

OpenPowerNet

Release Notes Version 1.6.0

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1 Introduction

1.1 Overview

The purpose of this document is to describe the changes and the status of OpenPowerNet version 1.6.0. The document contains:

- List of delivered files on DVD,
- Description of the main functionality,
- Any restrictions known,
- List of corresponding documentation and
- Known issues.

1.2 Configuration

See document Installation Instruction version 1.6.0 for required third-party software versions.

1.3 Acronyms and abbreviations

The following abbreviations are used within this document.



Abbreviation	Description
2AC	2 Phase AC
AC	Alternating Current
ATM	Advance Train Module
DC	Direct Current
DVD	Digital Versatile Disk
GUI	Graphical User Interface
ODBC	Open Database Connectivity
PSC	Power Supply Calculation

2 List of files on DVD delivery

```

OPN_InstallationInstruction_1.6.0.pdf
OPN_ReleaseNotes_1.6.0.pdf
OPN_UserManual_1.6.0.pdf
OpenPowerNet\my.ini
OpenPowerNet\createUser.bat
OpenPowerNet\OpenPowerNet-1.6.0.zip
OpenTrack\OpenTrack.V_1.8.3.2016-08-30.zip
ThirdPartyPrograms\ required by OpenPowerNet, see Installation Instructions
update\

```



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3 Main functionality

OpenPowerNet version 1.6.0 has the following main functionality:

- Calculation of AC, 2AC and DC power supply system,
- Calculation of magnetic coupling of conductors is done internally,
- AC / 2AC power supply models:
 - Transformer,
 - Converter,
 - Auto transformer,
 - Booster transformer,
- DC power supply models:
 - Rectifier/Inverter,
- Energy storage for stabilisation of line voltage and energy saving,
- Voltage limiting device model to limit the touch voltage,
- Calculation of tractive effort with retroactive effect to the railway operation simulator OpenTrack,
- Calculation regenerative braking,
- Consideration of tractive and braking current limitation,
- Consideration of power factor at vehicle pantograph,
- Calculation of electrical engines with single or multiple propulsion systems,
- Division of power consumption for multiple Train Operating Companies,
- Evaluation of engine energy storage,
- Consideration of coasting behaviour of the courses,
- Consideration of changing train mass at station stops,
- Calculation of short circuit currents,
- Quick evaluation of network structure using constant current engine model,
- Visualisation of results using prepared Excel-Files and
- Visualisation of results using the automated analysis of the Analysis Tool generating Excel and PDF files for:
 - Minimum pantograph voltage,
 - Maximum touch voltage,
 - Maximum leakage current,
 - Substation:
 - Feeder current versus time and as TRLPC¹,
 - Busbar voltage versus time,
 - Power (P,Q,S) versus time and as TRLPC for input, output and total (per substation and total of all substations of a network),
 - Power factor versus time,
 - Magnetic Field as flux density (B-field) and field strength (H-field),



¹ The **Time-Rated Load Periods Curve** (TRLPC) shows the maximum or minimum of a set of varying window-size averages where the window time duration is defined by the x-axis value.

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- Conductor and connector current versus time and as TRLPC¹,
- Voltage versus time and as TRLPC¹,
- Energy overview,
- Vehicle specific charts,
- Vehicle specific overview

4 Changes since version 1.5.9



- General:
 - New editor for engines, the so called Engine Editor to edit *.opnengine files, see User Manual chapter 4.4.5.
 - New static frequency converter model, see User Manual chapter 4.4.7.5.
 - Add brake resistor evaluation by automatic analysis.
 - Extended automatic analysis, in particular for engines, see User Manual chapter 4.6.3.8.
 - The three modules APserver, ATM and PSC are now combined in one executable, opncore64.exe → speedup of simulation.
 - Modify Project-File schema to improve the initial XML file structure.
 - Now recording all nodes, conductors and connectors to database regardless of voltage/current shall be recorded or not.
 - Add document Checklist to have a short step by step description of modelling and checkings
- GUI:
 - Rename perspective OpenPowerNet to Simulation. This perspective has now only one console to display the messages.
 - It is now possible to suppress messages, see User Manual chapter 4.3.4.
 - Create automatically linked folder to analysis output folder once the analysis is started.
 - Database default user name and ODBC DSN are now set into the database related dialogs.
 - Change default setting for "Shutdown modules", changed from false to true.
 - Prepared Excel Files:
 - Voltmeter.xlsx added
 - ImpedancePerFeeder.xlsx added
 - PowerSupply2.xlsx: Fixed calculation of P,Q,S at sheet SELECTION(2).
- Engine Editor:
 - Existing Engine-Files can be upgraded by selecting the file in the Project Explorer and selecting the context menu "Convert Engine-File to Engine-File.opnengine".
 - The *.opnengine file is still XML based and can be edited by the XML Editor.
- ATM:
 - Add calculation of current demand at nominal voltage.
 - Add calculation of effort achievable by the propulsion system.
- PSC:
 - New Static Frequency Converter Model, the model is defined at TypeDefs-File and only referenced at Project-File.

