

POWEL SIM

Powel Sim is the main modeling and configuration program with short-term hydropower planning within the Powel Smart Generation family. The Powel Sim kernel calculates the short-term consequences of given plans in a hydropower system, with given inflow forecasts and constraints. This simulation engine is used as part of the end-user operative work process from Powel Nimbus (see separate Product Sheet). Powel Sim may also be used for long-term simulations, based on historical inflow and reservoir rule curves or repetitive plans.

The user interface in Powel Sim allows the expert users to perform very flexible, ad-hoc analysis of the hydropower system behavior. The daily, operative work is modeled in Powel Sim as a set of tasks that are later performed step-by-step in Powel Nimbus by the end-users. Optimization results from Powel Shop (see separate Product Sheet) may be used as initial plans for the daily operative planning with Powel Sim.

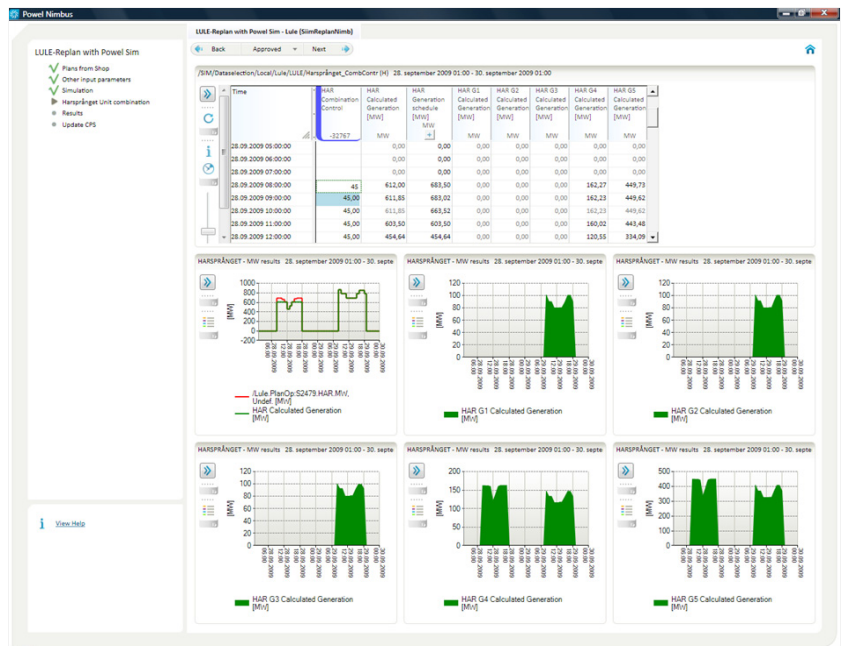
In order to start simulating or optimizing a given watercourse, the first configuration issue is to prepare a watercourse model with Powel Sim. Next, each main task within the planning process is modeled in Sim by defining an Input Dataset, and a corresponding Scenario. When performing the task with Powel Nimbus, data will be fetched from the database as defined in the Input Dataset. Then Sim is invoked to perform a simulation, and finally the user is allowed to store the result as a given Scenario. The resulting Scenario from one task may be used as input to the next task in the daily work process.

The operation modes offered by Sim are:

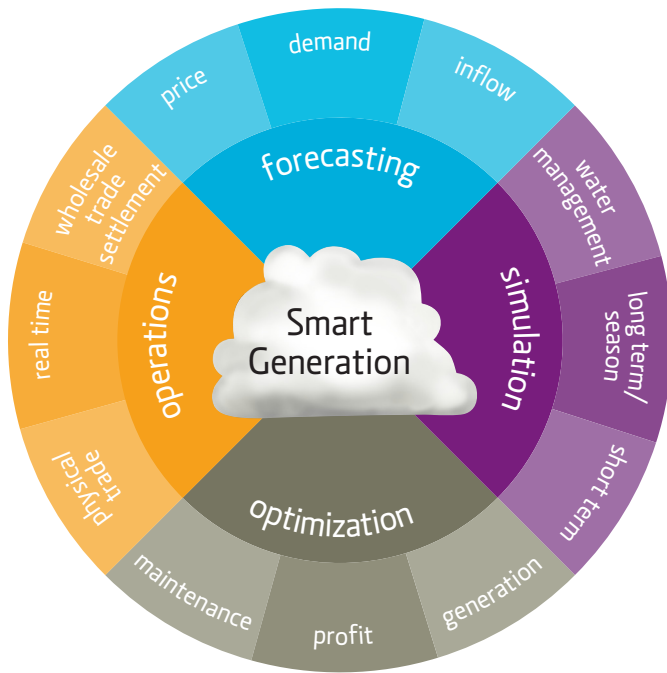
- Optimization – to find generation schedules that give maximum income and/or minimum cost. In this case, Sim acts as the user interface and the input/output server for the optimizer Powel Shop (prerequisite for optimization mode).
- Plan simulation – to calculate production, discharge, reservoir levels etc. for the entire balance group as a consequence of given plans. The results of an optimization with Shop are often used as a starting point for the plan simulation in Sim.

