Global Perspectives for Nuclear Power Generation

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Introduction of AREVA

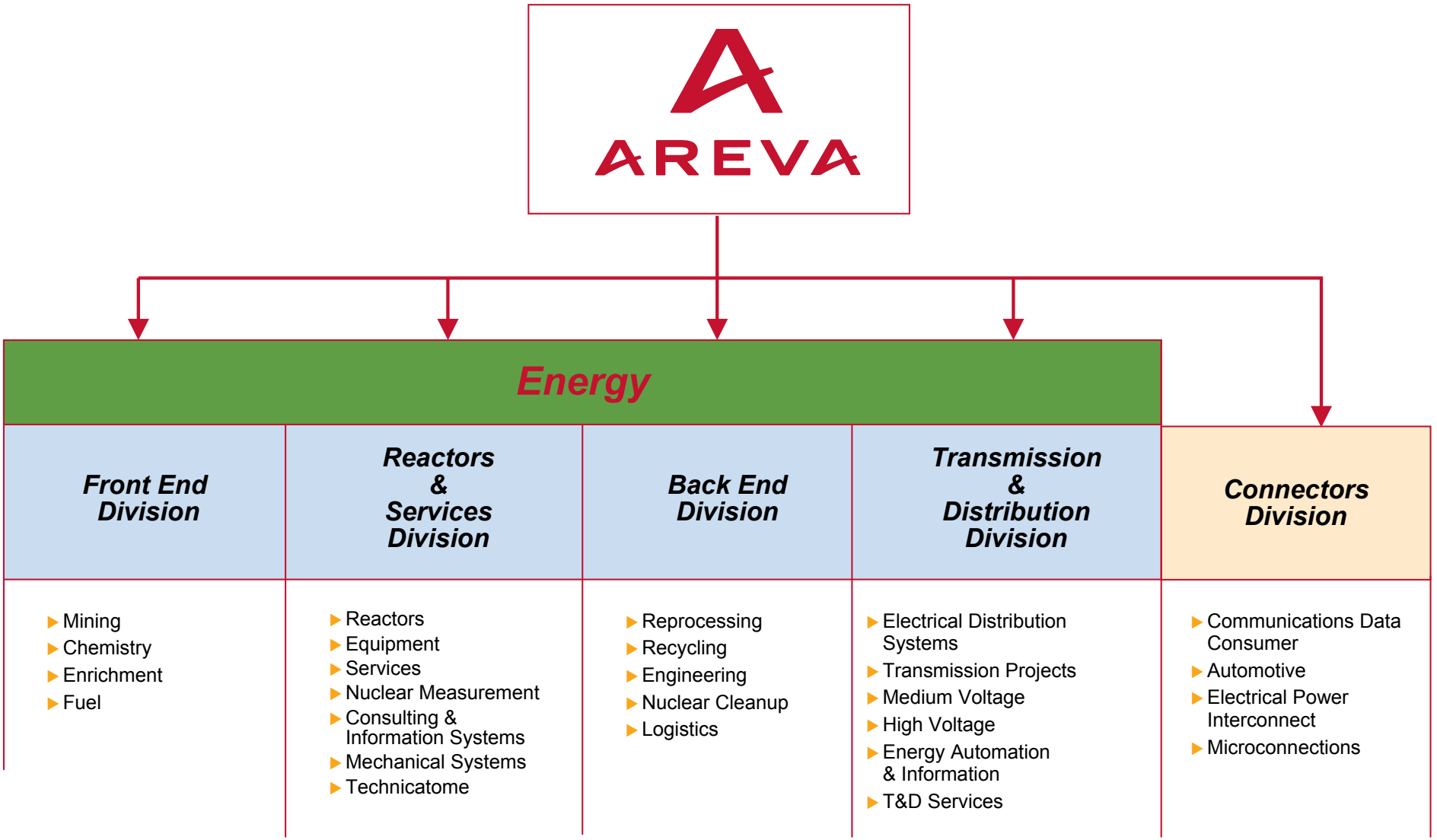
Current Status of Nuclear Power Generation

Nuclear Power Market Trends

Evolution of Reactor Technologies

Nuclear Energy in the Public Debate

Organization of the AREVA Group

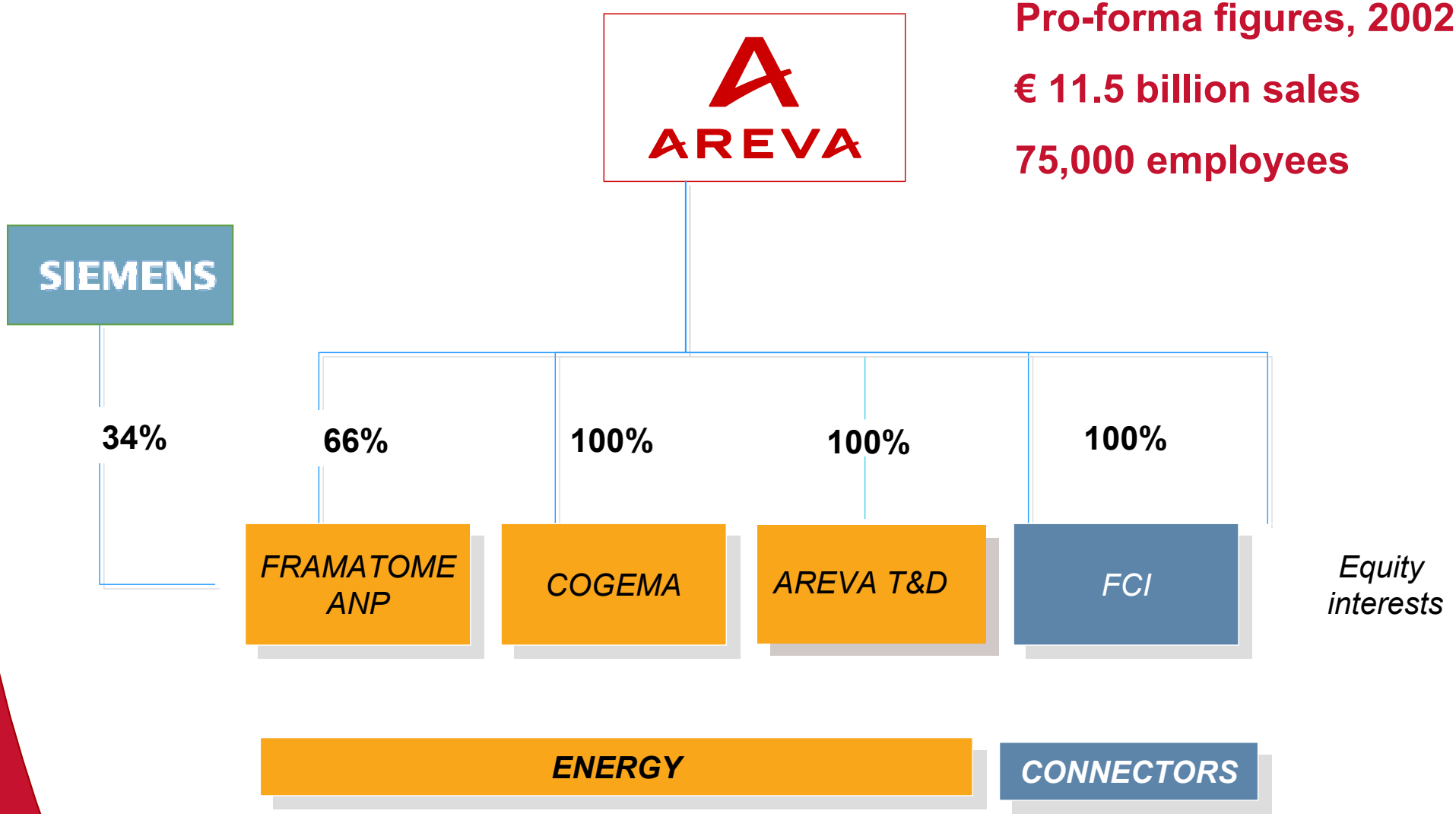


Legal Structure of the AREVA Grou

Pro-forma figures, 2002:

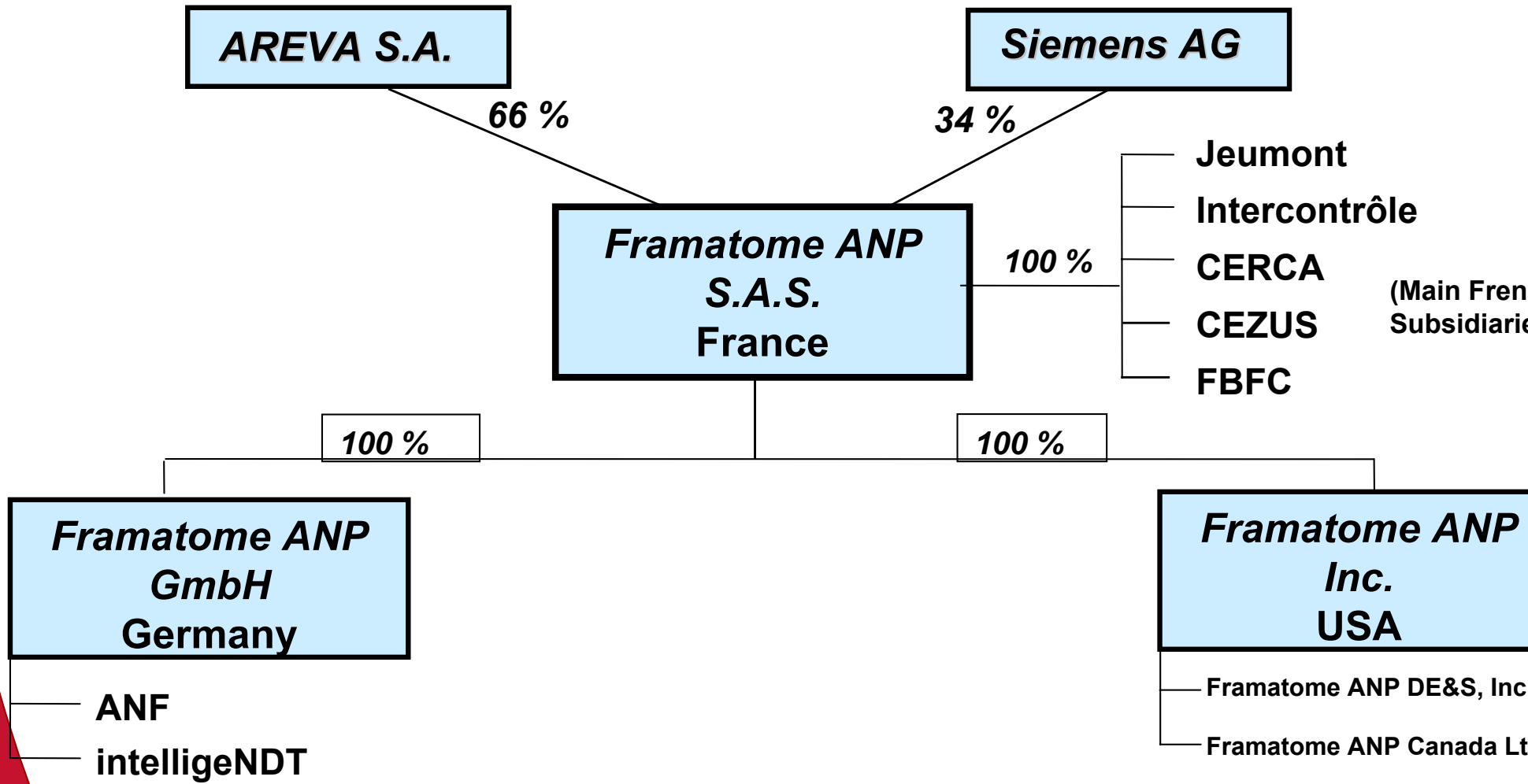
€ 11.5 billion sales

75,000 employees



Framatome ANP is an AREVA and Siemens Company

Legal Structure of Framatome ANP



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Countries with Reactors in Operation

Canada
USA
Mexico
Argentina
Brazil

Finland
Sweden
Netherlands
Belgium
France
Germany
Switzerland
Slovenia
Spain
United Kingdom

