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Kozloduy NPP and Future of Nuclear Power in Bulgaria and South East Europe

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The Future of Nuclear Power in Central and Eastern Europe

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Kozloduy NPP - Basic Information

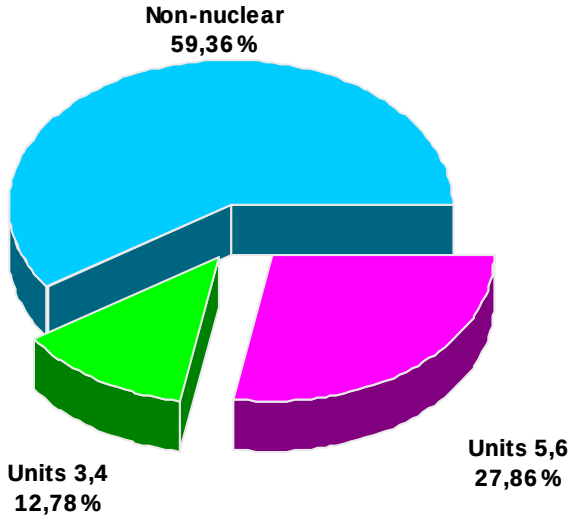
Six power generation units on the plant site, with a total installed capacity of 3760 MW, equipped with pressurized-water reactors (PWR).

- Commissioning of the Units:
  - Units 1 – 4, V VER - 440 type in 1970 -1982.
  - Units 5, 6 V VER - 1000 type in 1987 – 1991.
- Units 1 and 2 – were shutdown following a governmental decision on 31 December 2002.
- Units 3 and 4 - will shutdown following agreement between Republic of Bulgaria and European Commission (EC) on 31 December 2006.

Kozloduy NPP - Basic Information

- Spent fuel storage facility (wet) in operation.
- Spent fuel storage facility (dry) in design.
- Training center equipped with FS simulator and MF simulator.

Share of Kozloduy NPP output in the total power generation of the country more than 40% (47% in 2002):



About Kozloduy NPP

- Contribution to clean environment.
- Safety is subject of independent state control by the Nuclear Regulatory Agency.
- Major factor for sustainable development on national and regional level.
- Safe and reliable technology.
- The most widely spread type of reactors – 438 nuclear reactors are operated in the world today, 260 of them are PWR.

Modernization Programs

KNPP Units 1-4 Short Term and Complex Modernization Programs

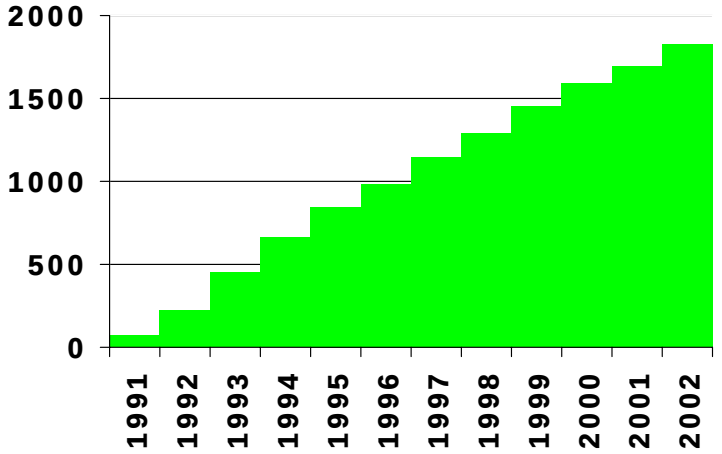
Duration	1991-1999
Funds allocated	245 M$
Design Changes	1452

