Artelys | OPTIMIZATION SOLUTIONS

Optimisation des systèmes énergétiques : outils quantitatifs et perspective européenne

Optimization of energy systems: analytics and european examples

Colloque AQPER 2014
L'énergie 2.0 Un monde en changement
Energy 2.0 - A Changing World

Feb. 2014

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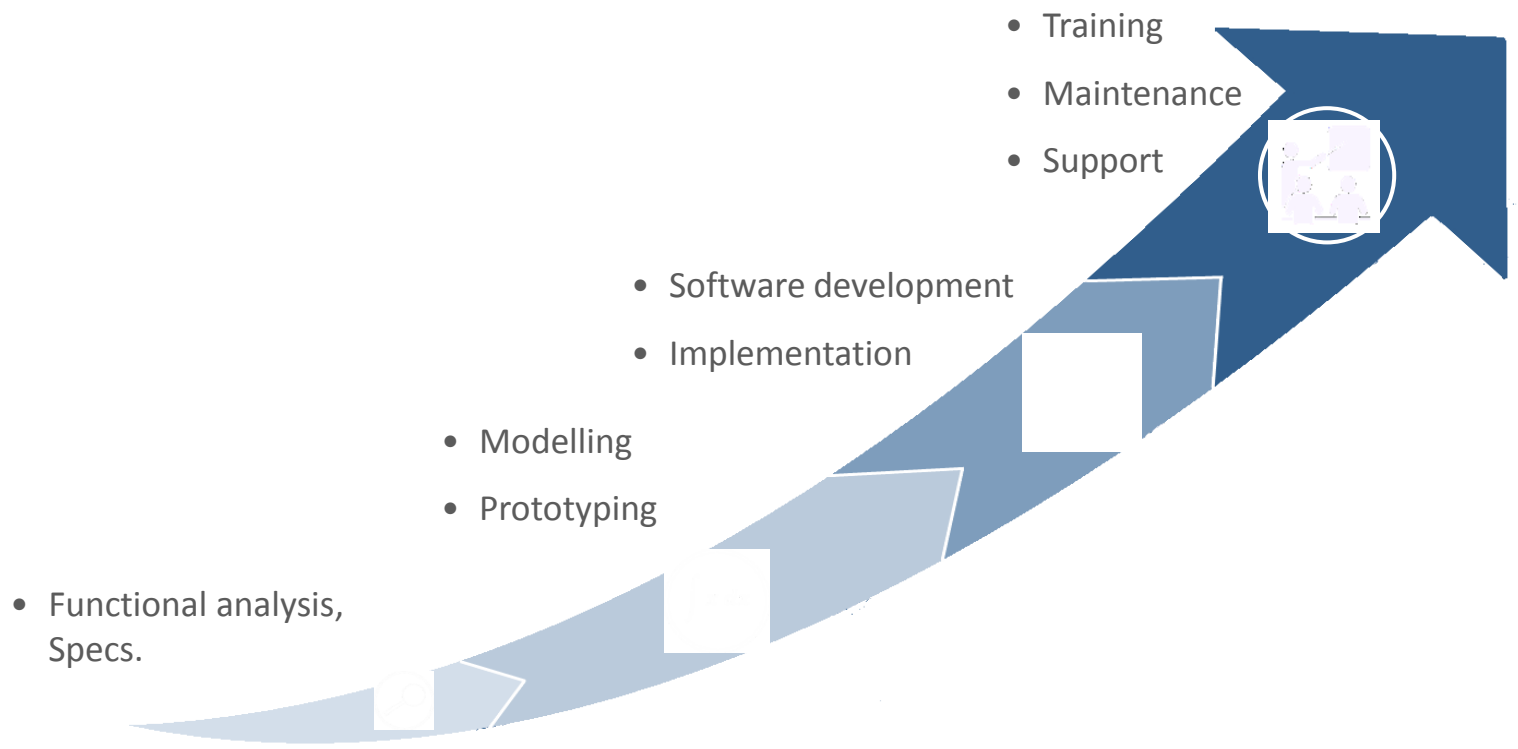
COMPANY OVERVIEW

