Power System Analysis Software

NEPLAN one of the most complete planning, optimization and simulation tool for transmission, distribution, generation and industrial networks.

Reliable – Efficient – User-friendly

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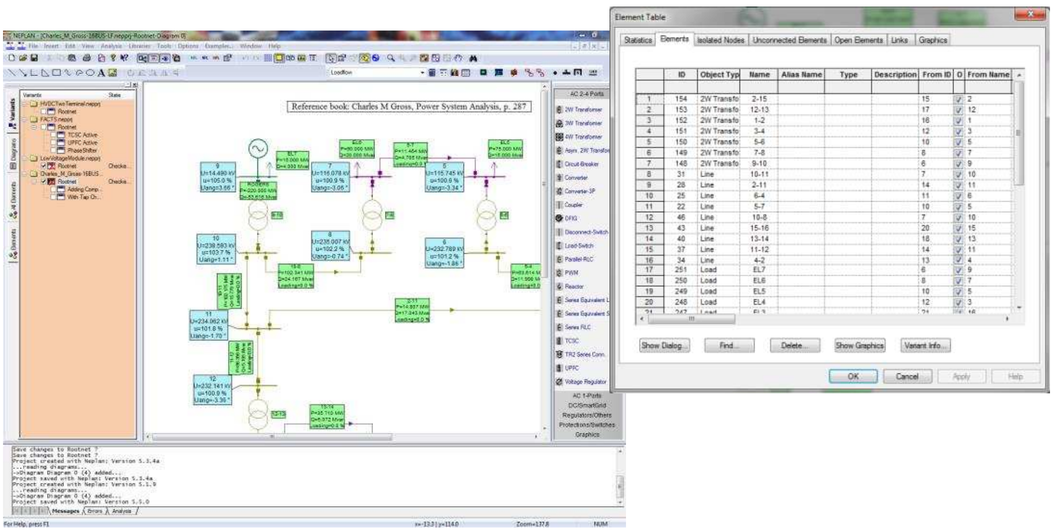
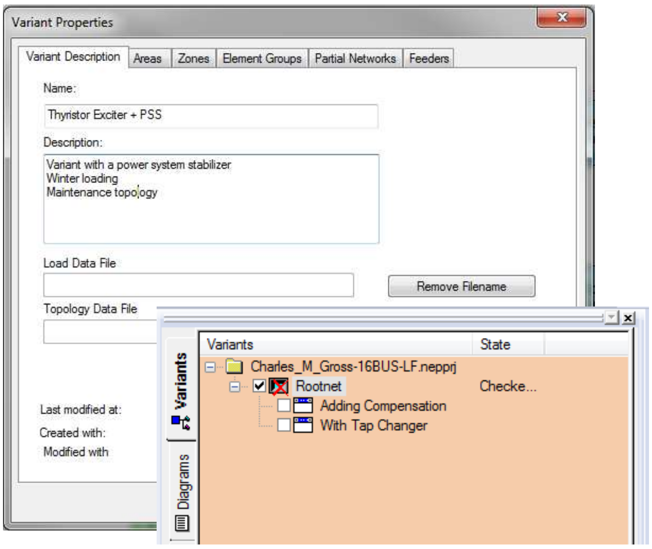
Data management

- Most intuitive Graphical User Interface
- Multi-document and multi-window system
- All equipment can be entered graphically and/or table oriented (like in a excel sheet)
- There is no restriction on drawing sizes and number of nodes and elements.
- Extensive editing functions like undo, redo, delete, copy, move and zoom for processing the network diagram are available. An element can be moved from one node to an other node without deleting the element.
- OLE functionality: Data and graphic can be moved to and from third party software (like MS-Excel, MS-Word). Project documentation was never easier.
- The equipment data are entered in dialogs, with plausibility checks provided. A coloring tool helps to show which data is needed for which analysis (e.g. short circuit, transient stability etc.)
- Integrated Variant Manager (insert, delete, append, compare variants, compare results, etc.).
- ASCII file or SQL database oriented import/export functions for exchanging network data, topology data and load data are available.
- Interfaces to external programs (e.g. measured data) can be implemented.
- Import of a geographic map as a background graphic, for easier schematic capturing.
- Import of almost any raster and vector graphic files (e.g. PCX and DXF files).
- Graphics can be exported as raster files (e.g. JPG, which can be used in any internet web browser).
- Option for combining and separating networks. Any number of independent network areas and zones are possible. Each element and node can belong to any independent area and zone.
- Extensive functions for network statistics and network documentations are available.
- A state of the art library manager with extensive libraries for each element type facilitates data entry.
- All computation modules access a shared database.
- Integrated chart manager allows to analyze and compare all results from all variants.
- Multi-lingual Graphical User Interface.



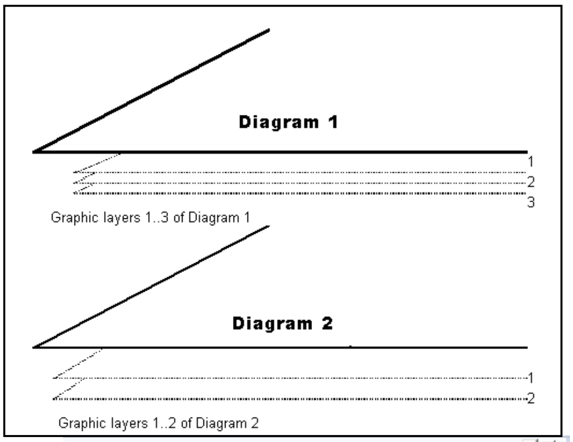
Variant Management

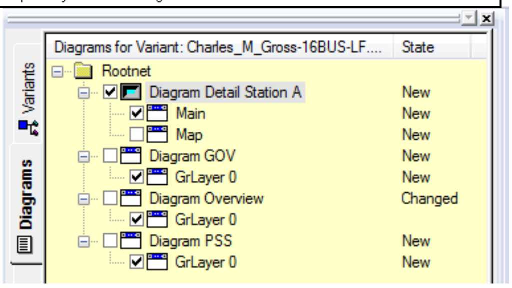
- Non-redundant storage and management of variants.
- For each network, you can select
- * any desired switch states (topology file)
- * any desired loading states (loading file)
- For each network you can define and store any desired number of variants and subvariants (variant tree). In the variant data, only the differences from the parent variant are saved.
- Variants can be compared, merged and deleted.
- The diagrams of different projects and variants can be displayed at the same time
- Results from two different variants can be displayed on the diagram in one result label.



- Results of two variants can be compared in the chart manager.

Multi-Diagram and Multi-Layer-Technique

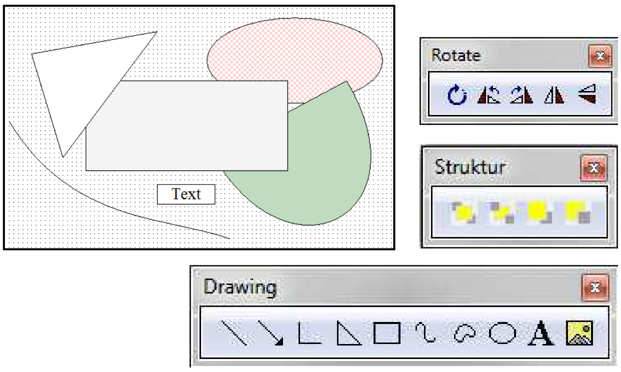


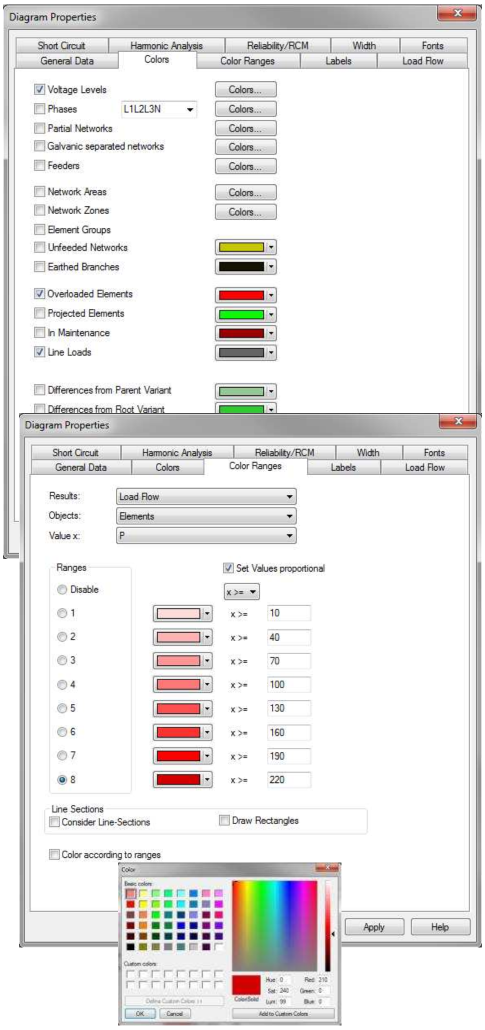


- A network can be entered in several different diagrams, so that the HV network, for instance, is in one diagram, and the MV network in one or more other diagrams.
- Each diagram can have any number of graphic layers. These layers can be colored, locked, hidden or shown.
- Zooming into stations: in the overview diagram, a station is shown as a black box, while in another diagram it is depicted in detail, with all its breakers, protective devices and instruments.
- Topological linkage of elements over more than one diagram.
- All diagrams will be considered for various analysis (e.g. load flow).
- One element can have more than one graphical representation in the same diagram or in different diagrams.
- OLE copy/paste graphic data from and to MS-Word

Auxiliary Graphics

- Auxiliary graphics can be used for documenting the diagram.
- Input of lines, rectangles, ellipses, arcs, ellipse sections, polygons, polylines, any kind of bitmap graphics.
- Input of user text with selectable character set.
- Color for background, foreground, line, outlines and fill patterns is user-selectable.
- Functions available for rendering overlapped symbol elements, rendering, alignment and rotation



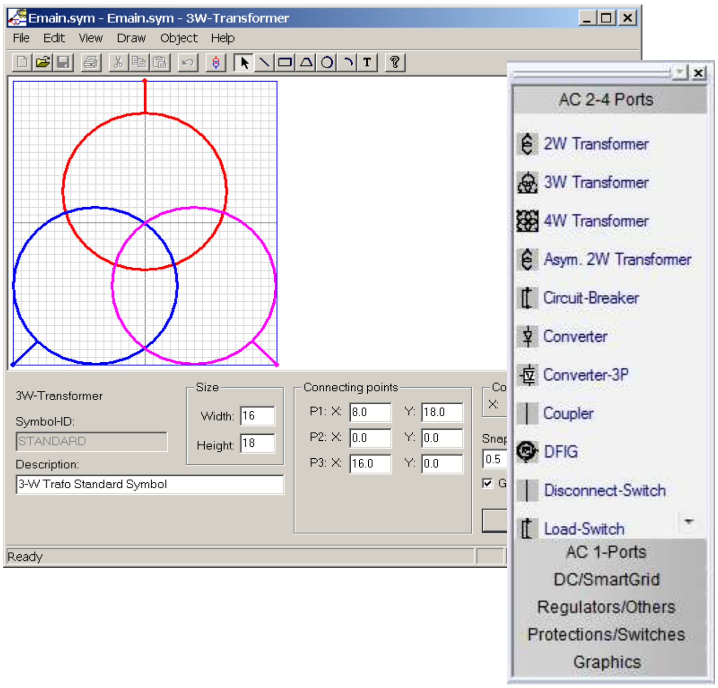


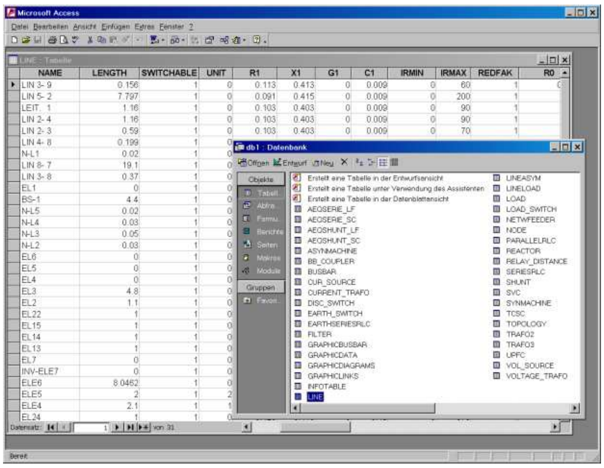
Network Diagram Coloring

- Colors and line types can be freely selected.
- Elements overloaded after a load flow or short-circuit-current analysis are color-highlighted.
- Isolated elements can be highlighted.
- Coloring options to distinguish user-selectable network areas, zones, feeders, voltage levels, earthed or un-supplied networks and galvanic separated networks.
- Differences to the parent variant or the root net can be colored.
- Each element can be colored individually.
- User defined graphic layers can be colored.
- Coloring according to ranges. Many calculated variables can be colored according to their values (e.g. according to element losses or according to voltage drops)
- Results in tables and graphic charts, flow animation, background visualization, gauche, pie charts

Symbol-Editor

- The user can create and define for each element type and node his own symbols.
- Any number of different symbols per element type or node can be defined.
- All symbols will be displayed while entering the diagram. Just drag and drop the desired symbol to the diagram
- On the diagram the symbols can be flipped, rotated and resized.

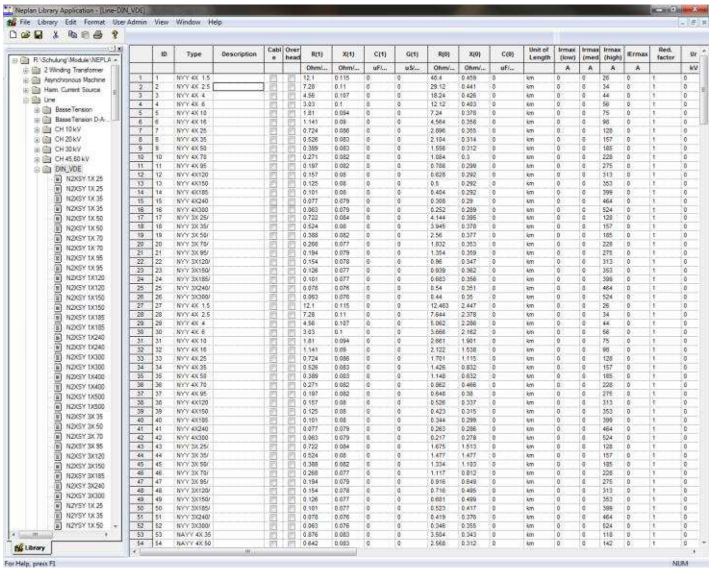




SQL Database Connection

- All element data can be imported and exported to any SQL database (like Oracle, MS-Access, etc.)
- SQL database includes all network equipment (HVDC, FACTS, protection devices, user defined data, etc.).
- The network topology can be stored.
- Graphic of the elements and nodes can be exported and imported.
- All data of all libraries can be imported and exported.
- Can be used as interface to existing GIS and NIS or DMS/SCADA systems.
- Very flexible storing and import features, like full import or only updating, storing only variant differences, network zones or areas, voltage levels, etc.
- Handles very large networks
- Partial reading of data fields (e.g. read only the line length but do not read the R and X values)

Library Manager



- The comprehensive library manager is fully integrated.
- NEPLAN offers an extensive element library for lines, synchronous and asynchronous machines, transformers, harmonic current sources and motor characteristics.
- The user can create complementary libraries.
- While entering network data the data in the library can be accessed. Further more the data entered in the network, can be exported to the library.
- All network data can be updated with changed library data.
- The data can be entered through excel like table sheets.
- Import/export to MS-Excel with drag and drop.
- Import/export to any SQL database. Update functionality from/ to database is provided.
- Part of diagrams with all technical data can be stored in the library (e.g. used for IEEE control circuits).

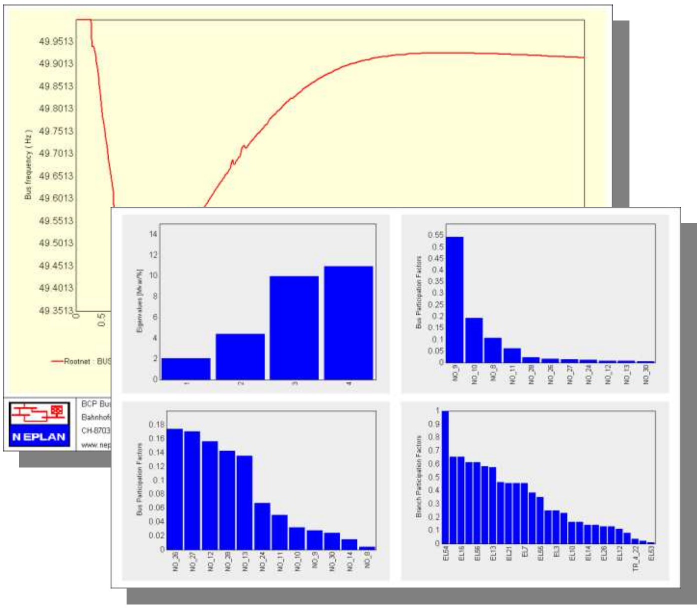


Chart Manager

- The chart manager allows to display the results in different charts (e.g. line, bar, etc.).
- Any number of sub charts can be displayed in one chart.
- A user defined logo (as bitmap) can be added to the header for documentation purposes
- Results from different variants can be compared and displayed in the same chart.
- Export the chart to *.JPG file for any internet browser.
- Copy/paste to the clipboard for documentation (e.g. MS-Words).

Data storing and Interfaces

NEPLAN stores all the network data, such as single line diagram, protection devices, controllers, calculation parameters and results in an internal database in order to handle in an easier and faster way the data.

NEVERTHELESS represents NEPLAN a very open system. All NEPLAN data are accessible from external system. Principally there several ways to transfer data from or to NEPLAN:

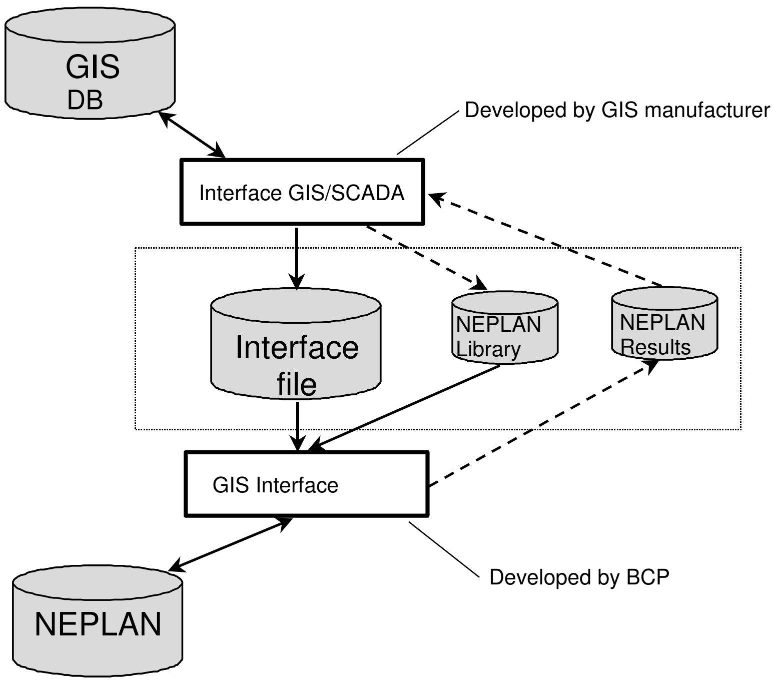
- NEPLAN Programming Library (NPL)
- ASCII files (Excel)
- GIS/SCADA interface
- SQL database

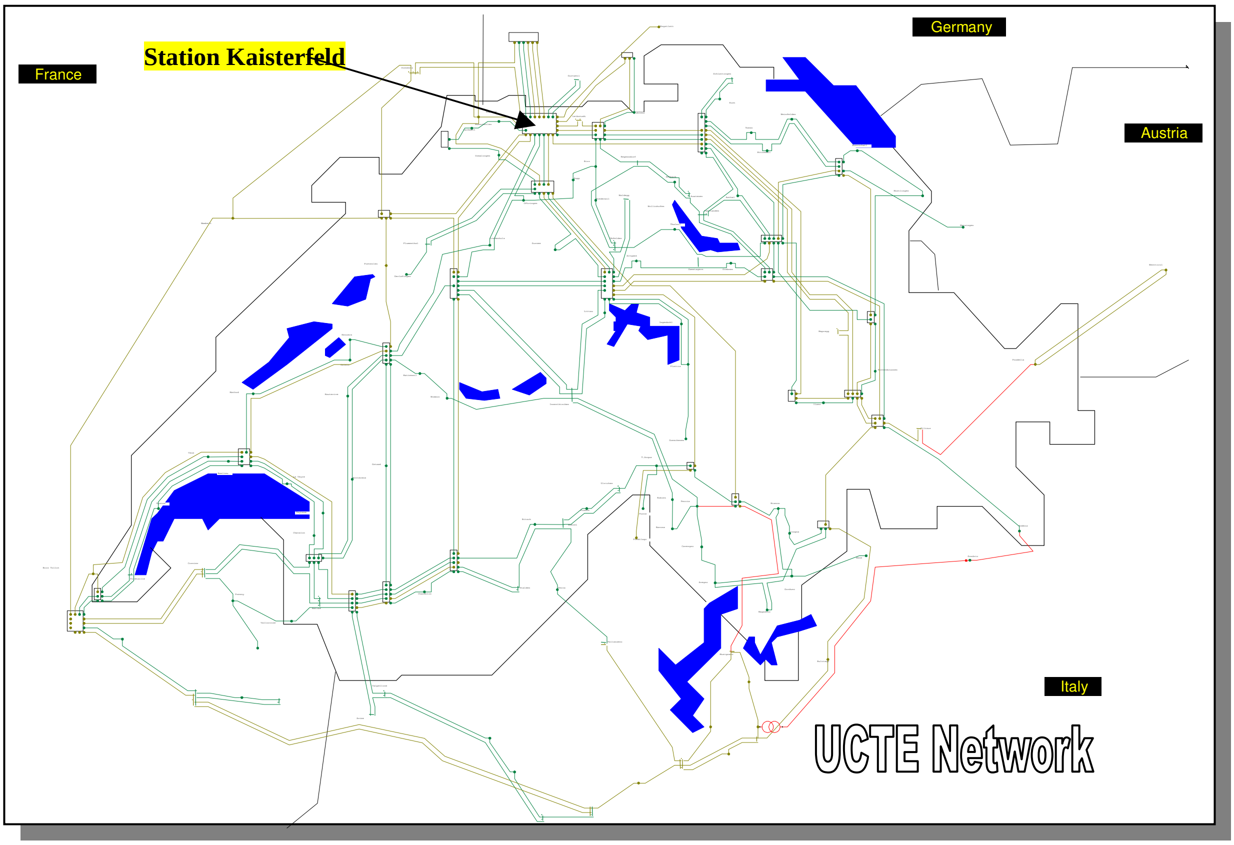
NPL is a C/C++ API library, which includes functions to access NEPLAN data and calculation algorithms through a C/C++ user written program. More information could be found in a separate document.

The ASCII files allows to import/export all the

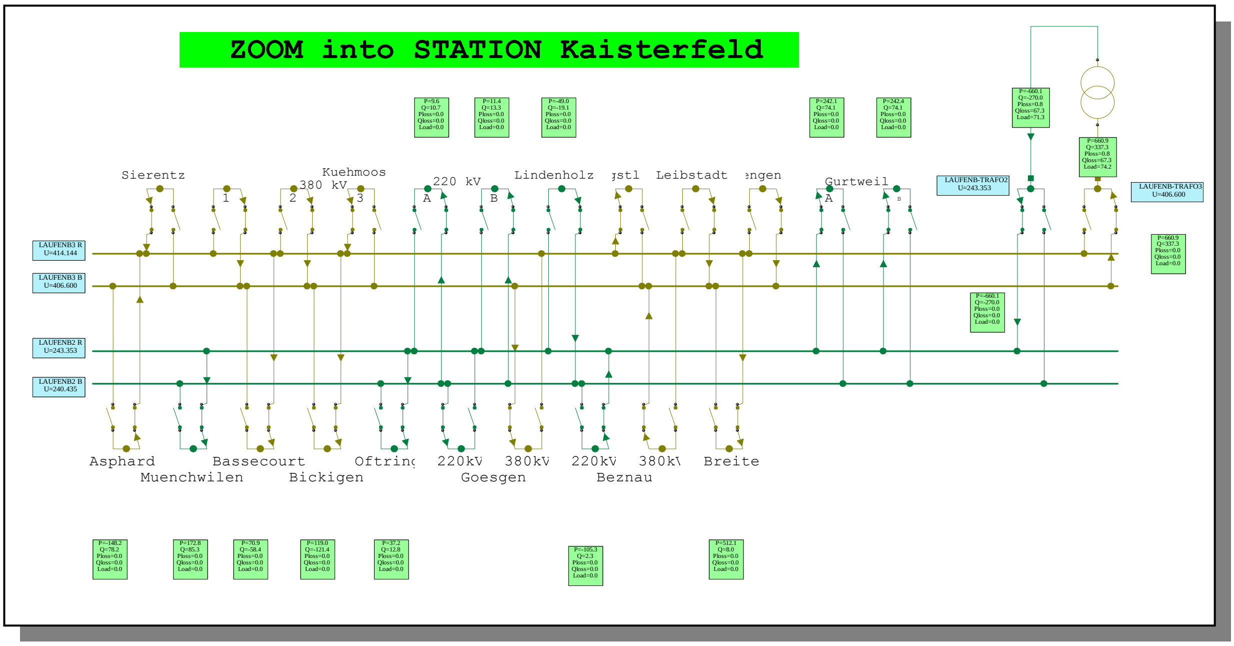
- electrical parameters of the primary elements, like lines, transformers, generators, motors, etc.
- load and measurement data as well as pre-defined load profiles
- protection device types and settings
- Harmonic currents and voltages
- Control circuit data (function blocks)

The GIS/SCADA interface is supported by many GIS manufacturers and is an ASCII file, which includes only the most essential information, such as graphic information, interconnection of elements, state of switches, type of elements and the line length. The electrical data are taken from the NEPLAN library.