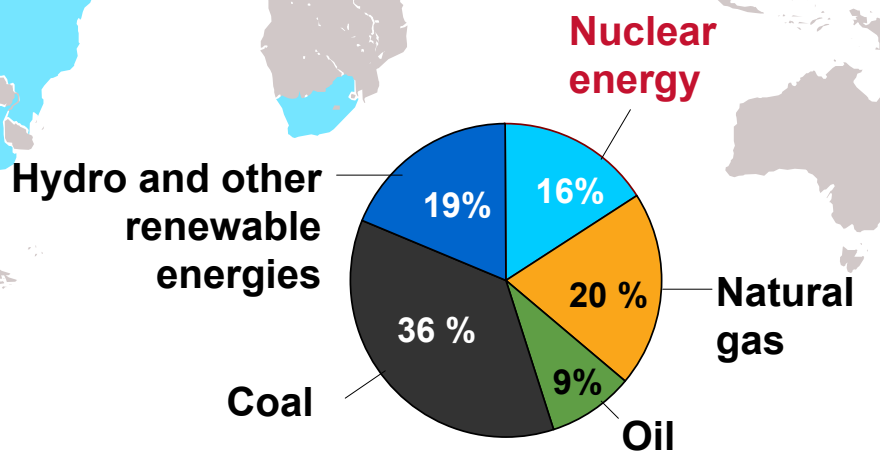
Countries using nuclear power represent 2/3 of the world population

Source: IAEA, WEC

Russia
Ukraine
Bulgaria
Czech Rep.
Slovakia
Hungary
Romania
Lithuania
Armenia

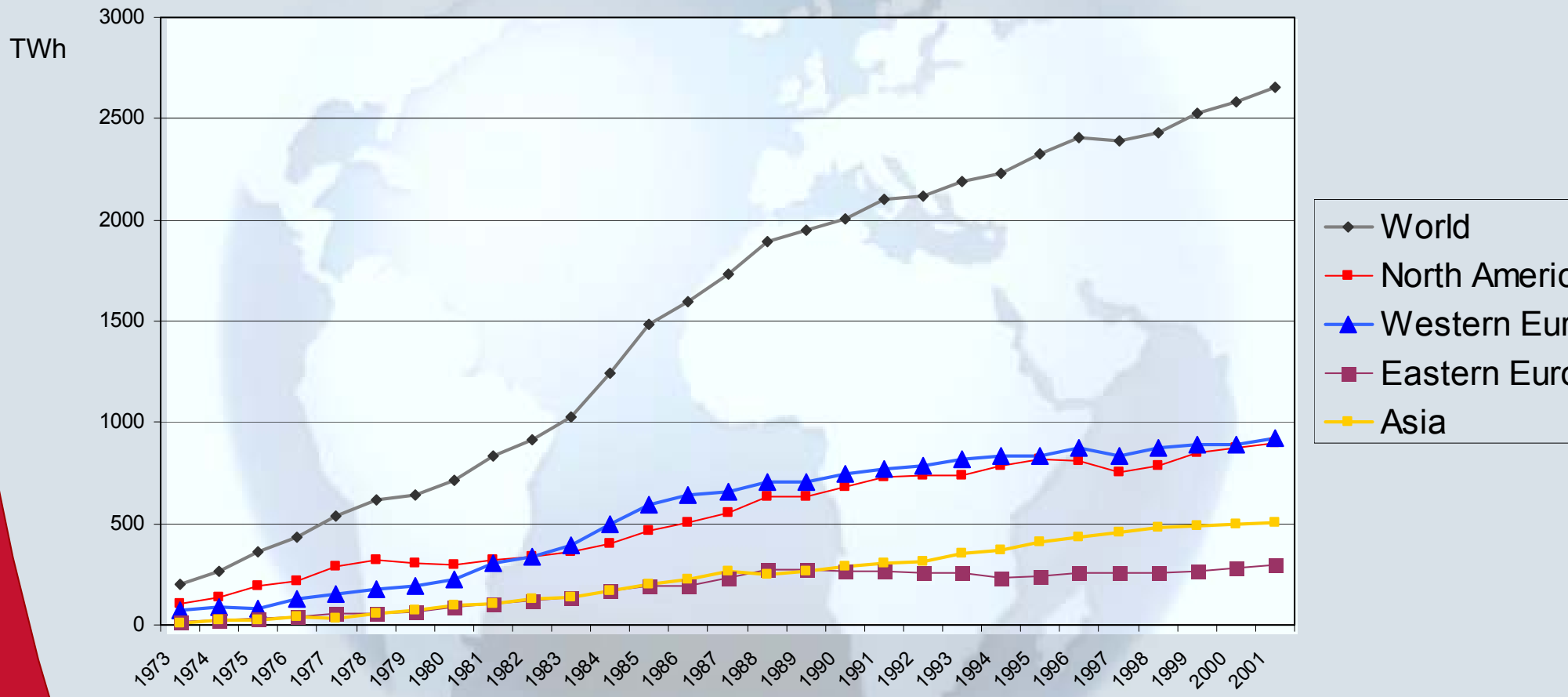
China
Japan
South-Korea
Taiwan
Pakistan
India

South-Africa



Power Generation worldwide by energy source, 2002

Nuclear Power Generation 1970-2002

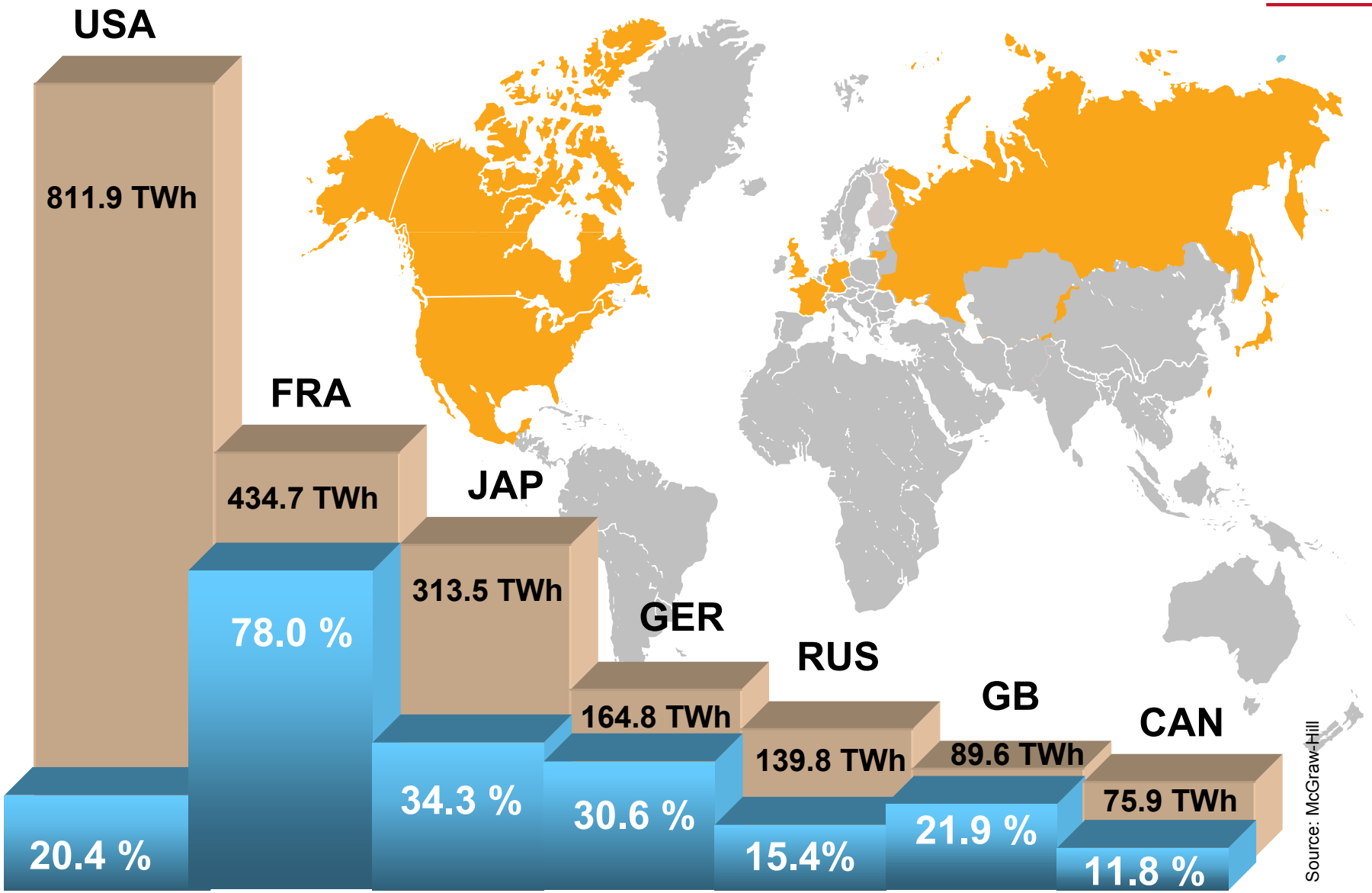


World Nuclear Power Status, January 200

	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	101	20	121	89 243
Africa	2	-	2	1 842
Total	**439**	**32**	**471**	**390 107**

