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# **Nuclear Perspectives**

- Nuclear Renaissance?

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Salzburg 19.9.2008

# Nuclear Power installed worldwide

Source IAEA PRIS 5.9.2008

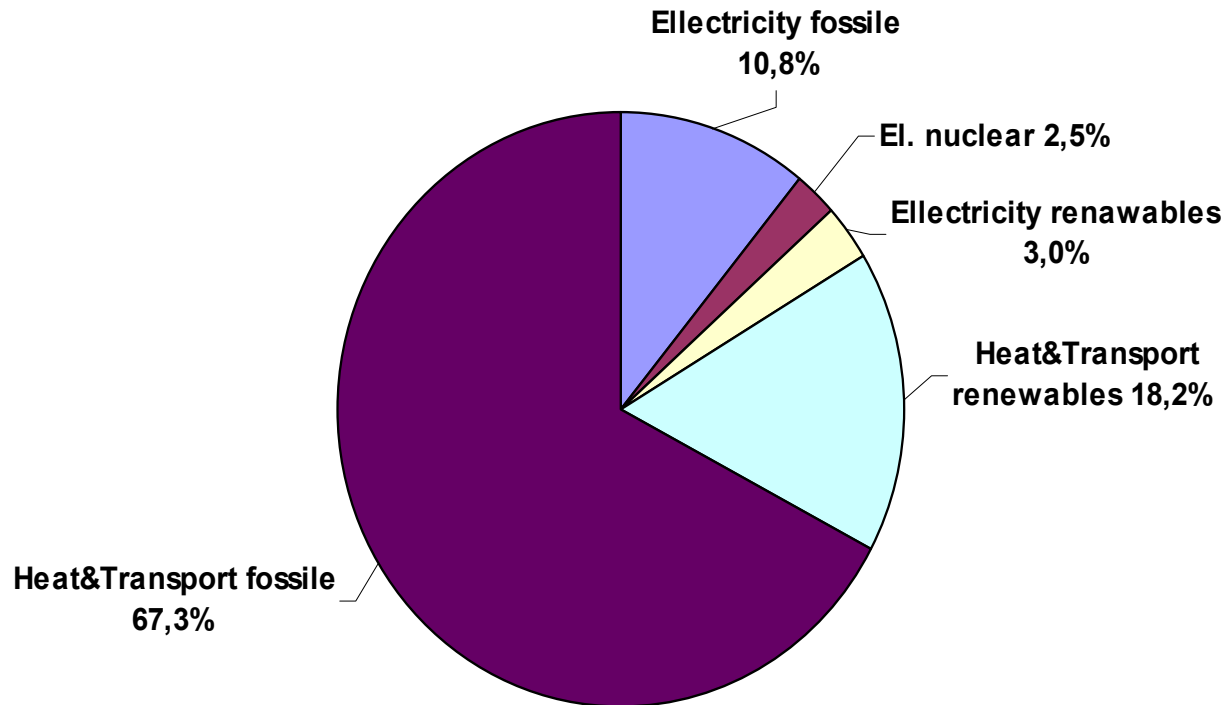
- **439 plants operating - capacity 372,2 GWe<sub>net</sub> - installed in 31 of 236 countries**
- **More than 2/3 of the capacity (254GW >68%) in only 5 countries: USA, France, Japan, Russia, Germany**
- **No nuclear plants in half of the EU- countries**
- **Nuclear capacity in Latin America, Africa & Asia (except Japan & Korea): 22,2 GW; 6% of world nuclear capacity in regions with >80% of world population**
- **of which in China: 8,6 GW (2,3% of world), generating 1,9% of chinese electricity production in 2007**

## World Nuclear El. Production 2005 by Countries - Source: IEA 2007

	Share % in World	Nuclear share % in
	nuclear production	el. product. n
<b>United States</b>	<b>29,2</b>	<b>19</b>
<b>France</b>	<b>16,3</b>	<b>79</b>
<b>Japan</b>	<b>11,0</b>	<b>28</b>
<b>Germany</b>	<b>5,9</b>	<b>26</b>
<b>Russia</b>	<b>5,4</b>	<b>16</b>
<b>Korea</b>	<b>5,3</b>	<b>38</b>
<b>Canada</b>	<b>3,3</b>	<b>15</b>
<b>Ukraine</b>	<b>3,2</b>	<b>48</b>
<b>United Kingdom</b>	<b>3,0</b>	<b>20</b>
<b>Sweden</b>	<b>2,6</b>	<b>46</b>
<b>Rest World 85% pop.</b>	<b>14,7</b>	<b>8</b>

# World Total Final Energy Consumption 2005 by Fuel

Source: IEA Key World Energy Statistics 2005



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## **RIA Novosti 7.12.2007 reporting about Moskau Conference on Development of Fast Breeder Reactors:**

**„First of all, without nuclear Energy, there will be no to-morrow for civilization, since nothing more effective and more competitive has been invented up to now.“**

**Original in Deutsch:**

**“Erstens hat die Zivilisation ohne die Kernenergetik kein Morgen, denn bisher ist nichts effektiveres und konkurrenzfähigeres erfunden worden.“**

# Contribution of nuclear Power to world energy supply in 2005

Source: IEA Key World Energy Statistics 2007

## Share of

- nuclear power in electricity production 15,3 %
- electricity in final energy consumption 16,3%
- > nuclear power in final energy supply 2,5%

## Thus:

- contrary to public opinion, the contribution of nuclear energy to world energy supply and accordingly to climate protection is rather modest

## However:

- Could nuclear become a really important source of world energy supply?

