

The top section of the slide features a blue background. On the left, a wireframe globe is partially visible. On the right, there is a technical diagram of a power system, showing various components like buses (e.g., NE\_03BB1, NE\_03BB2), lines (e.g., NW-SW\_L1, NW-SW\_L2), and loads (e.g., SE\_03, SE\_04).

**POWERFACTORY**



# AI-driven Power Flow Calculations based on Neural Networks

André Schindler

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MADE IN GERMANY

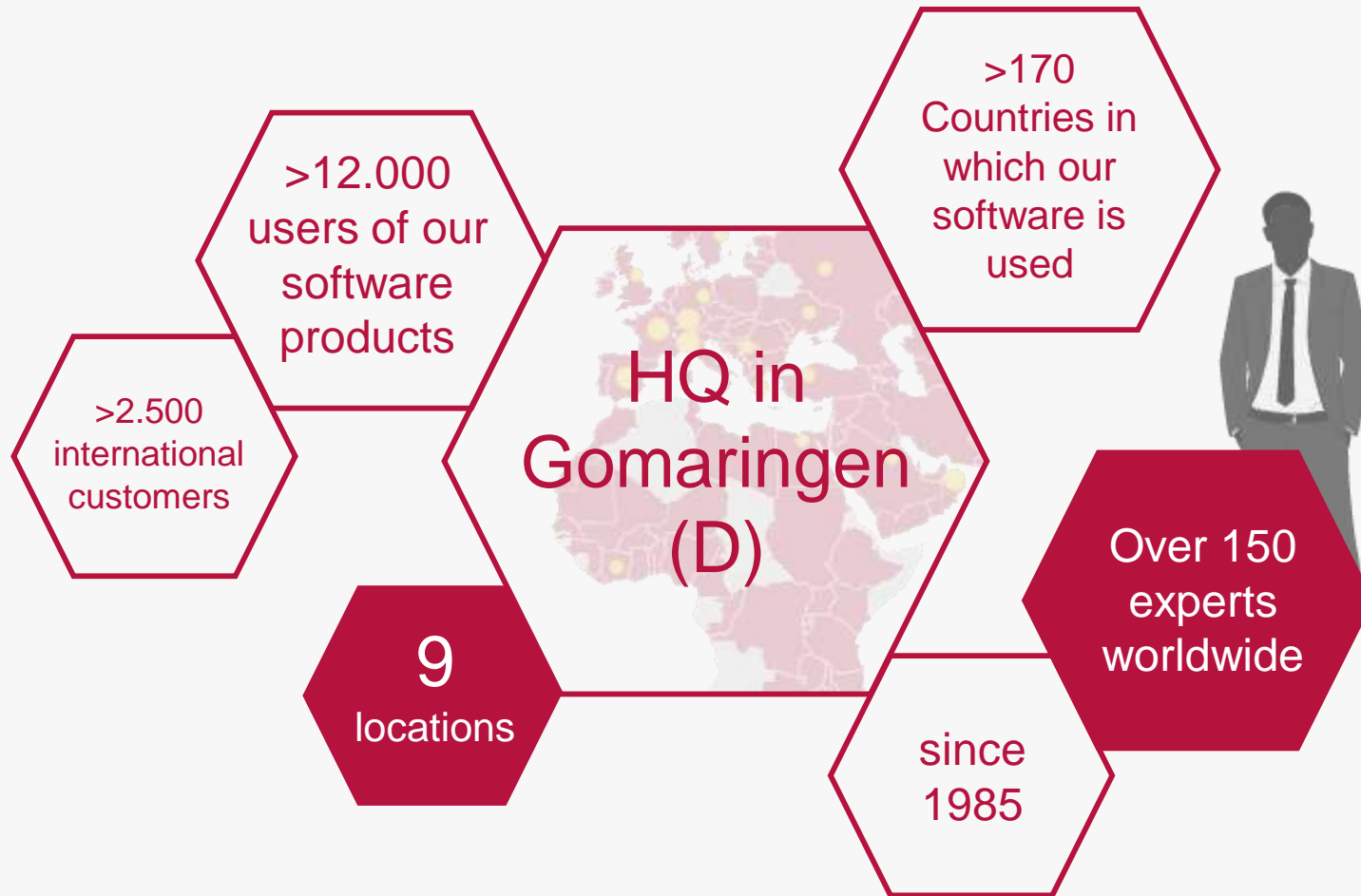


**DIGSILENT GmbH**

**Digital Simulation of Electrical Networks**

**POWER SYSTEM SOLUTIONS**  
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# DlgSILENT – at a glance

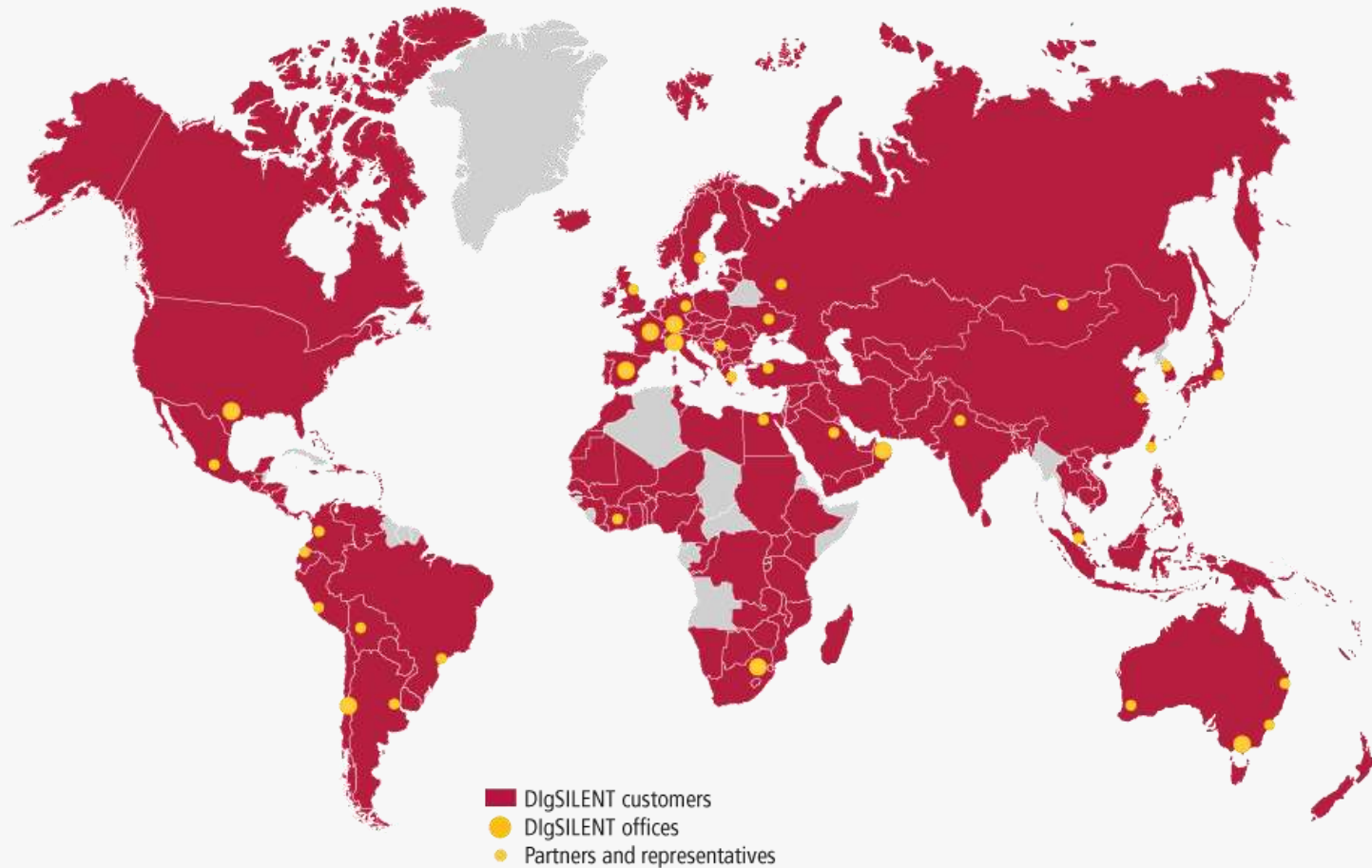


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- No institutional or personal involvement with other companies or associations





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## Software

**PF PowerFactory**  
Integrated power system  
analysis software

**SW StationWare**  
Protection settings  
database/asset  
management system



## Hardware/Software

**PowerSystem Monitoring**  
Dynamic Performance  
Monitoring System



**Grid Code Compliance  
Monitoring  
PFM300-GCC**



Continuous compliance  
auditing of power plants with  
respect to grid code  
requirements

## Services

**DlgSILENT Consulting**  
Consulting and research for T&D,  
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**Support, Training**  
Customer support regarding the  
software products, training courses,  
workshops, etc.