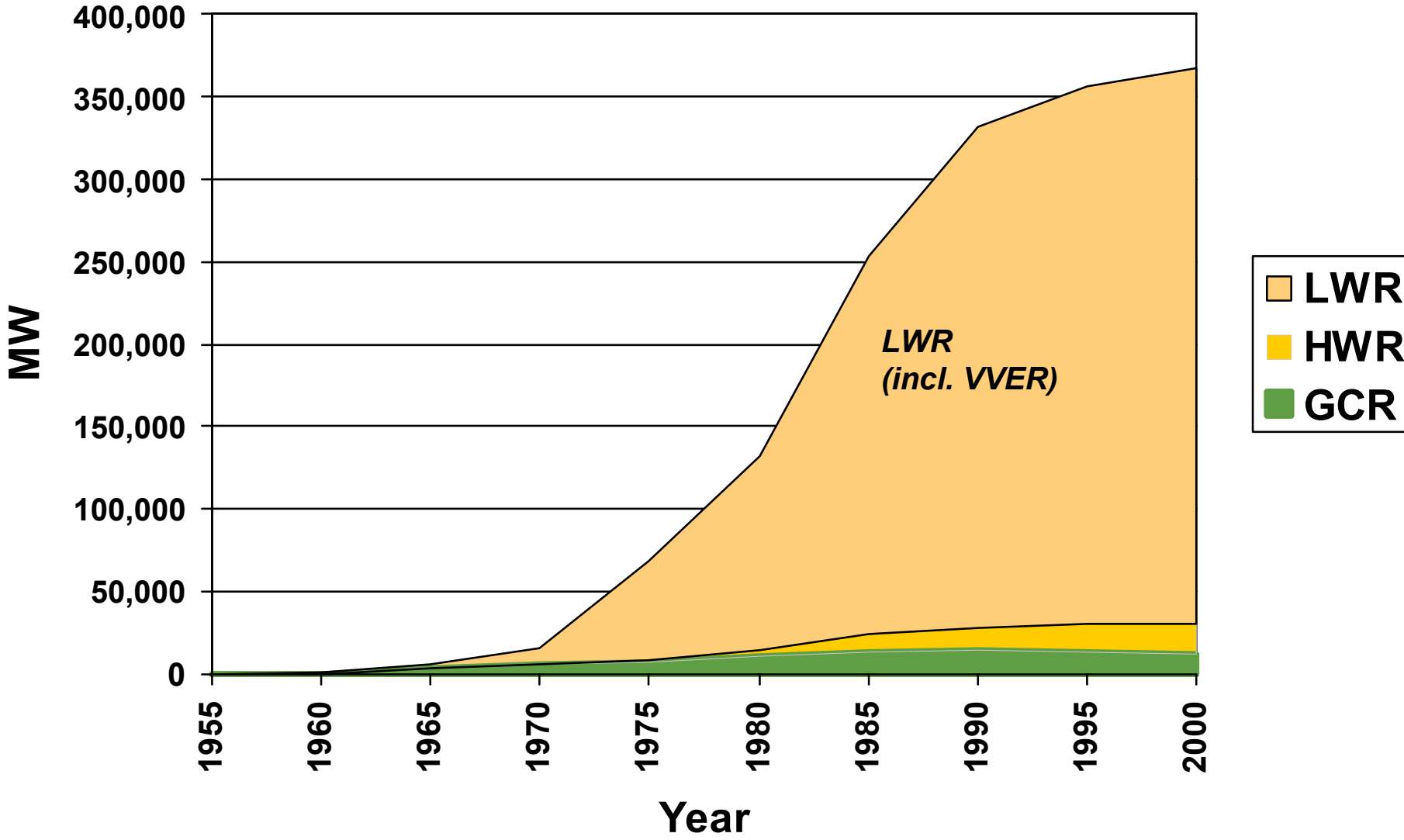
Source: IAEA, WNA

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

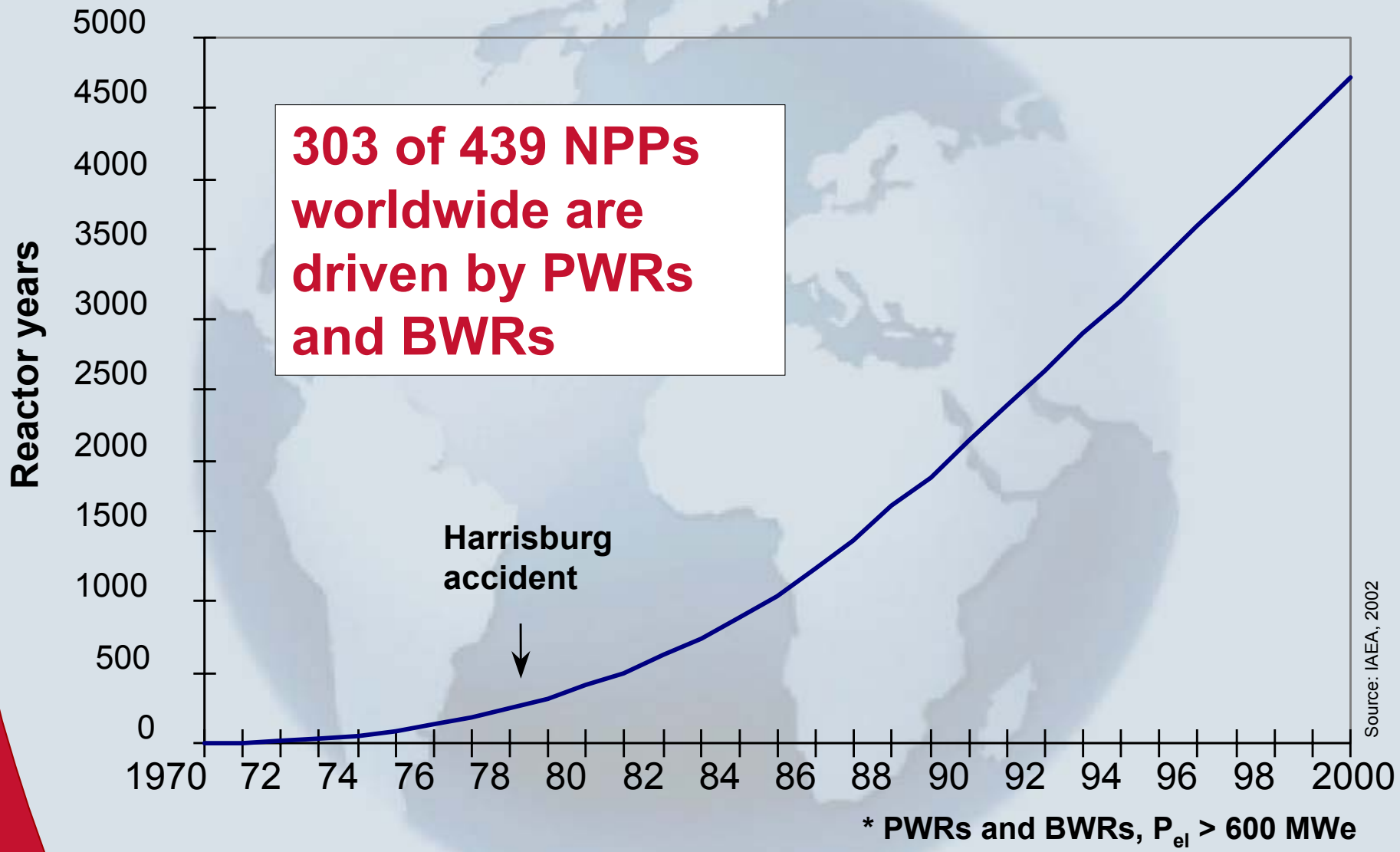


Source: McGraw-Hill

Installed NPP Capacity Worldwide by Reactor Types



Cumulative Operating Experience with Large-Capacity* Light Water Reactor



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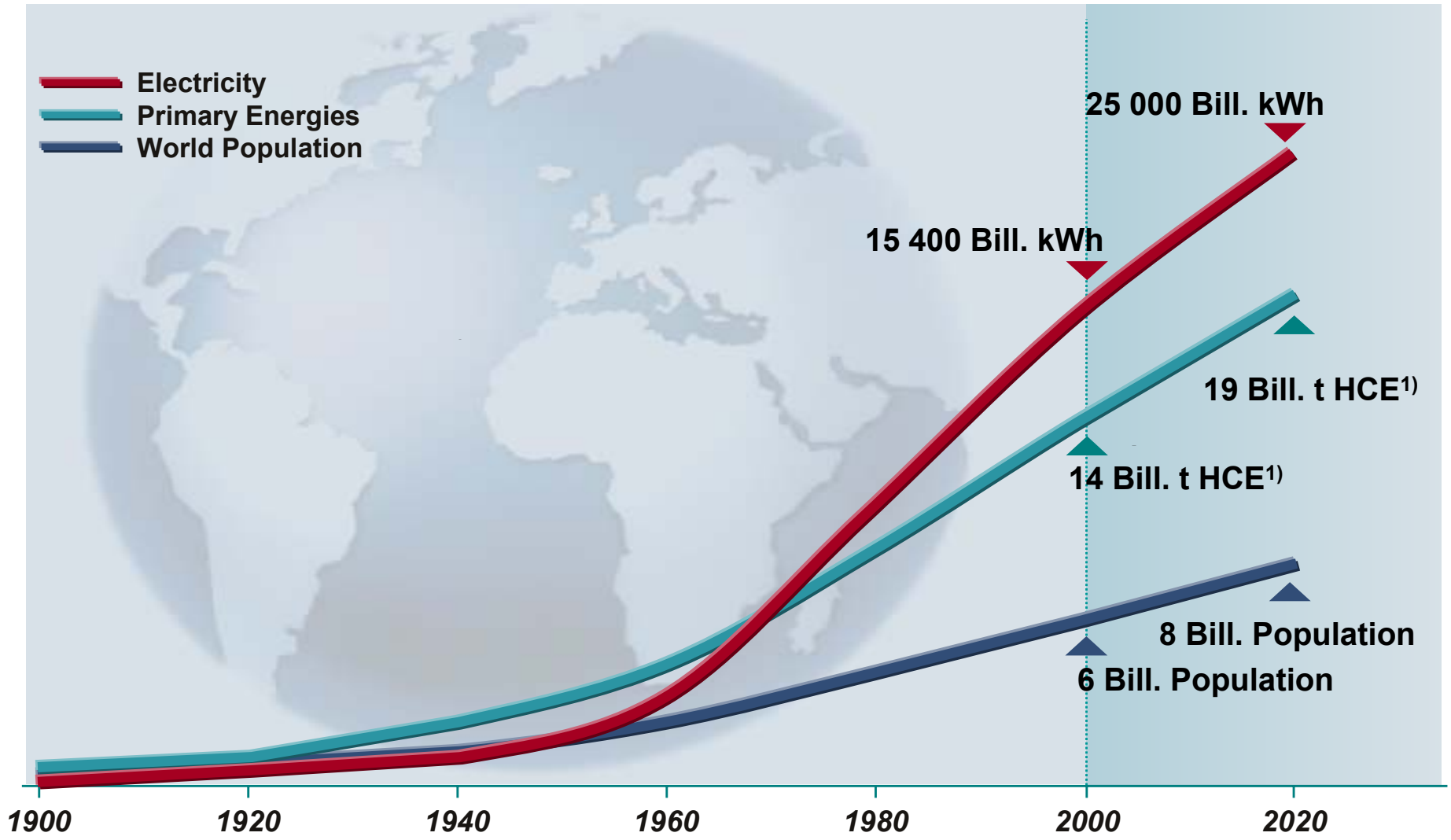
Perspectives for New NPPs

- **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 baseload power generation
  - Competitive power production costs

