Energetika XXI

Infrastructure to Integrate Renewable Energies

Digitization with Transmission System Operator

15.11.2018
Michael Kranhold
Digitization Agenda for Grid Operator to integrate Renewable Energies

1. Innovation in Grid Business is mostly Digitization driven

2. The goal is higher System Security for less money

3. Digitization helps in the broad range from transmission till settlement tasks
50Hertz as part of the European Electricity System

1. 50Hertz
2. TenneT TSO
3. Amprion
4. TransnetBW
Transmission grids are the technical backbone of the energy supply in Germany and in Europe

<table>
<thead>
<tr>
<th>Owner of the transmission grid</th>
<th>Owner of the transmission grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>In charge of operation, maintenance and the development of <strong>extra-high-voltage lines</strong> and <strong>power junctions</strong> (substations) as well as for the connection of <strong>large-scale generators</strong> and <strong>consumers</strong> (including offshore)</td>
<td></td>
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<table>
<thead>
<tr>
<th>System operator</th>
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<tbody>
<tr>
<td>Responsible for <strong>system stability</strong> of the transmission system around the clock: frequency control and voltage regulation, congestion management.</td>
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<table>
<thead>
<tr>
<th>Market developer</th>
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<tr>
<td>Catalyst for the <strong>development of the energy market</strong>, especially in Northern and Central-Eastern Europe.</td>
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<table>
<thead>
<tr>
<th>„Trustee“ for managing EEG developing</th>
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<tbody>
<tr>
<td>Responsible for managing cash flows <strong>resulting from the Renewable Energy Law (EEG)</strong>.</td>
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</table>

**Source:** 50Hertz
The power system in the 50Hertz grid area

**TSO (400 kV, 220 kV)**
- 5 TSOs
  - TenneT
  - CEPS
  - PSE
  - Energinet.dk
  - Svenska kraftnät

**DSO – 1st level (≤ 110 kV)**
- Approx. 1.200 Windfarms
  - PV, biomass and other RES
- 10 Distribution System Operators
  - AVACON
  - E.DIS
  - ENSO Netz
  - SW Magdeburg
  - MITNETZ Strom
  - Stromnetz Berlin
  - Stromnetz Hamburg
  - TEN
  - WEMAG Netz
  - SW Staßfurt

**DSO – 2nd to m. level (< 110 kV)**
- 200 Windfarms
  - PV, biomass and other RES
- 159 Distribution System Operators
  - Stromnetz Berlin
  - Stromnetz Hamburg
  - TEN
  - WEMAG Netz
  - SW Staßfurt

**DSO – low level (< 110 kV)**
- PV-, biomass and other RES

**9 Windfarms**
- 7 onshore
- 2 offshore

**3 Steel Plants**

**12 conv. power plants / storages**
- Schwarze Pumpe
- Boxberg
- Jänschwalde
- Lippendorf
- Reuter West
- Goldisthal
- Markersbach
- Hohenwarte II
- Brunsbüttel (GKW)
- Moorburg
- Rostock
- Schkopau

**Other DSOs**

Source: 50Hertz; as of 31/12/2017
## 50Hertz at a glance

<table>
<thead>
<tr>
<th></th>
<th>2010 (share Germany)</th>
<th>2017 (share Germany)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grid area</strong></td>
<td>109,589 km² (~31%)</td>
<td>109,619 km² (~31%)</td>
</tr>
<tr>
<td><strong>Length of lines</strong></td>
<td>9,800 km (~30 %)</td>
<td>10,200 km (~30 %)</td>
</tr>
<tr>
<td><strong>Max. load</strong></td>
<td>~ 17 GW (~20 %)</td>
<td>~ 16 GW (~20 %)</td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>~ 98 TWh (~20 %)</td>
<td>~ 96 TWh (~20 %)</td>
</tr>
<tr>
<td><strong>Installed capacities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- of which Renewables</td>
<td>38,354 MW (~35%)*</td>
<td>54,069 MW (~26%)*</td>
</tr>
<tr>
<td>- of which Wind</td>
<td>15,491 MW (~30%)*</td>
<td>31,177 MW (~30%)*</td>
</tr>
<tr>
<td></td>
<td>11,318 MW (~40%)*</td>
<td>18,556 MW (~34%)*</td>
</tr>
<tr>
<td><strong>RES share in power consumption</strong></td>
<td>~ 25 %</td>
<td>53.4 %</td>
</tr>
<tr>
<td><strong>Turnover</strong></td>
<td>5.6 bn. €</td>
<td>9.9 bn. €</td>
</tr>
<tr>
<td>- of which Grid</td>
<td>0.6 bn. €</td>
<td>1.3 bn. €</td>
</tr>
<tr>
<td><strong>Employees</strong></td>
<td>643</td>
<td>1,043</td>
</tr>
</tbody>
</table>

