

A Customer Management System for the Spanish Transport System Operator

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Abstract

The Active Demand Management (GAD) project is led by IBERDROLA's Networks business area as part of the National Strategic Consortium for Technical Research (CENIT) initiative, included in the Ingenio 2010 Program for the promotion of research, development and innovation in Spain. This project pools the efforts of 15 Spanish companies and 14 research centres into a single stable Consortium.

The final goal of the Active Demand Management (GAD) project is to optimize the way electricity is used and, therefore, the cost associated with that usage, while meeting the consumer's needs with the same level of quality.

The active involvement of the consumers and usage elements in the demand management mechanisms and the communication of the energy generation costs in real time, including the environmental costs, will contribute to raising public awareness and to changing the users' energy consumption patterns, thus moving towards the much needed energy sustainability.

This paper presents the software that has been designed and developed for the Customer Management System (in Spanish, Sistema Gestor de Clientes – SGCL). The SGCL is a distributed system with three subsystems that result from its functional decomposition per agent involved: (1) Transport System Operator (TSO), referred as SGCL-OS; (2) Distribution System Operator (DSO), referred as SGCL-OD; (3) Reseller (CM), referred as SGCL-CM. The paper is focused in the SGCL-OS part.

Keywords: Customer Management System, Demand prediction, Transport System Operator (TSO), SaaS, SOA

1. Overall system description

The system design starts with the implementation of an agreed set of functions with the other participants in the GAD project. On this specification has developed a complete hardware and software system, which serves the TSO as a tool to support Operation.

Related to the software layers used to meet the original specifications mentioned in the introduction, the system has been programmed as a web application (or standard e-business server-based application):

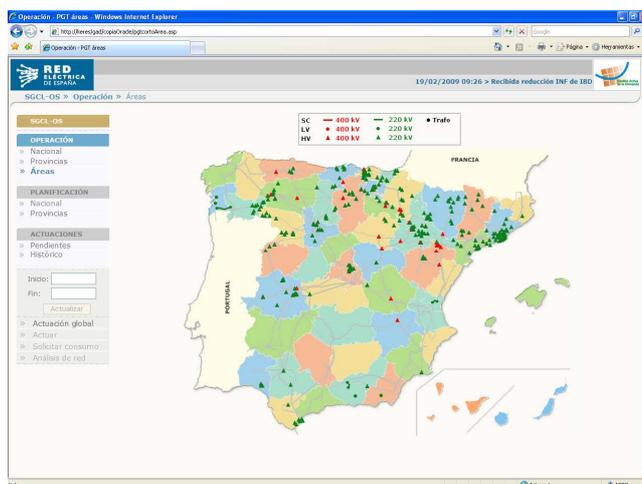
Data layer. This layer has been implemented as a relational database. It stores any information associated with the GAD project and all necessary data to carry out the functionality of SGCL-OS.

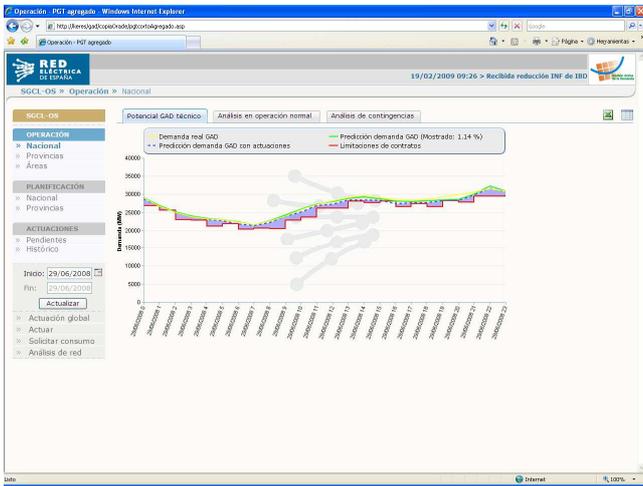
Logic layer. This layer refers to any internal implementation required for the operation and development of the Network Analysis Application.

Presentation Layer. It has been designed as a web application and is responsible for displaying information and interacting with the user (TSO).

Communication with other agents. In the current scope of GAD project there only exists direct communication between the TSO and the DSO.

