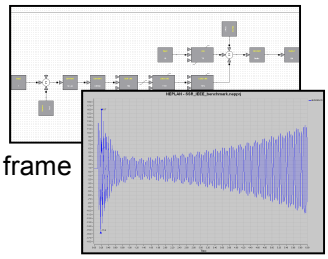
The NEPLAN® Dynamic Simulator is the most advanced on the market!

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)

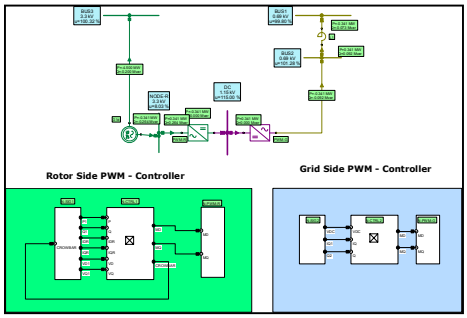
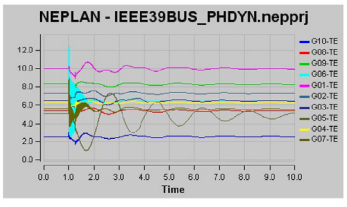
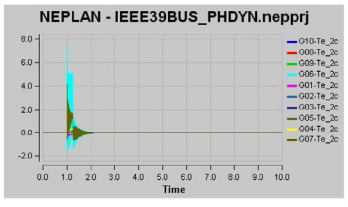
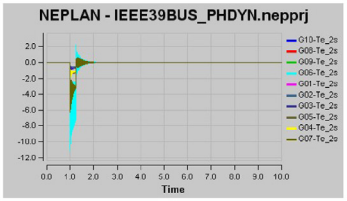


Fig.: Customized Wind Power Controllers (PWM, DFIG)







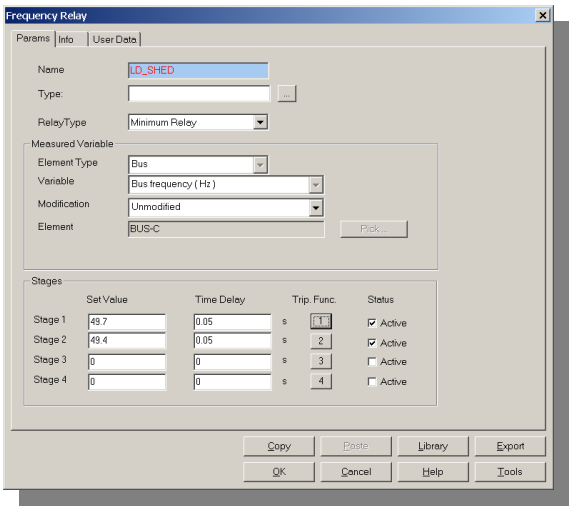
Applications

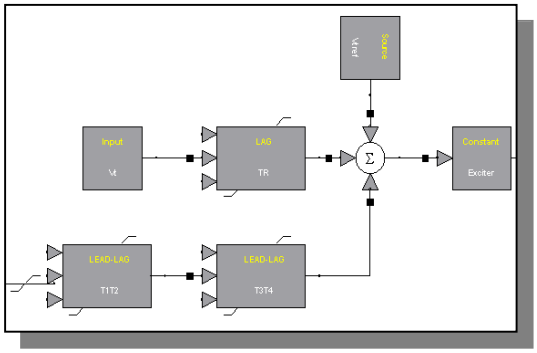
- Short-term, Mid-term and Long-term dynamic simulation.
- Sub-synchronous resonance with EMT simulation
- Load shedding and protection schemes
- HVDC, FACTS, SVC design and regulation
- Machine dynamics and startup simulations
- PSS tuning with Eigenvalue and Sensitivity analysis
- Automatic generation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

