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Nuclear Power Prospects Worldwide

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Introduction of AREVA

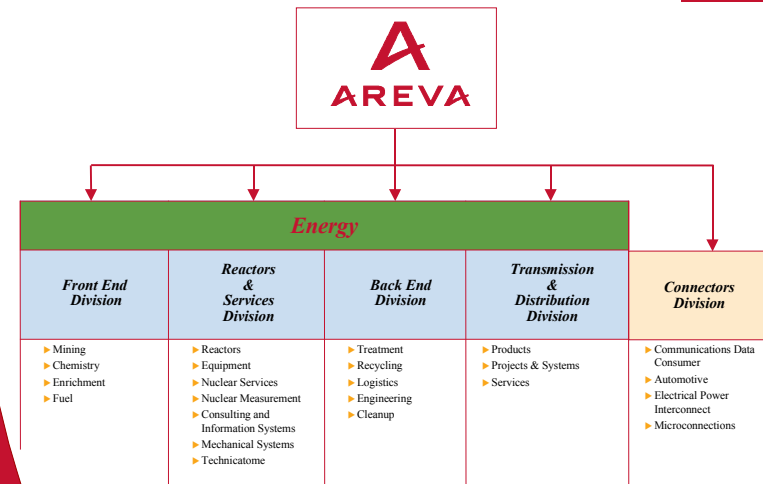
Current Status of Nuclear Power Generation Worldwide

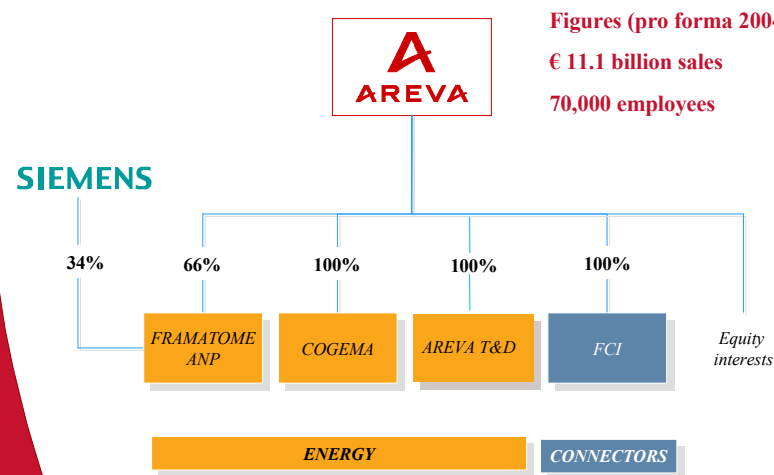
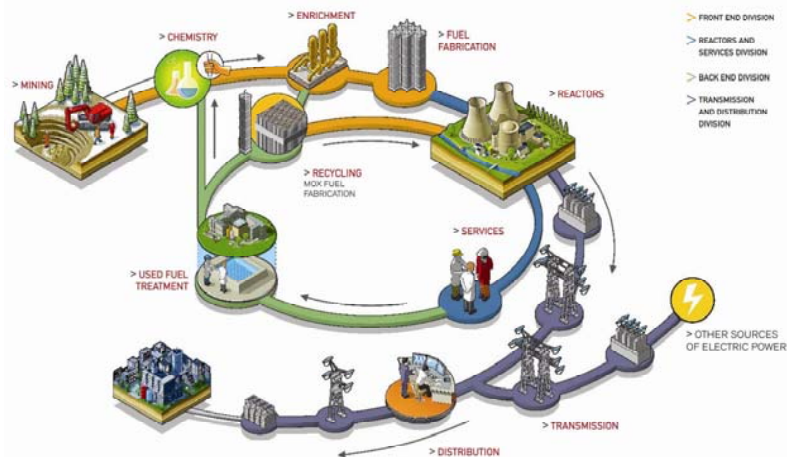
Nuclear Power Market Trends Worldwide