- Independent company created in 2000
- 40 consultants specialized in applied mathematics, computer science and energy

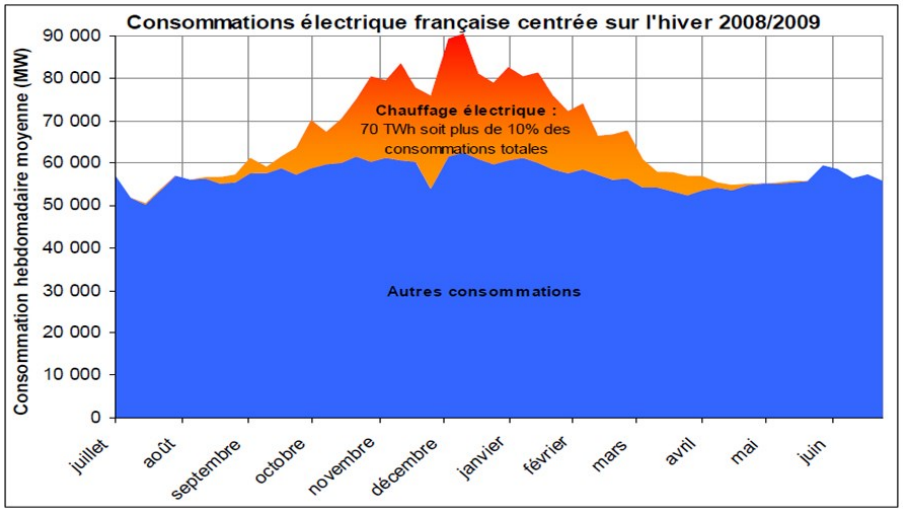
Paris, France Chicago, USA Montreal, Canada



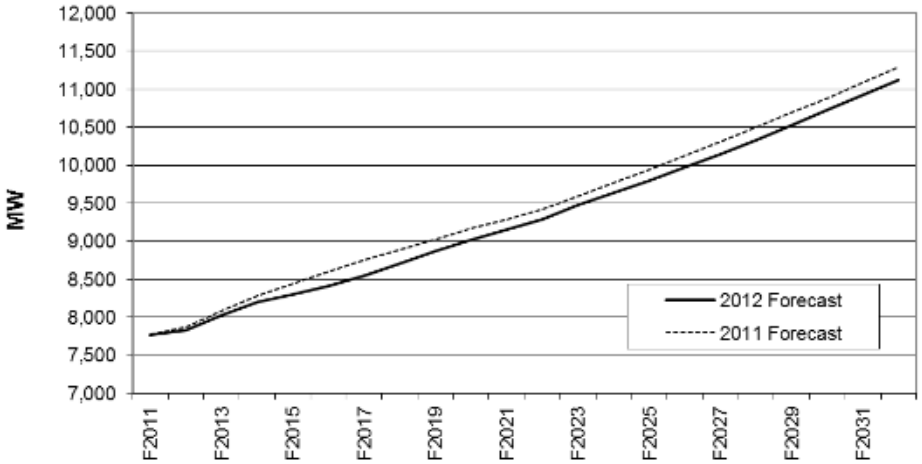
CHALLENGES

SOURCES OF UNCERTAINTY: NOT ONLY RE

- Supply: increase of intermittent sources (PV and wind)
- Load:
  - Large peak load (e.g. heating loads: effect of a one degree temperature decrease in winter: France + 2300 MW)
  - Increasing peak load



