

OpenPowerNet

Release Notes Version 1.8.0

Institut für Bahntechnik GmbH
Branch Office Dresden

Document No. OPN/RN/1.8.0

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| Author | Review | Release |
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| Date Harald Scheiner | Date Martin Jacob | Date Dr. Jörg von Lingen |

1 Introduction

1.1 Overview

The purpose of this document is to describe the changes and the status of OpenPowerNet version 1.8.0. 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 1.8.0 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 |
| EFE | Engine File Editor |
| GUI | Graphical User Interface |
| NMMV | Network Model Microscopic Viewer |
| OCS | Overhead Catenary System |
| ODBC | Open Database Connectivity |
| OPN | OpenPowerNet |
| OT | OpenTrack |
| PDF | Portable Document Format |
| PSC | Power Supply Calculation |
| SoC | State of Charge |
| VLD | Voltage Limiting Device |
| XML | Extensible Markup Language |

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2 List of files on DVD delivery



OPN_InstallationInstruction_1.8.0.pdf
OPN_ReleaseNotes_1.8.0.pdf
OPN_UserManual_1.8.0.pdf
OpenPowerNet\my.ini
OpenPowerNet\createUser.bat
OpenPowerNet\OpenPowerNet-1.8.0.zip
OpenTrack\OpenTrack.V_1.9.1.2018-05-10.Se38uK.zip
ThirdPartyPrograms\ required by OpenPowerNet, see Installation Instructions

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3 Main functionality



OpenPowerNet version 1.8.0 has the following main functionality:

- Calculation of AC, 2AC and DC power supply system,
- Calculation of magnetic coupling of conductors is done internally,
- Possible electrical network configurations include, but are not limited to:
 - Highspeed railway,
 - Freight railway,
 - Metro systems with OCS or 3rd/4th rail,
 - Monorail systems,
 - Tram networks,
 - Trolleybus networks,
 - Battery buses with charging station.
- AC / 2AC power supply models:
 - Transformer,
 - Converter (SFC),
 - Auto transformer,
 - Booster transformer,
- DC power supply models:
 - Rectifier/Inverter,
- Stationary 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,
- Consideration of 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 charging from regenerative braking and/or catenary,
- Evaluation of catenary-free operation,
- 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:

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



¹ The **T**ime-**R**ated **L**oad **P**eriods **C**urve (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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4 Changes since version 1.7.1

4.1 New features

- General
 - Updated OpenPowerNet logo.
 - Engine energy storage can be charged from OCS now and may be used to power the engine in catenary-free sections (tracks with modelled, but isolated OCS section, “NoPowerSupply”). Please see the corresponding tutorial in the user manual for more detail.
 - Added handling for connected courses. The new course will be able to take over storage SoC from its circulation course on arrival. Please see the OpenTrack documentation for more detail on modelling connections.
 - Added “region” model to the electrical network: The type "RegionOcsCharge" may be used inside a network line element to define allowance of OCS charging for proper engines whereas the type "RegionVehicleMod" may be used to overwrite the default value of pantoCurrentLimitationStandstill_A of engines at the particular position. The regions are defined in the Project-File under the Line elements and can be visualised by NMMV and Analysis chart output. Please see the modelling section and engine energy storage tutorial of the user manual for more detail.
- ATM
 - Added optional attribute “recoveryPrecision” to ATM/Options in Project-File to allow experienced users to tune calculation of recovered brake power from vehicle to OCS. The following values are possible:
 - normal (default): Best for most scenarios, corresponds to OPN versions before 1.8.
 - fast: Improves calculation speed, but produces less accurate results, especially for networks with voltage regulating devices. Not recommended if the project utilises devices like energy storages (vehicle or stationary) and converters. Only use if you know what you are doing, comparison to “normal” recommended before utilisation in project!
- PSC
 - The VLD model now optionally takes reactance as parameter for the open and close values in the TypeDefs-File.
- Analysis
 - Vehicle and Line charts: Values with pantograph voltage of 0.0 V may be hidden in output charts now by enabling the new checkbox "Hide Panto 0V" in the Selection Editor. This may be useful for neutral zones that do not utilise power signals in the OpenTrack model and for catenary-free sections with the new engine energy storage model. There will be a gap in the chart series in such cases. (Note: ContactWire voltages can not be hidden the same way, make sure to use a different conductor name for catenary-free sections to retrieve nice chart output!)
 - Vehicle charts: Added possibility to show the lineID in the legend entry of a region marker line. This may be helpful if there is output for corridors with multiple lines and identical region names. The placeholder %lineID% or %_lineID% has to be added to the title of the region item definition under Analysis/ChartTypes/Common/ItemDefs/ItemDef[@name=Region] in a custom preset file.

