LOAD PROFILING FOR THE ELECTRICITY MARKET

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In this paper the load profiles used by different entities (distribution utilities, suppliers) on the electricity market have been analysed. Load profiles are necessary for utilities from cost of service and rate design to load management and forecasting to settlement. Principal applications for retail suppliers include pricing, cost analysis, planning and assessment of load management, load scheduling and market settlement. Following some methods used to load profiling are presented, together with a case study done according with the Romanian procedure for load profiling.

Keywords: load profile, electricity market, case study.

1. Introduction

Free trading in electricity is dependent on the establishment of a system for the metering and calculation of how much electricity is bought and sold at all times. An immediate balance between production and consumption is a prerequisite for a power system [1]. The consumption will change continuously according to the end users' demand for power for heating, lighting, etc. Consumption will thus change significantly in the course of a day or year. Thus it must be possible to quickly regulate the production of power to cover the fluctuations in consumption.

Due to the continuous fluctuations in production and consumption, the value of the power will also change frequently. In Romania the power prices are fixed on an hourly basis. As with many other goods, the power price is set before delivery is made. The price will be dependent, every hour, on the supply and demand of power for future delivery periods. This variation of hourly prices is the reason why the distribution utilities, suppliers and consumers are interested to participate to the electricity market to avoid unnecessary costs.

2. Methods for load profiling

Load profiling is the process of allocating a customer's accumulated energy consumption over a billing cycle to the individual hours in that cycle (for monthly metered customers). Through load profiling, customers without hourly

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meters are able to participate in the electric retail market. Most (if not all) residential customers do not have hourly consumption meters.

Load profiling is applied to wholesale market processes that require an estimate of hourly loads:

- forecasting;
- scheduling;
- settlement;
- reconciliation;
- estimate of capacity and transmission obligations.

A single load profile, developed from the same source and method, should be applied to all customers within a rate class or subclass regardless of which entity supplies electricity to the customer.

Using a single entity to perform load profiling provides a consistent and relatively low-cost method of aggregating the customer's loads in the distribution utility's service territory regardless of the electric supplier. Various methods [2], [3], [4], can be used to develop load profiles from a load research sample:

- Dynamic profiling is a method that uses each day's load research sample to represent the class for that day. That is, the load profile used for settlement for a given day is the class average based on the load research sample from that day. Today's hourly load is represented by today's sample data. The method is called "dynamic" because it changes each day based on the current data. To use dynamic sampling on a next-day basis for market settlement, automatic data retrieval is needed to make the metering data immediately available. The main advantage of dynamic sampling is that it provides the best available estimate of this group today. The disadvantage is that it requires rapid, regular data processing.
- Static load profiles are an historical average load profile for each day type and month, typically based on one to three years of load data. Thus, today's hourly load is represented by the average historical loads from days that match the calendar. For example, the load profile for a Monday in June may be estimated by the average of all June Mondays of the last two years. The advantage of the static approach is that it can be determined well in advance. As a result, data processing needs to be conducted only periodically, even annually. The corresponding disadvantage is that the static load profile doesn't reflect the particular conditions of today, other than the calendar.
- Proxy-Day load profiles are load profiles determined by copying the load profile from the historical day most "like" the target day, in terms of specific criteria. The criteria for selecting the historic day whose load profiles are copied for the current day are typically based on the magnitude of the system load and/or weather conditions. With the Proxy-Day method,

today's hourly load shape is represented by the load shape for a prior day similar to today. The advantage is that the library of load shapes from which the proxies are selected needs to be created only periodically. However, unlike the static profile, the proxy-day load profile does reflect some of today's conditions. The disadvantage is that there may not be an historical day that is a good match to today's conditions. The method doesn't allow for picking a day that's like a mix of two or more prior days.

- Dynamic models are models of hourly load fit to historic load data for the class. The fitted model is then applied to today's conditions to estimate the load profile for today. Typical predictor variable used in the load models include weather, economic, and calendar terms. The model is called "dynamic" because the current conditions are entered into the fitted model to determine today's load profile. The advantage of a dynamic model is that it can create estimates tuned to today's conditions. The main disadvantage is the complexity.

