



Ariane

Utilities management and power plant optimization

Producing utilities at the minimum cost while respecting all constraints

In both industrial sites and district heating plants, challenges faced by utilities production plant designers and managers are multiplying and becoming increasingly complex: reducing production costs, minimizing investment risks, controlling polluting emissions, investigating cogeneration projects, evaluating different contractual options... To respond to these challenges they need efficient software tools to conduct in-depth analysis of the installation and to identify its optimal configuration, without considerable amount of expertise in modeling.

In many industrial sectors, energy production is the main operational cost, after the raw material. For district heating, it is the key element of a unit profitability.

Ariane software purpose is to reduce and manage efficiently these production costs. It is a decision support tool dedicated to the production of utilities (steam, electricity, hot water...).

In design, operations or planning, Ariane enables the user to determine how to operate the utilities production system to reach the lowest cost considering the current demands and prices.

Depending on the sites, the expected savings reach several percents of the global energy bill.

- 🔹 A modeling and optimization tool **specifically designed for utility production plants** of industrial sites, district heating networks and collective heating.
- 🔹 A technology that allows to manage and optimize the **most complex plant configurations**.
- 🔹 The possibility to use Ariane “**online**” for **real-time optimization**.
- 🔹 An **open software**, easy to implement and to use.
- 🔹 The **choice of many players** from refining industries, petrochemical plants, paper mills, district heating and providers of energy services.



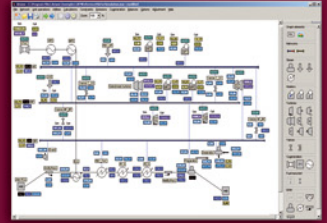
ProSim

Software and Services in process Simulation

A solution that responds to all energy production issues

Due to their structure and the numerous constraints they need to manage, utilities production plants are often more complex than they appear. Potential savings from an activity specific management and optimization tool such as Ariane, are therefore significant and can be materialized at many different levels:

- **In design and investment planning:** quickly evaluate different options, pre-size new equipment, consider existing equipment modification, analyze the relevancy of alternative fuels, adapt an installation to norms and external constraints (environmental regulation in particular), test new production configurations... *With Ariane, the project engineer can determine the most profitable investments and demonstrate their relevancy.*
- **In operation:** plan or adjust utilities production according to the plant needs and power costs, react quickly to equipment failure or to a change in demand, evaluate and minimize the true energy cost (reduction of waste streams, consumption of different fuels...), calculate the level of emissions, train and sensitize operators on some aspects of plant operation, compare actual production with planned production (a constant source of improvement). *At any moment, Ariane allows operations personnel to configure and operate the plant at the lowest possible cost.*
- **In management:** create complete financial balances of the utilities production from an accurate evaluation of costs, track performances of a single or several equipment items, schedule maintenance, select the best electricity, gas suppliers or tariff agreement among different offers, evaluate the profitability of cogeneration and the opportunity of electricity trading while knowing its exact cost, manage CO₂ quota, analyze costs over a long period according to load variations and resources prices. *With Ariane, the plant manager has a flexible tool to reduce the global energy bill.*



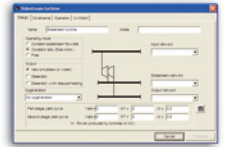
Utilities production plant representation

The means to represent the energy production accurately

Most of the tools developed to simulate or optimize energy production plants rely on linear models that use simplifying assumptions. It is rarely sufficient. Ariane, on the contrary, provides the user with a modeling environment that takes into account the full complexity of these plants.



- **A library of unit operations:** boilers, turbines, deaerators, valves, but also specific equipment for cogeneration and district heating networks (heat exchangers, water heaters, preparators...).
- Each equipment item can be configured to take into account its **technical constraints** (min/max), its **operating mode** (run, hold, imposed or "optimizable" flow), **design characteristics** (yield curves...) and **capital or maintenance costs**.
 - Models used for equipment items are **non-linear**. This allows a realistic representation of the evolution of their yield and enthalpy balances, whatever the load of the plant could be.
 - An **unlimited number of headers** can be taken into account. Each one is associated to a specific configuration and energy requirements (steam pressure level, temperature...).
 - A **thermodynamic model** able to represent accurately the properties of water, steam and fumes.
 - A **database that includes the most common fuel** (natural gas, oil, coal...) and that the user can enrich by creating his / her own fuels (biomass, black liquor, wastes...).



Side-stream turbine configuration window

Powerful and proven optimization techniques

Basic principles (maximum use of extraction turbines, no steam venting...) or simple calculation tools developed in a spreadsheet can be sufficient to operate small and simple plants, with limited flexibility. In many cases however, it is not enough and it is necessary to implement powerful numerical methods to take into account the full complexity of the system and to determine the optimal operating conditions.