**System Integration & IT-Services**  
Product Integration (SCADA, GIS,...),  
customer-specific developments,  
data exchange, etc.



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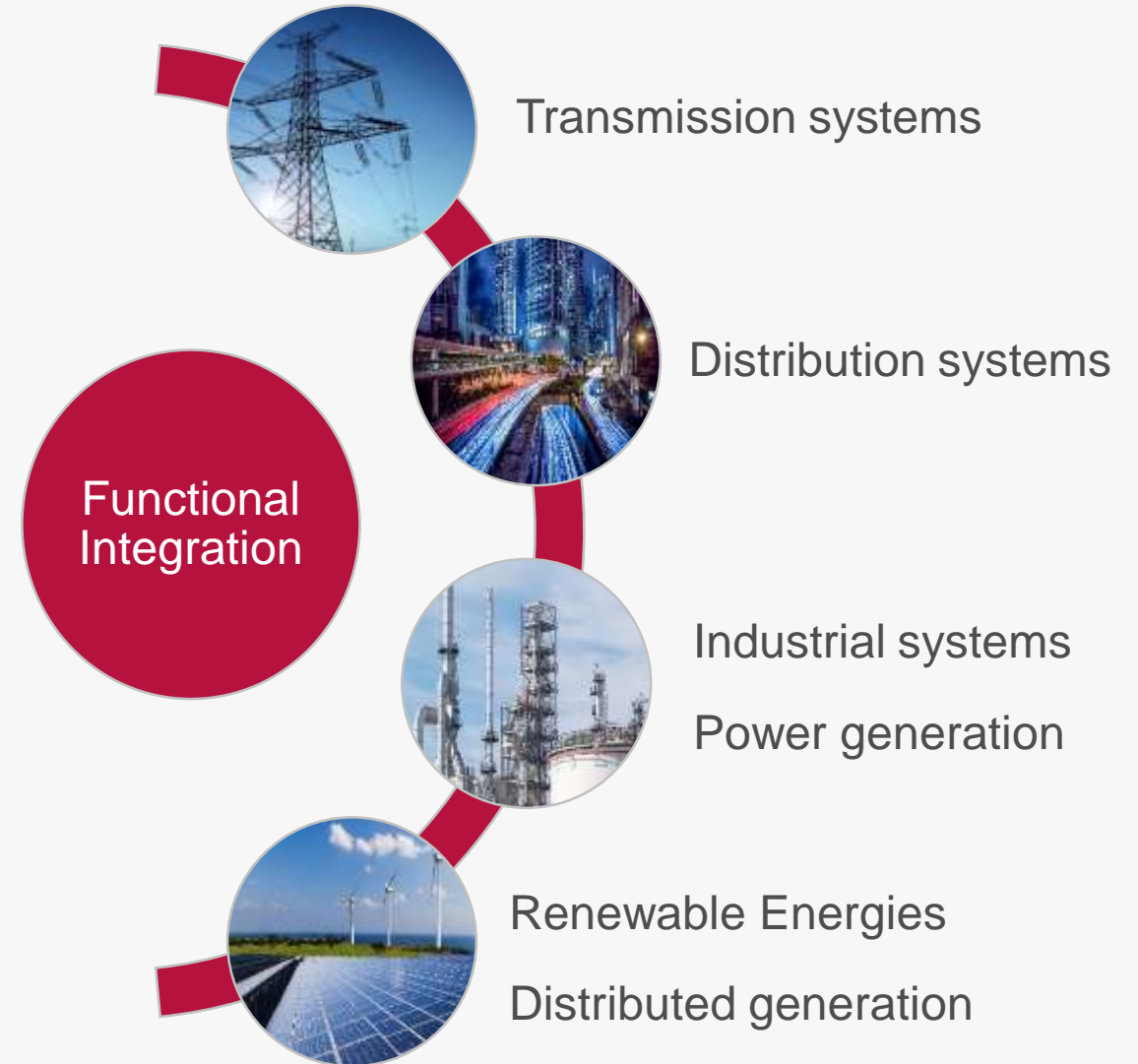
# PowerFactory

- #TRANSMISSION
- #DISTRIBUTION
- #INDUSTRY
- #GENERATION
- #INTEGRATION OF RENEWABLES













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- Leading power system simulation tool
- All-in-one solution with wide coverage of state of the art power system applications
- Extensive and flexible modelling capabilities with a rich suite of power equipment models and libraries
- Powerful network diagrams and graphic/visualisation features
- Supports all network representations and phase technologies
- Modular concept, scalable solution



The PowerFactory Base Package provides analysis modules coupled with a wide range of power equipment models, integrated tools and features for fundamental PowerFactory applications.

























