Predavanje:

Globalno zagrijavanje i nuklearna energija

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Predavanje o povezanosti globalnog zagrijavanja i korištenja energije. Neodređenosti oko ljudskog utjecaja na globalno zagrijavanje i dalekosežnost utjecaja na živi svijet sve su manje. No, neslaganja oko načina rješavanja problema su i dalje ogromna. Potencijalna uloga i prepreke vezane za veće korištenje nuklearne energije kao dio rješenja glavni je fokus predavanja.

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IEEE HRVATSKA SEKCIJA

Global warming and nuclear energy

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Global warming

- WMO, IPCC, national organizations
- Temperature increase, 1,5-4,5 ºC for doubling of CO_2
- Glacier melting, Greenland, Antarctic
- Permafrost melting, methane release
- Sea level rise
- Extreme weather frequency, hurricanes
- Danger is in the time scale!

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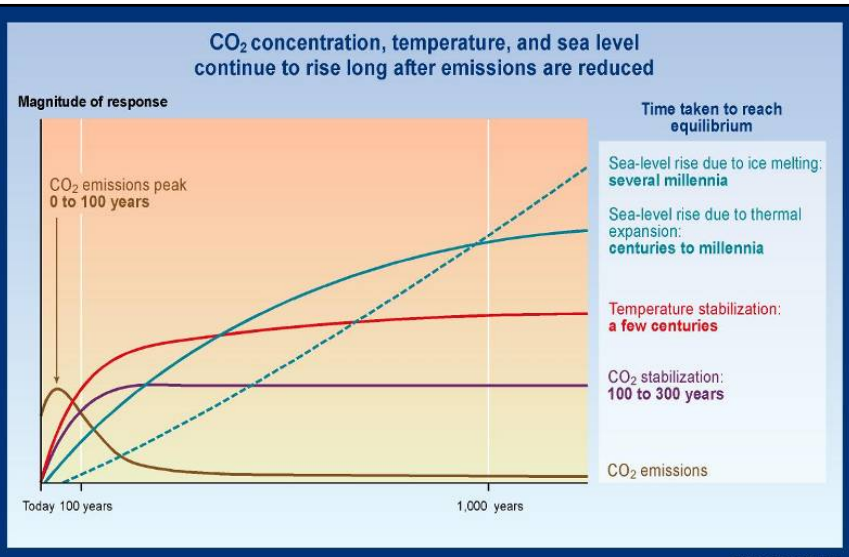

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

Second World Climate Conference 1990

- Jasan znanstveni konsensus (700 učesnika iz 139 zemalja)
- Bez odlaganja poduzeti akcije za smanjenje emisije stakleničkih plinova
- "Da bi se do sredine 21.stoljeća stabilizirala koncentracija CO2 u atmosferi na oko 50% iznad pred-industrijske razine, bilo bi potrebno odmah započeti s globalnom redukcijom CO2 od 1 do 2% godišnje"
- "Da bi izbjegle ekološki nepovoljan razvoj industrijskih zemalja u prošlosti, zemlje u razvoju moraju usvajati moderne tehnologije već u ranim fazama razvoja, naročito u proizvodnji i potrošnji energije."

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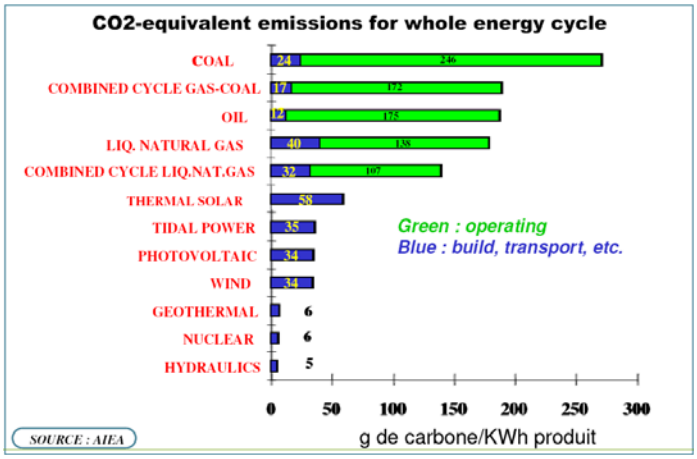
Greenhouse gases emission in electricity production

34% of UE electricity comes from nuclear power.
• avoided CO2 = 200 millions UE's vehicles emissions = 700 Million metric tons of CO_2 avoided annually