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

World Population, Primary Energy and Electricity Demand

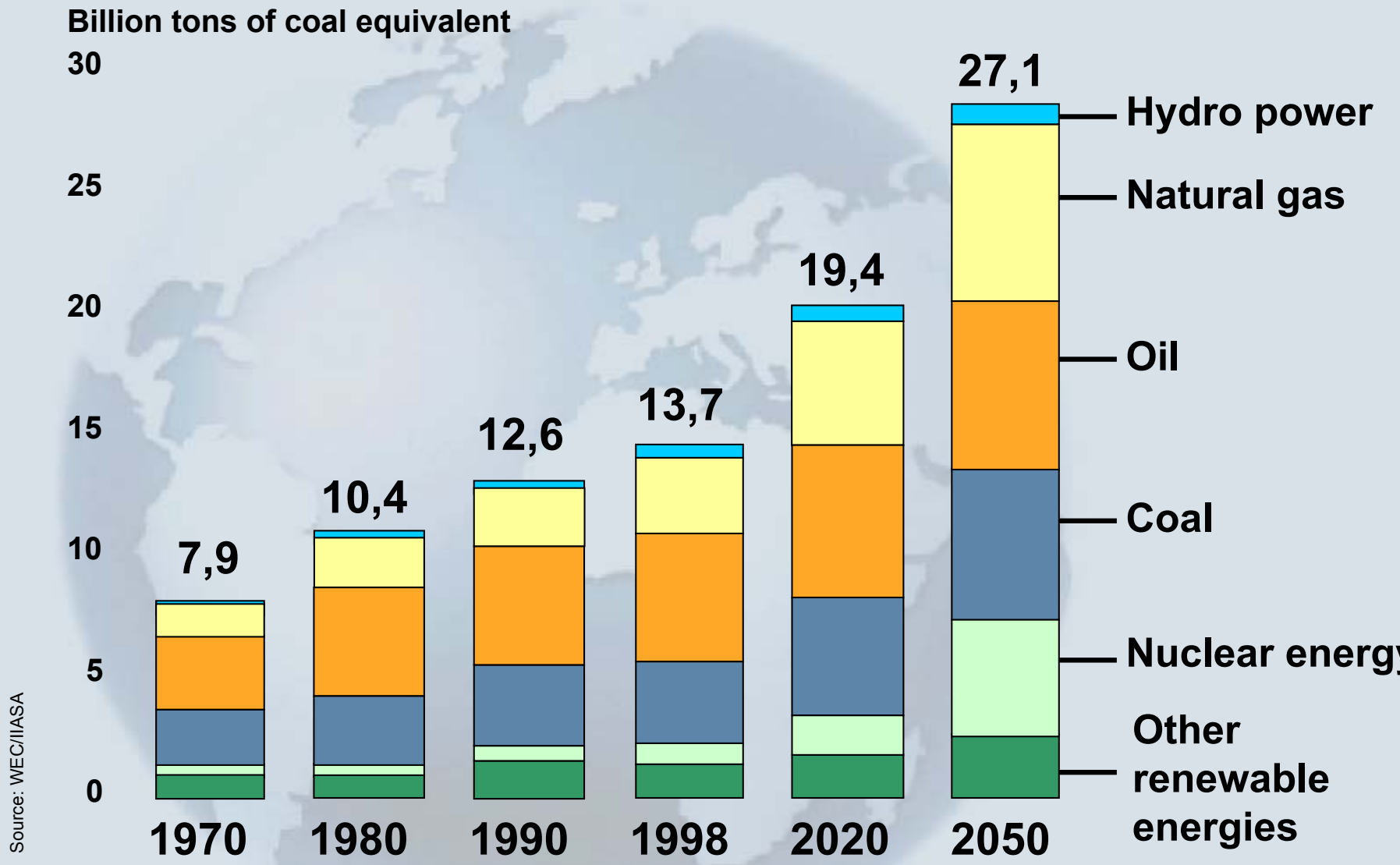


1) Hard Coal Equivalent

Source: Siemens PG, eigene Berechnungen

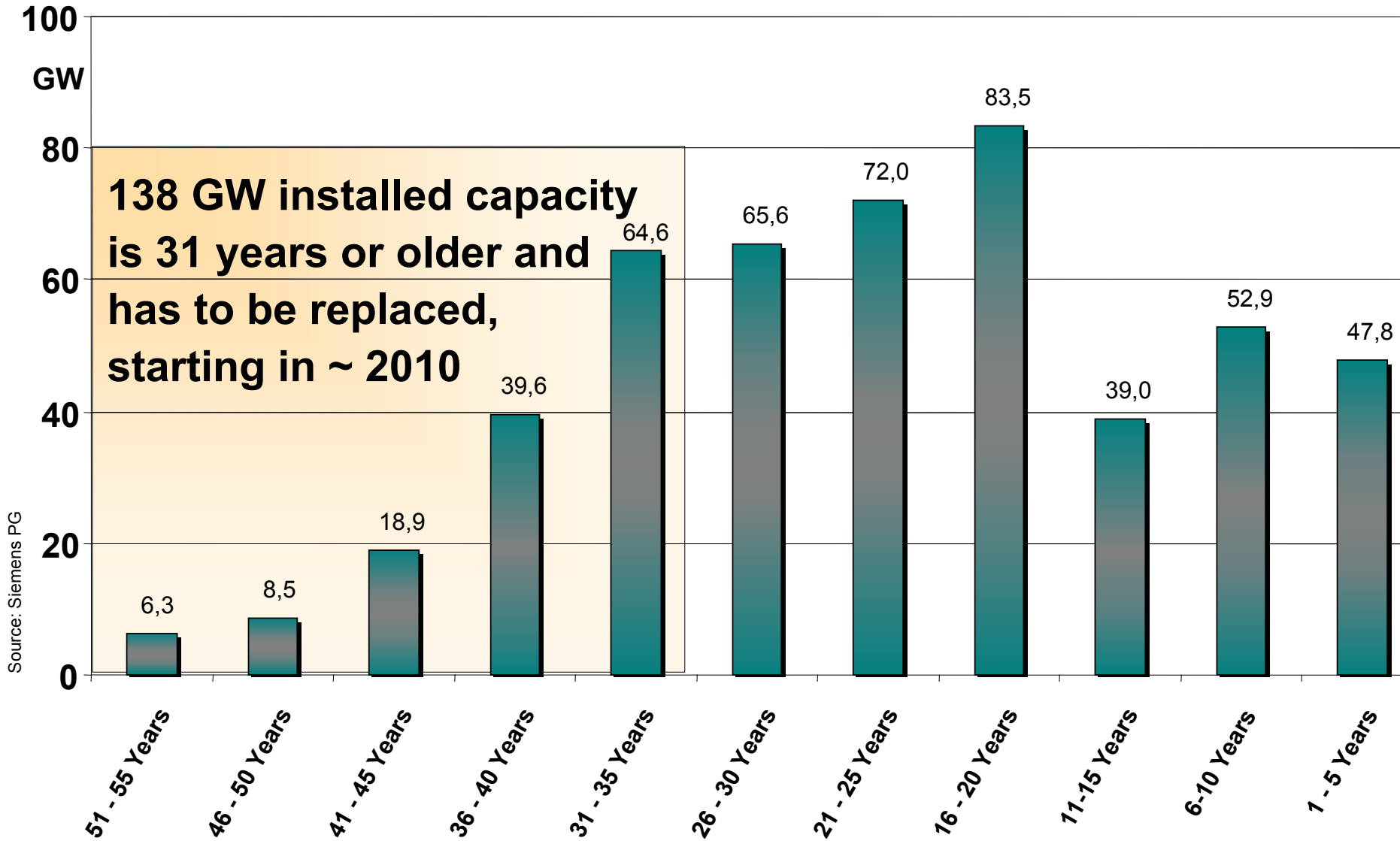
World Primary Energy Demand

(World Energy Council, Reference Scenario)

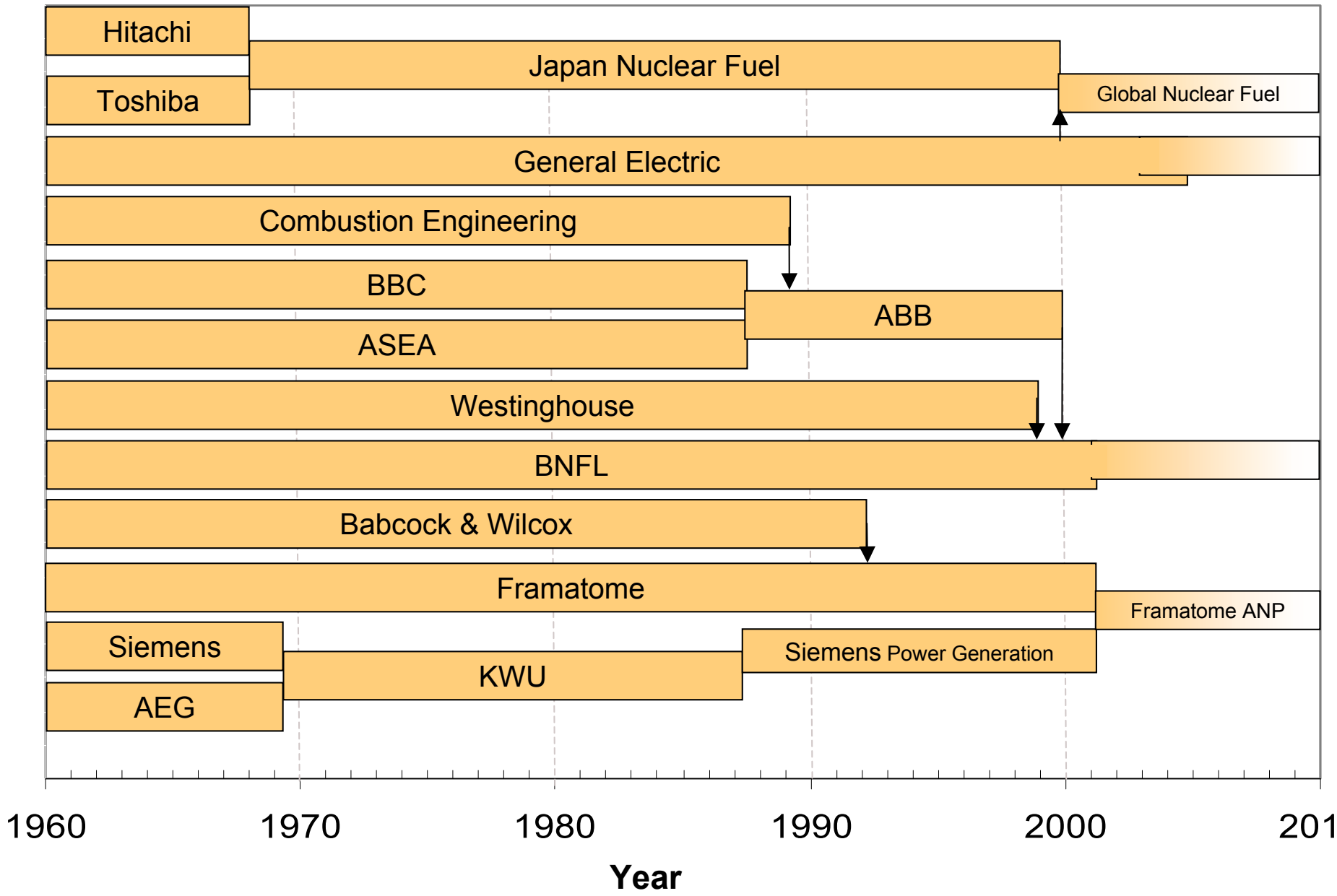


Age Structure of Power Plants in the EU-15

(of steam turbine, nuclear and combined-cycle power plants

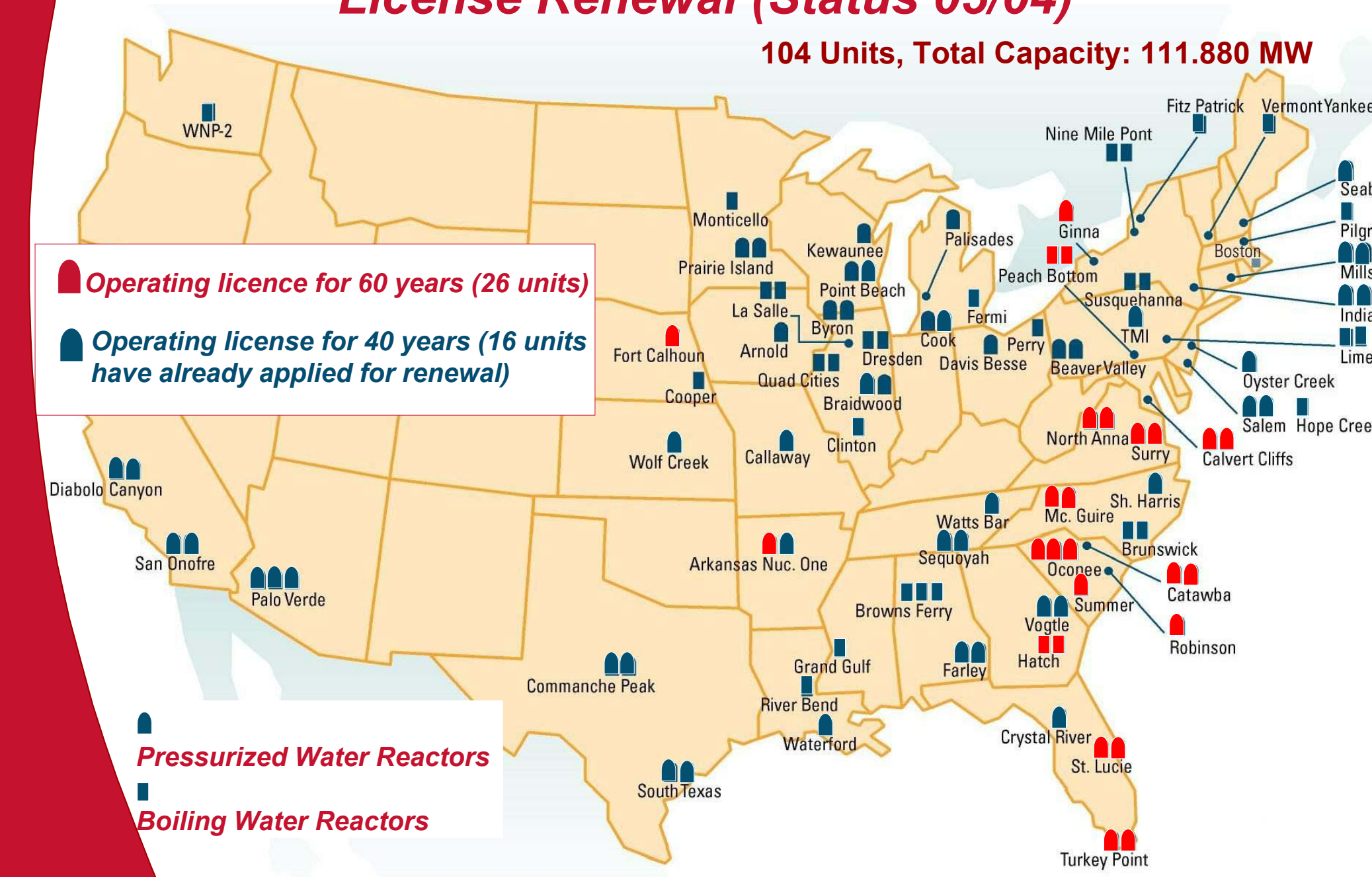


Nuclear Vendors: A Consolidated Global Marke

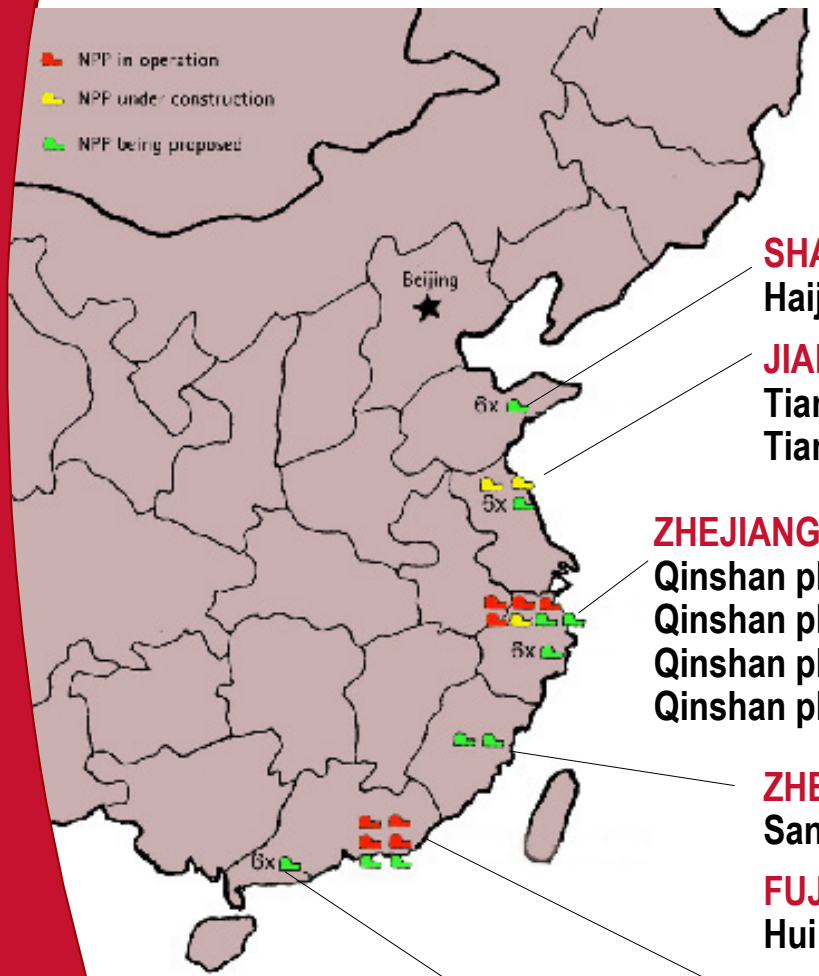


USA: Plant Applications for License Renewal (Status 05/04)