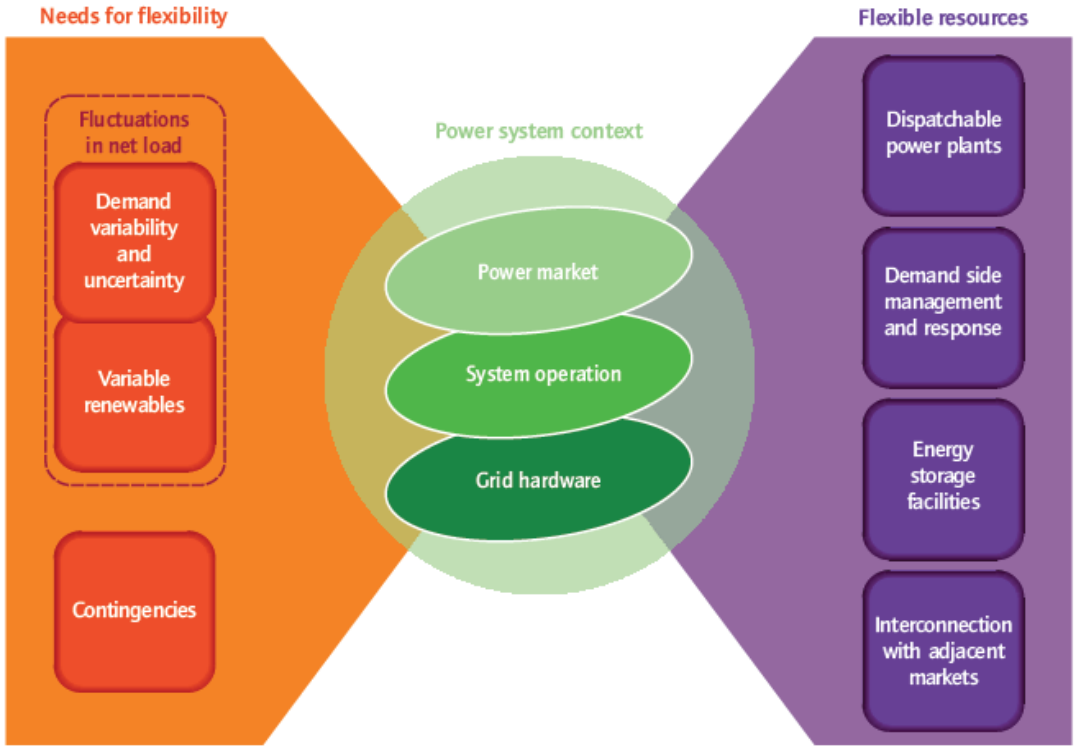
French electricity consumption, winter 2008-2009



Peak Load Forecasting, BC Hydro 2012 Forecast

EVOLUTION OF SUPPLY-DEMAND EQUILIBRIUM

- Former system
  - Fully controllable supply
  - Fixed demand
- Future system
  - Partly intermittent generation
  - Partly flexible demand

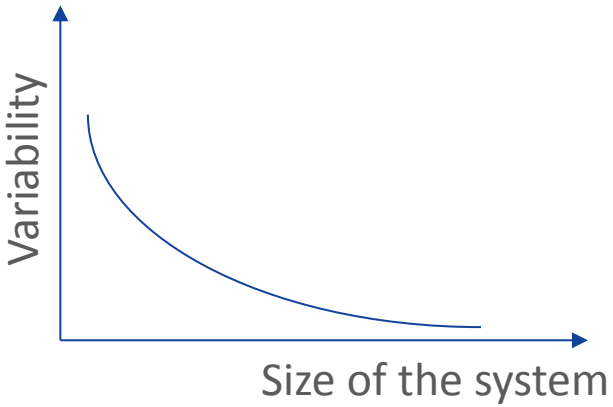


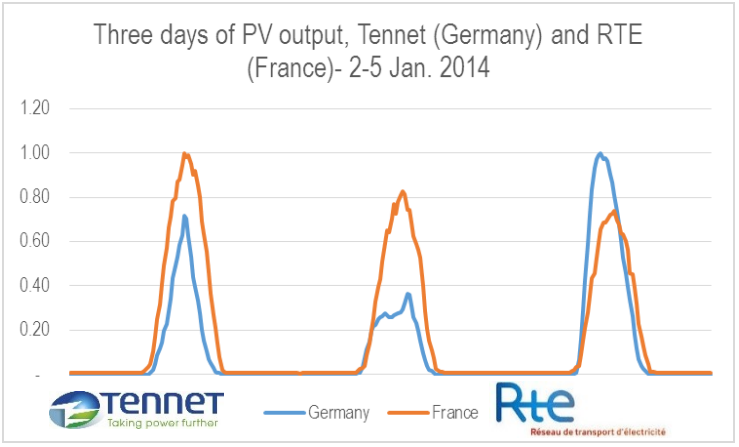
From « Harnessing variable renewables », IEA, 2011

