



EURODECISION
OPERATIONAL RESEARCH



EDF – GRENACHE PROJECT

OPTIMIZE THE SUPPLY OF EDF THERMAL POWER PLANTS BY FACTORING IN THE CONSTRAINTS OF MULTIMODAL TRANSPORT



Objective:

Minimize the total cost of supplying the plants by factoring in the assets and constraints of port handling and multimodal transport (sea, rail and river) of fuel while meeting forecast energy consumption demand



Solution:

- A linear programming model based on Ilog's Cplex solver
- Siren software developed by EDF



Results:

- Facilitate decision-making in the event of significant energy consumption fluctuations
- Overall control of the supply chain with the integration of the suppliers and their constraints

“Through the use of off-the-shelf linear programming tools, EURODECISION enabled us to easily model the CAPCOL logistics specialist discipline with a reasonable investment in terms of time and resources. In a deregulated market context, this is an additional asset compared to specialized software packages that provide the same types of response to all but that require adapting proven work methods to the specific characteristics of the software.” *Olivier DUBOIS – CAPCOL IT Dept Manager*

When CAPCOL decided to improve its modeling of the supply of EDF's thermal power plants based on an estimation of demand in electricity, nothing was left to chance. While the eleven coal-powered plants currently in service only supply 5% of the electricity generated in France, their role is crucial as their responsiveness represents the only recourse in the event of peak consumption. The cost of operating these plants remains high, however they benefit from a considerable advantage compared to nuclear and hydraulic power: start-up responsiveness along with control of the re-supply date.

A subsidiary of EDF, Capcol (Fuel and Logistics Supply Company) manages logistical problems related to the purchase of fuel, essentially coal and diesel oil. With an annual coal

consumption varying between one and ten million tons per year, and roughly 300,000 tons of diesel oil, Capcol's objective is to successfully supply the plants in this highly variable, constraint-intensive context while minimizing its overall cost. To do so, Capcol looks to the next 18 months for which EDF supplies forecast consumption scenarios to take into consideration. For each scenario, the level of demand detail is three time periods per day.

One of the major difficulties to overcome in this project is the optimization of multimodal supply of coal worldwide. It is procured from about fifteen locations throughout the world, from South Africa to Columbia and including China, Indonesia or Canada. The fuel is carried by ship to a dozen ports then travels by rail or river and even road to the power plants. The eleven EDF power plants actually include 18 generation units called "coal units". Each unit can only operate with one or two of the four types of coal ordered by Capcol. Diesel oil supply is simpler since the product is available in Europe in sufficient quantities.

Judging the old internal planning tool to be limited, since it only integrated continuous variables, Capcol launched the Grenache project with the support of an EDF R&D team specialized in optimization techniques. *"We selected EURODECISION because they could quickly implement the modeling of Capcol's problem with our team using a commercial solver,"* declared Jean-Yves Lucas, a research engineer at EDF R&D.

There are many project objectives. Naturally the overall cost of supply to the plants must be minimized while meeting forecast consumption demand. But the problem is complex, as the minimum stocks in the plants to be able to face unforeseen consumption events, the storage and handling capacity of the ports and plants, the transport capacities and lead times per freight line must be complied with and the specific characteristics of commercial contracts with carriers and ports must be taken into consideration.

The constraints that bind EDF with the various carriers must also be factored in. For SNCF, every month a number of trains that is a multiple of the number of business days must be chosen, as freight trains rarely run on weekends. For the shipping and river companies and SNCF, the very different capacities of various modes of transport must be integrated: ships (70,000 to 180,000 tons), river boats (700 tons), barges (2,000 or 5,500 tons) and trains (1,200 tons)!

The integration of the Siren software developed by EDF R&D, based on constraint propagation, allowed taking into consideration the break of load related to the transshipment of the ships onto trains or barges.

The Grenache solution is today used to optimize coal supply over 18 months, which represents 80,000 variables and 20,000 constraints. In less than 10 minutes the PC-based software displays the quantities of coal to order from each production source, the arrival of the fuel in the ports, the transport from the ports to the plants, the energy generated by each coal unit, across the month's 90 time periods.

Designed as a powerful decision-support solution, Grenache has also proven to be a precious simulation tool for running "what if" scenarios, making it an important asset when negotiating a new contract with a carrier or handler or controlling the risk of a break in supply for variable consumption.