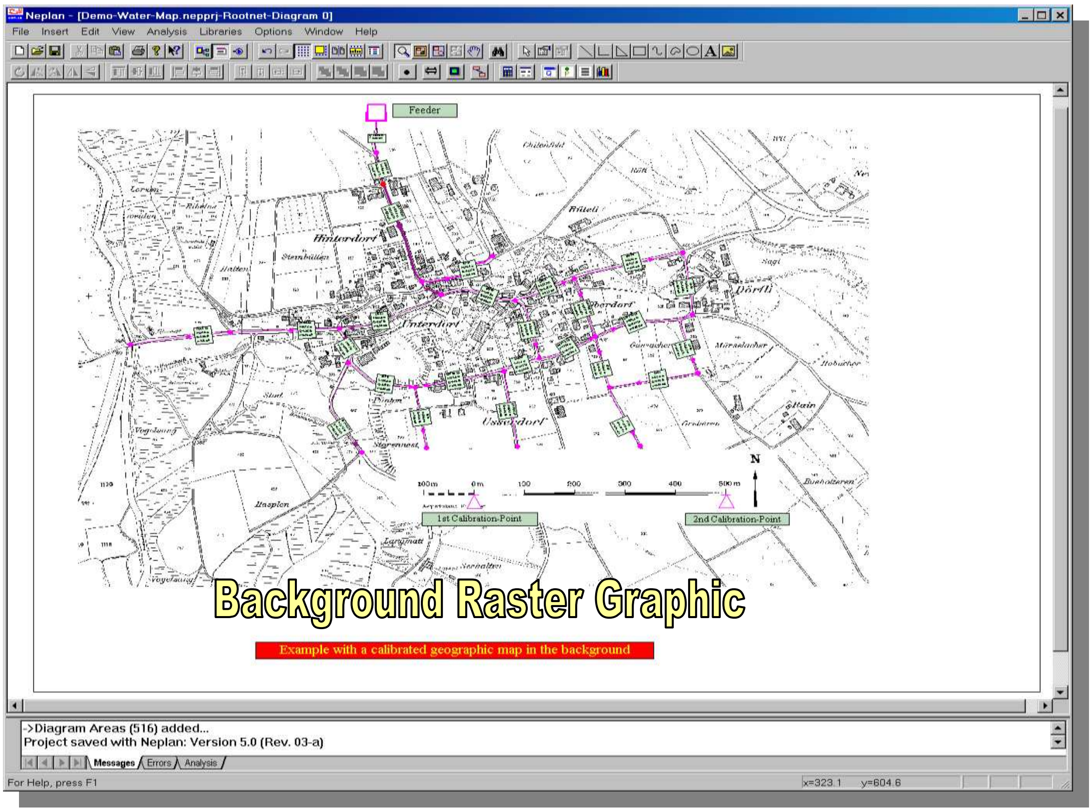




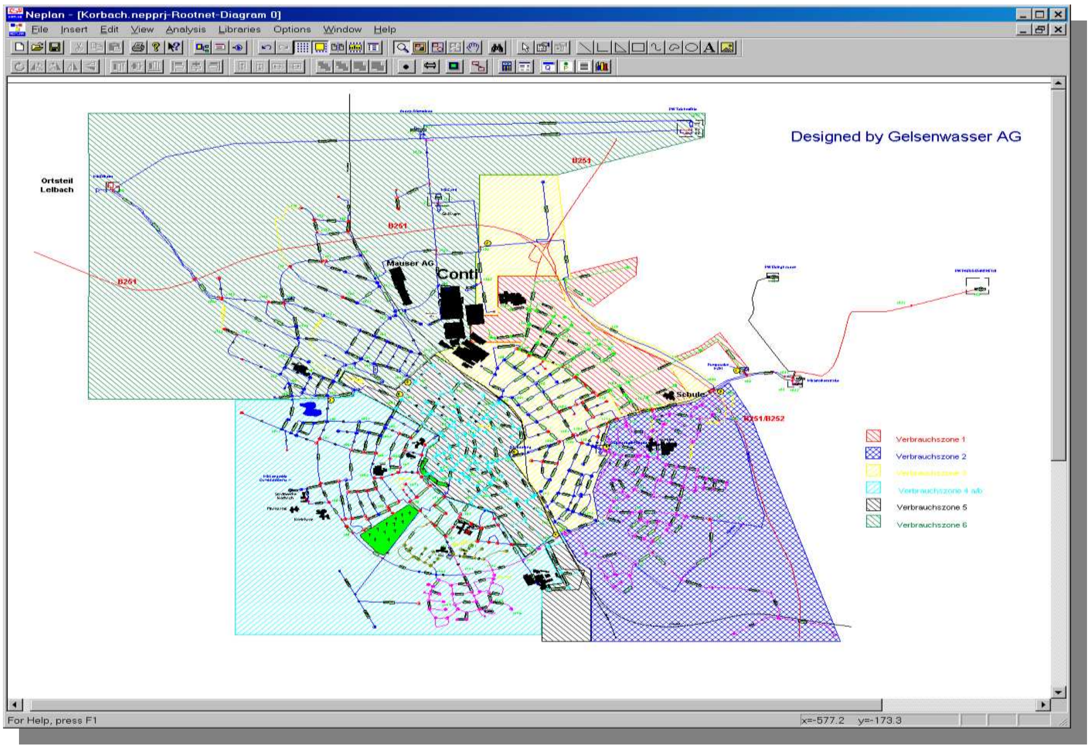
Station Kaisterfeld
France
Germany
Austria
Italy
UCTE Network



ZOOM into STATION Kaisterfeld
Sierentz
Kuehmoos
380 kV
220 kV
Lindenholz
Leibstadt
Gurtweil
LAUFENB-TRAFO2
LAUFENB-TRAFO3
LAUFENB3 R
LAUFENB3 B
LAUFENB2 R
LAUFENB2 B
Asphard
Muenchwilen
Bassecourt
Bickigen
Goesgen
Beznau
Breite



Neplan - [Demo-Water-Map.nepprj-Rootnet-Diagram 0]
File Insert Edit View Analysis Libraries Options Window Help
Feeder
1st Calibration-Point
2nd Calibration-Point
Background Raster Graphic
Example with a calibrated geographic map in the background
->Diagram Areas (516) added...
Project saved with Neplan: Version 5.0 (Rev. 03-a)
Messages
Errors
Analysis
For Help, press F1
x=323.1 y=604.6



Neplan - [Korbach.nepprj-Rootnet-Diagram 0]
File Insert Edit View Analysis Libraries Options Window Help
Designed by Gelsenwasser AG
Ortsteil Lelbach
B251
Conti
Schule
Verbrauchszone 1
Verbrauchszone 2
Verbrauchszone 5
Verbrauchszone 6
For Help, press F1
x=-577.2 y=-173.3

NEPLAN Modules

The power system analysis software NEPLAN consists of several modules, which can be bought individually. The modules can be grouped as follows:

Base Modules

- Load Flow/Contingency Analysis
- Short Circuit Analysis
- Harmonic Analysis
- Motor Starting Analysis
- Line Parameter Calculation
- Network Reduction
- Investment Analysis (present value)
- Dynamic Simulator: RMS-Simulation
- Over current Protection
- Distance Protection
- Reliability Analysis
- NPL Programming Library (C/C++)
- Interfaces GIS/SCADA (SQL, ASCII)

Transmission Modules

- Base Modules
- N-1 constrained Optimal Power Flow
- Available Transfer Capability Analysis (ATC)
- Dynamic Simulator: RMS, EMT, Phasor dynamics
- Voltage Stability
- Small signal Stability
- Day-Ahead Congestion Forecast (DACF)
- Asset Management (RCM)
- Grounding System Analysis

Distribution Modules

- Base Modules
- Load Forecast / Load profiles
- Optimization of Distribution Network
- Assessment of network disturbances
- Optimal Feeder Reinforcement
- Optimal Capacitor Placement
- Phase Swapping
- Optimal Network Restoration Strategy
- Cable thermal analysis
- Low-voltage calculation
- Fault Finding
- Asset Management (RCM)

Industrial Modules

- Base Modules
- Cable sizing
- Arc Flash Calculation
- Grounding System Analysis

NEPLAN Toolbox for Research

- All Modules
- NPL Programming Library (C/C++)
- Matlab/Simulink Interface

Some of the modules are explained below. Please ask for more information or visit our Homepage www.neplan.ch .

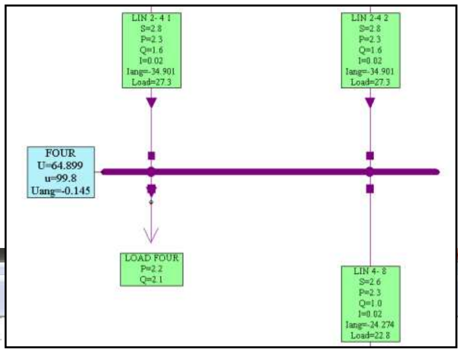
Load Flow Analysis

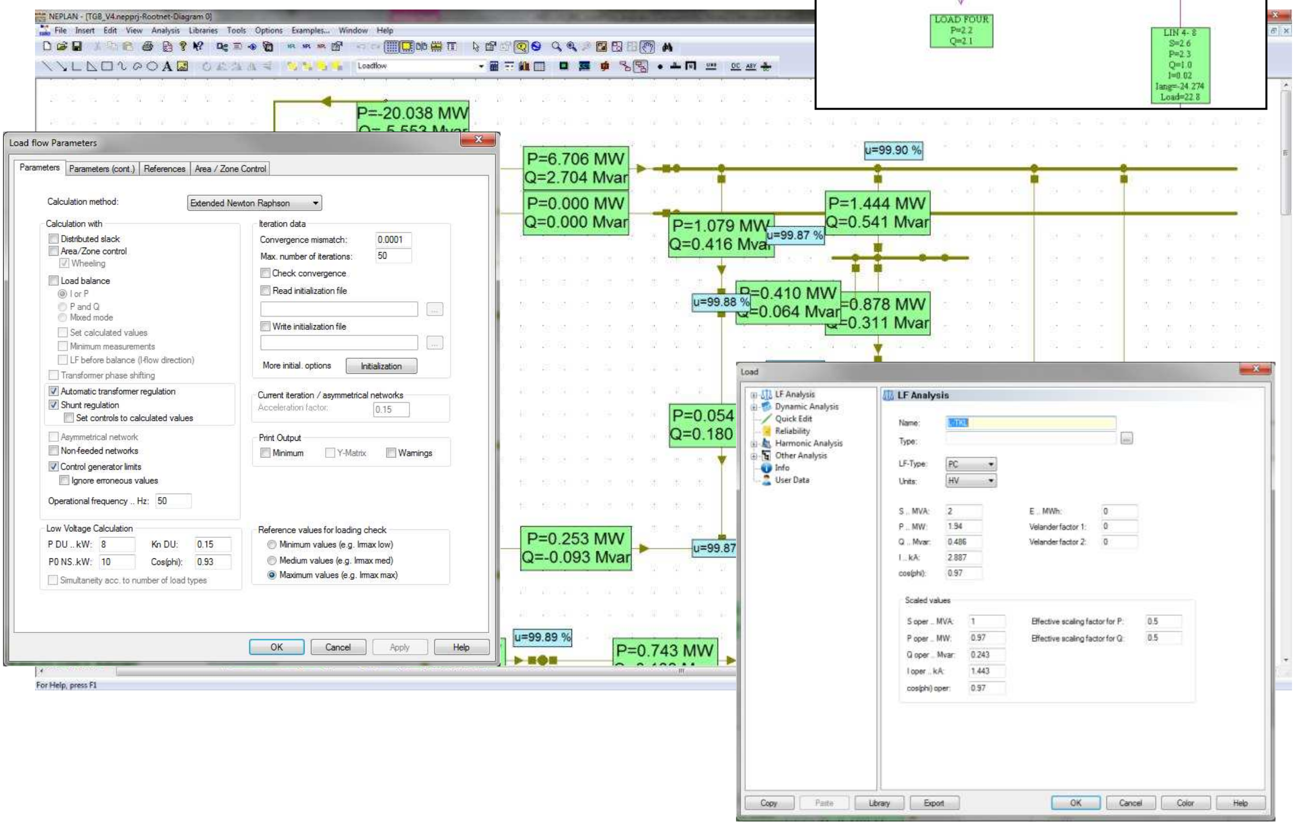
Application: Transmission – Distribution – Industrial - Generation

NEPLAN® Smarter Tools

General Characteristics

- Computation methods: Current Iteration, Newton Raphson, Extended Newton Raphson, Voltage Drop (per-phase), DC load flow
- 3-, 2- and 1-phase AC and DC systems for meshed, looped and radial networks from HV to LV
- Disperse generation models (wind power, photo voltaic, small hydro, geothermic, etc.)
- User-defined modeling with NEPLAN® C/C++ API.
- Voltage and flow control with phase-shifting transformers.
- HVDC, PWM and FACTS devices, like SVC, STATCOM, TCSC, UPFC
- Node types: slack, PQ, PV, PC, SC, PI, IC with intuitive assignment. More than one slack node possible.
- Power interchange between area / zones (area interchange control) and distributed slack node
- Predefined and user defined scaling factors for fast load and generation variations
- Measurement data import and load balancing
- Calculation of loss sensitivities (PDTF-factors)
- Powerful convergence control with initialization file input / output
- Limit check and appropriate automatic conversion of the node type.





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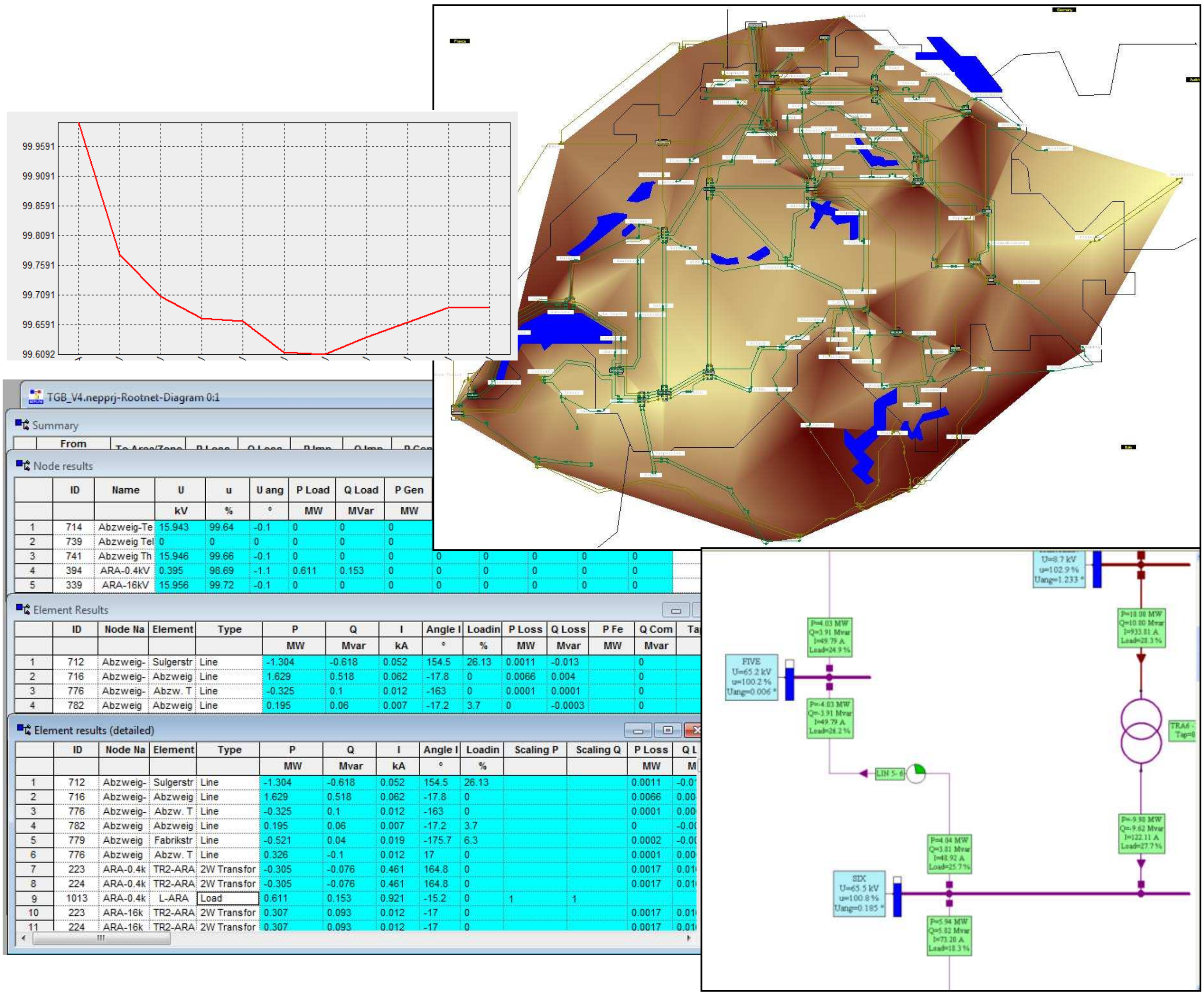
Results

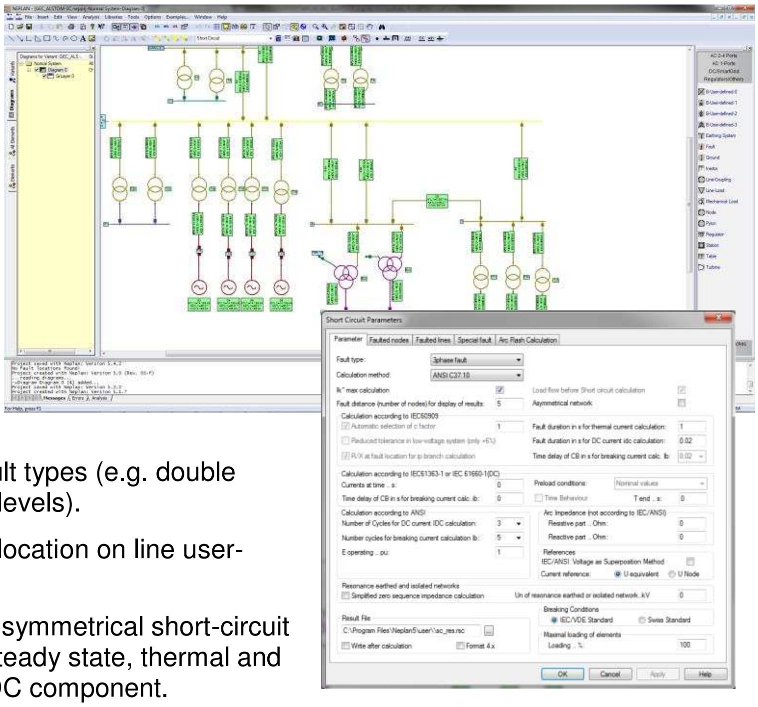
- Automatic display of results.
- 'Move' and 'Delete' function for result boxes.
- Self-defined result output: the user can select items, units, font, precision, placement.
- Overloaded elements or nodes with voltages outside predefined limits are highlighted.
- Line thickness corresponds to element loading.
- Results can be saved in a text file (ASCII).
- Table output: for the whole network, individually for each area / zone. Listing of power flows between area/zones, overloaded elements, sorting function, selective output.
- Table interface with MS-Excel.



Short Circuit Analysis

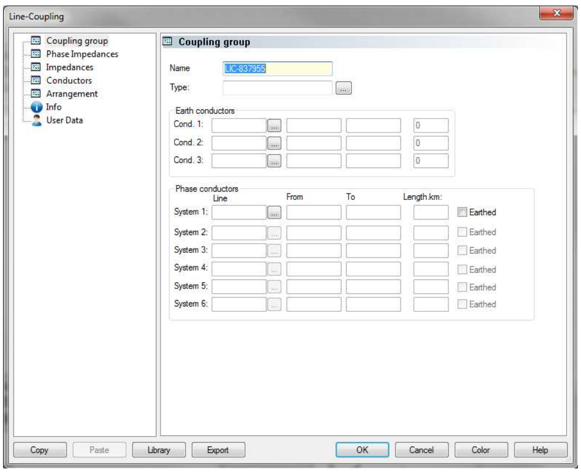
Application: Transmission – Distribution – Industrial - Generation

General Characteristics



- Standards IEC 60909, ANSI/IEEE C37.10/C37.13
- IEC 61363-1 for off-shore/ship plants, IEC 61660 for DC networks
- 3-phase, 2-phase and 1-phase AC system or DC networks
- Superposition method with consideration of prefault voltages from a load flow.
- Computation of single-, two- (with and without earth connection) and three-phase faults.
- Option for computing user-defined fault types (e.g. double earth fault, fault between two voltage levels).
- Option for computing line faults (fault location on line user-selectable).
- Computable fault current types: initial symmetrical short-circuit current and power, peak, breaking, steady state, thermal and asymmetrical breaking current, plus DC component.
- Computation of minimum/maximum short-circuit current.
- Accurate model for transformer earthing connection.
- Petersen coil tuning in resonance earthed networks
- Current limiting due to circuit breakers and MOV.

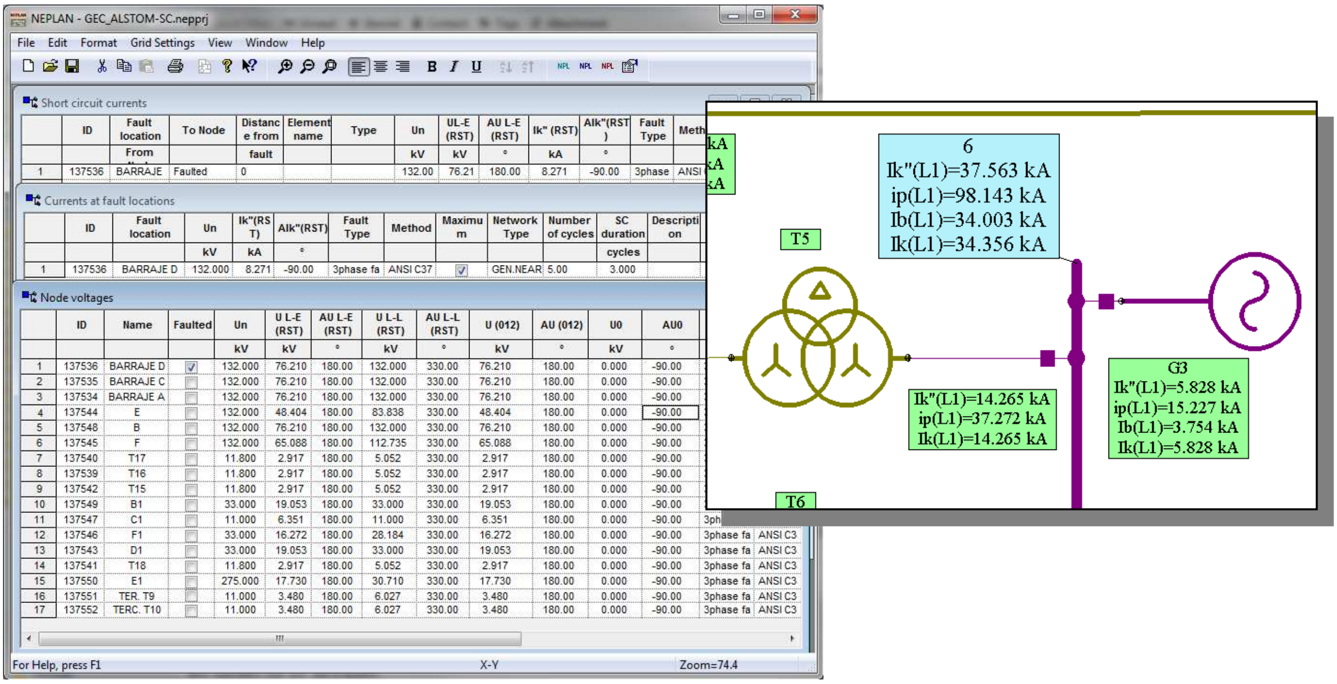
Line Coupling



- Mutual impedances and capacitances in the positive and negative-sequence systems are allowed for in short-circuit current computation.
- Circuit and coupling parameters of the overhead lines are computed from the conductor configuration.
- Overhead lines with up to 6 3-phase systems and 3 earth wires can be computed (earthing of 3-phase systems considered).
- Unrestricted number of overhead lines can be entered.
- Parameters and conductor configuration are saved in an SQL database.

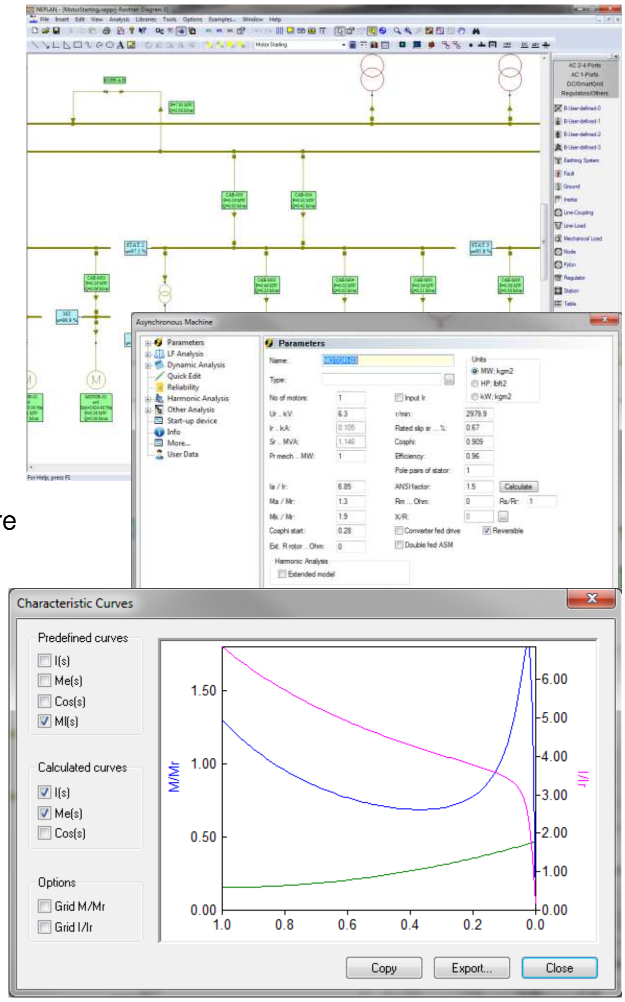
Results

- Automatic display of results.
- Move and delete function for result boxes.
- Self-defined result output in regard to units, formats and fault current types.
- Results can be inserted either at the beginning and/or end node, or also in the element's center.
- In the event of a short-circuit, all overloaded pieces of equipment (current transformers, voltage transformers, circuit-breakers, etc.) are highlighted.
- Results can be saved in a result file (ASCII file) and in an SQL database.
- Result lists can be saved in text files.
- List output: sorted by voltage levels. Short-circuit impedance and all computable fault currents are output as phase values or as symmetrical components.



Motor Starting Computation

- Simulation of motor start-up in unlimited networks.
- Simultaneous or time-delayed start-up for any desired number of motors.
- Identification of motor parameters using the least square method from input values for torque, current and cos(phi) in function of the slip.
- Different motor models, depending on the motor data entered.
- Saturation and eddy-current losses in the motor allowed for (linear or point-by-point).
- Libraries for standard motor data, plus additional libraries for Me(s), I(s) and cosj(s) are available (can be extended by the user).
- Operating point computation for all non-starting motors in accordance with their load characteristics (Newton-Raphson).
- Automatic tap changing transformers are allowed for after a user-defined time-delay.
- Load torque entered as a characteristic or as a linear or quadratic load torque curve.
- Libraries for load torques are available (can be extended by the user).
- Start-up devices are allowed for, such as star-delta starter, series resistor, transformer, soft starter, etc.



Voltage Drop

- Computation of voltage drop to the moment t = 0.
- Reduced data entry for motors and computation parameters.
- Non-starting motors can be simulated by a user-defined load PQ (constant power) or shunt.
- Overloaded elements, measuring instruments and protective devices or nodes with voltages outside a defined range are highlighted.
- Results of the voltage drop computation are displayed in the single line diagram.
- The motor data entered and the motor parameters computed can be accessed by clicking on the motor concerned in the single line diagram.

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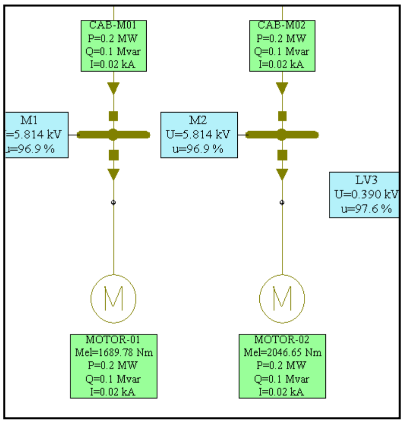
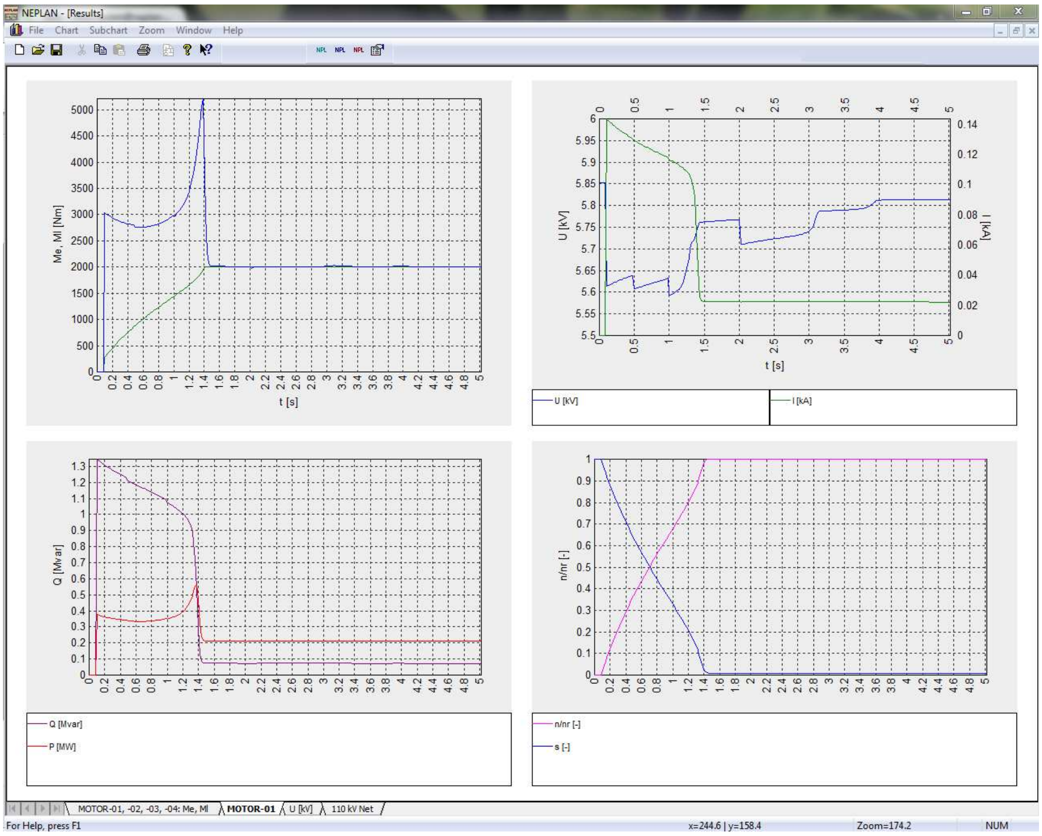
Results

- Computation of voltage U(t) at predefined nodes.
- Computation I(t), P(t), Q(t) for each predefined element.
- Computation of motor current I, load torque M, electromagnetic torque Me, active power P and reactive power Q as functions of time, or of the slip for starting-up and non-starting-up motors.
- Graphical output of the characteristic curves and time characteristics, with automatic scaling of the axes.
- Dimensioning and colors can be altered.
- Result lists can be saved in text files.
- Results can be saved in result files for evaluation by means of spreadsheet programs (such as MS-Excel).





