POWERFACTORY

GIS Integration

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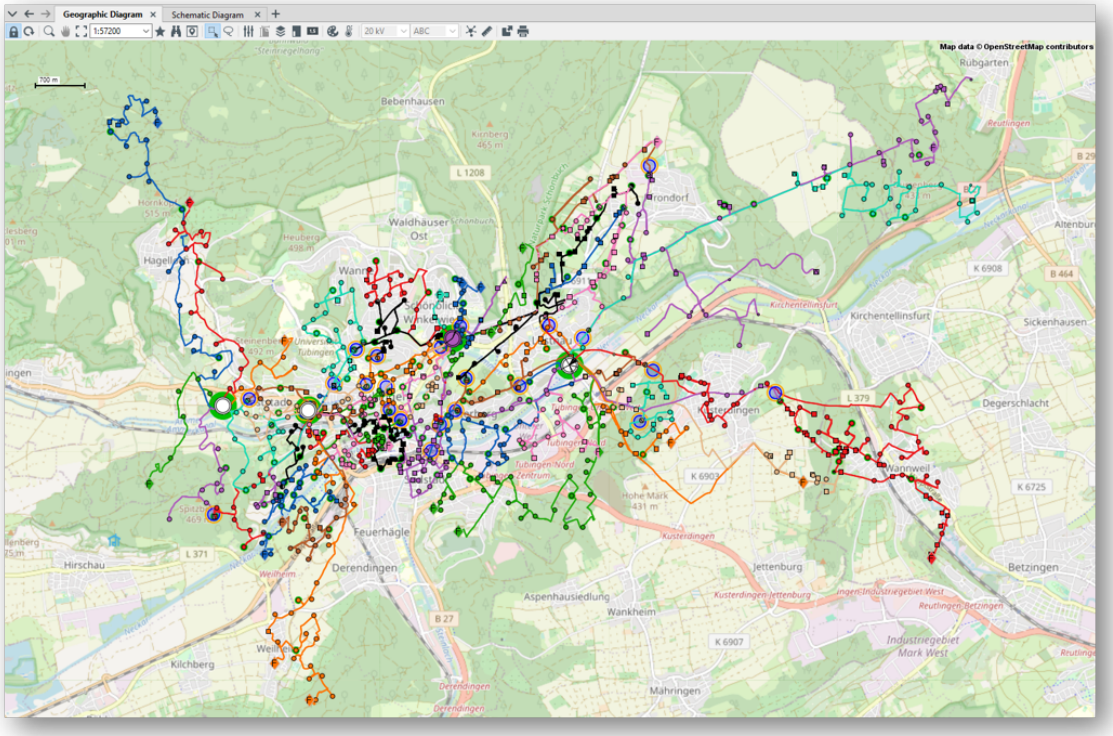
How to get GIS Data into *PowerFactory*

To run power system analysis, a network model is essential. For transmission networks it might be acceptable to build the model manually in a power system analysis tool. Distribution networks in the medium and low voltage level tend to contain much more nodes and lines, consumers and generators such as DER (Distributed Energy Resources). It can be challenging to draw such models manually. Distribution networks change frequently and changes are typically documented in Geographic Information Systems (GIS). Such GIS can be the source for the topology of an electrical network needed in a power system analysis tool such as *PowerFactory* to run power flow, short-circuit analysis and other calculations. This white paper describes DIgSILENT's solution for the integration of GIS data into *PowerFactory*.



Geographic diagram in *PowerFactory*

1 Introduction

An interface between GIS and *PowerFactory* can be developed by the following entities:

- the customer itself
- the GIS service provider or another third-party company
- *DIgSILENT*

The paper focuses on a solution based on a converter framework implemented by *DIgSILENT*. The highlights of this solution are:

- ✓ Different voltage levels can be combined into one network model.
- ✓ Network models can be loaded individually or as group based on partitioning.[1]
- ✓ Custom postprocessing or validation scripts can be conducted after the import.
- ✓ The full range of *PowerFactory* functionality can be used, depending on the availability of the required data in the source models.

The solution is available in two variations:

- *Standard* GIS Integration
- *Advanced* GIS Integration

The differences are related to the way input data is provided, the automation level, the range of functionality and usability. The following table provides an overview of the differences.