104 Units, Total Capacity: 111.880 MW



China: Challenging Nuclear Program Continu



SHANDONG
Haijang 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

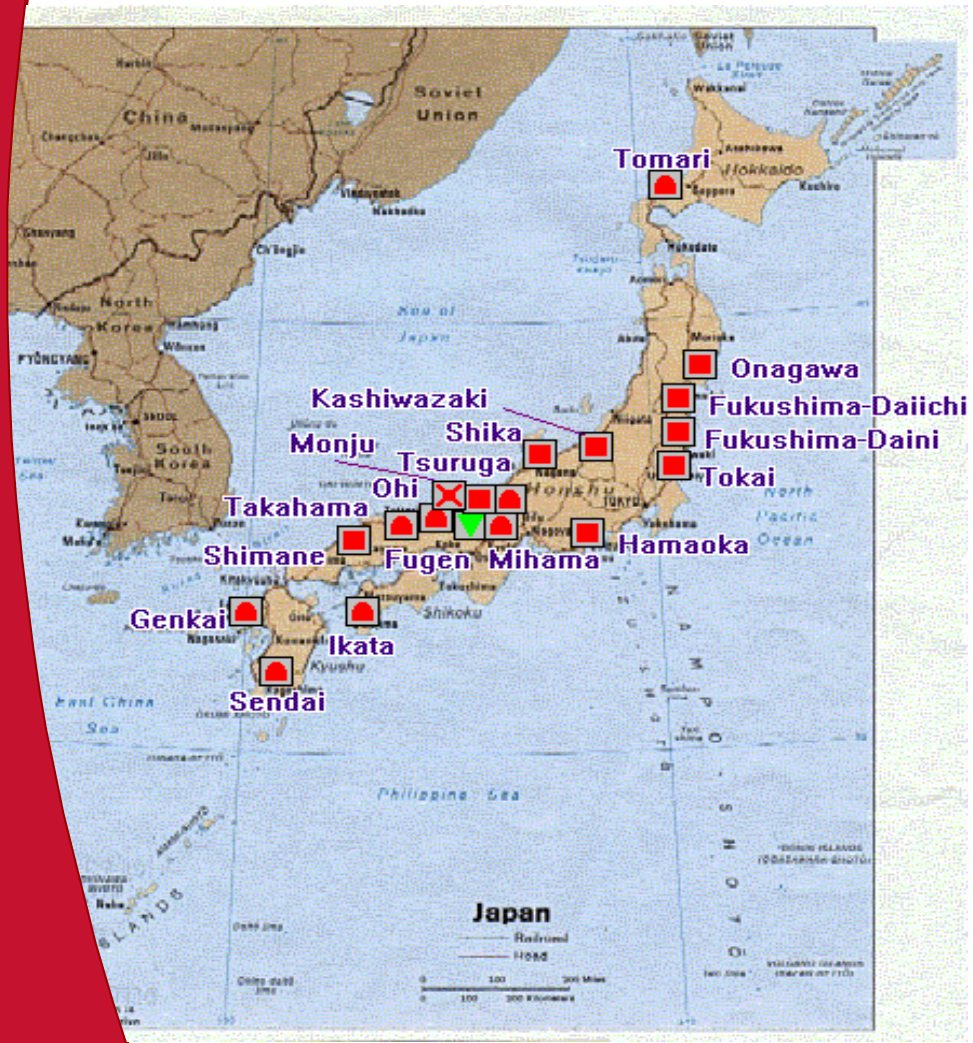
GUANGDONG
Daya Bay 2x 984 MW
Ling Ao 2x 984 MW
Ling Ao 2x 1000 MW

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 CO_2 emissions (coal productio 1.4 billion t)

- Nuclear program (Status 12/2003):
  - 8 NPP units in operation
  - 3 units under construction
  - Another 4 units to be ordered short for Qinshan and Ling Ao
  - Installed nuclear capacity to reach about 32.000 MW by 2020

Japan: On the Way to Number 2 in Nuclear Pow



- 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

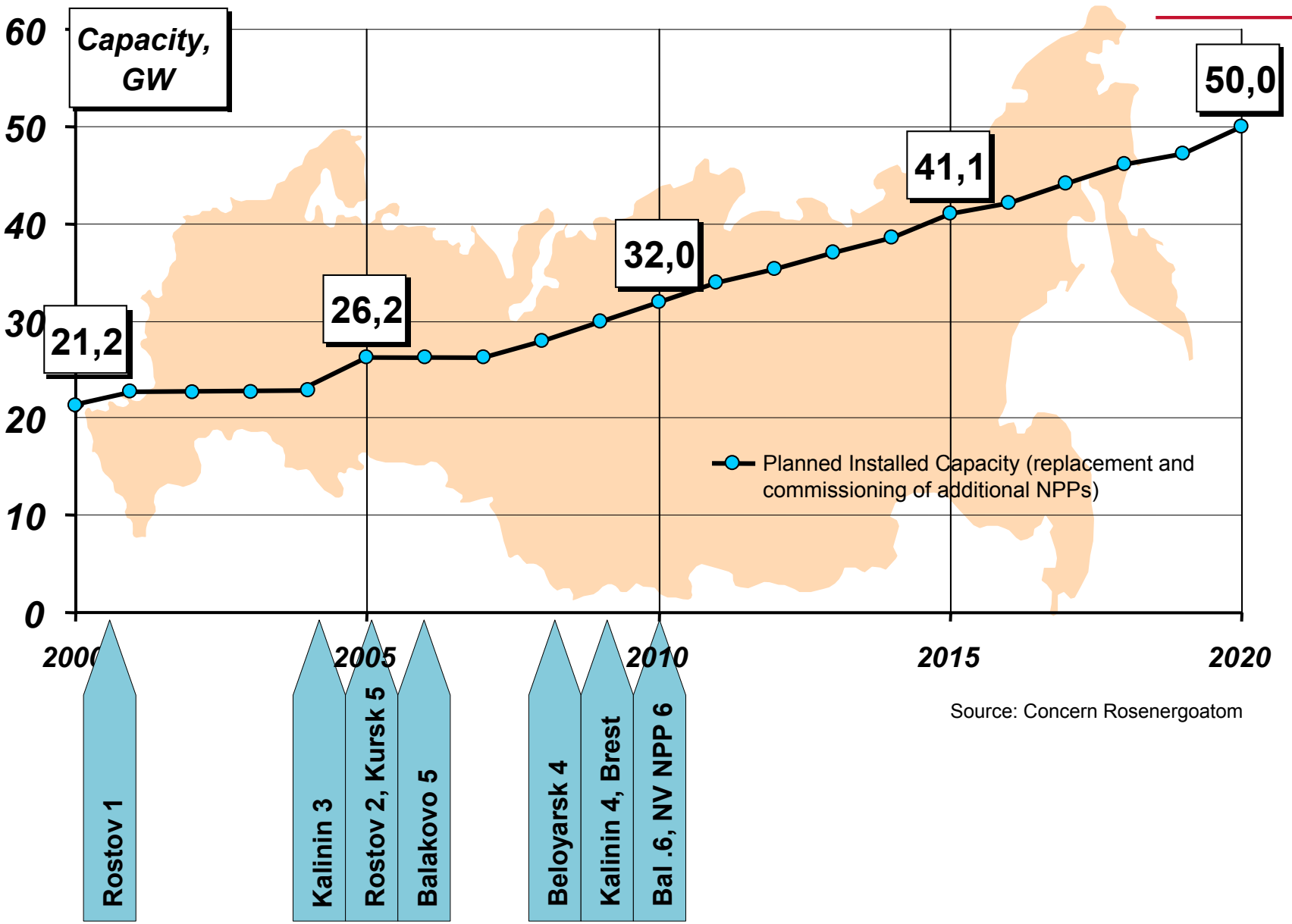
Nuclear Power in India

- Non-signatory of the 1970 Nuclear Non-Proliferati 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 %

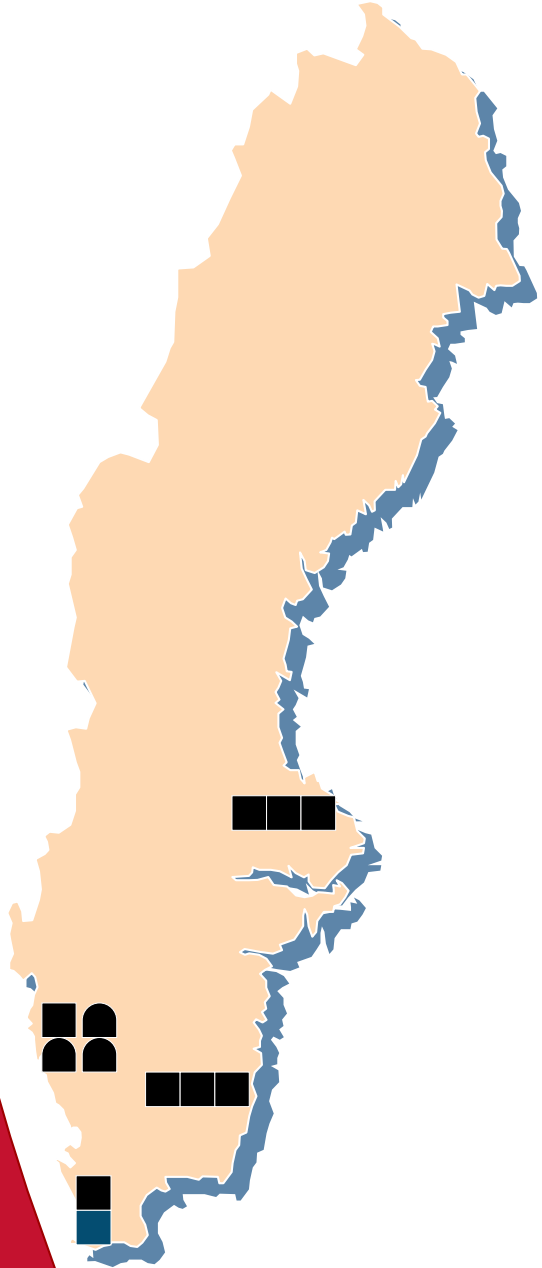
  2005 10 %

Russia banks on nuclear energy



Source: Concern Rosenergoatom

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 renewables, the fulfilment of the Kyoto commitments

Secures stable and predictable electrical price

Reduced the dependence on electricity import

Finland
Political Steps to the Approval for the 5th NPP

> 1998	Finnish utilities announce intention to build new NPP to cover demand growth. Feasibility studies show that nuclear is the most economical option
> 1999	Posiva selects Olkiluoto as site for final repository for spent fuel assemblies
> 2000, Dec. 21	Government approves choice of Olkiluoto for final repository of spent fuel
> 2000, Nov. 15	Utility TVO applies for government approval („decision in-principle“) of new PWR or BWR in the 1000 – 1600 MW range at Olkiluoto or Loviisa
> 2001, March 27	Government decides „National Climate Strategy“ that recognizes the construction of new NPPs as an option for climate protection
> 2001, May 18	Parliament ratifies almost unanimously (including majority of Greens) government decision on spent-fuel repository site
> 2002, Jan. 17	Government approves new NPP project
> 2002, May 24	Parliament ratifies government approval


OLKILUOTO , 2009

New NPP Projects in Europe to Replace aging NPPs

France

- Construction of EPR demo plant to be launched in 2004
- Replacement of aging NPPs by EPRs starting 2015 - 2020

Switzerland

- Utilities plan to replace Beznau 1 + 2 and Mühleberg by 1 EPR-sized new NPP by 2025