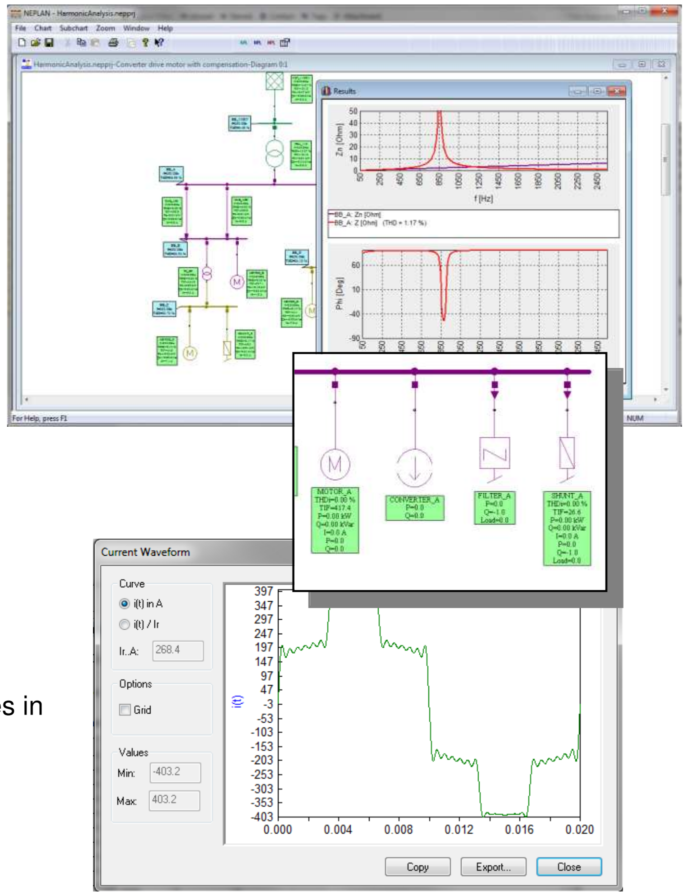
Harmonic Analysis

Application: Transmission – Distribution – Industrial

NEPLAN® Smarter Tools

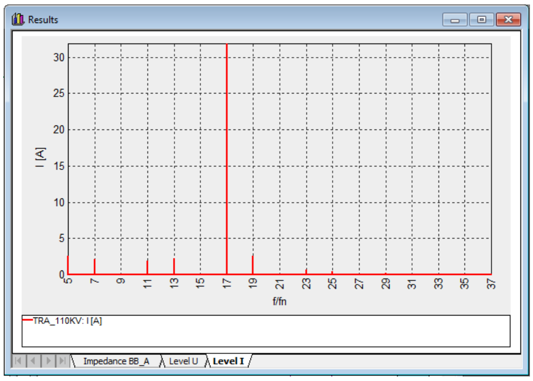
General Characteristics

- 3-phase, 2-phase, 1-phase AC systems.
- Planning of ripple control systems, dimensioning of compensators (SVC) and harmonic filters, determination of network impedance for sub-synchronous resonance or filter design.
- Frequency response of meshed networks.
- U-I and I-U sensitivity for each frequency.
- Distributed parameter line model applied.
- Computation of network impedance and harmonic level for each frequency and for each node.
- Frequency-dependence of elements is considered. Libraries available.
- Automatic frequency step length control during impedance computation to detect resonances.
- Calculation in the positive component system (symmetrical) or in the phase system
- Calculation of self- and mutual line impedances in function of the frequency
- Harmonic load flow (P, Q, I, U, losses)
- Results in frequency or time domain.



Harmonic Levels

- Current and voltage computation at all frequencies and at all predefined nodes and elements.
- Computation of r.m.s. values for harmonic voltages and currents with fundamental harmonic voltage or current taken from the Load flow (optional).
- Computation of total harmonic voltage factor in conformity with DIN/IEC and distortion factor in accordance with IEEE.



- Computation of telephone parameters (TIF, IT, KVT) or transformer k-factor.
- Comparison of computed harmonic levels with the limit values laid down in any standards desired.
- List output of ripple control currents and voltages at any desired frequencies and at each node and each element.
- Automatic entry of results in the single line diagram.
- Harmonic sum calculation: vectorial, geometric, arithmetic, acc. to IEC 1000-2-6

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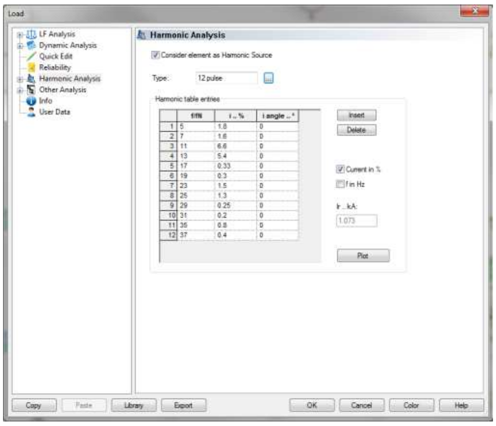
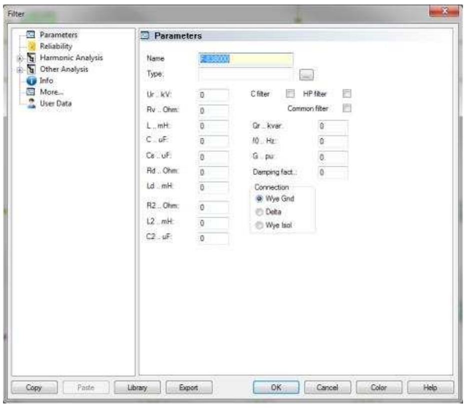
Harmonic source

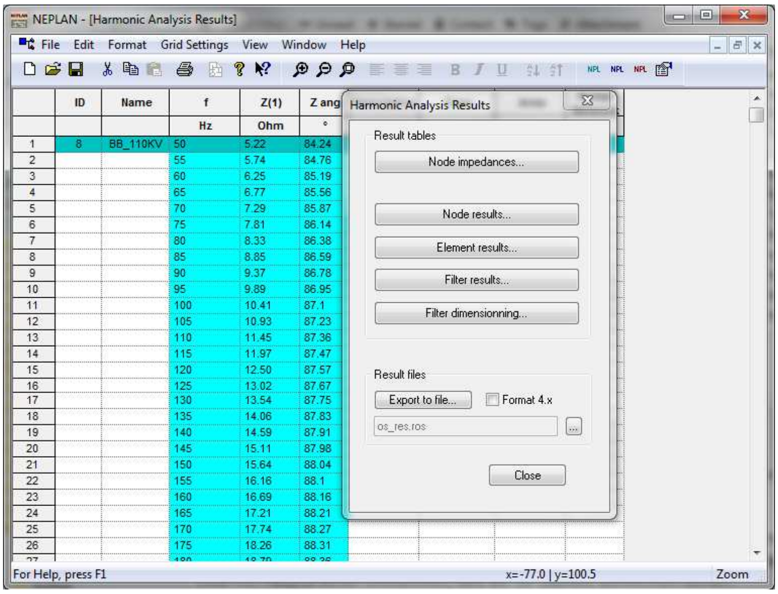
- Harmonic sources (current and voltage sources) are entered directly in the single line diagram. Libraries available
- Harmonic sources can be assigned directly to loads or any power electronic elements, such as Converter, SVC, PWM, etc.
- Unlimited number of harmonic sources (current/voltage) can be computed with each harmonic.
- Any harmonic can be handled, e.g. inter-harmonics due to saturation effects.



Filter Dimensioning

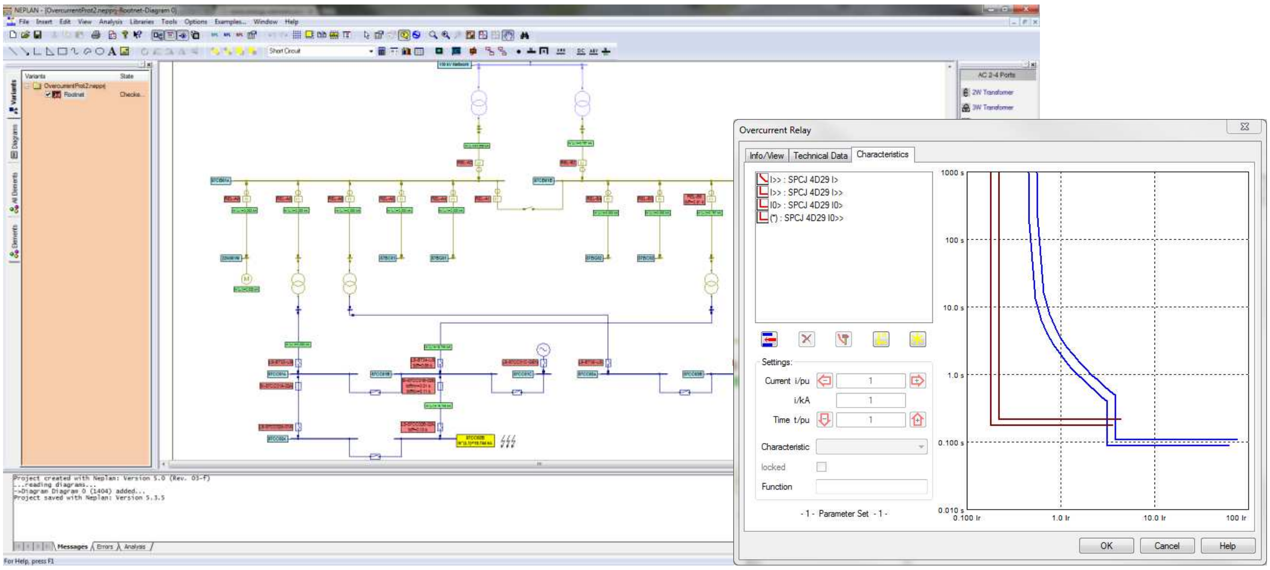
- Filter elements are transferred directly into the single line diagram.
- Filter elements: filters (normal, HP, C-filter), series RLC-circuits with or without earth connection, ripple control traps.
- Filters are dimensioned directly by the program.
- Filter data are listed or saved in a text file.
- Result lists can be saved in text files.
- Results can be saved in result files for evaluation by means of spreadsheet programs (like MS-Excel).

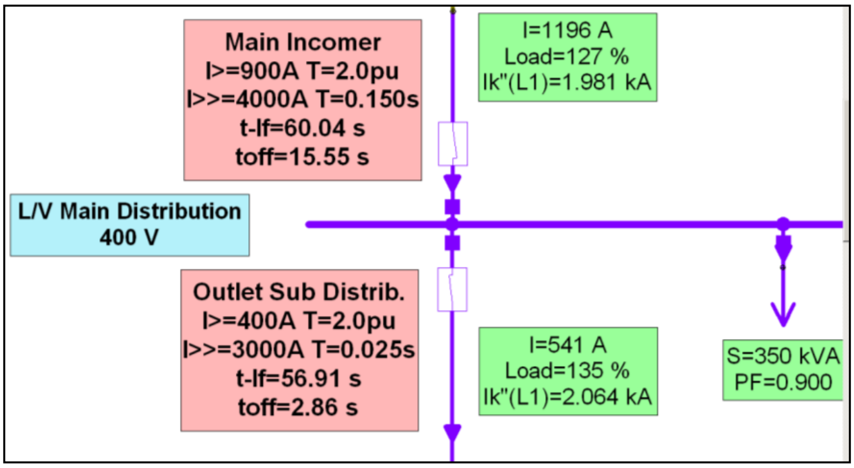




General Characteristics

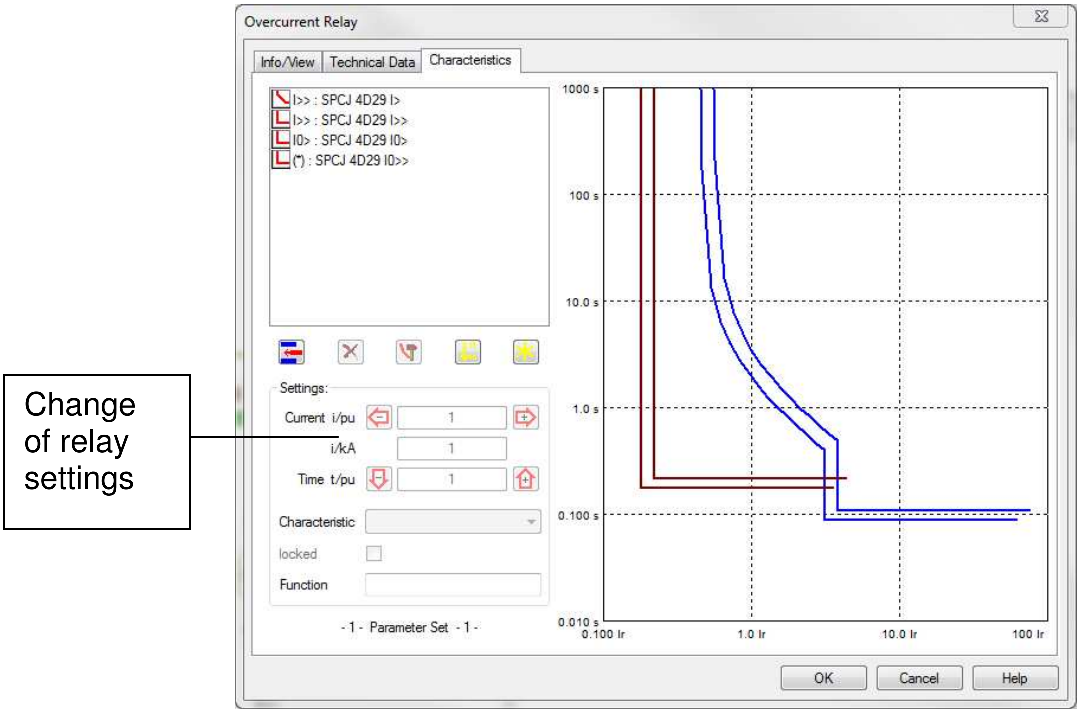
- All types of protective devices with a current-time characteristic can be entered: fuses, circuit-breakers, definite-time and inverse-time over-current relays, electronic relays.
- Several protective functions can be assigned to each protective device: non-directional or directional over-current and earth-fault protection).
- Exact modeling of setting ranges
- Extensive libraries with protective devices from a variety of manufacturers are available, and can be extended at will.
- Option for entering user-defined characteristics for simulating motor start-ups or thermal capability of conductors, transformers, etc.
- Characteristic can be shifted using a k-factor (inverse-time relay).
- Entry options for characteristics: point-by-point or formula in conformity with IEC or IEEE/ANSI.
- Simulation of fault clearing procedure in meshed networks, involves also distance protection.





Selectivity Diagram

- Protection device and current transformers are positioned in the network plan graphically.
- Automatic generation of selectivity diagrams based on s/c calculation
- Unrestricted number of characteristics can be incorporated in one diagram.
- Changing the relay settings directly in the selectivity diagram
- Unrestricted number of diagrams can be processed simultaneously.
- Selectivity analysis over more than one voltage level and independently of the network type and size involved.
- Two reference voltages for diagrams can be user-defined.
- Individualized coloring of the characteristics.
- No limit on number of diagrams and protective numbers for management.
- Export of complete diagram to Word etc. by clipboard or emf-files



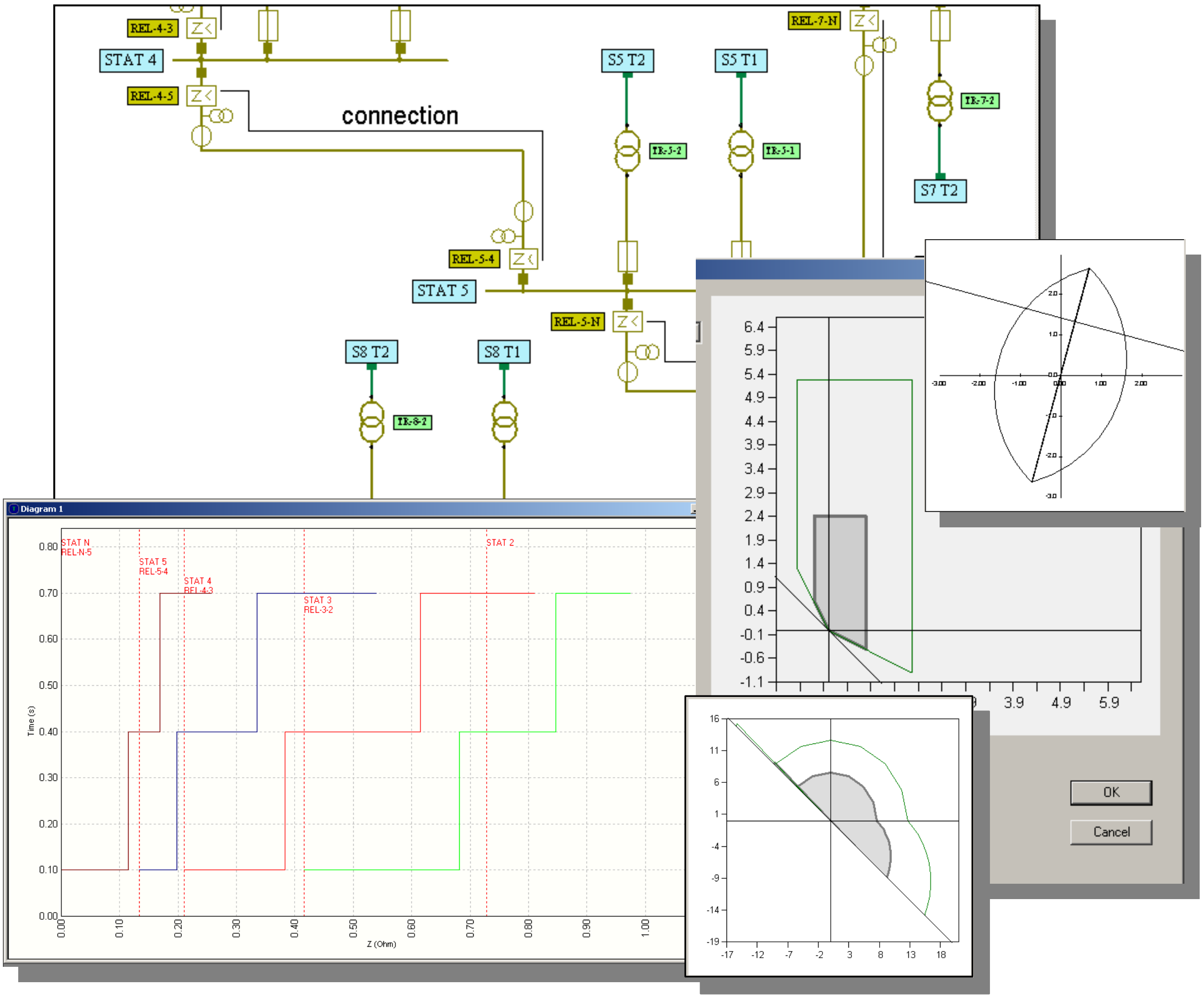
Transferring Current Values

- Direct connection from short-circuit current and load flow module for transferring the currents.
- Unrestricted number of currents can be transferred into one diagram.
- Import/export functions.

Protection Libraries

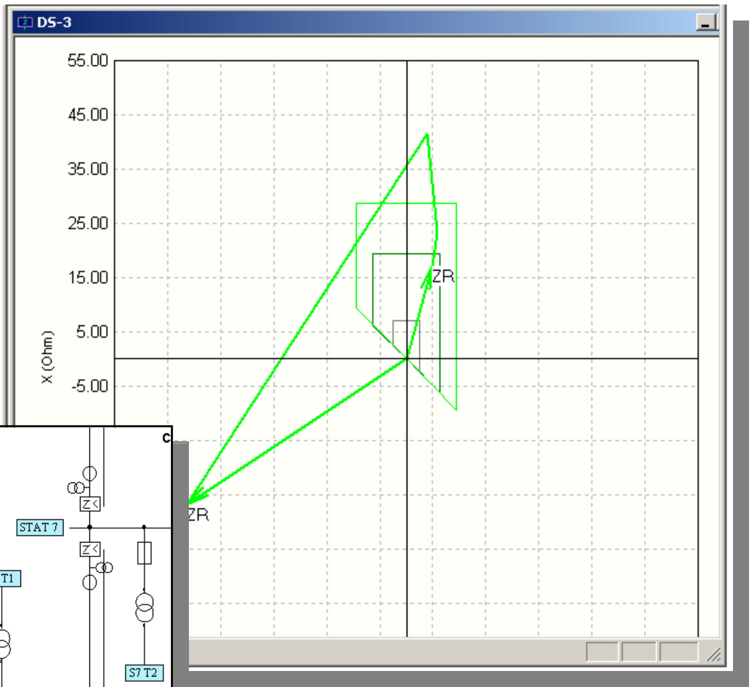
NEPLAN offers extensive libraries with most used relays-, circuit breaker - and fuse-types. The libraries are constantly updated and extended. It will be handed out for free at the moment of a NEPLAN software purchase or can be downloaded anytime from the Internet by users with a valid maintenance contract.

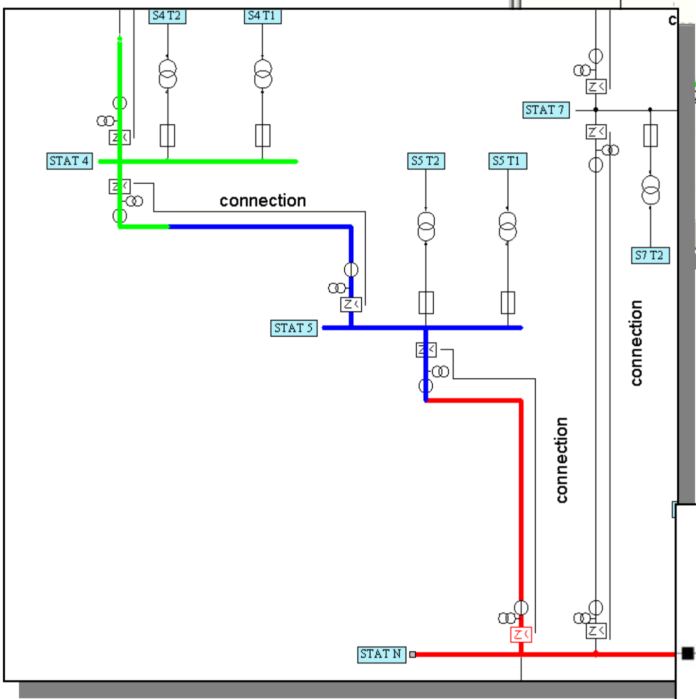
- All types of distance protection relays (irrespective of the manufacturer) can be entered.
- Relays up to 4 impedance zones, 1 over reach zone, 1 backward zone and 1 auto-reclosure zone for line-line and line-earth faults can be defined.
- Start-up characteristics: Over current, angle dependent under impedance, R/X-characteristic, directional/bi-directional end time.
- Processes analog and binary signals and sends out binary signals during dynamic simulation. Binary signals can be: Blocking, Enable, Intertripping, Range Extension, External Starting, Auto-reclosure Blocking, etc, e.g. POTT (Permissive over-reach transfer tripping) and PUTT (Permissive under-reach transfer tripping) can be simulated.
- Interaction between distance protection relay with any other relay type can be defined for dynamic simulation.
- Relay can be modeled within Matlab/Simulink or with NEPLAN function blocks for dynamic simulation.
- Input of any R/X-Characteristic: MHO, Circle, Polygone, Lens, etc. or defined by functions
- Modules for over current, power swing, pole sip.
- Interface to relay test devices. Import/Export of RIO-Format (Relay Interface by Omicron).
- Simulation of fault clearing procedure in meshed networks based on the short circuit module. It involves also over current protection.



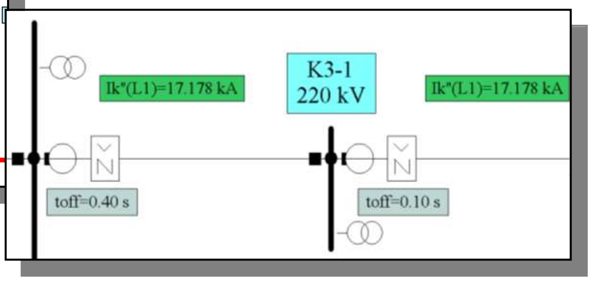
- Automatic setting of the relays considering several methodologies (selectable).
- Mutual impedances and capacitances of the positive and zero sequence systems as well as the loading state of the network and infeeds are considered for calculating network impedances.
- Impedance/Reactance of the positive sequence system or the loop impedances are calculated for any short circuit type. Compensation factors due to zero sequence system impedance and mutual coupling are considered in calculating the loop impedances.
- Automatic and user-defined creation of selective tripping schedule.
- Tripping time will be displayed in the single line diagram and in tables after a short circuit calculation.
- All fault types, plus sliding faults of the short circuit module are allowed for.
- Fault location finding. Fault location will be displayed in the single line diagram or listed according to the previously measured impedance value. Tolerance will be considered.
- Interactive change of relay setting parameters and characteristics.

- Display of all calculated impedances with the relay characteristics
- Impedances can be entered/displayed in primary or secondary values. CT and VT are considered.





- Zones are colored in the single line diagram for a predefined relay.

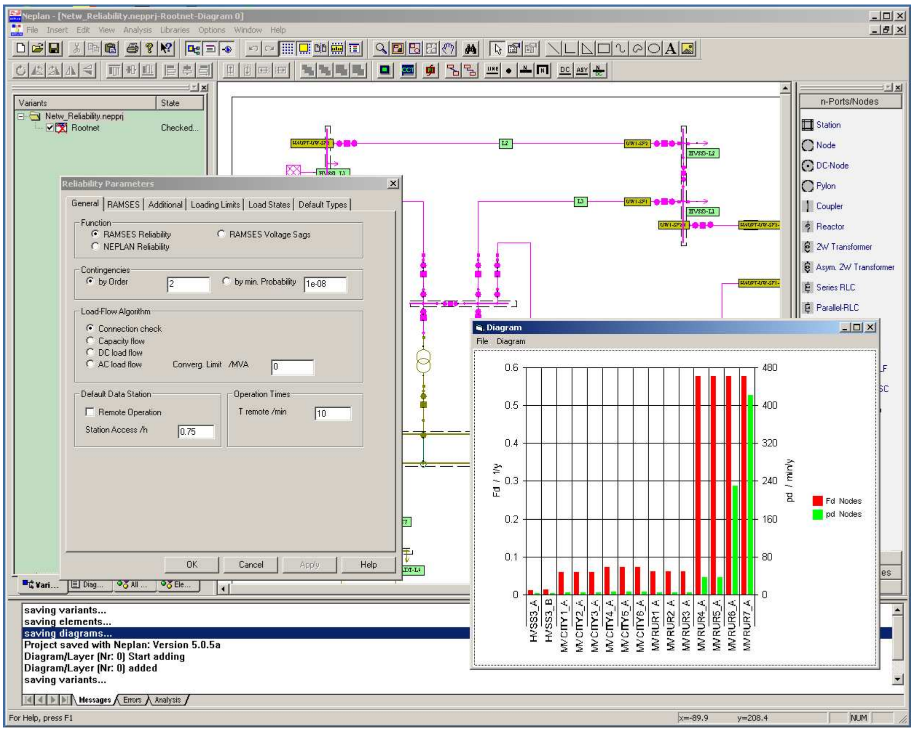


Probabilistic Reliability Analysis

Determining the frequency, average duration and cost of network component failures, leading to supply interruptions.

Consideration of

- Outage behavior (failure rate and repair times) of network equipment
- Network operation in normal state and for multiple order network contingencies
- Admissible short-time component overloading
- Protection concept including protection failures
- Realistic generation patterns and load curves



Reliability Analysis is imperative for

- Optimum asset allocation and cost-benefit analysis for investments in transmission and distribution networks
- Design and evaluation of innovative substation layouts
- Weak-point analysis in existing networks
- Design of automation concepts in public and industrial distribution networks
- Detailed and objective discussion of network connection concepts for high-demand customers and power plants
- Cost-effective mitigation of power quality problems (voltage sags)
- Add-on for NEPLAN-Main – a tool to apply Reliability Centered Maintenance (RCM) Strategy, which leads to substantial reduction of maintenance expenses

Procedure of Reliability Analysis

Relevant component failures

Single order contingencies:

- Stochastic failures
- Common-Mode failures
- Spontaneous protection tripping

Second order contingencies:

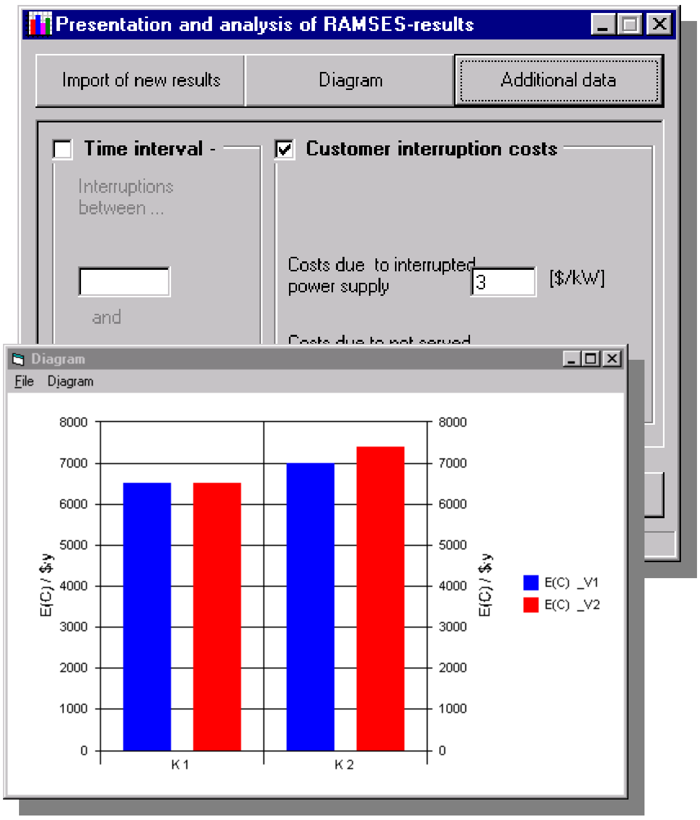
- Overlapping independent stochastic outages
- Failure occurring during the maintenance of the backup components
- Protection failure or overfunction
- Multiple earth-faults

Calculated results

- Frequency of supply interruptions	fd	in #/yr
- Probability of supply interruptions	qd	in min/yr
- Mean interruption durations	Td	in hrs
- Energy not served in time	Wd	in MWh/yr
- Interruption cost	C_d	in $/yr

Presentation of results

- Result values printed at load nodes in network plan
- Color shading of the network graph in dependence of the reliability results
- Various filter functions implemented for detailed analysis
- Integrated flexible diagram functions to visualize the calculation results
- Results fully exportable for use in tables and diagrams



Evaluation functions

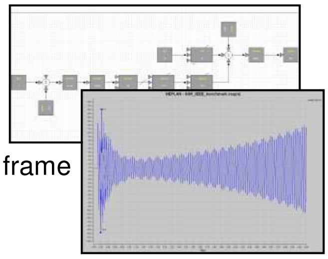
- Consideration of power/energy-specific interruption cost
- Filter to investigate component contributions to load node interruptions
- Copying of diagrams into clipboard
- Shading of network diagram in dependence of load node results
- Analysis of system reaction after faults

Dynamic Simulator

Application: Transmission – Distribution – Industrial - Generation

The NEPLAN® Dynamic Simulator is one of the most advanced on the market!

