



Markus Bayegan
Chief Technology Officer

ABB's vision of the future electricity



Carnegie Mellon Electricity Industry Center
March 20, 2002

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IEEE July 2001



Agenda

- ABB in brief
- Trends in future electricity
- Future grid
- How do we in ABB cope with that
- Concluding remarks

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ABB in brief

24 BUSD revenues
Present in more than 100 countries




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A global technology leader


Market position



- 1 Drives
Robotics
Analytics
Electrical Machines
Line protection
Force Measurement
Power Electronics
Switches & fusegear
- 2 Instruments
Motors
Metering
Control products


Source - Automation Research Corporation, AMR Research, Goldman Sachs, CSFB and others

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A global knowledge leader


Market position



- 1
 - Power plant automation
 - Power transmission
 - Upstream Oil & gas
 - Flexible automation
 - High voltage DC
- 2
 - Substation automation
 - Metals automation
 - Pulp & paper automation
 - Pharmaceutical biotech automation

Source - Automation Research Corporation, AMR Research, Goldman Sachs, CSFB and others

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Power technology – global leadership

- Global presence with 28,600 employees in over 170 factories in 42 countries
- The world's leader in power technology products with the largest product portfolio and the highest market share




High voltage technology Medium voltage technology Power transformers Distribution transformers

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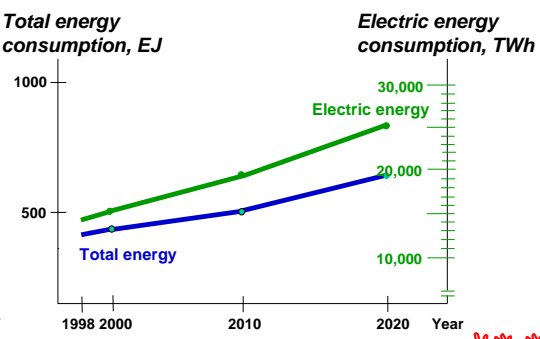
Trends in Power Transmission and Distribution



- Increased competition due to deregulation
- Customers interested in solutions, not only products
- Strong focus on environmental issues
- More intelligent networks

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Continuous growth of energy consumption



Total energy consumption, EJ

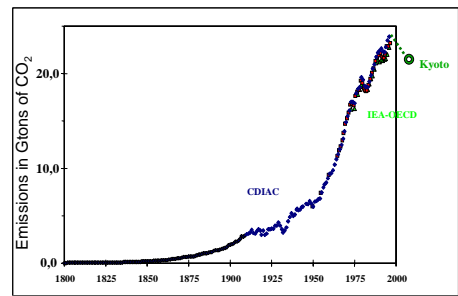
Electric energy consumption, TWh

1998 2000 2010 2020 Year

Source: Forecast by IEA

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World CO₂ Emission



Emissions in Gtons of CO₂

1800 1825 1850 1875 1900 1925 1950 1975 2000


CDIAC

IEA-OECD

Kyoto

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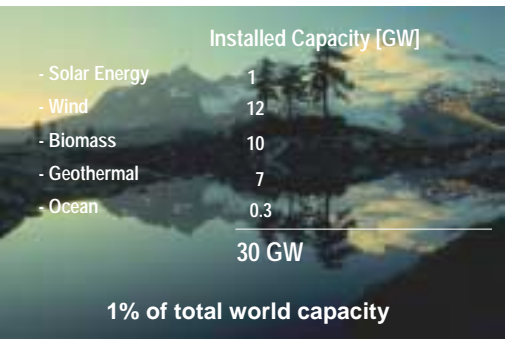
Sustainable development: Driving forces



- Environment a growing concern
- Reduction of greenhouse gases
- Growth in alternative energy solutions
- More distributed power - fuel cells, wind power, combined heat and power, microturbines

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Renewable Energies*



	Installed Capacity [GW]
- Solar Energy	1
- Wind	12
- Biomass	10
- Geothermal	7
- Ocean	0.3
Total	30 GW

1% of total world capacity


* excluding hydro energy

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Vision of a bright future

The Silk Road Genesis Project*

*proposed by Sanyo



Vision of solar farms in China along the historic silk road to cover 1/3 of China's energy demand in 2030

