Nuclear Energy

Juozas Augutis

Lithuanian Energy Institute

Joint Research Centre

Milan, 18-19 January 2010

"Stakeholder Meeting on: Electricity, Renewables, Demand, Nuclear energy, Severe accidents / terrorist threat" of the SECURE project

Presentation content

- Objectives of WP5.4
- Nuclear energy situation
- Energy security & cost aspects in nuclear field
- Nuclear energy scenarios
- Near-term policies of EU countries and economies currently using nuclear energy
- Nuclear energy threats
- Indicators
- Conclutions

Objectives of WP5.4

- The main objective of the task is to develop assessment methodology of energy security supply in nuclear energy sector, elaborate state-of-the-art analysis methods for nuclear energy scenarios, and evaluate geopolitical, EU and national political, technical, economic and regulatory influence to security of nuclear energy supply.
- Development and testing of a tool to evaluate all possible influence to the nuclear energy security supply in terms of technical issues including any type of disturbances and economical-political uncertainties.
- Application of the sensitivity and uncertainty analysis for the development of the models and testing simulations.

Objectives of Task 1 and Task 2

- **Task 1: Geopolitical Issues (lead: LEI**; partners: GRCF, JRC)
- An analysis of geopolitical issues relevant to the upstream nuclear fuel cycle and transport taking into account resource allocation, location of enrichment, fabrication and other facilities for preparation of nuclear fuel, transportation routes of nuclear fuel and relevant materials. Elaboration of methods and tools will allow quantifying information related to these issues in order to use it further for preparation of common tools and evaluation of security aspects in nuclear sector.
- **Task 2: EU and national political Issues (lead: JRC**; partners: GRCF, LEI)
- An analysis and generalisation of EU and national political issues relevant for the nuclear sector will be performed. Energy security supply will be analysed in the light of national and EU political strategies on nuclear energy future.

Energy security aspects in the nuclear field

Nuclear energy is more able than oil or gas to provide security of supply because the fuel – uranium – comes from diverse sources and the main suppliers are operating in politically stable countries.

•Identified uranium resources are sufficient to fuel an expansion of global nuclear generating capacity, without reprocessing, at least until 2050.

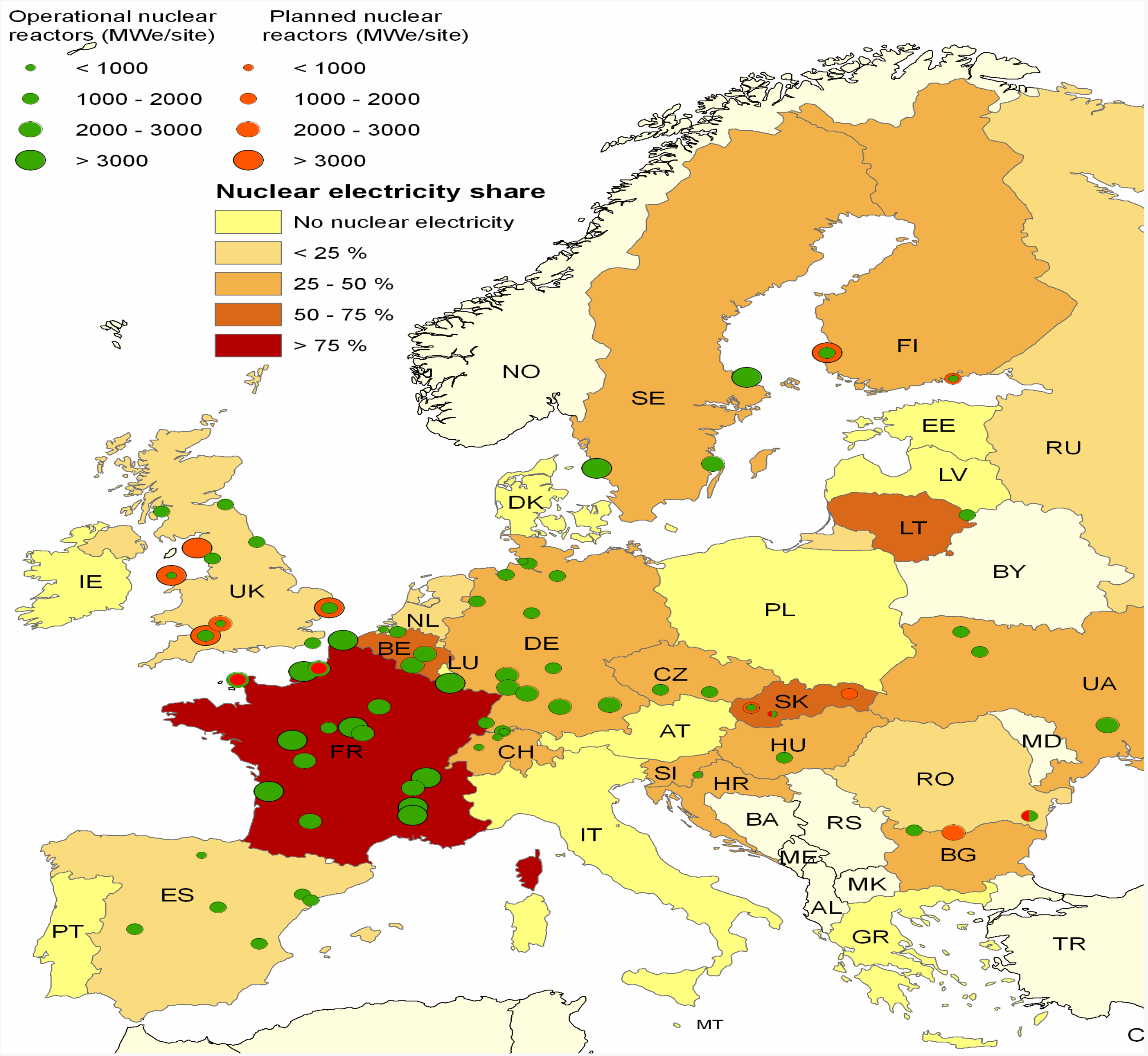
•Based on regional geological data, resources that are expected to exist could increase uranium supply to several hundreds of years.

