

A BETTER KNOWLEDGE OF ELECTRICITY CONSUMPTION FOR RESIDENTIAL CUSTOMERS THROUGH THE LINKY SMART METER

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ABSTRACT

This presentation shows how the AMM project deployed in France, known as Linky, improves knowledge of residential consumption, through the combined effects of an appropriate customer panel and a modelling method, adapted to more frequent reading of consumer indices. This presentation is one of the first applications of the rollout of "smart meters" in France regarding settlement management. The historical consumption profiles are built up using a residential panel managed by ERDF. The simulation of more frequent reading of meter indices has enabled us to study and test various scenarios covering the quality of electricity consumption estimates, depending on various criteria: meter reading frequency, profiling choice (adjusted, dynamic, flat), and the size of the sample used to build up the profile (for dynamic profiling). The quality of the estimates is based on a MAPE criterion (Mean Absolute Percentage Error) between an actual curve and an estimated one, on a half-hourly consumption basis. Studies conducted by ERDF have demonstrated that meter reading frequency and quality of dynamic profiling are two major levers to increase the accuracy of consumption modelling for a given client portfolio. A higher meter reading frequency provides enhanced accuracy but reaches a threshold at 5.5% (meter reading every day) on the adjusted profile, whereas the quality of dynamic profiling and hence the sampling process enables us to obtain greater accuracy (3% instead of 5.5% for a daily meter reading frequency with 1,000 customers). We can also conclude that it is possible to take advantage of the Linky meter without waiting for the end of deployment, using dynamic profiling. In fact, the dynamic profile enables us to increase the accuracy of the system, and hence its quality. This study provides ERDF with strong arguments when selecting its strategy, i.e. investing in dynamic profiling with Panel 3000.

INTRODUCTION

Since the full opening of the French electricity market, suppliers have been financially responsible for the balance between energy injected and consumed in their portfolio. In order to charge the suppliers for the differences between energy injected and consumed, measured every 1/2 hour, ERDF evaluates the consumption flow for each supplier using modelled consumption profiles, readjusted by the consumption level of each customer. The AMM project has led to two major evolutions: the possibility of increasing the frequency at which consumer indices are read and the

possibility of setting up larger customer panels, which are updated in real time. The combination and the advantages of these two approaches are evaluated below.

SETTLEMENT MANAGEMENT

Distributing 340 TWh of electricity per year for about 35 M customers, ERDF represents 95% of the French territory and 75% of French consumption.

Since the opening of the French market in 2004, ERDF has also been involved in settlement management in France with three distinct missions:

1. The first mission is to calculate the global half-hourly electrical flux for each supplier. The goal is to evaluate the difference between each supplier's own forecast injection levels and the actual consumption for its portfolio. This allows determining the financial compensation for balance management
2. The second mission is to give the true value of each customer segment as precisely as possible, whatever the offers and whatever the meter reading method. This is an essential condition for development of TOU offers. Otherwise suppliers do not stand to gain from selling TOU offers.
3. Finally, by adding up all these calculations, ERDF evaluates the monthly or annual amount of energy for each supplier. These calculations give each actor's electrical balance sheet directly, including that of the actor in charge of electrical losses.

ERDF thus has to produce reports on several time scales: half-hourly, monthly, and annual, whatever the type of meter.

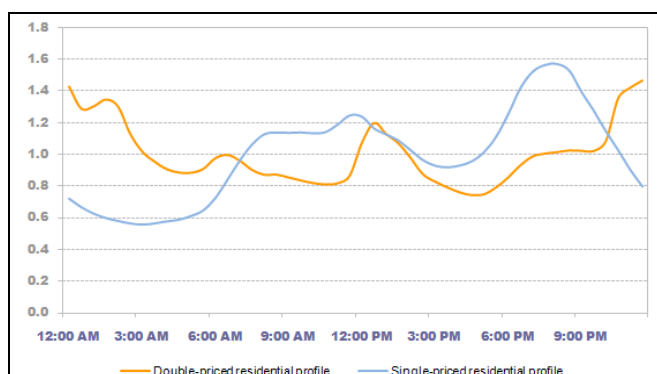
In France, two-thirds of the annual consumption is still accounted for by consumers without remote reading. Depending on the type of reading methods, ERDF uses the following types of data:

1. **For consumers with remote reading:** the load curve
2. **For consumers without remote reading:**
 - Cumulative consumption (indices in kWh)
 - Consumption profiles

Both solutions provide half-hourly estimations of load curves whatever the reading method. Of course, even with the best profiling techniques, the accuracy of profiling methods cannot match that obtained from load curves read by automatic reading meters.