Simulator Modes



The NEPLAN simulator includes the following five calculation modes:

- RMS Transient Simulation in the DQ0 and ABC reference frame
- EMT Electromagnetic Transients Simulation in the DQ0 and ABC reference frame
- EMT Electromagnetic Transients Simulation using Dynamic Phasor Models.

The RMS mode is used for simulating the slower electromechanical transients, where the electrical model quantities are described by their fundamental frequency components. The EMT simulations are performed for the simulation of fast electromagnetic transients using instantaneous values. The simulation of symmetrical network conditions (e.g. 3-phase faults) in DQO mode is much faster than in ABC mode. However the modeling in ABC mode is more flexible and is the preferable mode if unsymmetrical network condition must be simulated.

The use of Dynamic Phasor models is a completely new approach which is unique on the market. This mode allows the simulation of fast electromagnetic phenomena as accurate as in an EMT mode, but much faster.

No more struggling with initialization, since the simulator has sophisticated built in initialization algorithms.

Dynamic Models - Matlab®

- Extensive library with many AC, DC and controller models, e.g. exciters, turbines, regulators.
- For researchers: Most effective and flexible development of customized models in Matlab®. Existing Simulink® controllers may be run together with NEPLAN®
- Any variable (signal) of any component may be accessed to build up master controllers (e.g. wind park controllers or AGC - automatic generation control)

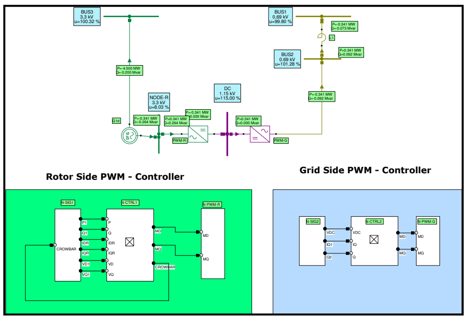
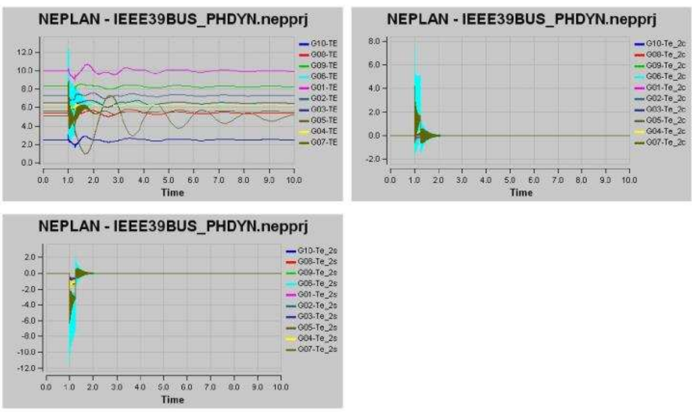


Fig.: Customized Wind Power Controllers (PWM, DFIG)



Applications

- Short-term, Mid-term and Long-term dynamic simulation.
- Sub-synchronous resonance with EMT simulation
- Load shedding and protection schemes
- HVDC-(light), FACTS, SVC design and regulation
- Machine dynamics and startup simulations
- PSS tuning with Eigenvalue and Sensitivity analysis
- Automatic generation control (AGC)

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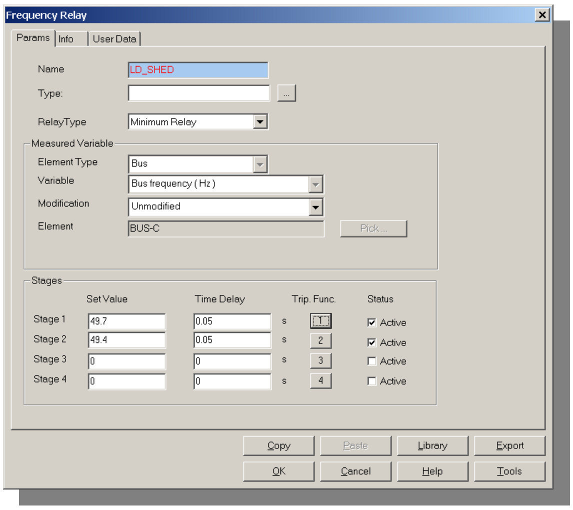
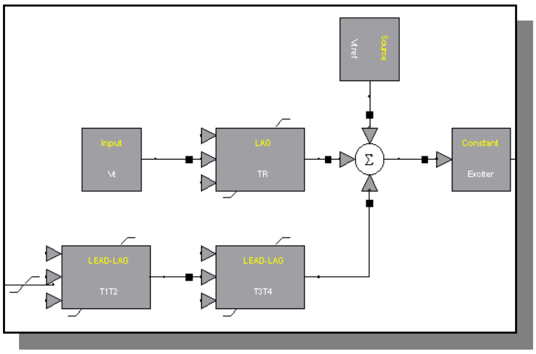
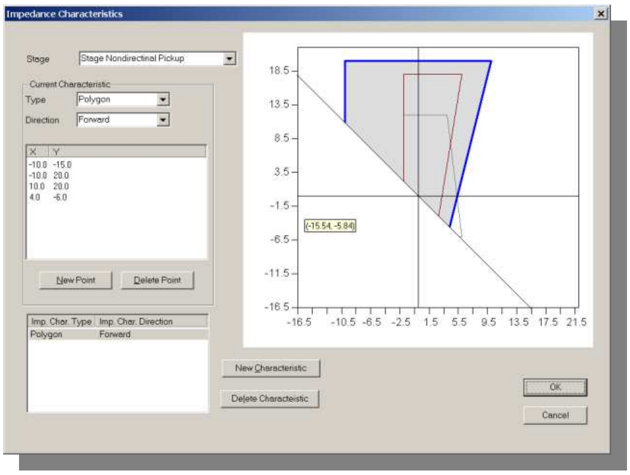
Protection Devices

- Min-max-relays (overcurrent, undervoltage, frequency,...): modeled with up to 4 tripping stages. E.g. various load shedding schemes may be simulated.
- Over current relays and fuses
- Pole slip relays, model includes binary input signals from external sources.
- Distance protection with any characteristic: pick-up and tripping stages, impedance diagrams, binary input signals from external sources.
- User defined protection described by equations or function blocks







Disturbances

- Generation and storage of various disturbance cases.
- Each disturbance case may have more than one event.
- Definition of faults (symmetrical and unsymmetrical) on buses, bus elements, branches.
- Loss of generator excitation
- Different switching operations (feed-forward control in control circuits, cross coupling of protective devices, in/out of branches, etc.).
- Transformer tap modification.
- Load shedding scenarios (also in relation to frequency relay).
- Disturbances with function generators (step, ramp, sinusoidal function or combination).
- Start-up of motors with different start-up devices.
- User-defined disturbances (every variable can be modified in the network/control)

User-defined modeling in Dynamic Simulator

Application: Transmission – Distribution – Industrial - Generation

NEPLAN® Smarter Tools

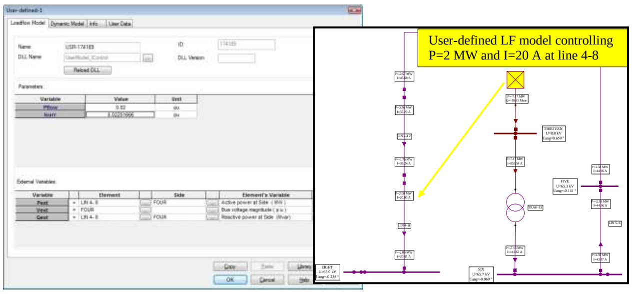
Researcher and developers need to have the ability to define their own power system component models. That could be amongst others:

- special load flow models
- special dynamic models for machines or loads
- controllers for wind power systems or FACTS devices
- wide area network controllers
- detailed model of protection devices
- etc.

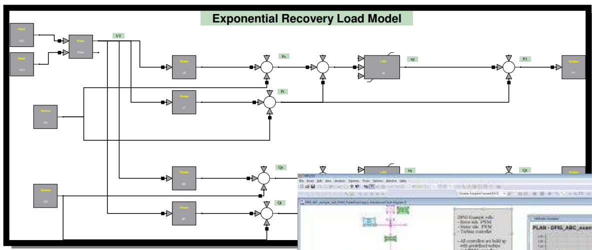
NEPLAN® offers excellent functionalities to develop such user defined models (UDM) and integrate them into an existing NEPLAN® network model. Furthermore NEPLAN® data may be accessed by a C/C++ API, the NEPLAN® Programming Library (NPL). The model will be used in binary format, in order to protect the work and know how of the developer of such a UDM.

Modelling for Researchers

- Modelling with the C/ C++ API
- Function block diagram editor
- Modelling in Matlab® with DSAR
- Run NEPLAN and Simulink and use Simulink® defined models and controllers



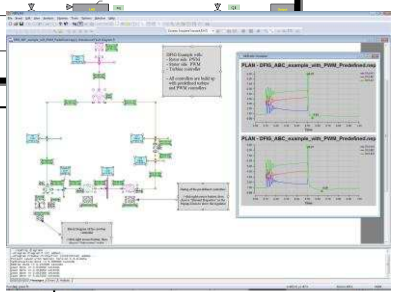
1) **Load flow models** may be defined with the NEPLAN® C/C++ API. Basically the load flow equations will be written in a C/C++ program. The compiled DLL file will then be assigned in the NEPLAN graphical editor. The dialog in NEPLAN show the parameters and signals which have to be defined for the model.



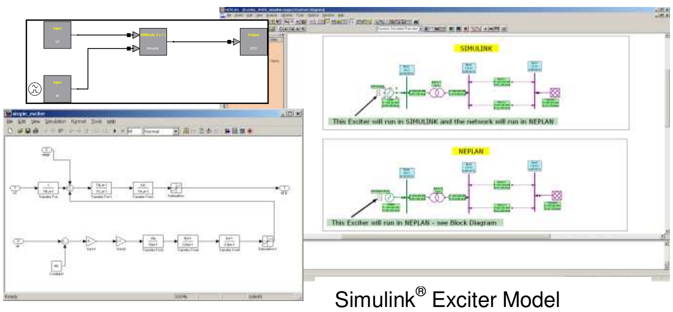
2) With the NEPLAN **function block drawing editor** the user may define graphically new dynamic models for controllers as well as for primary components and loads. The example on the right shows an exponential recovery load model.

3) The models may be described directly in Differential Switched-Algebraic State Reset Equations (DSAR) in Matlab®. The NEPLAN® - Matlab® interface automatically generates a binary DLL file which may be assigned to user defined NEPLAN® component. Parameters and external signals may be set in the NEPLAN dialog.

```
%---------DSAR  model -------------
f_equations:
%-------------------------------------------
dt(dVf)= 1/TR*(VT - dVf)
dt(dEFD)= 1/TA*(KA*xtgr -
dEFD)*NOLIMIT
dt(dxi)= xerr - xtgr
if t < 0
   dt(dVref) = VT - Vsetpoint
else
   dt(dVref) = 0
end
```



DFIG User defined controller in ABC simulation mode



Simulink® Exciter Model

4) It is possible to use directly the models and controllers from Simulink®. Simulink® and NEPLAN® are the running at the same time and in each time step NEPLAN® and Simulink® exchange data.

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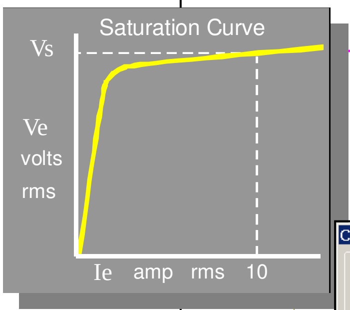
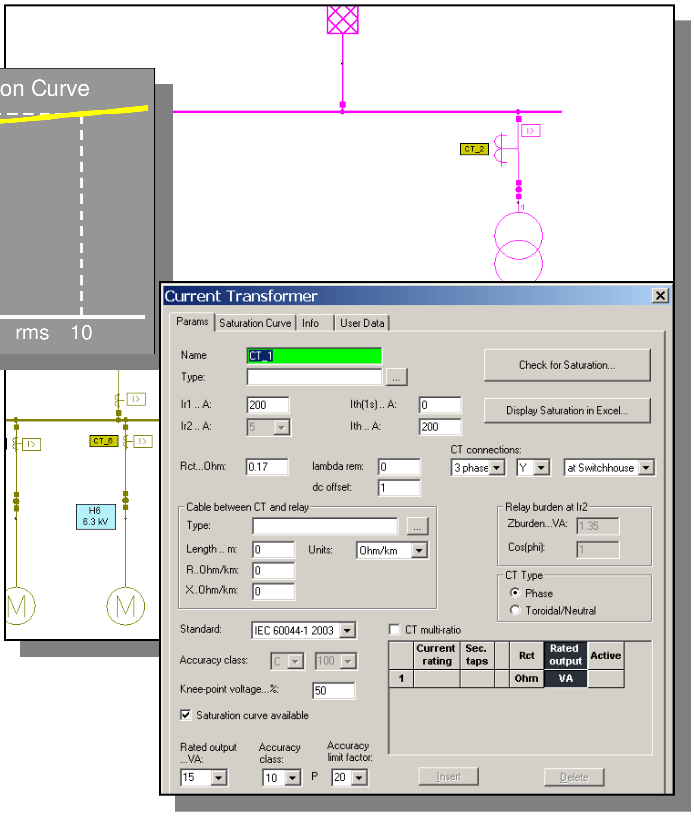
CT Saturation and Thermal Analysis

Application: Transmission – Distribution – Industrial - Generation

Current Transformer Saturation



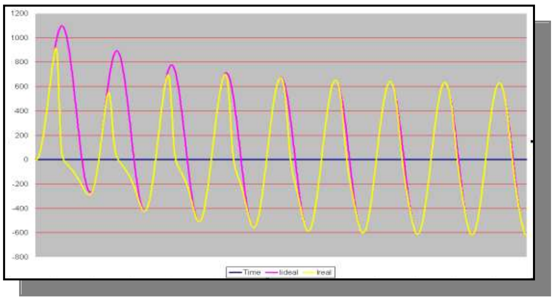


Saturation check according to

- IEEE C37.110-1996
- IEC 60044-1 2003

Results

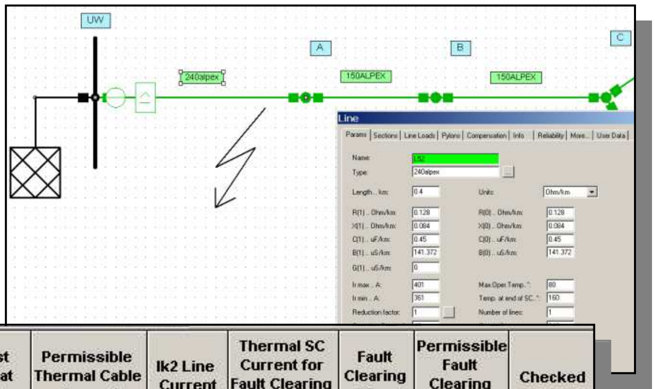
- Individual check or all CTs together
- Check for 3-phase and 1-phase faults
- Saturation criteria's according to standard are listed in tables
- Plot of ideal and distorted secondary CT current



Thermal Line Analysis

Thermal short circuit capacity

- DIN VDE 100 Part 540, IEC 865-1:1993 or ANSI
- Cable or overhead lines
- Worst fault location for thermal cable stress determined
- Permissible thermal cable current according to standards and line input values determined
- Tripping time of protection devices considered
- Permissible fault clearing time calculated
- Radial and meshed networks



	Line	Worst Fault at Node	Permissible Thermal Cable Current	Ik2 Line Current	Thermal SC Current for Fault Clearing Time	Fault Clearing Time	Permissible Fault Clearing Time	Checked
			kA	kA	kA	s	s	
2	L57	A	9.510	24.073	25.030	0.100	0.148	☒
3	L62	B	9.510	13.931	14.203	0.100	0.463	☒
4	L72	M	6.023	9.144	9.283	0.100	0.431	☒
5	L77	P	6.023	8.380	8.503	0.100	0.514	☒
6	L67	C	6.023	11.755	11.962	0.100	0.259	☒
7	L87	O	9.510	10.502	10.676	0.100	0.817	☒
8	L92	T	9.510	8.899	9.038	0.100	1.139	☒
9	L82	C	9.510	11.755	11.962	0.100	0.651	☒
10	L102	X	6.023	6.314	6.403	0.100	0.908	☒
11	L107	Z	6.023	6.746	6.842	0.100	0.795	☒
12	L97	L	6.023	7.508	7.620	0.100	0.641	☒
13	L112	Y	6.023	7.236	7.342	0.100	0.690	☒
14	L117	L	6.023	7.508	7.620	0.100	0.641	☒

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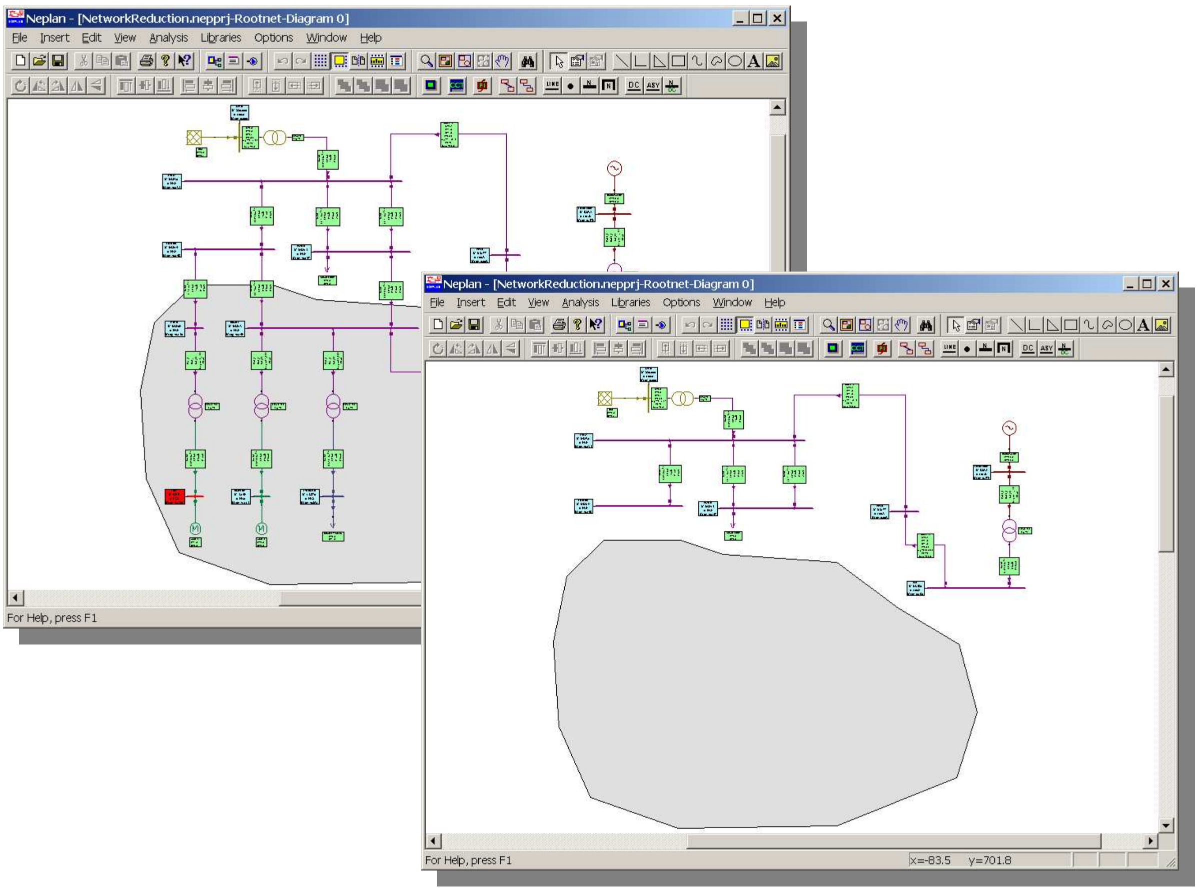
This module is designed to reduce the size of a network model by replacing sets of buses and the network elements (lines, transformers,...) that connect them with a smaller but exact, numerically equivalent network. For a properly chosen set of buses, this equivalent network will have fewer buses and branches than the original, yet still provide the correct response to faults or load flow calculations in the unreduced portion.

The network can be reduced for

- symmetrical or asymmetrical short circuit calculations according to IEC909, IEC60909, ANSI/IEEE or superposition method and
- load flow calculation.

The reduced network gives the same short circuit or load flow results as the original network. Giving the nodes to be reduced, the program determines the boundary nodes automatically.



Network Reduction

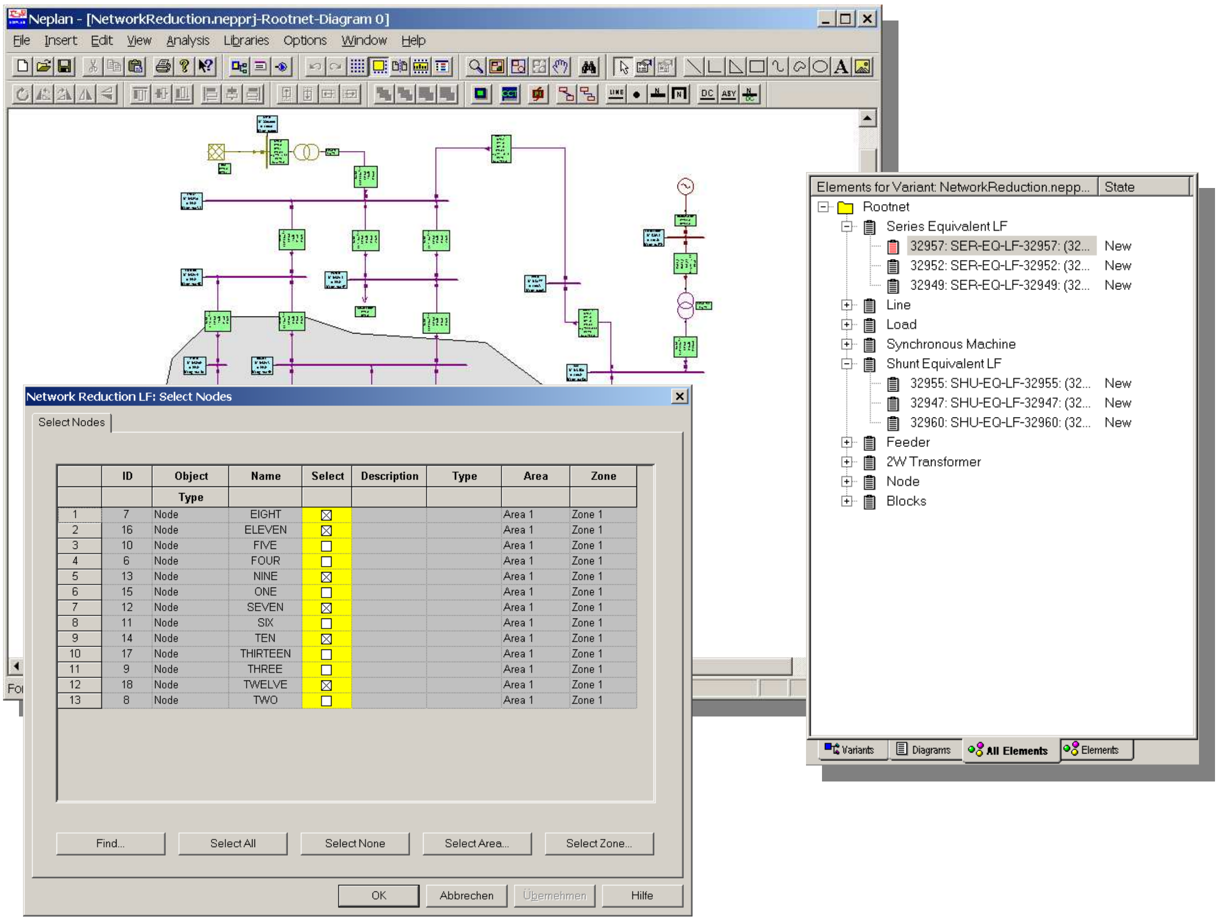
Application: Transmission – Distribution

Input

- any network as for short circuit or load flow calculation
- nodes to be reduced during network reduction
- functions to select a complete network area to be reduced are available
- boundary nodes are determined automatically by the program

Output

- shunt and series equivalents, which can be saved in the data base
- the shunt and series equivalents consists of data for the positive, negative and zero system dependent on the type of network reduction (load flow or short circuit)
- for load flow network reduction boundary injections and boundary generators are calculated



NEPLAN Programming Library

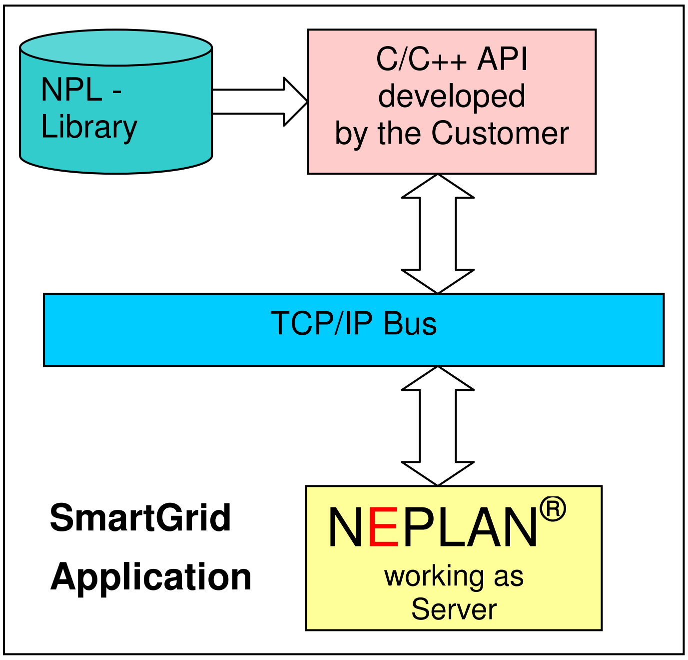
Application: Transmission - Distribution – Industrial - Generation

NEPLAN® Smarter Tools

NPL - NEPLAN Programming Library

The NPL – NEPLAN Programming Library is a C/C++ API library, which includes functions to access NEPLAN data and calculation algorithms through a C/C++ user written program. Functions included among others are:

- Access any variable of any component
- Change any variable of any component
- Execute any analysis/calculation function
- Retrieve the calculation results
- Add new components to the network
- Delete components from the network
- Add and change the graphical information (x, y coordinates, symbols, etc.) of any component



NPL - Applications

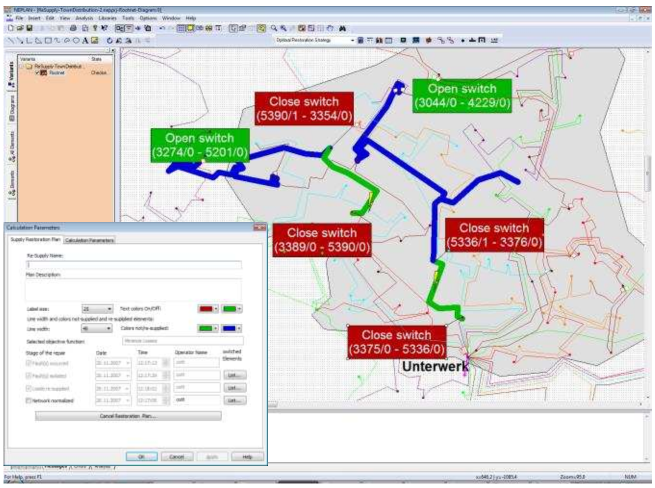
Many customized applications are possible:

- Implement NEPLAN with a NPL application in a SmartGrid environment
- Use NEPLAN in batch mode (e.g. running several load flows and short circuit calculations cases)
- Build customized interfaces (e.g. GIS, SCADA/DMS, DACF, CIM, etc.)
- Develop a network master controller with events (such as "if u <90% switch on reserve generator") and run the application in a quasi stationary mode
- Checking protection behavior under various network conditions
- Use NEPLAN as server and connect NEPLAN to a TCP/IP bus. The client may send any NPL command to the NEPLAN server (e.g. run load flow, open switch, change load, etc)
- Use NEPLAN as On-line system and build a DMS application using the NEPLAN graphic editor and the analysis tools
- Researchers may even develop their own calculation algorithms (e.g. OPF, reliability, capacitor placement etc.)
- ….. and much, much more…..

