NCP

short term energy scheduling

Objective

NCP determines the transmission-constrained least cost hydro-thermal dispatch for a horizon of up to two weeks using hourly time steps. NCP can also be used to determine the revenue maximization strategy for companies in competitive markets, such as the NordPool.

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 mixed-integer optimization problem, with the following characteristics:

- Active hourly power balance in each bus bar of the transmission system, including Kirchoff 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 up-time 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)
- 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
- Security constraints (different types of reserve criteria)
- 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, which 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 hourly steps

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 application 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.

Recent Applications

- NCP is the official dispatch model in Bolivia and Ecuador and is in the process of becoming the official model in Peru, Costa Rica, Nicaragua, Dominican Republic and Guatemala
- Used by generation utilities in Turkey
- Used in Albania, Bosnia & Herzegovina, Bulgaria, Macedonia, Romania, Slovenia, Serbia and Montenegro in the activities related to the SEETEC Project
- Used in Norway for maximizing revenues in the Nordpool

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