- |  |   |
|--|---|
|  Load Flow Analysis                   |  Network Model Management              |
|  Short-Circuit Analysis               |  Outage Management                     |
|  Sensitivities / Distribution Factors |  PowerFactory Administration           |
|  Basic MV/LV Network Analysis         |  Network Diagrams and Graphic Features |
|  Power Equipment Models              |  Results and Reporting                |
|  Network Representation             |  Various Data Converters             |

... and it can be extended with a wide variety of additional functions according to specific requirements of the user



# Advanced Functions



	Contingency Analysis		Reliability Analysis Functions
	Quasi-Dynamic Simulation		Optimal Power Flow (OPF)
	Network Reduction		Unit Commitment and Dispatch Optimisation
	Protection Functions		State Estimation
	Arc-flash Analysis		Stability Analysis Functions (RMS)
	Cable Analysis		Electromagnetic Transients (EMT)
	Power Quality and Harmonic Analysis		Motor Starting
	Connection Request Assessment		Small Signal Stability (Eigenvalue Analysis)
	Transmission Network Tools		System Parameter Identification
	Distribution Network Tools		Scripting (Python/DPL) & Automation
	Economic Analysis Tools		Artificial Intelligence (Neural Network Analysis)
	Probabilistic Analysis		Interfaces



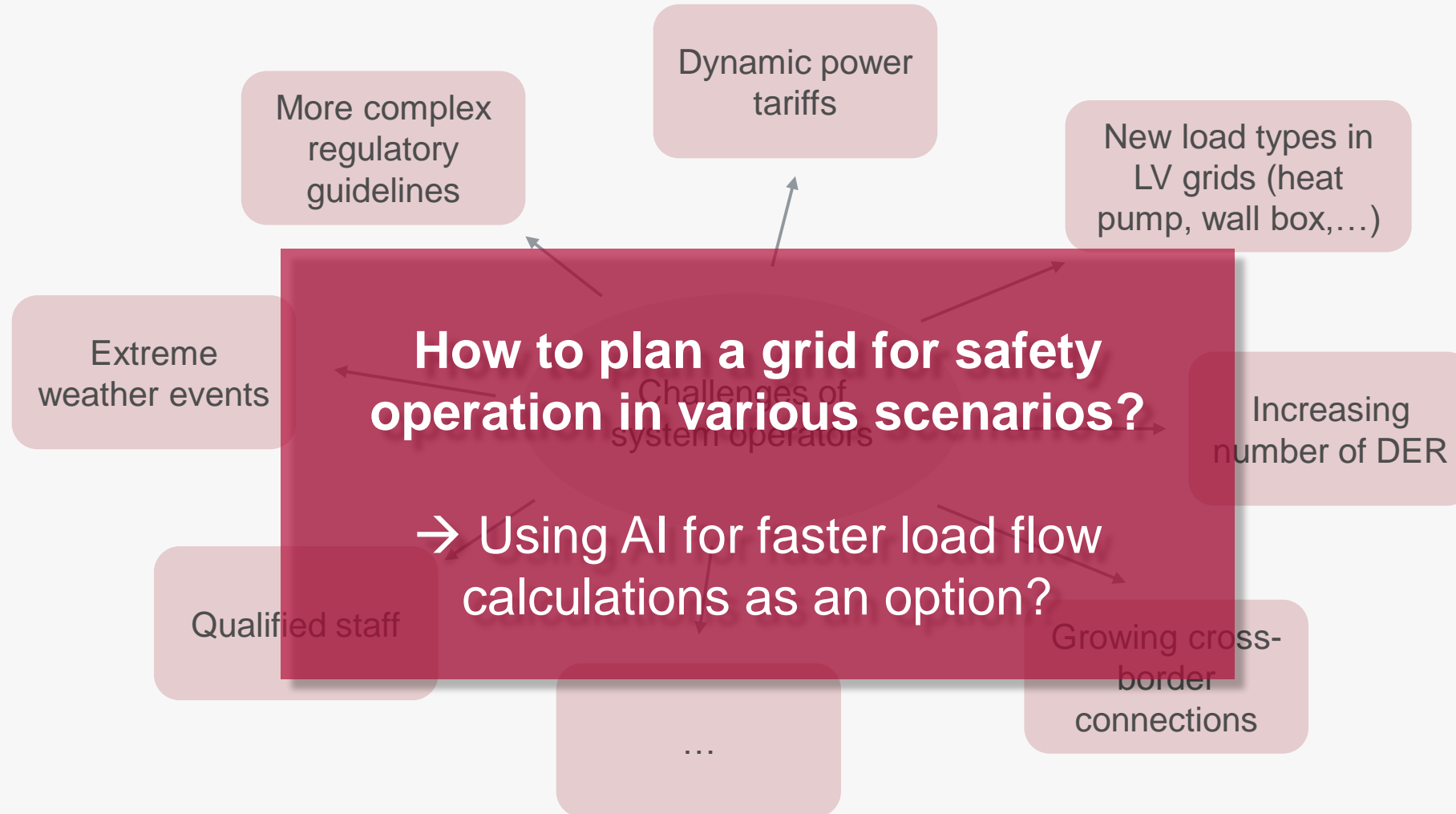
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# Application of Artificial Intelligence in PowerFactory

