Benefits for solar power plants in respect of grid stabilization

Bernhard Beck, CEO BELECTRIC, Germany
BELECTRIC: Company profile

- **Over $700M** total operating performance for 2011
- **2,000** employees in 17 countries
- Actual we install more than **2 MWp** every working day

10+ YEARS OF EXPERIENCE

391+ MWp WORLD LEADING PV-SYSTEM INTEGRATOR IN 2011

500+ CONSTRUCTION WORKERS WORLDWIDE

1000+ MWp FIRST COMPANY WITH OVER 1 GIGAWATT SOLAR POWER INSTALLED
# BELECTRIC: Our business areas

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<td>• Photovoltaic Modules</td>
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BELECTRIC: International

BELECTRIC Headquarters: Germany - Regional offices: Australia, Chile, Czech Republic, France, Greece, India, Israel, Italy, Poland, Romania, Spain, Switzerland, Turkey, United Arab Emirates, United Kingdom, USA
Next Generation of Grid-supportive Solar Power Plants

Energy production through innovative power plant technology
Basic power supply:
Use of solar power plants and wind turbines as direct energy converters, which cannot be regulated, but on the other hand with no “fuel costs”.

Additional power supply on demand:
- Use of power plants that can be regulated and consume resources (biogas, natural gas, coal and hydropower)
- Efficient storage solutions such as pumped-storage power plants and electric storage systems
Energy future: **Intelligent power grids**

The energy system of the future combines the different segments into **one system**

- Increase in grid quality (normalization of peak loads and stabilizing the mains voltage)
- Safeguarding from regional blackouts
- Intelligent power generation according to demand with very low CO2 emissions

! BUT: Energy must be affordable for customers!
Project investment costs and LCOE

Optimizing all processes, power plant technologies and the whole system design

Simplification

Standardization

Improvement in efficiency

Maximize the solar power generation and minimize the construction and maintenance costs at the same time

→ Reduction of the LCOE
2.5 MegaWattBlock® for Solar Power Plants
STANDARDIZED, FUTURE-PROOF AND INTELLIGENT
The 2.5 MegaWattBlock®

- A power plant block, developed for the construction of solar power plants in up to 2.5 MWp steps
- Standardized system design
- Efficient modules technologies
- Inverter technology with intelligent grid services
- Lowest costs per kWh (LCOE) for pv under real conditions
The 2.5 MegaWattBlock®
2.5 MegaWattBlock®: PV modules

- Modern thin-film technology to ensure optimal use of solar irradiation
- Requires significantly fewer raw materials during production than traditional silicon-based technologies
2.5 MegaWattBlock®: PCU

- Power Conditioning Unit (PCU) includes the SMA CP Outdoor inverter unit, the transformer with 20kV feed-in and the PADCON grid control unit
- Dynamic reactive power control at **day and night**
- Active **grid stabilizing** features
- Built-in PID protection device
2.0 MegaWattBlock®: Plant Controller

- RealTime Monitoring System:
  - Web-based monitoring system with a permanent and real-time data access
  - Extensive data reports und analysis functions with all important power plant parameters

- Grid Management:
  - Power reduction at electricity grid overloads
  - Reactive power control to stabilize grid voltage
  - Frequency-dependent effective power control
PV energy costs: **Long-term reduction**

<table>
<thead>
<tr>
<th>Year</th>
<th>Initial investment and depreciation of infrastructure</th>
<th>Repowering</th>
<th>O&amp;M</th>
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<tbody>
<tr>
<td>2012</td>
<td>5 ct/kWh</td>
<td>&lt; 3 ct/kWh</td>
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<tr>
<td>2022</td>
<td>15 ct/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2032</td>
<td>15 ct/kWh</td>
<td>7 ct/kWh</td>
<td></td>
</tr>
<tr>
<td>2042</td>
<td>15 ct/kWh</td>
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</tr>
<tr>
<td>2052</td>
<td>15 ct/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2062</td>
<td>15 ct/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2072</td>
<td>15 ct/kWh</td>
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</tbody>
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Energy price trend, inflation 3%

Energy price trend, inflation 1.5%

< 3 ct/kWh
What does ‘renewables’ mean for the electricity network?
Our public grid: **Renewable energy**

Decentralized regenerative energy suppliers feed into the public grid at various network points in a way that is controlled and dependant on energy sources (sun, wind etc.). Consumers use electricity at different times.