Cost aspects in nuclear field

- The cost of uranium amounts to only about 5% of the cost of generating nuclear electricity.

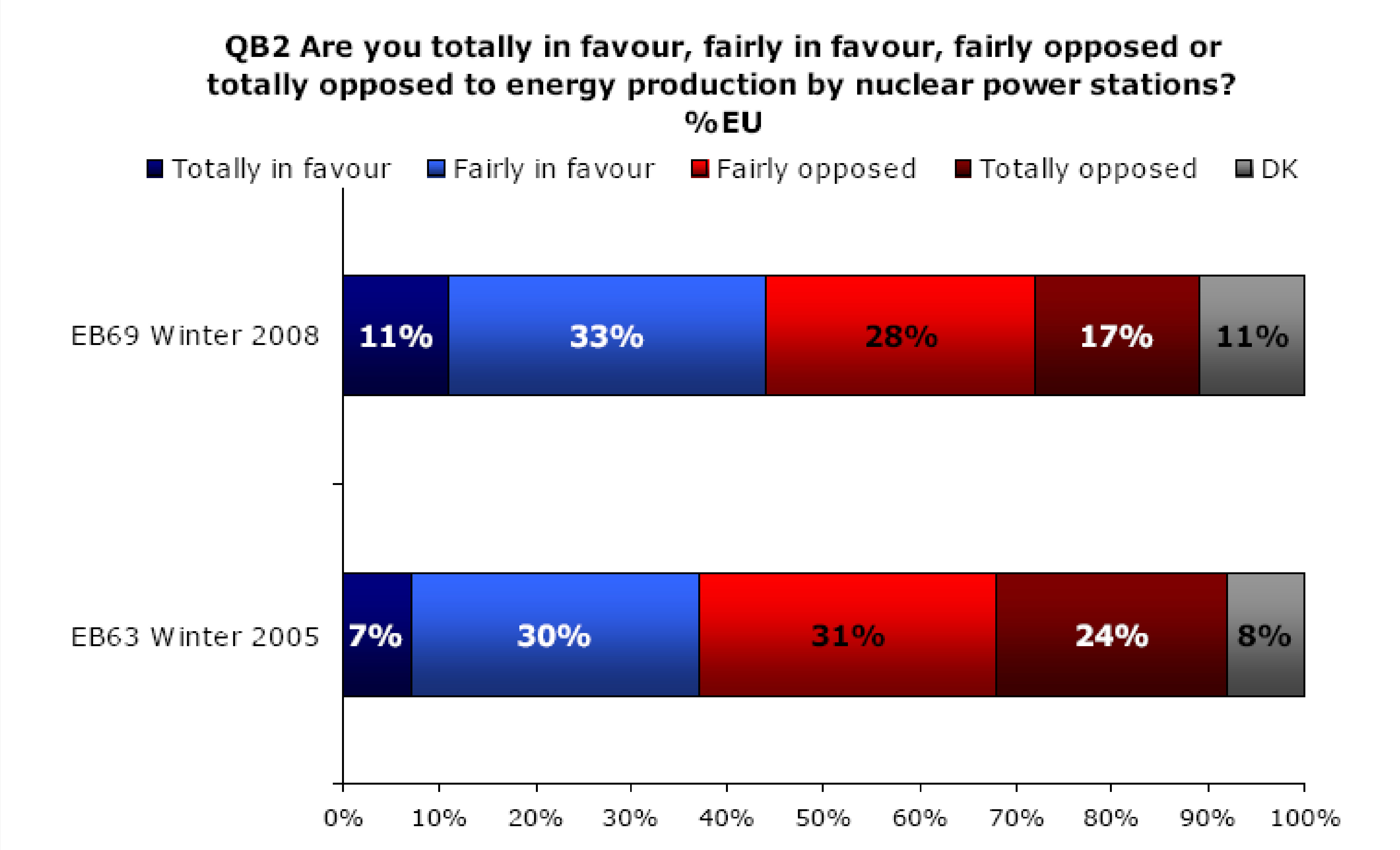
- Returns from existing nuclear energy investments have in many cases been increased through improved availability, power up rates and licence renewal.