KNPP Units 3&4 Program - VJC and SAM System

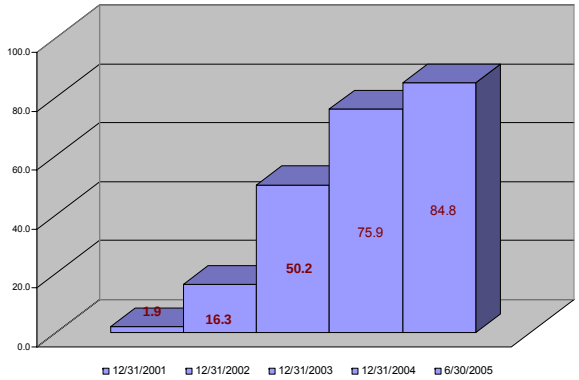
Duration	2000-2005
Funds allocated	66 M$
	14.3 M€
Design Changes	375

KNPP Units 5-6 Modernization Programs

Initially defined in:	1995
Planned budget:	491 M€
Number of measures:	212
Selection of Main Contractors in:	1996



Design modifications through the years

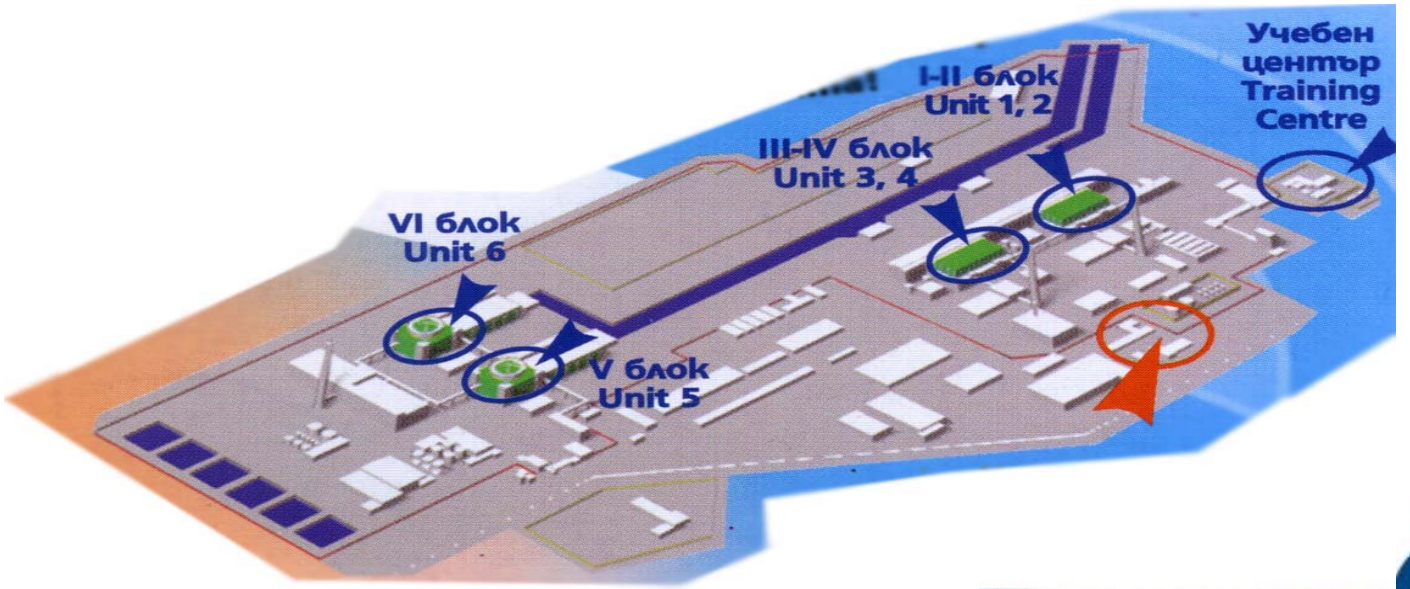


Program implementation throughout the years

Kozloduy NPP

Kozloduy (μSv/hr)