HOW TO MEET THESE CHALLENGES: TOOLS

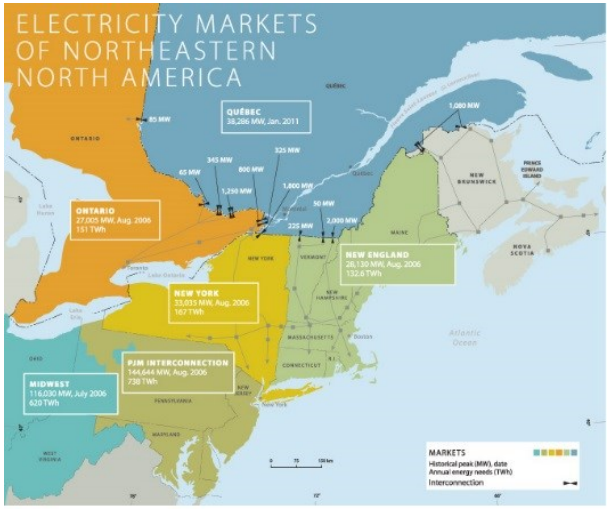
TOOLS: INTERCONNECTIONS

- Variability of intermittent output varies inversely with system size



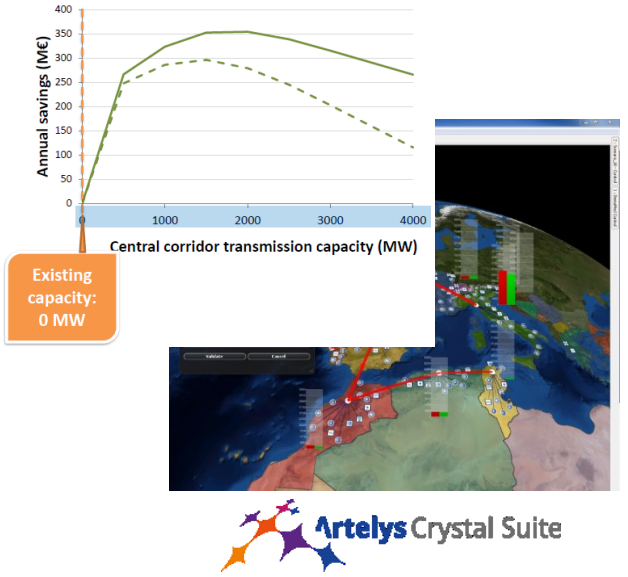


- Asynchronous peak for demand as well
- Complementary production structures
- Electricity storage opportunities abroad



NEW VALUATION'S CHALLENGES

- Example: value of new electrical trans-Mediterranean interconnections :
  - Load flows, marginal production costs
  - For different scenarios
  - New interconnections bring value to the Mediterranean power system **in all scenarios**
  - What is the value and the environmental impact of such interconnections ?



- Example: 4/02/2014, Europe's power markets, price coupling plateform (4 Power Exchanges, 13 TSOs)
  - Belgium, Denmark, Estonia, Finland, France, Germany/Austria, Great Britain, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland (via the SwePol Link), and Sweden
  - What is the value of an asset in such an interconnected context?