EPR

Conclusions

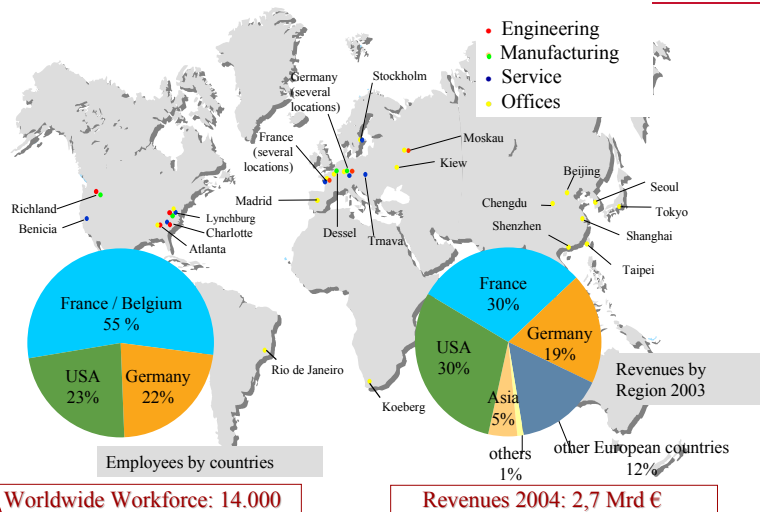
Organization of the AREVA Group





Figures (pro forma 2004):
 € 11.1 billion sales
 70,000 employees

Framatome ANP: 14.000 employees worldwide



Introduction of AREVA

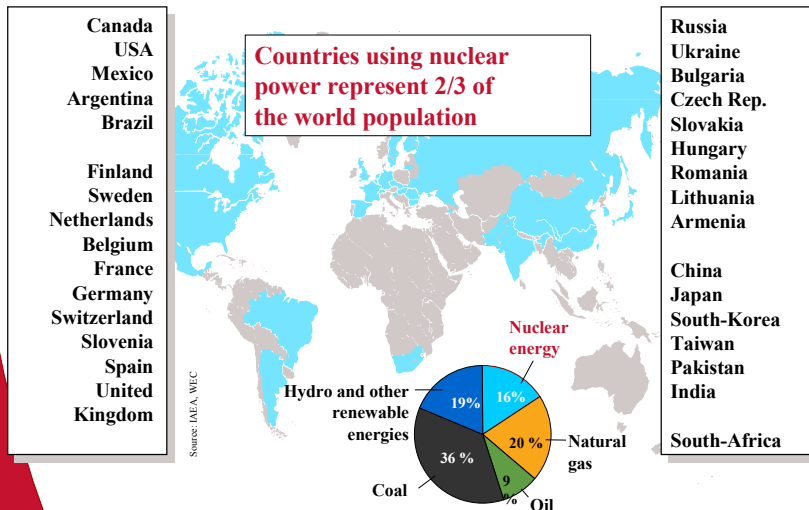
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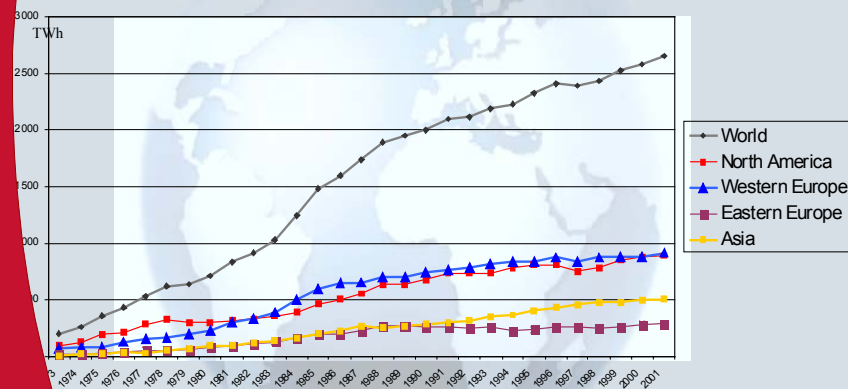
Conclusions

Countries with Reactors in Operation



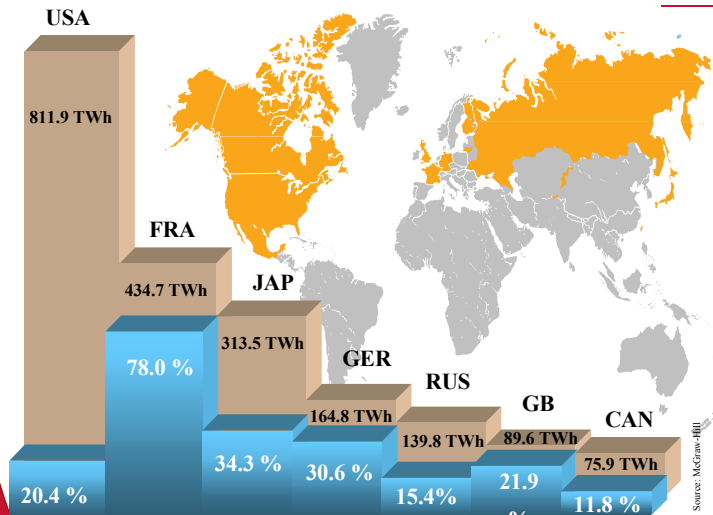
Source: IAEA, WEC

Nuclear Power Generation 1970-2002



Source: IAEA, WEC

Nuclear Power Generation (in TWh and %) in Leading Industrial (G8) Countries, 2002