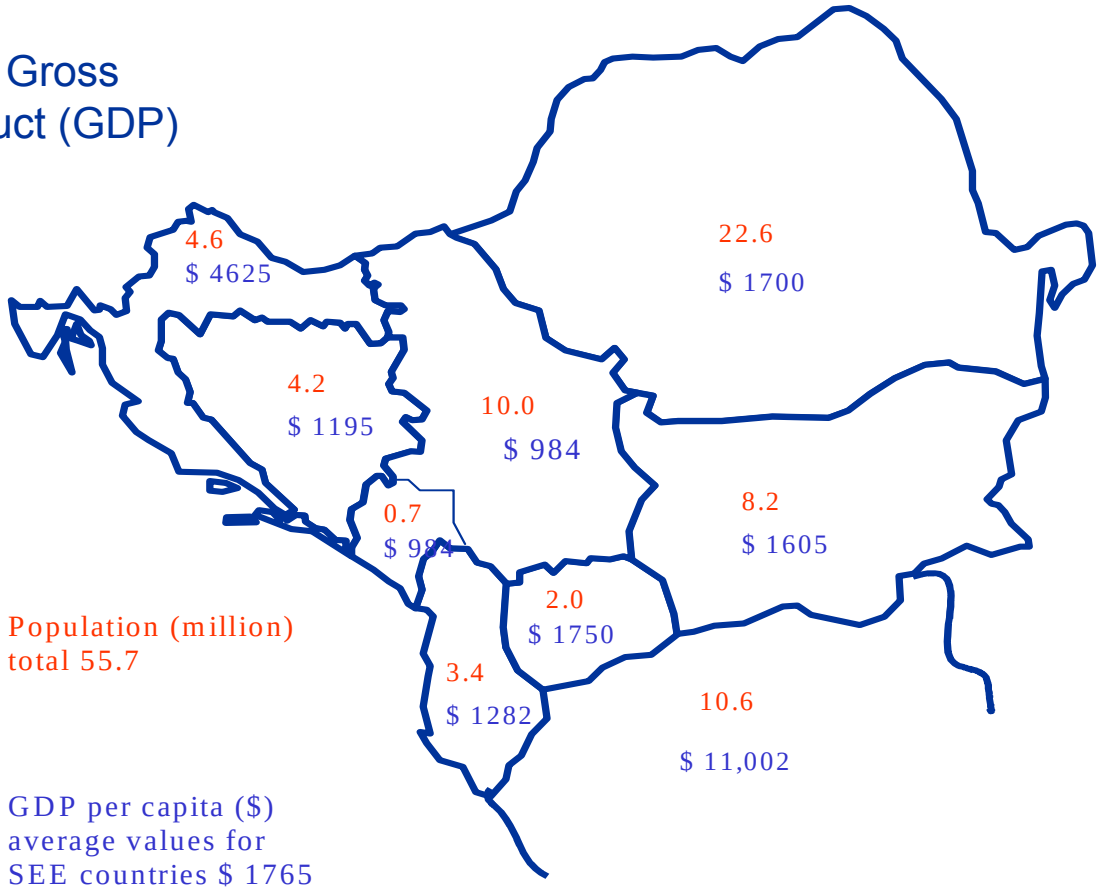
Sofia (μSv/hr)



Review of Electricity Supply and Demand in Southeast Europe

Source – Joint Office for South East Europe (Support EC/ World Bank)

Population and Gross Domestic Product (GDP)