- Many plants have been up rated, some by as much as 20%; a significant number of reactors have had lifetimes extended from 40 to 60 years.


Operational nuclear reactors (MWe/site)
< 1000
1000 - 2000
2000 - 3000
> 3000
Planned nuclear reactors (MWe/site)
< 1000
1000 - 2000
2000 - 3000
> 3000
Nuclear electricity share
No nuclear electricity
< 25 %
25 - 50 %
50 - 75 %
> 75 %
NO
SE
FI
EE
RU
LV
LT
DK
IE
UK
BY
PL
NL
BE
DE
LU
CZ
SK
UA
FR
AT
CH
HU
MD
SI
HR
RO
BA
RS
IT
ME
BG
MK
ES
AL
PT
GR
TR
MT
C

EU Nuclear Power Reactors

Country	Nuclear Power Reactors			Annual Electrical Power Production for 2007, GWh(e)		Part of nuclear energy, %
	Under Construction	Operational	Shutdown	Total Power Production (including Nuclear)	Nuclear Power Production	
Belgium	0	7	1	84841	45853	54.0
Bulgaria	2	2	4	42664	13694.752	32.1
Czech Republic	0	6	0	81412	24624.409	30.2
Finland	1	4	0	77740	22499	28.9
France	1	59	11	549100	418300	76.2
Germany	0	17	19	488369.371	133209.366	27.3
Hungary	0	4	0	37722.51	13887.065	36.8
Italy	0	0	4	200100	0	0.0
Lithuania	0	1	1	14100	9074.846	64.4
Netherlands	0	1	1	97449	3993.875	4.1
Romania	0	2	0	54348	7078.542	13.0
Slovakia	0	4	3	26076	14158.473	54.3
Slovenia	0	1	0	13057.77	5428.1932	41.6
Spain	0	8	2	300146	52331	17.4
Sweden	0	10	3	139637	64396	46.1
Switzerland	0	5	0	65802	26342	40.0
United Kingdom	0	19	26	380370	57523.689	15.1
Total in EU	**4**	**150**	**75**	**2652934.651**	**912394.2102**	**34.4**



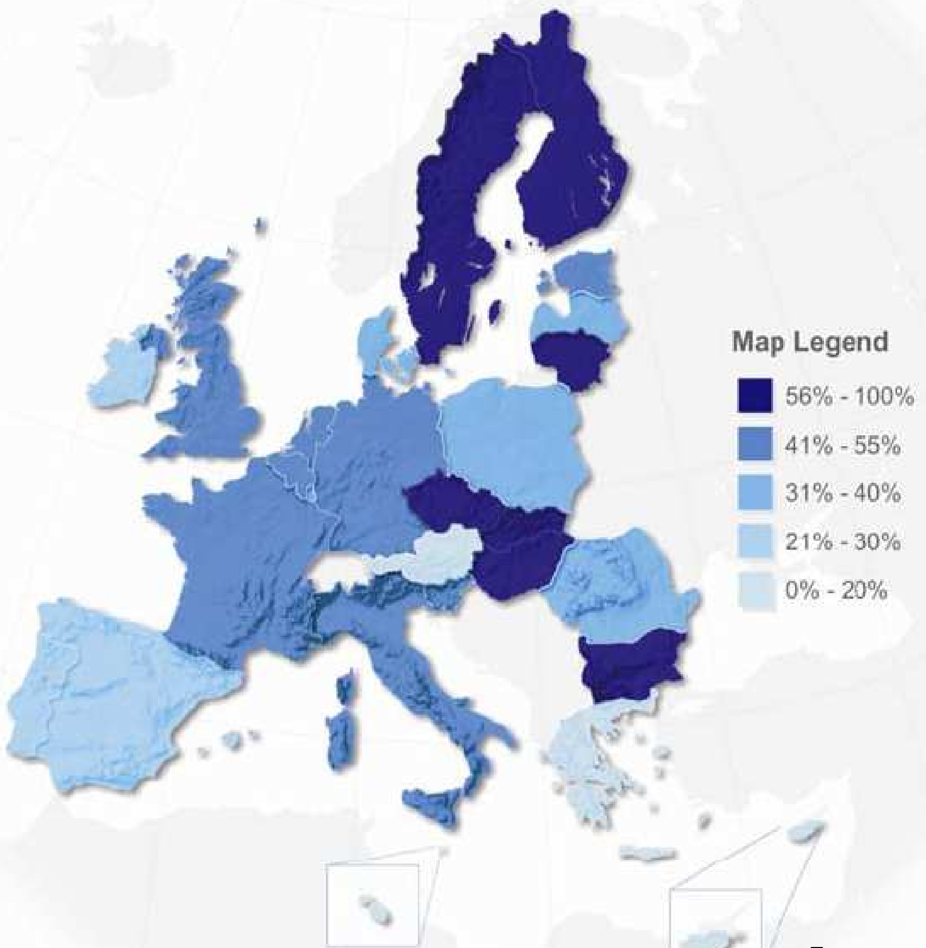
Eurobarometer

Question: QB2. Are you totally in favour, fairly in favour, fairly opposed or totally opposed to energy production by nuclear power stations?