# Nuclear review

- **IAEA forecast 1974: nuclear capacity worldwide will be 4500 GW; now (2008) installed 372 GW**
- **1974 in USA 228 GW installed, under construction & ordered; 2008 98 GW installed, none ordered**
- **After mid- seventies, the nuclear market collapsed, only in France still important build- up**
- **Since 1986, orders for plants only in 7 east Asian countries, recently also in Finland, France, Russia**
- **9/2008 under construction 33 plants, 29,3 GW, for 10 of these construction started before > 20 years, 23 of these plants are new orders**

# Reactors under Construction

Source: IAEA 10.9.08

	Units	Total MW(e)	start construction	
			< 20 Years	>2003
			units	units/MW(e)
ARGENTINA	1	692	1	
BULGARIA	2	1906	2	
CHINA	6	5220		6/ 5229
FINLAND	1	1600		1/1600
FRANCE	1	1600		1/1600
INDIA	6	2910		2/ 960
IRAN	1	915	1	
JAPAN	1	866		1/ 866
KOREA,	3	2880		3/2880
PAKISTAN	1	300		1/ 300
RUSSIA	5	4658 +2x30MW	3	2/1835
Taiwan	2	2600		
UKRAINE	2	1900	2	
USA	1	1160	1	
<b>Total:</b>	<b>33</b>	<b>29.3 GW</b>	<b>10 units</b>	<b>17 units</b>
			<b>11,3 GW</b>	<b>14,6 GW</b>



# EU Commission, Trends to 2030, update 2007

## Forecast for OECD to 2030:

- The share of nuclear will continue to drop..., reaching 10.6% in 2030 (nearly half of the share in 2000), owing to incomplete replacement of units to be decommissioned...

## Change in OECD nuclear Capacity Baseline Scenario

■ 2005	2005 – 2020	2020 – 2030	2030	2005 -2030
■ Capacity	Closure - 28.9GW	Closure -58.6GW	Capacity	Closure - 87,5GW
■ 134,2 GW	New + 7.4 GW	New + 48.4GW	102.4 GW	New + 55,8 GW

**Since investment in new plants is lower than total decommissioning, nuclear capacity in 2030 is lower than in 2000.**

# IEA World Energy Outlook 2007, Scenarios 2030

Year	2005	2030 RE- ference Scenario	$\Delta$ 2030 - 2005	2030 Alterna- tive Policy Scenario	$\Delta$ 2030 - 2005
CO2 emissions Mt	26620	41905	+57%	33890	+27%
Nuclear electricity generation TWh	2771	3275	+18%	4144	+50%
Share nuclear % in electricity generation	15	12		13	
Share electr. % in final consumption	17	19		22	
Share nuclear % in final consumption	2,6	2,3		2,9	

# IEA Energy Technology Perspectives 2008

## World CO<sub>2</sub> . Δ 2050 -2005

Year	2005	Gt	
Scenario Baseline	2050	62	+130%
Scenario BLUE Map 2050 („Energy revolution“)		14	- 48%
<u>Δ Baseline – BLUE Map</u>		<u>48</u>	

### Share in this 48 GT CO<sub>2</sub> saving:

• End use efficiency	36%	17,3
• End use fuel switching	11%	5,3
• Renewables	21%	10,1
• CCS	19%	9,1
• Nuclear	6%	2,9
• Others	7%	3,3
<u>Σ</u>	<u>100%</u>	<u>48,0</u>

# Problems arising from large capacity increase

- **Assumed nuclear contribution only achievable by installing plants in most regions of the world**
- **But 205 of the 236 states until now did not opt for nuclear (did not want it !), why should most of them decide to go nuclear in future?**
- **What about non proliferation policy? Would nuclear weapon states, in particular the USA, tolerate nuclear infrastructure in almost every state? (see Iran, North Korea)**
- **nuclear plants cost per kW 5 times more than high efficient gas-fired plants. How could nuclear expansion be financed in developing countries?**
- **Conclusion: the scenario looks quite unrealistic.**

## **Another Problem: Uranium Resources**

**Secured + additional estimated reserves: 4,6 million tons = 4600 kt**

- At present yearly uranium requirements: 66 kt/a at this level reserves will last 70 years.**
- Scenario requirements 2050:  $4 \times 66 \times 0,7 = 185$  kt/a at that level reserves would last 25 years.**

**Shortage will lead to tapping of yet undiscovered and of unconventional uranium resources.**

- But that would lead to mining of poor rock with less than 1% uranium content, causing severe environmental problems.**

# Uranium mining

- **At present 1% uranium content. Almost all of the rock is turned into waste**
- **Chemical separation of uranium leaves poisonous + radioactive mud lakes**
- **Example uranium mining in East Germany (Wismuth): since 14 years, 2200 employees redevelop 300 million cbm slagheap, 160 cbm mud lakes, budget 13 billion Euros.**
- **Uranium mining discontinued in Europe, current uranium mining 50% from remote areas of Canada and Australia, 1/3 from Kazakhstan, Nigeria, Namibia, Russia**

## **Fast Breeder experience**

**In theory, breeders may generate up to 60 times more energy from natural uranium than present reactors.**

**Up till mid- seventies, commercial use of breeders seemed close.**

**Forecasts breeder capacity installed in 2000**

- 1974 USAEC for USA: 450 GW**
- 1975 UKAEA for GB: 33 GW**
- 1978 CEA for France: 16 – 23 GW**

**Now world- wide in operation: 1 Breeder plant  
600 MW in Russia**