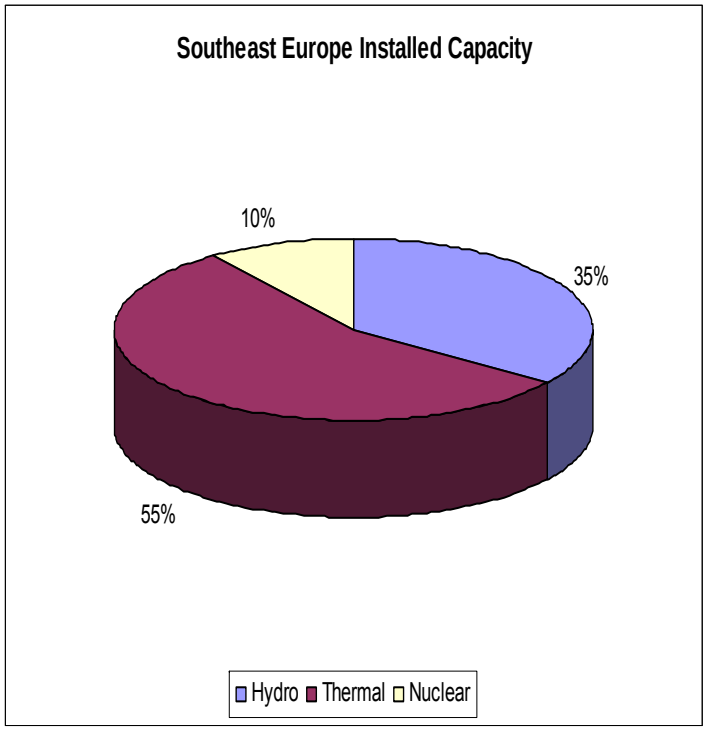
Population (million) total 55.7

GDP per capita ($) average values for SEE countries $ 1765

Review of Electricity Supply and Demand in Southeast Europe

Source – Joint Office for South East Europe

- Installed capacity 49.5 GW
- Regional GDP grows.
- Expected peak load increase of 2.2% per annum for the period 2002-2012 – 31.4 to 38.2 GW.
- Regional utilities expect total electricity demand to grow at a rate of 2.3% p.a. for the period 2002-2012 -from 171 TWh to 214 TWh.
- The region plans to add about 4.5 GW through 2012 to meet demand.
- Rehabilitation of about 4,000 MW of existing capacity would be required.
- Without investments in generation the region may loose up to 6500 MW.



Planned Capacity Additions 2012

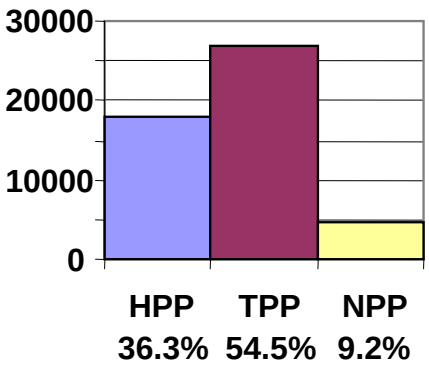
Source – Joint Office for South East Europe

Generation Capacities (MW)		Thermal		Hydro		Nuclear		Total	
		Installed	New	Installed	New	Installed	New	Installed	New
Albania	2001	172		1457				1629	
	2012	750	578	1700	243			2450	821
B&H	2001	1790		2052				3842	
	2012	2467	677	2965	913			5432	1590
Bulgaria	2001	4900		2729		3409		11038	
	2012	7000	2100	2600	-129	3300	-109	12900	1862
Croatia	2001	1429		2076		316		3821	
	2012	2237	807	2222	146	316	0	4775	953
Macedonia	2001	1010		436				1446	
	2012	1020	10	1130	694			2150	704
Montenegro	2001	210		658				868	
	2012	420	210	808	150			1228	360
Romania	2001	11845		5905		800		18550	
	2012	8251	-3594	6099	194	1600	800	15950	-2600
Serbia	2001	5524		2831				8355	
	2012	6126	602	2983	152			9109	754
Region	2001	26880		18144		4525		49549	
	2012	28271	1390	20507	2363	5216	691	53994	4444