The choice of the most appropriate load profiling method for any situation depends on a great number of factors:

- data availability;
- equipment availability;
- accuracy requirements;
- regulatory requirements;
- cost considerations.

In some European markets where supply prices are still regulated, regulators require that suppliers use load profiling to fairly allocate the power purchase costs to the different customer categories for which regulatory tariffs are set. The reason for using load profiling for regulated prices is to ensure that the projected revenue from each customer class is close to the class's allocated cost. To prove that this is so, the suppliers have to undertake a cost of service study. Load profiles or class load curves are a key part of the cost of service study. The suppliers are obliged to use load profiles developed on the basis of statistically valid samples of customers with interval metering data for each tariff class.

3. Load profiles for pricing and settlement in competitive markets

Load profiles can be used for retail pricing also in competitive markets, and in addition, they are the devices that allows wholesale settlement in a situation where retail competition extends to customers who do not have hourly (half-hourly) metering.

- Price setting by competitive retailers: The retail supplier in a competitive market must set prices to cover costs. A large proportion

of that cost is the cost of purchasing power in the competitive wholesale market. In a well functioning market the price the retailer pays for energy will depend on the retailer's load profile. The retail supplier must contract for power matching the retailer's aggregate load by hour. More loads at peak hours means a higher average cost per kWh. The retailer should try to charge more to those customers who contribute more to the retailer's costs. If generation costs are the only consideration, these are the customers who contribute more to the consumption at peak-price hours.

- Load Profiles for Wholesale Settlement: If customers without interval meters are allowed to choose their own suppliers load profiles are needed for wholesale market settlement. Each retail supplier's total load by hour is calculated as the sum of interval metered loads plus load profiled customer hourly loads (plus losses). Monthly (or bi-monthly) consumption is known from meter readings for most customers. Class load profile shapes are is used to distribute customers' known monthly consumption over hours, to calculate retail supplier totals. For some customer classes, load profiles may give the magnitude as well as the shape. Typically, this use of load profiles is restricted to customer classes with fixed loads at predictable operating schedules, such as traffic signals and streetlights.

The Europeans utilities have calculated and offer to their customers different types of load profiles:

- Residential Load Profiles
- Commercial Load Profiles
- Large Commercial and Industrial Load Profiles
- Agricultural Load Profiles
- Street Lighting Load Profiles
- Standby Load Profiles

4. Case study according to the Romanian load profiling procedure

In the procedure for defining and use of the generic load profiles [5], the Romanian Energy Regulatory Authority - ANRE proposed that:

- for each hour of the billing cycle, the distribution system operator compute the *total hourly consumption* (of all consumers that contribute to the generic load profile), C_{hPGC}:

$$C_{hPGC} = C_{hT} - (C_{hE} + CPT_h + C_{hPSC}) \quad (1)$$

where C_{hT} is the total hourly consumption for the entire distribution utility's service territory;

C_{hE} – the total hourly consumption for all eligible consumers that have hourly consumption meters;

CPT_h – the hourly values of the technological consumption in the distribution networks;

C_{hPSC} – the hourly consumption of all the consumers with specific load profiles.

- the Distribution Operator establish the *generic normalized profile* for all the hours of the billing cycle:

$$c_{hPGC} = C_{hPGC} / \sum C_{hPGC} \text{ , } h= 1,2,....n \quad (2)$$

- the generic load profile for a consumer is obtained by multiplying the hourly values of the generic normalized profile by the value of the consumption of the specified consumer for the billing cycle.

According to the above algorithm, we have analyzed the case of an industrial consumer and the results are presented in the figure 1 (C_{hT}, CPT_h and C_{hE}), figure 2 (C_{hPGC}) and figure 3 (c_{hPGC}). Figure 4 presents a comparison between the real consumption and the load profile resulted for the specified consumer.