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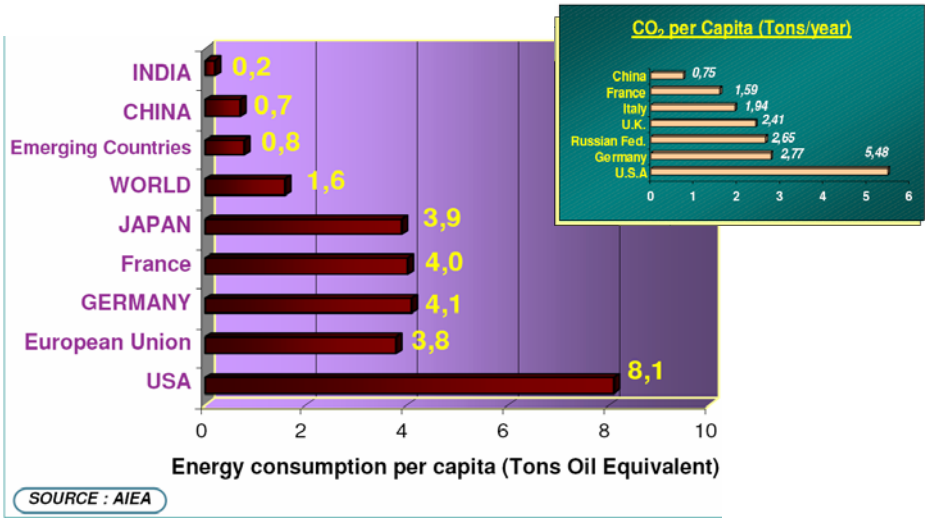
Very large energy consumption range



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•James Lovelock, author of Gaia hypothesis, in his talk at the Adam Smith Institute March 15th 2004 urges Green to abandon objections to nuclear energy as "unscientific and perverse".

"**We need a portfolio of energy sources, with nuclear playing a major part, at least until fusion power becomes practical option; and we must stop fretting over the minute statistical risks of cancer from chemicals or radiation".**

•Jim Hansen, the director of NASA Goddard Institute for Space Studies reporting on the satellite observation of Greenland glaciers movement notes rapid acceleration in recent years. Earlier modelling of Greenland ice melting which viewed it as a single block of ice could be completely wrong. Much faster sea level rise could result.

He thinks that we have to stabilize CO_2 emission within a decade (The Independent, 17. February 2006).

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EC Green Paper, 8 March 2006

Key EU energy challenges

1. Urgent need for investment to meet expected energy demand and replace ageing infrastructure (1 trillion Euro in next 20 years)
2. Rising import dependency, often from insecure regions (50% at present, 70% in next 20-30 years)
3. Resources concentrated in few countries, insecure regions
4. Increasing global world demand for energy (80 % by 2030)
5. Oil and gas prices rising (nearly doubled in last 2 years)
6. **Global warming issue (1.4 to 5.8 degrees by end of century): EU to reduce CO_2 emissions by 50 % over next decades in order to limit temperature rise by 2 degrees as compared to pre-industrial era**
7. Not yet fully competitive internal energy market

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Six priority areas in energy field

- Development of fully competitive EU internal energy market
- Security of energy supply, enhanced solidarity among Member States
- **Sustainable, efficient and diverse energy mix: considering all different sources from renewables to coal and nuclear**
- **Addressing the challenges of global warming in an integrated manner**
- **Strategic energy technology plan: Energy efficient and low carbon technologies**
- Establishment of common EU external energy policy

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Kako ostvariti ove planove?

Kako ostvariti ove ciljeve?

A study prepared for European Commission
" World Energy, Technology and Climate Policy Outlook" (WETO), 2003,

- increase of world energy consumption by 70% between 2000 and 2030, annual increase of 1,8% for a 3% growth in GDP.
- share of large-scale hydropower and geothermal energy would stabilize at 2% of the total in 2030.
- Solar, small scale hydro-energy and wind would grow with 7% annually from 2000 to 2010 and then with 5%, doubling their share in total energy consumption, but that will be only 1% of the total energy consumption in 2030.
- Summing up all renewables, i.e. large and small hydro, solar, wind, plus wood and waste (5%), total would be 8% by 2030.
- With slow growth of nuclear energy based on present situation (0,9%/ year), nuclear share would be reduced from 6,7% in 2000 to 5% in 2030.
- The sum of non-fossil energy, i.e., nuclear plus renewables comes to 13%.
- "Alternativni" izvori i nuklearna enegija nisu u suprotnosti, zajedno neadekvatni u ovoj projekciji energetskog razvoja EZ
- Kada se razmišlja o energiji vjetra i sunca na velikoj skali tada se mora predvidjeti i alternativa alternativama!
- Praktičnost energije vjetra u velikim razmjerima je upitna.
- Jedne veliku nuklearne elektrane od 1500 MW(e) mijenja 1000+ danas najvećih vjetroelektrana snage 4-5 MW. (70 m lopatice na 200 m visokom stupu).

