Securing European Energy Supplies: Making the Right Choices
Increasing power consumption even with slow global economic growth

Demographic dynamics

- Population growth: 7.5 bn in 2020 (+1.1 bn)
- Megacities (>10 million inhabitants): 27 megacities in 2025

Source: UNO

Resource scarcity

- Geopolitics: 70% of world oil and gas supplies only in a few countries
- Oil price fluctuations

Climate change

- Climate targets: Political programs for long-term reduction of CO₂ emissions

Need for efficiency: Increasing electrification of society

Growing demand for “clean” power

Increasing power consumption

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Energy Sector
1) Optimization of energy mix

- Privileged feed-in of renewables
  - Wind power
  - Solar thermal power
  - Photovoltaic

- Intermediate-load/peak-load for load leveling
  - With high efficient, high flexible combined cycle PP

- Low-emissions base load
  - CCS
  - Nuclear
  - Hydro

Power Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Oil</th>
<th>Gas</th>
<th>Water</th>
<th>Nuclear</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>41%</td>
<td>6%</td>
<td>21%</td>
<td>13%</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>2030</td>
<td>21%</td>
<td>2%</td>
<td>20%</td>
<td>15%</td>
<td>15%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Privileged feed-in of renewables:
- Wind power
- Solar thermal power
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- With high efficient, high flexible combined cycle PP

Low-emissions base load:
- CCS
- Nuclear
- Hydro
Integration of Renewable Energies

Use of hydro power in China
- Hydro > 30...50 GW

Use of renewable energy in Europe
- Wind > 20...40 GW
- Hydro > 10...30 GW
- Solar > 10...20 GW

CO2 Abatement: 32.900.000 t/a

- Powerful wind energy plant
- Wind off-shore plant
- High-efficient turbines solarthermal power generation
- Integration of renewable energies via HVDC PLUS
- Energy lines with UHVAC and UHVDC
- Gas-insulated lines (GIL)
2) Efficiency along the energy conversion chain

- Efficiency up to ~50% for All Electric O&G
- Efficiency up to more than ~60% for CCPP
- Output up through upgrades
- Output up Average energy production / year
- Efficiency up in power transmission
- Emissions down CO₂ reduction with Siplink

Current Ø for All Electric Siemens O&G
Ø state of the art GT in CCPP Siemens CCPP Example: NPP Borssele 35 MW increase in 35 days!
Capacity of average wind turbine Siemens 2.3 MW turbine with 101m rotor Efficiency in current AC systems Siemens 800 kV UHVDC system

Optimization with most advanced technology for intelligent grid management
Irsching - The world's most efficient gas turbine with more than 60% efficiency CCPP

Efficiency up to more than ~60% for CCPP

<table>
<thead>
<tr>
<th>Efficiency Triangle</th>
<th>Impact</th>
<th>EU in the World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security of Supply</td>
<td>&gt;Increased electricity output</td>
<td>&gt;Decreasing dependence on energy imports</td>
</tr>
<tr>
<td></td>
<td>&gt;High flexibility and availability</td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>&gt;Lower generation costs (fuel etc.)</td>
<td>&gt;EU leading green technology for global implementation</td>
</tr>
<tr>
<td></td>
<td>&gt;Less EU-ETS allowances</td>
<td></td>
</tr>
<tr>
<td>Climate Change</td>
<td>&gt;Only 345g CO2-emissions per kwh, power generation worldwide: 578g aver.</td>
<td>&gt;Contributes to meet EU'S international emission reduction targets</td>
</tr>
</tbody>
</table>
The usage of Power Electronics increases efficiency

**Example: E-Car**

In an electric car, electricity from batteries is converted to kinetic energy with 95-percent efficiency.

**Example: All Electric Oil&Gas**

**Traditional Concepts:**
Gas turbine direct drive of compressors and pumps

**Efficiency:** 20-25%

**All-Electric Solutions:**
Central power generation and all drivers E-motors

**Efficiency:** 34-50%
3) Systemic optimization: Smart Grid
The future’s intelligent grid

Drivers for flexible and (cost)-efficient grids
Smart Buildings as a “prosumer” - a new active element within Smart Grids

### Low energy tariffs
- Intelligent filling of storage capacities, e.g.:
  - Load e-car
  - Load thermal storage (boiler, ice, building structure, indoor air)
- Minimal use of CHP
- Use comfort band to build reserves

### High energy tariffs
- Use energy from storage, e.g.:
  - Use reserves in e-car
  - Empty thermal storages
- Maximum use of CHP
- Minimize el. consumption within comfort band
- Use or sell self produced energy (PV, wind, CHP…)
- Switch to oil or gas

Building is energy consumer to grid

Grid

**CHP**: Combined Heat & Power

**BMS**: Building Management System

**PV**: Photo Voltaic

Building may even deliver energy to grid

Grid

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Energy Sector
CO2 emissions are constantly on display.

Large centralized power plants supply the majority of power demand.

Smart Grid Application at Decentralized Generation:
- Large and very small generation plants need to be managed in parallel.
- Car-parking for plug-in vehicles, buy or sell electricity shaving peak loads.
- Energy corridors underground by gas insulated lines or cables (DC or AC).
- Storage plants buffer fluctuating generation.

Wireless sensors and smart metering coupled to load management and market driven energy supply software.
Transmission Grid enabling bulk renewable in-feed

- Large storage plants buffer fluctuating generation
- Nano-materials enhance insulation and conductivity of equipment
- CO2 sequestration and storage facilities
- Wind farm connected by Gas Insulated Lines or cables (DC or AC)

Bulk Power Generation and Long Distance Transmission

- Large centralized power plants supply the majority of power demand
- Supply of deep-sea oil & gas exploration and production

Nano-materials enhance insulation and conductivity of equipment.