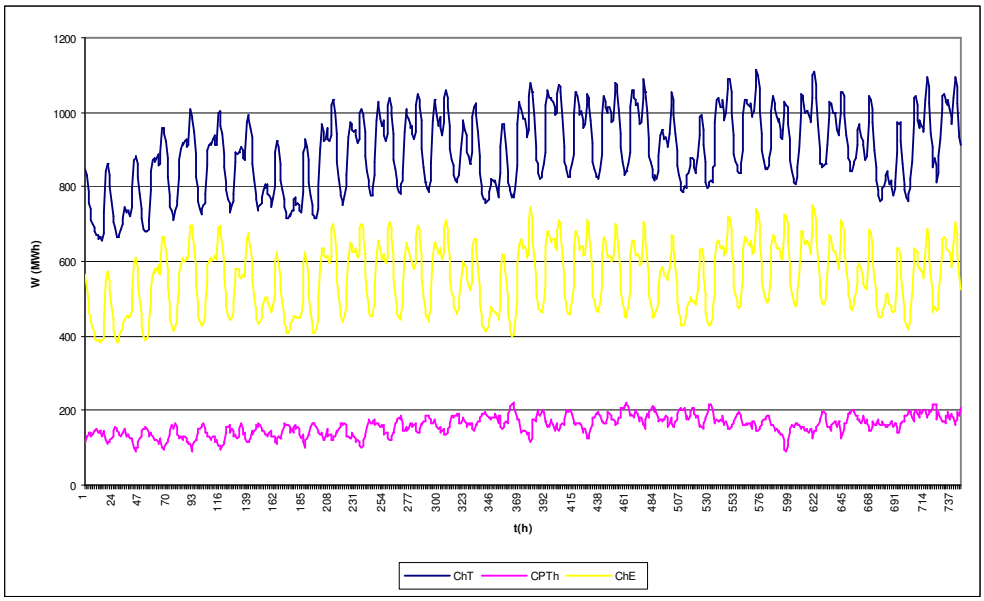

Fig. 1. The C_{hT}, CPT_h and C_{hE} curves

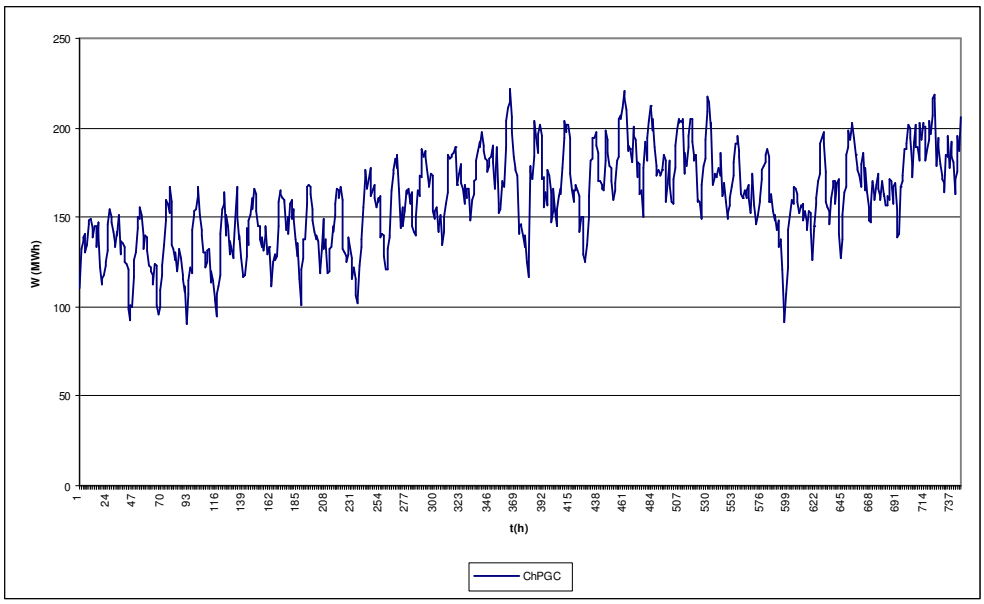

Fig. 2. The C_{hPGC} curve

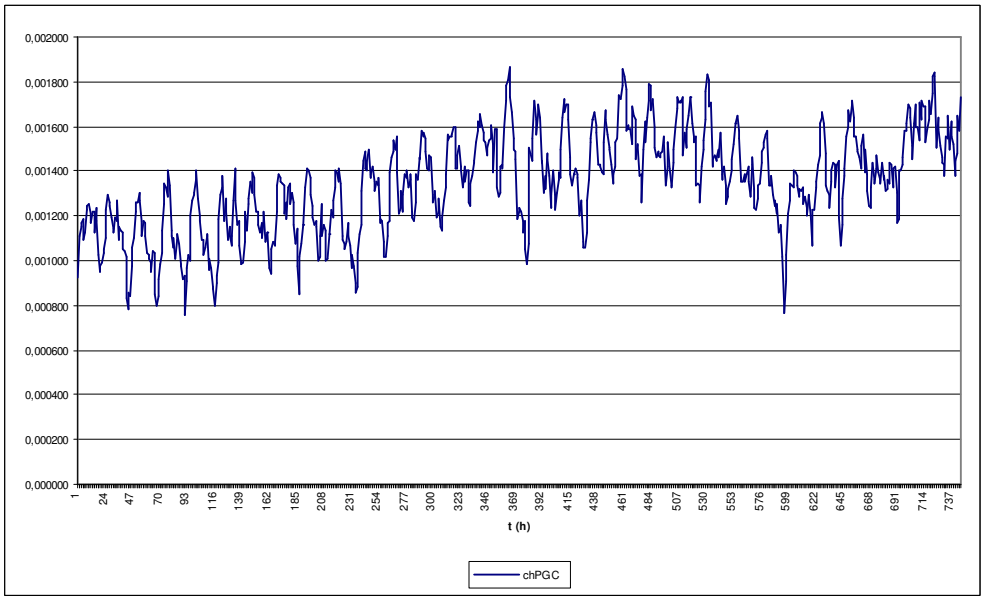

Fig. 3. The c_{hPGC} curve

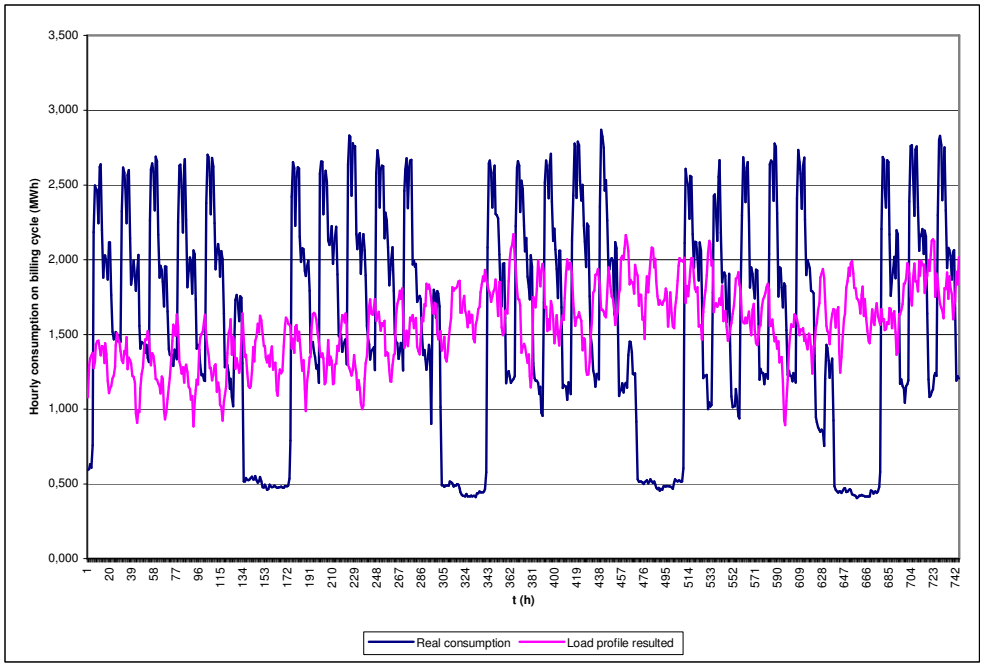

Fig. 4. Comparison between the real consumption and the load profile resulted

5. Conclusions

As is shown in the figure 4, the consumers which are not billed by the real metered values of the consumption will be affected by the generic load profile resulted. This generic load profile is influenced by other types of consumers (most of them are residential consumers).

The generic normalized profile could be used to help understand how different types of customer use electricity and avoid unnecessary costs.

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