NPL – C++ Program example

```
//C ++ NPL Programm
void RunTestNPL()
{
  //Open a NEPLAN project file
  OpenNeplanProject(_T("NeplanDemoProject.nepprj"));
  //run initial load flow
  RunAnalysisLF();
  //change the line length of line 'Line-1' to 0.5 km
  unsigned long ElementID=0;
  GetElementByName(_T("LINE"),_T("Line-1"), ElementID);
  if (ElementID > 0)
     SetParameterDouble(ElementID, _T("Length"), 0.5);
  //run load flow with changed line length
  RunAnalysisLF();
}
```

This colour means these are C++ NPL library functions



On-line DMS application: Optimal restorations after a fault

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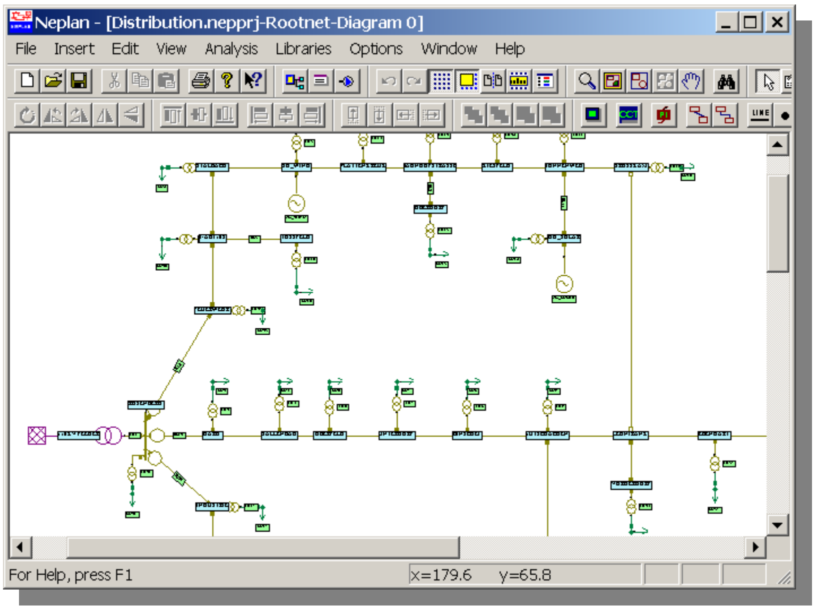
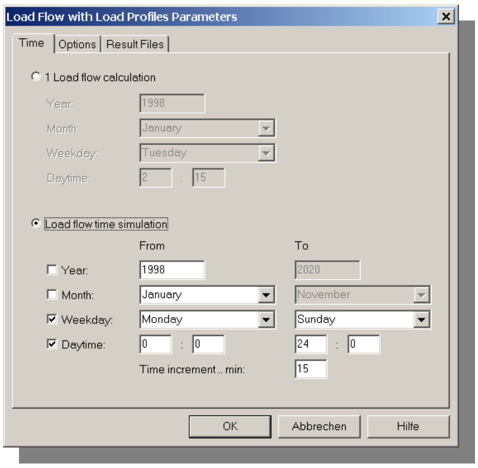
Load Flow with Load Profiles

Application: Transmission – Distribution

Input Data

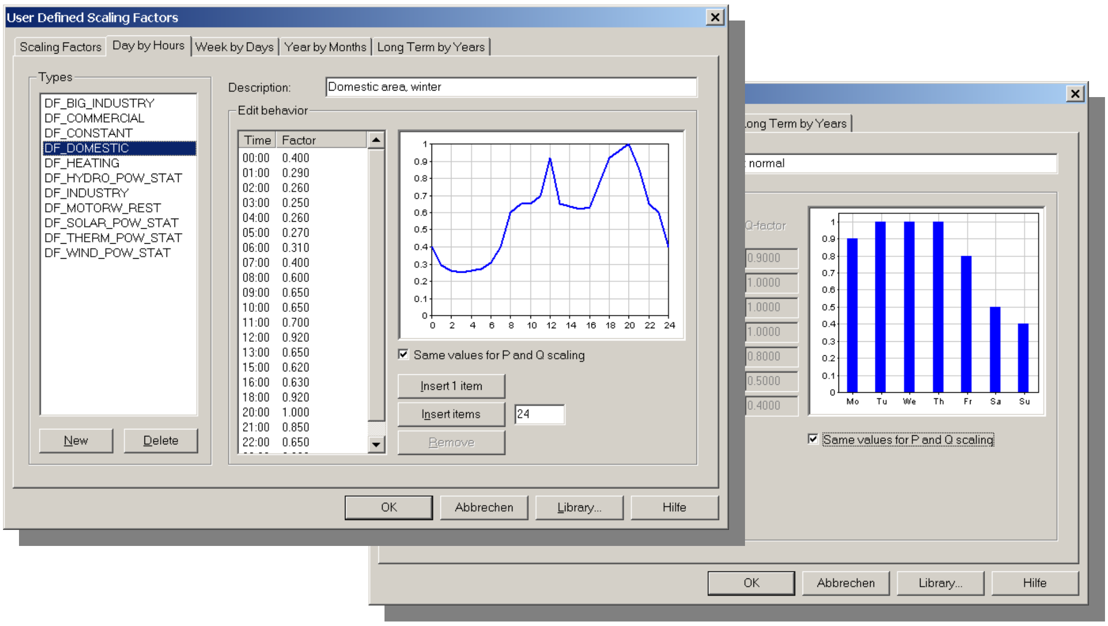
- User-defined load and generation profiles (day, week, month and year factors)
- Unlimited number of profile types for consumers and generators (e.g. household, industry, ...)
- Import of measurement data and load profiles





Calculations

- Single load flow calculation (load forecast) and time simulation
- User-defined time increment
- Combination of time intervals
- Load balancing mode: loads are automatically changed in the way that load flow results fit best to measured values (behaviors)



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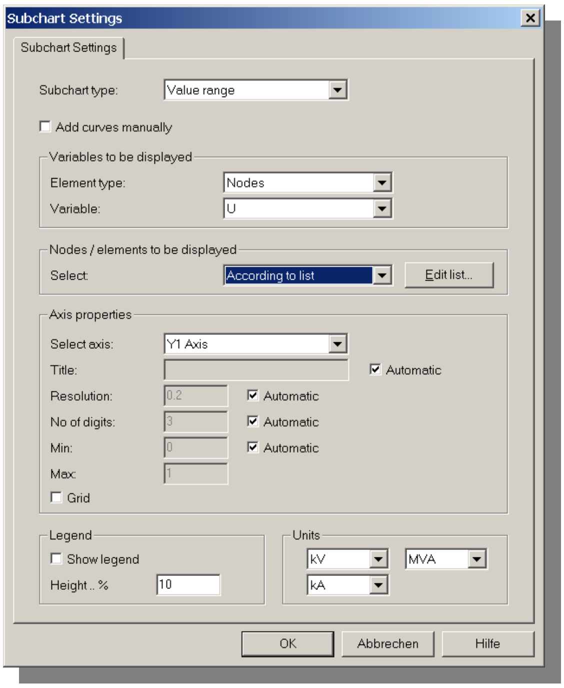
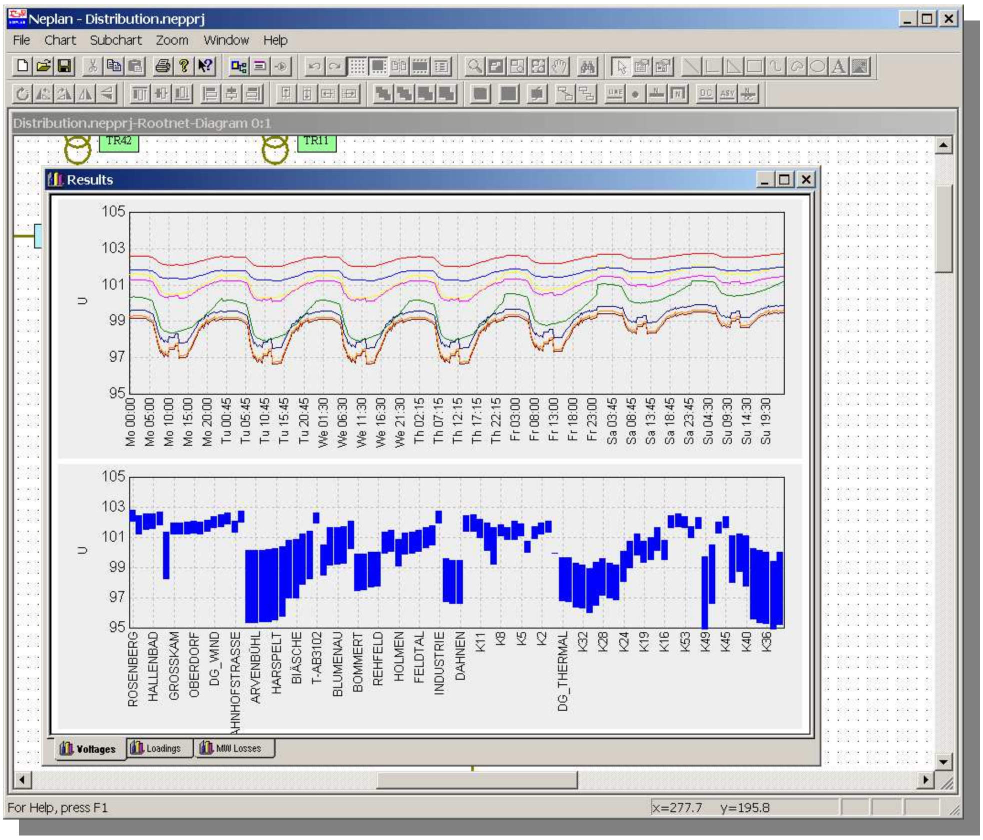
Results

- Time behavior and value range charts
- Characteristics of network, elements and nodes (voltages, currents, loadings, power, MW losses, energy losses,…)
- Any system quantities may be plotted, or compared





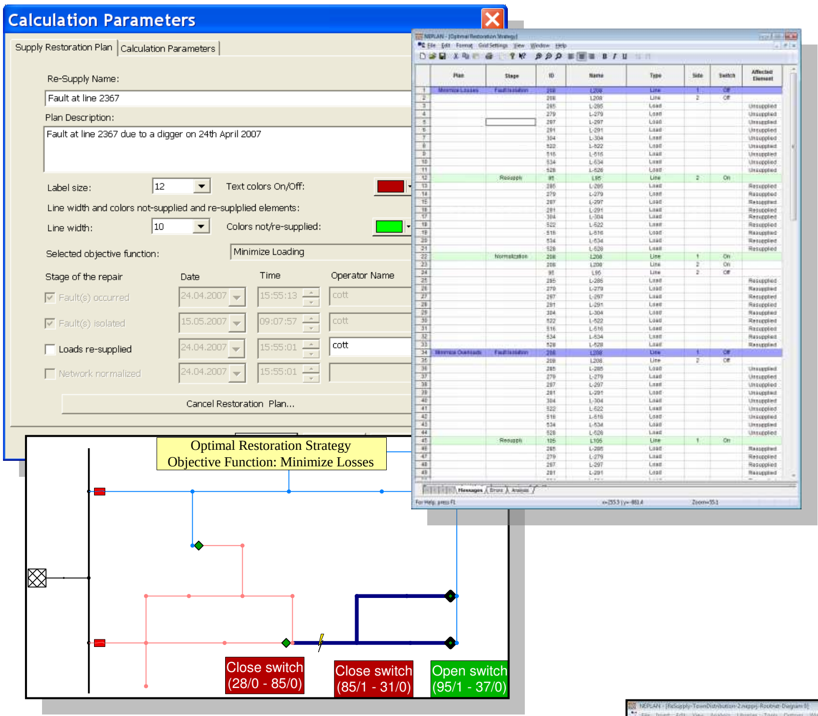
Optimal Network Restoration Strategy

Application: Distribution

This module is designed to study the impact of single forced (e.g. fault on a line) or planned outages on the electrical distribution system. It finds the optimal switching plan to restore electrical power to customers. This module may be used for off-line application to pre-define strategies in case of outages or as on-line application to help the network operator to find quickly the correct strategy after a fault has occurred.

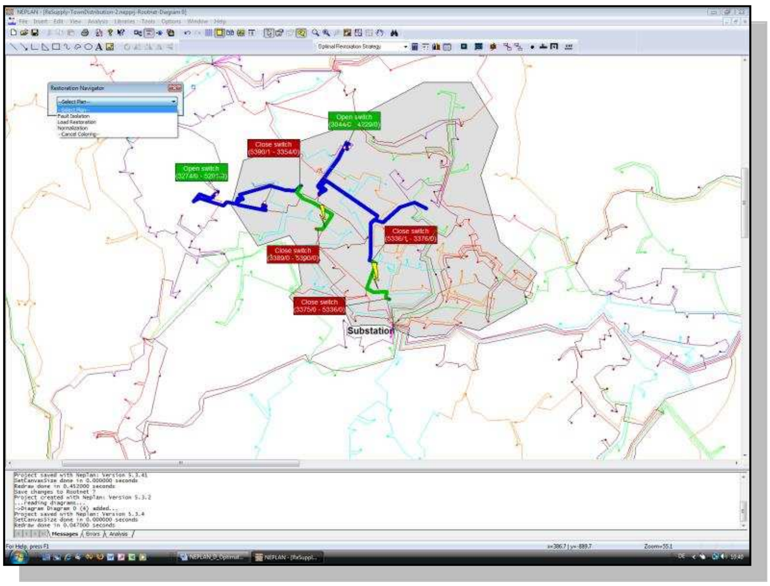
The following objective functions are implemented:

- Minimize network losses
- Minimize the number of overloaded elements
- Minimize the average loadings of the elements
- Maximize the average voltage



Restoration Stages

- Four stages in the restoration strategy will be evaluated and may be stored in a fault history database:
  - Occurrence of the fault
  - Isolation of the fault -> NEPLAN shows the unsupplied customers
  - Re-Supply of customers which are affected by the fault -> NEPLAN shows which customer are re-supplied again
  - Normalization of the network after the repair of the fault
- All stages of the selected optimal restoration plan with the new switch positions will be graphically displayed on the single line diagram



DMS On-Line Application

- Results with the new switch positions of all re-supply stages, including all objective functions are displayed as spreadsheet tables or can be accessed as text file for further evaluation (e.g. in DMS applications)
- All dialogs and restoration algorithms are available trough a C++ API, the NPL - NEPLAN Programming Library. With NPL NEPLAN data and functions can be accessed with a user written C++ program. This allows building up customized restoration strategies for network operators.

More information and free DEMO **www.neplan.ch**

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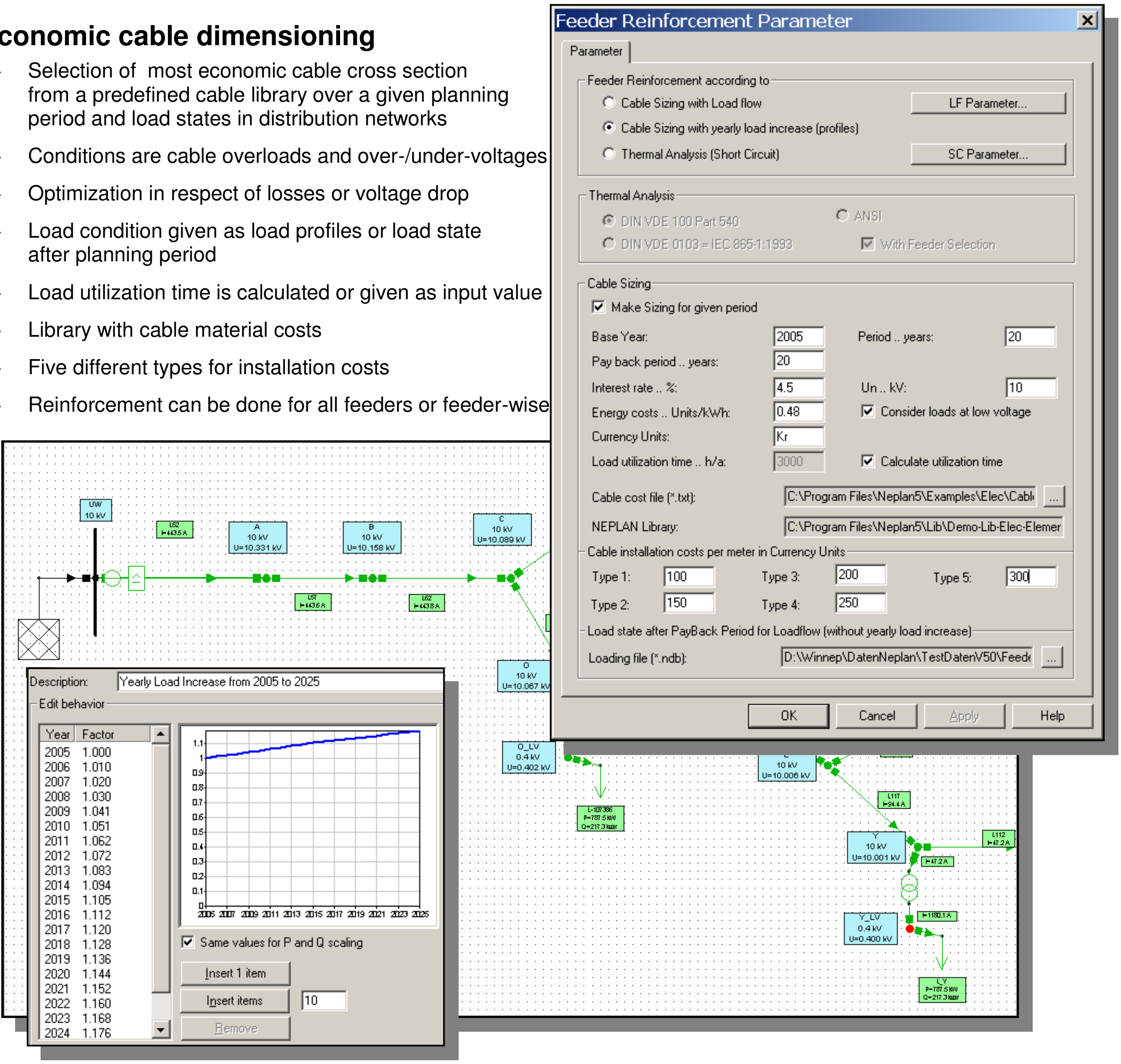
Economic cable dimensioning

- Selection of most economic cable cross section from a predefined cable library over a given planning period and load states in distribution networks
- Conditions are cable overloads and over-/under-voltages
- Optimization in respect of losses or voltage drop
- Load condition given as load profiles or load state after planning period
- Load utilization time is calculated or given as input value
- Library with cable material costs
- Five different types for installation costs
- Reinforcement can be done for all feeders or feeder-wise



Results

	No.	Year	Line to be Replaced	From	To	Caused by Line Overload	Total Line Length	Cable Material Costs	Installation Costs	Total Cable Costs	Losses before Replacement	Losses after Replacement	Loss Reduction	Selection Criteria	Best Cross Section (Voltage opt.)	Most economical Cross Section	Minimum Length
							m	Kr	Kr	Kr	kW	kW	Kr	Kr/Volt	mm2	mm2	m
1	1	2005	L57	A	B	☐	1000.0	320000.0	0.0	320000.0	122.9	74.7	668639.1	-2841.7	240	240	1000.0
2	2	2008	L62	B	C	☐	400.0	128000.0	0.0	128000.0	54.5	33.3	280300.7	-5863.3	240	240	400.0
3	3	2013	L52	UW	A	☐	400.0	128000.0	0.0	128000.0	65.8	40.2	310922.1	-3266.3	240	240	400.0
4	4	2017	L82	C	O	☐	300.0	96000.0	0.0	96000.0	12.9	7.9	79692.3	1495.7	240	240	300.0
5	5	2018	L67	C	M	☐	500.0	160000.0	0.0	160000.0	39.6	15.7	200443.5	-852.5	240	240	500.0
6	6	2019	L92	T	L	☐	600.0	192000.0	0.0	192000.0	15.8	9.7	94623.0	5676.8	240	240	600.0
7	7	2021	L87	O	T	☐	500.0	160000.0	0.0	160000.0	14.2	8.7	82179.9	5261.5	240	240	500.0
8	8	2024	L102	X	I	☐	500.0	160000.0	0.0	160000.0	2.8	1.1	23521.5	10706.5	240	150	174.0

This module is used for the assessment of the network disturbances according to the D-A-CH-CZ technical rules, which has been released by the utility associations

- VDN – Verband der Netzbetreiber in Germany,
- VSE – Verband Schweizerischer Elektrizitätsunternehmen in Switzerland,
- VEÖ – Verband der Elektrizitätsunternehmen in Austria and
- CSRES – Ceske sdruzeni rozvodnych Energetickych Spolecnosti in Czeck Republik.

Due to the increased employment of power electronics and the thereby associated rise in nonlinear consumers at all network levels, disturbances on the networks occur at an increasing rate, which can make themselves noticeable by undesired changes in

- the level
- the waveform
-

of the mains voltage. As a consequence of this, other electrical devices and plants connected to the network can be disturbed through interference. One differentiates between:

- Functional failures
- Malfunctions
- Direct or indirect damage including possible consequential damage.

The possible disturbances are dependent on the amplitude, the frequency and the duration of the network disturbances, as well as the degree of spread of certain types of devices. In addition, the simultaneity factor of the electrical devices and plants, that in operation cause network disturbances, is to be taken into account.

The disturbances on the network itself can manifest themselves e.g. in the following manner:

- Deterioration of the power factor (increase in the transmission losses and reduction in the efficiency)
- Insufficient ground-fault compensation.

It is in the interest of all

- to ensure the adherence to a balance between additional emitted disturbances in the network and the protection of other electrical devices and plants connected to the network.
- to meet the significantly increased quality demands of modern devices and processes despite the rising pressure of costs.
- to maintain the existing high level of quality in the face of the changing generation structures and the additional requirements on the networks resulting therefrom.

For this reason, the network operators must have the possibility of keeping the network disturbances caused by the electrical devices and generating stations connected to their networks and their consequences within tolerable limits, even under changing framework conditions.

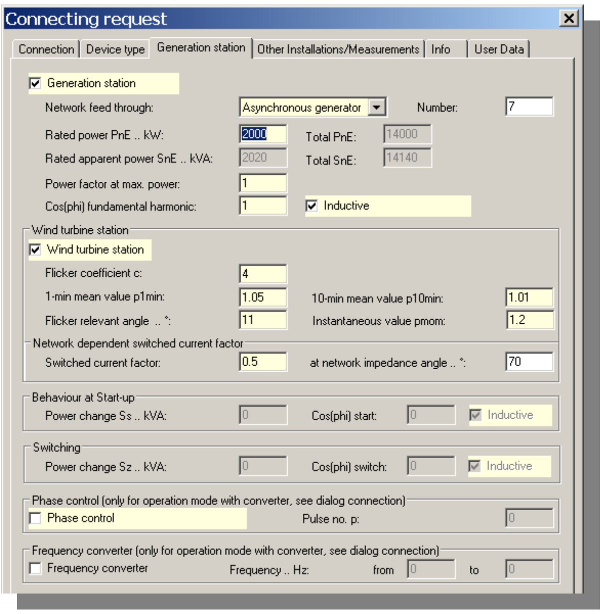
For the purpose of an appropriate distribution of the resulting responsibility, for this the following fields of action come into consideration:

- suitable design and operative measures in the networks, under consideration of the objective quality requirements and the economic justification.
- an adapted setting of limiting values for requirements on electrical devices and equipment in the relevant EMC-standards as well as their observance.
- if necessary, the imposed duty to undertake corrective measures to reduce network disturbances

This method of procedure is supported by several statutory regulations at European or individual member state level.

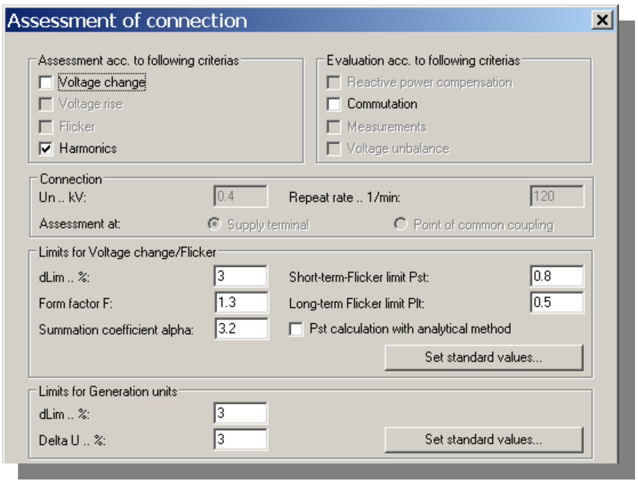
Input values

- Installation can be a motor, welding machine, converter drive motor, wind power plant, photo voltaic plant, biogas plant, small water plant, hybrid electric vehicles, etc.
- Network connection point
- Type of connection: 3-phase, 2-phase, 1-phase connection
- Apparent power of the installation (equipment or plant). Maximum power change.
- Power consumer or generator.
- Cos(phi) of the power or current change
- Repeat rate of power or current change per minutes
- Temporary return feed possible.
- Assignment to harmonic group



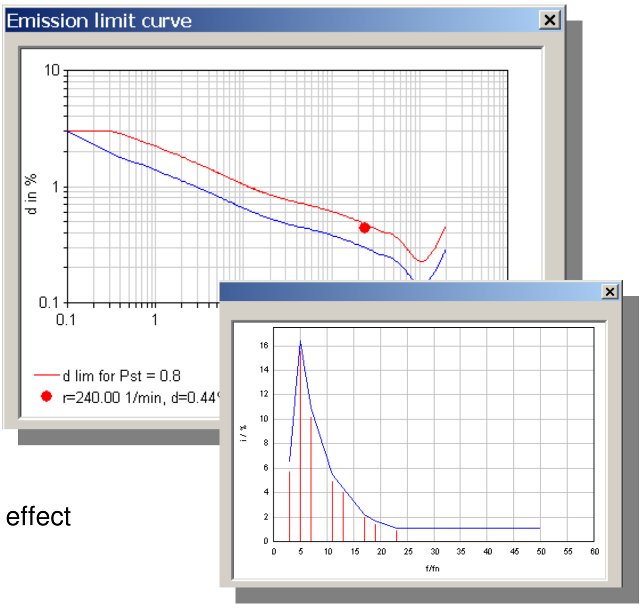
Assessment criteria

- Voltage change
- Voltage rise
- Flicker
- Harmonics
- Voltage unbalance
- Measurements
- Data for the reactive power compensation



Results

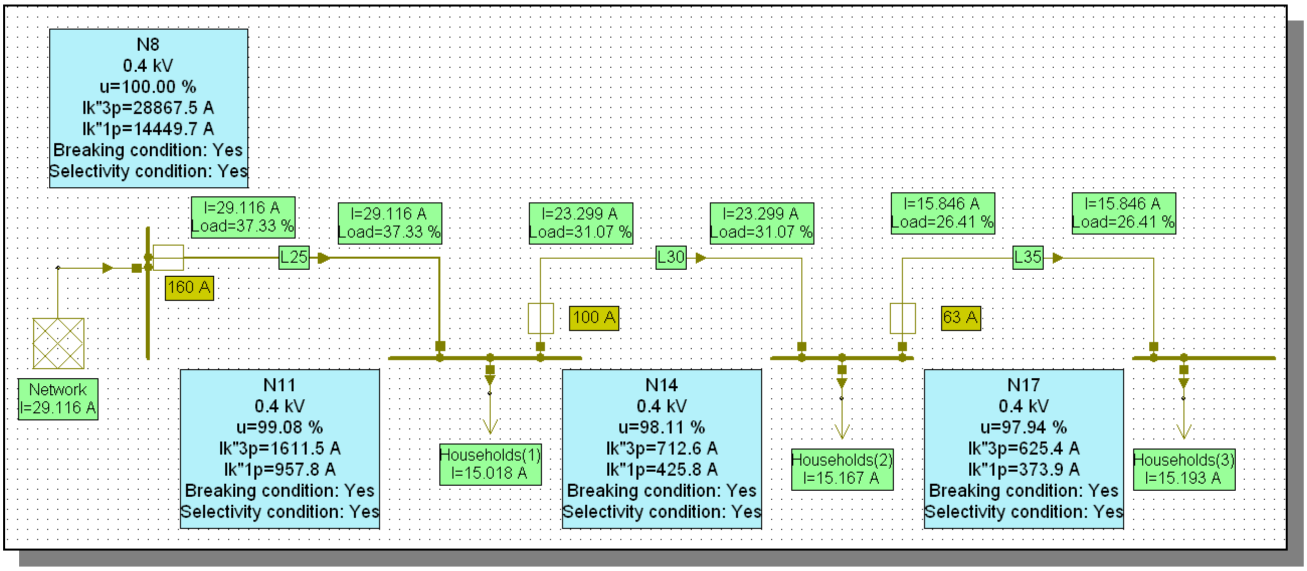
- Connection permissible or only with measurements
- Maximum voltage change or rise
- Short- and long-term flicker intensity Pst, Plt
- Total harmonic load
- Allowed harmonic current/voltage limits, comparison with measured I/U-harmonics
- Evaluation of voltage unbalance
- Maximum impedance for minimum absorption effect for compensation (ripple control systems)



Characteristics

- Calculation of the voltage drop and cable loadings with variable simultaneity factor for consumer types.
- Simultaneity factor is dependent on the number of loads of the same type in a feeder or line.
- Pre-defined consumer types are: household, warm water treatment, continues-flow water heater, storage warm water treatment, night heat storage.
- Consumer types and their characteristic can be defined by the user.
- Calculation of the minimum 3-phase and 1-phase short circuit.
- Checks the breaking condition
- Checks of the selectivity of fuses

Results



	ID	Node	Description	U	u	U Angle	Ik"1p min	Ik"1p min Angle	Ik"3p min	Ik"3p min Angle	Ib	Breaking condition	Selectivity condition	Bad fuse for breaking	Bad fuse for selectivity
				V	%	°	A	°	A	°	A				
1	8	N8		400	100	0	14449.7	-88.1	28867.5	-84.3	29.1	☑	☑	-	-
2	27949	N11		396.3	99.08	-0.7	957.8	-70	1611.5	-69.6	29.1	☑	☑	-	-
3	27955	N17		391.8	97.94	-1.6	373.9	-69.2	625.4	-69	15.8	☑	☑	-	-
4	27952	N14		392.4	98.11	-1.5	425.8	-69.3	712.6	-69.1	23.3	☑	☑	-	-
5		Pv= 0.1 kW	Qv= 0.6 kVar									☐	☐	-	-