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- Calculation of earth conductor has changed slightly, see User Manual chapter 6.5.
- Leakage attribute `yImag_S_km` is now optional.
- Renamed attributes at Project-File:
 - `temperature_GradCelsius` to `temperature_DegreeCentigrade`
 - `Conductor/@type` to `Conductor/@condSort`
 - `VLD/@type` to `VLD/@typeRef`
- TypeDefs-File:
 - Add Converter
 - Change XML Element structure.
- Selection Editor:
 - General page:
 - Add copyright, projectID and reportID.
 - Add individual output selection by page.
 - Comment as part of designation does now NOT remove "special" characters as `!"#%&'()*+,-./:;<=>?[\\]^_{}`~.`
 - Select all substation items by default
 - Add Corridors page.
 - Lines:
 - Add minimum and maximum chainage to reduce the scope of the diagram.
 - The 300s average for rail-earth-potential as default according to EN 50122-1.
 - Add infrastructure selection.
 - Magnetic Field:
 - Add file output format emf.
 - Add maximum value image type.
 - Add Vehicles page:
 - Add Preferences for Vehicles page, defining chart types and overview types to be used across different projects.
 - TRLPC now also from mean average and absolute mean average for substation, connectors, inline current and inline voltage.
- Analysis:
 - Highlights:
 - Added creation of Engine charts. These charts may be freely defined by the user. The user may select the x and y value types and combine them as desired. Predefined chart types are available. User defined chart types may be defined under preferences and reused by multiple analysis runs within the same workspace.
 - Added creation of user defined engine overview. The user can now define the tables freely. Predefined overview table types are available. User defined overview tables types may be defined under preferences and reused by multiple analysis runs within the same workspace.
 - Rewrote axis scaling of Excel charts. This should lead to a much more convenient presentation of the results.
 - Added a lot more layout modification options to presets, which led to a restructuring the `AnalysisPreset.xml` file. Previously customised `AnalysisPreset` files have to be updated manually.



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- Chart output: Rewrote axis scaling.
 - Stepsize and scaling are adjusted for a fixed number of 10 steps and y=0 to be on the grid. This is the default behaviour for all but the continuous axes (time, position and distance). It may be changed in preset by setting the optional attribute `autoScale` to `false`.
 - If defined in preset, range between min/max values should be dividable by 10 for best results. Adjusted default presets to match this requirement.
 - Preset parameter `scaleStep` is only considered with `autoScale` set to `false`. For secondary y-axis, the setting should be synchronised to the primary y-axis.
 - `scaleStep` is rounded to integer for `numberFormat="0"`.
 - Clearance between axis and chart series is only applied if `autoScale` is enabled.
 - The x-axis is now forced to the bottom, y-axis to the left if there are negative values.
 - The y2-axis and its items now use italic font to separate it from the primary axis. This may be disabled in preset by settings attribute `y2FontItalic` to `false` under `Settings/Excel/PageSetup`.
 - New optional preset attribute `syncToPrimary` for secondary axis may be used to set the same scaling between axes.
 - Draw lines to highlight the coordinate system. The setting is enabled automatically for most y-axes and some x-axes, but may be disabled by setting the attribute `markCoordinates` of the particular axis elements to `false`. The line items may be modified or disabled completely using the preset elements under `Settings/Excel/CoordinateSystem`. Note: The secondary y-axis can not be marked due to limitations in the Excel plot order.
 - Added possibility to define transparency for chart items and `hLine/vLine` items in preset. The default values are 0.6 for chainage items like isolator and infeed and 0.4 for `hLine/vLine` items like nominal voltage. This makes the output more focussed on the data series.
 - Renamed preset parameters `valueMin`, `valueMax` and `valueStep` to `scaleMin`, `scaleMax` and `scaleStep`.
 - Removed preset parameters `valueStep`, `valueMinTreshold` and `valueMaxTreshold`.
 - Improved handling of chart axis number format.
- Presets:
 - Chart item titles and item titles for the new Vehicle Overview now utilise placeholders `%fctPrefix%` and `%fctSuffix%` around the particular item title. This allows to apply different function strings to a single item. They are composed inner to outer from the generic function strings in the `Strings` section of the preset file (e.g. `abs_fctPrefix` and `abs_fctSuffix` may be modified to show absolute value of a variable as `abs(x)` or `|x|`).
 - Added possibility to modify the footer content of chart and sheet output in the preset file under `Settings/Excel/PageSetup/Footer`.
 - Added possibility to set the default `numberFormat` and `scaleMax` for all axes of type "Time" under element `Settings`. This allows to modify all time axes



