Siemens Environmental Portfolio Elements

Munich, December 2014
Environmental Portfolio elements

Sustainable power generation

- Renewable energies
- Fossil power generation

Low-loss power transmission

Power transmission and distribution

Efficient energy use

- Smart grids
- Energy storage

- Mobility
- Industry solutions
- Building technologies
- Healthcare
- Water

Efficient energy use

- Sustainable power generation
- Low-loss power transmission
- Power transmission and distribution
- Intelligent distribution and storage
- Efficient energy use
Connecting offshore wind farms to the grid

The design of high-voltage offshore wind parks to the grid comprises intelligent collection systems at the medium-voltage level. The design of the high-voltage transmission system and the onshore receiving substation meet local grid code requirements.

Key features
- Turnkey solutions to connect large scale wind farms to the grid

Environmental value
- Better use of renewable energy sources, thanks to modern transmission technology
- Avoids CO$_2$ and NO$_x$ emissions that harm the environment
- Offshore wind farms at any distance from the shore are feasible

Customer value
- High reliability
- Low investment costs and efficient transmission

Source: Siemens Environmental Portfolio Element No. 11102
High-voltage direct-current (HVDC) transmission

The transmission of electricity over great distances with HVDC reduces CO$_2$ emissions due to lower energy losses. HVDC also provides an optimal grid access to renewable energy sources.

**Key features**
- High transmission capacity
- Power transmission over long distances
- Low energy losses

**Environmental value**
- Reduction of CO$_2$ emissions through low energy losses
- Footprint of HVDC towers is 50 percent smaller than for A.C. system

**Customer value**
- Economic transmission technology
- Established and reliable
- High transmission capacity

Source: Siemens Environmental Portfolio Element No. 11105
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Components for green transmission solutions

For the realization of gas-insulated switchgears (GIS) and high-voltage direct current (HVDC) transmission systems, various special high-voltage products and components were developed and are now in successful operation.

**Key features**
- GIS: Compact size and the ability to use higher voltage levels closer to the load
- HVDC: Full portfolio of HVDC products up to 800 kV DC

**Environmental value**
- GIS: Reduced transmission losses
- HVDC: Footprint of HVDC towers is 50 percent smaller than for A.C. systems, HVDC lowers CO₂ emissions and primary energy consumption

**Customer value**
- GIS: Ultra compact substations, highest reliability and low maintenance costs
- HVDC: High transmission capacity and lower losses and costs

Source: Siemens Environmental Portfolio Element No. 11101
Efficient transformers

Siemens provides the right transformers for every need – from compact distribution transformers to large power transformers with ratings far above 1,000 MVA.

Key features
- The replacement of an old transformer with a new one increases the energy efficiency of the power grid significantly
- All products are optimized with regard to individual customer requirements

Environmental value
- Low losses (load and no load) lead to an improved transmission efficiency
- Low noise emissions
- Biodegradable insulation liquids
- Advanced transformers with reduced losses support the energy efficiency of rolling stocks

Customer value
- Tailored solutions for the customer.
- Fulfills strict noise level requirements
- Can be operated in critical fire protective areas or in stringent protected environmental areas
- Extended lifetime through prevented oxidation of insulation material
Parallel compensation (Static var compensator)

A parallel compensator is an electrical device for providing reactive power on high-voltage electricity transmission networks. By providing the missing reactive power locally, it is not necessary to transmit this power via the transmission line.

### Key features
- Provision of inductive or capacitive reactive power
- Voltage control

### Environmental value
- Increased transmission efficiency
- Reduced ohmic losses in the overhead line which leads to reduced demand of loss energy and less CO₂ emissions from power generation

### Customer value
- Voltage control
- Reactive power control
- Damping of power oscillations (option)
- Unbalance control (option)

Source: Siemens Environmental Portfolio Element No. 11106

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Gas-insulated switchgears (GIS) have become an established product worldwide for transporting electricity directly into megacities, due to their reduced footprint. This reduces losses and increases energy efficiency.

**Key features**
- Fully encapsulated and shielded primary equipment
- Ultra low gas leakage rates

**Environmental value**
- Reduced transmission losses due to compact size and the ability to use higher voltage levels closer to the load
- Life cycle assessments show that the negative impact due to the use of the greenhouse gas SF6 is over compensated

**Customer value**
- Ultra compact substations
- Highest reliability
- Low maintenance costs

Source: Siemens Environmental Portfolio Element No. 11103
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Gas-insulated transmission lines

Gas-insulated lines (GIL) enable high power underground power transmission with very low losses and superior EMC (electro-magnetic compatibility).

Key features
- Encapsulated and sealed power transmission “pipeline”
- High transmission capacity

Environmental value
- Low-loss energy transport
- Best electro-magnetic compatibility
- No disturbance in the landscape

Customer value
- High reliability
- Maintenance-free construction
- Long life-time
- Fire-safe operating
- Lower operating costs
- High transmission capacities

Source: Siemens Environmental Portfolio Element No. 11104
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Substations with gas-insulated switchgear

The compact design of gas insulated switchgear reduces emissions, while the concept maximizes personal safety and makes the switchgear practically maintenance-free. Gas-insulated switchgear help to improve the CO$_2$ balance when viewed over their entire life-cycles.

Key features
- Highly compact design
- Requires up to 70% less space compared to AIS
- Practically maintenance-free

Environmental value
- Saves developed space
- Energy efficient, thereby reducing total lifecycle CO$_2$ emissions (including SF$_6$ emissions)
- Environmentally compatible power transmission and distribution

Customer value
- Extremely small footprint and usage of existing facilities
- Fast assembly and high reliability
- Minimum maintenance requirements
- Economical and safe power distribution
- Ease of operation with high personal safety

Source: Siemens Environmental Portfolio Element No. 11205
Power management & controlling covers products, solutions, infrastructure and industrial applications to monitor and reduce electrical energy consumption. The objective of power management systems is to identify and implement energy savings.