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- Vehicle charts: Create chart series for absolute SoC of the energy storages (SoC_abs). The previous relative SoC output was renamed to SoC_rel.
- Vehicle charts: Create chart series for self discharge of energy storage.
- Energy overview: Added possibility to customise the strings for conductor sort in a custom preset file. Use placeholders %condSort% or %condSort_plural% in description of row item E_loss_Conductors.
- Substation device overview: Added optional possibility to create output for "E_S_abs" in device overviews. To create the output, the attribute "use" has to be set to true in a customised preset file for the corresponding column items under TableTypes/Substations/TableType/Section[Device].
- GUI
 - New file wizards to create a new Project-File, Switch-File, TypeDefs-File or Analysis-Preset-File.

4.2 Improved user experience

- General
 - Added message type "Deprecation". This type will be used to display and count messages connected to renamed or introduced XML attributes and elements. The log level is set between Info and Warning. Each deprecation message will be displayed for first occurrence only.
 - Improved some display messages like network model size for better overview.
 - Improved validation of some user input from XML Project-File, e.g. tolerance options, Conductor definitions and false configuration of the Converter controller curves.
 - Improved handling of invalid ODBC datasource.
 - Made database settings configurable through config file. The optional parameters are named identical to attributes in project file and overwrite them. An info message shows the resulting settings.
- PSC
 - The parallel connector warning will not be shown for the last position of a leakage element anymore, as it is not shown for the first position. So there should not be any warning for neighbouring leakages anymore.
- NMMV
 - Added separate buttons to hide nodes, connectors between lines and regions.
 - Nodes with line connectors will be drawn with bold border.
 - Redraw on change in preferences.
 - Optimised redrawing while scrolling.
- GUI
 - Speedup NMMV and Selection Editor.
- Prepared Excel Files
 - Messages: Added default data filters, improved text formatting for cells and removed obsolete selection of OPN module.

4.3 Changes to models and results

- General
 - In some cases with strong limitation of the achievable effort through OPN, there could be a glitch in driving dynamics, so that the train would achieve a slightly bigger or

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smaller acceleration than actually possible when considering the electrical network. This will be compensated in the next acceleration timesteps of the same travel cycle now, maintaining an effort at least equal to train resistance. Also fixed application of switch states and distribution delay during calculation of the achieved effort for OpenTrack.