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at one place and also sets the format for tables and chart titles. Also added different number formats that may be used to customise the time scales, like 12h format or with/without days and millisecond (see schema documentation).

- Slightly modified some chart titles for better consistency and clarity (TRLPC charts and Device Losses chart).
 - Slightly modified title of overview tables for consistency (Busbar and Feeder Overview, Device Overview, Vehicle overview).
 - Renamed axis attributes `valueName` and `valueUnit` to `variable` and `unit`.
 - Renamed y-axis of $I = \text{TRLPC}$ from "RMS-Current" to "Current" to share the presets. The particular items still show "_rms" in the legend though. Same applies to RMS-Voltage in $U = \text{TRLPC}$.
 - Renamed TRLPC axis title from "Time" to "Duration".
- Output for vehicles:
 - Added chart series output like speed, tractive effort, power, voltage and current versus time, distance or speed. The presets for these charts are stored in a new format as `ChartSet`, which consists of several `xType` and `yType` definitions. This enables more possibilities to compose them with the Selection Editor. Items along the line (e.g. feeders, isolators and stations) are drawn from all tracks of the defined corridor. For all engines chart feeders from unselected tracks will be drawn if there is a direct connector at the same position.
 - Create Fv histogram.
 - Create overview tables for the selected vehicle corridors and overview types.
 - Overview tables: Show degree of energy at pantograph against nominal voltage for consumption and recovery as well as energy losses in brake resistor.
 - Output for substation, charts:
 - Added busbar connectors.
 - Added current through the busbar (" $I_{<busbar name>}$ "), which is the sum of all positive currents for each time step. It will be drawn if there is more than one feeder or busbar connector, but it is always added to the datasheet.
 - The current infeed from devices into the busbar (" I_{Device} ", previously " $I_{<busbar name>}$ ") will be drawn if there is more than one feeder or busbar connector and at least 1 device, but it is always added to the datasheet.
 - Added chart types for aggregation of device power $f(t)$ and TRLPC (only power supplies) that show single chart series per device and the sum on secondary y-axis. Previously there were only charts that showed the sum of the aggregated devices.
 - Added possibility to create $I = f(t)$, $I = \text{TRLPC}$ and $P = \text{TRLPC}$ charts without calculation of absolute values as well as TRLPC charts for rms or mean values according to selection in the Selection Editor. For complex values (AC), the absolute values with sign of real part are calculated to show the direction of current or load flow.
 - Added hLines for system voltage nom/min/max and nominal voltage of the device.
 - Show the device type string from preset instead of "Device" in chart subtitles. Also show this string in overview tables instead of short type string.