Source: IAEA, WEC

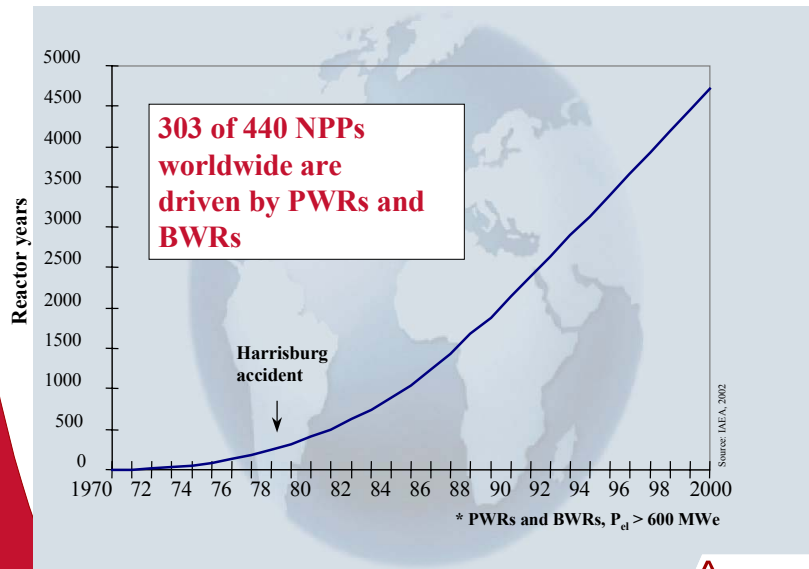
World Nuclear Power Status, January 2004

	Number of NPPs		Total	
	In operation	Under construction	Plants	MW net
Americas	127	2	129	117 710
- North America	121	-	121	111 673
- Latin America	6	2	8	6 037
Europe	209	10	219	181 312
- West	141	1	142	126 693
- Central & Eastern	68	9	77	54 619
Asia	102	20	121	89 243
Africa	2	-	2	1 842
Total	440	32	471	390 107

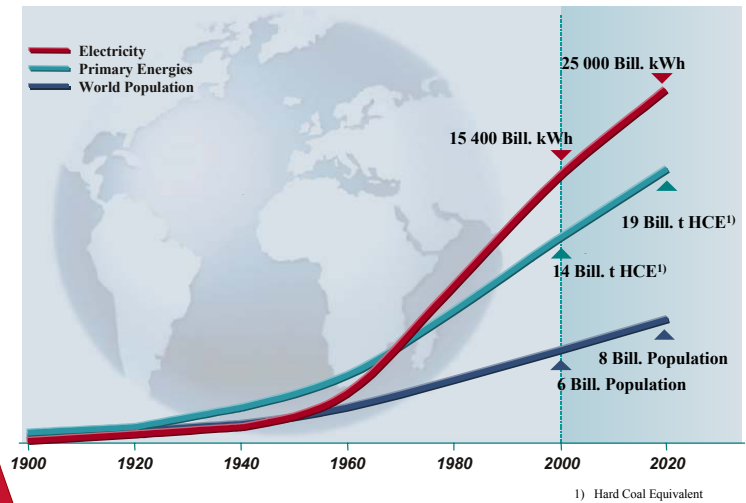
Source: IAEA, WNA

Source: IAEA, WEC

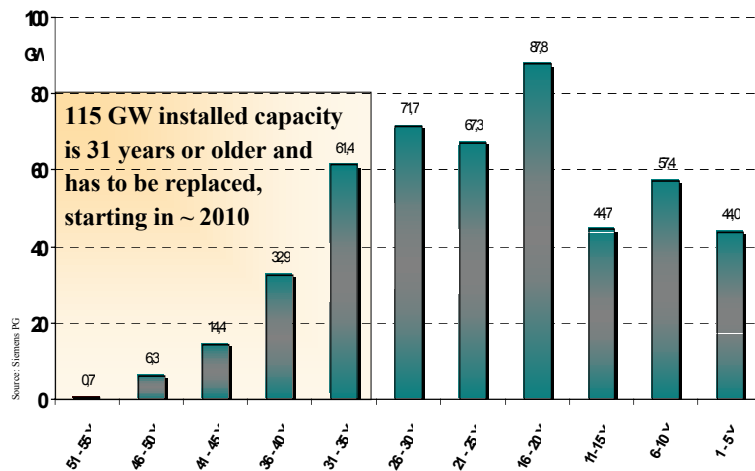
Cumulative Operating Experience with Large-Capacity* Light Water Reactors



