PSR

NCP

Overview

NCP determines the least cost dispatch of power systems in hourly time steps or less (30, 15 or 5-minutes). The planning horizon ranges from a few hours up to two months ahead. The most common applications are the day-ahead, week-ahead and re-dispatch planning.

NCP can also be used to determine revenue maximization dispatch strategies for electricity companies in competitive markets.

The model represents the following elements:

Hydroelectric plants

- Individual and detailed representation of reservoirs
- Storage and flow change limits through turbines, spillways, channels
- Run-of-river hydroelectricity
- Pumping stations
- Water travel time between hydropower plants in cascade
- Different ancillary services
- Spillway rating curve
- Forebay ramps

Hydroelectric units

- Unit commitment constraints
- Net head (forebay, outlet and penstock friction losses representation)
- Turbine efficiency (hill curve) and forbidden zones
- Inertia provision
- Different ancillary services
- Ramping constraints

Thermoelectric plants

- Unit commitment constraints
- Open cycle / combined cycle modeling
- CHP modeling with the coupling of the power sector with heat/steam demand
- Multi-fuel power plants representation
- Non-linear heat rate curve
- Start-up costs, including differentiation for hot, warm, and cold start-ups
- Ramping constraints
- Energy bids in competitive markets / no-load cost
- Different ancillary services
- Greenhouse gas emissions

Variable renewable energy (VRE)

- Curtailment
- O&M cost
- Different ancillary services
- Production scenarios

Batteries / Fast response storage devices

- Round-trip efficiency
- Storage capacity
- Charge/discharge ramping constraints
- Different ancillary services
- Energy injection bids
- Target storage

Transmission network

- Kirchhoff laws
- Power flow limits
- Quadratic losses
- Phase-shifters
- Wheeling costs
- Export / import limits
- Sum of circuit flow constraints in regional exchanges

Objective

NCP co-optimizes dispatch & reserves, including many components in the objective function of the problem, such as: fuel usage (variable production and startup costs), deficit costs, and penalties for the violation of operative constraints, among others. NCP can be integrated with mid/long-term models such as SDDP, by reading a terminal function, that is, a future cost (or benefit) function of a given week or month.

To couple short-term decisions with mid/long-term objectives, NCP can use one of the following additional options:

- Target storage for each reservoir at the end of the horizon
- Target generation (individual or a set of plants)
- Individual terminal functions (stored water level x future cost)

Furthermore, the following aspects are considered by the model:

- Demand response: response to price signals by segment at systemic or bus levels
- Multi-objective frequency control ancillary services: involving the largest generator contingency, system inertia, interconnection flows, absolute limits, and any requirement combination between them

Methodology

The short-term energy planning tool is formulated by NCP as a large scale mixed-integer linear programming (MILP) model. The problem is solved with state-of-the-art optimization techniques for Linear and Mixed-Integer Linear Programming (including Branch & Bound, branch & cut generation strategies, and heuristics).

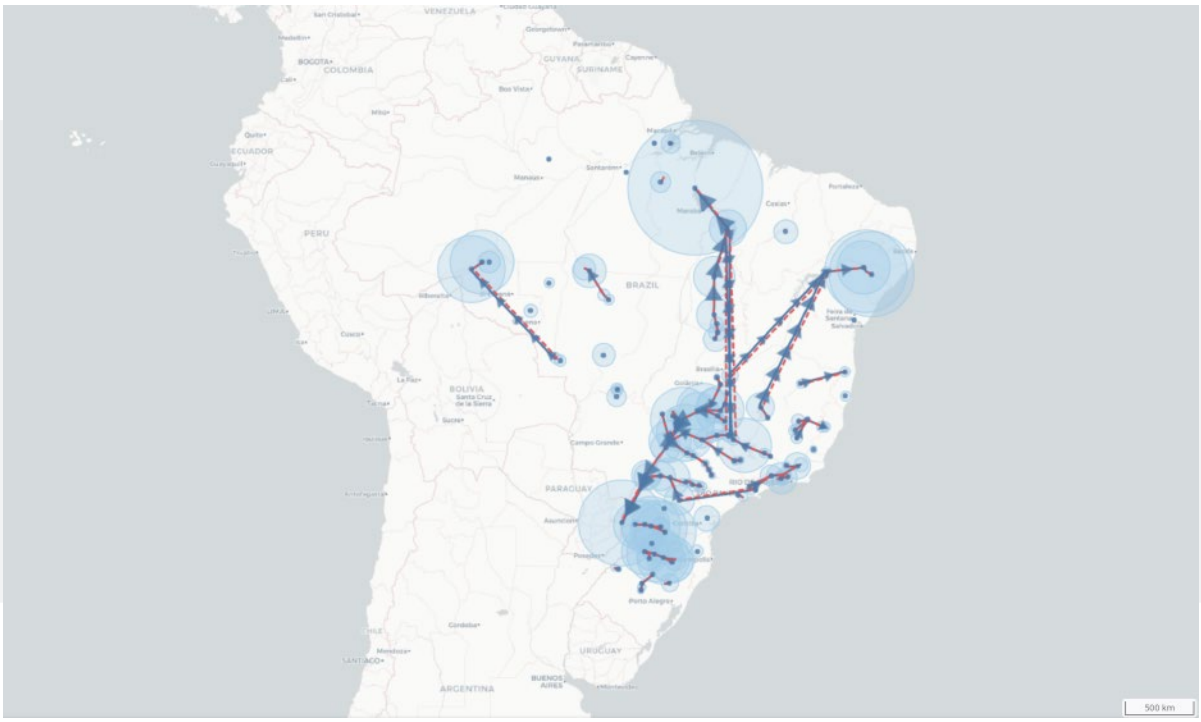
Users can intervene in the solution process and applied strategies by setting execution parameters, such as the absolute tolerance or relative gaps, and the maximum CPU time allowed.

