



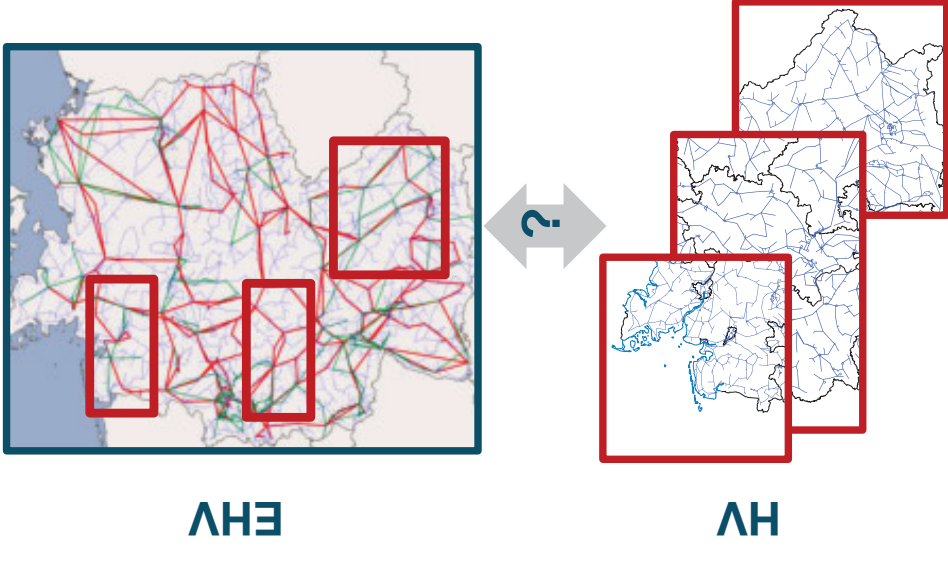
STUDY HV-EQUIVALENT MODELS

Investigation on the Suitability of Equivalent Models of
the High Voltage Level for Security Analyses of the TSOs

Final Report

Background

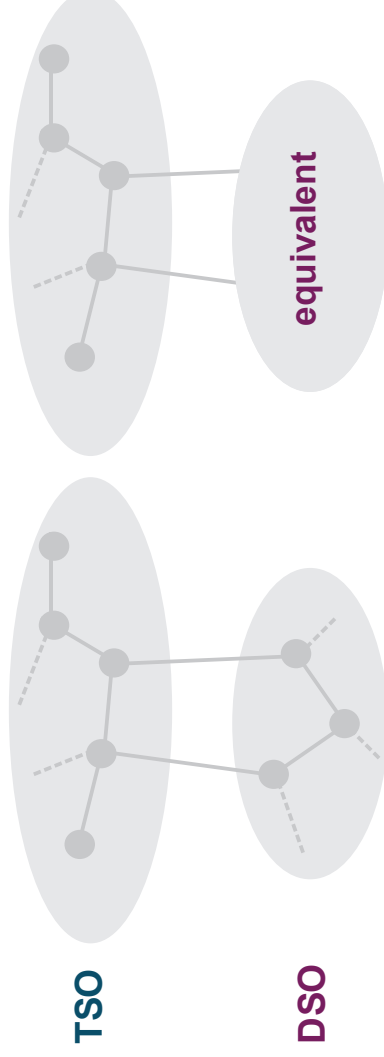
- **Task of the TSOs**
Coordinated calculation of cross-border coupling capacities by means of a common grid model in Europe (through individual models)
- **Based on this**
Determination of grid security margins through grid security analyses
- **Problem**
Different data available on HV-levels for other TSOs in the EU
- **Practice in Germany**
aggregated HV models at coupling points



Question

- Is a network reduction of the HV-level sufficient for carrying out security analyses at TSO level?

Management Summary – What is needed?