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Towards a hydrogen based society

example Iceland

- 2040 Hydrogen society completed
- 2000 Start of a hydroelectric hydrogen economy
- 1940 Geothermal space heating
- 1800 Importing liquid fossil fuels
- 1700 Importing coal and coke
- 874 Settlement of Iceland



Wind Energy: Global availability

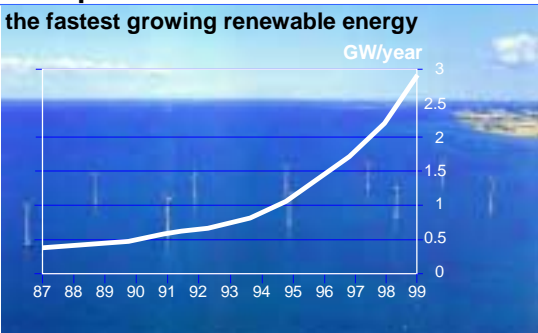
Available wind energy
= 4 X
Global installed capacity of
conventional electrical energy



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Windpower - the fastest growing renewable energy



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Windpower Generation Gotland /Sweden



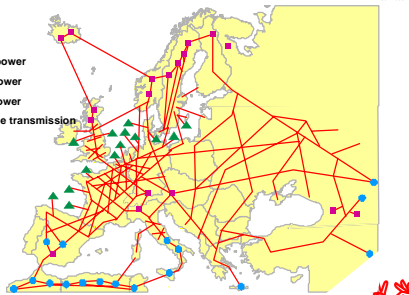
- Already today about 18% of the energy supply is based on wind power
- The goal is to increase this share to 30%

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Vision: Remote renewable energy sources connected to loads by DC grid

- Hydro power
- Solar power
- Wind power
- DC cable transmission



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Visibility : a growing environmental concern



No longer accepted



- Invisible grids
- water
 - oil & gas
 - electricity
 - information

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The future grid

- A network of distributed generation sites
- Renewable energies a major part
- Mostly invisible
- Cost effective DC transmission and distribution
- Controlled by "virtual utilities"
- Operated and controlled via Internet / Intranet

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How does ABB cope with that ?

- Components
- Systems
- Technology

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A comprehensive portfolio for wind power



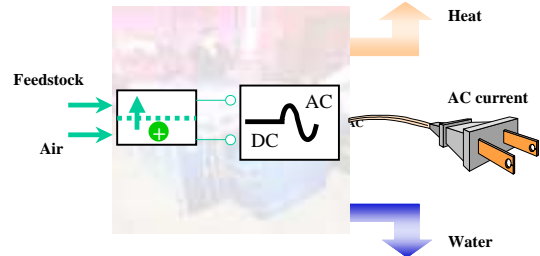
- A whole range of generators (already produce 25% of world's wind power generators)
- Converter technology
- System design
- Windformer

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Partnership for fuel cell systems

ABB and DuPont have formed an alliance



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TURBEC

A partnership for microturbines

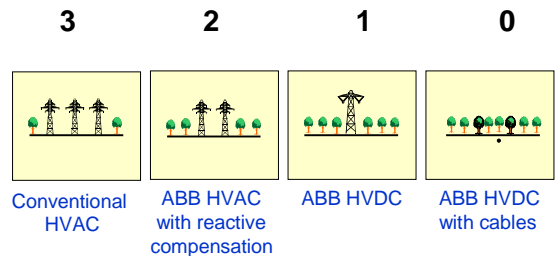


- ABB / Volvo JV
- Up to more than 60 units (~100 KW) delivered
- Building up business in combined heat and power

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Going Underground: Renaissance for Cables



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Low cost underground transmission and distribution systems



Overhead Transmission



New Lean XLPE Cable



Cost ratio OH line/cable

- traditional cable 15:1 - 5:1
- with new XLPE 4:1 or less
- future target 2:1



AC DC



HVDC Light: new transmission technology

- Modular build-up
- Compact
- Stabilizing networks

Conventional HVDC
130 MW
10,000 m²

↓

HVDC Light
130 MW
2,000 m²

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HVDC units shrink in size

Power: 50 MW

	Traditional HVDC	HVDC Light	Future HVDC
Plant size:	10 000 m ²	1000 m ²	350 m ²
Power/area:	1	50	200
Frequency:	0.050 kHz	1 kHz	5-10 kHz