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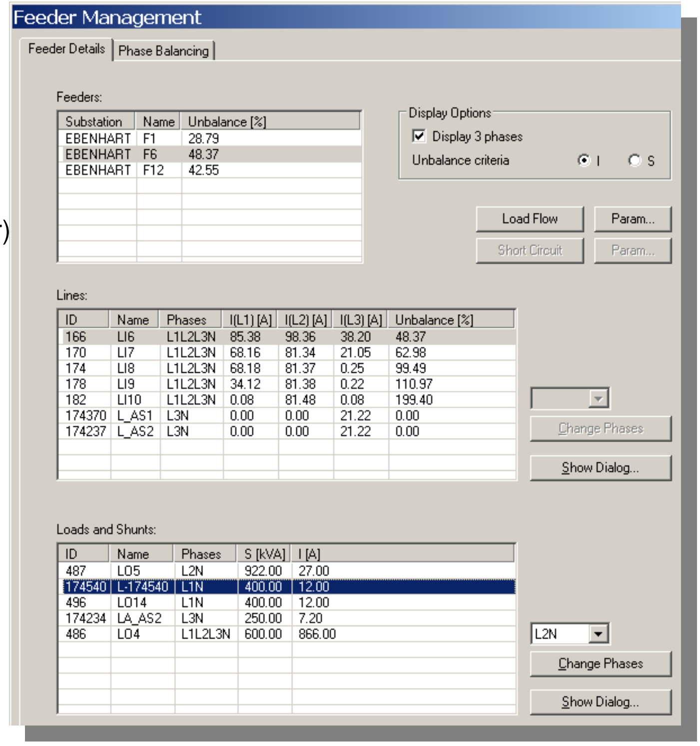
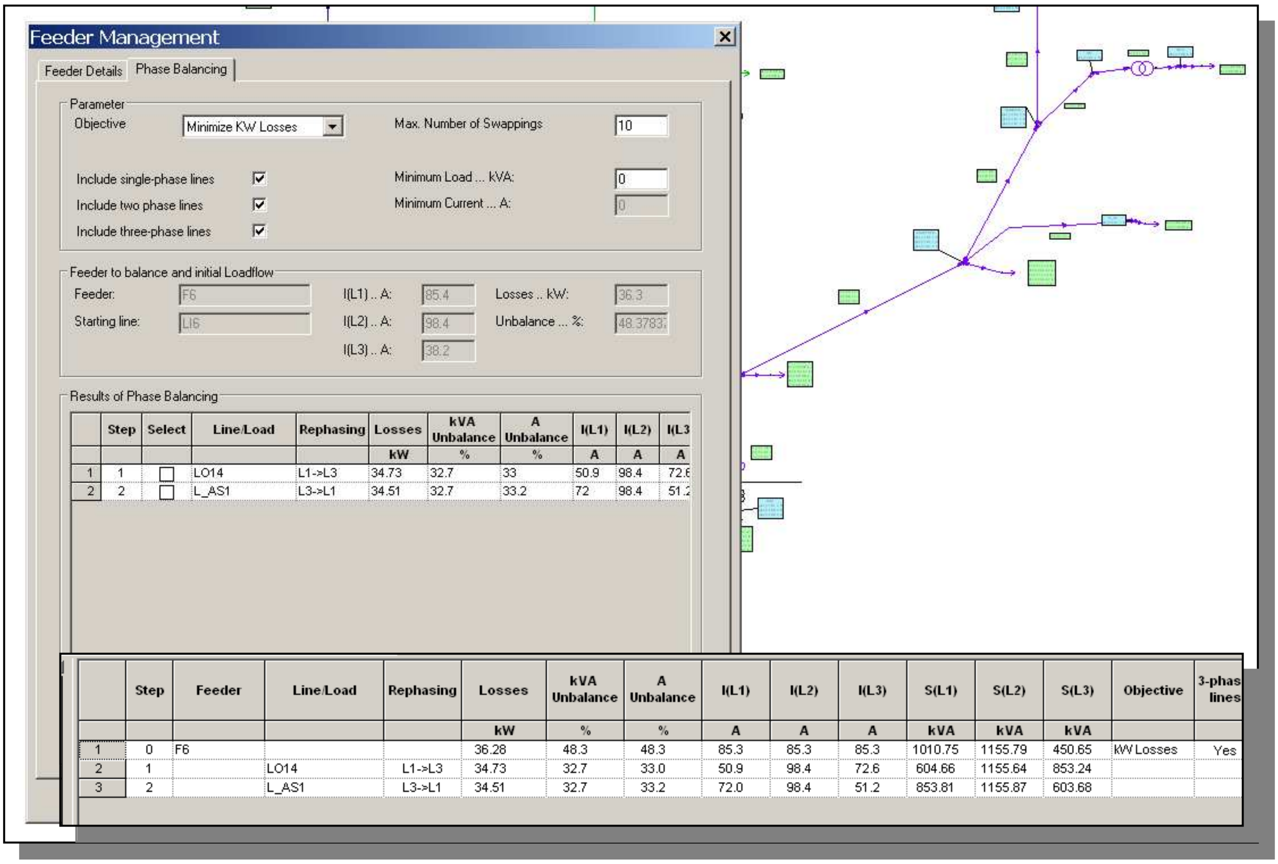
Phase Swapping
Application: Distribution

Characteristics

- Phase Swapping allows to reduce the unbalance in the phases by re-phasing single/two phase loads and lines
- Re-phasing can be done to:
  1. Minimize the kW losses,
  2. Minimize kVA Unbalance (apparent power)
  3. Minimize A Unbalance (current).
- Max. number of swapping can be defined
- Re-phasing works feeder-oriented
- Shows the unbalance and losses before and after re-phasing
- Manual re-phasing can be done
- Single-phase load flow can directly be started from Feeder Management



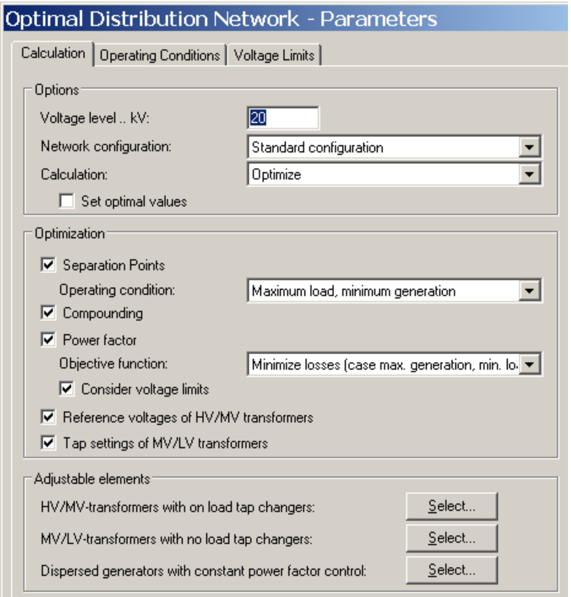
Results



Goal

Minimization of MW losses and improve voltage levels with the following optimization criteria (all optional):

- Optimal separation points (least loss switch configuration)
- Optimal compounding for transformers
- Optimal power factors of disperse generators
- Optimal set voltage for on-load transformers
- Optimal LV/MV-transformer tap setting
- For normal operation and N-1 operation

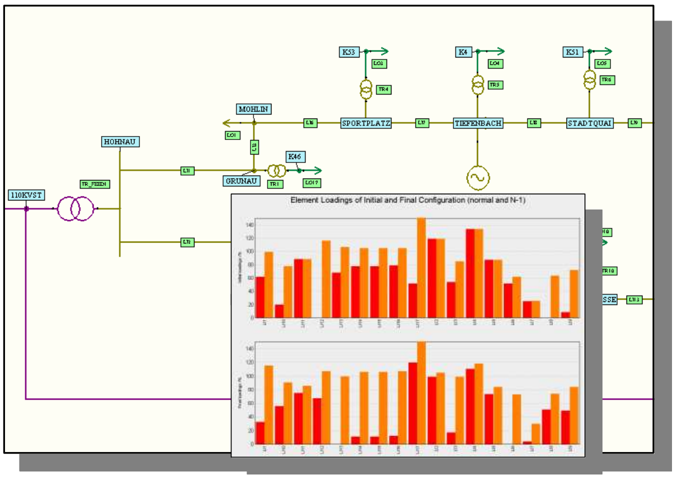


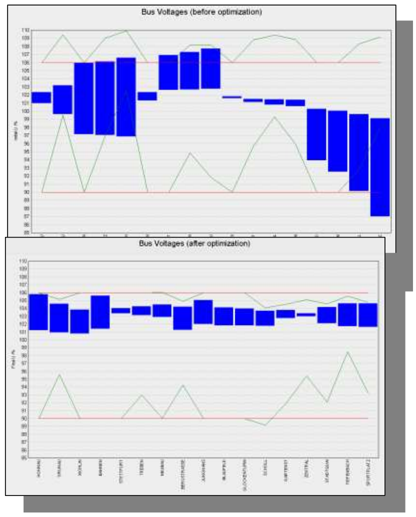
Limits

- Voltage limits at MV and LV-side (user-defined)
- Thermal limits of the cables and transformers

Load situation

- Load range defined by a maximum and minimum with scaling factors and load data import
- User defines loads and disperse generators to be scaled





before

after

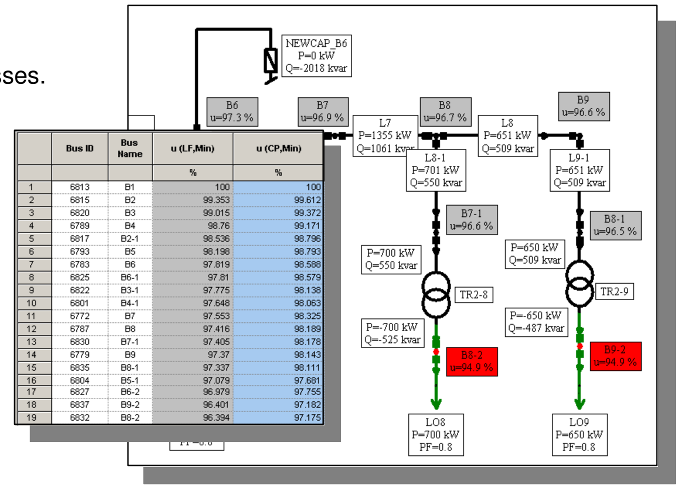
Optimal Capacitor Placement

Identifies key locations in radial primary feeders, where the placement of shunt capacitors minimizes the MW losses.

Results are:

- the bus of the primary feeder, where a shunt capacitor would be located,
- the MVAR size of the capacitor, and
- the additional reduction in MW losses (in %).

	Load factor	Bus ID	Bus Name	Size	Losses	Additional Loss reduction
				kVar	MW	%
1	**0.6**				**0.0534**	
2		6783	B6	1210	0.0379	29
3		6820	B3	940	0.0358	3.74
4	**1**				**0.1564**	
5		6783	B6	2130	0.1085	30.6
6		6820	B3	1690	0.102	4.12



	Bus ID	Bus Name	u (LF,Min)	u (CP,Min)
			%	%
1	6813	B1	100	100
2	6815	B2	99.353	99.612
3	6820	B3	99.015	99.372
4	6789	B4	98.76	99.171
5	6817	B2-1	98.536	98.796
6	6793	B5	98.198	98.793
7	6783	B6	97.819	98.588
8	6825	B6-1	97.81	98.579
9	6822	B3-1	97.775	98.138
10	6801	B4-1	97.648	98.063
11	6772	B7	97.553	98.325
12	6787	B8	97.416	98.189
13	6830	B7-1	97.405	98.178
14	6779	B9	97.37	98.143
15	6835	B8-1	97.337	98.111
16	6804	B5-1	97.079	97.681
17	6827	B6-2	96.979	97.755
18	6837	B9-2	96.401	97.182
19	6832	B8-2	96.394	97.175

NEPLAN Maintenance (Reliability Centered Maintenance)

A good overview over different maintenance strategies and the NEPLAN-Maintenance philosophy can be found on this web-site:

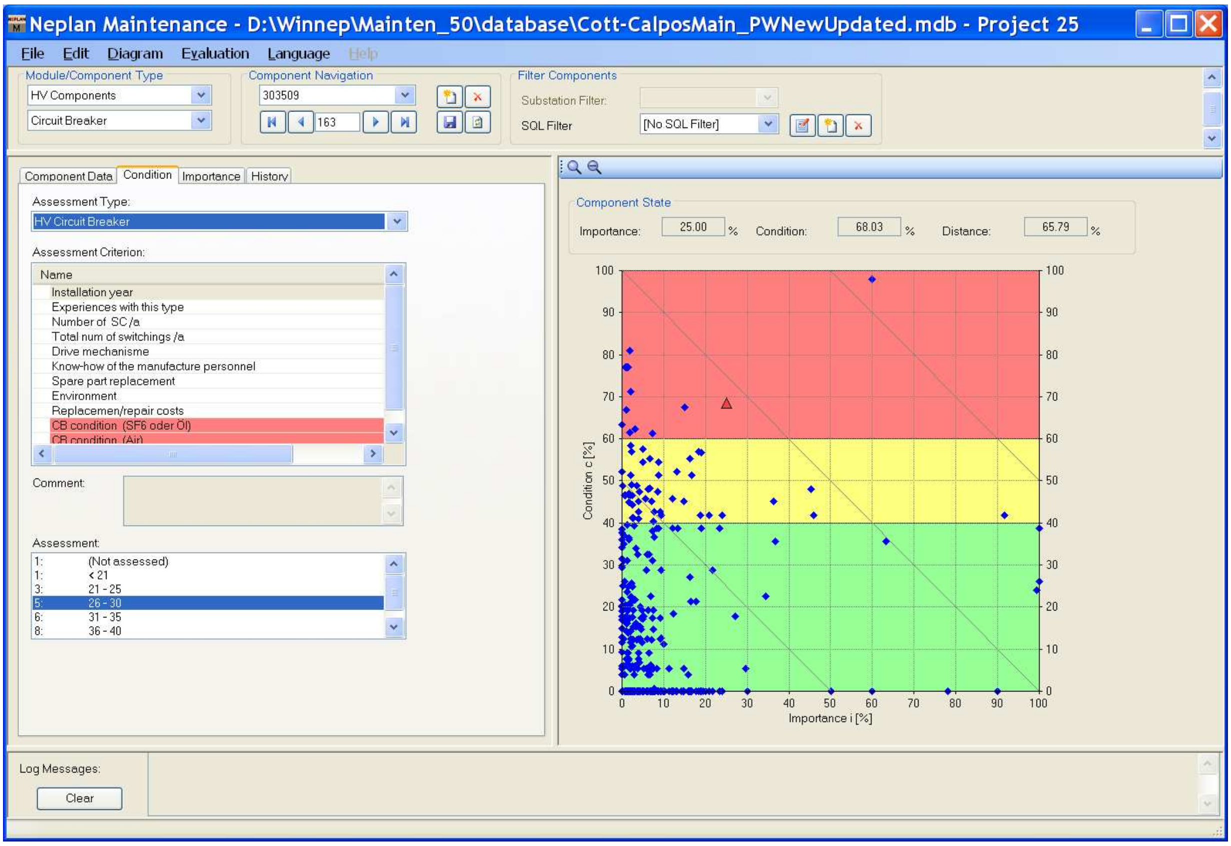
www.neplan.ch/downloads/public/NEPLAN-Maintenance-Strategies_e.pdf

The main features of the NEPLAN-Maintenance module are:

- Available sub-modules are:
    - HV Components
    - HV AIS Substations
    - HV GIS Substations
    - HV/MV Overhead line
    - MV Substations
    - MV Local Substations
    - MV Cables
- Data can be stored in any database (e.g. Oracle, MS-Access, SQL Server etc.)
- Allows easy integration to existing ERP systems (e.g. SAP)
- Assessment criterion can be added or changed by the user
- Allows quickly to assess the conditions of the components
- Different charts give a useful overview over the overall conditions of the components
- A budgeting evaluation tools is available, which calculates the costs for the following maintenance strategies:
    - TBM Estimation (estimated time based maintenance)
    - TBM (time based maintenance)
    - CBM (condition based maintenance)
    - RCM (reliability based maintenance)
- **Integrates smoothly with our famous NEPLAN-Reliability module**
- Can be excellently used a for reinvestment strategies

Component Assessment in NEPLAN-Maintenance

The picture below shows on the left side the assessment sheet of the current component. The diagram shows all condition (y-axes) and all importance (x-axes) of all components (in this case circuit breakers). The actual circuit breaker to assess is colored differently. The user can define any filter to reduce the amount of displayed components.

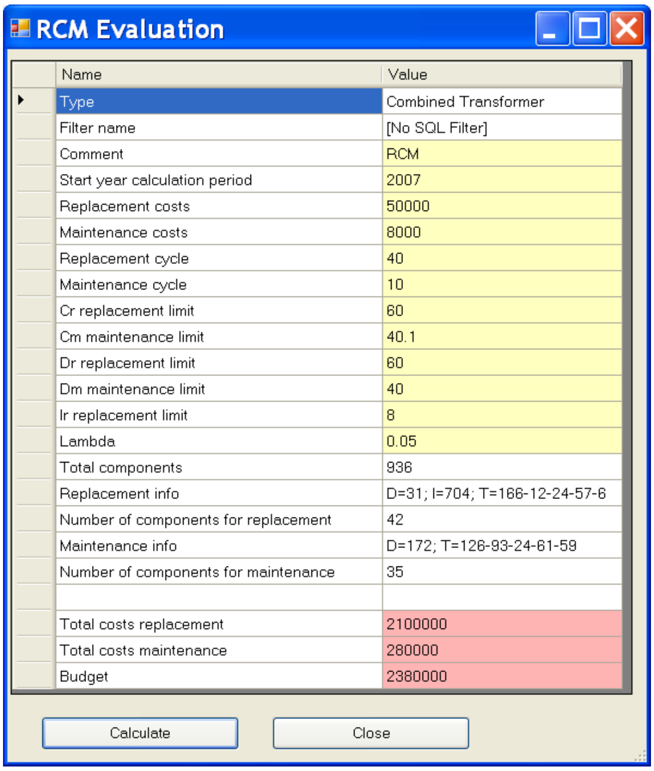


The condition of each component can easily be assessed with the freely configurable assessment sheets.

Budgeting Evaluation Tool in NEPLAN-Maintenance

In NEPLAN-Maintenance a budgeting tool is included, which allows evaluating the costs of the different maintenance strategies:

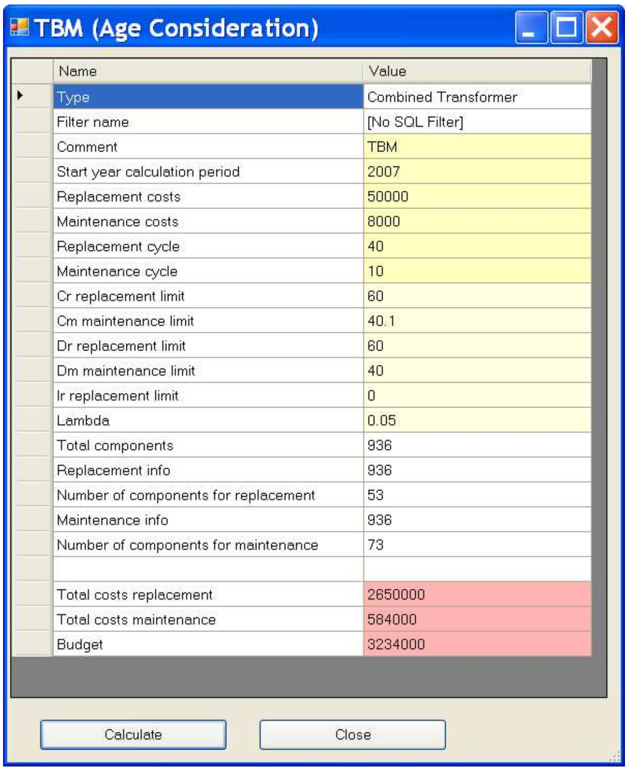
- TBM Estimation (estimated time based maintenance)
- TBM (time based maintenance)
- CBM (condition based maintenance)
- RCM (reliability based maintenance)



RCM Evaluation

Name	Value
Type	Combined Transformer
Filter name	[No SQL Filter]
Comment	RCM
Start year calculation period	2007
Replacement costs	50000
Maintenance costs	8000
Replacement cycle	40
Maintenance cycle	10
Cr replacement limit	60
Cm maintenance limit	40.1
Dr replacement limit	60
Dm maintenance limit	40
Ir replacement limit	8
Lambda	0.05
Total components	936
Replacement info	D=31; I=704; T=166-12-24-57-6
Number of components for replacement	42
Maintenance info	D=172; T=126-93-24-61-59
Number of components for maintenance	35
Total costs replacement	2100000
Total costs maintenance	280000
Budget	2380000

Calculate | Close



TBM (Age Consideration)

Name	Value
Type	Combined Transformer
Filter name	[No SQL Filter]
Comment	TBM
Start year calculation period	2007
Replacement costs	50000
Maintenance costs	8000
Replacement cycle	40
Maintenance cycle	10
Cr replacement limit	60
Cm maintenance limit	40.1
Dr replacement limit	60
Dm maintenance limit	40
Ir replacement limit	0
Lambda	0.05
Total components	936
Replacement info	936
Number of components for replacement	53
Maintenance info	936
Number of components for maintenance	73
Total costs replacement	2650000
Total costs maintenance	584000
Budget	3234000

Calculate | Close

At your fingertips: budgeting evaluation of RCM and TBM can be easily compared

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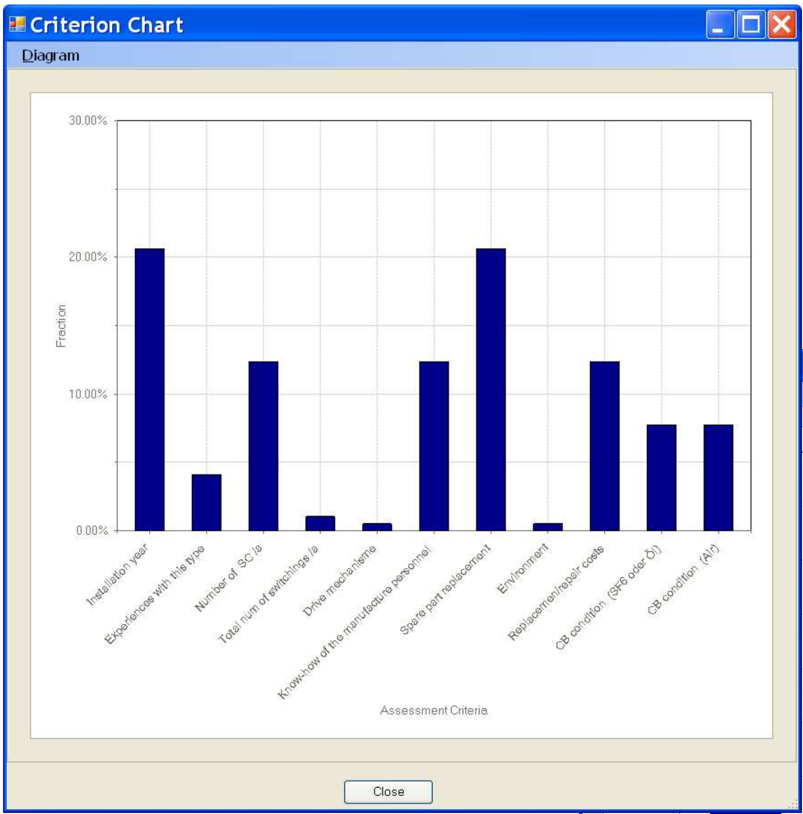
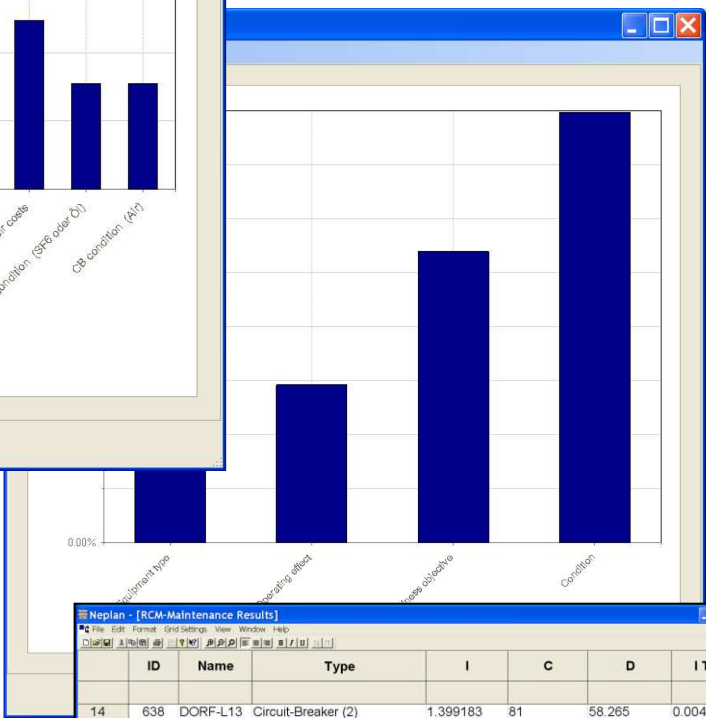
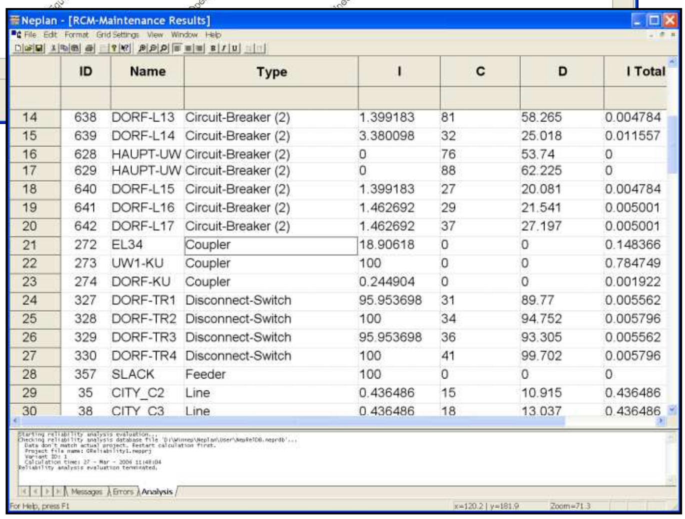
Chart Evaluation Tool in NEPLAN-Maintenance

The integrated chart manager shows for example the influence of each criterion to the overall conditions of all components. Each criterion can be assigned to a cluster (e.g. operating condition, component type, etc.). NEPLAN allows evaluating the overall conditions according to these clusters.





This chart shows the influence of different clusters to the overall conditions of all components.
It shows for example the effect of all criterions which belong to the 'Operating Conditions' cluster compared to the other effects of the other clusters.