World Population, Primary Energy and Electricity Demand



Age Structure of Power Plants in the EU 15 (of coal fired, nuclear and combined cycle power plants)



- Introduction of AREVA
- Worldwide Current Status of Nuclear Power Generation
- Nuclear Power Market Trends Worldwide
- EPR
- Conclusions

Perspectives for New NPPs

● Driving Forces

- ▶ Rising electricity demand and/or need for replacement of aging nuclear and fossil power plants
- ▶ Instability of international markets for fossil fuels
- ▶ Ongoing commitment to improving the environment and combating climate change
- ▶ Need for dependable base load power generation
- ▶ Competitive power production costs

● Prerequisites

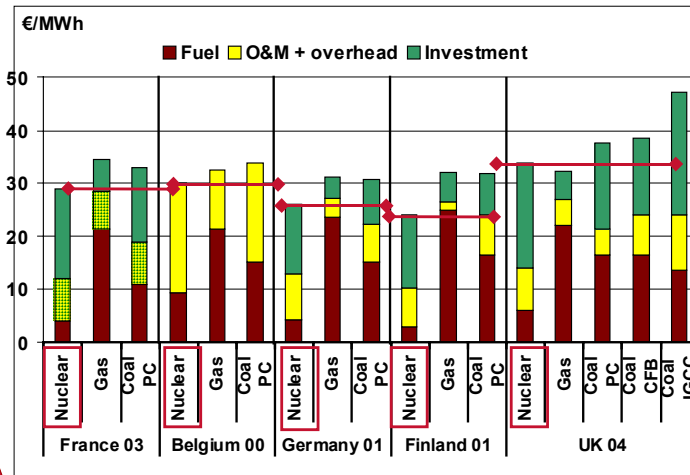
- ▶ Competitive NPPs
- ▶ Safety enhancement ($CDF \leq 10^{-6}/a$)
- ▶ Worldwide-acting vendors of NPPs with long-term commitment
- ▶ Viable sub-supplier base
- ▶ Ongoing R&D and education in nuclear technology
- ▶ High-level waste repositories (long-term issue)
- ▶ Public acceptance



Time for a Nuclear Renaissance

What Has Changed?

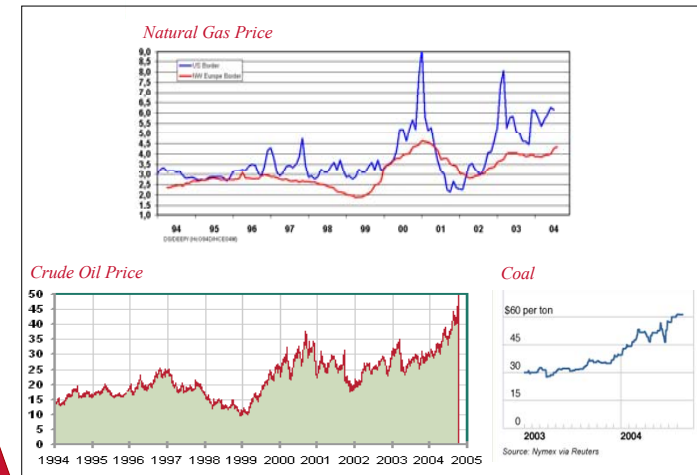
1. Revised Assessments of Elect. Production Costs (w/o CO₂ Tax)



Time for a Nuclear Renaissance

What Has Changed?

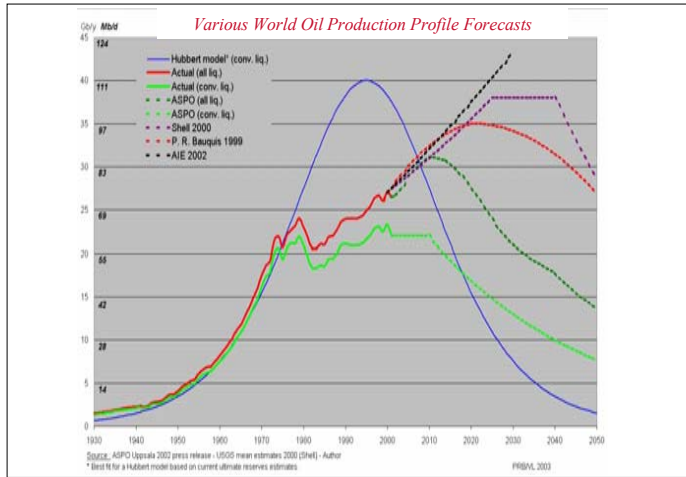
2. Higher Volatility of Fossil Fuels Market Prices



Time for a Nuclear Renaissance

What Has Changed?