	Standard GIS Integration	Advanced GIS Integration
Target Group	- consultants - small utilities	large utilities
Data Source	files	database
Network Partitioning	no	yes
Import GUI	no	yes
Validation	no	yes

2 Architecture and Components

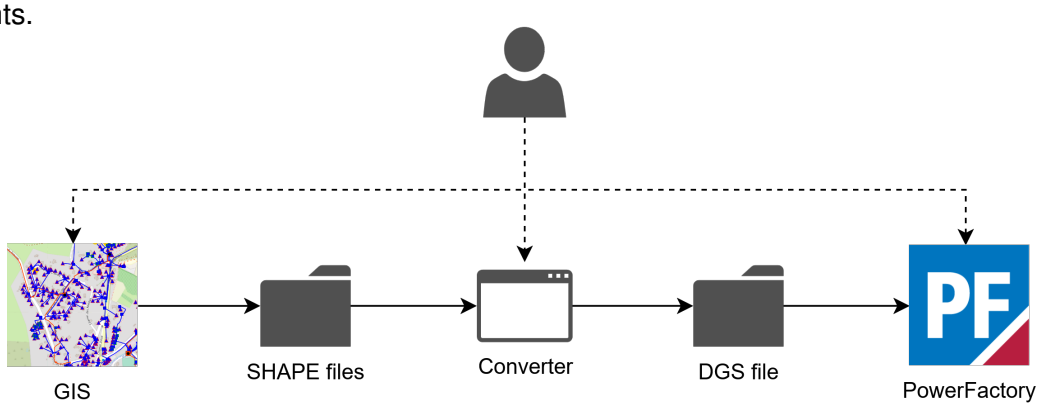
In the solution developed by *DIgSILENT*, GIS is the main source for the topology of the network model. If the GIS cannot provide all data needed for calculations, other systems can be added to enrich the data from GIS and merge it to the network model. The data flow is from GIS to *PowerFactory*. It is not possible to transfer data back to GIS.

In the *Standard Integration*, the converter is started manually and uses the previously exported GIS data based on files. The converter supports various formats such as SHAPE and CSV. The output of

[1] The model retrieved from GIS can be split into parts. One part represents a region supplied by one or more transformer stations. When importing the model into *PowerFactory*, the user can decide how many adjacent parts are loaded for the analysis.

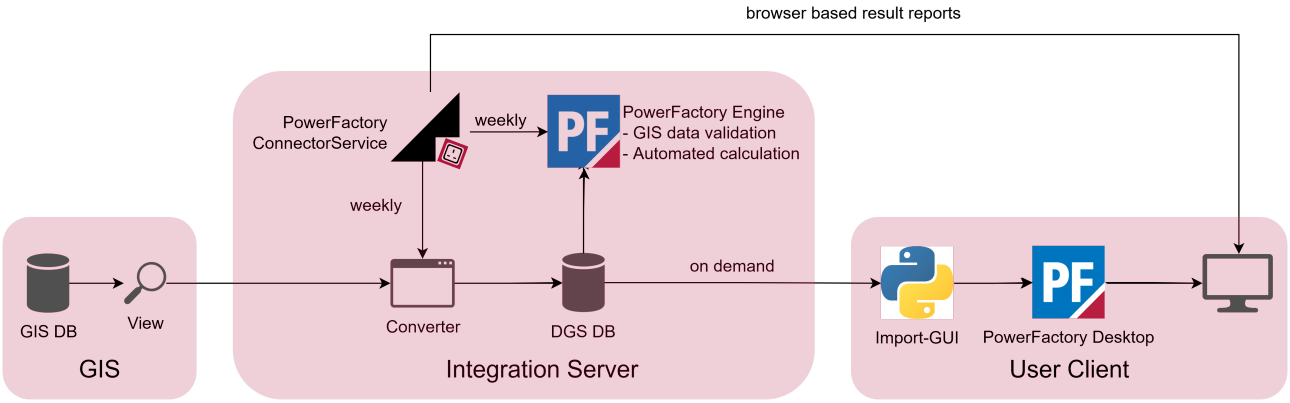
the conversion process is a DGS file which can be imported by using the standard import function of *PowerFactory*.

The following figure illustrates the data flow for the *Standard Integration* and shows all relevant components.



Standard GIS Integration

In the *Advanced Integration*, the converter has direct access to the GIS database and reads the complete data. The converter splits the model into parts. The user can select the parts to be imported via an easy-to-use user interface. Postprocessing scripts are automatically executed and various import modes such as extend, update or overwrite are available.