Simulation, simple optimization, optimization with stop or restart, the different calculation modes available in Ariane allow technical and economical analyses of a power plant at different levels of details in order to respond to both operational and strategic needs of a company.

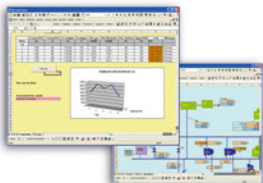
These possible calculations use powerful and rigorous algorithms that are based on an approach suited to the complexity of the system: linear optimization (as a first step), non linear in continuous variable (NLP) or mixed (MILP: permutable turbines, run / hold of equipment items...).

Furthermore, initialization and weighting capabilities make Ariane a robust, reliable but also flexible tool that can respond to the complexity of the problem and handle all kinds of particular case (unusual constraints or operating conditions...).

| Equipment | Fuel | Cost | Value | Unit | Value | Unit |
|--------------------|------|---------|---------|------|---------|------|
| Boiler | Coal | 1000000 | 1000000 | \$/T | 1000000 | \$/T |
| Turbine | Coal | 2000000 | 2000000 | \$/T | 2000000 | \$/T |
| Deaerator | Coal | 500000 | 500000 | \$/T | 500000 | \$/T |
| Water Heater | Coal | 300000 | 300000 | \$/T | 300000 | \$/T |
| Preparator | Coal | 200000 | 200000 | \$/T | 200000 | \$/T |
| Heat Exchanger | Coal | 100000 | 100000 | \$/T | 100000 | \$/T |
| Valve | Coal | 50000 | 50000 | \$/T | 50000 | \$/T |
| Header | Coal | 20000 | 20000 | \$/T | 20000 | \$/T |
| Extraction Turbine | Coal | 1000000 | 1000000 | \$/T | 1000000 | \$/T |
| Generator | Coal | 500000 | 500000 | \$/T | 500000 | \$/T |
| Condenser | Coal | 300000 | 300000 | \$/T | 300000 | \$/T |
| Water Pump | Coal | 200000 | 200000 | \$/T | 200000 | \$/T |
| Steam Pump | Coal | 100000 | 100000 | \$/T | 100000 | \$/T |
| Extraction Pump | Coal | 50000 | 50000 | \$/T | 50000 | \$/T |
| Header | Coal | 20000 | 20000 | \$/T | 20000 | \$/T |
| Valve | Coal | 10000 | 10000 | \$/T | 10000 | \$/T |
| Header | Coal | 5000 | 5000 | \$/T | 5000 | \$/T |
| Valve | Coal | 2000 | 2000 | \$/T | 2000 | \$/T |
| Header | Coal | 1000 | 1000 | \$/T | 1000 | \$/T |
| Valve | Coal | 500 | 500 | \$/T | 500 | \$/T |
| Header | Coal | 200 | 200 | \$/T | 200 | \$/T |
| Valve | Coal | 100 | 100 | \$/T | 100 | \$/T |
| Header | Coal | 50 | 50 | \$/T | 50 | \$/T |
| Valve | Coal | 20 | 20 | \$/T | 20 | \$/T |
| Header | Coal | 10 | 10 | \$/T | 10 | \$/T |
| Valve | Coal | 5 | 5 | \$/T | 5 | \$/T |
| Header | Coal | 2 | 2 | \$/T | 2 | \$/T |
| Valve | Coal | 1 | 1 | \$/T | 1 | \$/T |

Financial balance after Simulation and Optimization

What-if studies and real-time "online" optimization



Analysis of data from Plessala in MS-Excel

Ariane is used to create the plant model and to run "offline" analysis of different parameters configurations and production scenarios. Plessala, an add-on module of Ariane, allows the user to run "online" optimizations that identify at regular intervals the actual operation cost, the possible minimum costs and the means to reach it. With Plessala a direct link with the real-time plant database (and therefore the DCS) is established and Ariane runs automated calculations with the data retrieved. The user can analyze, manipulate data and exploit the results in any software that supports the COM technology, in particular MS-Excel. The potential utilization are greatly expanded and in particular, it becomes possible to:

- Manage constraints on long periods (cogeneration contracts, annual CO₂ quota...).
- Generate retrospective balances and conduct multi-period or multi-site analyses.
- Perform data validation and detect sensors failures.
- Produce results according to users expectations: operators, engineers, managers...

Implementation suited to the needs and resources of each company

Ariane provides a very intuitive environment, which does not require the user to be an expert in modeling to retrieve benefits.

The graphical interface offers numerous features that ensure quick learning and reliable utilization: consistency controls on the data keyed in, direct access to equipment configuration and results, results export to MS-Excel....

In case the user does not have the necessary internal resources, ProSim can take in charge of all or part of the optimization project (data collection, model tuning, optimization configuration, links with DCS, users training...).