Answers: Total "in favour"

☼	Czech Republic	64%
☼	Lithuania	64%
☼	Hungary	63%
☼	Bulgaria	63%
☼	Sweden	62%
☼	Finland	61%
☼	Slovakia	60%
☼	The Netherlands	55%
☼	France	52%
☼	Slovenia	51%
☼	Belgium	50%
☼	United Kingdom	50%
☼	Germany	46%
	European Union (27)	44%
	Italy	43%
	Estonia	41%
	Poland	39%
	Denmark	36%
	Latvia	35%
☼	Romania	35%
	Luxembourg	34%
☼	Spain	24%
	Ireland	24%
	Portugal	23%
	Greece	18%
	Malta	15%
	Austria	14%
	Cyprus	7%

☼ Has operational NPP



Eurobarometer

Nuclear Energy Agency (NEA) assumptions. The phase-out scenario

- This scenario assumes that, in spite of the potential advantages of nuclear power in mitigating climate change and contributing to energy security, all or almost all countries reject its use.

- This would lead to nuclear power capacity being gradually reduced over the next few decades.

- In the case where no additional nuclear power plants are built, there would be practically no nuclear contribution to total electricity generation by 2050.

- The rate of phase-out would depend on the extent to which the operating lives of currently operating plants would be extended.

POWER REACTOR INFORMATION SYSTEM

IAEA PRIS

- WHAT IS PRIS
- PUBLICATIONS
- SERVICES
- HOW TO ORDER
- PRIS PC SOFTWARE

NUCLEAR POWER PLANT INFO

- WORLD SUMMARY
- REACTOR DETAILS

Select Country

Sorting Order

alphabetically

SEARCH

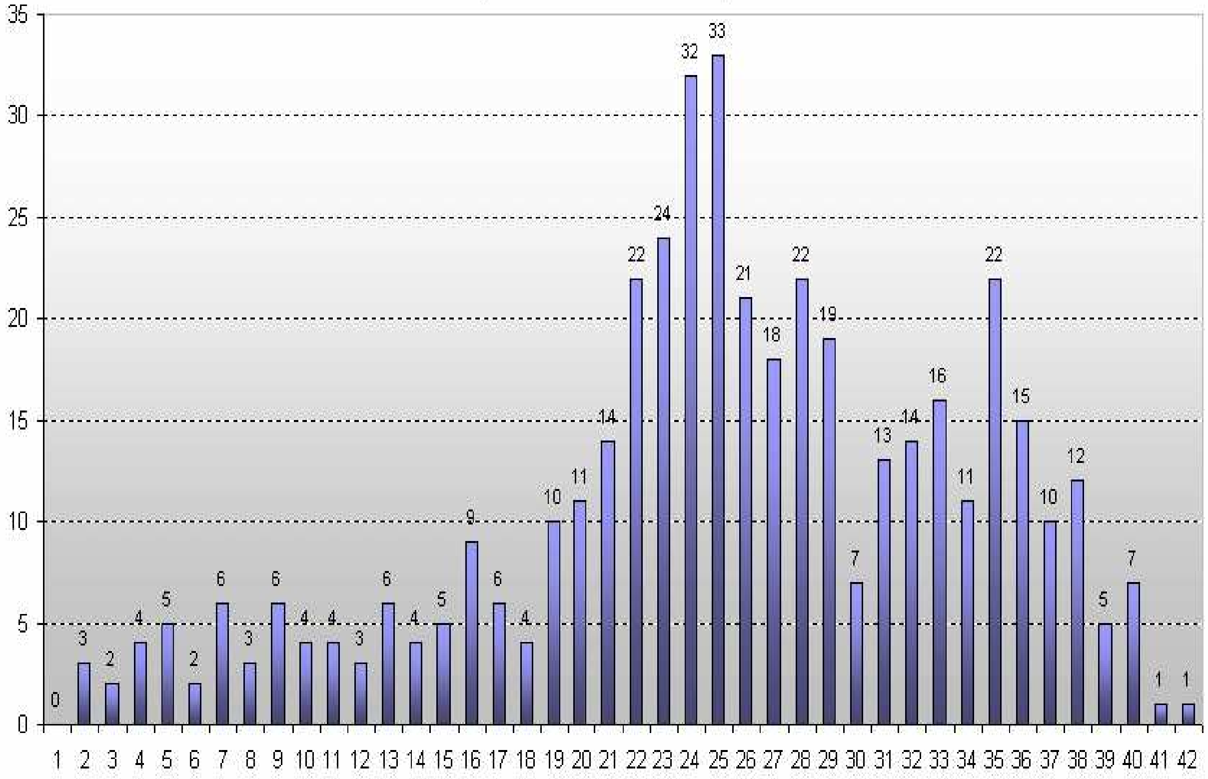
(*) Information on nuclear power plants in Taiwan, China can be provided on request.