- The requested effort will be written to database table “enginedata” as demanded by OpenTrack now, even if there is a distribution delay or other cause that hinders acceleration.
- Changed behaviour of current limited engine trying to accelerate from standstill: Do not allow acceleration when auxiliary power is limited. Also changed behaviour of current limitation at standstill: This will be applied for effort request of 0 kN only.
- ATM
 - Improved brake model “U_source”: Removed the minimum recovery power at pantograph behaviour (fixed 0.5 W setting). In the past, the recovery process was aborted if recovered power was below this value to achieve a behaviour similar to the “I_source” model. When trying to recover to OCS with “U_source” model now, either full recovery should be possible or the maximum recovery voltage as configured should be observed at the pantograph. This should lead to an increased efficiency of regenerative braking compared to “I_source” model, if receptivity is limited - primarily in DC networks. Also, simulation speed should be improved in some situations. Furthermore, the internal temporary switching between “U_source” and “I_source” during load flow iteration was optimised. Please note that the setting `retryRecovery=false` (retry at next braking process) will not work with “U_source” model anymore as recovery will never be aborted. If you need this behaviour, please use the “I_source” model.
 - Removed attribute `retryRecovery`: As the behaviour is now limited to I_source model, the setting was merged into attribute `brakeMode`. Please see the updated XML schema.
 - Attribute `pantoCurrentLimitationStandstill_A` allows a value of 0.0 A now.
 - The value “delta load loss power” defined in OpenTrack Trains Dialog may now be negative.
- PSC
 - The default value of `PSC/Options/@tolerance_A` in Project-File was changed from 0.01 A to 1.0 A to gain a significant speedup with some network configurations.
 - When defining Conductors or Connectors with impedance per km, temperature and temperature coefficient are optional now.
- Analysis
 - Vehicle charts and overviews: Introduced with version 1.6.0, the consuming and recovering state at the engine pantograph was defined by the sign of the current at nominal voltage to allow calculation of the values `ratio_consumption` and `ratio_recovery`. With the enhanced engine energy storage model this could have led to a false detection of the states in some configurations, so the states are now detected separately for nominal voltage values and simulated values. The ratio values will not be calculated for timesteps with non-matching current signs, resulting in a gap in the chart series.
- Prepared Excel Files
 - Removed prepared Excel files for stationary energy storage, please use the automatic analysis tool to examine those devices.
- Database

- Besides the additional tables and columns for new features, several database columns were renamed to match the renamed XML attributes. In particular this affects the tables for vehicle and stationary energy storage, but also the binary columns of table sim. To analyse older simulations, it is recommended to use the matching OPN version, which may be installed in a separate folder, or re-run the simulation with the new version.

4.4 Changes to user input

In OPN 1.8.0, some XML elements and attributes were renamed for clarification and unification.

While the migration of Engine-Files is done automatically whenever opening an old file with the Engine-File Editor, old Project-Files need to be migrated manually according to the updated schema file.

The old elements and attributes are still accepted by the new OPN version. There will be display messages however, stating that their usage is deprecated. It is recommended to migrate the files because the old names will not be accepted anymore in a future release.

The following table shows an overview of the changed elements and attributes (@) in the XML Project-File:

| Old Name | New Name |
|--|-----------------------------------|
| Project-File, XPath: OpenPowerNet | |
| @rstFile | @engineFile |
| @typedefsFile | @typeDefsFile |
| XPath: OpenPowerNet/ATM/Vehicles/Vehicle/Propulsion/ | |
| @tractiveCurrentLimitation | @pantoCurrentLimitationConsuming |
| @brakeCurrentLimitation | @pantoCurrentLimitationRecovering |
| @vMinRecovery_km_h | @minSpeedRegenerativeBraking_km_h |
| XPath: OpenPowerNet/ATM/Vehicles/Vehicle/Storage/ | |
| @shareLoad_percent | @shareCharge_percent |
| @shareUnload_percent | @shareDischarge_percent |
| @loadModel | @chargeModel |
| @unloadModel | @dischargeModel |
| XPath: OpenPowerNet/PSC/Networks/Network | |
| Earth | ReferenceNode |
| XPath: OpenPowerNet/PSC/Networks/Network/Substations/Substation | |
| Boostertransformer | BoosterTransformer |
| XPath: OpenPowerNet/PSC/Networks/Network/Substations/Substation/Rectifier | |
| @nomVoltage_kV | @noLoadVoltage_kV |
| XPath: OpenPowerNet/PSC/Networks/Network/Substations/Substation/TwoWindingTransformer | |
| @nomSecondaryVoltage_kV | @noLoadSecondaryVoltage_kV |
| XPath: OpenPowerNet/PSC/Networks/Network/Substations/Substation/ThreeWindingTransformer | |
| @nomSecondaryVoltage_kV | @noLoadSecondaryVoltage_kV |
| XPath: OpenPowerNet/PSC/Networks/Network/Substations/Substation/Storage | |