Source: 50Hertz; *preliminary data; as of 06/03/2018

* (based on electricity supplied to end-consumers in acc. with Renewables Energy Law „EEG“)
RES generation in the 50Hertz grid area: Installed capacities and feed-in

Development of the installed capacities of RES generation plants in the 50Hertz grid area

- Development of the installed capacities of RES generation plants in the 50Hertz grid area
- Installed capacities and feed-in
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017

Development of the RES production in the 50Hertz grid area

- Development of the RES production in the 50Hertz grid area
- RES production
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017

Source: 50Hertz; *preliminary data; as of 06/03/2018

Steady growth of RES generation capacity in the 50Hertz grid area: 53% RES share in final consumption.
Feed-in of renewable energies within the 50Hertz grid area

50Hertz grid area: development of RES feed-in (TWh)

50Hertz grid area: composition of RES feed-in (2017, in %)

Source: 50Hertz; *preliminary data, as of 03/01/2018
The implementation of the German Renewables Energy Law (EEG) led to a massive growth of RES in Germany.
New RES targets: additional effort required to integrate higher shares of RES

New target for the expansion of renewable energies: 65% share of energy consumption instead of 55% until 2030

Equals an additional 65 TWh from renewable energies (compared to the prior target of 55% until 2030)

- Wind onshore: 55% target until 2030
- Wind onshore: 65% target until 2030
- Wind offshore: 55% target until 2030
- Wind offshore: 65% target until 2030
- PV: 55% target until 2030
- PV: 65% target until 2030

+ 16 – 24 GW
+ 2,5 – 5 GW
+ 7 – 11 GW
Transmission Tasks
Motivation for Innovation/Digitization in Grid Business

- Increase in power transmission demand beyond 2030 expected

- Higher network utilization due to innovative system management concepts with the highest system and network security

- Reduction of network intervention costs

Innovation = Digitization

System Security & Cost Efficiency
Costs for grid stabilization measures in Germany

The data is subject to continuous updates.
# Consortium of InnoSys 2030

<table>
<thead>
<tr>
<th>TSO</th>
<th>50hertz</th>
<th>Tennet</th>
<th>Transnet BW</th>
<th>Amprion</th>
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</thead>
<tbody>
<tr>
<td>Konsortialführung</td>
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<thead>
<tr>
<th>DSO</th>
<th>Avacon</th>
<th>MITNETZ Strom</th>
<th>WESTNETZ</th>
<th>Netze BW</th>
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<thead>
<tr>
<th>Science</th>
<th>Technische Universität Dortmund</th>
<th>FAU</th>
<th>Fraunhofer IEE</th>
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<tbody>
<tr>
<td></td>
<td>Technische Universität Ilmenau</td>
<td>FHT</td>
<td>Fraunhofer FKIE</td>
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<thead>
<tr>
<th>Manufacturer</th>
<th>PSI</th>
<th>Siemens</th>
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11/21/2018 Customer management and digitization of 50Hertz Transmission GmbH
Темы проекта "InnoSys 2030"

- Применение SPS (автоматика системы)
- Адаптация настроек защиты (функция PSB, отказоустойчивость и т. д.)
- WAP и WAMS
- Избыточные концептуальные решения
- Решения касательно нового оборудования
- Методы оценки дальнейшего развития (например оценка стабильности)
- Повышение безопасности ИКТ
- Улучшение безопасности системы
- Доработка EMS/SCADA
- Further development EMS/SCADA
- Расширенные методы динамических / стационарных расчетов
- Adaption of the protection system
- FACTS / HVDC / PST for power flow control
- Increasing the flexibility of generation / consumption
- Улучшение гибкости производства / непрерывности потребления
- Оптимизированный поток энергии при нормальной эксплуатации и после отключения оборудования
- Оптимальное размещение FACTS и т. д.
- Стратегии реактивного контроля
- Электромобильность, крупные хранилища и т. п.
- Виртуальные линии / Электростанции
- Инновативные инструменты по выполнению автоматической адаптации потока энергии, облегчение негативных последствий и т. д.
Topics of the Project "InnoSys 2030"

- Implementation of SPS (system automatics)
- Adjustment of protection settings (PSB function, fault tolerance, etc.)
- WAP and WAMS
- Redundant concept solutions
- Consideration of new equipment
- Further development of evaluation methods (e.g. stability assessment)
- Increased ICT security
- Extended dynamic / stationary calculation methods
- FACTS / HVDC / PST for power flow control
- Increasing the flexibility of generation / consumption
- Adaptation of the protection system
- Optimized power flow in normal operation and after equipment outages
- Optimal placement of FACTS etc.
- Reactive control strategies
- Power adjustments in the range of seconds
- Electro mobility, large storage etc.
- Virtual Lines / Power Plants
- Innovative tools to perform automated power flow adjustments, curative relief, etc.
Overview of possible measures in 50Hertz