Registered Users

NUCLEAR POWER PLANTS INFORMATION

Number of Operating Reactors by Age

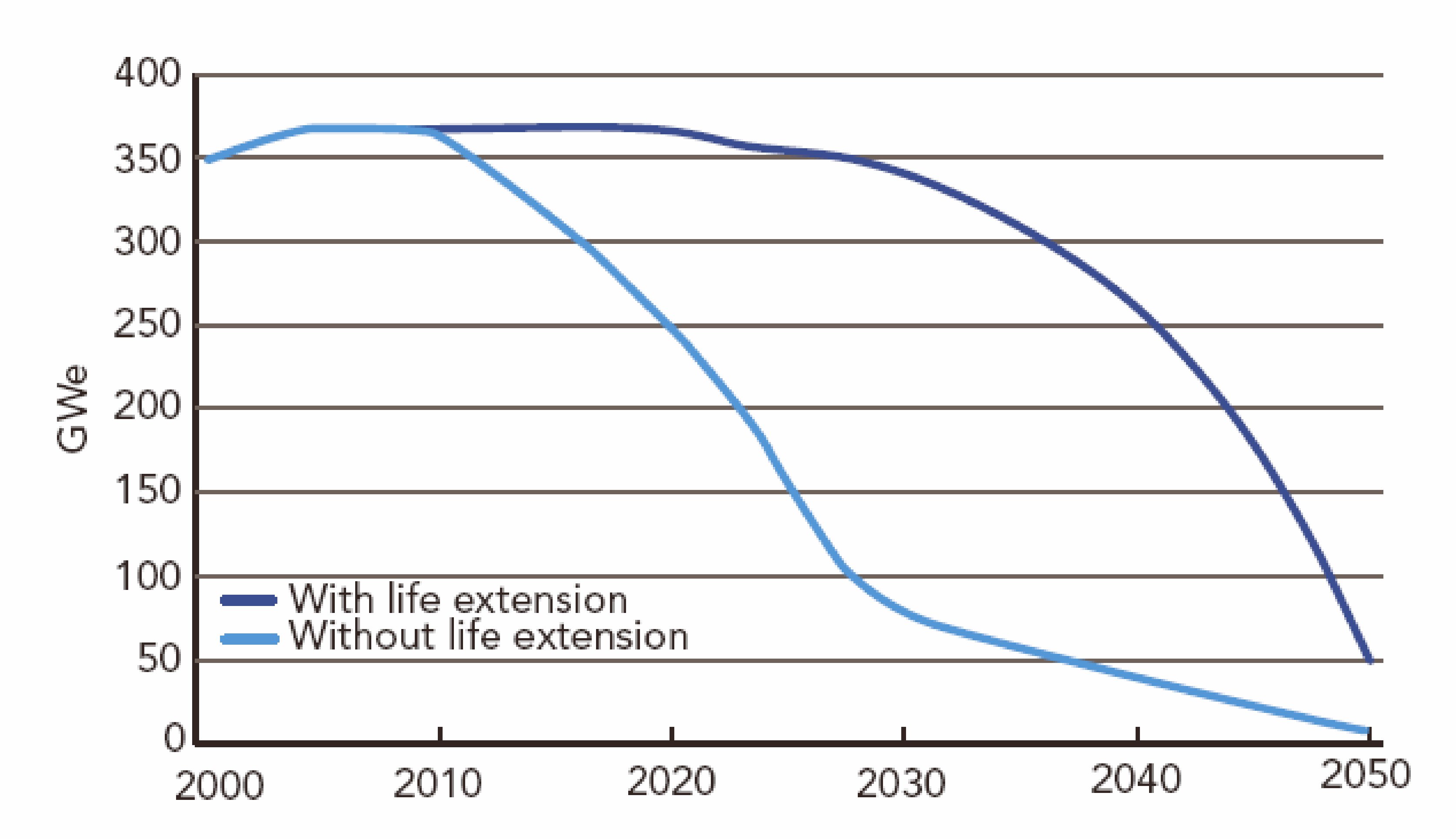
(as of March 2009)



Note: Age of a reactor is determined by its first grid connection.

Go Back to Nuclear Power Plant Information

World nuclear capacity in the phase-out scenario



NEA assumptions. Low scenario

Low scenario - new plants are built only to replace retirements in the two decades to 2030. Capacity is maintained or slightly increased via life extension, up rating and higher power replacements.

Low scenario could be conditioned by the next circs between 2020 and 2040:

- Carbon capture and storage are successful.
- Energy from renewable sources is successful.
- Experience of new nuclear technologies is poor.
- Public and political acceptance of nuclear power is low.