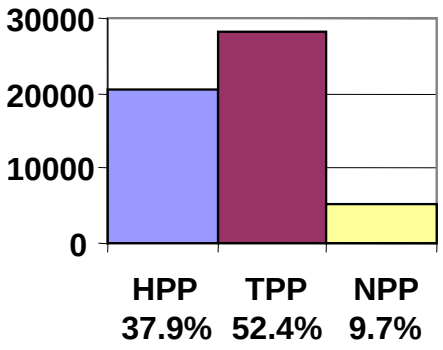
Generation Expansion Scenarios

Source – Joint Office for South East Europe

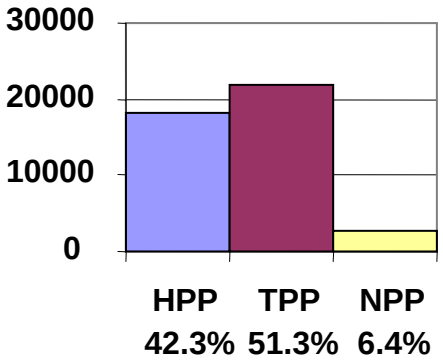
2001
49.5 GW



2012 High investment scenario
54 GW



2012 Non investment scenario
43 GW



Conclusions

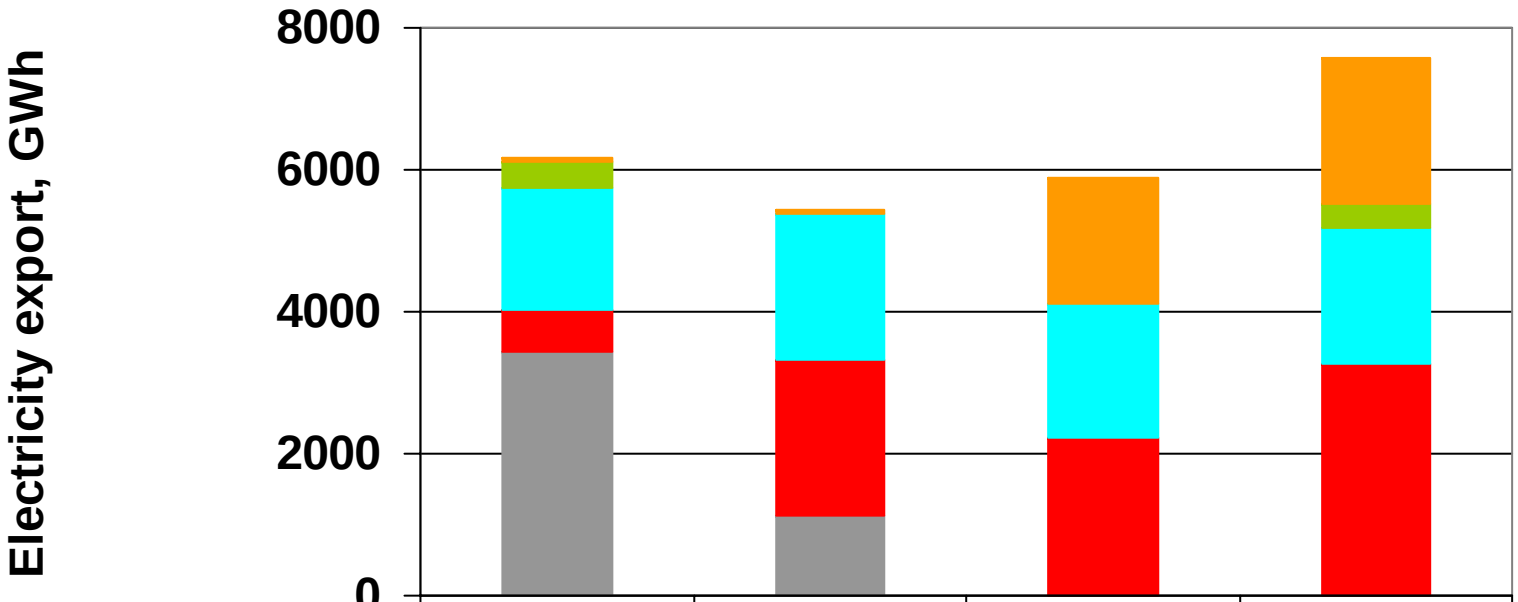
Source – Joint Office for South East Europe

- Needs for further research.
- Available capacity is far less than the installed.
- Expected demand growth – substantial investments needed.
- No significant addition to capacity in the last 10-15 years.
- Bottlenecks in transmission interconnection network.