→ **Result:** Differing grid voltages and unpredictable, extreme values can occur

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DS = Decentralized power supplier  
C = Power consumer
The public grid: **Extreme scenarios**

Grid voltage excess in the event...
- of high supply from energy producers and little consumption,
- of high consumer load and little supply from energy producers

→ Grid voltage moves outside the recommended corridor
Grid expansion would be the only solution... if there would not be decentralized reactive power generation.
Grid stability through reactive power

Through **phase shifting of electricity and voltage** (decentralized provision of reactive power) in the **distribution network**, the grid voltage can be raised and lowered at network points.

→ Reactive power can compensate for voltage fluctuations in the network.
State-of-the-art reactive power control

New feed-in guidelines for renewable energy production in Germany: Modern photovoltaic systems have to provide reactive power in normal operation and ‘control’ their own voltage influence on the network:

- MV guidelines: $\cos \phi = 0.95$ (inductive) and 0.95 (capacitive)
- LV guidelines: $\cos \phi = 0.90$ (inductive) and 0.90 (capacitive)

Reduction in the voltage excursion through reactive power control of the supply
State-of-the-art reactive power control

- Maximum value of reactive power (Q) is dependant on the apparent power, i.e. on the currently produced energy
2.5 MegaWattBlock®: Grid stabilization

Power Conditioning Unit (PCU) allows:

- Reactive Power, day and night, independent from solar irradiation
Reactive power control through PCU

→ Q can be controlled independently from S
→ Q + P <= max. connection output of the unit/PCU
Grid Stabilization: \textbf{Voltage comparison}

Comparison of grid voltage at end consumer (0.4kV network)

- **Grid voltage at consumer level in unregulated operation:**
  - Voltage [V] range: 220 to 237.5
  - Data shows fluctuations throughout the day.

- **Grid voltage at consumer level with actively controlled reactive power:**
  - Target value of grid voltage set at 233V
  - Voltage [V] range: 228 to 235
  - Data shows steady voltage levels with minimal fluctuations.
  - Switching of the transformer level (110kV/20kV) by the grid provider.
2.5 MegaWattBlock®: Grid Integration

The regional power grid of the future

1. Solar power plant: 4 x 2.5 MegaWattBlock with Power Conditioning Unit (PCU)
2. Power Plant Controller (PPC) and grid access point
3. Transformer station
4. AC power line (medium and high voltage grid)
5. Private households
6. Conventional power plant
7. Urban area
8. Industrial area
Active reactive power control regulates the grid voltage and compensates for phase shifting

Result: No extreme voltage deviations

Voltage corridor (according EN 50160 (UN ± 10%))

110% = 253V
100% = 230V
90% = 207V
The result of active grid stabilization

The integration of grid-stabilizing solar power plants...

- works – actively – also when the solar power is not available
- stabilizes the electricity network with regard to voltage

→ Saves expansion costs in the distribution & transfer networks
→ Enables modern grid technologies like high-temperature low-sag conductors

And what does this mean to customers?

Solar Power Plant with a high energy yield... ...wants to feed into the public grid – any time of the day

**Grid stabilized network**
- Complete feed-in
- High project returns

**Instable network**
- No feed-in
- No solar fees

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Outlook: SPP with energy storage

Future problem:
Due to the penetration of fluctuant energy sources, such as wind and solar, the real time discrepancy between supply of energy and demand will increase. This reduces the stability of the existing network and increases the risk of a blackout.

The solution for solar energy:
Solar power plants and energy storage are combined to balance supply and demand in order to level the power generation.
Thank you for your attention

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