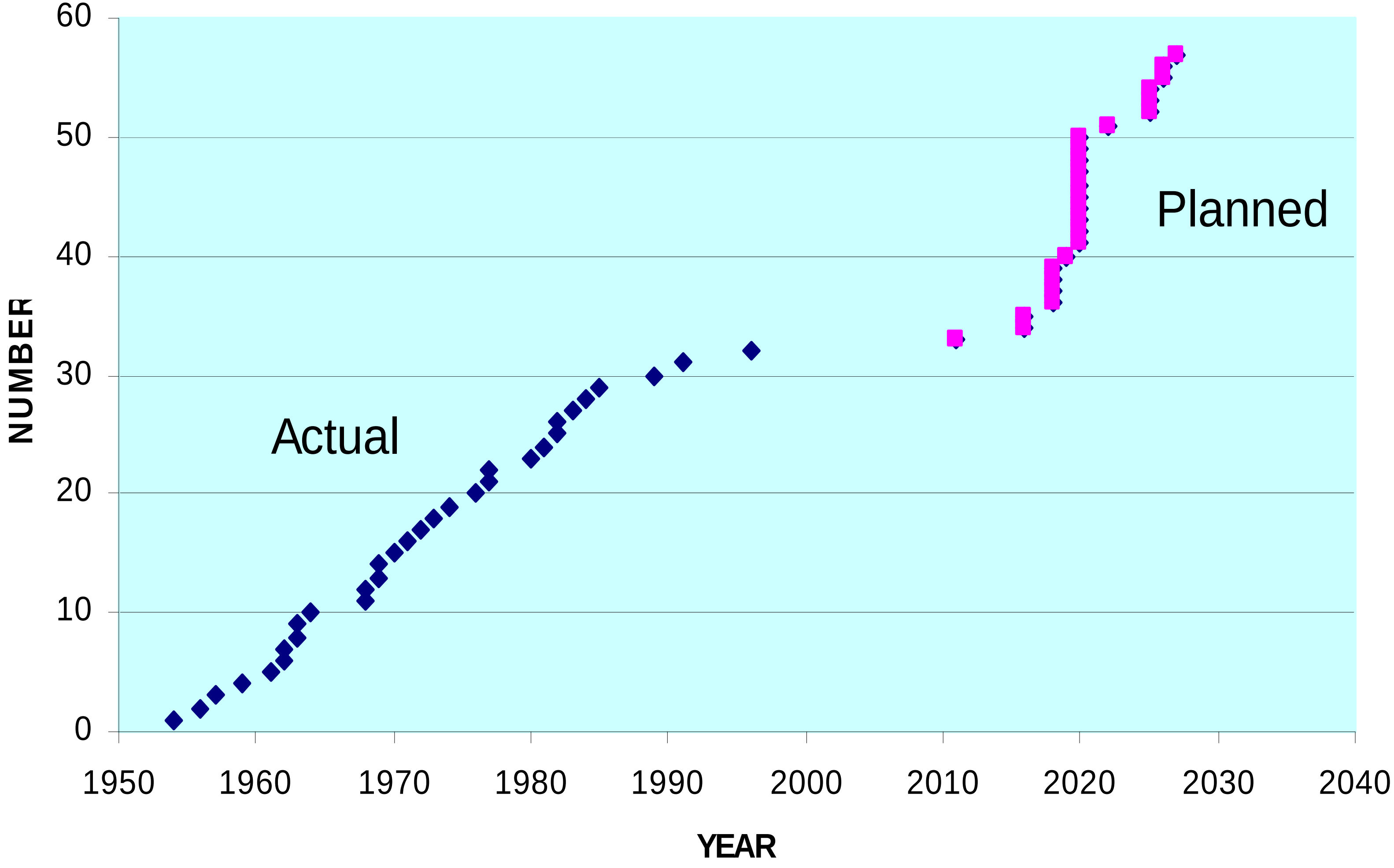
NEA assumptions. High scenario

High scenario – life extensions and plant up ratings continue. Current national plans and authoritative statements of intent for additional capacity by 2030 are largely implemented.

Between 2020 and 2040:

