Trends und Innovationen für ein Energiesystem der Zukunft
Kundentag 2017 – Siemens Energy Systems; Michael Weinhold

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Trends
Kundentag 2017 – Siemens Energy Systems
The Energy Revolution: Big Picture

From **centralized power** and **unidirectional grid** …

… to **Decentral and Distributed Energy Systems** and **bidirectional balancing**

1. Changing generation mix
2. Generation capacity additions
3. Distance from source to load
4. Decentralization (public/private)
5. Refurbishment/upgrades
Generation mix in 2030, example European Union (forecast to be further verified)

Impact on Grid business

- Integration of Renewables
- Grid extensions
- Stability challenges (less inertia, towards “solid state grid”)
- Power quality and reliability of supply
- Cyber Security
- Automated operation and situational awareness
- New business models, solutions and customers
- Regulatory uncertainty and public acceptance
- Disruptive potential from cheap storage

Source: Siemens
Germany: more renewable generation capacity than peak load

More installed Wind- and PV-capacity than Peak Load

>65GW of Wind and PV-Power Plants connected to LV- and MV-systems

Trend towards an „Electronic Grid“

Resulting Challenges for grid operators:
- Renewable integration
- Frequency and Voltage Stability
- Short Circuit Power
- …

Germany: Power Generation and Consumption in March 2017

Renewable Power Generation:
- ca. 55 GW
- ca. 10 GW

Source: https://www.agora-energiewende.de/de/themen/-agothem/-Produkt/produkt/76/Agorameter/
Political Targets and Breakthrough Technologies lead to more Renewables, Distributed Energy Systems and Electrification

**Political Targets:**
1. De-carbonization
2. Sustainability
3. Energy Efficiency
4. Resiliency

**Breakthrough Technologies:**
2. Energy Storage
3. Digitalization

1. **Large-scale Renewable integration into the electricity system** (Wind, PV, Hydro)
2. **Distributed Energy Systems** to maximize:
   1. Energy System efficiency
   2. Local Renewable integration
   3. Resiliency
3. **Electrification of Consumption** (e.g. Heat Pump, E-Car)

**Changing System Operation** ("Physics & Acceptance")

**Consumer-centric Energy World** ("Physics & Psychology")
Innovationen
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ULTRANET, Germany, 2021
World’s first VSC HVDC with full-bridge converter

Customer: Amprion / TransnetBW
Project Name: ULTRANET
Location: Osterath – Philippsburg, Germany
Power Rating: 2000 MW, bipolar
Type of Plant: HVDC PLUS in full-bridge topology, 340 km
Voltage Levels: ±380 kV DC
400 kV AC, 50 Hz
Semiconductors: IGBT
HVDC PLUS Power Electronics
Compact transmission lines are used in three main applications

1. Transmission lines
2. Hydro power plants – vertical GILs
3. Substations and conventional power plants
Single Phase / Mobile Resilience Units – an innovative technology not only for emergency issues

138 kV dry type cable potheads

138 kV flexible EPR cable

3x100 MVA single phase dual voltage 345/138 or 138/69 kV Transformers with either 138/69 kV bushings or HV cable connections

Ensure short downtimes after failures with flexible Transformers
Agile and 360° digital: standards-based end-to-end architecture and services

Enterprise IT

Planning and simulation
Operations / control
Applications, analytics

Smart communication + control

Substation
Field area networks

Primary equipment
Primary equipment

Cyber security

OT-IT integration, consulting

Managed/cloud services

Central power
TSOs
DSOs/Municipalities
Distributed generation
Oil & Gas, heavy industries
Discrete Manufacturing
Infrastructure & Data Center
Construction/Buildings

Electrification
Automation
Digitalization
Information technology
At the front edge of digital innovation: Elhub: Market transaction management, Statnett, Norway

DSO: Distribution System Operators  
TSO: Transmission System Operators  
MTM: Market Transaction Management

EnergyIP® 8
- Meter Data Management (MDM) application
- Market Transaction Management (MTM)

Benefits
- Peak avoidance
- Distributed optimization
- CO₂ and cost avoidance
- Allocation of grid losses and unaccounted energy

DSO: Distribution System Operators  
TSO: Transmission System Operators  
MTM: Market Transaction Management
Digitalization optimizes investments of New Brunswick (NB) Power, Canada

- Decentralized generation and consumer load bundled on a virtual platform
- To be used as a flexible single power plant

Benefits:
- Optimization of investments
- New business model makes NB Power fit for the future
- CO₂ reduction

DEMS: Decentralized Energy Management System
DRMS: Demand Response Management System
Research project
Dynamic Grid Control Center

Challenge:
- Changing system dynamics
- More power electronics within the grid, less rotating mass

Target:
- Autopilot and Master Power Control operation
- Controllable grid dynamics
- Self healing capabilities

Partnering:
- 3 universities
- 4 TSOs
- 2 scientific institutes
Political Targets and Breakthrough Technologies lead to more Renewables, Distributed Energy Systems and Electrification