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Nuclear fission energy?

- Almost everybody looks now at the nuclear energy, but the question is whether nuclear energy can fulfill the expectations.
- Future of nuclear energy depends on positive answers on several questions

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Near and itermediate term issues

- **Cost of electricity**
- **Nuclear safety**
- **Waste disposal**

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Summary of electricity cost ranges
(USD/MWh)
NEA-IEA study Projected Costs of Generating Electricity, 2005 Update

Plant	Dsct.rate 5%	Dsct.rate 10%	Remark
Coal fired	25 - 50	35 - 60	No ext.c.
Gas fired	37 - 60	40 -63	No ext.c.
Nuclear	21 - 31	30 - 50	Dec.inc.
Wind	39 - 95	45 – 140	No back
Solar	150- 400	200 - 530	up costs
CHP	25 - 65	30 - 70	Site spec

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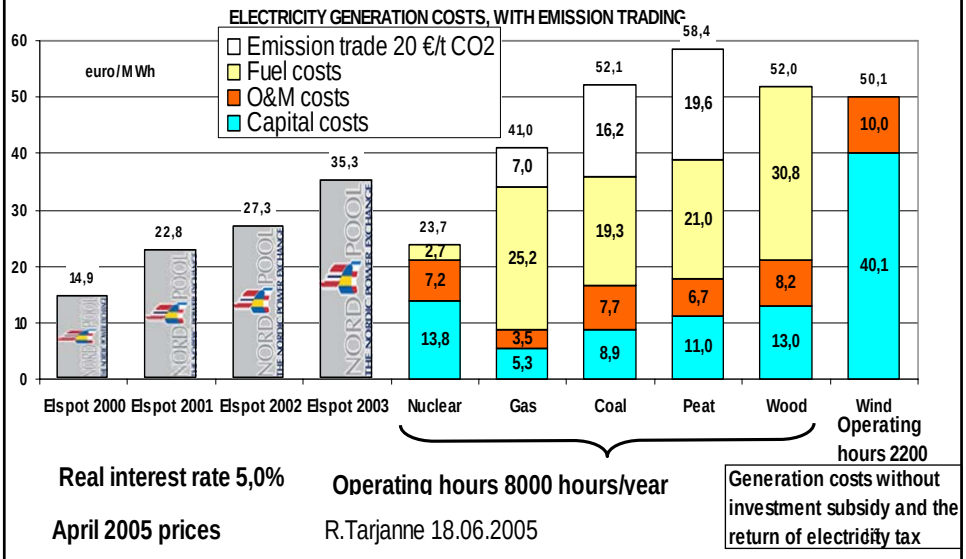
Finish cost study 2005



Nuclear safety (PWR)

Core melting probability as indicator of nuclear reactor safety

For period 1969- 1974:	**from 10^{-4} to 10^{-3}/year**
With numerous retrofits after 1979, for a period 1980-82:	**~ $1{,}5 \cdot 10^{-4}$/year**
Sizewell B, operation 1996:	**~ $1{,}1 \cdot 10^{-6}$/year**
AP 600 project :	**~ $1{,}2 \cdot 10^{-6}$/year**
with the probability for serious radiation emission of	**~ $3 \cdot 10^{-9}$/year**

