Flexibility choices for distribution networks
New roles and tasks for the DSOs to facilitate markets

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Evolution is about to embrace change & be the one most responsive to change.

“It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.”

-Charles Darwin, 1809
Game changers ahead: The energy transition implies changes for network operators and the power sector

ENERGIEWENDE
... = KICK start towards decentralization, decarbonisation, smart systems & digitalisation

DSOs are on their way to embrace the changes ahead. But their roles and responsibilities within the regulated domain need as well to be adjusted at EU and Member State level.
Our mission: DSOs act as neutral and efficient infrastructure service suppliers for the market
In Germany > 95% of RES power generation capacity is connected to distribution networks. That’s >114 GW!

**Distribution network**

- **LV-networks** = 230-400V
  - approx. 1,100,000 km
- **MV-networks** = 10/20/30kV
  - approx. 510,000 km
- **HV-networks** = HV = 110kV
  - approx. 95,000 km

**Transmission network**

- **EHV-networks** = 220/380kV
  - approx. 35,000 km

**Smart, if strong enough!**

**RES generation capacity connected (in total 120 GW):**

- 25%
- 45%
- 25%
- 5%
Energy market in Germany in evolution
Increased decentralisation of power generation

End of year 2015

Installed power generation capacity (GW)

- Onshore-wind
- Photovoltaics
- Biomass

Circle area is proportional to the installed capacity

Source: Data of 50Hertz, TenneT, Amprion, TransnetBW, VKU e.V. Germany
Further evolution of distributed & flexible loads in Germany - utilization towards 2030 is the next smart challenge to facilitate.

Source: Own graph based on E-Bridge Study 2017 “Ausgestaltung eines zukunftsgerichteten Rollenzuschnitts des Verteilnetzbetreibers in der Energiewende”
The value of flexibilities varies across time AND location on the different voltage levels of the German power system.

There will be sufficient flexibilities in the grid: By 2050, more than 60 million\(^1\) facilities will be connected to the grid of German DSOs, which can/have to be actively controlled.

### Consequences

**DSO Redispatch process is needed**
- DSO shall perform own redispatch fully automated. Selection based on minimum costs.

**DSO Red Flag Process is needed**
- DSO must be able to limit the use of flexibilities connected to its own network to ensure safe and secure operation or this would otherwise be endangered.

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\(^1\)More than an additional 40 million electric cars, more than 15 million additional electric heating solutions, more than 5 million additional generation facilities and storage facilities in the distribution system.
Congestion Management will become a common task for DSOs throughout Europe

- Network infrastructure is planned and built for a low „load factor“ of demand (< 10 % in LV networks).
- The future development of demand requires network expansions also in urban areas.
- Network simulations show that 85 % of the congestions occur during less than 5 % of the time.
- The DSO must establish an effective congestion management based on increased smartness and were appropriate utilize capacity/flexibility to run an overall efficient power system.

Load flow forecast distribution system (e.g. day-ahead)

DSO carries out congestion management and uses network flexibilities

Grid Capacity

Cost (annuity) for complete grid expansion (“copper plate”)

Cost (annuity) for network expansion and use of network-related flexibility

100 %

ø 77 %

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Urban Grid (2035)
- 15,000 inhabitants
- 10 MW PV power
- 1,500 electric cars
- 850 heat pumps
- 300 small storages

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Fine, but .... asking those who should have the choice and who have the future means .... the connected grid users

Annual capacity payment expected in Euro for providing PV, EV or storage and % of people would be willing to provide flexibility in terms of capacity based on their own assets

What are you talking about?

- I am not interested: 33%
- 0-50€: 33%
- 51-100€: 19%
- 101-200€: 15%
- 201-500€: 10%
- 501-1000€: 6%
- >1000€: 5%
- Annual capacity payment expected
DSOs must be fully responsible for switching and operations in their own grids

*How could a system look like, where multiple operators may try to conduct the system at the same node?*
The flexibilities in the DSO network are utilized by different parties – an intelligent coordination mechanism is required

- Large-scale generators are replaced by small-scale distributed generation.
- Decentralized generation in the DSO networks – together with distributed load and storage facilities – are the source as flexibilities to the entire system.
- These facilities are needed for different purposes by different parties.
- Access to these flexibilities has to be coordinated to ensure a safe and secure operation of the networks and the system.
- Such a coordination mechanism is lacking → DSO is only required to react. No transparency about access to the flexibilities or the services sold.