Bulgaria

- To replace old Kozloduy units, government decided to restart Belene project

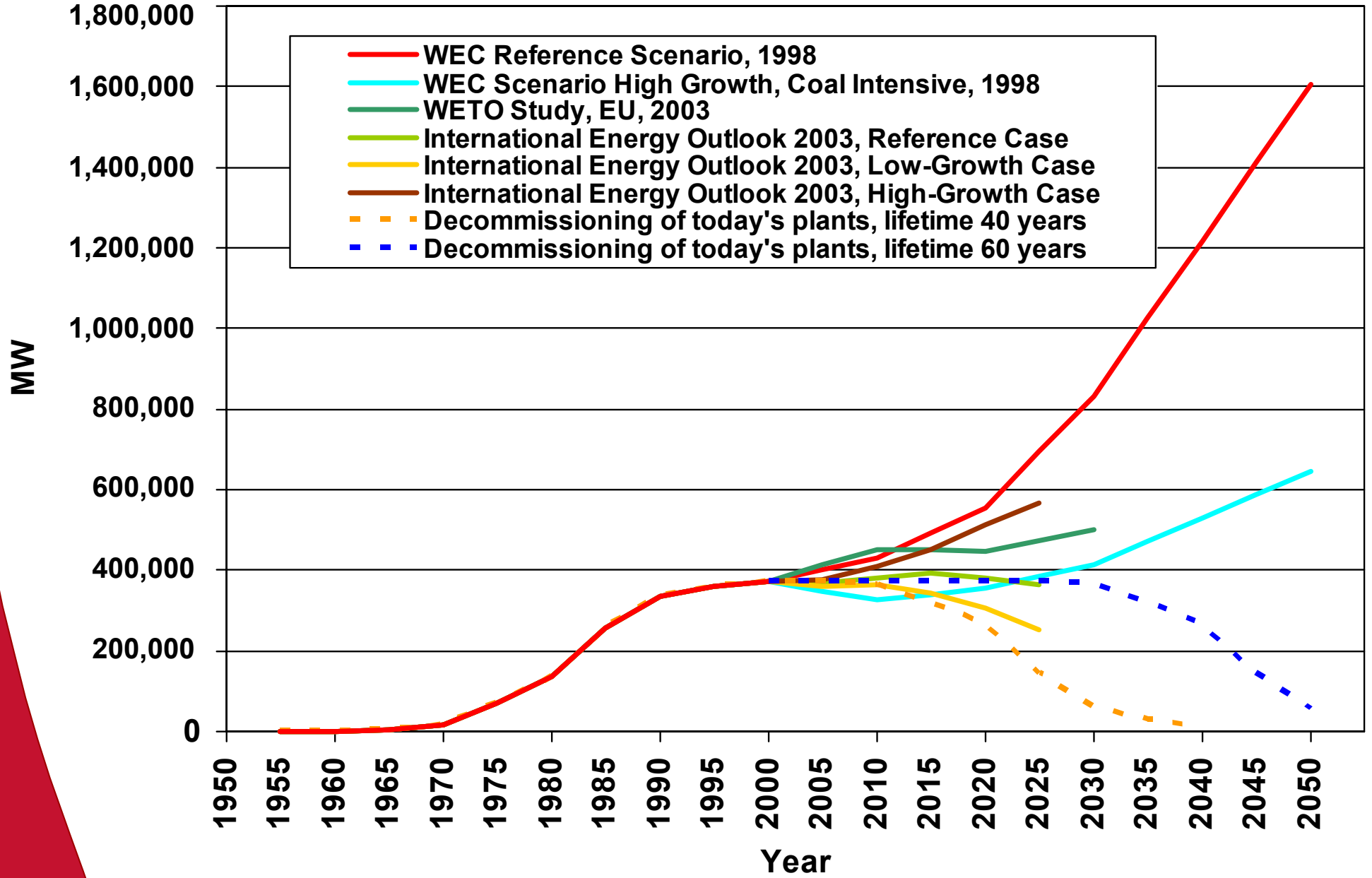
Lithuania

- To compensate for shut-down of Ignalina (RBMK type, 2 x 1300 MW), a new Western-type NPP project is under consideration

Programs for Final Repositories for High-Activity Waste (selected countries

Country	Program Status	Underground Laboratory	Candidate Site for Final Repository	Geology
Belgium	HADES Underground Research Facility in operation	HADES URF, Mol	Open	Clay
Canada	Concept demonstration	URL	Open	Granite
Finland	**Site approved by Parliament. Exploration underway**		**Olkiluoto**	**Granite**
France	Survey of potential sites underway	Bure Granite site open	Open	Clay Granite
Germany	**Gorleben Site exploration interrupted by moratorium**	**Asse**	**Gorleben ?**	**Rock sal**
Spain	Geological survey completed. Site decision after 2010	-	Open	Granite Salt, Clay
Sweden	**Exploration of two sites underway. Site decision planned for 2007**	**Stripa (closed) HRL Äspö**	**Östhammar Oskarshamn**	**Granite Granite**
Switzer-land	Feasability study for Benken (opalinus clay) completed in 2002	Grimsel Mont Terri	 Benken	Granite Clay
USA	**Site selected in 2002. Licence application planned for 2004, start of operation 2010**	**Yucca Mountain**	**Yucca Mountain**	**Tuff**

Forecasts for Worldwide Installed Capacity of NPP



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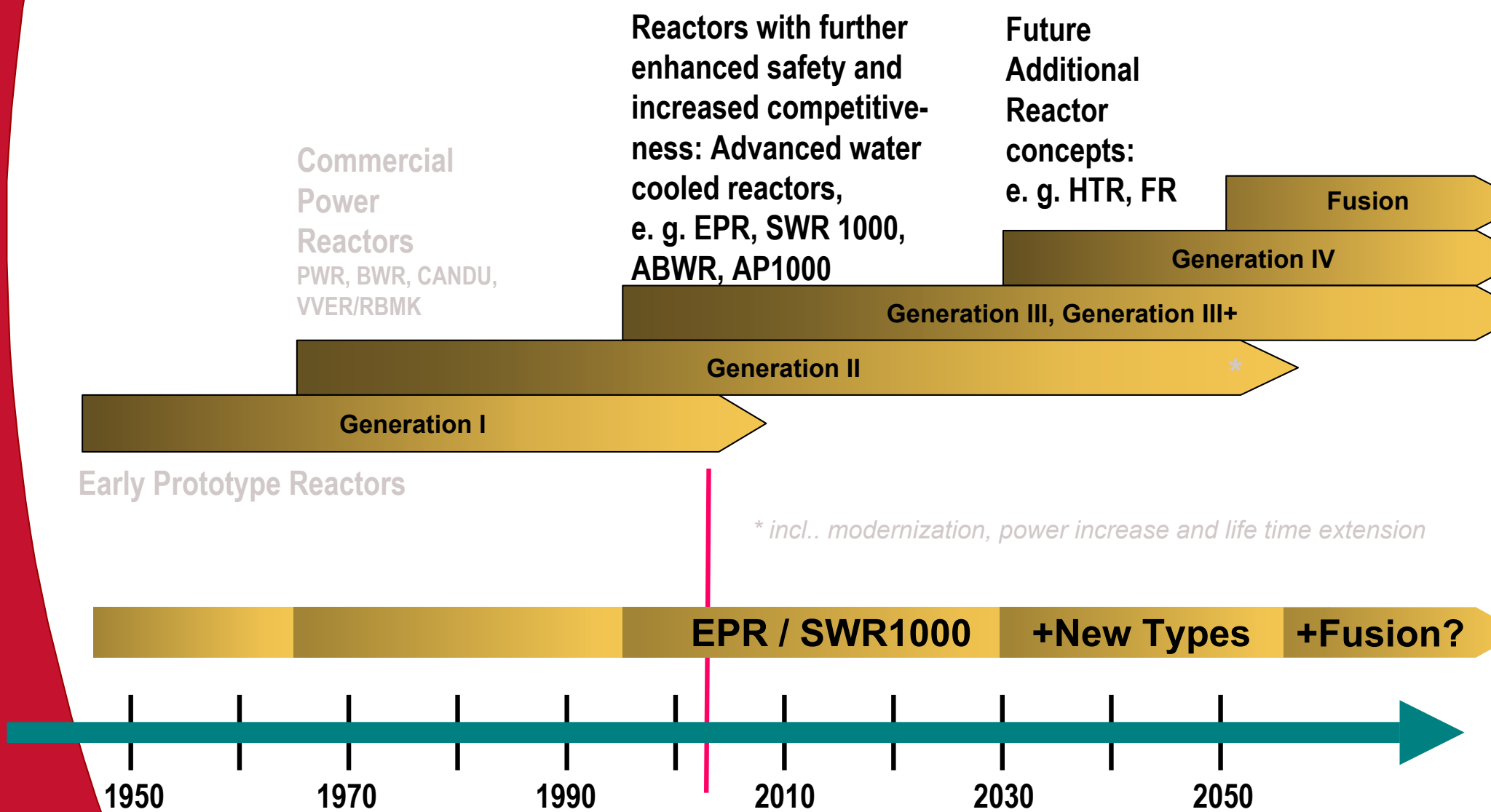
Reactor Generations



Certification in the U.S for New Water-cooled Reactors

Reactor Design	Lead Vendor(s)	Design Category	Status at NRC
System 80+	Westinghouse BNFL	PWR	Certified
ABWR	GE, Toshiba, Hitachi	BWR	Certified
AP600	Westinghouse BNFL	PWR	Certified
AP1000	Westinghouse BNFL	PWR	Certification
ESBWR	GE	BWR	Pre-certification
SWR-1000	Framatome ANP	BWR	Pre-certification
ACR-700	AECL	PHWR	Pre-certification
IRIS	Westinghouse BNFL	PWR	Pre-certification
EPR	Framatome ANP	PWR	No application decision
ACR-1000	AECL	PHWR	No application decision

Source: US DOE EIA

EPR, the European 3rd-Generation Reacto

- The EPR results from a Franco-German cooperation since 1993 involving:
  - Safety Authorities
  - Utilities
  - Framatome and Siemens KWU (now merged into Framatome ANP)
- The EPR follows the rules of the French and German safety authorities
- The EPR takes into account the European Utility Requirements (EUR) as well as the Utility Requirements Document (URD) of the U.S. Electric Power Research Institute
- Two-fold goal:
  - Further enhance safety
  - Improve economics

An Evolutionary Design Built on Experience from the Most Recent Reactors

		EPR	N4 Framatome	Konvoi Siemens
Thermal power	MWth	4300	4250	3850
Electrical power	Mwe	~1600	1450	~1400
Efficiency	%	37	34	34,5
Number of primary loops		4	4	4
Number of fuel assemblies		241	205	193
Service lifetime	years	60	40	-

Chooz 1-2
Civaux 1-2

Neckar 2
Emsland
Isar 2

> 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 more 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

The EPR Safety Improvements (1/2)

> Reinforced prevention of core meltdown accidents

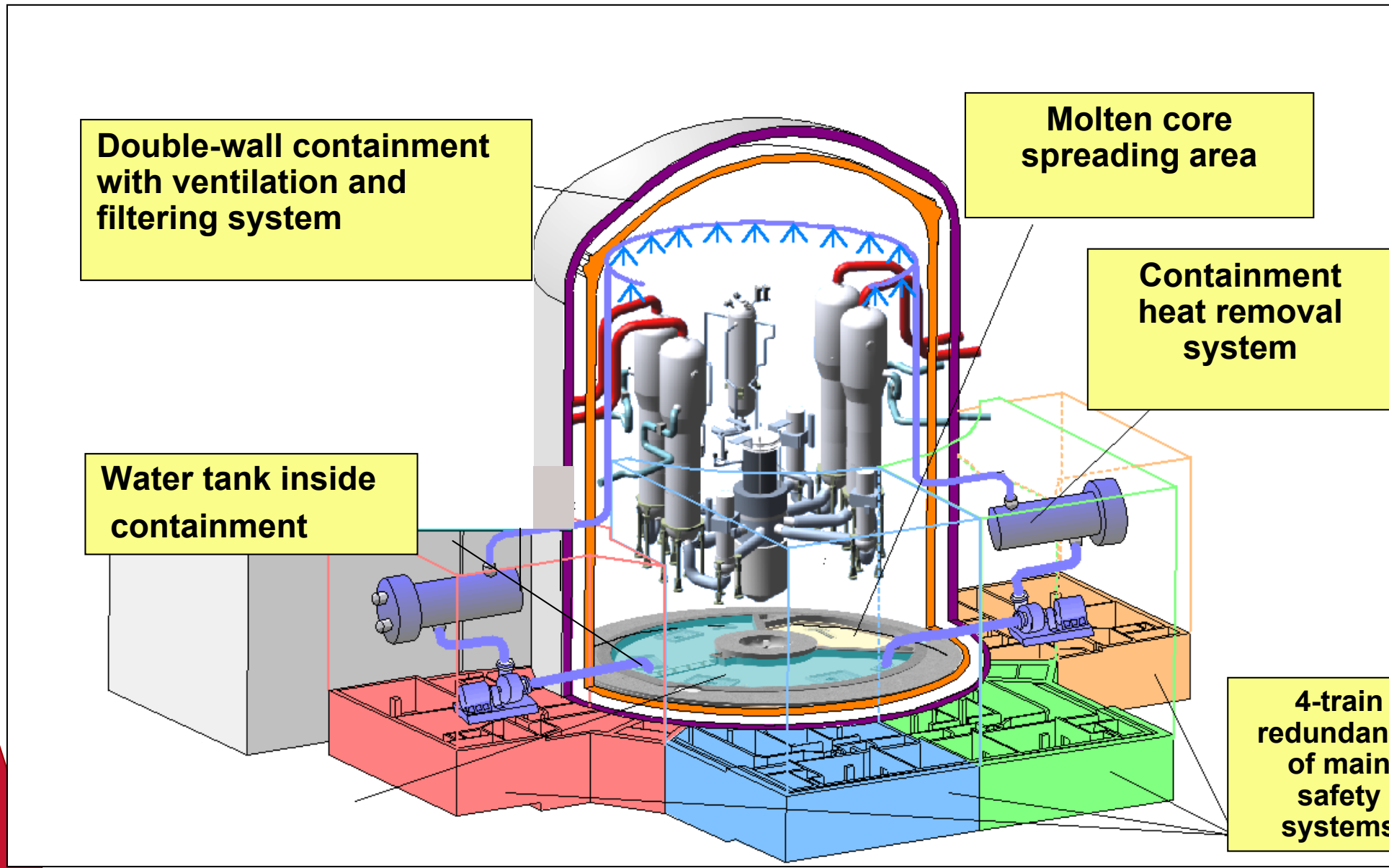
- Increased water inventory of the primary coolant system
- Reduced probability of initiating events of internal origin
- Increased reliability of safeguard systems in particular, through the use of a 4-fold redundant, diversified and separate system