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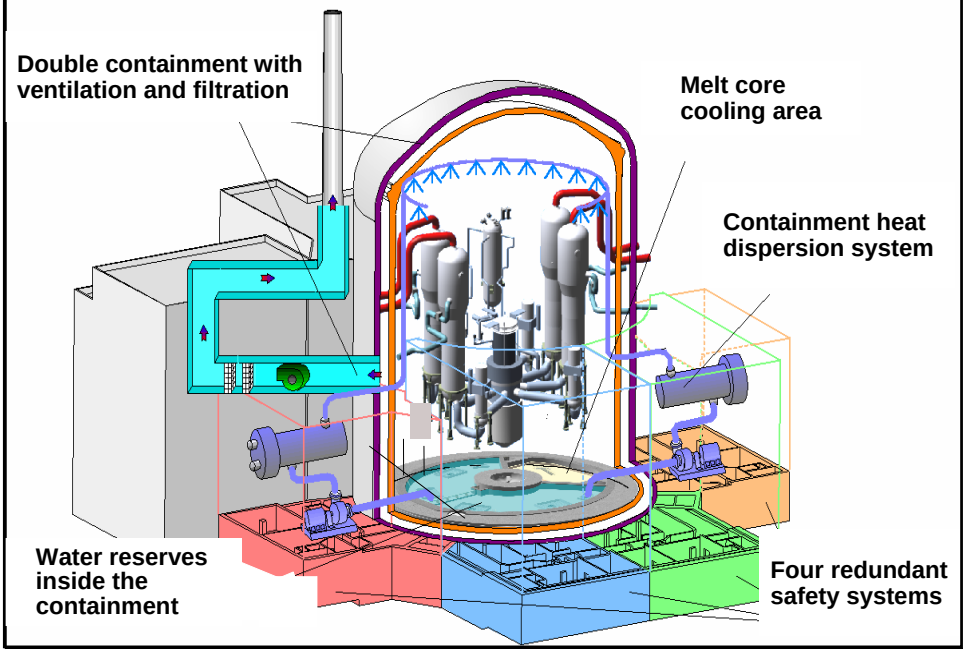
Main EPR Safety Features



Nuclear waste

- Overall optimal method to be selected, technical solutions for safe disposal exist already, new ones proposed
  (such as deposition into deep wells, below ground water level)
- National, regional or international deposition sites?
- Before final decision on the overall best method for permanent disposal is reached there are several methods for the intermediate storage for periods of up to 100 years or more.

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Long term issues

- **Sufficiency of nuclear fuel**
- **Wider use of nuclear energy**
- **Nuclear proliferation safety**

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Sufficiency of nuclear fuel?

- Present 440 nuclear reactors use about 70 000 t of uranium per year. This extrapolates to 3 million tons of uranium in 40 years
- Estimated reserves between 15 and 25 million tons
- Use of uranium 238 and thorium 232 multiplies available fission energy by a factor of many hundreds
- How to convert U238 and Th232 into fissile materials?
  a) reactor breeding
  b) accelerator breeding, fission-fusion hybrid

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Wider use of nuclear energy

- **At present nuclear electricity globally ~ 17%**
  EC-25 ~ 34%
- **Sectors of primary energy consumption:**
  - **Production of electricity**
  - **Transport**
  - **Industrial processes, space heating etc.**
- **each sector about 1/3 of total,**
- **so if in the future nuclear energy is to cover more than 1/3 of total energy consumption, it must enter into sectors of transport and industrial use.**
- **Nuclear reactors, high temperature types, are well suited for the production of hydrogen* and for supply of industrial heat.**

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Nuclear proliferation

- Present status
- Future challenges
- Possible solutions

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Present status

- 5 nominal nuclear powers
- 2 nuclear superpowers, US and RF, in posession of over 20 000 nuclear warheads
- nuclear power stations in 31 country
- 12 countries, in addition to 5 nuclear countries, in posession of enrichment and reprocessing installations
- 4 or 5 of these developed nuclear explosive
- **failure of NPT!**

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Future challenges

- At least 10 new nuclear countries in the next 15 years
- Need for reprocessing in the second half of century
- Saving the NPT (189 parties to the treaty!)
- (by **all** parties to the Treaty acting according to their obligations ; Clause VI essential, commitments made at the 6th NPT Review conference in 2000 not fulfilled. Specifically CTBT and FMCT)

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Immediate (balanced) steps

- Offer of internationally guaranteed supply of nuclear fuel through IAEA, or by a new specialized UN Agency, to the countries intended to develop peaceful use of nuclear energy and willing to abandon national enrichment and reprocessing installations. Offer to be followed by negotiations with interested countries.
- Conclusion of verifiable Fissile Materials Cut of Treaty (FMCT) by nuclear weapon countries
- Entry into force of Comprehensive Nuclear Test Ban Treaty (CTBT)

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Final goal

- Internationalization of **all** national enrichment and reprocessing installations
- Establishment of **International Nuclear Fuel Agency**

  (on the lines of US proposal to UN in 1946 and IAEA Director General Statement at the 49th General Conference in 2005)

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