A technically reliable and economically efficient access to the flexibilities must be guaranteed by any new coordination mechanism to come.
Highly efficient coordination mechanisms between network operators are necessary and will be a core requirement

- **Clear access rules for system responsibility** in the future decentralized energy industry with millions of prosumers and mobile consumers!
- **Everyone is responsible for a secure and efficient energy supply in his network.**
- **Coordination of access to network-oriented flexibility** is the **central task** of the distribution network operators.
- **Clear definition of tasks and responsibilities** at the interface between distribution and transmission networks.
- **Cascading principle** for operation and data provision to ensure system services

**Outlook:** System stability has to be organized with DSOs!
DSONs will increasingly take advantage of flexibility for efficient network operation

<table>
<thead>
<tr>
<th>Grid and system state</th>
<th>DSO activities</th>
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<tbody>
<tr>
<td><strong>System stability endangered</strong></td>
<td>• Non marked-based congestion management, e.g. by peak load capping</td>
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<tr>
<td>• Acute congestion or overload</td>
<td>• Marked-based congestion management, e.g. by buying flexibility</td>
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<tr>
<td>• Market flexibility exhausted</td>
<td>• Optimized grid control</td>
</tr>
<tr>
<td><strong>Congestion foreseen</strong></td>
<td>• DSO acts as a market facilitator through grid enforcements</td>
</tr>
<tr>
<td>• Some system states</td>
<td></td>
</tr>
<tr>
<td>• Market flexibility available</td>
<td></td>
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<tr>
<td><strong>Normal operations</strong></td>
<td></td>
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<tr>
<td>• Generation and consumption balanced</td>
<td></td>
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<tr>
<td>by market participants</td>
<td></td>
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<tr>
<td>• Sufficient reserves and market</td>
<td></td>
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<tr>
<td>flexibility available</td>
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An active grid optimization is the responsibility of the DSO – including the choice of the right tools and flexibility measures.
The roles of DSOs increase in size and complexity – platforms will emerge and will be interconnected to ensure market facilitation.

Key roles of DSOs: Network & System Operation

1. Plan, build and optimize the grid infrastructure according to market needs
2. Connect new customers to the grid and manage grid fees in a non-discriminatory way
3. Operate the grid in a safe, secure and efficient way
4. Provide system services from the distribution grid for the energy system

Optional activities of DSOs related to market facilitation

- Metering and SM-gateway administration
- Plan, build and operate e-mobility infrastructure
- Plan, build and operate digital communication infrastructure
- Integrate storages
- ...
DSO’s responsibility: providing system services beyond the DSO grid borders needs to be ensured

In a decentralized electricity system, the system stability can only be ensured together with DSOs

Operating the own distribution grid

- Congestion management in the distribution grid
- Voltage quality management in the distribution grid
- Physical balancing of generation and load in the distribution grid*
- Restoring of supply in the distribution grid

Providing system services beyond the own grid borders

- Congestion management in the transmission grid out of the distribution grid
- Voltage quality management in the transmission grid out of the distribution grid
- Balancing power for the transmission grid out of the distribution grid
- Restoring of supply in the transmission grid out of the distribution grid

* For separated, cellular subsystems

Highly efficient communication and data exchange between DSOs and TSOs is required
Conclusion: DSOs are shaping up for success in the energy transition based on large scale demonstrators.

**DSO 1.0**
- Centralised generation
- HV
- MV
- LV
- Consumer

**DSO 1.5**
- Centralised generation
- HV
- MV
- LV
- Prosumer

**DSO 2.0**
- Centralised generation
- HV
- Active MV
- Active LV
- Prosumer

*Past*
- From the generator to the consumer

*Today*
- Streamlining the classical network business
- Integrating decentralized generation

*Tomorrow*
- System manager with new roles of the DSO

**Integration**
- Energy control

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Data becomes key for system operators to optimize the network as infrastructure asset

DSOs must be responsible for their data management and their communication within their own network
Evolved TSO-DSO data management is required DSO and TSO have agreed on common principles

Report by DSO and TSO associations on data management presented to EC

Clear need for improved TSO-DSO data management identified in five use-cases:
- Congestion management
- Balancing
- Use of flexibility
- Real-time control and supervision
- Network planning

Shared key principles of TSO-DSO data management:
- Guarantee data privacy, data / communication security
- Guarantee a fair, equal access to the data / information
- Deliver a non-discriminatory processing of the data
- Be of proven cost efficiency, as accepted by the National Regulatory Authorities (NRAs).
- Facilitate innovation by opening, as much as possible and legally allowed, the access to the data
SINTEG-project enera will demonstrate the utilization of flexibility in a model region in northwest Germany

Core areas of the project

- SMART MARKETS
- ENERGIEWENDE - APPSTORE
- SMART GRIDS
- BIG DATA + ANALYTICS

Objective

Demonstration of the functional capability of the german energy transition in a model region

The model region:
- Districts of Aurich, Friesland & Wittmund
- City of Emden
- 2,665 km²
- 390,000 Inhabitants
- 200,000 households
- 1,75 GW of installed RES generation capacity
- 1,5 GW wind power capacity
- 170% share of RES
Thank you for your attention!

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