To provide the communication between both agents has been used Web Services technology.





2. Demand prediction models

One TSO GAD goal is to flatten the customer demand curve in the long-term during the global planning that means a stable situation not only from the consumption point of view but also from the generation. Other goal is to improve the local optimization of demand peaks due to for example air conditioning in the Spanish east shore in summer.

So, TSO must be able to predict contingencies or grid inefficiency situations, to avoid grid overcharge and the subsequent malfunction. Thus, the demand behaviour prediction becomes necessary.

In order to achieve such goal, the TSO implements a *demand prediction* algorithm that is able to predict the demand on both a short and a long term, which is implemented by using a linear regression. This algorithm is able to perform electrical demand forecast under a known set of circumstances, such as historical demand values (see the following picture), the working days calendar and the meteorology.

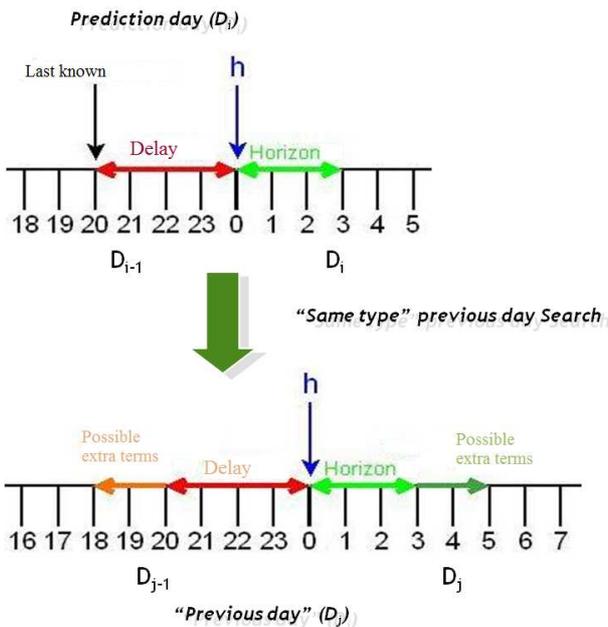


Figure 1. Demand prediction algorithm diagram

This prediction algorithm's goals are twofold: to be a useful tool not only for the operation in real time but also

to help grid planning for mid and long term. Therefore two different variants exist: the first one obtains predictions with hourly resolution, extendable to daily or even weekly and the second has a longer resolution such as a three months period or even a year.

3. Conclusions

Due the current scope of GAD project, the following paragraphs refer only to the *demand prediction* algorithm in the short term, within the transaction in real time.

The algorithm design is done following two steps: (1) Historical data preparation that involves demand differences calculation, hourly temperature data interpolation, etc. in order to obtain the model data inputs; (2) Algorithm execution, modeling and executing the regression in order to obtain the final prediction.

Below it is described the scenario tests and the errors obtained with the best model:

- (1) 1 hour delay: prediction time lapse starts at 0 hours, taking demand data of the last hour.
- (2) Horizon: hourly predictions are issued for the following 24 hours.
- (3) Regression terms: 29 differences in demand hourly of day earlier; 24 temperature estimations a day to predict; one constant term.
- (4) Modelling period: 01/01/2004 - 30/06/2006.
- (5) Prediction period: 01/07/2006 - 30/06/2007.

Validation methodology: In order to measure the models implemented, we have used the relative linear error (RLE), absolute linear error (ALE), Pearson's correlation coefficients (PCC) and mean quadratic error (MQE). In order, we show the Global Mean (G), Monday (M), Tuesday-Wednesday-Thursday (T), Friday (F), Saturday (S), Sunday- Vacations (V).

Table 1 shows the errors of the *demand prediction* algorithm that have been obtained as a result of applying the above scenario.

	G	M	T	F	S	V
RLE	2.03	2.46	1.96	1.98	1.64	2.21
ALE	603	744	624	634	445	544
PCC	98.5	98.07	98.1	98.21	98.24	97.62
MQE	884.	1085.	940.	858.73	619.19	765.52
E	69	68	62			

Table 1. Demand prediction algorithm errors

4. Acknowledgments

This system has been developed for Red Eléctrica de España. We want to thank the team involved in all phases of the project.