EPSEM

Fact Sheet

Motivation

The operational management of complex energy nodes with several energy carriers, like electricity, heath, cooling etc., requires a strategy that looks for the optimal integration of the different energy forms fulfilling the plant technical constraints and user demands. Optimal working point of the plant can be sought by minimizing the plant running cost, its environmental impact or both. Interactions with external economical conditions like electricity prices and environment like renewable energy sources production, call for a high level modeling of the system that is described in terms of power flows. After the optimization procedure has defined the power flows within the plant, thermodynamic and electrical set-points can be consequently adjusted.

The Software

EPSEM (**E**nergy **P**roduction **S**ystem **E**xecutable **M**odel) is a software for the ***simulation and optimization of polygeneration systems*** with different energy carriers, like cogeneration and trigeneration plants.

It is the result of a project that has involved different partners: **Emisfera** – Verbania, **Net Surfing** – Ivrea, **Hal Services** - Borgosesia, **Politecnico di Torino** and has been developed with the contribution of European funds (PAR FSC 2007-2013 A.1.3.C).
Roughly EPSEM is a web solution built upon a library called XEM13 provided by Politecnico di TORINO (DENERG).

The software takes into account ***technical, economical and environmental aspects*** of an energy system in an integrated way and it can be ***used for different purposes*** as, for example:

- *planning of the new installations* by evaluation of the real performances of the plant
- *operational management* of the existing plant based on forecast prices and demand.
- *check the plant component performances* by comparison between simulation and measurements on field

The ***analysis is based on the balance of power flows of the different energy carriers*** and it takes into account contribution of the Renewable Energy Sources both in thermal and electric form. The *software can simulate and optimize energy systems with a wide number of components* connected through the following energy carriers:

- hot, cold and low enthalpy water
- electricity
- steam

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The ***optimization*** procedure of EPSEM ***finds the production profiles of all controllable power sources, minimizing the operational cost*** of the plant by means of a mathematical formulation of the problem using *Mixed Integer Linear Programming*. In this way also technical constraints are taken into account as, for instance, the operational and ramp limits or the minimum on time and shutdown time of each components.

The software is equipped with a ***GUI interface*** for the input of the plant structure and with an editable database of power components.

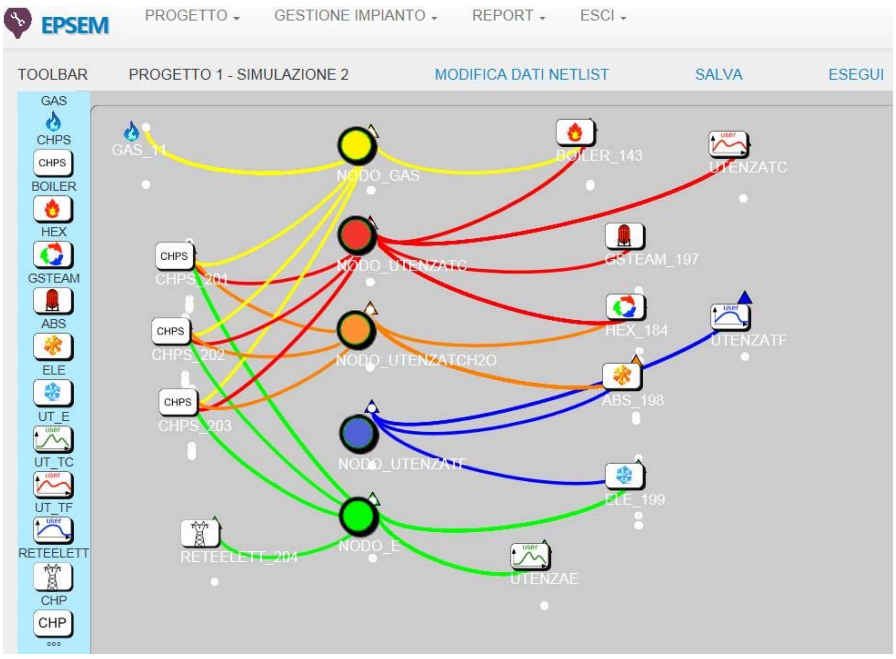

Figure 1. Example of GUI: colors refers to different energy carriers, circles represent balance nodes for each energy carriers and power modules are shown as icons.

The user interface is provided with a *components toolbar*. Each component can be dragged into the main workspace, and then further moved and customized. A consistency check is performed on each energy vector so that each component can only be connected other ones using the same energy vector.

Reporting on results simulation and optimization ***is made in alpha-numeric form*** (i.e. CSV files), ***in graphical form*** on the dynamic production commitment of different units and on the share and interactions of energy carriers by means of ***Sankey diagrams***.