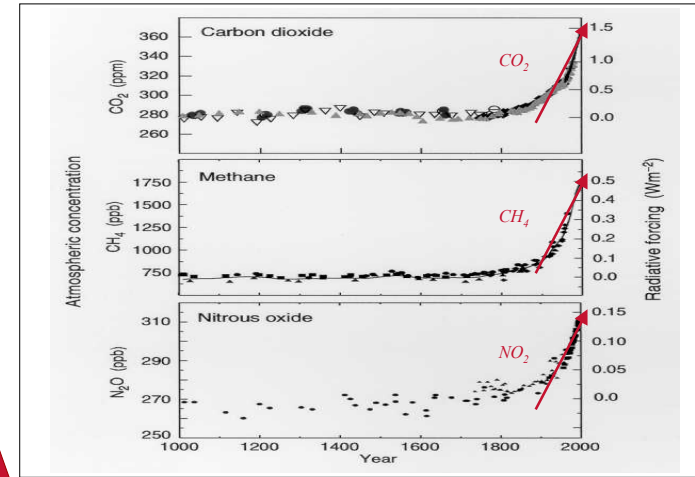
3. Increased Awareness about Limited Fossil Fuels Supply



Time for a Nuclear Renaissance

What Has Changed?

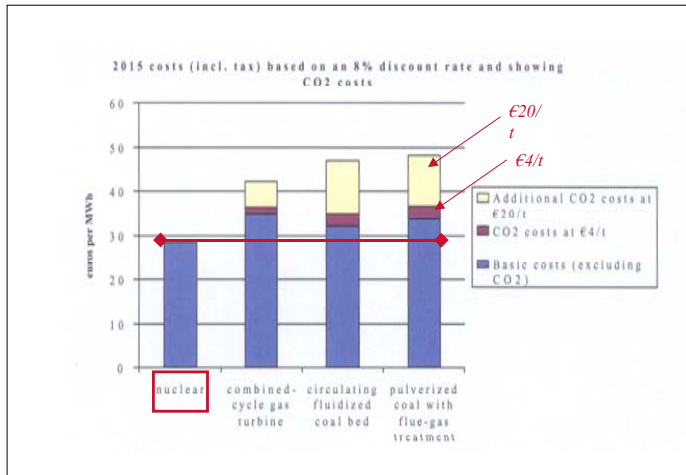
4 - Growing Concerns for Greenhouse Gas Emissions ...



Time for a Nuclear Renaissance

What Has Changed?

5 - ... that Will Translate in a New Economic Equation



Time for a Nuclear Renaissance

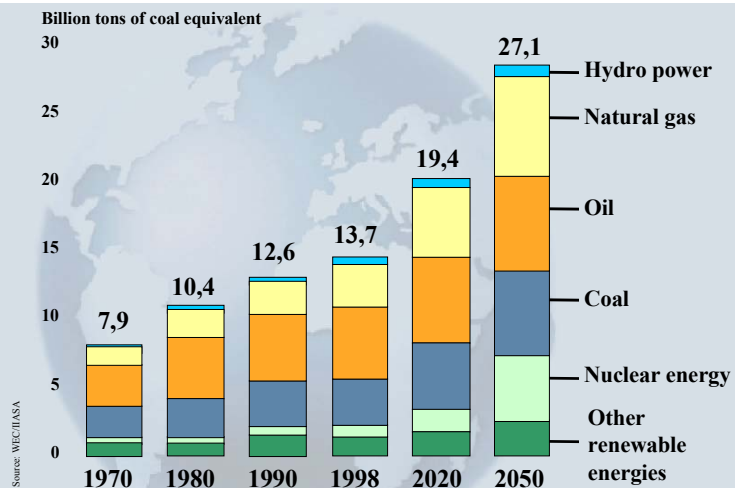
What Has Changed?

