MIXOPTIM: a tool for the evaluation and the optimization of the electric mix in a territory

Brief overview

Bernard Bonin and Henri Safa

CEA DEN, Direction Scientifique

Axel Laureau and Elsa Merle-Lucotte, PHELMA

Joachim Miss and Yann Richet, IRSN

- MIXOPTIM (tool developed by CEA) proposed to simulate the behavior of an electric mix by using Monte-Carlo simulations

- **The total cost** of a mixture of electricity sources, the evaluation of **the amount of CO2** produced and **the degree of energy independence** , are evaluated by taking into account
  - the fluctuations of the demand
  - and the stochastic nature of the availability of the various power sources that compose the mix, e.g, wind, solar, hydraulic, nuclear, coal, gas, etc…
  - …

  by **means of a Monte-Carlo simulation** of the source management.

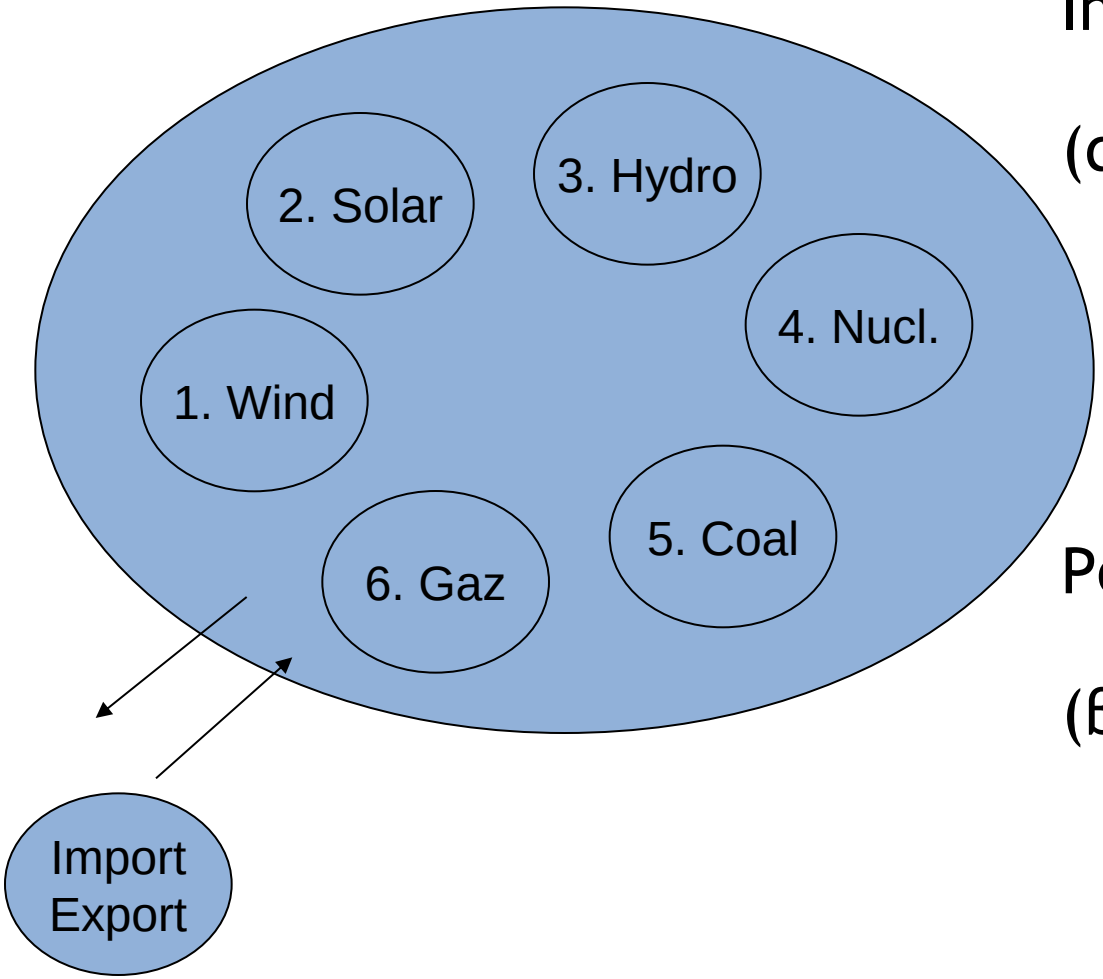
- The load factor Kp of each source is determined via the simulation, contrary to many other evaluation tools, where the Kps are assumed.

- The method of cost evaluation makes a distinction between the fixed costs, which are proportional to the installed power for each source, and the marginal costs, which are proportional to the amount of energy produced by each source.

- Power of Monte Carlo approach to treat such no-linear problem

Publication under construction

Sources and territory



Installed power

(α1, α2, …αi, …).