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Figure 2. Example of node balance report.

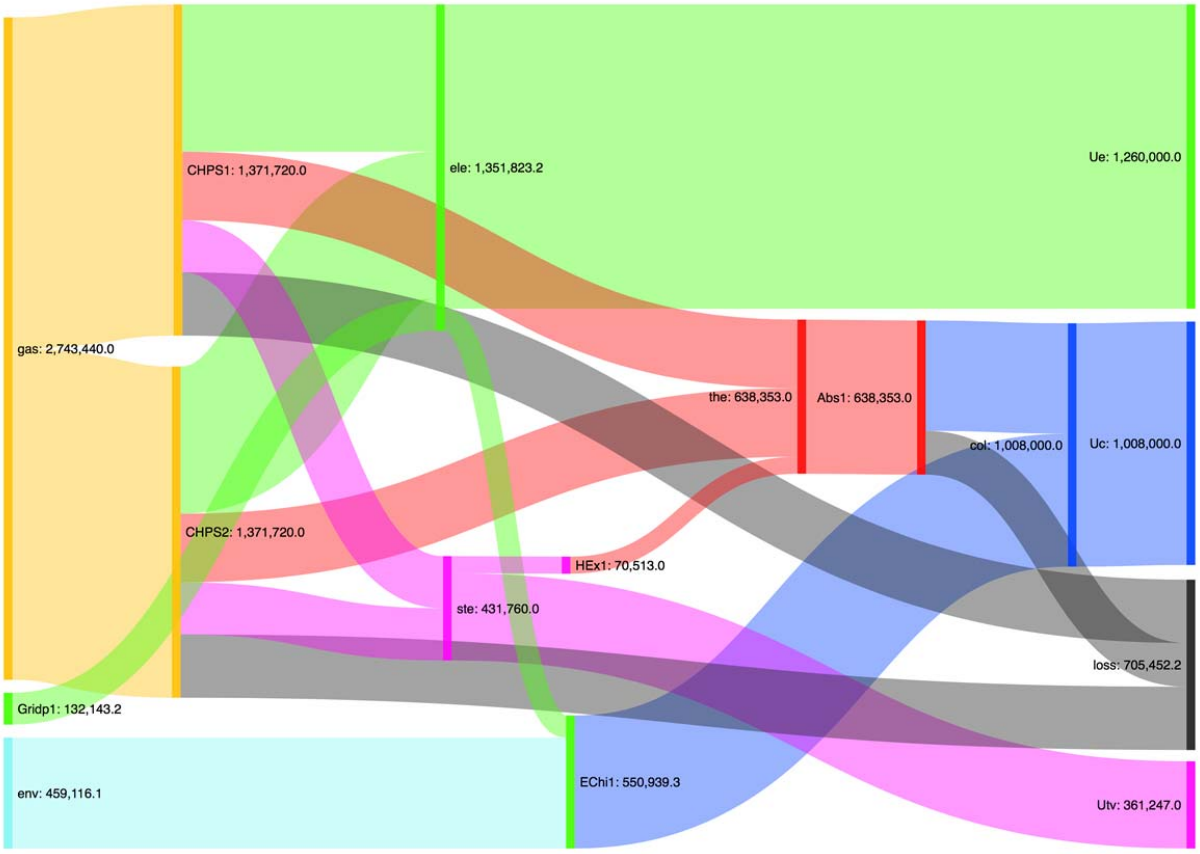

Figure 3. Example of Sankey diagram report.

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EPSEM thus merges technical, economical and environmental aspects of an energy plant configuration in a single tool with the following characteristics:

Technical Aspects:

1. Plant layout and interactions between different energy carriers by components characteristics;
2. Components technical constraints on minimum power, ramp limits, minimum on and shutdown times;
3. Load demands and possible non-dispatchable renewable contributes are used as constraints of the problem;
4. Optimizes energy storage management on a scheduling period (a day, a week, etc.)

Economical Aspects:

1. Electricity prices dynamics are taken into account in a market hourly basis;
2. Fiscal incentives on fuels are implemented into the problem formulation;
3. Incentive on renewable contributes are considered in the economic balance of the problem

Environmental Aspects:

1. Power components fired by conventional fuels are characterized by their emission coefficients (i.e. emission factors) in terms of greenhouse gas global pollutant, like carbon dioxide, and local pollution as NOx, particulate matter, etc.
2. Emission factor for consumption of purchased electricity from the grid is based on country database
3. Biomass fired components emissions are considered

Possible application of EPSEM can be the following:

- District Heating with RES contribution as solar thermal, low-enthalpy heat recovery, etc.
- District Heating with and without thermal storage
- Household Energy Management with RES and energy storage

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