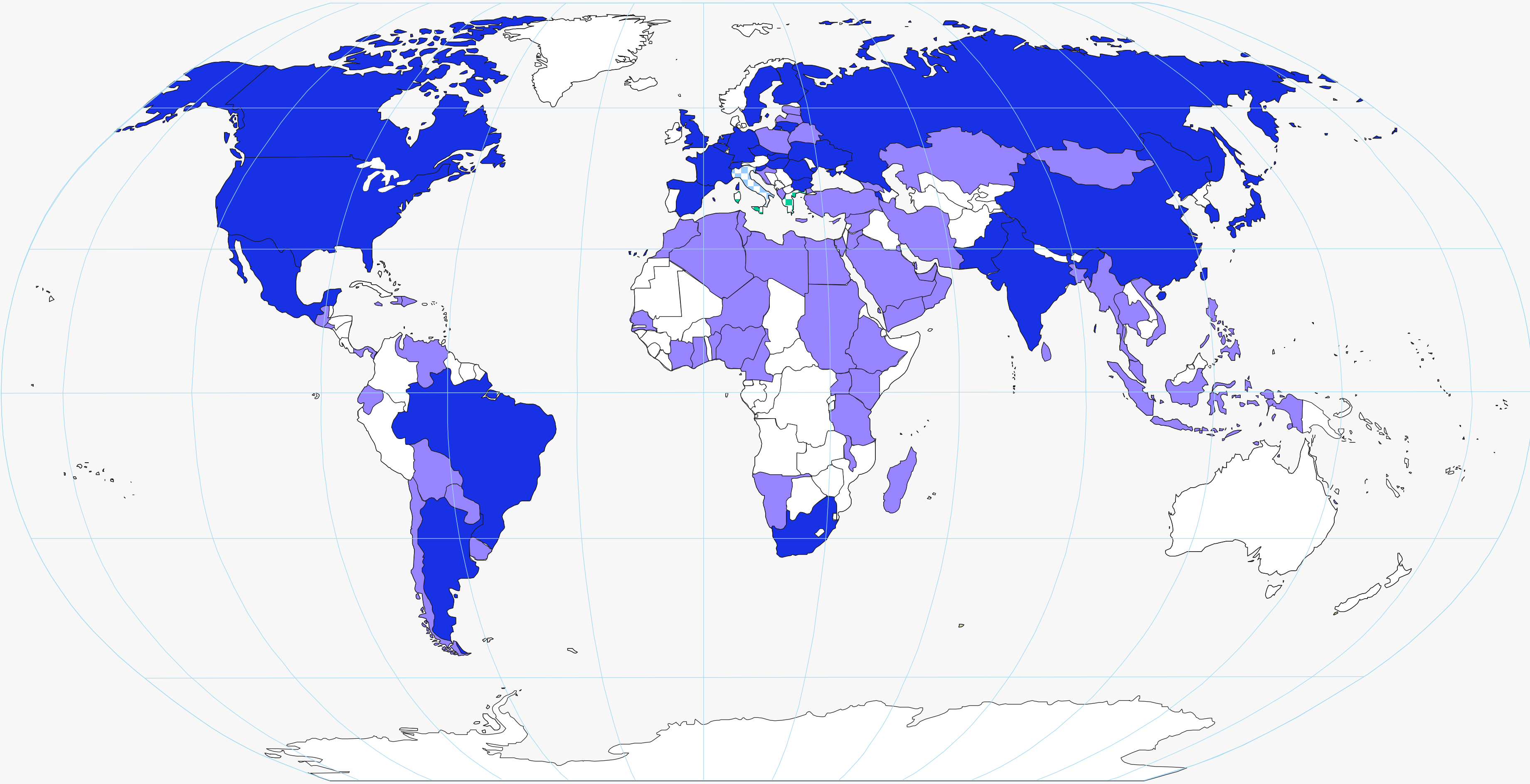
- Carbon capture and storage is not very successful.
- Energy from renewable sources is disappointing.
- Experience and new nuclear technologies is good.
- Public concern about climate change and security of supply increases, significantly influencing governments.
- Public and political acceptance of nuclear power is high.
- Carbon trading schemes are widespread and successful.

Countries introduction of NPP



Source: IAEA

Countries considering introduction/expansion of nuclear power



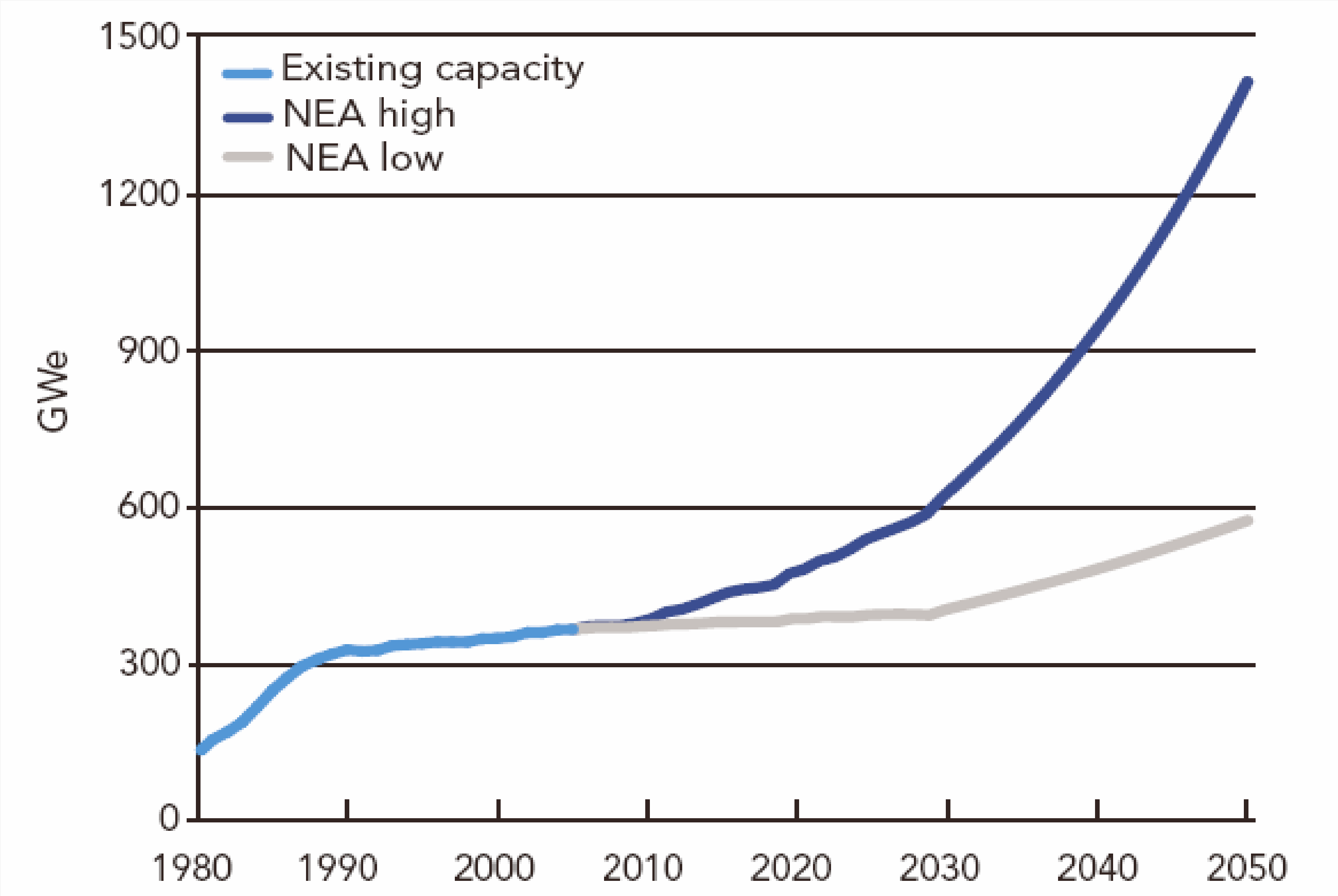
Operating (30)

