

SDDP VERSION 16.0



New features

► TIME SERIES LAB (TSL)

In the SDDP model, scenarios of renewable generation can be expressed in two resolutions: (i) by blocks; or (ii) hourly, defined as an annual profile or detailed profile for the entire study horizon. The worldwide increasing penetration of Variable Renewable Energy sources (VREs) continuously requires an increase in the quality of the input scenarios for operation planning studies. Because of that, PSR is pleased to officially announce a new tool called Time Series Lab (TSL), which can generate these scenarios. TSL is completely integrated with SDDP and offered free of charges for all SDDP licensed users.



Time Series Lab's interface.

TSL has two main modules: (i) TSL-Data and (ii) TSL-Scenarios:

TSL-Data creates a synthetic hourly renewable generation historical record by processing the information available at the MERRA-2 global reanalysis database. The idea behind TSL-Data is to download historical reanalysis data of wind and/or solar irradiance (available since 1980) and transform these natural resources into power production based on: (i) the characteristics of the wind turbine model and height of the hub, and (ii) solar panels (with different tracking systems). By creating a synthetic hourly historical record, this methodology allows the assessment of new sites for renewable candidates located anywhere in the world, besides the improvement in the representation of existing renewable plants;

TSL-Scenarios is a statistical model that uses historical data to estimate parameters and generate future scenarios for the SDDP model. In the case of VREs, these scenarios may be (i) the real input data (based on generation measurements) or (ii) the synthetic historical record created by TSL-Data, always generated maintaining the spatial and temporal correlations between all renewable stations. Additionally, it is possible to choose whether to contemplate (or not) the effects of spatial and temporal correlations with hydro inflows that will be later used by SDDP.

For more details about TSL, please refer to the documentation available [here](#).

► New features for hourly representation

► **New “hourly parameters” screen:** Available in the “Execution options > Economic dispatch” section with several execution options for hourly runs, check it out!

► **Operating constraints of hydro plants ¹:** SDDP can now represent turbinning/spilling water travel times (in hours), outflow ramp-up/down (in m³/s/min) and ramp-up/down (in MW/min);

► **Fuel contracts and reservoirs** can now be represented in hourly executions;

► **Execution status heatmap:** some of the underlying MIP optimization problems solved by SDDP may require a substantial computational effort, especially those related to the hourly representation. To have a better overview of the tradeoff between solution quality × effort, we added to the dashboard a new chart entitled “Execution status per stage and scenario”. In this chart, the status of the problem solved in each stage and scenario is illustrated in a heatmap according to the following color scheme:

Green (success):

Optimization problem successfully solved.

Yellow (warning):

Maximum CPU time has been reached and the feasible solution found exceeds the MIP convergence tolerance.

Red (error):

No feasible solution has been found within the maximum CPU time.

► **Parallel executions (applicable to PSR Cloud only):** aiming to speed-up the solution process, it is now possible to define the (i) the minimum memory per process and (ii) the number of threads per process. These parameters enable the fine-tuning of the computational resources available for the solution of the hourly problems in the cloud.

Besides the enhancements above, we have dedicated a lot of effort to increase the robustness of hourly runs in this new version.

¹ The operating constraints of thermal plants have been already available in SDDP since version 15.0

► Generic pollutants with (or without) emission budgets

SDDP can now represent generic pollutants and their corresponding thermal emission coefficients. Besides presenting outputs of the emissions, each pollutant can have (i) associated emission costs, which will increase the thermal operating costs and/or (ii) multistage emission budget constraints. All related data is defined in the new section “Complementary data > Emissions”.

► Fuel price scenarios

SDDP can now handle multiple user-defined fuel price scenarios. This means that the decisions will consider fuel price forecast variability in addition to the other sources of uncertainty already considered such as hydro inflows and renewable generation.

The input data is flexible and it is possible to choose for each fuel whether its price varies per scenario or not. In the “Basic data > Fuel > Fuel configuration” screen, the user can select if the fuel prices (i) will just be chronologically updated or (ii) besides being chronologically updated, they will change by scenario in the “Type of price variation” field. If for a given fuel option (ii) is chosen, the number of scenarios and the fuel prices per scenario can be introduced in the “Complementary data > Fuel > Fuel price > Chronological by scenario” screen.

► Other new features

► **Hourly prices of elastic demands** can be defined in the “Basic data > Demand configuration > Price per hour” screen. The selection of this data must be enabled through the “Demand (Price) > Per hour: detailed” option in the “Execution options > Economic dispatch > Data resolution”;

► **General constraints:** a generic user-defined constraint can be created in the “Complementary data > System > General constraints” screen. Each constraint term is defined by its coefficient and the corresponding variable (turbinning, spilling, or final storage) of a selected agent. Additionally, the constraint type (“Less than or equal to <=”; “Equal to =”; or “Greater than or equal to >=”) and the requirement (fixed or chronological) must be selected. In this version, these constraints are limited to hydro plants²;

► **Power injections:** SDDP can now represent generic power injections in cases with the representation of the electrical network. Input data required is the injection capacity and price (optional), both of which can be defined per block or in hourly resolution;

► **Automatic regulating factor for batteries:** new modeling enhancement for battery operation in cases with the standard non-chronological per block representation is available in the “Execution options > Solution strategy” screen. In this formulation, we add regulation constraints to limit energy transfer between blocks aiming at the improvement of its representation in the executions per block. More details available [here](#).