In France, thanks to the relatively homogeneous population behaviour (weather, lifestyles, prices), we consider that five residential profiles enable us to cover the different supplier situations for 35 million customers.

The two main residential profiles for an average winter day are shown here:



The two main residential profiles

THE LINKY SYSTEM

Linky, the French AMM project, can already be used to improve the settlement management process even though Linky was developed for many other services purposes.

2 types of experiments can be used for this goal:

1. Use of a panel of 3,000 customers throughout France which has been providing half-hourly consumption readings since 2010. This panel is a good way of updating the national residential profiles.
2. Use of a pilot sample of 300,000 customers in Lyon and Touraine who have been providing daily information since 2010 and represent a one-hundredth scale model of France. The pilot sample is the best tool for testing the enhanced accuracy of a better database.

Thanks to these two types of Linky data, it is possible to estimate the benefits of the future rollout of Linky regarding global settlement management.

TWO LEVERS TO IMPROVE THE CURRENT SYSTEM

With Linky, two approaches are possible to improve the current system: the report data and the consumption profiles. These two levers are made available by the Linky meter. We will test these two levers on half-hourly reports and annual reports.

Report data: Accelerating the reading system

As regards the report data, we will simulate an acceleration in reading frequencies: from every 6 months, as is currently the case now, to every day.

Consumption profiles: Improving profiling quality

As to consumption profiles, we will test 3 types of profiles,

from the easiest to the most sophisticated:

- No profile: The consumption curve is flat, which means that customers consume at the same level whatever the time and whatever the season.

- Static profiling: the previous system is improved by a model that translates average customer behaviour (known thanks to consumption panels).

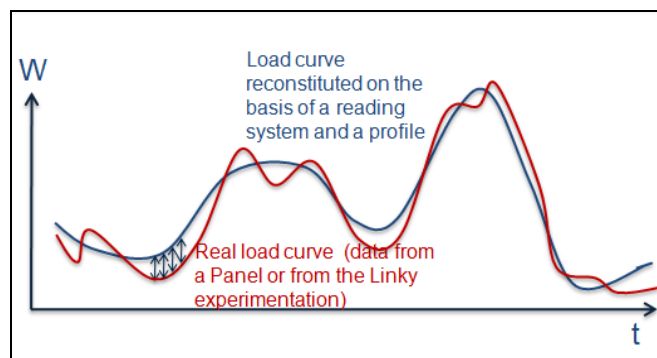
- Modelled profiling: Enhancing the profile by adjusting it according to the actual temperature. **This is exactly what we do today.** A profile can represent 15 million customers.

- Dynamic profiling: Thanks to the Linky smart meter, we can test a new type of profiling, dynamic profiling. This is no longer a model, but a direct average of measures calculated for a sample set of customers. This kind of profile can capture short-lived events.

It is to be noted that these studies are based on a Panel and on a perfectly regular reading system.

ACCURACY OF HALF-HOURLY REPORTS

The accuracy of half-hourly reports is measured as an average of the differences between the actual curve and the estimated one. Starting from actual consumption curves, we create a reading system and reconstitute a load curve. Every half hour, we calculate the differences in absolute values between these two curves. The accuracy is measured via the MAPE (Mean Absolute Percentage Error) which corresponds to the average of the differences over a given period (e.g. a year):



The accuracy of half-hourly reports

The current situation

The results are shown on a graph that crosses the reading frequency with the inaccuracy levels, for the various profiling methods. The current situation is the modelled profile with a reading frequency of 6 months:

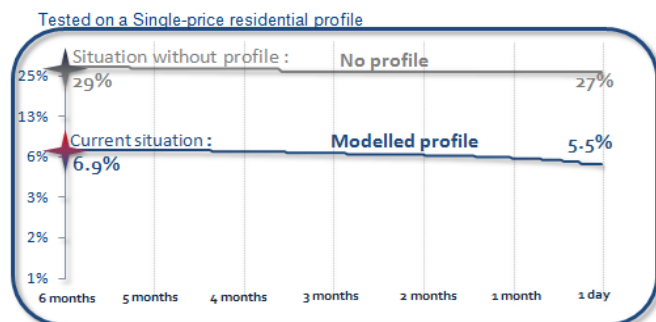


Accuracy of half-hourly reports in the current situation

Without a profile, the inaccuracy level would be very high (29% instead of 6.9%).