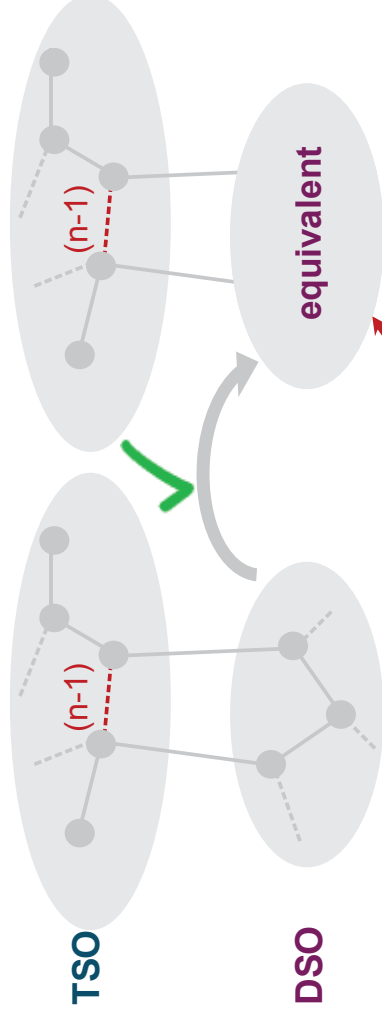
Statement

- For the normal steady system state one equivalent of the HV grid is needed.
- For contingencies in the TSO network no additional equivalent of the HV grid is needed.
- For a selection of contingencies in the DSO network separate equivalents of the HV grid are needed.
- Since the most DSO-contingencies are in the vicinity of the substations a reduction of needed equivalents is possible.

Management Summary - Key Statements (1)

1. Statement

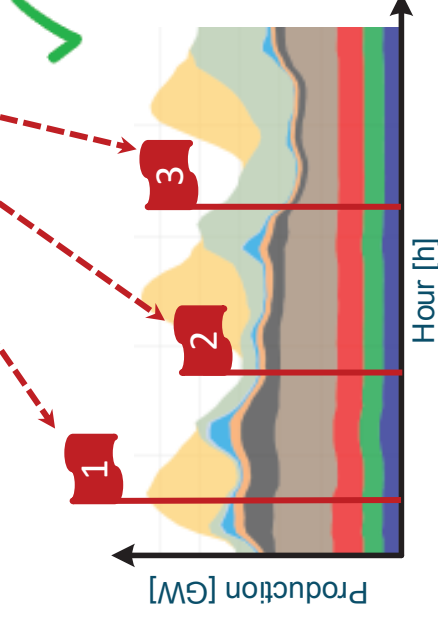
The normal and (n-1) steady system state of the TSO can be accurately and efficiently achieved by an equivalent of the HV grid. This is also valid for different HV grid structures.



2. Statement

A once created equivalent can be adapted for all grid usage cases in the transmission network and is afterwards usable for statement 1.

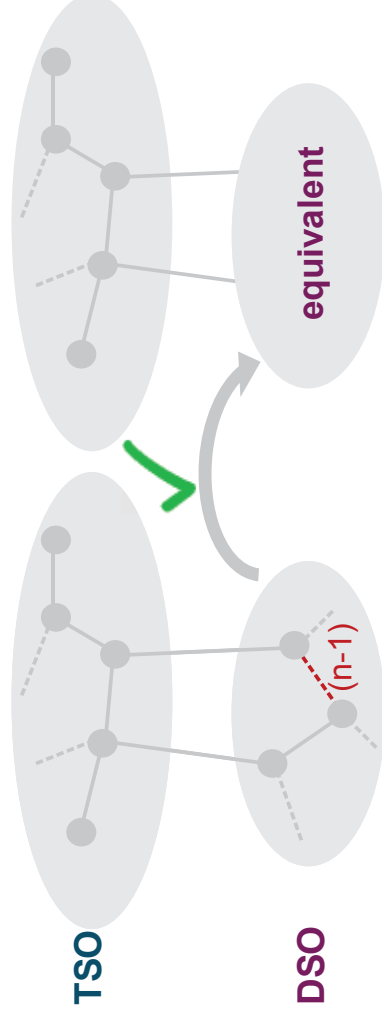
- PV nodes can be a critical source for model errors



Management Summary - Key Statements (2)

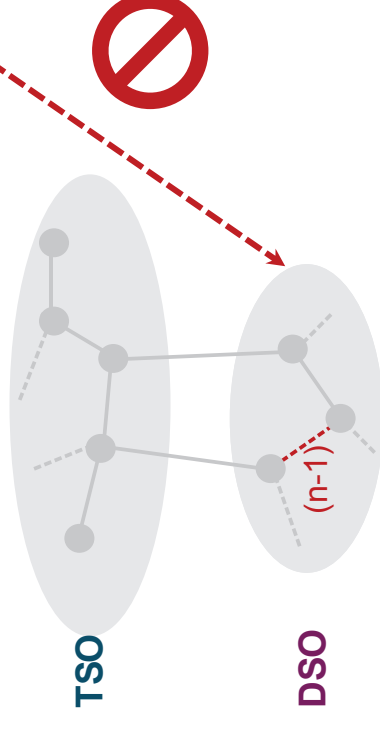
3. Statement

If the equivalent is applied to the (n-1) case in the distribution network, it is accurate and can be used for the first and second statement.