Presentation of an Implementation based on  
Neural Networks



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## Estimation of load flow results in time-series calculation

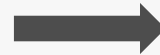
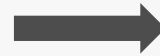
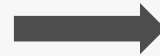
- Usage of historic smart meter data in LV grids to detect critical states in the past.
- Determination of actions for grid planning based on time-series calculation.
- Analysis of large networks with many load flow calculations for different scenarios
- Transparency of grids

 ...and many more



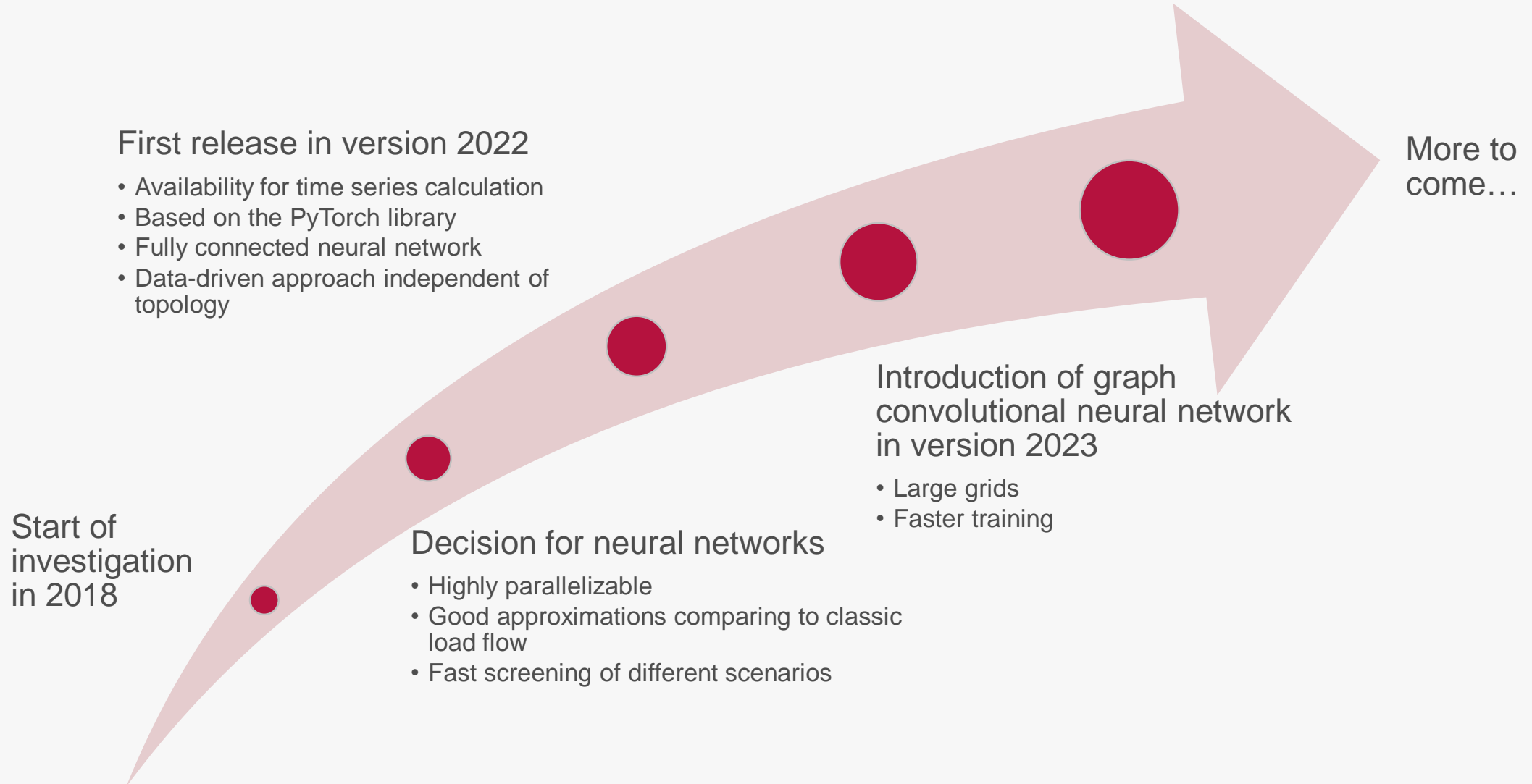
## Conventional Load Flow Algorithms

- Based on physical rules and algorithms such as Newton-Raphson
- Works without any historical results
- Iterative Approach
- “Exact” results