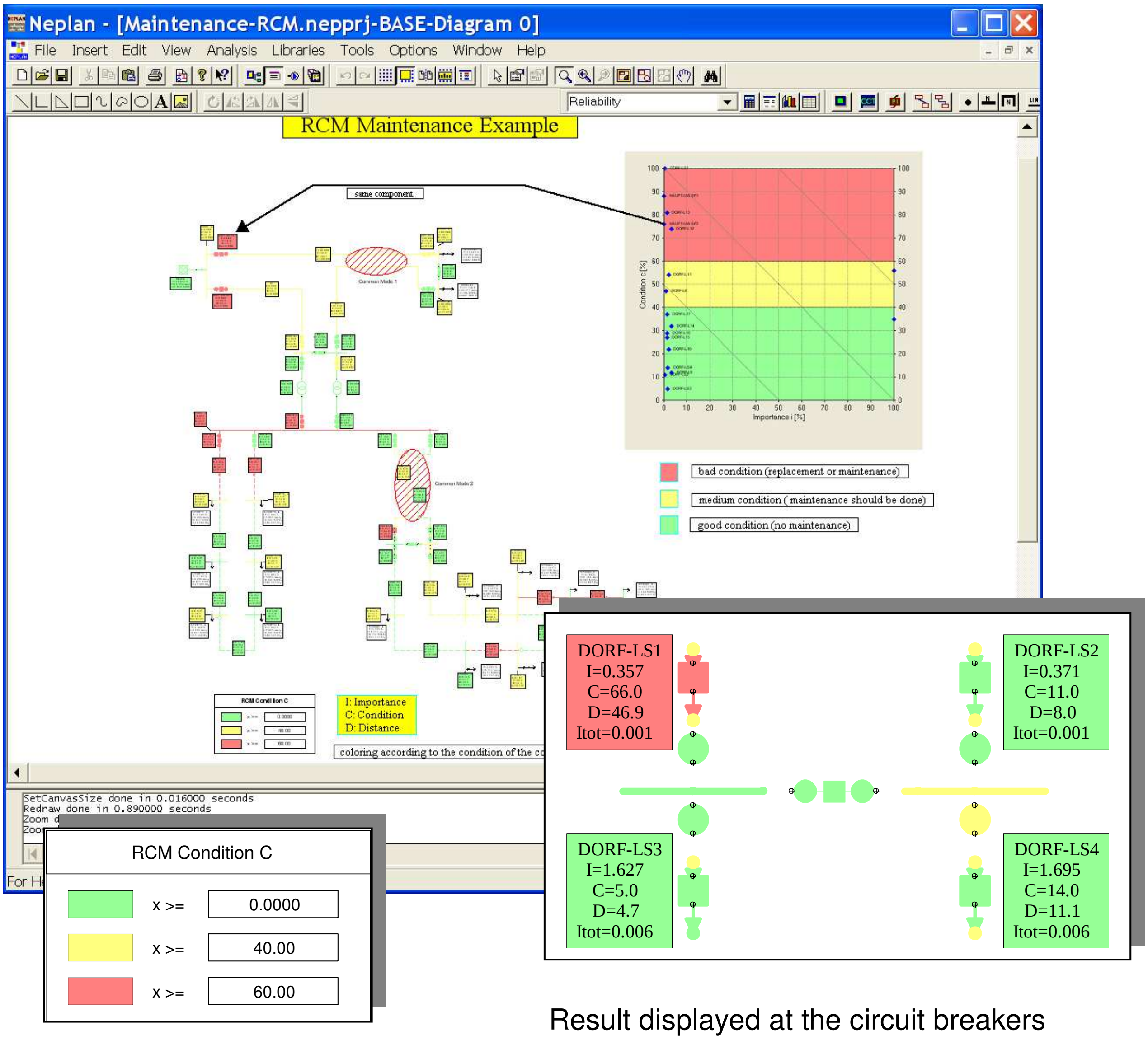


	ID	Name	Type	I	C	D	I Total
14	638	DORF-L13	Circuit-Breaker (2)	1.399183	81	58.265	0.004784
15	639	DORF-L14	Circuit-Breaker (2)	3.380098	32	25.018	0.011557
16	628	HAUPT-UW	Circuit-Breaker (2)	0	76	53.74	0
17	629	HAUPT-UW	Circuit-Breaker (2)	0	88	62.225	0
18	640	DORF-L15	Circuit-Breaker (2)	1.399183	27	20.081	0.004784
19	641	DORF-L16	Circuit-Breaker (2)	1.462692	29	21.541	0.005001
20	642	DORF-L17	Circuit-Breaker (2)	1.462692	37	27.197	0.005001
21	272	EL34	Coupler	18.90618	0	0	0.148366
22	273	UW1-KU	Coupler	100	0	0	0.784749
23	274	DORF-KU	Coupler	0.244904	0	0	0.001922
24	327	DORF-TR1	Disconnect-Switch	95.953698	31	89.77	0.005562
25	328	DORF-TR2	Disconnect-Switch	100	34	94.752	0.005796
26	329	DORF-TR3	Disconnect-Switch	95.953698	36	93.305	0.005562
27	330	DORF-TR4	Disconnect-Switch	100	41	99.702	0.005796
28	357	SLACK	Feeder	100	0	0	0
29	35	CITY_C2	Line	0.436486	15	10.915	0.436486
30	38	CITY_C3	Line	0.436486	18	13.037	0.436486

Integration with NEPLAN-Reliability Module

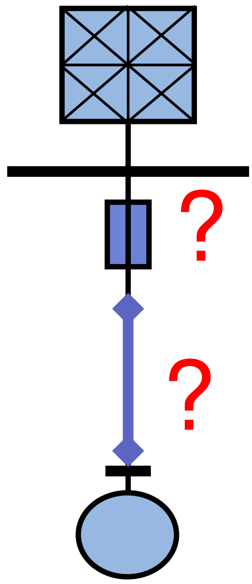
The NEPLAN-Maintenance module can make use of the calculated results of our famous NEPLAN-Reliability module. The NEPLAN-Maintenance module integrates smoothly to the NEPLAN single line diagram. The conditions C, importance I and the distances D (function of condition and importance, D = f(C, I)) can be displayed on the single line diagram. The coloring according to C, I and D shows very quickly which components must be replaced or maintained first.

The NEPLAN-Maintenance module is at the moment the only RCM module on the market, which integrates, with a robust network reliability module.

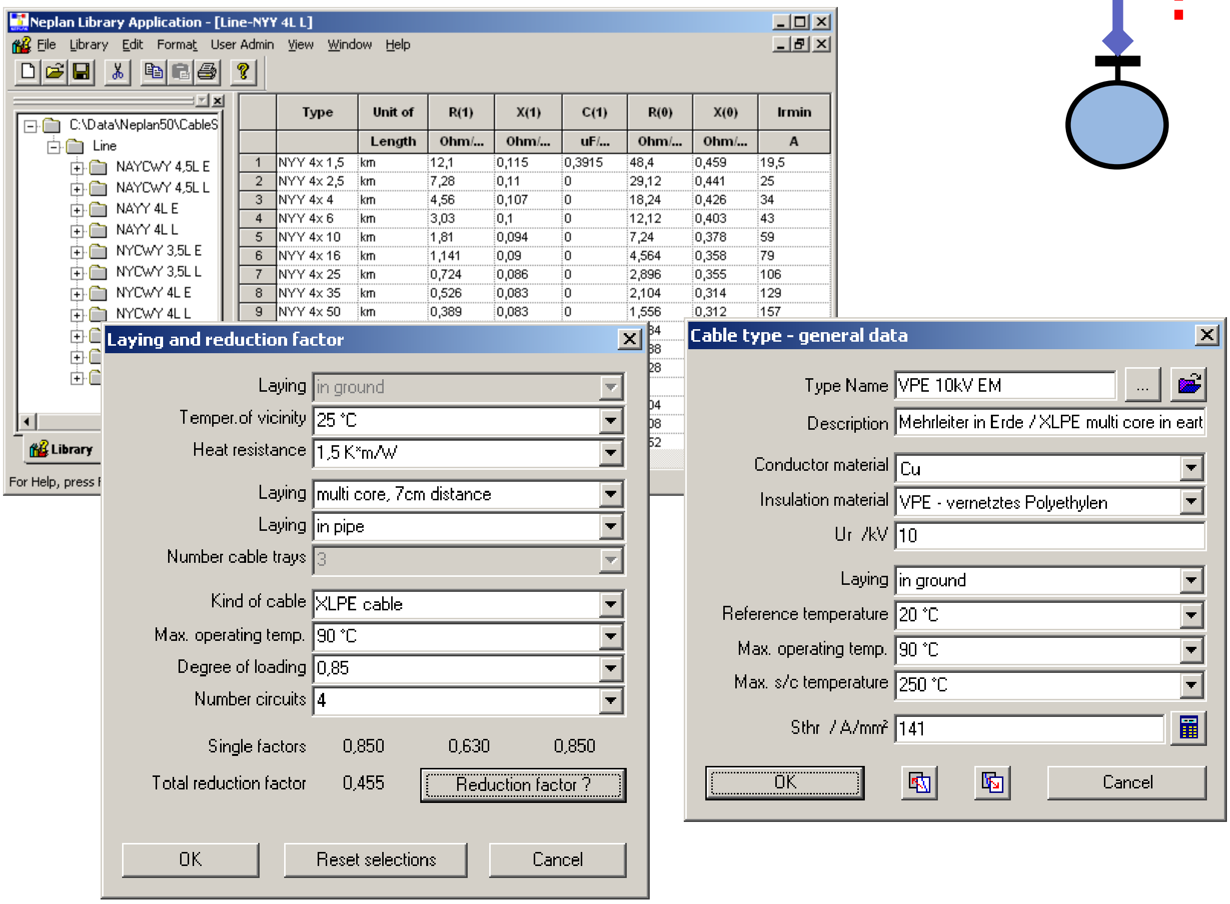


Result displayed at the circuit breakers

Characteristics



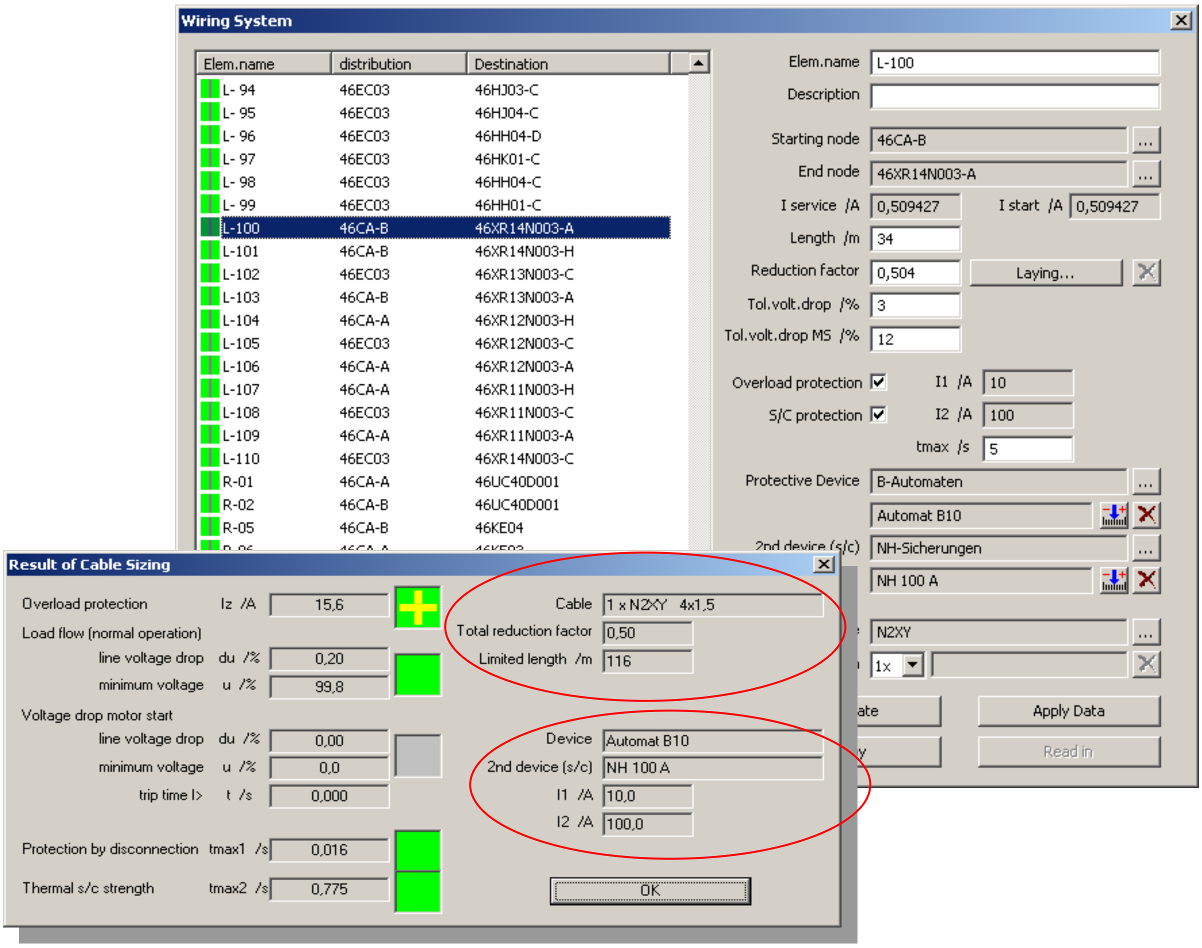
- Selection of cable (type, cross section) and protection device for an assumed passive or motor load and a given infeed.
- Cable length is given by the user.
- Cable type is taken from a predefined cable library (pool) within NEPLAN.
- Automatic selection of protection device rating and setting. Device is taken from NEPLAN protection library.
- Sizing of one cable or any number of cables together (distributed radial network)
- Maximum length of selected cable type and section for which the criteria is still fulfilled
- Inspection of already installed cables.



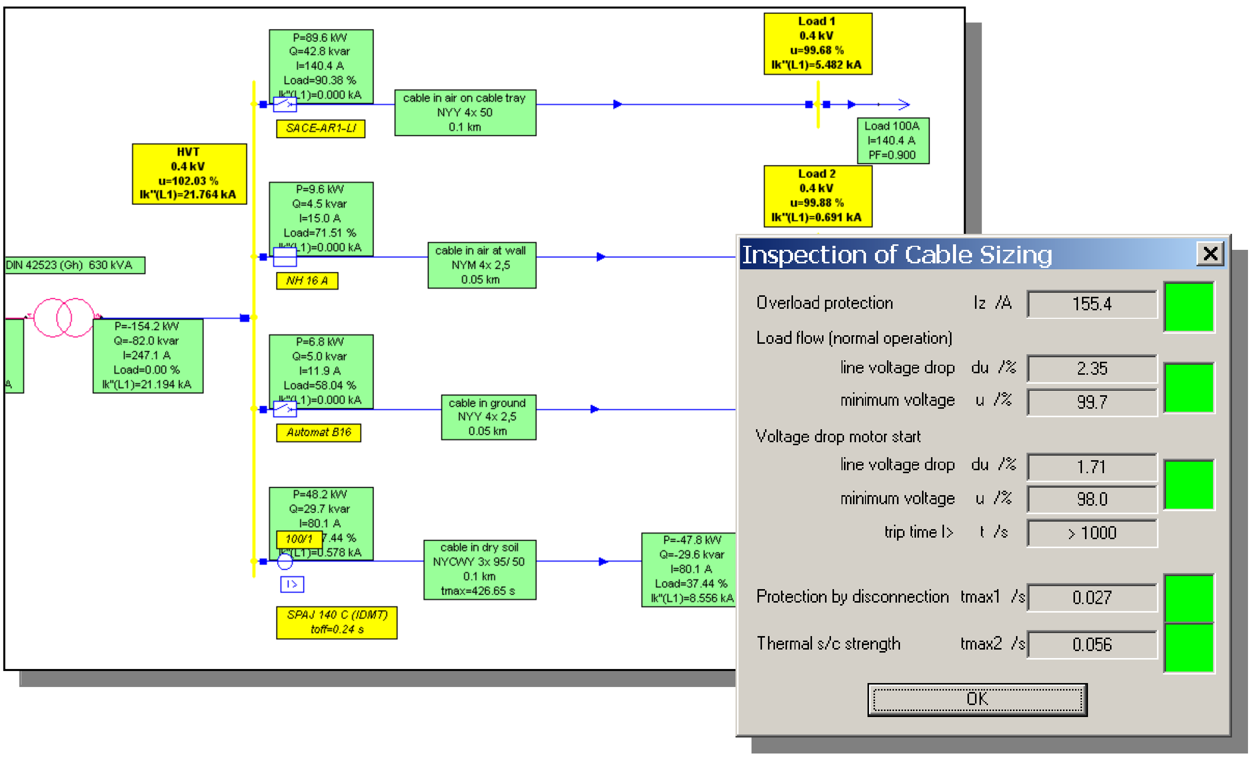
Criteria of dimensioning

- Service current of consumer, influence current rating of cable
- Protection of cable against overload
- Tolerable voltage drop and voltage limits
- Protection against hazardous voltage (protect persons), influence switch off in tolerable time
- Protection of cable against short-term overheating

Results



Wiring System
Elem.name
distribution
Destination
L- 94 46EC03 46HJ03-C
L- 95 46EC03 46HJ04-C
L- 96 46EC03 46HH04-D
L- 97 46EC03 46HK01-C
L- 98 46EC03 46HH04-C
L- 99 46EC03 46HH01-C
L-100 46CA-B 46XR14N003-A
L-101 46CA-B 46XR14N003-H
L-102 46EC03 46XR13N003-C
L-103 46CA-B 46XR13N003-A
L-104 46CA-A 46XR12N003-H
L-105 46EC03 46XR12N003-C
L-106 46CA-A 46XR12N003-A
L-107 46CA-A 46XR11N003-H
L-108 46EC03 46XR11N003-C
L-109 46CA-A 46XR11N003-A
L-110 46EC03 46XR14N003-C
R-01 46CA-A 46UC40D001
R-02 46CA-B 46UC40D001
R-05 46CA-B 46KE04
Elem.name L-100
Description
Starting node 46CA-B
End node 46XR14N003-A
I service /A 0,509427
I start /A 0,509427
Length /m 34
Reduction factor 0,504
Laying...
Tol.volt.drop /% 3
Tol.volt.drop MS /% 12
Overload protection
I1 /A 10
S/C protection
I2 /A 100
tmax /s 5
Protective Device B-Automaten
Automat B10
2nd device (s/c) NH-Sicherungen
NH 100 A
N2XY
1x
Apply Data
Read in
Result of Cable Sizing
Overload protection Iz /A 15,6
Load flow (normal operation)
line voltage drop du /% 0,20
minimum voltage u /% 99,8
Voltage drop motor start
line voltage drop du /% 0,00
minimum voltage u /% 0,0
trip time I> t /s 0,000
Protection by disconnection tmax1 /s 0,016
Thermal s/c strength tmax2 /s 0,775
Cable 1 x N2XY 4x1,5
Total reduction factor 0,50
Limited length /m 116
Device Automat B10
2nd device (s/c) NH 100 A
I1 /A 10,0
I2 /A 100,0
OK



P=89.6 kW
Q=42.8 kvar
I=140.4 A
Load=90.38 %
SACE-AR1-LI
cable in air on cable tray
NYY 4x 50
0.1 km
Load 1
0.4 kV
u=99.68 %
Ik"(L1)=5.482 kA
Load 100A
I=140.4 A
PF=0.900
HVT
0.4 kV
u=102.03 %
Ik"(L1)=21.764 kA
P=9.6 kW
Q=4.5 kvar
I=15.0 A
Load=71.51 %
NH 16 A
cable in air at wall
NYM 4x 2,5
0.05 km
Load 2
0.4 kV
u=99.88 %
Ik"(L1)=0.691 kA
DIN 42523 (Gh) 630 kVA
P=-154.2 kW
Q=-82.0 kvar
I=247.1 A
Load=0.00 %
Ik"(L1)=21.194 kA
P=6.8 kW
Q=5.0 kvar
I=11.9 A
Load=58.04 %
Automat B16
cable in ground
NYY 4x 2,5
0.05 km
P=48.2 kW
Q=29.7 kvar
I=80.1 A
100/1
cable in dry soil
NYCWY 3x 95/ 50
0.1 km
tmax=426.65 s
P=-47.8 kW
Q=-29.6 kvar
I=80.1 A
Load=37.44 %
Ik"(L1)=8.556 kA
SPAJ 140 C (IDMT)
toff=0.24 s
Inspection of Cable Sizing
Overload protection Iz /A 155.4
Load flow (normal operation)
line voltage drop du /% 2.35
minimum voltage u /% 99.7
Voltage drop motor start
line voltage drop du /% 1.71
minimum voltage u /% 98.0
trip time I> t /s > 1000
Protection by disconnection tmax1 /s 0.027
Thermal s/c strength tmax2 /s 0.056
OK

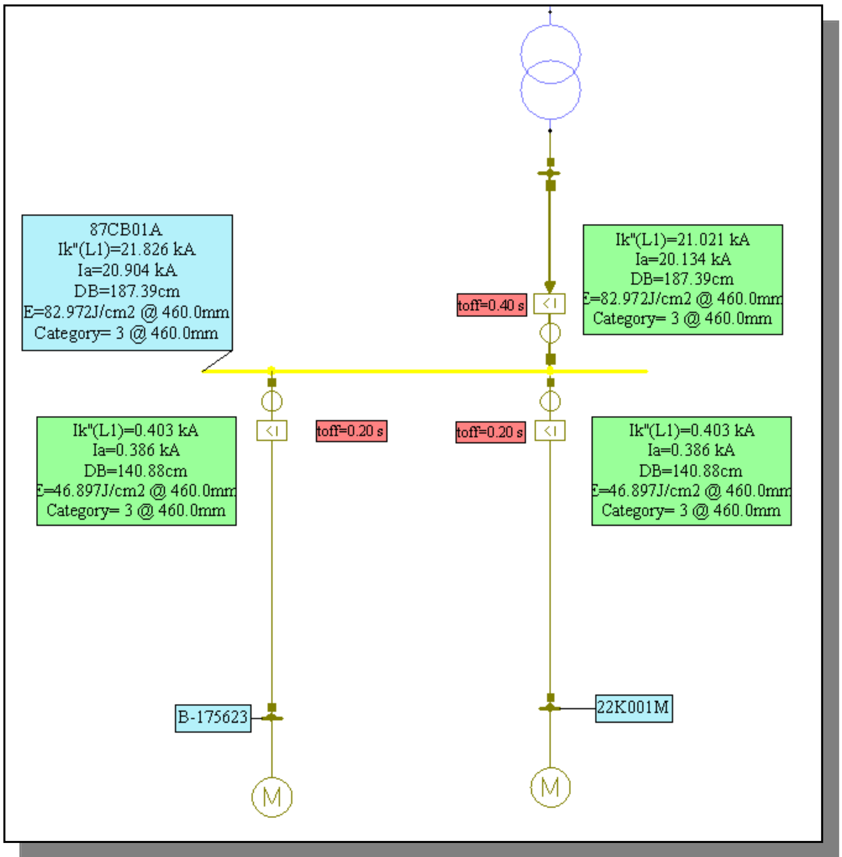
Arc Flash Analysis

Application: Industrial - Generation

NEPLAN® Smarter Tools

Characteristics

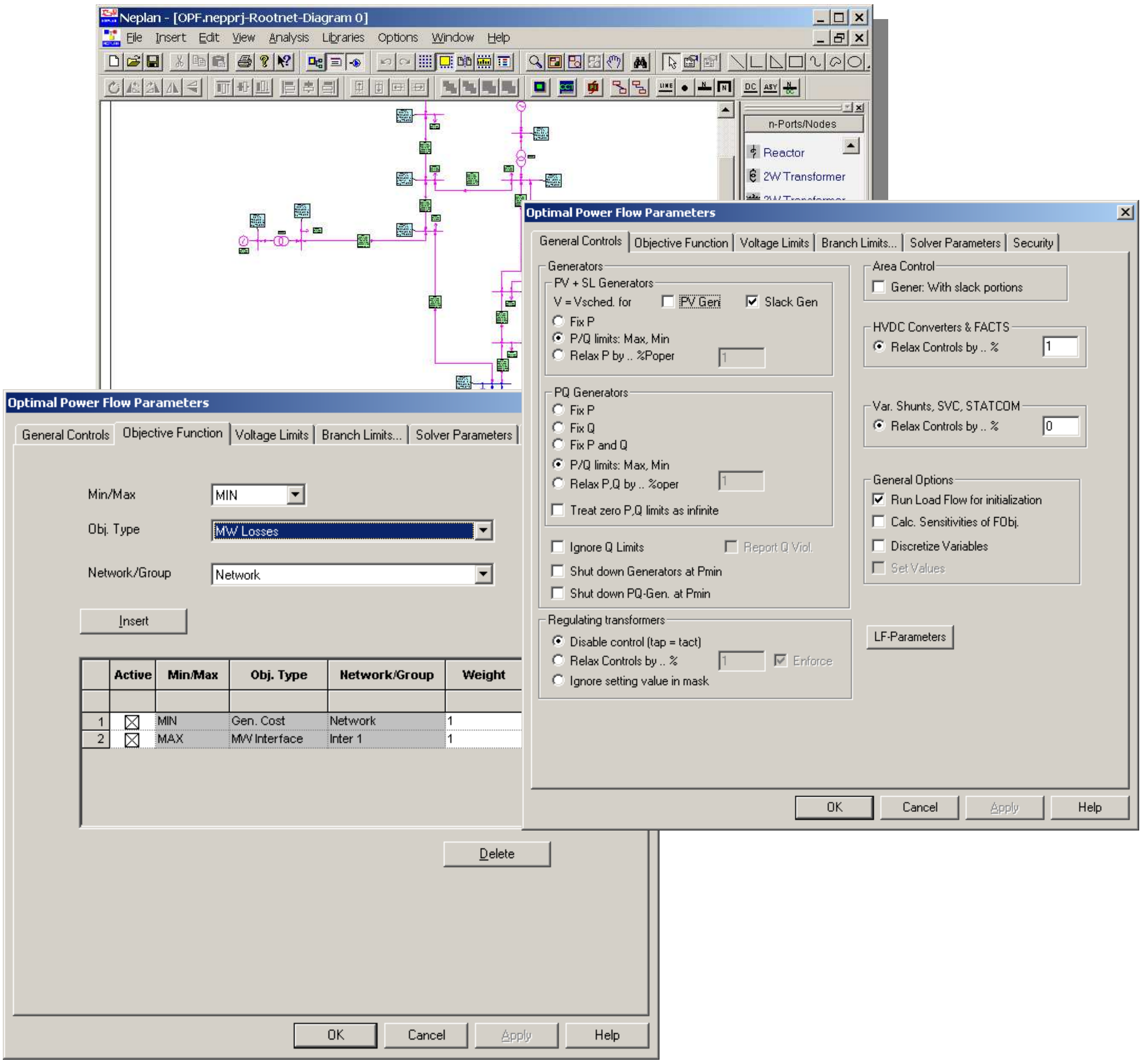
- Calculation methods IEEE 1584 & NFPA 70E
- Completely integrated and based on NEPLAN short circuit and selectivity analysis modules
- Supports ANSI/IEEE and IEC short circuit calculation for symmetrical and unsymmetrical fault.
- Calculates the incident energy for reduced and unreduced arcing current and in function of the working distance
- Automatically determine the Arcing Fault Clearing Time (reduced and unreduced arcing current)
- Determine individual arcing current contributions
- Individual parameter setting to determine the incident energy
- Automatically assign hazard category for LV (<240 volts) with bolted current less than 10 kA
- Multiple arc flash simulations in one run



Name	Type	Faulted Node	Un	Ik	Iarc	Iarc reduced	Arc Time	Arc Time reduced	Flash protection boundary	Working distance	Incidence energy unreduced	Incidence energy reduced	Incidence energy decisive	Category
			kV	kA	kA	kA	s	s	cm	mm	J/cm2	J/cm2	J/cm2	
	Node	87CB01A	10.00	21.826	20.904	20.904	0.460	0.460	187.387	460.0	82.972	82.972	82.972	3
										610.0	47.183	47.183	47.183	3
										760.0	30.396	30.396	30.396	2
										910.0	21.201	21.201	21.201	2
K-BT01-US	Line			21.021	20.134	20.134	0.460	0.460	187.387	460.0	82.972	82.972	82.972	3
										610.0	47.183	47.183	47.183	3
										760.0	30.396	30.396	30.396	2
										910.0	21.201	21.201	21.201	2
K-22K001M	Line			0.403	0.386	0.386	0.260	0.260	140.879	460.0	46.897	46.897	46.897	3
										610.0	26.669	26.669	26.669	2
										760.0	17.181	17.181	17.181	2
										910.0	11.983	11.983	11.983	1
L-175616	Line			0.403	0.386	0.386	0.260	0.260	140.879	460.0	46.897	46.897	46.897	3
										610.0	26.669	26.669	26.669	2
										760.0	17.181	17.181	17.181	2
										910.0	11.983	11.983	11.983	1

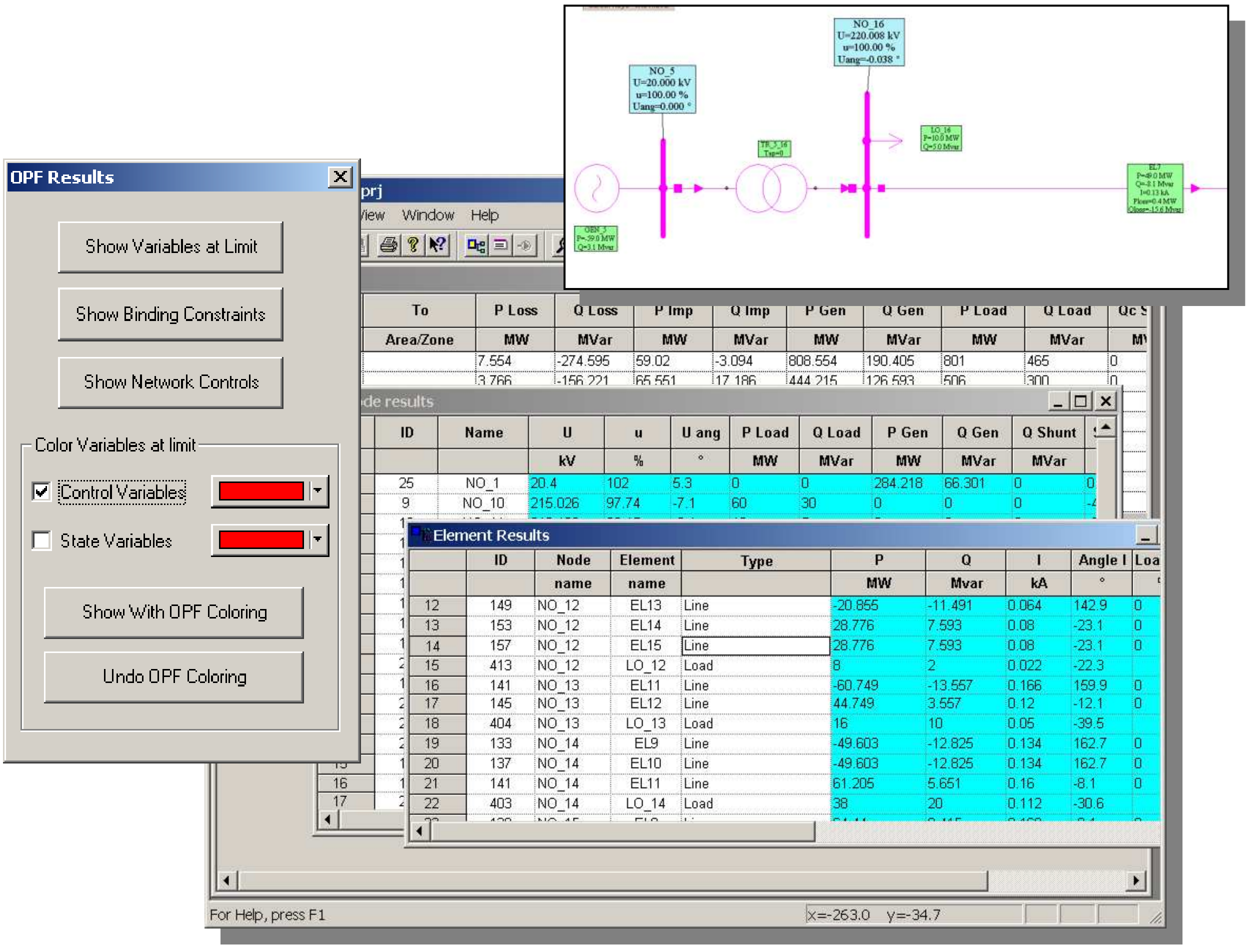
General Characteristics

- Control variables: active / reactive power generation, schedule voltages of generators and taps of ULTC-transformers, reference values of HVDC systems and FACTS (UPFC, STATCOM, SVC, TCSC)
- Variable limits for bus voltages, branch loadings, active and reactive power of generators
- Individual or general limits, 'consider/not consider' limits function
- Objective function: apply to whole network / to a certain area or zone, minimize / maximize MW losses, Mvar losses, generation cost, MW import or Mvar import, MW Interface flow
- Multi objective function is possible (use of weighting factors)
- Security constrained optimization (with n-1contingency constraints)