4. Statement

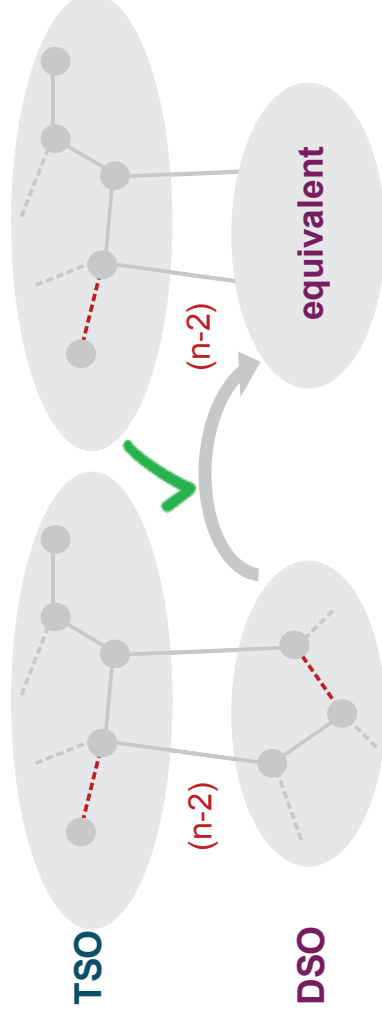
An equivalent can only be used to a limited extent for other (n-1) outages in the distribution grid.



Management Summary - Key Statements (3)

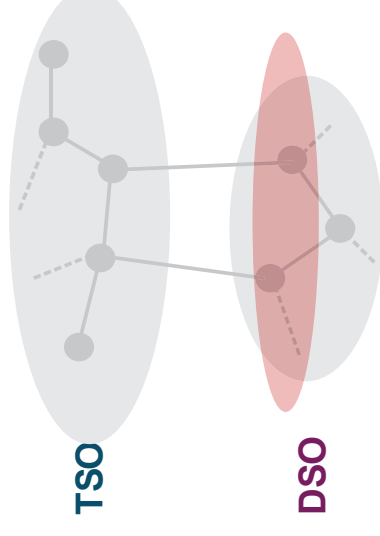
5. Statement

For (n-2) analyses of the TSO, an equivalent is suitable for representing the (n-1) case in the distribution system.



6. Statement

Contingencies in the distribution grid in the vicinity of the substations have a potential high influence on the transmission system.

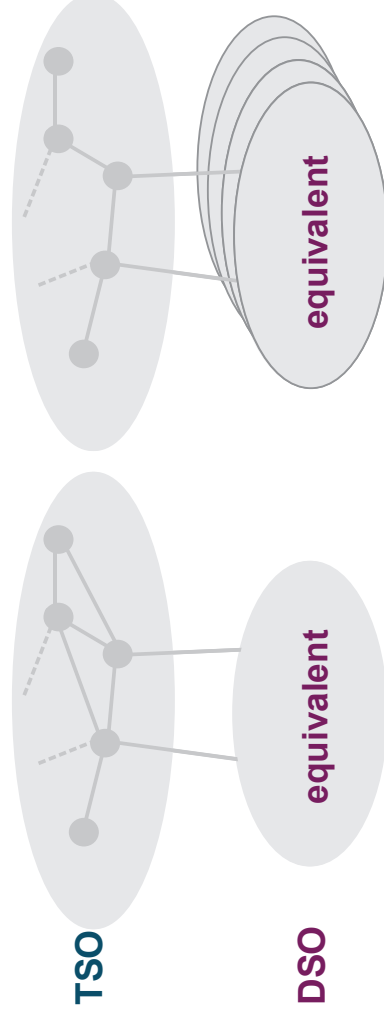


Management Summary - Key Statements (4)

7. Statement

The number of required equivalents scales with the size of the distribution network and decreases with the meshing density of the overlying transmission network.

- Number of needed equivalents is in a one-digit or lower two-digit range if only loading of EHV lines are considered.
- Maximal amount of equivalents is in distribution grids with transmission character.



Management Summary - Key Statements (5)

8. Statement

A higher loading of the transmission grid caused by a (n-1) case in the distribution grid does not necessarily lead to a critical system condition.