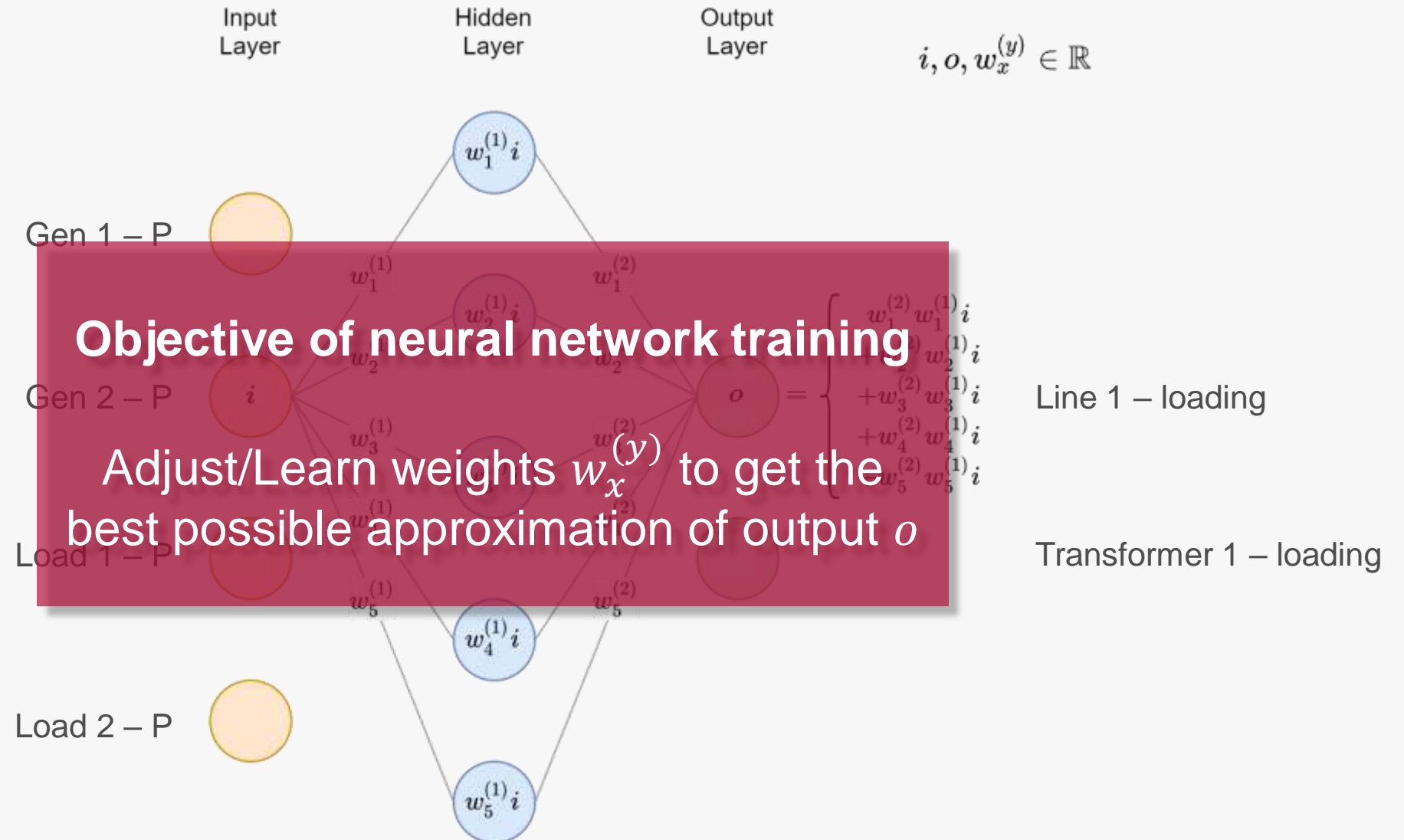


## Artificial Neural Network

- Blackbox without specific electrical engineering calculation rules
- Needs to be trained with huge amount of data
- Direct calculation
- Approximation of results



# Artificial Neural Network – Basics



? Where to get sufficient amount of training data representing different situations?

## → Historic Measurements

- Enough measurements for observability of the grid?