Security of Electricity Supply in the Region

- Bulgaria covers the electricity deficit in the Balkans.
- In 2003 Bulgaria covered 90% of electricity deficit in the region.

Bulgaria's Export



	2002	2003	2004	2005
Bulgaria-Roumania	59	81	1777	2057
Bulgaria-FYROM	382			323
Bulgaria-Serbia	1718	2053	1894	1920
Bulgaria-Greece	567	2180	2230	3273
Bulgaria-Turkey	3448	1135	0	0

Security of Electricity Supply in the Region

- After shut-down of Units 3&4 – no export of electric power.
- Negative impact on security of supply.
- Negative social impact.
- Power shortage in Macedonia and other countries.

World Energy Situation

Source – IAEA

- World Energy consumption will increase up to 70 % between 2000 and 2030 years.
- World Energy mix till 2030 in demand conditions:

  - Almost 90% fossil fuel: 34% oil, 28% coal and 25% natural gas.

  - 5% Nuclear Energy.

  -8% renewable sources.
- New Nuclear Power Plants in India, Russia, Japan, China, Ukraine, Argentina and Iran

Europe Energy Situation

Source – IAEA

- EU-25 Energy demand will increase up to 19% between 2000 and 2030.
- EU-25 Energy mix till 2030 in conditions of demand:
  - 82% fossil fuel: 35% oil, 32% natural gas and 15% coals.
  - 9,5% Nuclear Energy.
  - 8,5% renewable sources.
- EU-25 – Energy import dependency will increase almost 70% in 2030.
- EU-25 - CO_2 emissions will exceed 1990 level 14% due to factors as follows :
  - Rejection of Nuclear Energy development in some member states.
  - Impossibility the nuclear Energy production losses to be replaced by renewable sources.
- Fossil fuel use increasing in place of nuclear Energy.

Russian Federation (RF) Development Plan

- In accordance with the RF approved Energy strategy electricity generation in 2020 should be 1350.10^9 KWh, 23% of which to be nuclear generated.
- It means that the overall generating capacity of NPP in operation will be 45 GW after 15 years.
- Very simple calculations, taking into account the actual situation of the nuclear Energy in RF, show that to reach these planned levels, it is necessary to commission annually equivalent power generating capacity of 3 GW.
- Having in mind this information, we should remember the significance of RF for Europe as natural gas supplier, as well as the situation from the beginning of this year when the gas supply to Europe through Ukraine was cut off.

Natural Gas Export From RF to Europe for 2004 – Total 104.5 Bm^3

World Nuclear Energy Today

- There are 440 units in operation in 31 countries, overall installed generating capacity of 365 560 MW (el.).
- The share of Nuclear Energy in overall electricity production is 16%.
- At the end of 2004 year, 26 new units ≈ 21 276 MW (el.) are under construction, 17 of them are in China, Republic of Korea, DPRK, Japan and India.
- According to the lower prognosis of IAEA electricity production from NPP in 2030 will increase 34% compared to 2003.
- The bigger prognosis shows 86% increasing of electricity production from NPP in 2030 year compared to 2003.
- All forecasts show biggest increase of nuclear electricity production for the same period to be realized in the Far East.
- Both forecasts predict significant increase also in Eastern Europe.

Nuclear Energy Role Today

- Maintain certainty of energy supplies and stability despite of increasing oil prices.
- Decrease dependency on fossil fuel and electricity import.
- Decrease energy dependency for any particular country.
- Nuclear Energy is the main source of CO_2 emissions reduction.
- It is accepted that the nuclear Energy and the renewable sources are complemented each other.

