detail. For the BTN consumers, three distinct profiles (Class A, Class B, and Class C) according to the rated power and to the total annual consumption of the consumer.

I order to obtain the consumption for each 15 minutes period, one must depart from the estimated monthly consumption. The estimated month consumption for client (consumer) *c*, in the month *m* and in the tariff period *p* ($C^{c}_{estimated_{m,p}}$) is estimated according to the consumption historic data. When the historic

data concerns a period longer than one year, the following equation should be used.

$$C^{c}_{Estimated_{m,p}} = \frac{cel^{c}_{P} * N_m}{N_d} \quad (1)$$

Where:
cel^{c}_{P} – Consumption between measurements (L2 – L1);
N_m – Number of days in the specific month;
N_d –Number of days between real measures.

The 15 minutes consumption for client "c", calculated for the 15 minutes period "h" of the day "d" in the month "m", belonging to the tariff period "p" ($CH^{c}_{m,d.h.p}$) is calculated as follows:

$$CH^{c}_{m,d.h.p} = \frac{P^{0}_{m,d,h}}{\sum_m P^{0}_{m,d,h}} * C^{c}_{Estimated_{m,p}} \quad (2)$$

Where:
$P^{0}_{m,d,h}$ – Initial profile, for month "m", day "d", and 15 minutes period "h".

Using these equations, it becomes possible to the consumption diagram for each 15 minutes.

2. Methodology for the Definition of the Available DR

The proposed methodology, which aims at identifying the opportunities of using the typical consumption profiles in order to define the available amount of DR in each 15 minutes period has been implemented in MATLAB. The procedure is presented in Figure 1.

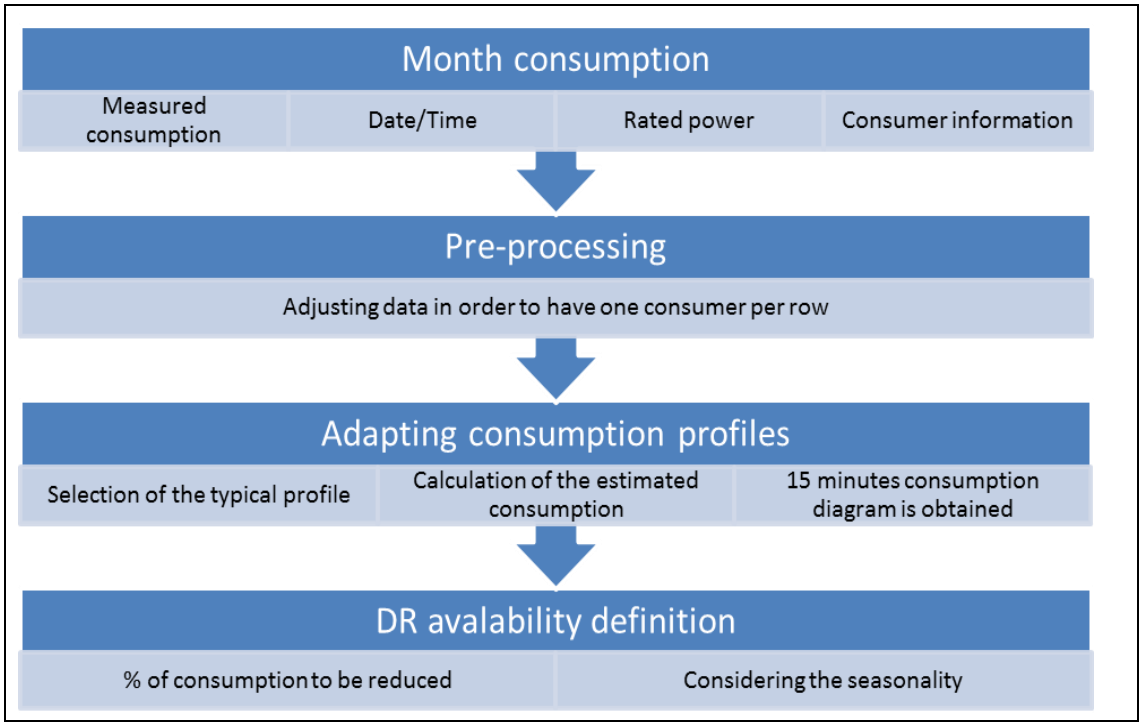

Figure 1 – Proposed methodology diagram.

Once we get the 15 minutes consumption diagram for a certain consumer and knowing the estimated percentage of consumption reduction, it is possible to, using the ERSE methodology estimate the available DR capacity. This is very important in the cases that the consumption data is only known for periods higher than 15 minutes.

3. Case study

Here is presented the application of the proposed methodology to a case study concerning to distinct clients, focusing on the definition of the 15 minutes consumption for each consumer and the respective error estimation error.

The Client 1 is characterized as follows:

⇒ Medium voltage consumer

⇒ Industrial type;

⇒ Measured peak power – 360 kW;

⇒ Rated power – 750 kW;

By applying the proposed methodology, it was possible to achieve the following results for client 1 and for client 2.