- Enough samples for training and validation with clean and plausible data?
- Different situations in appropriate number of occurrences such as peak load, generation,...?

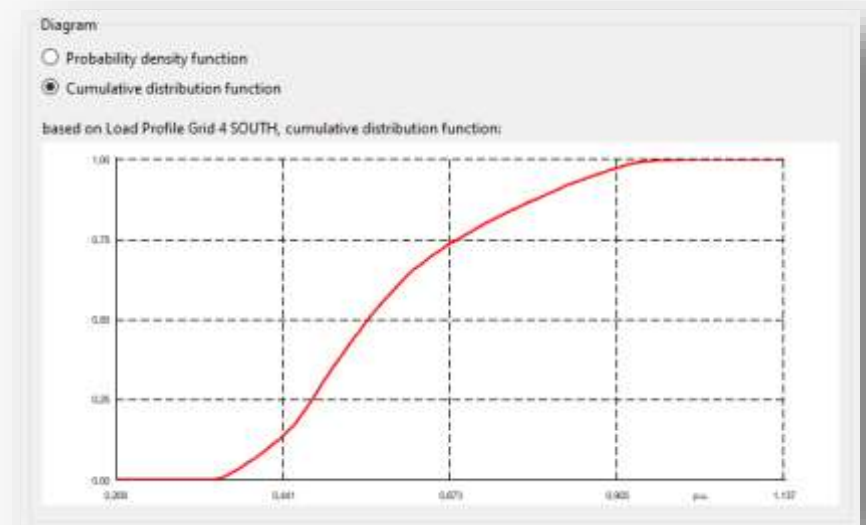
! Solution: *Probabilistic Analysis* function within PowerFactory for synthetic data

→ Individual selection of variables for input/output

→ Usage of distribution functions

→ Usage of correlations

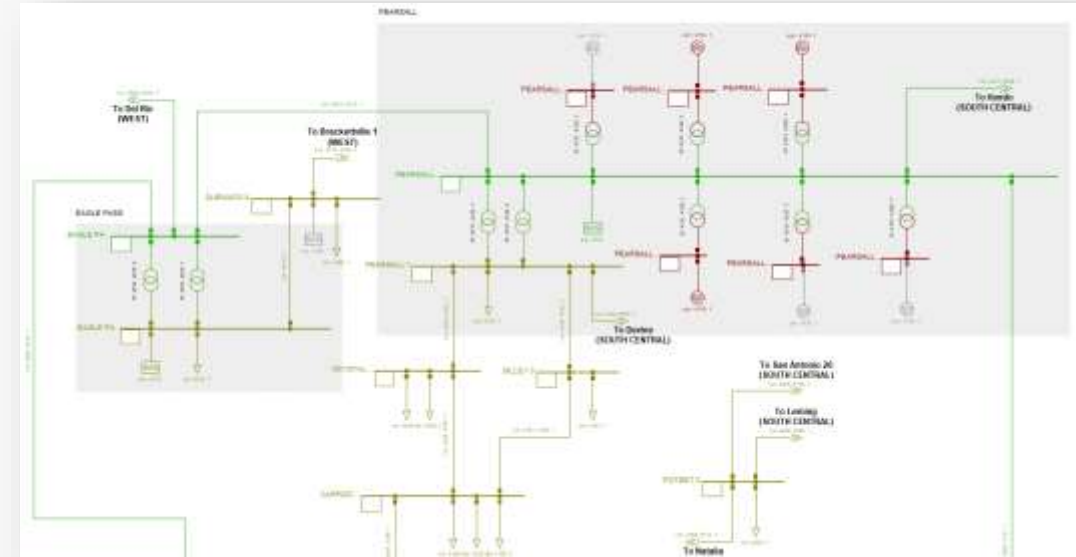
→ Monte Carlo simulation for arbitrary number of samples