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Technology platforms

for HVDC and SVC Light (annual growth 30%)

HVDC Cables

Dry Capacitors

Power Electronics

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Cables for environmental friendly solutions

- **Invisible power** HVDC Light & AC
- **Oil free transformers**
- **HV machines**
- **Highly efficient Windpower**

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High energy density capacitors

- Very compact capacitors - 75% volume reduction
- Compact substations, SVC and HVDC plants possible, customers save space

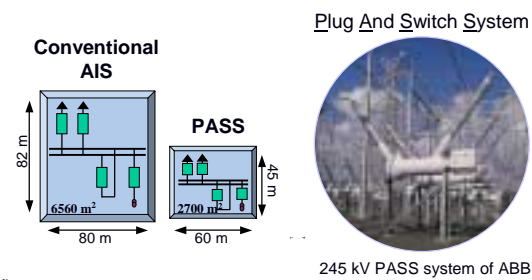
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New power electronic technologies

The graph plots Relative loss (%) on the y-axis (0 to 5) against Time on the x-axis. A horizontal line at approximately 1% is labeled 'Typical transformer losses'. A dashed line labeled 'Traditional Si' starts at ~3.5% and decreases to ~1.5%. A solid line labeled 'New converter concepts' starts at ~2.5% and decreases to ~1%. A dashed line labeled 'SiC' starts at ~2.5% and decreases to ~1%. A dashed line labeled 'Super junctions' starts at ~2.5% and decreases to ~0.5%.

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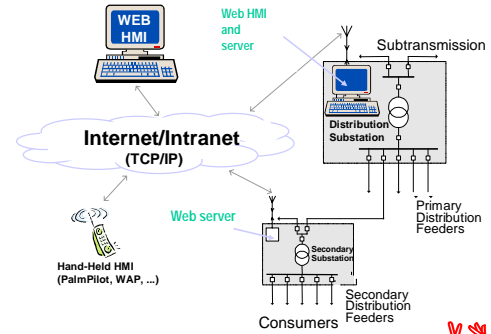
AC substations shrink in size



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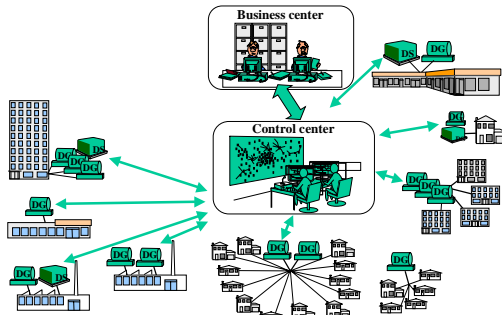
The INTERNET as platform for network control



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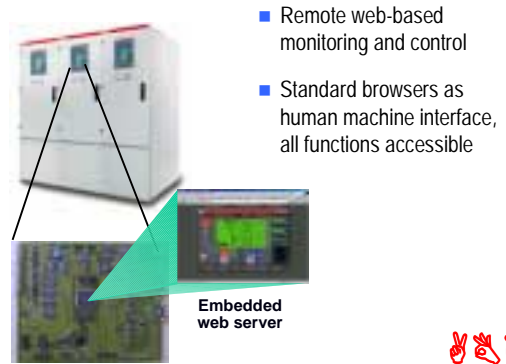
Virtual Utility



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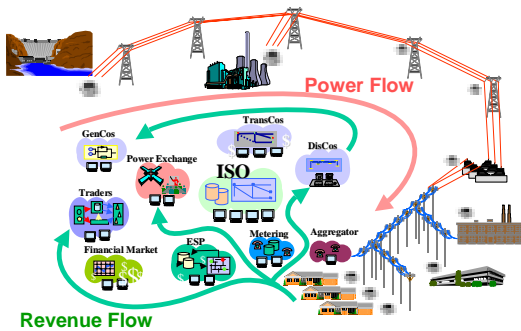
Web based substation control



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Operating the future grid



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Concluding remarks

- The future grid will be very different
- New technologies will change
 - sustainability and efficiency
 - visibility and economy
 - operation and control
- ABB through its R&D is shaping this future

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