Generation Shift Key (GSK)
The Generation Shift Key (GSK) defines how a change in net position is mapped to the generating units in a bidding area. Therefore, it contains the relation between the change in net position of the market area and the change in output of every generating unit in-side the same market area. Due to convexity pre-requisite of the Flow Based domain, the GSK must be linear.
Every TSO assesses a GSK for its control area taking into account the characteristics of its network. Individual GSKs can be merged if a hub contains several control areas.
A GSK aims to deliver the best forecast of the impact on Critical Branches of a net position change, taking into account the operational feasibility of the reference production program, projected market impact on units and market/system risk assessment.
In general, the GSK includes power plants that are market driven and that are flexible in changing the electrical power output which includes the following types of power plants: gas/oil, hydro, pumped-storage and hard-coal. TSOs will additionally use less flexible units, e.g. nuclear units, if they don't have sufficient flexible generation for matching maximum import or export program or if they want to moderate impact of flexible units.
The GSK values can vary for every hour and are given in dimension-less units. (A value of 0.05 for one unit means that 5% of the change of the net position of the hub will be realized by this unit).

Individual procedures

GSK for the German-Austrian bidding zone:
The German TSOs and APG have to provide one single GSK-file for the whole German/Austrian hub. Since the structure of the generation differs for each involved TSO, an approach has been developed, that allows the single TSO to provide GSK's that respect the specific character of the generation in their own control area and to create out of them a concatenated German/Austrian GSK in the needed degree of full automation.
Every German TSO as well as APG provides a reference file for working days, bank holidays and weekends. Within this reference file, the generators are named (with their node-name in the UCTE-Code) together with their estimated share within the specific grid for the different time-periods. It is also possible to update the individual GSK file each day according the expectations for the target day. So every German TSO as well as APG provides within this reference-file the estimated generation-distribution inside his grid, that adds up to 1.
An example: Reference-file of TSO A for a working day

00:00 – 07:00:
GenA (Hard-Coal) 0,3
GenB (Hard-Coal) 0,3
GenC (Gas) 0,1
GenD (Hydro) 0,2

GenE (Hydro) 0,1

07:00 – 23:00
GenC (Gas) 0,3
GenD (Hydro) 0,5
GenE (Hydro) 0,2

23:00 – 24:00:
GenB (Hard-Coal) 0,2
GenC (Gas) 0,3
GenD (Hydro) 0,4
GenE (Hydro) 0,1

In the process of the German/Austrian merging, the common system creates out of these five individual reference-files, depending on the day (working day / week-end / bank holiday), a specific GSK-file for every target day. Therefore, every German TSO and APG gets its individual share (e.g. TransnetBW: 14%, TTG: 17%, Amprion: 43%, 50HzT: 9 %, APG: 17%). The content of the individual reference-files will be multi-plied with the individual share of each TSO. This is done for all TSOs with the usage of the different sharing keys for the different target times and a Common GSK file for German/Austrian bidding zones created on daily basis.

Example: Taking the reference-file and the share key above, assuming TSO A is TransnetBW, it leads to the following shares in the concatenated German/Austrian GSK-file:

00:00 – 07:00:
GenA (Hard-Coal) 0,3*0,14 = 0,042
GenB (Hard-Coal) 0,3*0,14 = 0,042
GenC (Gas) 0,1*0,14 = 0,014
GenD (Hydro) 0,2*0,14 = 0,028
GenE (Hydro) 0,1*0,14 = 0,014

07:00 – 23:00:
GenC (Gas) 0,3*0,14 = 0,042
GenD (Hydro) 0,5*0,14 = 0,07
GenE (Hydro) 0,2*0,14 = 0,028

23:00 – 24:00:
GenB (Hard-Coal) 0,2*0,14 = 0,028
GenC (Gas) 0,3*0,14 = 0,042
GenD (Hydro) 0,4*0,14 = 0,056
GenE (Hydro) 0,1*0,14 = 0,014

With this method, the knowledge and experience of each German TSO and APG can be brought into the process to obtain a representative GSK. With this structure, the nodes named in the GSK are distributed over whole German-Austrian bidding zone in a realistic way, and the individual factor is relatively small.

The Generation share key (GShK) for the individual control areas (i) is calculated according the reported available market driven power plant potential of each TSO divided by the sum of market driven power plant potential in the bidding zone.

$$\text{GShK TSO}_i = \frac{Available\ power\ in\ control\ area\ of\ TSO_i}{\sum_{k=1}^{5}(Available\ power\ in\ control\ area\ of\ TSO_{k)}}$$

Where k is the index for the 5 individual TSOs
With this approach the share factors will sum up to 1 which is the input for the central merging of individual GSKs.

Individual distribution per German TSO

TransnetBW:
Based on an internal analysis performed for the year 2012, a seasonal dependence of power plant availability can be highlighted. In order to model it, the GSK is updated every season as described hereinafter.
The potential of power plants is determined depending of the period of the year for working days, weekend and furthermore differentiated between peak and off-peak hours.
The coefficient is determined as:

$$Coefficient\ Powerplant\ i = \frac{Available\ potential\ of\ power\ plant\ i}{\Sigma(\text{Available potential of the power plants in the TNG control area})}$$

The available potential of power plant i is calculated by (Pmax-Pmin)

In winter and spring: there is no differentiation between peak/off-peak/working days and weekend, since the hard coal power plants are either feeding in the grid or not in operation. The GSK is there-fore composed only of hydraulic units.

In the summer season, there is a differentiation between working days and weekend:
For the working days in off-peak hours, one hard coal power plant is generally available and therefore taken in consideration in the GSK. For the rest of the time, the GSK is only composed of the hydraulic units.

In autumn, for the peak hours (weekend and working days), only the hydraulic units are available. For the off-peak hours, the hard coal power plants, which have power-potential, are as well added in the GSK.
Nuclear units are excluded upfront)

Amprion:
Amprion established a monthly standard-process in order to keep the GSK as close as possible to the reality. In this process Amprion checks for example whether there are new power plants in the grid or whether there is a block out of service. According to these monthly changes in the grid Amprion updates its GSK.

If needed Amprion adapts the GSK in meantime during the month.
In general Amprion only considers middle and peak load power plants as GSK relevant. With other words basic load power plants like nuclear and lignite power plants are excluded to be a GSK relevant node. From this it follows that Amprion only takes the following types of power plants: hard coal, gas and hydro power plants. In the view of Amprion only these types of power plants are taking part of changes in the production.

All blocks which are considered as GSK relevant have the same GSK factor.

TenneT Germany:
Similar to Amprion, TTG considers middle and peak load power plants as potential candidates for GSK. This includes the following type of production units: coal, gas, oil and hydro. Nuclear power plants are excluded upfront.

In order to determine the TTG GSK, a statistical analysis on the behaviour of the non-nuclear power plants in the TTG control area has been made with the target to characterize the units. Only those power plants, which are characterized as market-driven, are put in the GSK. This list is updated regularly. The individual GSK factors are calculated by the available potential of power plant i (Pmax-Pmin) divided by the total potential of all power plants in the GSK list of TTG.

APG:
APG's method to select GSK nodes is the same as for the other German TSOs. So only market driven power plants are considered in the GSK file which was done with statistical analysis of the market behaviour of the power plants. In the case of APG pump storage and thermal units are considered. Power plants which produce band energy (river power plants) are not considered. Only river plants with daily water storage are also considered in the GSK file. The list of relevant power plants is updated regularly in order to consider maintenance or outages. Furthermore will the GSK file be also updated seasonally because in the summer period the thermal units will be out of operation.