## Using a trained neural network

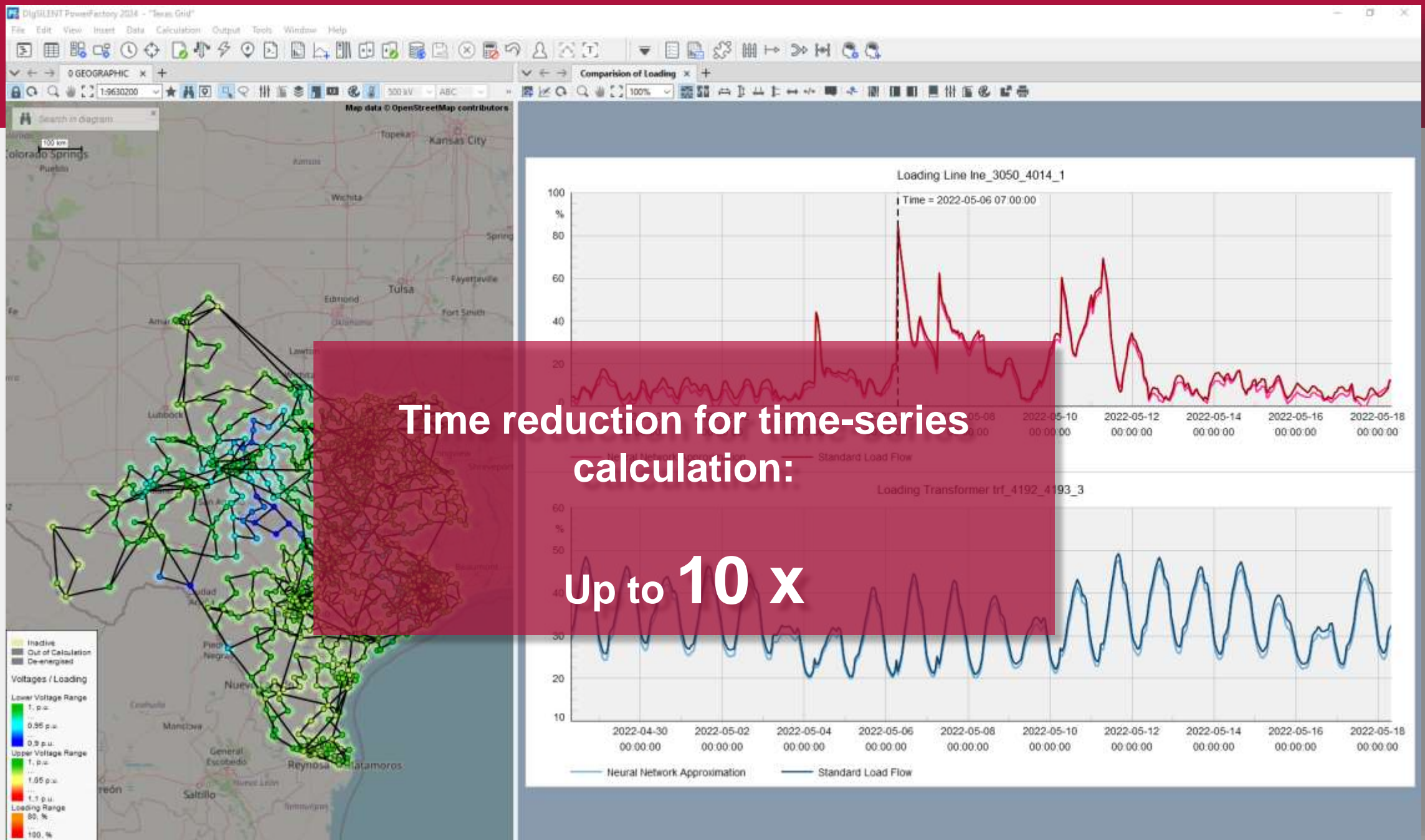
- No change of topology – even open/close of switches
- No adding of new elements
- No change of calculation settings
- No change of variables afterwards



New training of the model needed



It's not possible to take over a neural network to another network model topology





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**DIG**

**Thank You!**

„The secret of going ahead  
is doing the first step”

- Mark Twain -

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