- Inflow calculation – to calculate hourly local inflow for each reservoir. This is normally done as a fully automated job, which calculates the inflow for previous day based on metered data. Sim does this calculation very accurately, based on each unit's efficiency curve and losses at the actual reservoir head for every time step.

The key to smooth operation of the daily planning process is to automate and pre-define the input data processing. Powel Smart Generation uses the Oracle-based Powel Time Series Manager (TSM) for all storage of time series data.



Planning unit usage with Powel Sim, as shown in Powel Nimbus



Powel TSM contains specialized and highly effective tools for time series management, including validation and correction of input data and tailor made functions for time series calculations.

The hydropower system in each watercourse is modeled in Powel Sim by doing “drag-and-drop” from a palette into a topology editor. The main components are power plants, pumps, reservoirs and creek inlets. These components are connected by waterways and junctions. Each power plant is modeled as a number of units with turbine and generator efficiency curves, head losses and so on. Gates are defined as part of the waterways.

Hundreds of different watercourses with complex hydropower installations have been successful modeled and run with Sim, and best-of-breed simulation functionality has been implemented based on this experience.

Several hydropower systems may be joined into a Balance Group in Sim, in order to ease the daily planning work and to optimize the systems jointly. If e.g. a customer has two hydropower systems and wants to fulfill a given hourly total contract, this is easily handled by specifying the total contract as the optimization target at Balance Group level.

The Input Datasets in Sim are used to organize the time series efficiently for each planning task. Each Input Dataset contains links to different time series with up-to-date realized data, price and inflow forecasts, time dependant constraints etc. Revisions and restrictions that are defined in the Powel Availability module may be automatically linked in each Input Dataset. When creating a new planning task in Powel Nimbus, all input data and parameters are set correctly for that task simply by referring to the right Input Dataset.

The Custom Screen feature in Powel Sim allows the user to setup a customized user interface both for checking input data, and for inspecting the results from simulations or optimizations. By using a handy wizard for Custom Screen definition, the user gets access to any input or output data in Sim and Shop and can easily design tabular displays according to his/her own preferences. The tabular displays are also used for data entry, and can be toggled into chart displays for visual inspection of time series data. Custom Screens defined with Sim are also used to inspect and modify input data, and present results in most Powel Nimbus tasks.

Desired production level can be specified as MW or discharge plans at power plant or unit level, or as reservoir rule curves in Powel Sim. Inflow forecasts from Powel Inflow may be used to predict the expected local inflow per reservoir, or Sim can use percentiles of historical inflow.

Sim is used both for long- and short-term generation planning. Time step length for the simulation can be from 1 hour down to 1 minute. The planning time span for the simulator may vary from a few hours, till several years.

Areas of use for long-term planning is to see the effect on reservoir levels etc. from planned revisions, or to analyze how the snow melting in spring time will affect the reservoirs with a given set of plans.

When Powel Smart Generation is used for operative during-the-day planning, a special Scenario is used to hold the current operative plans. By storing to the Current Plan Scenario, the operator approves the plans and they are ready for execution by external SCADA systems. Integration with different SCADA systems is easily established to transfer plans and measured values, via communication protocols or Powel Autopilot.

KEY FEATURES HANDLED BY POWEL SIM:

- Calculation of reservoir levels, discharge, losses and production in the entire watercourse
- Calculation of system data like regulation strength, rotating reserves and slow reserves
- Calculation of best unit combination to fulfill a given plant production plan
- Start/stop cost consideration when changing unit combinations
- Unit and gate prioritizing
- Time delays in waterways
- Automatic bypass through gates, to keep reservoir at planned level when inflow is high
- Function to model how water flows between reservoirs at approximately same level