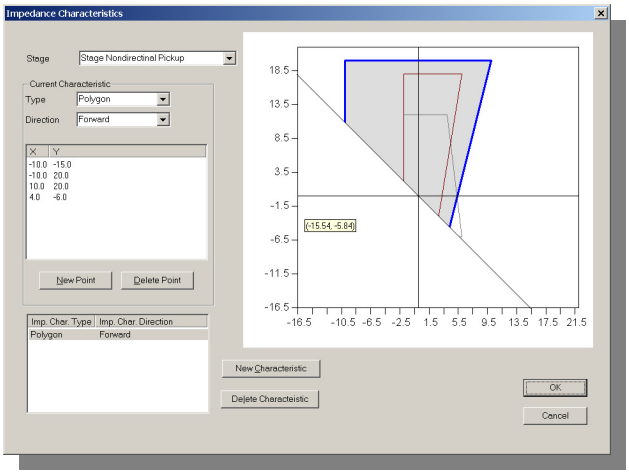
BCP Busarello + Cott + Partner AG I Power Systems Engineering I Bahnhofstrasse 40 I CH-8703 Erlenbach (ZH)
Phone +41 (0)44 914 36 66 I Fax +41 (0)44 991 19 71 I www.neplan.ch I bc@neplan.ch

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)

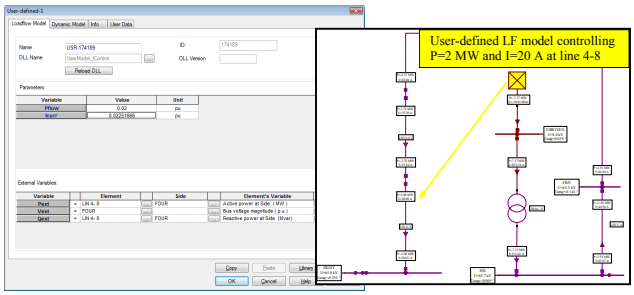
Researcher and developers need to have the ability to define their own power system component models. That could be amongst others:

- 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.

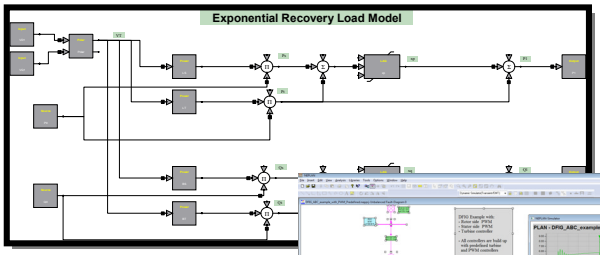
Modelling for Researchers

- 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



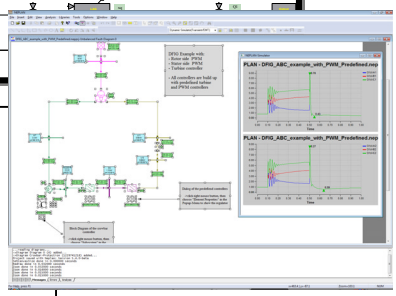
1) **Load flow models** may be defined with the NEPLAN® C/C++ API. Basically the load flow equations will be written in a C/C++ program. The compiled DLL file will then be assigned in the NEPLAN graphical editor. The dialog in NEPLAN show the parameters and signals which have to be defined for the model.

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.

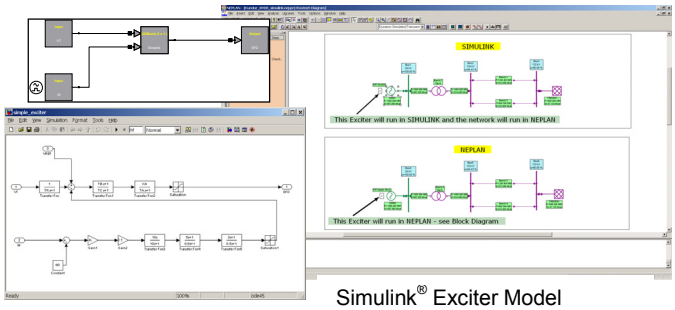


3) The models may be described directly in Differential Switched-Algebraic State Reset Equations (DSAR) in Matlab®. The NEPLAN® - Matlab® interface automatically generates a binary DLL file which may be assigned to user defined NEPLAN® component. Parameters and external signals may be set in the NEPLAN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