NCP PSR

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Objective

NCP determines the very detailed transmission-constrained least cost dispatch for a horizon of up to one month using time steps of one hour, thirty minutes or fifteen minutes. NCP can also be used to determine the revenue maximization dispatch strategy for companies in competitive markets.

NCP minimizes thermal production costs (variable costs and start-up costs) and penalties associated to the violation of operational constraints, such as minimum outflows or energy rationings. NCP can be integrated with mid-long term models such as SDDP, by importing the future cost (or benefit) function for the end of the first week or month. This function can be "plugged" at the end of NCP planning horizon and is associated to the reservoirs end storage vector. NCP's revenue maximization mode works similarly to the least cost mode. The only difference is that exogenous spot price scenarios must be provided.

Modeling Aspects

NCP is formulated as a detailed mixed-integer optimization problem, with the following characteristics, among others:

- Active power balance for each stage in each bus bar of the transmission system, including Kirchhoff laws, transmission capacity constraints and circuit losses resulting from the optimum power flow;
- Hydraulic balance for hydro plants in cascade, including travel times from upstream to downstream stations and wave propagation effect;
- Minimum and maximum production for hydro and thermal plants;
- Commitment-type decisions, ramp constraints, minimum uptime and down-time constraints, maximum up-time constraint, maximum number of start-ups for the study horizon or in each day, initial conditions (if plants are on/off in the beginning of the study and for how long they have been in that state);
- Representation of renewables and batteries;
- Co-optimization of generation and reserves;
- Minimum and maximum reservoir storage, alert and flood control storage, irrigation, minimum and maximum total outflows, minimum and maximum turbine outflows;
- Target generation constraints (at least, at most and exactly types) for a user-provided timeframe within the study (horizon) and for a set of selected hydro and/or thermal power plants;
- Target (end of horizon) reservoir storage constraints;

- Hydro unit optimization, considering the variation of the turbine generator efficiency versus turbined outflow, tailwater elevation, head versus storage relationship in the reservoir, hydraulic head loss in the penstock and generation units;
- Forbidden zones of production for hydro plants.

The optimum solution is obtained through advanced techniques of mixed-integer programming.

System Characteristics

- Windows-based user friendly interface;
- Module for graphing output results, integrated with Excel. The results include: hydro and thermal power, marginal costs in each bus, circuits power flows and losses, start-ups and decisions, operating costs, load rationing, stored volumes, turbine and spillway outflows, and many others. Results are given in time steps of one hour, thirty minutes or fifteen minutes, depending on the granularity of the case defined by the user.

Integration with Other Models

As mentioned, NCP can import future cost functions (water values) from SDDP and other models.

NCP results, based on an active power flow model, may be used by OptFlow – optimal AC power flow model also developed by PSR. OptFlow verifies additional network constraints (e.g. voltage levels) and indicates requirements for reactive support.

NCP is integrated to ePSR – the Oracle-based platform developed by PSR. ePSR has a common interface, database and file sharing system and is responsible for the management of energy planning studies made with both SDDP and NCP. ePSR also integrates NCP's daily or weekly dispatches to external SCADA platforms.

Uses of NCP

- NCP is the official short term dispatch model, used by the Independent System Operators (ISOs) in Bolivia, Ecuador, Peru, El Salvador, Costa Rica, Nicaragua, Guatemala, Panama, Honduras and Sri Lanka, as well as by several utilities in those countries and in Turkey, Morocco, France and Chile;