6 - Significant Improvements on Safety Issues of Public Concern

- **Several countries made significant progresses with waste disposal**

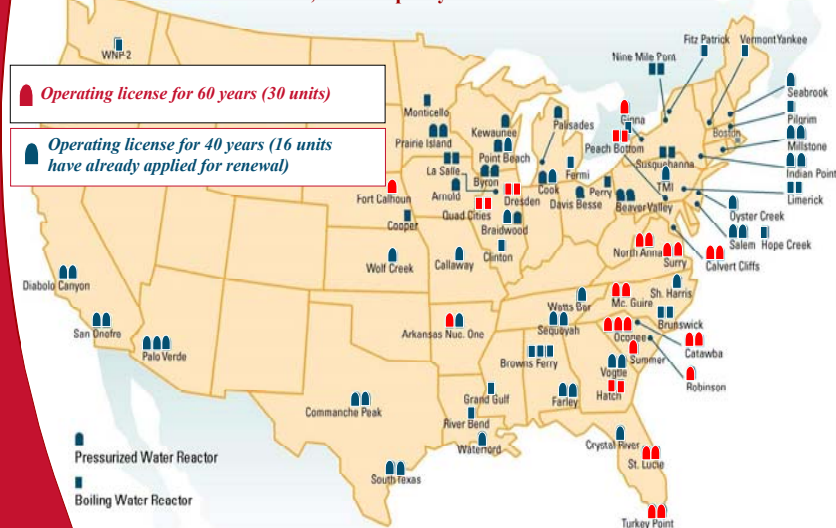
- **Manufacturers developed new generations of reactors**

World Primary Energy Demand (World Energy Council, Reference Scenario)

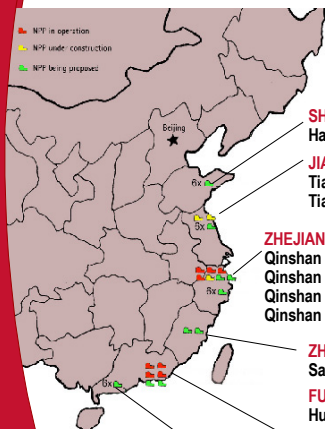


USA: Plant Applications for License Renewal (Status 11/04)

104 Units, Total Capacity: 111.880 MW



China: Challenging Nuclear Program Continues



SHANDONG
Haijiang 6x 1000 MW

JIANGSU
Tianwan 2x 1000 MW
Tianwan 6x 1000 MW

ZHEJIANG
Qinshan phase I 300 MW
Qinshan phase II 2x 600 MW
Qinshan phase III 2x 700 MW
Qinshan phase IV 2x 1000 MW

ZHEJIANG
Sanmen 6x 1000 MW

FUJIANG
Hui An 2x 1000 MW

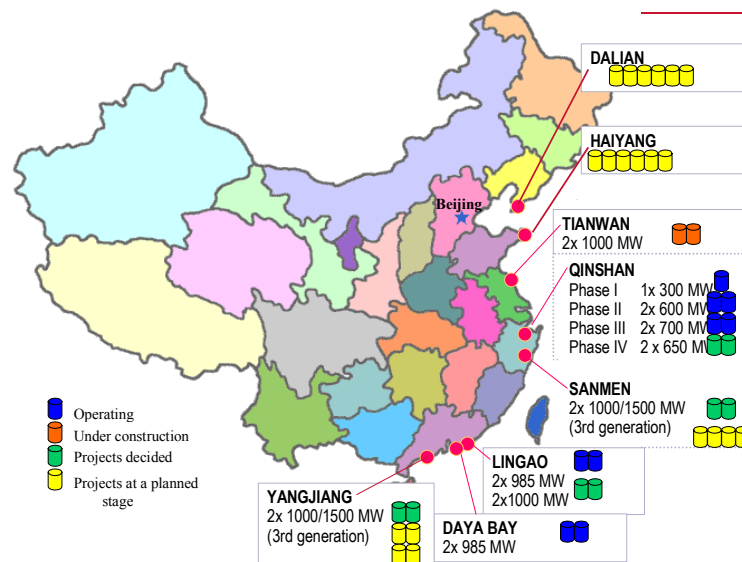
GUANGDONG
Daya Bay 2x 984 MW
Ling Ao 2x 984 MW
Ling Ao 2x 1000 MW

GUANGDONG
Yangjiang 6x 1000 MW

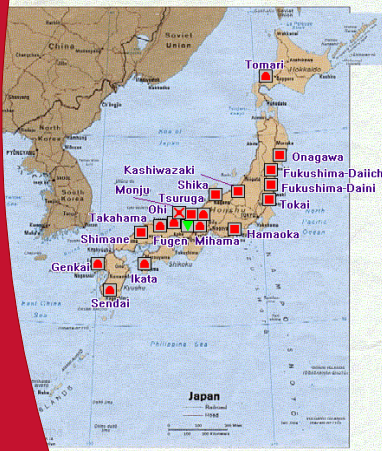
- 1.3 billion inhabitants
- Strong economic growth
- Second-largest electricity market:
 - 1368 billion kWh in 2000
 - Demand growth rate 10 %/a
 - 310.000 MW installed capacity
 - (600.000 MW expected for 2015)
 - High CO₂ emissions (coal production 1.4 billion t)