Power produced at time t

(β1, β2, …βi, …)

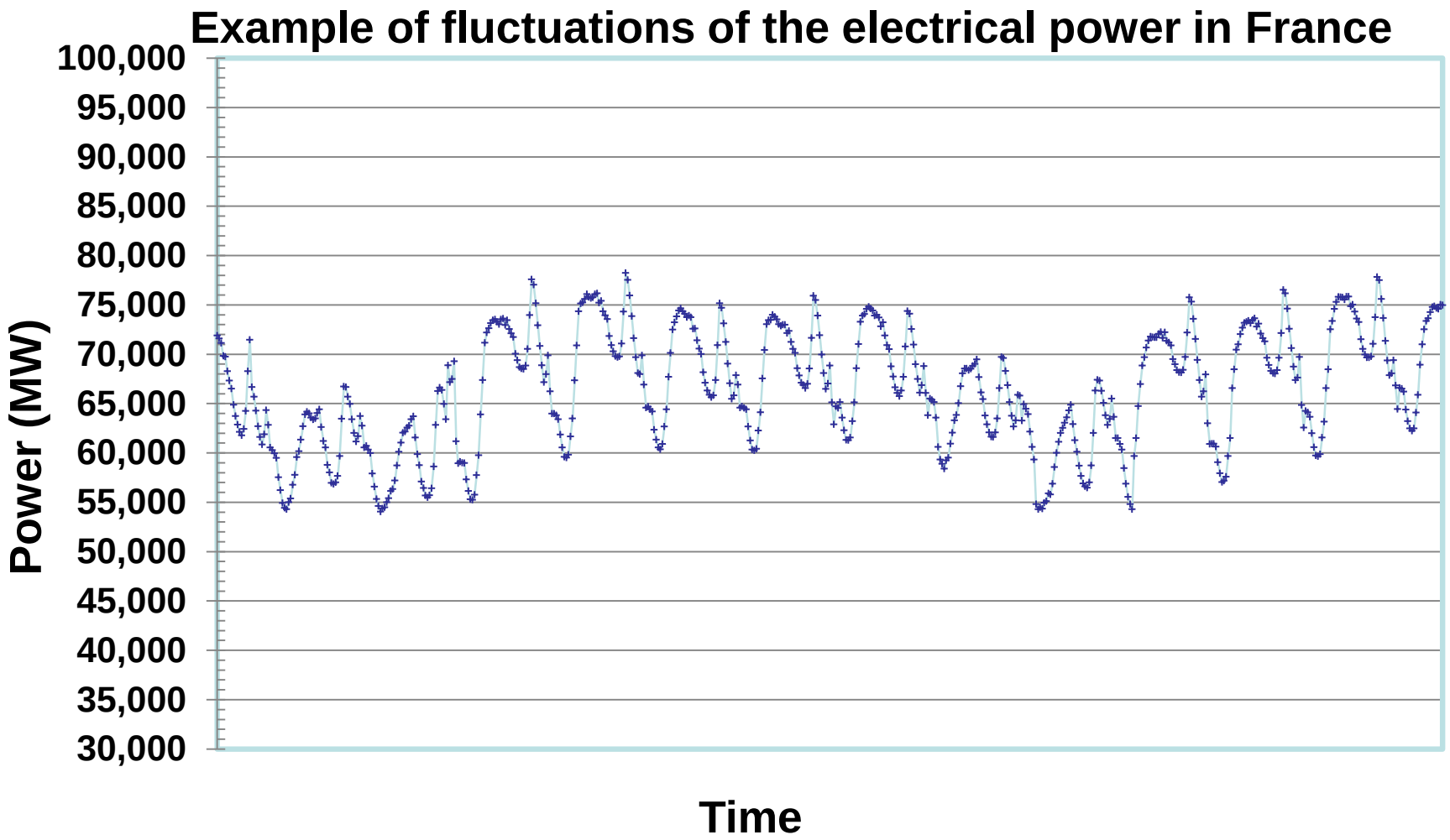
How much to ensure electricity demand?

- Fluctuation of the demand
- Fluctuation in sources availability
- Priorisation in sources utilisation

$$D(t) = \sum_i \beta_i \quad ; \quad \beta_i(t) = x_i(t).\alpha_i$$

- Many conditional probabilities
- Difficulties to determine the average values
- particurlarly nonlinear system

Monte-Carlo Simulation



Fluctuations (and correlations) on the diurnal, hebo- and seasonal timescales are taken into account by the tool

Each source produces electricity at a given cost Ci (expressed for example in €/h). At any given time t, this total cost can be split into two components:

$$C_i = F_i.\alpha_i + M_i.\beta_i$$

€/h

Fixed cost of the source i, i.e. the cost that has to be paid even if the source is not solicited at time t. This cost component includes the amortization of the production installation, the cost of the personnel, the share of the cost of the distribution infrastructure, the cost of insurances, etc…).

In €.MW^{-1}.h^{-1}

Installed power(MW)

the part of the cost that is *proportional* to the power produced by the source(€/MWh)

Produced power(MW)

+ Validation process

+ Importance of statistical input data used to build pdf

+ Mix optimization capabilities

Thank you for your attention
Questions