Accelerating the reading system

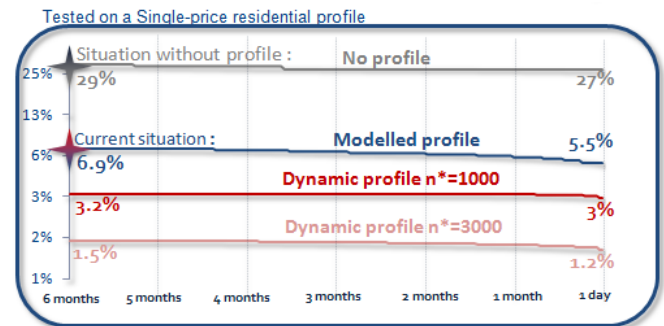
Accelerating the reading frequency improves accuracy, but the improvement reaches a limit of 5.5%, whereas the inaccuracy decreases moderately. This means that volatility of less than a day is not revealed by the profile:



Accelerating the reading frequency for each meter

Improving the profiling quality

The profiling quality enhances accuracy more sharply. The quality of the reports is multiplied by 2 with dynamic profiling built up on the basis of 1,000 customers. The level of accuracy can be controlled by changing the size of the sample:

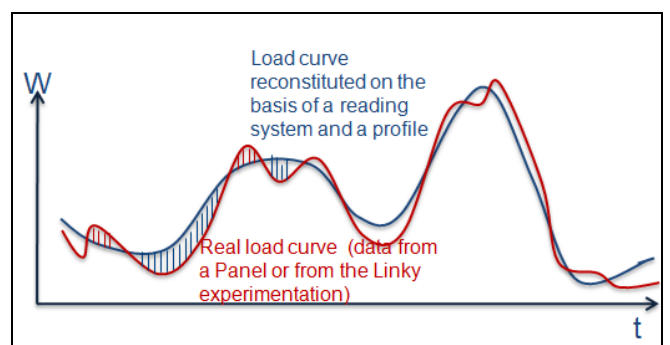


Improving the profiling quality

The key factor is that we can improve accuracy as compared with the current situation, even with a long reading interval. Thus it is possible to reach good accuracy levels realistically and without waiting.

THE ACCURACY OF ANNUAL REPORTS

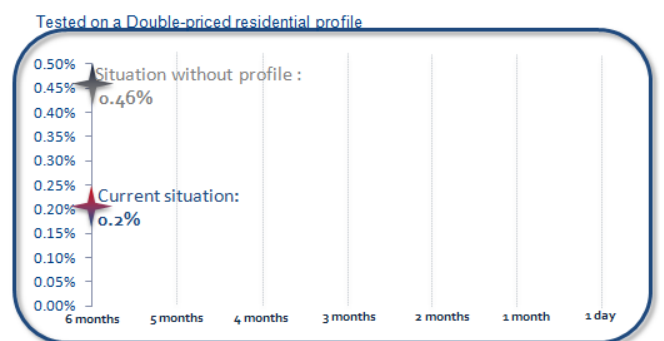
The accumulation of half-hourly error levels is also reflected in the annual accounts. Accuracy is currently measured using the difference in absolute value over a full year, and not a mean of half-hourly differences. At an annual rate, it is the overall error that is taken into account; the half-hourly differences cancel each other out:



The accuracy of annual reports

The current situation

In the same way as above, the results are represented on a graph that crosses the reading frequency with the inaccuracy levels, for the various profiling methods:

