NETPLAN VERSION 4.0

Integrated data base among optimization and simulation models

The energy and electrical data bases used by SDDP, OptGen and NetPlan models are integrated among themselves.

- Energy data: edition by means of the graphical interface of SDDP model
- Project data: edition by means of the graphical interface of OptGen model
- Electrical data: edition by means of the graphical interface of NetPlan environment

This allows not only data integration but also provides the means to share results produced by the models. Operation decisions of SDDP regarding dispatch scenarios of plants are automatically incorporated to the data base and provide the corresponding chronological generation schedules and demand uncertainties to optimization models of NetPlan. The investment decisions made by these models are also automatically provided to the operation and expansion modules of SDDP and OptGen.

Management module: data, communication among modules and results

Connectivity between data, modules and results:

- Filter to separate *data edition* from *result visualization*, by module
- Global constants are shared by all the models: tolerance for circuit flow violation (normal and emergency operation), minimum impedance and power factor for circuit capacity
- Edition of detailed project data: investment data of candidate projects for expansion and specific constraints (association, exclusivity and precedence)
- Edition and changes in expansion plan

Incorporation and treatment of new data:

- 6 digits identification number for AC and DC buses
- Capacity of circuits given in MVA. Capacity in MW is determined as a function of the power factor capacity of circuits
- Generator data: new generation deviation factor and new voltage control type for renewable plants

- Static VaR compensator: registry data, scenarios of connected units and desired value of reactive power
- Batteries: reactive power data and scenarios of production
- Power injection: scenarios of injections
- Transformer data:
    - Flow control of phase shifting transformer: registry data, scenarios of desired angle value and flow limits (normal and emergency)
    - Voltage control of transformer tap: registry data, scenarios of desired tap values and its operating limits
- Switchable series capacitors: registry data, scenarios for desired reactance value, its flow limits (normal and emergency) and the state of the bypass connection
- Three winding transformers: individual data registry for each winding, individual scenarios per winding with the connection state of each transformer, desired tap value, phase shifter angle and flow limits (normal and emergency)
- AC-DC converters, classified in three groups: LCC (Line-Commuted Converters), P2P (Point-to-Point converters) and VSC (Voltage Source Converters). Definition of registry data, scenarios of connection state, desired value of injection and converter tap, per group
- Definition of data for circuit breakers and switches
- User defined candidate shunt units in the expansion plan, with the corresponding commission dates
- Individualized retirement data of each optimized candidate in the expansion plan
- Bus and circuit contouring in the network drawing, for a group of user defined network configurations
- Individualization of additional constraint data: bus voltage angle differences, sum of circuit flows, environmental constraints for candidate projects, circuit path constraints and right-of-way constraints
- Data importation from PSS/E files - version 32, 33 and 34
- Data exportation to PSS/E files - version 34
- Several illustrative case examples showing new data and novel module features

OptNet module for transmission expansion planning

The new data and novel candidate project features of OptNet are described below:

- Investment cost of project: annualized cost instead of a fixed cost along the whole horizon. The value for a given year considers the financial data of the project, such as inversion and O&M costs, its lifetime and the interest rate

- Special constraints among chosen projects: association, exclusivity and precedence constraints
- New network violation (severity) measure: total circuit overload considering monitored circuits instead of the traditional load shedding severity measure (still available)
- Relaxation criterion: generation deviation with respect to the provided dispatch scenarios, within a pre-specified margins:
    - The margin, a percentage of the initial generation or capacity, can be individualized per generator
    - Thermal and hydro plants can increase and decrease the generation within the margin
    - Renewable plants can only decrease the initial dispatch within the margin
    - Batteries are kept fixed
- Representation of new scenarios for:
    - Batteries
    - Power injections
    - Hourly generation and demand
- New candidate projects:
    - Three winding transformers, with or without circuit flow control.
    - Series capacitors, with or without circuit flow control
    - Three winding transformer
    - DC link project, representing AC-DC converters (LCC, P2P or VSC) and DC circuits
- Reconducting circuit project: AC line, transformer, three winding transformer, series capacitor, AC-DC converter and DC circuit
- Expansion plan:
    - Possibility to consider an initial expansion plan
    - Monthly performance analysis of a given expansion plan for selected scenarios
- Novel operating limits:
    - User defined circuit monitoring list
    - User defined sum of circuit flow limits, per load block
- Output files used to analyze results for selected scenarios and time stages; also used as input to PSRFlow module
- Dashboard summary results

PSRFlow module for AC and linearized (DC) power flow analysis

- Integrated with OptNet and OptFlow modules; analysis considers the projects in the expansion plan, for selected scenarios and time stages
- Representation of new scenarios for:
    - Batteries
    - Power injections
    - Hourly generation and demand
- New controls:
    - Tap and angle of AC-DC converter
    - Angle of phase shifting transformers
    - Commutable series capacitor
    - Static VaR compensator
    - VSC AC-DC converter
    - Renewable generator with different reactive controls
- Output files used to analyze results, for selected scenarios and time stages

OptFlow module for reactive power expansion planning

The new data and features of OptFlow are described below:

- Cost of shunt project: annualized cost instead of a fixed cost along the whole horizon. The value for a given year considers the financial data of the project, such as inversion and O&M costs, its lifetime and the interest rate
- Reactive power injection: can automatically determine injections in all buses necessary to solve nonlinear OPF and provide locations for VaR sources in lacking buses
- Relaxation criterion: generation deviation with respect to the provided dispatch scenarios, within a pre-specified margins:
    - The margin, a percentage of the initial generation or capacity, can be individualized per generator
    - Thermal and hydro plants can increase and decrease the generation within the margin
    - Renewable plants can only decrease the initial dispatch within the margin
    - Batteries are kept fixed
- Representation of new scenarios for:
    - Batteries
    - Power injections

  - Hourly generation and demand
- Possibility to consider an initial expansion plan
- New controls:
  - Angle and tap of AC-DC converter
  - Reactive power generator with voltage control of controlled bus
  - Fixed Shunt; can also have voltage control of controlled bus
  - Fixed transformer tap; can also have voltage control of controlled bus
  - Fixed phase angle; can also have circuit flow control
  - Fixed reactance of series capacitor; can also have circuit flow control
  - Reactive static compensator
  - New heuristic to discretize number of shunt units
  - New VSC AC-DC converter model
- New operating constraints:
  - User defined circuit monitoring list
  - User defined sum of circuit flow limits, per load block
  - Bus voltage monitoring; can also consider a list of monitored buses
- Output files used to analyze results; also used as input to PSRFlow module