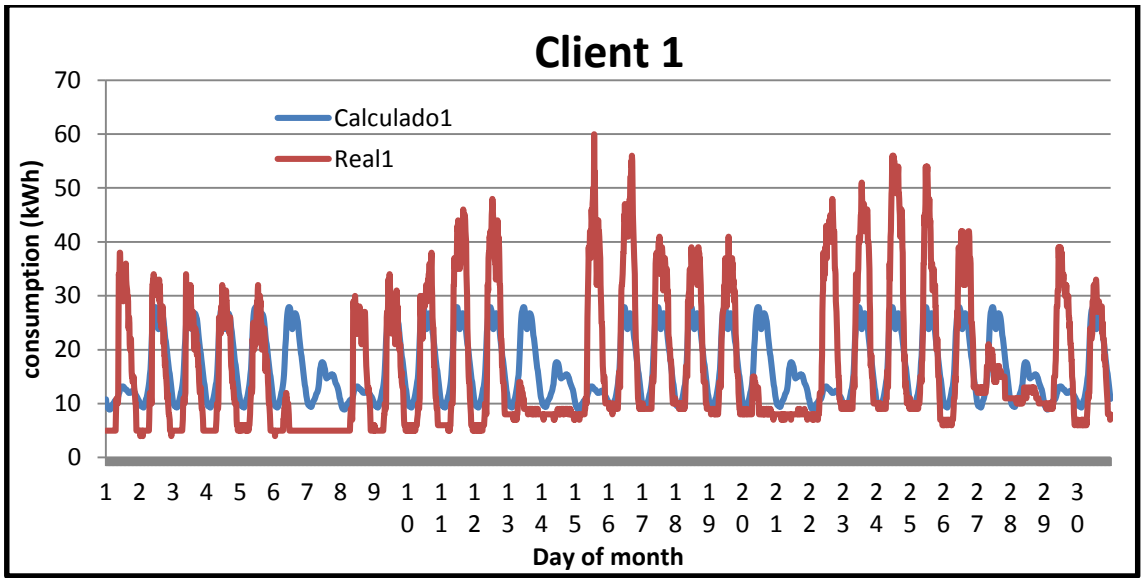

Figure 2 – Consumption of Client 1 in September.

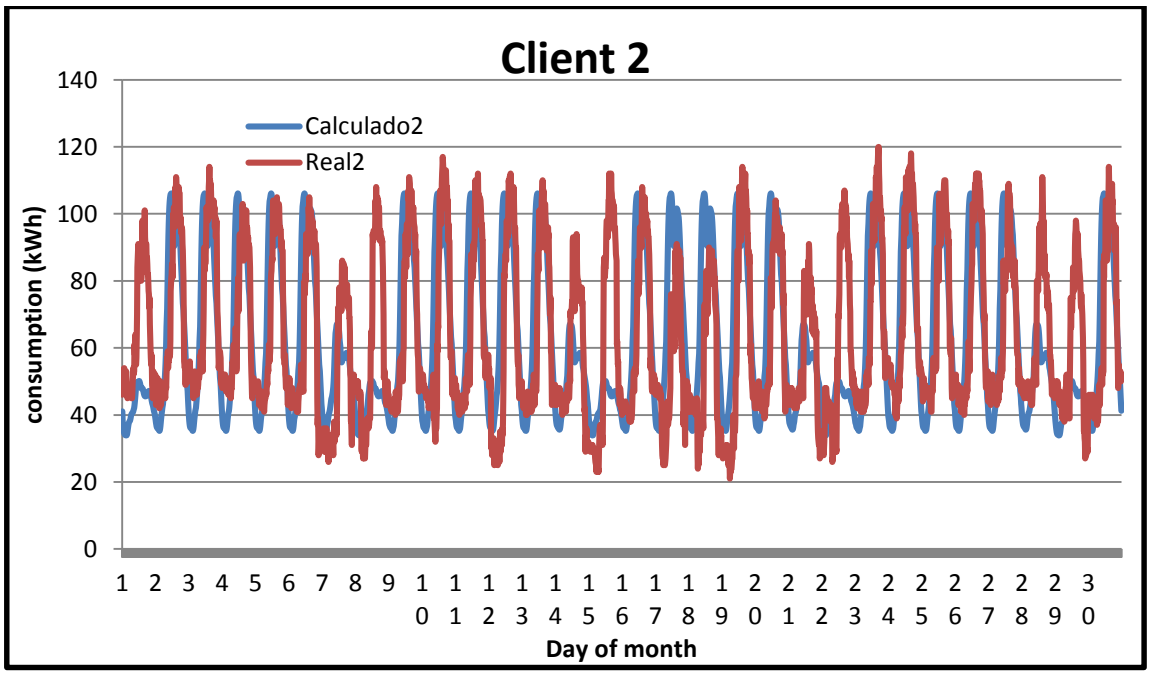

Figure 3 – Consumption of Client 2 in September.

Table 1 – Average and standard deviation of the estimation error.

Client:	**1**	**2**
Average Error	59,68%	26,21%
Error standard deviation	0,625	0,279

It can be seen that the estimation error is lower in the case of Client 2. In fact, these two clients are very different in what concerns its typical consumption profile so the proposed methodology obtains distinct performances in each one.

The authors have also made studies in order to compare the performance of the proposed methodology when applied to these 2 clients, in distinct tariff periods as actually implemented in Portugal, where the consumers are able to pay distinct prices for electricity, along the day. The maximum number of distinct tariffs is 4, for large consumers.

4. Conclusions

The present paper has bring a methodology for the determination of the consumption in each 15 minutes period, for consumers that have electricity consumption measurements monthly. Here it has been used the typical consumption profiles actually used by ERSE, the regulatory Portuguese entity for the energy sector.

The focus and motivation of the work relied on the fact that the implementation of demand response programs should be handled for consumption periods of reduced duration and the most of consumers are actually having only monthly measurements. The effectiveness and accuracy of the methodology has been done for 2 real consumers.

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