Results

- Automatic display of results.
- Optimization results (binding constraints, variables at limits, lambda multipliers, sensitivities, network controls, coloring of limiting network elements in the graphic)
- 'Move' and 'Delete' function for result boxes.
- Self-defined result output: the user can select items, units, font, precision, placement.
- Overloaded elements or nodes with voltages outside predefined limits are highlighted.
- Line thickness corresponds to element loading.
- Results can be saved in a text file (ASCII)
- Table output: for the whole network, individually for each area / zone. Listing of power flows between area/zones, overloaded elements, sorting function, selective output.
- Table interface with MS-Excel

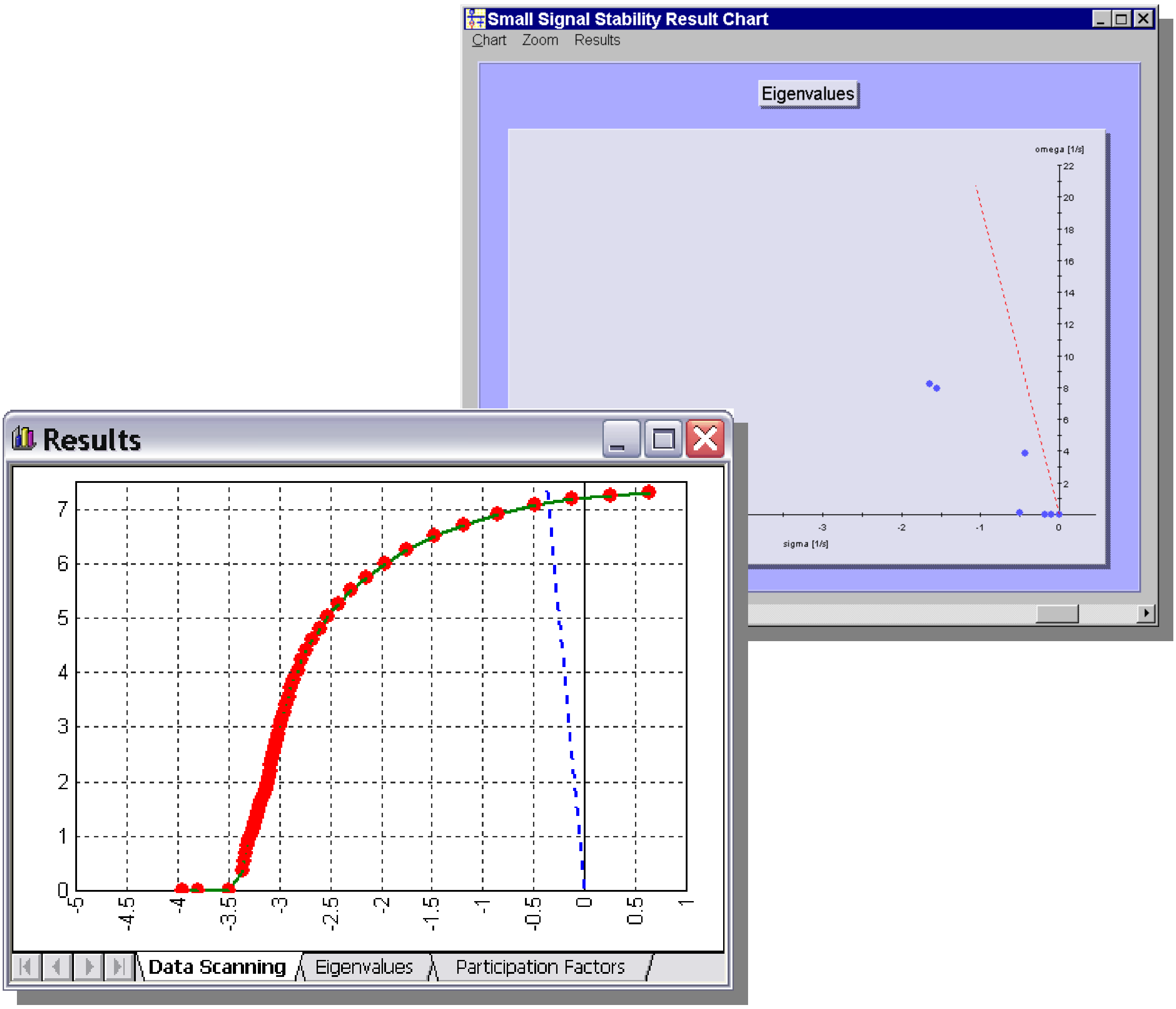


Small Signal Stability
Application: Transmission

The NEPLAN Small Signal Stability module provides eigenvalue analysis (modal analysis) for electrical power systems. It combines exceptional ease of use with the latest techniques and standards in both electrical power engineering and software design.

Applications

- Analysis of interarea oscillations
- Analysis of interplant oscillation
- Analysis of subsynchronous oscillations/resonance (SSR)
- Identification of groups and subgroups of machines swinging against each other
- Determination and improvement of power oscillation damping
- Design and placement of control equipment, such as power system stabilizers
- PSS tuning



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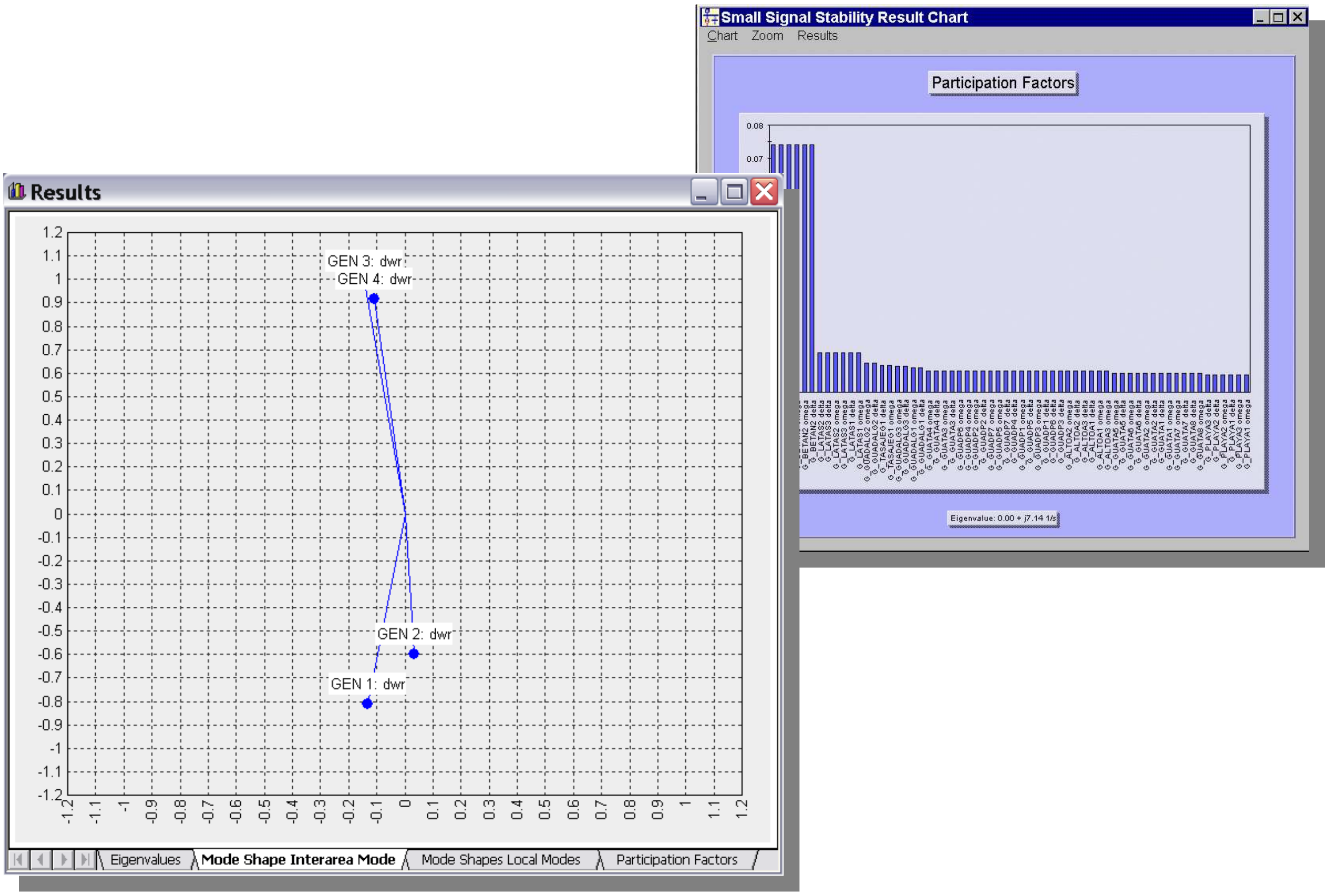
Small Signal Stability
Application: Transmission

Main Features

- Data scanning and eigenvalue sensitivity functions
- Automatic construction of the linearized state space notation for the complete system, including generators, static loads, control circuits, etc.
- Advanced synchronous machine modeling: choose for every synchronous machine one of the five models infinite, classical, transient, subtransient and general. Saturation curves for both, d-axis and q-axis.
- Automatic calculation of eigenvalues, eigenvectors, mode shapes, participation factors for eigenvalues and state variables.
- Text results: results are presented in clear form and can be customized by several output options.
- Graphical results: results can be visualized by the fully integrated graphical results manager. Charts can be easily printed and exported to external programs (e.g. Microsoft Word) by clipboard functions. A variety of chart options is available.
- The only requirement is the NEPLAN load flow module. However, the Small Signal Stability and the Transient Stability (Dynamic Simulation) module of NEPLAN complement each other ideally.
- The Small Signal Stability module is completely integrated in NEPLAN and uses standard dynamic element data.



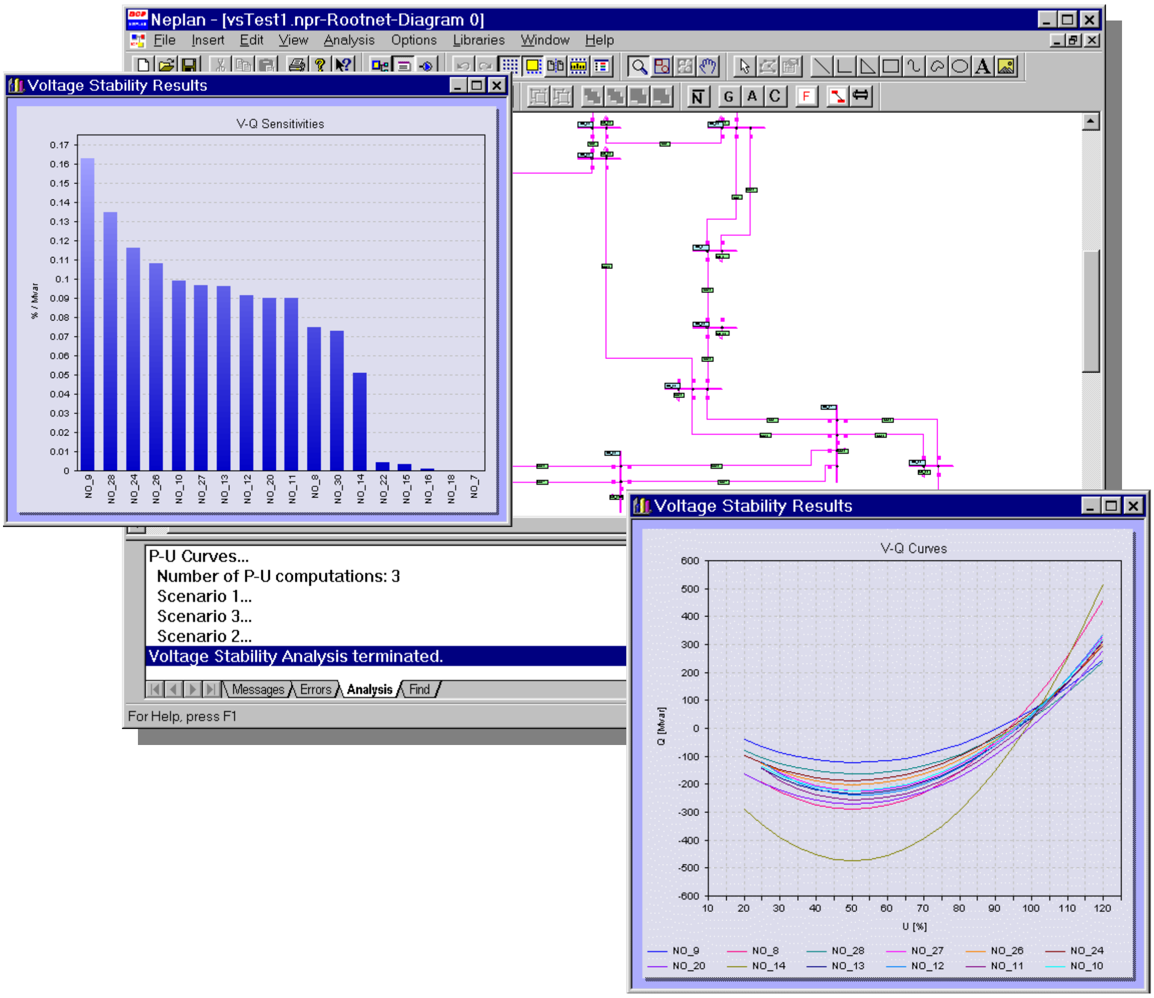
Voltage Stability Analysis

Application: Transmission

As an integral part of NEPLAN software, the Voltage Stability module provides four approaches for static voltage stability analysis of power systems: **V-Q curves, P-V curves, V-Q sensitivity analysis** and **Q-V eigenvalue analysis (modal analysis)**. This module allows examination of a wide range of system conditions. It is an ideal tool to provide much insight into the nature of voltage stability problems.

Applications

- Identification of weak / not controllable / unstable areas
- Identification of weak and heavily loaded links
- Proper distribution of reactive reserves in order to maintain an adequate voltage stability margin
- Voltage sensitivity information
- Degree of voltage stability
- Most effective measures in improving voltage stability



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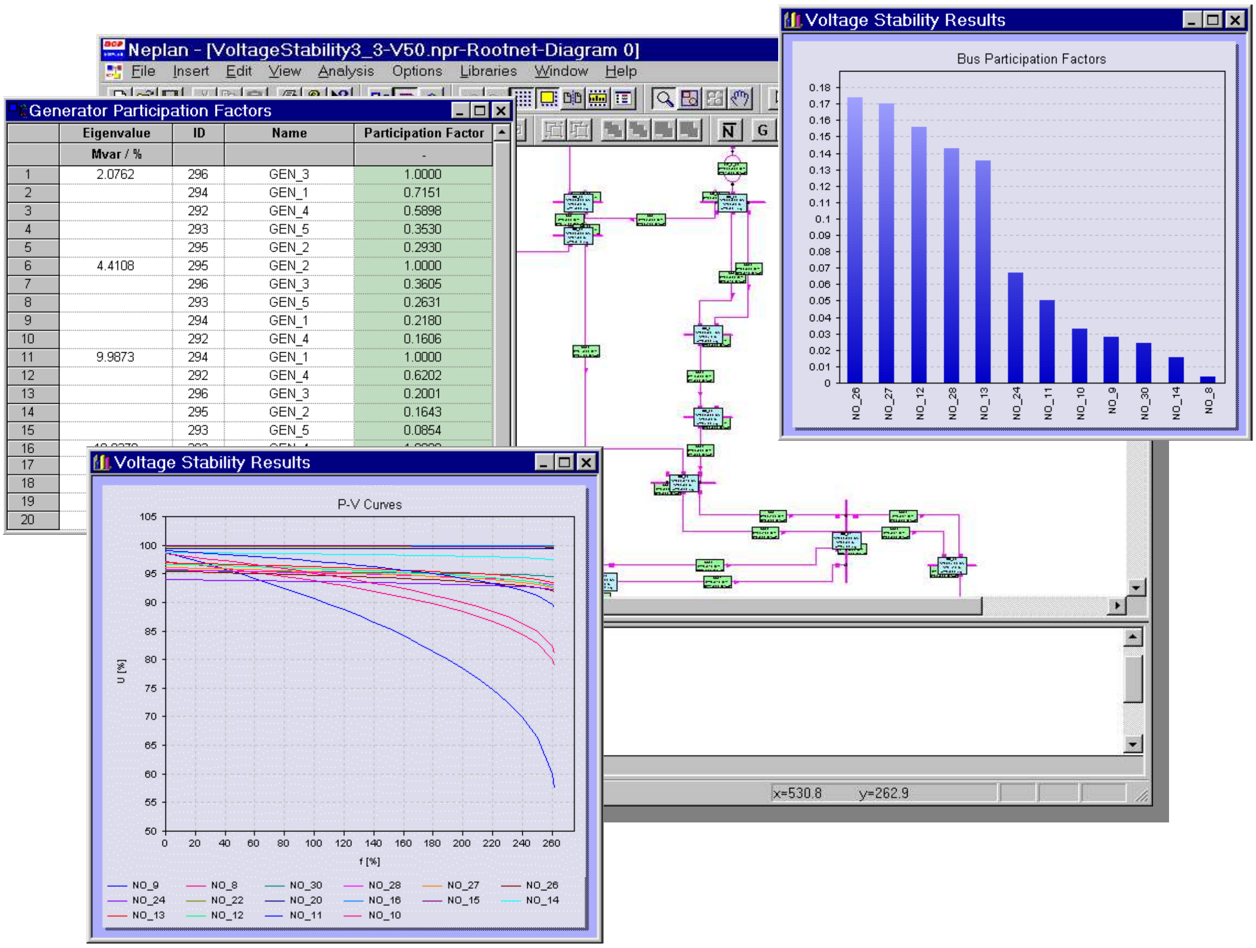
Voltage Stability Analysis

Application: Transmission

NEPLAN® Smarter Tools

Main Features

- Automatic calculation of P-V curves, V-Q curves, dV/dQ self-sensitivities, dV/dQ mutual sensitivities, eigenvalues, eigenvectors, bus participation factors, branch participation factors and generator participation factors.
- Result tables: results are presented in clear form and can be exported by Copy-Paste-methods to external programs (e.g. MS-Excel).
- Graphical results: results can be visualized by the fully integrated graphical results manager.
- Export files: results are stored in text files for advanced data export.
- Charts can be easily printed and exported to external programs (e.g. MS-Word) by clipboard functions. A variety of chart options is available.
- Input: standard load flow input data



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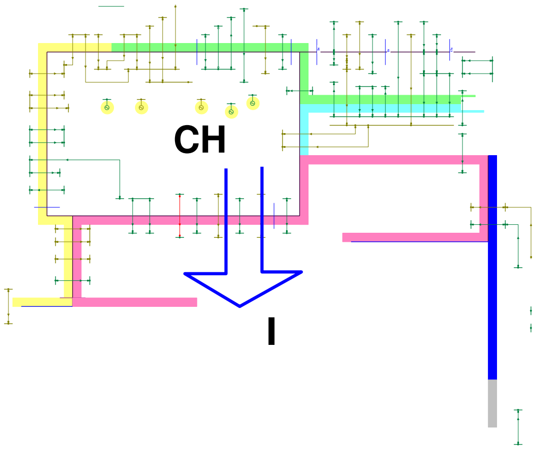
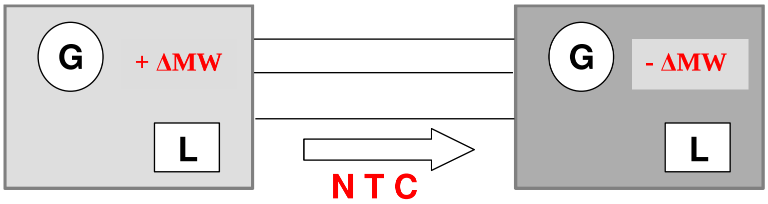
Features

- Calculation of max. MW transfer between regions
- ETSO methodology (load flow based, MW generation shift)
- Large flexibility in limit handling (individual activation of limits)
- Consideration of user-defined contingency scenarios
- Consideration of TRM (Transmission Reliability Margin)



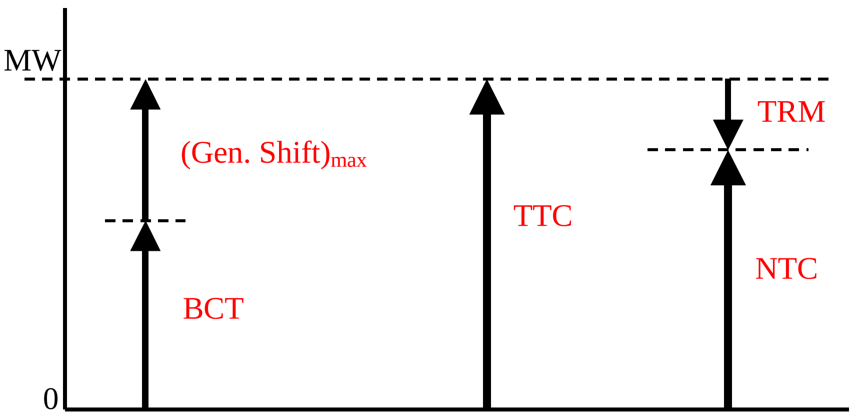


Generation shift from source to sink

Results

Report for every step of MW transfer on:

- Limit violations for base case
- Limit violations for each contingency case
- Calculation of TTC (Total transfer capacity) and NTC (Net transfer capacity)



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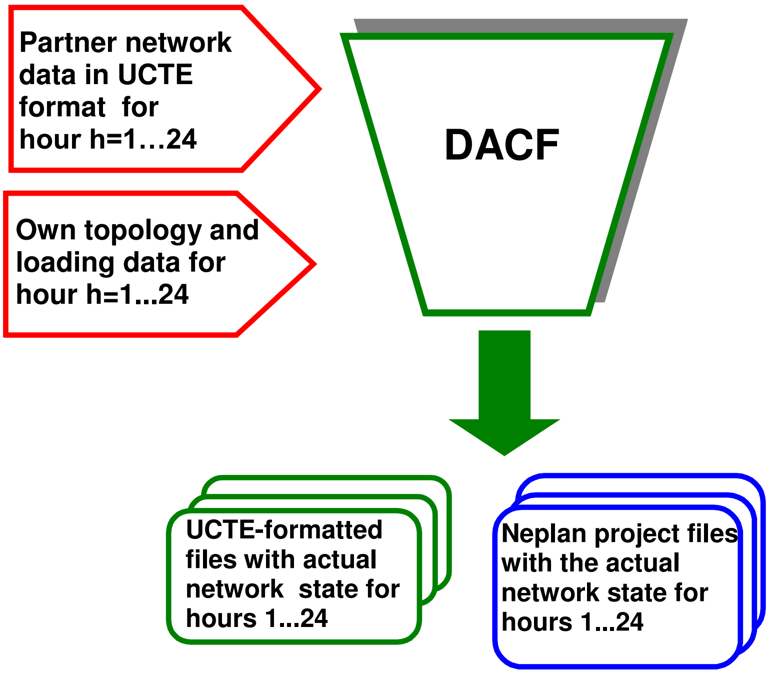
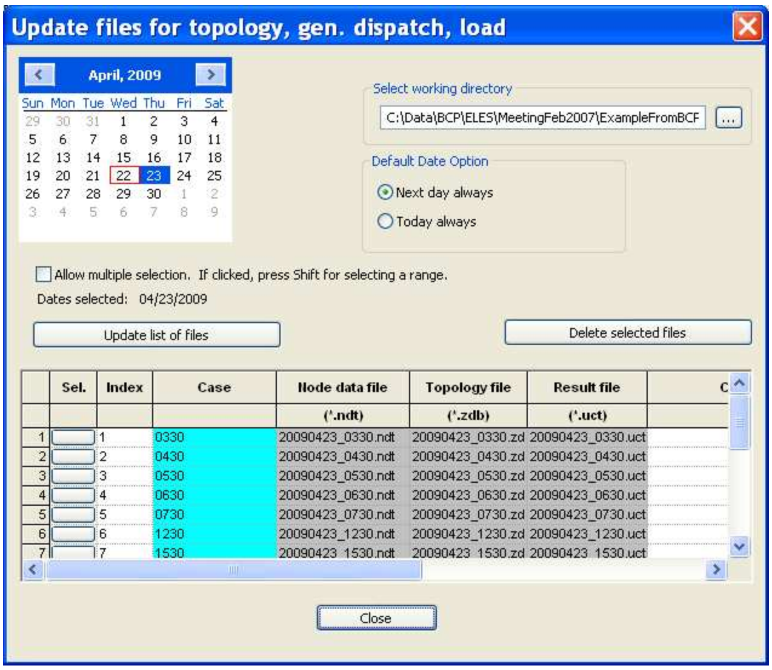
NEPLAN
Smarter Tools

Build UCTE files for different topology and loading network scenarios (cases). It can be used for importing UCTE files, running load flows for every hour of the next day and storing the load flow results in UCTE format or as a NEPLAN project.

Features

- Import UCTE-formatted network data (own network, partner network data)
- Use of reference network data in case of missing partner files
- Check for errors and consistency of imported UCTE files
- Import topology and loading data for each hour of the next day
- Use of map files in order to export only certain HV nodes and lines from the detailed network model
- EASY HANDLING! All information is stored in the project, so that the overhead of restarting DACF computation each day is minimal.





Results

- Export UCTE-formatted data for own network for each hour of the next day. Each file corresponds to the load flow solution for the actual loading and topology state of that hour.
- Create a network model (NEPLAN nepprj file) for each hour of the next day. The user can edit and work on each NEPLAN file directly.

NEPLAN® - Consulting

BCP Busarello + Cott + Partner is part of the international NEPLAN®-Consulting group. The NEPLAN®-Consulting group offers a wide range of power system studies and consultancies. More than 1000 projects all over the world have already been successfully realized. The NEPLAN®-Consulting group conducts studies to evaluate energy markets, solve electric system design, planning and operations related problems, perform system engineering, and provide equipment application expertise. We help you to optimize the value of your energy assets and transactions, and to better design, plan and operate your transmission, distribution, industrial systems, and/or merchant plant integration projects.

Our services include:

Merchant Project Siting
- *Energy locational marginal price analysis*
- *Capacity value assessment*
- *Value of ancillary services*
- *Forward price discovery*
- *Transmission constraint evaluations*
- *Value of transmission congestion relief*

Market and Individual Asset Evaluation
- *Valuation of generating and transmission assets*
- *Market risk assessment, profit and lost potentials*
- *Project due diligence activities*
- *Physical transmission access capability*

Feasibility/System Impact/Facility Upgrading
- *Load flow, contingency, short circuit, and stability analysis for the interconnection of merchant projects*
- *Interconnection configuration and conceptual designs*
- *System reinforcement option and cost assessment*

Transmission Capability Analysis
- *Transmission constraint identification and mitigation*
- *Simultaneous transfer limit calculations*
- *ATC calculation with consideration of TRM/CBM*

System Dynamics and Control
- *Transient and dynamic stability analysis*
- *Control tuning, design, and interactions*
- *SSR, SSTI, transient torque, torsional interaction*
- *Voltage instability*

Transient Analysis and Insulation Coordination
- *Arrester rating, energy requirements and location*
- *Switching transients, equipment BIL, BSL*
- *Phase-to-ground & phase-to-phase clearances*
- *Contamination performance*
- *Circuit breaker recovery voltage*

Harmonic Analysis
- *Harmonic filter design, filter performance and rating*
- *AC/DC harmonic filters, including active filters*
- *Network harmonic flow*

Distribution System Planning
- *Budget constrained planning*
- *Two-Q (Quality & Quantity) Engineering*
- *Distribution network evaluation*
- *Distributed resource interconnection*

Reliability
- *Probabilistic system planning*
- *T&D system reliability evaluation*
- *Substation RAM studies*
- *Integrated generation and transmission planning*
- *Failure mode, effect, fault tree analysis*

Protective Relaying and Controls
- *Protective system design and relay coordination*
- *Adaptive relaying, fault location*
- *Phasor estimation, power quality, high impedance fault detection*
- *Integration of protection, control and monitoring*
- *Wide-area disturbance protection and control*

HVDC
- *AC/DC interactions, and planning*
- *Conversion of AC lines to DC*
- *Dynamic performance & control requirements*
- *AC/DC filter design*
- *Reactive power requirements*
- *Equipment specification*

Flexible AC Transmission (FACTS)
- *Planning: location, type and size*
- *Dynamic performance & control requirements*
- *Control design, interactions*
- *Static VAR systems: SVC, GTO-based SVC*

Wind Energy
- *Stability aspects in power system and wind park*
- *Determination of optimal connections in regard of technical and economical aspects*

Education & Training
- *Short 3-5 day courses, regional or at customer site*
- *1 day NEPLAN introduction*

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