We need all energy sources and the nuclear is a part of the decision

Nuclear Energy in Europe

- It is broadly used within the Europe (35 % of generated electricity is nuclear origin).
- When the EU has enlarged from 15 to 25 countries, the countries, used nuclear Energy, have increased from 8 to 13 … and Bulgaria, Romania, Ukraine and Croatia are knocking into the EU door.
- A new NPP is under construction in Finland.
- Plans for NPP constructions in France and Bulgaria.
- Nuclear programs under revision in Germany and UK.

Sustainable Development and Climate Change

- The future of the nuclear Energy will depend on how much it will contribute to respond to increasing global Energy demands and solving the ecological problems, arising from electricity production and consumption.
- Main issue in the environment protection is still global worming as a result of increasing accumulation of gases in the atmosphere.
- Global worming of the atmosphere is : 70% due to CO_2 emissions increasing, 24% due to methane emissions increasing and 6% due to nitrogen oxides emissions increasing.
- The only active mechanism to coordinate greenhouse gases emissions limitation now is the Kyoto Protocol. This extremely important goal might be achieved only owing to increase of nuclear energy production.

Kyoto Protocol

- Bulgaria has agreed to reduce emissions of greenhouse gases by 8% as compared to 1988 levels.
- Thanks to Kozloduy NPP Bulgaria can meet the quantified emission limitations as determined in the Kyoto Protocol.

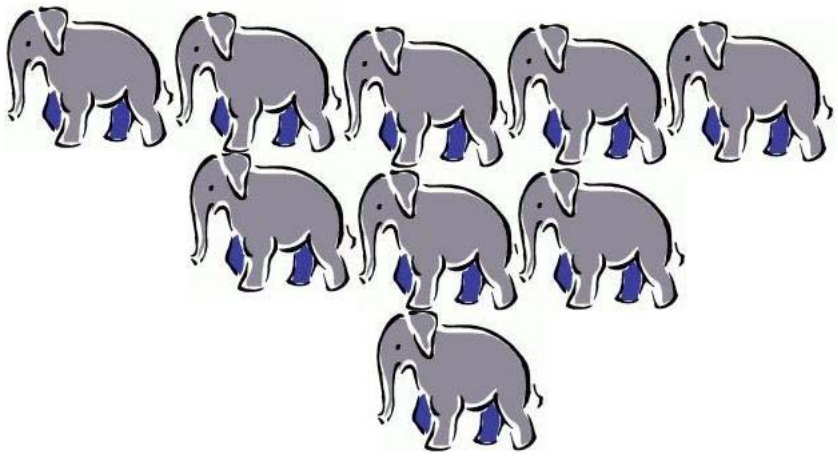
Greenhouse gases		Prevented harmful emissions from 1974 to 2005
SO_2	0	24 mln. tons
NOx	0	
CO_2	0	660 mln. tons (carbon dioxide equivalent)
CO	0	
Consumption of O_2	0	

Impact on the Enviroment

Data about EU-25:

- Nuclear industry generates far less waste.

CO_2 emissions from fossil fuels
1,200,000,000 tons/ year



High level nuclear waste
2,600 tons/ year

Economical Aspects

- When well managed existing NPP are competitive and beneficial sources of electricity, evidence of which is NPP licenses extension in USA, Canada and other countries.
- For new NPP competitiveness will depend on expanses of the alternative possibilities on the free energy market concerning investment expanses.
- Production costs of the NPP are predictable and constant (natural uranium is maximum 8 % of overall production costs at comparatively fixed prices), meantime oil and gas prices are increasing continuously.
- NPP economical indicators are lower than other electricity production rivals, which in tern leading to lower prices for consumers.
- Technical and economical indicators of NPP are good precondition for their life extension.