- Grid expansion
- Grid-Booster
- HVDC
- Back-To-Back-Station
- PST
- High-temperature conductors
- Improved redispatch processes
- Overhead power line monitoring
- Reactive feed-in management
- Power factor correction
- Depending on the scope of approval

- 0-2 years
- 2-4 years
- 4-10 years

Customer management and digitization of 50Hertz Transmission GmbH
### Current projects with 50Hertz (Extraction)

<table>
<thead>
<tr>
<th>Project</th>
<th>Topic</th>
<th>Target date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PST in HH/East</td>
<td>More North / South capacity through uniform load of lines</td>
<td>2022/2023</td>
</tr>
<tr>
<td>Usage extension of overhead line monitoring</td>
<td>Development of a roadmap to extend the usage of overhead line monitoring (for chosen lines)</td>
<td>Q3 / 2018</td>
</tr>
<tr>
<td>Reactive feed-in management</td>
<td>Krajnik Grid – Vierraden (n-0)-safe operation of the interconnection line through intertripping of the Bertikow Wind Farm upon a power circuit failure</td>
<td>2018</td>
</tr>
<tr>
<td></td>
<td>Substation Stendal/ West (n-0)-safe Substation-operation through intertripping of the Wind Farm upon a transformer failure</td>
<td></td>
</tr>
<tr>
<td>Research project InnoSys 2030</td>
<td>Grid-Booster, reactive operation</td>
<td>2021</td>
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</tbody>
</table>
Digitization of Energiewende
Grid Settlement and Use Cases
New: Obligation of measuring point operator and TSO to transfer iMSys-Data regarding framework “conditions for the measuring point operation”
Growth of data volumes

Forecasted growth of data volumes in MB per quarter for the 50Hertz control area

50Hertz seizes opportunities from new processes and IT systems
To safeguard the start date, the MSB will initially distribute the smart meter data as a star shaped communication.
TSO use cases:
Reduce costs, strengthen system security

Permitted use of data

1. Providing control and accounting of balancing power in decentralized plants
2. Forecasting of own generation of offtake points to improve marketing according to § 59 EEG
3. Information about the current feed-in from photovoltaic systems
4. Improvement of short-term forecasts and projections of actual feed-in used by direct marketers and network operators
5. Control and remuneration of capacity obligations and estimation of maximum residual load
6. Aggregation of the load and supply profiles of individual metering points to balancing group cumulative profiles per balancing group and balancing area for balancing group accounting
7. Balance coordination
8. Reimbursement of financial support and collection of avoided grid charges according to § 57 EEG
9. Collection of the EEG-levy from electricity supply companies according to § 60 EEG
10. Collection of the EEG-levy from end users and self-suppliers according to § 61 EEG
11. Fulfilment of further obligations resulting from the provisions of the Federal Network Agency pursuant to § 75 MsbG

Input

A: Daily for the previous day load or meter values in 15-minute resolution (§60,(3) MsbG)
B: Annual energy values (§60,(3.3) MsbG)
C: Base data (§63 MsbG)
D: Grid condition data (at the request of the grid operator) (§64 MsbG)

1) according to §67 (1) MsbG; 2) at measuring points equipped with intelligent measuring systems; 3) Voltage and current values and phase angles as well as values which can be calculated or deduced therefrom and which can be used to determine the network condition (§2 (16) MsbG)

Output

1. Daily for the previous day for the purpose of forecasting and balancing the aggregated profiles from the measured values according to the network level for the respective accounting area
2. Daily for the previous day for the measured values according to the accounting grid management aggregated profiles for the respective balancing group
3. Data for the fulfilment of further obligations resulting from the provisions of the Federal Network Agency pursuant to § 75 MsbG

Use cases

System management, operational planning, network planning, energy-related obligations and processes
Summary

1. Innovation in Grid Business is mostly Digitization driven
   *Use of Mass data; innovative algorithms; new Materials and technologies*

2. The goal is higher System Security for less money
   *Integration of Renewable Energies into Electricity Market*
   *Keep the high quality of Supply with affordable cost*

3. Digitization helps in the broad range from transmission till settlement tasks
   *Transmit with same lines more power*
   *Use mass data for better forecast and pricing*

Right People & Mindset needed
Выводы

1. Инновации в электросетях главным образом основаны на дигитализации
   Использование массивов данных; инновационные алгоритмы; новые материалы и технологии

2. Цель – повышение безопасности системы за меньшие деньги
   Интеграция возобновляемых источников энергии в рынок электроэнергии
   Сохранение высокого качества поставок энергии по доступной цене

3. Дигитализация приносит пользу в широком диапазоне от передачи энергии до расчетов за нее
   Передача большего объема энергии с помощью тех же линий
   Использование массивов данных для улучшения прогнозирования и ценообразования

Необходимы подходящие люди и правильный образ мышления
Thank you for your attention

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