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- Output for substation, overviews:
 - Added current through the busbar ("I_<busbar name>"), current per device and busbar connectors to Busbar and Feeder Overview.
- Output for lines, pantograph voltage; output for vehicles: Added handling of time steps with main switch state OFF.
 - Pantograph voltage charts and U_mean_useful: Values for these time steps will be skipped, resulting in gaps in the chart series. For TRLPC charts, the time series will be split and the resulting minimum/maximum curve will be calculated from all of those "time windows".
 - Other vehicle values: Mechanical values (driving dynamics) are not affected directly by the main switch, other electrical values like will current and power will be 0 for these time steps, therefore calculation of TRLPC charts will not be affected.
- Output for lines:
 - Use the new minimum and maximum position setting from Selection Editor to limit mileage scope of each chart.
 - Use the new selection for infrastructure items (feeders, isolators, conductor switches and stations) in Selection Editor to enable or disable drawing of these items. Another option allows to show the substation name (default) or feeder name for each feeder position in the output chart.
- Output for magnetic field:
 - Create output for the maximum magnetic field (maximum value at each position of the cross section). The displayed conductor current for shading type is the absolute maximum current of this conductor.
 - Use default designation if specific one is not given.
 - Added optional output file type EMF.
- Output for Conductor Currents and Connectors:
 - Removed functions TRLPC mean average for I and P as this is no useful output (sign is just current direction).
- General:
 - Rearranged output files and folders. E.g. output for network based selections and corridor based selections is now created in separate subfolders. The output base folder name will be taken from the `Project ID` setting.
 - Excel sheets now get shorter names for better overview and to omit limitation of length. Sheets for text labels are hidden.
 - If there was some kind of error during output creation, the resulting PDF output file could become a big collection of useless data columns. These files are not saved any longer.
 - In overview tables, the time string in the subtitle is now using a format with day if necessary, like the chart output.
 - The time string in titles now only includes days and milliseconds if necessary.
 - The warning message about time steps with failed iteration now considers the selected time window.
 - Added converter model.
 - Now reading travelled distance of engines from database.
- Fixes:
 - Fixed time step rounding issue in TRLPC function.

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- Fixed position string in line charts for negative mileage.
- Fixed inserting of text into Excel cells where certain strings could be destroyed by automatic interpretation.
- Fixed a bug, where the last time step of chart output was rounded to full seconds. This could lead to wrong axis scaling.
- Database:
 - Change database version to 20 due to new feature in ATM recording.
 - Add view `view_engineBrakeResistor`.
 - Table `engineData`: new columns
 - `effort_propulsion_kN`: The effort achievable by the engine propulsion system without considering any limitation, e.g. low or high voltage.
 - `current_Unom_real_A`, `current_Unom_imag_A`: The current of the engine at nominal voltage.
 - `distance_travelled_km`: The travelled distance of the course in km.
 - `delay_s`: The delay of the course in seconds.
 - `ms_state`: Main switch state, OFF = 0, ON = 1.
 - Table `sim`: new columns
 - `projectID`: An ID or abbreviation of the current project. This will be displayed at the automatic analysis diagram footer.
 - `reportID`: An ID or abbreviation of a report. This will be displayed at the automatic analysis diagram footer.
 - New tables:
 - `converter_loss_type`,
 - `converter_losses`.
- OpenTrack:
 - Updated to 1.8.3 (2016-08-18)

5 Known restrictions

OpenPowerNet is tested with OpenTrack version 1.8.3 (2016-08-30) and should only be used with this version.

OpenPowerNet is a single user application. It is not tested to use the same database for multiple users at the same time.

6 Version of corresponding documentation

The following table lists the version of the documents related to OpenPowerNet 1.6.0.

Document	Version
Installation Instruction	1.6.0
User Manual	1.6.0

7 Known issues

The following table contains all known but unsolved issues.

ID	Summary	Status
371	<p>When using larger time steps other than 1s, OpenTrack sends the requests not for all courses in the same time raster but OpenPowerNet is designed to calculate always in the same time raster.</p> <p>Workaround 1: Use always 1s simulation time steps. Workaround 2: Set all times within OpenTrack in the raster according to the selected simulation time step, e.g. for 3s time step only time hh:mm:00, hh:mm:03, hh:mm:06</p> <p>The simulation will be terminated by OpenPowerNet in case of OpenTrack requests outside of the time raster.</p>	Can't be solved.
458	<p>The information of split, merged and connected courses is not available in OpenPowerNet. Therefore the engine energy storage of an engine will be reset to the initial values even if the new course is connected with the previous course and the two courses represent the same physical train.</p>	Open
582	<p>Creation of magnetic field image needs the desired character set to be used for output set as system locale as Matlab plot functions do not handle unicode characters.</p>	Open
op1502	<p>Number of chart series in Excel is limited to 255 only. Therefore the number of charts in ALL Engine Chart Types is very limited and may be exceeded by the selection.</p> <p>Workaround: To reduce the number of chart series the selected infrastructure items shall be reduced as much as possible.</p>	Open