| Old Name | New Name |
|--|------------------------------|
| @nomVoltage_kV | @noLoadVoltage_kV |
| @loadImax_A | @maxCurrentCharge_A |
| @unloadImax_A | @maxCurrentDischarge_A |
| @efficiencyLoad_percent | @efficiencyCharge_percent |
| @efficiencyUnload_percent | @efficiencyDischarge_percent |
| @maxLoad_kWh | @maxSoc_kWh |
| @initialLoad_kWh | @initialSoc_kWh |
| @lossPower_kW | @selfDischargePower_kW |
| XPath: OpenPowerNet/PSC/Networks/Network/Lines/Line/Conductors/Conductor/ToProperty | |
| @temperature_DegreeCentigrade | @temperature_degreeCelsius |
| XPath: OpenPowerNet/PSC/Networks/Network/Lines/Line/Connectors/Connector | |
| @temperature_DegreeCentigrade | @temperature_degreeCelsius |

Additionally, some changes were made regarding new or changed models, please see the separate notes.

Furthermore, there were some changes to the default preset file of Automatic Analysis to make some content clearer. Particularly output items for storage were renamed from load/unload to charge/discharge and SoC (state of charge). Please validate against the current schema file to update existing custom preset files!

4.5 Changes to the database schema

Together with the renamed elements and attributes in the XML input files, some columns in the database were renamed for clarification and unification. In particular this affects the tables for vehicle and stationary energy storage, but also the binary columns of table sim, that are used to store the XML input files. Furthermore, there were extensions for new features.

Due to the extensions, it is not intended to upgrade a previous simulation database to the new schema, as some content would be missing.



- Extensions
 - added tables “region” and “region_engine_occurance”
 - added column “previousID” to table engine (stores the ID of the previous engine instance if using course connections in OpenTrack, otherwise NULL)
 - added new message type “Deprecation” to table “msgtype”
- Renamed columns

| Table name | Old column name | New column name |
|-------------|-----------------|-----------------------|
| sim | rstFile | engineFile |
| | typDefFile | typeDefsFile |
| | auxPowerFile | rollingStockFile |
| storage_atm | maxLoad_Ws | maxSoc_Ws |
| | loadImax_A | maxCurrentCharge_A |
| | unloadImax_A | maxCurrentDischarge_A |
| | loadPmax_W | maxPowerCharge_W |
| | unloadPmax_W | maxPowerDischarge_W |

| Table name | Old column name | New column name |
|------------------|--------------------------|-----------------------------|
| | loadModel | chargeModel |
| | unloadModel | dischargeModel |
| storage_atm_data | load_Ws | soc_Ws |
| | P_W | terminalPower_W |
| | loss_W | lossPower_W |
| | load_loss_W | selfDischargePower_W |
| storage | maxLoad_Ws | maxSoc_Ws |
| | initialLoad_Ws | initialSoc_Ws |
| | loadImax_A | maxCurrentCharge_A |
| | unloadImax_A | maxCurrentDischarge_A |
| | efficiencyLoad_percent | efficiencyCharge_percent |
| | efficiencyUnload_percent | efficiencyDischarge_percent |
| | nomVoltage_kV | noLoadVoltage_kV |
| | lossPower_kW | selfDischargePower_W |
| storage_data | load_Ws | soc_Ws |
| storage_state | state:LOAD | state:CHARGE |
| | state:UNLOAD | state:DISCHARGE |