- Nuclear program (Status 12/2004):
 - 9 NPP units in operation
 - 2 units under construction
 - Another 4 units to be ordered shortly for Qinshan and Ling Ao
 - Installed nuclear capacity to reach about 32.000 MW by 2020

China Plans to Erect 30 NPPs More



Japan: On the Way to Number 2 in Nuclear Power



- ▶ Fourth-largest energy market, after USA, China und Russia
- ▶ High dependence (80%) of primary energy imports
- ▶ Nuclear share of electricity > one third
- ▶ 54 Reactors in operation, installed capacity totals 45 500 MW
- ▶ 3 units under construction, 12 more units planned to go on line by 2015
- ▶ New Energy Policy Law of 2002:
 - Strives for balance between environment, security of supply and market forces
 - Heavy reliance on nuclear to reduce greenhouse gas emissions

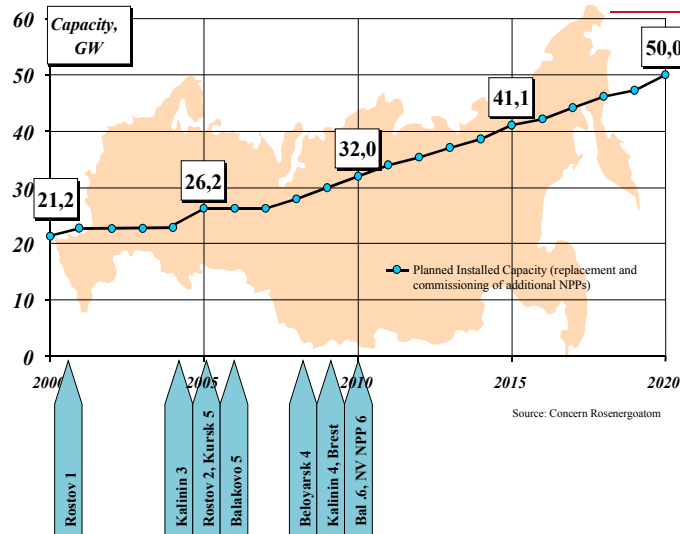
Nuclear Power in India



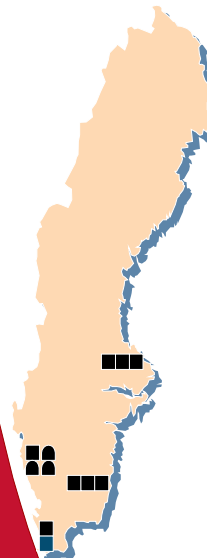
- > Non-signatory of the 1970 Nuclear Non-Proliferation Treaty (NPT)
- Two 150 MW BWRs from USA and two small Candu PHWRs are under safeguards
- > Independent reactor technology and nuclear fuel cycle
- > Program based on domestic heavy-water reactors, complemented by fast breeders and imported VVERs
- > 14 NPPs (90-200 MWe) in operation, totalling 2493 MWe
- > 9 NPPs (200 – 950 MWe) under construction, totalling 3688 MWe
- > Installed nuclear capacity planned for 2020 is ~ 20.000 MWe
- > Nuclear share in electricity:

2001	3,7 %
2005	10 %

Russia banks on nuclear energy



Sweden: Stop of Phase-out ?



- **Energy situation:**
 - ▶ Power intensive, export oriented industry
 - ▶ Nuclear power has important share 2002: 46 % (hydro 46 %, fossil 8 %)
 - ▶ 11 NPPs, capacity 8850 MW
- **Energy politics**
 - ▶ In 1980 decided: Phase-out to be completed by 2010
 - ▶ Now: phase-out date lifted in 1998, no new date defined
 - ▶ Only 1 NPP (615-MW unit Barsebäck 1) shut down in 1999
 - ▶ Power uprate of other 11 NPPs until 1999 by 620 MW
 - ▶ No sustainable concept for replacement of nuclear power
 - ▶ Discussion on lifetime extension for existing NPPs (40 yrs +)
 - ▶ Industry and trade unions are pro-nuclear
 - ▶ 67 % of population are against shut-down of Barsebäck 2
 - ▶ Liberal party demands to allow construction of new units

Finland: Why additional Nuclear Power?