Important remark: this option is not intended to replace the hourly representation, which is the most suitable way to accurately capture the benefits that batteries bring to the system.

► **Generation constraints:** in addition to hydro and thermal plants, it is now possible to add renewable plants and batteries in the “Complementary data > System > Generation constraints”;

► **Secondary reserve:** besides hydro and thermal plants, batteries may now also contribute to secondary reserve requirements and therefore are available to be selected in the “Complementary data > Reserve > Secondary reserve requirement” screen;

² Our goal is to extend this functionality to cover all agents. Tell us your favorite ones and help us to prioritize the next developments!

- New data/constraints of hydro plants:

▶ **New flow tables:** the following tables are available in the “Basic data > Hydro plant” screen. More than one table can be defined to model seasonal behavior.

- Turbining × efficiency
- Storage × Maximum turbinning

▶ **Maximum spillage constraints:** available in the “Complementary data > Hydro plants > Single reservoir constraints > Flow constraints > Maximum spillage” screen.

▶ **Constant water flow constraints:** it is now possible to force the turbinning and/or the spilling and/or the total outflow for each hydro plant to be constant throughout the stage in the “Complementary data > Hydro plants > Constant water flow constraints” screen.


- New fuel contract Take-or-Pay (ToP) clauses:

▶ **Carry forward right** provides the option to anticipate ToP quantities from future contract periods to avoid extra payments associated with fuel consumption over the current ToP quantity. This debt is carried forward to the future periods as a reduction of the ToP quantity.

▶ **Make-up right** provides the option to recover ToP payments associated with unused fuel of previous periods, granting the buyer the right of getting fuel over the ToP quantity without or with a reduced payment (depending on the make-up credits). In previous versions, SDDP represented unlimited make-up credits via transfers between contract renewals. Now, SDDP represents an associated “expiration” time and the consequent obligation of using the current make-up credits inside this period.

- Additional features in the interface:

▶ **Technology type of renewable stations and plants** are now available. The options are: general, wind, solar, biomass, and small hydro. A renewable plant must have the same technology as its associated station.

▶ **User preferences in the graph module:** can be accessed through the following new button:  Available options are (i) printing the study path and/or (ii) the timestamp in the outputs.

▶ **Customization when deleting files using “Clean case folder” option (👉):** by adding “file masks” to be deleted in the C:\PSR\Sddp16.0\Oper\sddpclear.cfg file. For example, it is possible to include a mask related to old files generated by the graph module by adding “GRAF*.csv”. In this case, when the user clicks on this button, they will also be deleted.

► New outputs

There are more than 20 new outputs available! Besides the ones related to the new features, we have:

► **Hydro:** ► Violation maximum spillage ctr. ► Violation cost of max. spillage ctr. ► Max. spillage ctr.

► **Thermal:**
Thermal emission cost per plant

► **Renewable sources:**
Renewable O&M cost

► **Circuits:**
Losses in circuit flow ctr.

Important remark: in previous SDDP versions, the agents related to interconnection and DC Link outputs were separated by direction, presenting the following signs to differentiate: “<-” and “->”. There is now only one agent presenting the net flow results for each related output.

► Restructuring of input data files

- The bus modification file (MBUS.DAT) has been discontinued. If this file still exists in the SDDP database, the interface will load it but will always convert it to the new file format (DBFYXX.DAT);
- The fixed duration of blocks is now saved in a new file (DURFIX.DAT) and not in the header of the demand files;
- The annual profile data of the renewable station scenarios defined by block will now be saved in the following new file: BLRENW.DAT (the old GNDZ.DAT file has been discontinued).

When a case is opened in SDDP's interface version 16.0, the files are automatically updated to the new format. Before the conversion process, the original data is copied to a backup folder (entitled BAK folder). We recommend the verification of the converted data. Thereafter, the backup folder can be deleted.

► PSR CLOUD

PSR Cloud is our web-based computational environment that can be used to run SDDP, avoiding thus the need for the users to invest in high-performance computers. It is a pay-per-run and per processor scheme in which the users may select the desired number of processors for each execution. The machines available for execution are constantly upgraded. For more details about PSR Cloud please visit:

<https://www.psr-inc.com/software-en/?current=p4083>.

PSR offers to all SDDP users the free use of up to 64 processor-hours in PSR Cloud;
Please contact PSR at sddp@psr-inc.com for more details.