4.6 Bugfixes

- General
 - Fixed implementation of the SOAP communication interface between OpenPowerNet and OpenTrack that could lead to a state where OpenTrack waits indefinitely.
 - When using an OPN start time later than OT start time, the first effort acknowledged to OpenTrack at the beginning of OPN simulation time scope was calculated based on the voltage from the timestep when the engine had been created.
 - Fixed some minor issues connected to Option “skipBigEffortChanges”.
 - Fixed that the achieved effort of a constant current engine could be 0 inside a neutral zone.
 - Fixed display of warning and error count at the end of the simulation.
- ATM
 - In some cases, if the auxiliary power was limited due to a current limitation, the calculated current for the engine could be bigger than actually defined in the engine file.
 - Fixed an error where the achieved auxiliary power of current limited engines with multiple energy storages would become bigger than actually demanded.
 - There was an error in the calculation of brake effort for engines with energy storage, slower than minimum regenerative braking speed and power at pantograph limited to less than auxiliary power. This would result in a small effort for the electrical part (no influence on driving dynamics) and a warning about negative brake resistor power in the automatic analysis tool.
 - Fixed an issue for application of current limitation that could lead to an insignificant negative current.

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- There was an error in calculation of self discharge power of engine energy storages if the simulation timestep was different from 1 s. This could also result in negative SoC of the storage. Terminal power gets prioritised over self discharge power now in the last timestep before the SoC becomes 0 Ws.
- The SoC of an engine energy storage could become negative if the defined self discharge was too big.
- Fixed engine energy storage could calculate a positive power while unloading to achieve minimum load.
- Using “delta load loss power” definition in OpenTrack it was impossible to achieve an auxiliary power smaller than the initial value.
- Auxiliary power could be limited for engine during regenerative braking although it did not hit any limitation.
- PSC
 - If a network element like substation or line connector created a new node position, that did not exist while creating the line itself, the connector for a defined leakage element would be missing there. Now the leakages will be parsed separately after Network and Merger elements.
 - Usage of SFC with strategy Synchronous lead to error PSC-E-061 or appcrash.
- GUI
 - Multiple fixes for Engine File Editor, Selection Editor and NMMV.
- Analysis
 - If there were engines with energy storage and just one timestep inside time scope, this could hinder creation of the energy overview. Warning OPN-W-506 would be shown. Also fixed a minor glitch in calculation of SoC balance for vehicles.
 - Vehicle charts: Fixed consideration of timestep in kilometre jump detection to prevent disruption of vehicle charts.
 - The checkbox for Copyright in Selection Editor did not have any effect, the copyright string was always added to charts if set under preferences.
 - Fixed an error, which would lead to the label of a horizontal line being oriented vertical although there was enough space for a horizontal label. This could be the case e.g. for chainage markers in vehicle charts for corridors with reverse sections.

5 Known restrictions

OpenPowerNet is tested with OpenTrack version 1.9.1 (2018-05-10) 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 1.8.0.

| Document | Version |
|--------------------------|---------|
| Installation Instruction | 1.8.0 |
| User Manual | 1.8.0 |

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.</p> <p>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. |
| 582 | <p>Creation of magnetic field image and vehicle histogram needs the desired character set to be used for output set as system locale as Matlab plot functions do not handle unicode characters.</p> | Can't be solved. |
| n/a | <p>Due to a limitation of the Excel VB interface, placement of the footer logo is limited to particular language editions. If you should face the corresponding warning message, please install the english edition and/or report the displayed code to the developers! The preset attribute "footerLogoFormatCode" under Settings/Excel may be modified to use the proper VB format code.</p> | Can't be solved. |
| n/a | <p>Warning message PRE-W-506 might be displayed on localised systems. This happens due to a limitation of the Excel VB interface, if the printer can not be set correctly. Technical background: As Excel sets the page size of new sheets according to the current printer, a printer with proper setup has to be selected before creating output. This is normally achieved using "Microsoft XPS" printer. If it fails, the user has to take care, that the system default printer is configured as desired. The warning message may be ignored in this case.</p> | Can't be solved. |
| n/a | <p>Vehicles, charts for all courses with multiple time windows: As data is written to the sheet sorted by engine first and timestep second, the chart series in a subchart can not be limited as easy as if sorted by timestep and therefore will contain time data from other subcharts. The axis scaling will be set correctly though.</p> | Can't be solved. |
| n/a | <p>Folder names, that contain user content (like project, network and corridor name) are limited to the system character set. Please ensure to use compatible names or create the output on a system with matching character set.</p> | Open |

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