Political Targets:
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Breakthrough Technologies:
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Changing System Operation ("Physics & Acceptance")

Consumer-centric Energy World ("Physics & Psychology")
Prosumers in the Distributed Energy System

Distribution grid

- Buildings
- Private photovoltaics
- Storage
- Photovoltaics
- Onshore Wind
- E-mobility
- Industry

Microgrid / Nanogrid

- Railway infrastructure
- Data centers
- Buildings
- Industry
- Airports
- Harbors

- Industry
- Infrastructure
- Facilities
Microgrid
IREN2 research project in Wildpoldsried, Germany

Solution
Combining micro grid and Virtual Power Plant to form a topological power plant, which can be operated in island mode

Benefits
- Stable and economically optimized grid operation
- Black start capability
- Profitable use of renewable resources
- Ancillary services from the distribution grid
Energy storage applications and sector couplings

Application cases by location of storage

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<th>Distributed</th>
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<td>Small utilities, municipalities, industry – prosumer</td>
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<td><strong>Pumped storage</strong></td>
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<td>Grid stability, self-supply, electro-mobility</td>
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- **Electricity**
- **H2**
- **Methane (gas grid)**
- **H2 Fuel for car**
- **Power to gas**
- **Power-to-chemicals**
- **Grid stability, self-supply, electro-mobility**
- **Power-to-heat**
Selected Battery Storage applications (SIESTORAGE References)

SIESTORAGE installation as standard container at the grid of ENEL, Italy
for network stabilization with infeed of power from decentralized, renewable sources
Commissioning in 2012
1MVA/500 kWh

SIESTORAGE installation in existing modernized substation of VEO*
Eisenhüttenstadt, Germany
for black start in the steel and rolling mill of Arcelor Mittal GmbH (AMEH)
Commissioning in 2014
2,8 MVA /720 kWh

One-stop-shop:
- From planning and installation through to commissioning and services
- Possibility of integration into prefabricated standard container or existing building

* (Vulkan Energiewirtschaft Oderbrücke GmbH)
Energiepark Mainz
Electrolysis hall

Key facts

- Three SILYZER 200
- In total about 4 MW DC nominal load and DC 6 MW overload
- High dynamic: load changes within sec.
- 35 bar pressure at gas outlet
- Produced were so far up to 500 kg(H₂)/day
  -> Fuel for about 50,000 km in a fuel cell passenger car*

Assumption: Passenger Fuel cell car consumption about 1 kg/100km
Reference projects demonstrate the broad range of different prosumers in a distributed energy system

Battery storage system safeguards power supply at VEO

- Black start capability of power plant's gas turbine at any time and without feeding in power from the public grid
- This island network keeps the critical production processes at the steel mill operating

Data analytics decision-making support for GESTAMP

- Real-time monitoring via web portal
- Early detection of machinery failure and inefficient processes
- Customized reports
- Worldwide implementation possible

Turnkey integrated power supply solution for Südzucker

- Drawing power from the high-voltage grid, but also feeding electricity from the on-site power plants into the grid

Intelligent microgrid for Savona University

- Highly energy-efficient conventional and renewable sources are controlled in real-time
- The campus can generate enough electricity and heat to satisfy its needs autonomously
Modularity of Decentralized Energy systems well-suited to campus environments

Siemens Campus Erlangen

- Multidimensional grid combines heating, cooling and electricity
- 8-MW cogeneration plant with four gas motors, heat pumps, 4-MWp PV system
- Electrical control technology, energy management

Reduction of up to 30% in CO₂ emissions through biogas cogeneration plant and PV

3-4 MW energy storage to balance base and peak loads

Note: Reference values; campus currently under step-by-step construction
Distributed Energy System
Green Tower Freiburg (under construction)

Energy-/Power Management System
• Optimization of self-generated Energy

Building Automation
- Security
- Fire protection
- Building and Room Automation, Energy Monitoring and Controlling (EMC)

Building Supply
- AC loads e.g. typical household loads
- Internal DC loads e.g. for lifts, emergency lighting

Power Supply
- DC-link
- CHP or Engine
- Li-Battery (0,5 MWh)
- PV-System (400kWp)

Source:
http://www.freyarchitekten.com/projekte/549_smart-green-tower.html
Partnership Siemens – LO3 Energy
Innovative Microgrid solution supporting New York’s Reforming the Energy Vision (REV) program (currently under development)
Vision of the future for discussion: The three essential grids in context of an energy cell concept

Energy cells can be
- Community, Campus
- Village
- Factory
- Power plant
- Dedicated storage facility

Energy cells may contain
- Power generation
- Thermal and gas grids
- Energy storage
- Sector couplings
- Power-to-X (-value)
- Dynamic load control
- ICT, self-organizing, self-healing intelligence
- Resiliency, microgridability
- Peer-to-peer trading
### Outlook

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