Advanced GIS Integration

The solution consists of the following main components:

GIS to DGS Converter

The converter reads the GIS data from the GIS database. A database view can be used to prepare the data. If the database cannot be used, GIS data based on a file export can be read by the converter. It is possible to join the GIS data with data from other sources in the conversion process. The converter creates an electrical and topologically connected network model that can be imported by *PowerFactory*. If required, data validation and topology corrections such as handling of isolated customers based on rules can be carried out.

The model retrieved from GIS can be split into parts. Each part represents a network region supplied by one transformer station. The converter performs network tracing to assign the objects to a dedicated part. The starting point is the transformer. The tracing ends at open switches, adjacent

transformer stations and the end of branches. When importing the model into *PowerFactory*, the user can decide what parts are loaded for the analysis.

The frequency of the conversion depends on the frequency of changes in the GIS data. The conversion can be done daily or less frequent such as once a week.

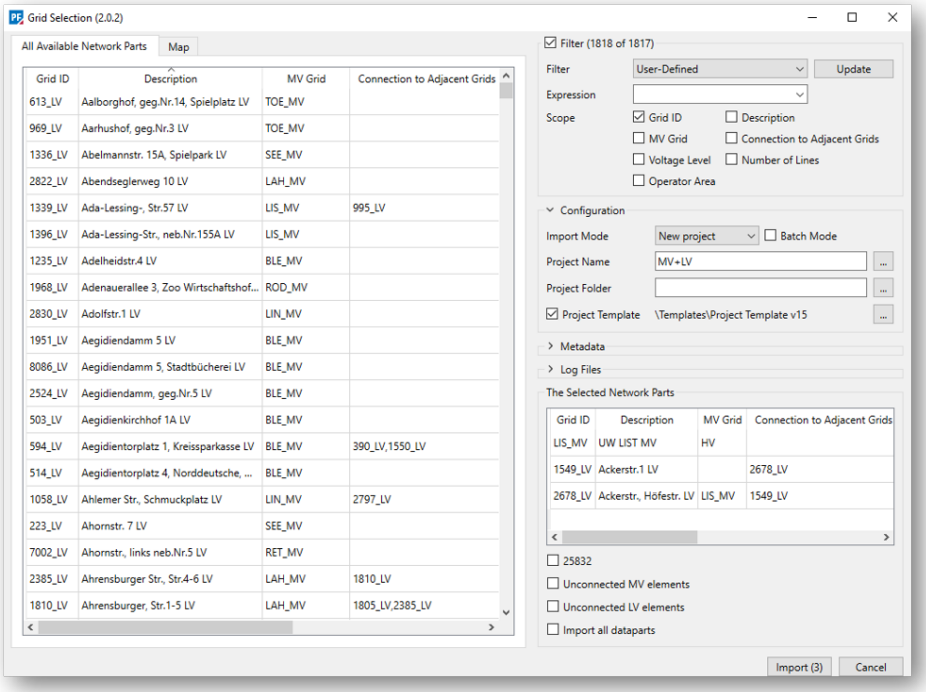
DGS Database

The output of the converter is a *PowerFactory* model based on the DGS format. DGS covers all relevant object classes and properties supported by *PowerFactory* for power system analysis. The DGS model is typically stored in an intermediate database but can be a file as well. DGS supports the partitioning of network models. Horizontal boundaries between parts of the same voltage level and vertical boundaries that cross voltage levels can be both modelled.

Interface for Selection of GIS Data

In *PowerFactory*, a GUI based on Python is provided to import the GIS data. The user can decide what parts are to be imported based on a list or a geographic map. Typically, one stand-alone part or one part and the adjacent parts (vertical or horizontal) are loaded. It is also possible to add parts to an existing *PowerFactory* project or to update a model with new data.

After the import of the model, post-processing scripts can be conducted to further prepare the model for the calculation. Custom calculation requirements such as profiles for different load types can be automatically applied. The model can be imported into a template project, which contains individual configurations such as custom-specific symbols for transformer stations, custom background maps or data extensions for custom properties.



GIS Import-GUI, tabular view

Optional: *PowerFactory* Connector Service

Optionally, the *PowerFactory Connector Service* can be used to visualise the results of the validation in a web browser. The validation runs after a model conversion and checks if the converted data can be used for power system analysis based on rules. The rules can be customised according to the requirements of the utility. In addition, automated calculations can be performed on the models to regularly provide information such as the hosting capacity of connection points.