Electricity Production Expanses without Emission Trading

Source – R. Tarjanne & K. Luostarinen, 2004, Lappeenranta University of Technology

Euro/MWh (March 2004)

Total costs	Capital costs	Operational & maintenance	Fuel costs
Nuclear - 23,7	13,8	7,2	2,7
Gas - 31,2	5,3	3,5	22,4
Coals - 32,9	7,6	7,4	17,9
Peat - 34,6	10,2	6,5	17,9
Wood - 46,8	13	8,2	25,6
Wind - 50,1	40,1	10	

Electricity Production Expanses with Emission Trading

Source – R. Tarjanne & K. Luostarinen, 06.04.2004, Lappeenranta University of Technology

Euro/MWh (March 2004)

Total costs	Capital costs	Operational & maintenance	Fuel costs	Trade 20 €/tCO_2
Nuclear - 23,7	13,8	7,2	2,7	
Gas - 38,2	5,3	3,5	22,4	7
Coals - 49,1	7,6	7,4	17,9	16.2
Peat -54,2	10,2	6,5	17,9	19.6
Wood - 46,8	13	8,2	25,6	
Wind - 50,1	40,1	10		

Radioactive Waste Management

- This basic question is closely related to the future of nuclear energy.
- According to the Convention on safety in Radioactive Waste and Spent Fuel Management, the country where the waste and spent fuel are generated is responsible for safety.
- “Eurobarometer” research dated 2000 year shows, that more than 50 % of the EU citizens support nuclear Energy if Radioactive Waste and Spent Fuel are managed safety in long-term perspective.

- **The main challenge is to find integrated approach for Radioactive Waste and Spent Fuel management, which would guarantee safety and security, economical effectiveness and social and political acceptability in long-term perspective.**

Eurobarometer 2005

A Research made for European Commission for Energy and Transport, about the Europeans opinion on nuclear energy as a whole and Radioactive Waste treatment in particular.

Main results:

- 60% of Europeans do believe that Nuclear Energy gives possibility for energy resources diversification.
- 61% of Europeans do believe that Nuclear Energy helps for natural gas dependence decrease of Europe.
- 62% of Europeans do agree that Nuclear Energy generate less CO_2 emissions compared to coals and oil.

Advantages, Challenges and Solutions Regarding Bulgarian Nuclear Industry

- More than 40 years nuclear research and development activities.
- More than 40 years university nuclear education.
- More than 30 years scientific and practical experience in construction, commissioning, operation, maintenance, design changes and modernization of nuclear facilities.
- About 140 reactor/years safe and reliable operation.
- Availability of adequate attitude and strong corporate culture.
- Availability of qualified human recourses.
- Availability of training facilities.
- Comprehensive training system.

Advantages, Challenges and Solutions Regarding Bulgarian Nuclear Industry

Economical Trends:

- Expectation for sustainable economical growth.
- Lack of alternative primary energy resources.
- Energy market liberalization.
- Decommissioning of units 3&4.
- Restart of Belene NPP construction.

Educational System Reforms:

- Engineering study vs. Academic study - Price/Trouble ratio deterioration.
- Decreasing of number of students in nuclear area.
- Limited number of nuclear specialties in Bulgarian universities.
- Conservatism of post graduation system.

Advantages, Challenges and Solutions Regarding Bulgarian Nuclear Industry

DEMOGRAPHIC TRENDS:

- Ageing and depopulation.
- Emigration and “brain drain”.
- Impact of prolonged retirement system reforms.

PUBLIC OPINION:

- Strongly positive.

CONCLUSIONS

- Nuclear Energy is necessary for:
  - Increasing the confidence in energy supplies.
  - Decreasing dependency on coals and electricity import.
  - Encourage sustainable development.
  - Limitation of CO_2 emissions and fighting the climate changes.
- What have to be done in order to get support for Nuclear Energy as part of energy mix in Europe's future:
  - Increasing the public acceptance.
  - Encourage investments in new NPP, researches and developments on new and existing nuclear technologies.
- Nuclear Industry will expand in Central and Eastern Europe, in particular in Bulgaria and South East Region of Europe.

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THANK YOU FOR YOUR ATTENTION!