North-Western Europe

TOOLS: FLEXIBILITY : TÜPRAŞ

- Already today, flexibility of many industrial consumers may have a significant value
  - Example: Izmit refinery (Turkey) run by Tüpraş
  - 3 000 GWh steam consumption, 420 GWh of electricity, 100 MW network connection
  - Strategies optimization challenges:
    - Handling operational constraints **together with** global economic optimization (costs, market opportunities, environmental impact)

Costs et pollution reduction by 10+% with no investment

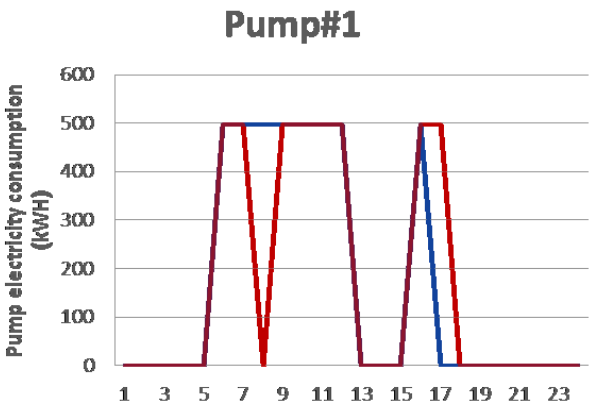
- **Example**: Water networks contribution to Demand Response

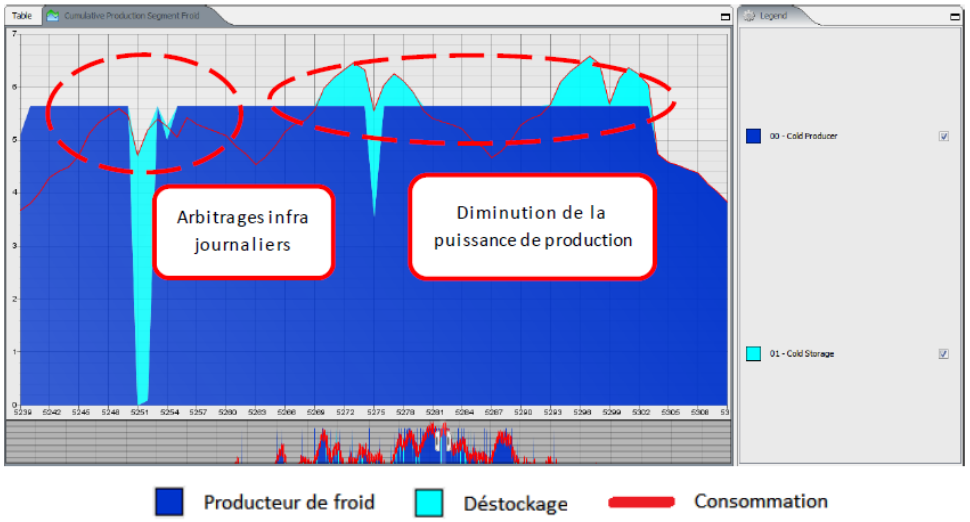
ARROWHEAD

Schneider Electric

  - Case study Birkerod (Danemark), ~600kW pumps
    - ↳ Tarification evolution+demand response programs

- **Example**: Cool storage in refrigerated warehouses
  - 1mio sq. feet building- 600m3 ice storage