> Protection against the consequences of core meltdown

- Elimination of the risk of core meltdown in the high-pressure reactor vessel
- Spreading of corium under the reactor vessel and protection of the concrete
- Hydrogen recombiners

> Protection against external (airplane crash) and internal risks (fire, flood)

Main safety systems of the EPR



International Programs for New Reactor Types

Goals

- *Innovative technical options for deployment in 20 - 30 years at the earliest*
- *Use of nuclear energy not only for power generation but also for process heat, desalination and H_2 production*
- *Improvement of economy, safety, proliferation resistance and minimization of nuclear waste*
- *Inclusion of industrialized and developing countries*

Proceeding

- *International cooperation in substantiating goals, predefinition of criterias*
- *Selection of promising reactor types and appropriate nuclear fuel cycles*

International Programs for New Reactor Types *(cont.)*

International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

- *IAEA special program under considerable Russian influence; participants comprise 12 countries plus the EU Commission*
- *Holistic approach based on various demand scenarios; comprehensive catalog of criteria for economic efficiency, safety, safeguards and waste management currently being developed*

Generation IV International Forum (GIF)

- *10 countries, led by USA (Department of Energy)*
- *6 reactor types selected, all requiring considerable further development, although in some cases the basic concept has been known for decades*
- *Formation of multilateral development partnerships is a key objective*

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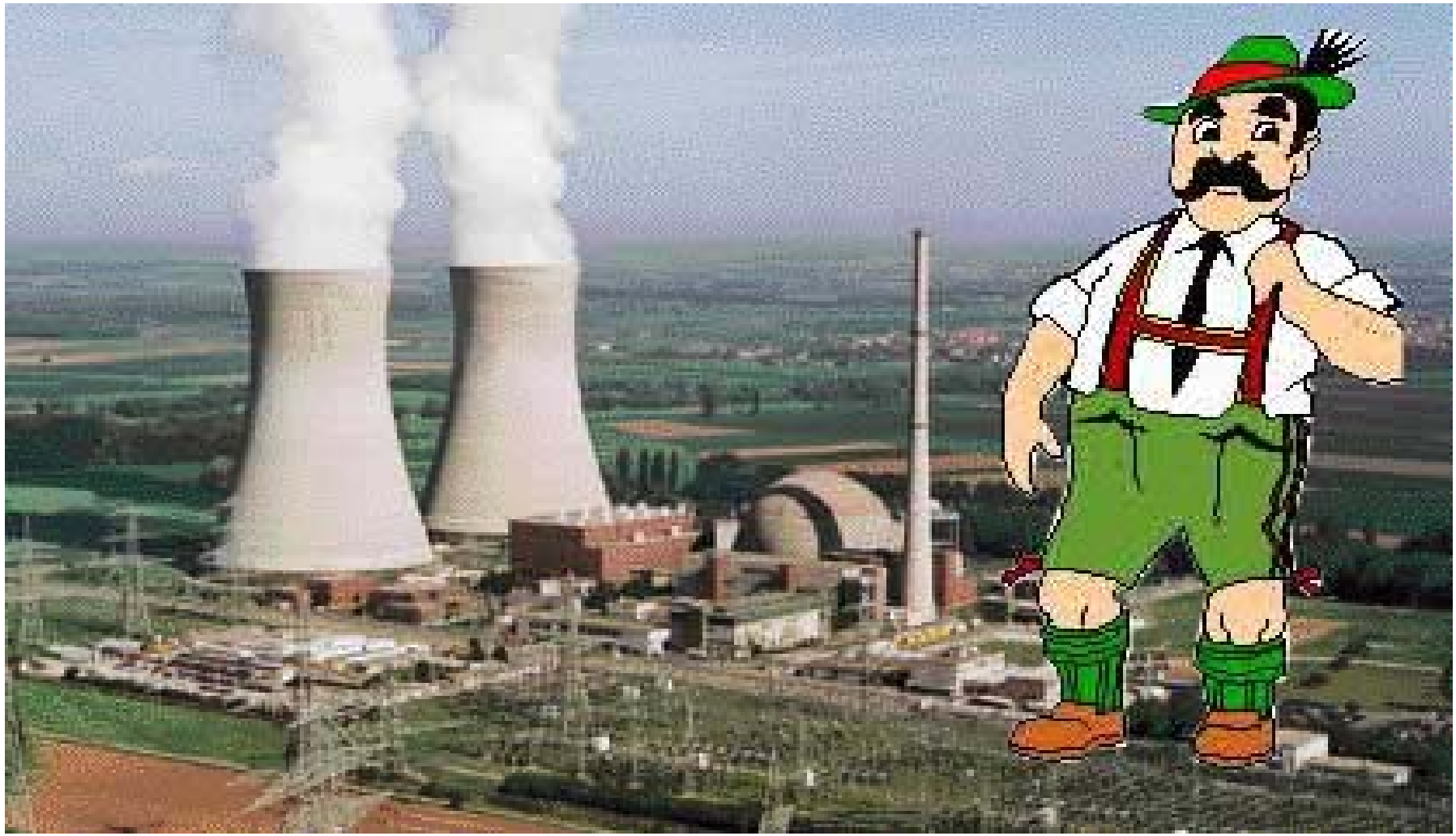
Nuclear Power in Germany – Facts & Views



Nuclear Power in Germany - the Facts

- 18 NPPs in operation,
  22,400 MW installed capacity
  Production in 2003: 165,1 TWh
- Most important energy source for electricity generation: 31 % of overall power consumption,
  ~ 50 % of baseload power production
- Most cost-effective way to generate electricity, key asset in a competitive European Electricity market
- Stands for about 40,000 jobs in the nuclear industry and 110,000 in other industries
- Avoids about 160 million tons of CO_2 every year

Nuclear Policy in Germany
Government - Utilities Agreement of June 2001

- *Lifetime of the 19 operating NPPs limited to 32 years translated into kWh. Total residual generation 2623 billion kWh*
- *Utilities are free to shift residual generation from older to newer plants*
- *Government assures politically undisturbed operation of plants*
- *Government ensures transport of spent fuel*
- *Utilities build on-site fuel storage facilities to minimize transports*
- *Exploration of the Gorleben salt dome as final disposal site will be stopped for at least 3 ye but not more than 10 years*
- *No changes in safety requirements, no discriminatory tax rules*
- *Utilities „take note“ that government intends to introduce legal ban on construction of new NPP*

Nuclear Policy in Germany
Intentions behind the Government - Utilities Agreement

***Government**:*

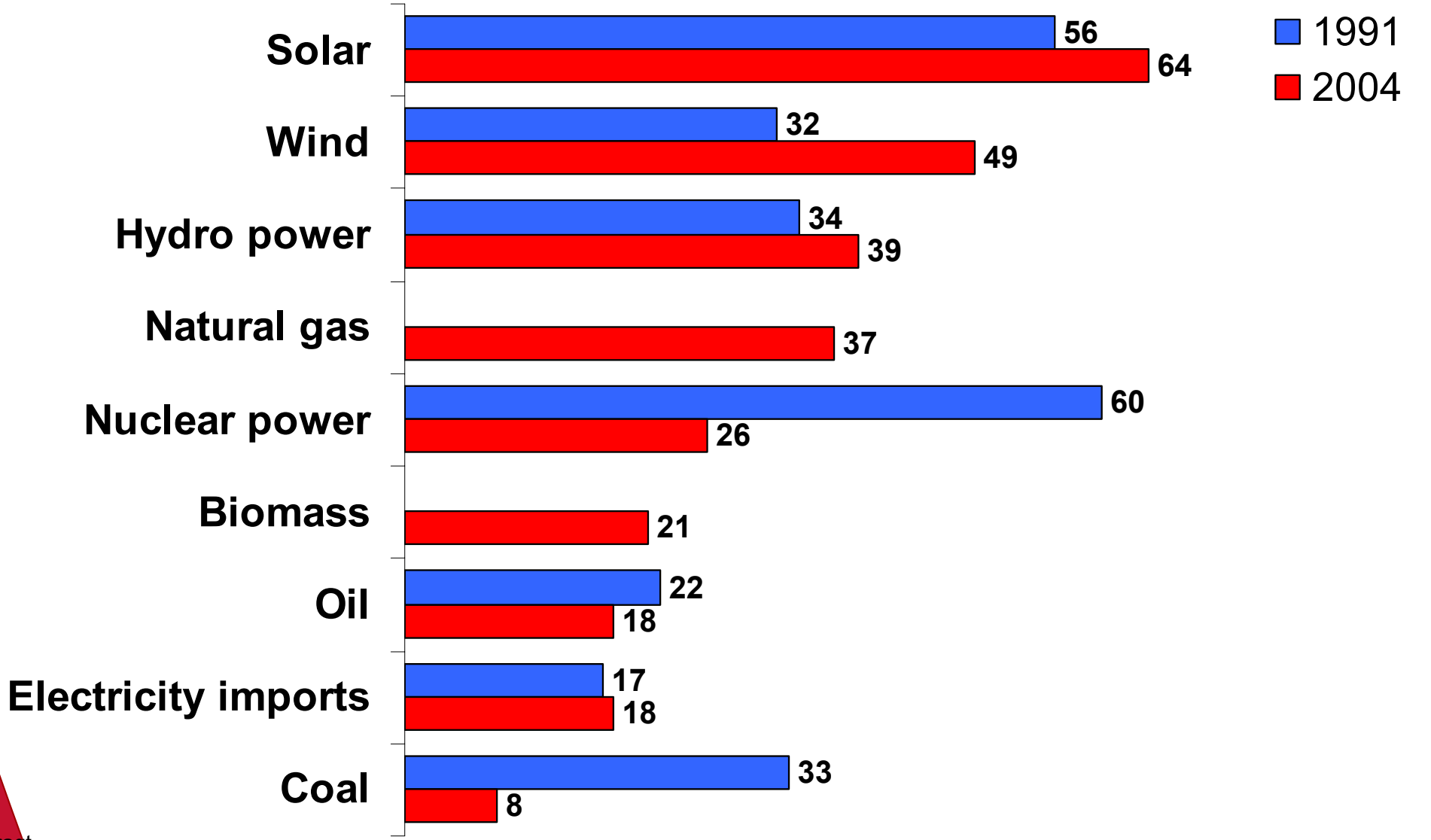
- *Paying the price for government participation of Green party, while limiting damag to the economy*
- *„Pacifying“ a field of social conflict marked by violent demonstrations*

***Utilities**:*

- *Protection of their investment in NPPs, continued profitable operation of their plan for maximum time period achievable in negotiations*
- *Escape from discriminatory treatment experienced in several Länder (German states) in the 1990s („pin-prick policy“)*
- *Keeping the door open for later change in nuclear policy (no demand for new NPP this decade)*

„Which energy sources will make the largest contributio to our energy supply in the next 20 to 30 years