New nuclear power plant

Covers partly the additional electricity demand and replaces old power plants

Enables, together with renewable, the fulfillment of the Kyoto commitments

Secures stable and predictable electrical price

Reduced the dependence on electricity import



OLKILUOTO, 2009

Future Possible NPP Projects and Market Potential

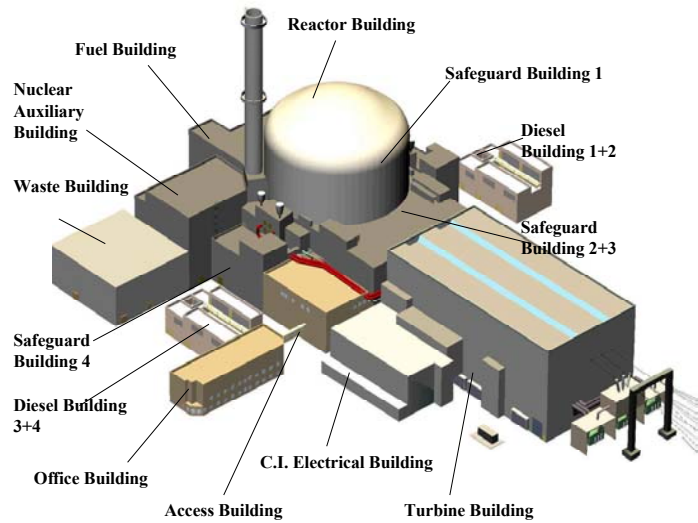
- Belgium: **Secretary of State for Trade and Industry intends to cancel phasing out decision from 2002**
- UK: **New NPPs considered in order to reach climate protection targets.**
- Switzerland: **National electricity supplier consider to replace NPPs Beznau 1 + 2 and Mühleberg till 2020 by a new big NPP (e.g. EPR-type)**
- Italy: **Italy ensures NPP resources in France and Slowakia, „It is too expensive to refrain from nuclear power“ Berlusconi said.**
- Bulgaria: **Government decided to restart completion of NPP Belene in order to replace Kozloduy Units 1 - 4**
- Lithuania: **Considerations to erect a NPP of western type for compensation of Ignalina's (RBMK Type, 2 x 1300 MW) shut down.**
- Brazil: **Construction of Angra 3 considered**
- Argentina: **Completion of Atucha 2 under discussion**

Introduction of AREVA Current Status of Nuclear Power Generation Worldwide Nuclear Power Market Trends Worldwide

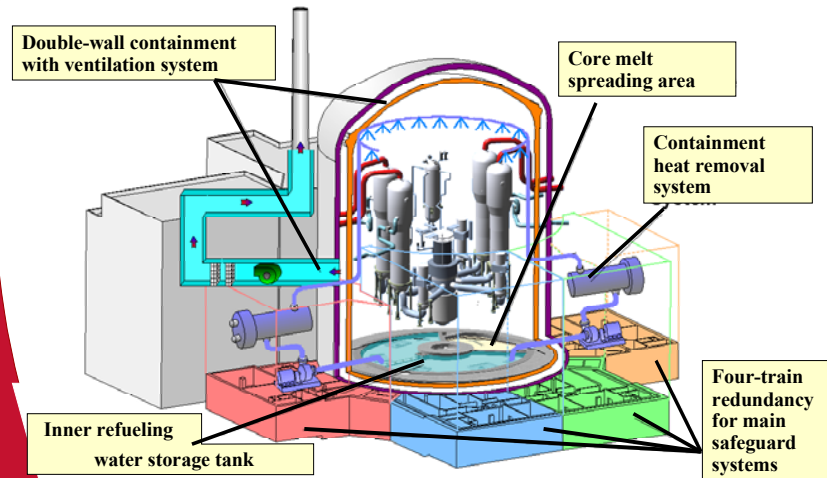
EPR

Conclusions

EPR - Plot Plan



Advanced Reactor Generation EPR - Main Safety Systems



The EPR Competitiveness

> A very cost-efficient design

- Unit power increased to about 1,600 MWe
- Secondary-side pressure increased to 78 bar, leading to 37% efficiency
- Better use of fuel burn-up greater than 60 GWd/t, lower consumption of uranium,
- Simplified maintenance: accessibility, standardization, in-service maintenance of equipment installed outside the reactor building
- Shorter refueling outages for better availability
- Lower radiation doses
- Service life of 60 years

The EPR-generated MWh cost is 10% lower than in the most recent reactors in operation

EPR Main Design Features



OBRIGADO PELA ATENCAO !