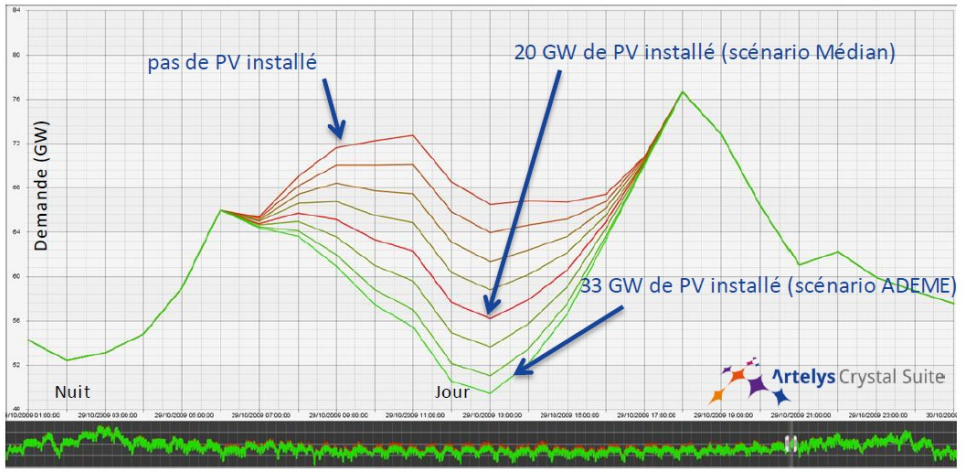


TOOLS: FLEXIBILITY: STORAGE FOR FRANCE IN 2030

- Example: Techno-economic study to assess the potential for energy storage in France
  - French environment agency / French Ministry for Industry / industry consortium
  - Joint evaluation of the value of all the services provided by storage : load shifting, ancillary services, avoidance of network reinforcement costs
  - Several 2030 policy scenarios

  - What is the value of various types of storage ?

- **First conclusion at the French level, for moderate PV production**
  - PV coincides with high demand
  - Needs for flexibility do not increase dramatically



- For larger PV production, optimized management of EWH storage brings additional Flexibility

TOOLS: FORECAST

Improvement of forecast accuracy reduces the uncertainty

Large amount of data can be processed

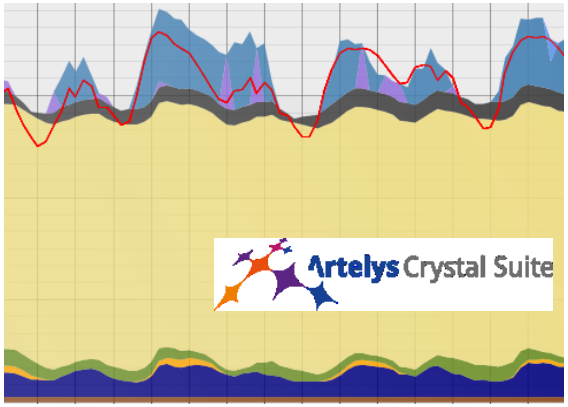
- Load curves forecast based on historical data and temperature forecasts
  - ↳ **3 years of data, more than 2000 network nodes**
- Heat demand forecast for an heat network operator

Predictive model for demand-side management potential

- For a smart grid operator in Europe
- Only residential sites
- Using quantile regression (e.g. pool accessible 90% of the time)

OPTIMIZE DISPATCH

- Interconnections + Flexibility + Forecast
- Short-term optimization of the daily electricity production
  - Satisfying all operational constraints
  - Reducing global production costs
- Example: Artelys Crystal Energy Planner is currently deployed (EDF SEI and E-ON)

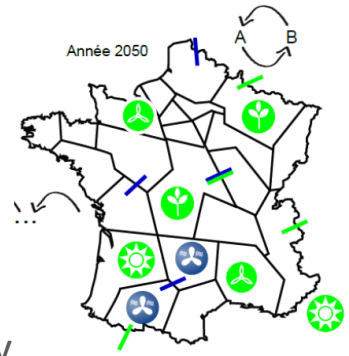


100% RENEWABLE ELECTRICITY ?

100% RE FOR FRANCE IN 2050

- Is it possible to optimize supply, demand management and interconnections together ?
  - German study (SRU)
  - US study (NREL-DOE)

"generation from technologies that are commercially available today is more than adequate to supply 80% of total U.S. demand"



  - Ongoing study at the French level funded by French environment agency
    - How can 100% renewable electricity supply meet French demand in 2050 ?
    - 2010-2050 transition path analysis

- Very detailed description of the supply-demand equilibrium, based on detailed meteorological scenarios (temperature+wind+sun) is required:
  - Renewable's variability in output
  - Geographical dispersion of production assets (France divided in more than 20 regions, including inter-zones transport capacities)
  - Interconnections with neighbouring countries
  - In this context, the optimization of the generation mix together with transmission system turns out to be a new and very challenging problem

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