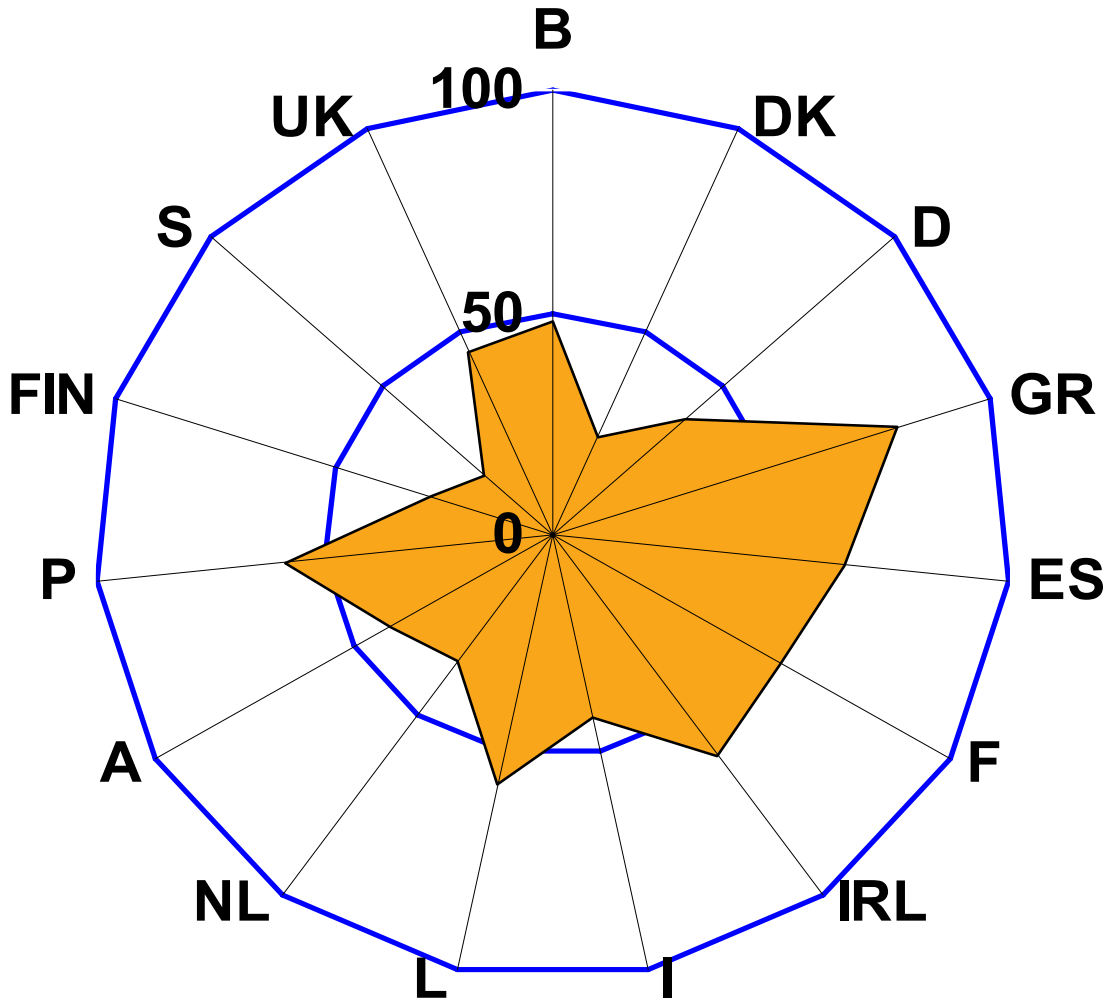
[% of Germans interviewed, multiple answers allowe



994 nicht befragt

Quelle: Allensbach Studie Umwelt 1991, 04/2004

„Do NPPs contribute to global warmin
and climate change?



Eurobarometer poll 200

... this is what 47% of
those interviewed in 2002
in the EU-15 believed

Views on Nuclear Power: Public Opinion Polls in Germany

Q: Will we be able to manage the nuclear phase-out, or will it be impossible – also in the long term – to do without nuclear energy?

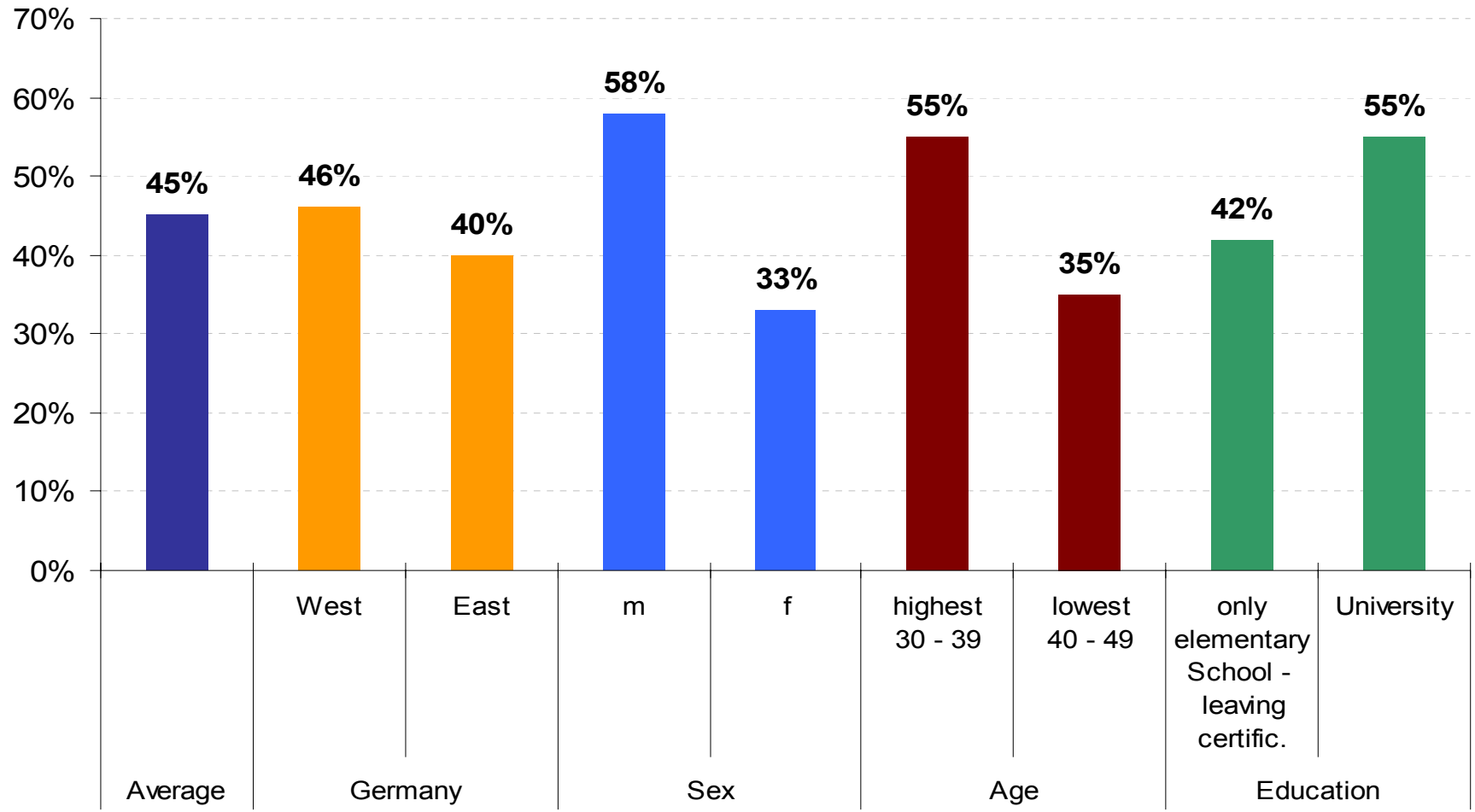
				Top Manager		
	Germany Average	Germany		Industry and Commerce	Politics	Admini-stration
		West	East			
able to manage	30.2	29.6	33.0	22.9	48.8	45.5
impossible	67.8	68.2	66.0	75.4	51.2	48.5
don't know	2.0	2.2	1.0	1.7		6.1

Source: Capital, November 2003

Views on Nuclear Power: Public Opinion Polls in Germany

Do you agree with the following statement?

„Nuclear power is an acceptable source of energy“

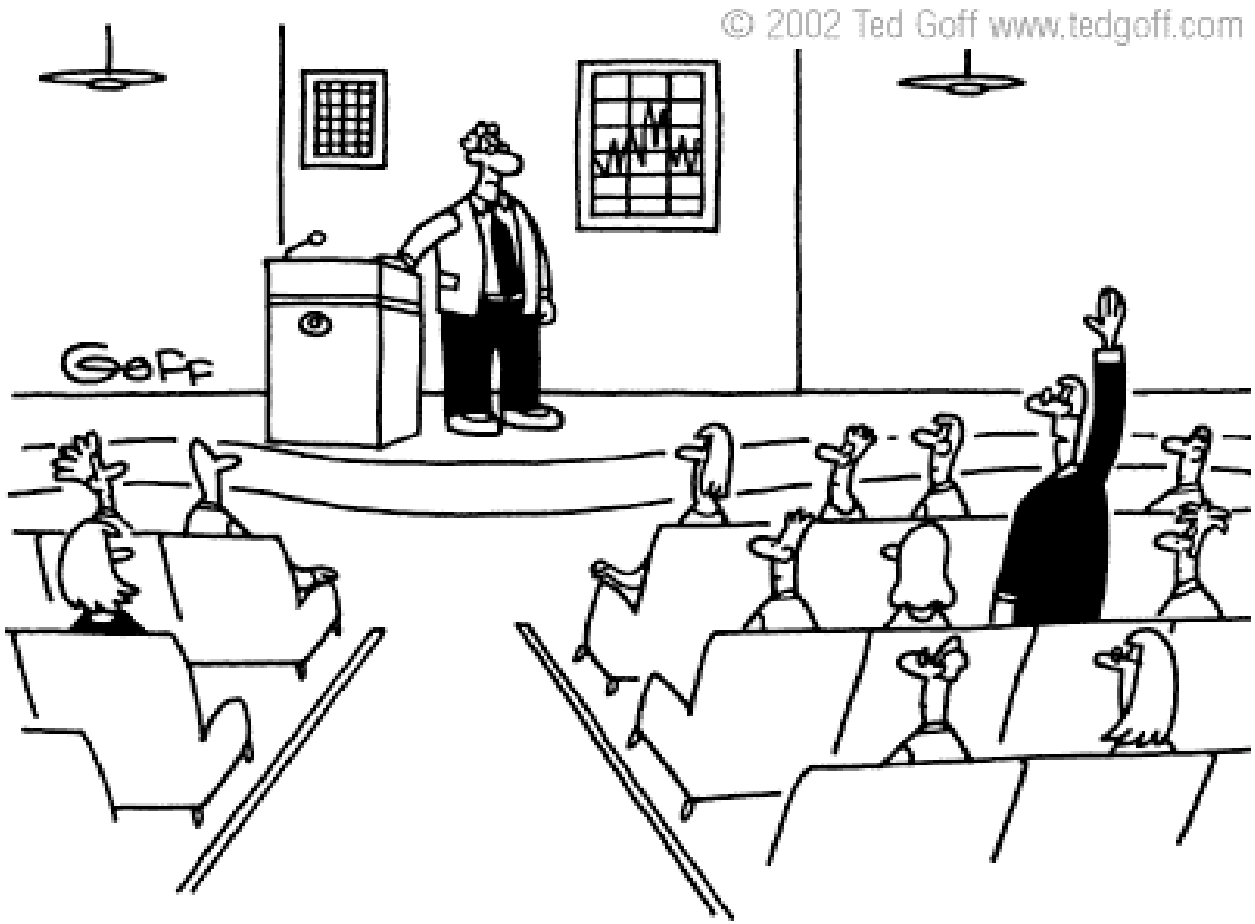


Source: P.M. Magazin / tns emnid, June 2003

Conclusions

- *Nuclear energy further expands in Asia and has maintained its position as a stable and economic basis for power supply in both the U.S. and Europe - even in the new context of the liberalized power markets*
- *The leading industrialized countries count on nuclear power as a contribution for economic competitiveness and sustainable development*
- *The nuclear vendors have developed advanced LWRs which are now ready for construction*
- *Nuclear industry and research institutes develop innovative reactor concepts, which could expand the use of nuclear energy beyond its present boundaries in the long run*
- *Besides technological enhancement, public programs for waste management and transparent performance of the nuclear industry are the key issues in order to (re)gain public acceptance for nuclear power*

Any questions? Please go ahead!



"Did you just say that anyone who asks another question will be fired?"