3 Input Data

To run a power flow in *PowerFactory* on a topologically connected network model, some requirements for the input data must be fulfilled. Data for the following object classes must be available:

- ✓ Nodes such as busbars or junctions with voltage level
- ✓ Stations such as transformer or switching station, substation or cable cabinet
- ✓ Customer connections with load and generation data
- ✓ Transformer, including impedances and voltage
- ✓ Lines, including length and impedances
- ✓ Switches, including switch state

To use a geographic map in *PowerFactory*, geographical coordinates are required for lines, stations, junctions and customer connections. The topology can be created based on coordinates and references. Typically, both information is used to get the best results. For transformer stations with multiple transformers and busbars it is beneficial to have the information about the busbar connection of transformers.

Load and generation data is often not available in the GIS. The converter is able to read data from further sources and join the data, if a reference between the data sources exists. It is also possible to import this data in *PowerFactory* later on from files.

If impedances of lines and transformers are not maintained in the GIS, it is possible to refer to types in a *PowerFactory* library. For this, only the reference of the line or transformer type must be available in GIS. The electrical information is stored in a type library, which can be custom-specific.

4 Network Model

The converter creates a node-breaker model based on a standard modelling approach. As *PowerFactory* offers a lot of flexibility in the modelling of electrical networks, custom modelling requirements can be supported. Some functionality in *PowerFactory* expect a hierarchical structure of the model. The converter ensures that hierarchy is used wherever applicable.

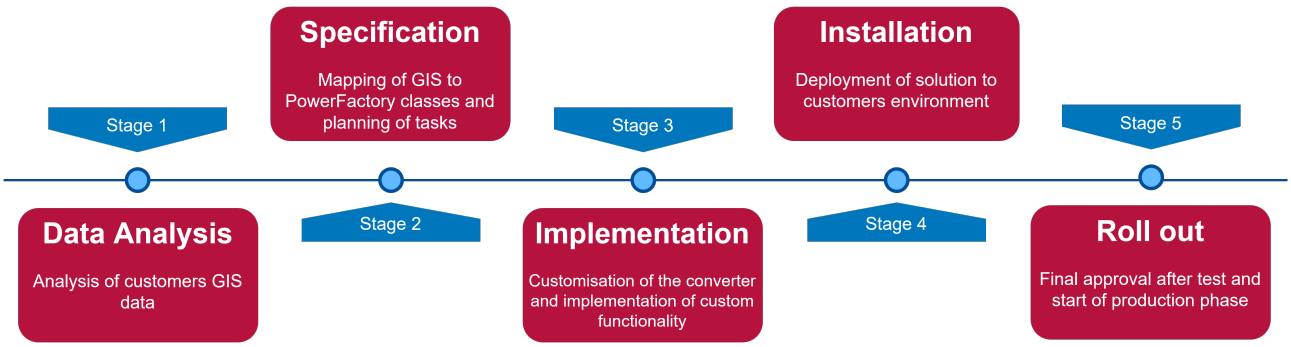
5 Graphical Representation

PowerFactory offers a wide range of functionality for representing a network model graphically. If geographic coordinates are used in the conversion, a geographic diagram is available for the overall network representation. In addition, automatically created station diagrams can be used to see the inner parts of a station such as transformers or switches. Schematic diagrams can be drawn automatically based on predefined feeders. Feeders are created in the conversion process at the beginning of lines in stations.

If the GIS contains single line diagrams (SLD) of the network or station diagrams or the SLDs can be provided by other systems like SCADA, the graphical information can be considered in the conversion and schematic diagrams provided for the analysis of the network in *PowerFactory*.

6 GIS Integration Project

The implementation of the solution is part of an integration project. The process of a typical GIS integration project can be seen in the following figure:



Steps of a GIS integration project

7 Licence Configuration

The solution uses the DGS format to import the network model. The DGS format is an open and machine readable format. The ability to perform a DGS import or export is part of the *PowerFactory Base Package*.

The *GIS to DGS Converter* is a customised tool that is the result of the implementation project and not licensed. If requested, maintenance can be offered for the GIS Integration solution.

Mandatory
✓ Scripting & Automation

Optional
✓ Connector Service