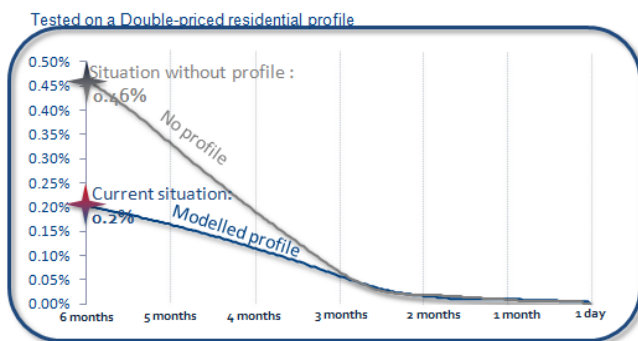


Accuracy of annual reports in the current situation

In the annual reports, and on a double-priced residential profile, we obtain an error level of 0.2% (as regards the total amount of energy for a year, which represents a relevant amount of kWh). Without a profile, the error level would be twice as high.

Accelerating the reading system

This time, by accelerating the reading frequency to once every two months, the inaccuracy is reduced on annual reports to almost zero:

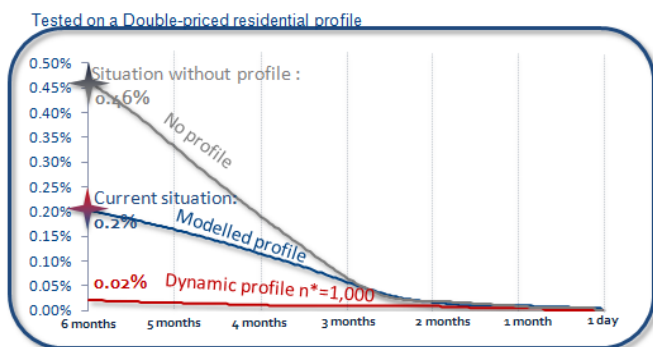


Accelerating the reading frequency for each meter

This result is very important because it means that we can reach a very good level of accuracy for annual reports with a modelled profile, if we read the meters every month.

Improving the profiling quality

However, with a good profile, the inaccuracy level can be cut to 0 whatever the reading frequency, even at 6 months, as in the current situation:



Improving the profiling quality

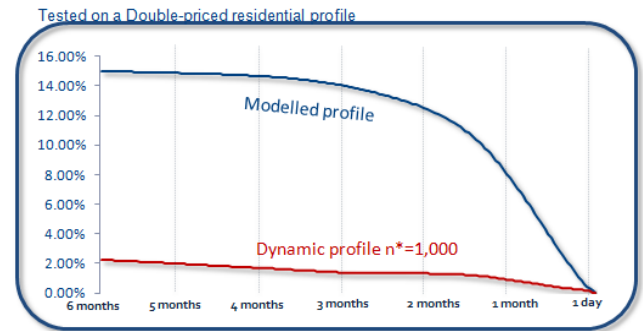
Hence, dynamic profiling enables to quickly improve the accuracy of annual reports, without having to wait for the end of the Linky rollout.

ACCURACY OF MONTHLY REPORTS

It's possible to check these results by drawing up reports at shorter intervals, such as every month for example. This is not currently the case, but it would be the case in the future with Linky meters. Of course, the errors will be bigger on

monthly reports because of seasonal effects. In most cases, the error level is calculated as the maximum of the 12 monthly values for a given year.

The results are shown on the graph below, with a different reading system as above:



Accuracy of monthly reports

In the current situation, the inaccuracy level for annual reports stands at 2%. The inaccuracy for monthly reports would be about 15% (maximum of the monthly differences). The most important point to stress here is the difference between a modelled profile and a dynamic profile. It is easy to see that it would not be possible to produce monthly reports without dynamic profiling.

CONCLUSION

It's possible to benefit quite quickly from a good level of accuracy for reports thanks to panels. Moreover, this solution avoids having to deal with 35 million load curves. The use of representative samples can be effective soon after the general rollout has begun, thanks to the "leopard strategy".

Accelerating the reading frequency enhances the accuracy of the reports, but the curve flattens out for half-hourly reports. Although the accuracy is good as regards annual reports, it would not be the case for monthly reports.

However, improvements in profiling are sharper, and benefits are felt sooner. This also enables to avoid loading bandwidth and use it in other ways (services, demand response, etc.). But, even for settlement management, the general rollout of Linky is important to make it easier to rotate the panels. The initial simulations are encouraging, but they have to be checked after the rollout of the first Linky meters.