User interface

NCP has a Windows based user-friendly graphical interface that facilitates the input of modelling options, as well as the execution parameters.

Additional features include:

- **Power View:** visualization of transmission-related study results on a georeferenced map. Integrated environment, animated circuit flows, circuit loading, and bus-related information such as production or load. It is also possible to show an animated chronological evolution of the input data or results for the horizon.
- **Hydro View:** similar to PowerView but applied to the visualization of hydropower projects in cascades.
- **PSR IO:** a business intelligence tool for post-processing outputs and creating user-customized dashboards to facilitate better decision-making. It is a scripting language developed in Lua to query data in databases and perform user-specified mathematical, statistical, and data processing operations. PSRIO automates and standardizes everyday operations by delegating tasks to an easy-to-use and secure language, minimizing manual errors and repetitive works.

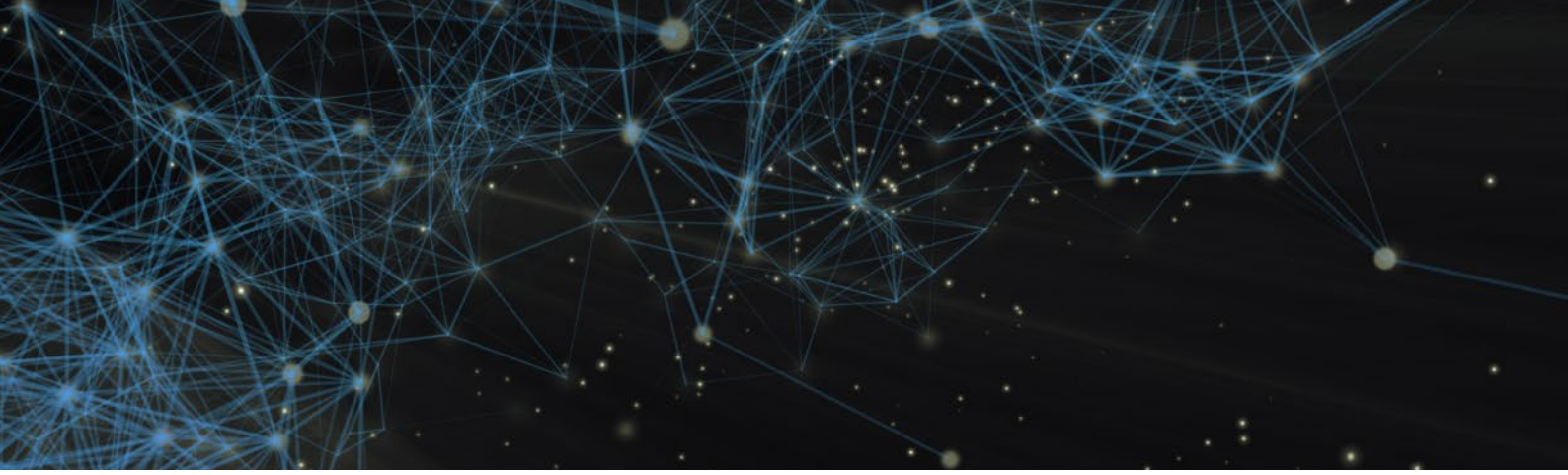


Application programming interface (API) for Integration & Automation

The API of NCP establishes communication between external applications and NCP. This scheme allows the automation of data input, data transformation and control of the execution flow. This is especially useful for real-time redispatch analysis, SCADA system integration and for trading in intraday markets.

The main characteristics are:

- Real-time modification of any configuration data or scenario using instructions written in JSON protocol and/or CSV files
- Management and execution of simultaneous NCP cases
- Requests and response handling (HTTP service or a .NET library)



Main results

NCP produces over 250 reports in Excel-friendly formatted files. The results are managed by the graphical interface that extracts the desired statistics and creates charts directly in Excel.

Examples of NCP results include:

- System operation statistics: deficit risks, transmission flows, emissions, production, and respective costs among others
- Commitment status of power units (On/Off)
- Allocation of ancillary services
- Locational marginal costs
- Transmission congestion costs
- Water values of each hydro plant

Furthermore, aggregated results such as average marginal costs, total generation and total costs are produced in CSV-format reports and can be visualized through a dashboard, available online:

Uses of NCP

The NCP model is the official short-term tool of many national dispatch centers and it's globally used by regulatory agencies, generators, and utilities. NCP has also been applied in dispatch scheduling studies in several countries in all five continents:

AMERICAS	EUROPE	ASIA	OCEANIA	AFRICA
Mexico, United States, Canada, Panama, Guatemala, Honduras, Costa Rica, El Salvador, Nicaragua, Dominican Republic, Brazil, Ecuador, Bolivia, Chile, Peru, and Colombia	France, Norway, Turkey, Ukraine, Albania, Bosnia y Herzegovina, Bulgaria, Macedonia, Montenegro, Serbia, Kosovo, Romania, and Slovenia	Sri Lanka, India, Philippines, Vietnam, Malaysia, and Pakistan	Australia, New Zealand, and New Caledonia	Morocco, Egypt, Senegal, and Tanzania