**Key features**
- Support energy purchasing through a comprehensive consumption data base
- Avoids overload situations

**Environmental value**
- Identifies energy-intensive consumers
- Increases energy awareness
- Identifies potential for energy-saving

**Customer value**
- Reduces energy costs by avoiding load peaks
- Optimizes capital efforts for power distribution
- Minimize downtime of electrical network

Source: Siemens Environmental Portfolio Element No. 10302
Medium voltage grid access for renewable energy

Mid- to small-sized renewable energy projects fed into medium- or low voltage distribution systems. Siemens provides turnkey solutions for this kind of grid access for renewable energies.

**Key features**

- Efficient integration of renewable energy sources

**Environmental value**

- Substitute carbon intensive power generation
- Reduce the overall CO₂ emission from the national power generation
- Lower NOₓ emissions that harm the environment

**Customer value**

- High reliability
- Turn-key solutions from one supplier using state of the art technology

Source: Siemens Environmental Portfolio Element No. 11206

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Siemens offers operation & maintenance (O&M) services for networks. Optimized operation and management increase the efficiency of grids. Monitoring and diagnostic services are offered in order to allow the usage of existing infrastructure to its full extend.

**Key features**
- Operation and maintenance services for environmentally friendly products and solutions

**Environmental value**
- Improve the efficiency of infrastructure (power transmission and distribution grids)
- Prevention of hazardous failures and consequential damages of environment
- Saving CO$_2$ by securing operation of wind farms

**Customer value**
- Reduce costs for power losses in grid operation
- Reduced risks and costs of hazardous failures
- Customized services in terms of technical, financial, and regulatory asset performance

Source: Siemens Environmental Portfolio Element No. 11202

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Network planning and trainings

Siemens offers consulting services for network connection and system integration of renewable energy sources and distributed generation units. In addition, Siemens provides power system analysis, software tools and professional trainings for the planning of integration of renewable energy.

Key features

- Network planning software and trainings for renewable forms of energy and resource-efficient power supply systems

Environmental value

- Saving CO$_2$ by enabling system integration of renewable energy sources and distributed generation
- Reducing losses and CO$_2$ footprint by network optimization

Customer value

- Reducing costs through reduction of power losses
- Meet environmental standards set by regulation
- Cost efficient network connection and system integration of renewable energy sources and distributed generation

Source: Siemens Environmental Portfolio Element No. 11203
Grid Control Centers (Spectrum Power product family) provide network monitoring and control solutions for load and supply management with network transmission, distribution and generation scheduling applications.

<table>
<thead>
<tr>
<th>Key features</th>
<th>Customer value</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Manage efficiently all tasks of network operation and generation scheduling</td>
<td>• Optimizes power generation</td>
</tr>
<tr>
<td>• Guaranteed availability, reliability and security</td>
<td>• Increases failure tolerance of installations</td>
</tr>
<tr>
<td>• Scalable and customizable solutions</td>
<td>• Optimizes power plant control</td>
</tr>
<tr>
<td></td>
<td>• Minimizes losses on the grid</td>
</tr>
</tbody>
</table>

- Increases energy efficiency
- Reduces energy losses on grids
- Reduces CO₂ emissions due to an improved integration of low-carbon, decentralized generation sources such as combined heat and power or renewables

Source: Siemens Environmental Portfolio Element No. 11201
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Smart Grid Applications

An intelligent and flexible grid infrastructure, smart generation, and smart buildings are essential for achieving low carbon energy systems.

Source: Siemens Environmental Portfolio Element No. 11204

Key features
- Software for optimizing the power grid and make efficient use of renewable generation
- Energy management system for monitoring, planning, and optimization of distributed energy resources

Environmental value
- Increased efficiency of energy systems through bidirectional communication between supply and demand side
- Improved carbon intensity due to grid integration of low-carbon decentralized generation

Customer value
- Energy cost savings and Installation cost savings through increased network performance with intelligent control
- Optimization of decentralized energy resources – economically and ecologically
- Possibility for bidirectional energy flow
Smart metering data management and services

Metering services are a substantial part of the smart grid and future smart grid applications and deliver measurable improvements to the acquisition, communication and processing of meter data, to meter management and to customer communication.

**Key features**
- Each of the metering services contributes to a more efficient usage of available energy resources

**Environmental value**
- Improved energy efficiency through increased transparency on energy consumption
- Smaller ecological footprint through improved efficiency of metering operations
- Increased large-scale renewable in-feed by improving readiness of grids

**Customer value**
- Improved operational efficiency of metering operations
- Smart metering is the basis for new business models
- High quality data, and its communication, enables improved energy efficiency management

Source: Siemens Environmental Portfolio Element No. 11204

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SIESTORAGE (Siemens Energy Storage)

The modular energy storage system SIESTORAGE (Siemens Energy Storage) ensures a sufficient amount of available reserve power for balancing and regulation purposes and creates higher grid stability.

Key features
- Cutting-edge power electronics for grid applications and the latest high-performance Li-ion batteries.
- Power of up to 8 MW at capacities from 0.2 up to 2 MWh: The modular design enables power and capacity to be adapted to specific demands.

Environmental value
- Example with an energy content of 500 kWh and a CO₂ reduction of 350 g per load you can save depending to the number of cycles and the DOD between 700 t to 3,500 t during the lifetime¹)

Customer value
- Frequency Regulation
- Stabilization of Renewable Energy
- Power Quality Management:
  - Peak Power Control
  - Black-Start Option

¹) In relation to energy generation in Germany with an about 590g CO₂ generation per kWh

Source: Siemens Environmental Portfolio Element No. 11207