Considering through IAEA TC Project (61)

Other countries having expressed interest

Source: IAEA

Global nuclear capacity in the NEA high and low scenarios



Nuclear fuel cycle

Nuclear sector threats (1)

Technical threat

- Accidents and failures with or without release of radioactive substances. Accidents and failures inside nuclear infrastructure. Accidents and failures in associated infrastructure.
- Obsolete electricity infrastructure.
- Not adequate reserve capacity at power plants
- Not sufficient links between neighbouring countries (lowers possible of utilization of large capacities of nuclear plants).
- No significant progress in the nuclear safety (delay of Gen IV, passive safety systems…).

Nuclear sector threats (2)

Economical threats:

- Not sufficient economical attractiveness and competitiveness of nuclear energy.
- Insufficient economical potential (weak economic development, economic crises, etc.) of countries to develop and to maintain nuclear energy.
- Absence of commonly adopted methodology for solving development of nuclear energy.
- Unsolved problem of storage and depository of radioactive waste and spent nuclear fuel.
- EU does not have its own sufficient resources of nuclear fuel.

Nuclear sector threats (3)

Socio-political threats:

- Negative public opinion.
- Insufficient support in energy strategies
- Political disturbances among nuclear countries and inside of them.
- Society protests against nuclear objects (power plants, factories, depositories, transportation of nuclear materials, etc.).
- Very high safety requirements and standards.
- Terrorism.
- Nuclear materials proliferations.

Nuclear sector threats (4)

Environmental threats:

- Possible large scale damages due to natural disasters (earthquake, extreme winds, external fire, external flooding, extreme showers, etc.).
- Possible accidents with consequences consisting impact to the environment.
- Small scale radioactive, thermal and other pollution into atmosphere, water and ground (due to normal operation, storage radioactive waste and spent nuclear fuel).

Blocks of indicators

NO	INDICATOR	DIRECTION OF SCALE	UNIT
1.	TECHNICAL BLOCK		
1.1	***Accidents*** in nuclear installations infrastructure	min	Probability
1.2	***Accidents*** in nuclear installations	min	Probability
1.3	Aging of nuclear installations	max	Mean time before failure
1.4	Possibilities of accidents management and consequences liquidation	min	Time of liquidation of accident consequences

Blocks of indicators

NO	INDICATOR	DIRECTION OF SCALE	UNIT
2.	**ECONOMICAL BLOCK**		
2.1	Independence of Nuclear sector from foreign imports, based on domestic energy storage and/or resources	max	Ratio
2.2	Investments in the investigations and development of nuclear energy	max	€/MWh
2.3	The price of installed capacity of new nuclear station (price of nuclear installations constructions)	min	€/MWh
2.4	Price of fuel generation	min	€/MWh
2.5	Price of fuel transportation	min	€/MWh
2.6	The ratio of nuclear fuel price with generated electricity price	max	€/MWh
2.7	Part of nuclear energy in total energy balance	max	ratio
2.8	Possible loss due to accidents in nuclear installations	min	€/MWh

Blocks of indicators

NO	INDICATOR	DIRECTION OF SCALE	UNIT
3.	SOCIO-POLITICAL BLOCK		
3.1	Diversification of nuclear fuel suppliers	max	ratio
3.2	Threat of terroristic attacks	min	probability
3.3	Possible consequences due to accidents in nuclear installations	min	Negative attitude of society
3.4	Good public opinion to nuclear plants	max	Ordinal scale (expert assessment)
3.5	Positive nuclear energy policy	max	percentage

Blocks of indicators

NO	INDICATOR	DIRECTION OF SCALE	UNIT
4.	ENVIRONMENTAL BLOCK		
4.1	Radiation (land contamination) due to nuclear sector on accidents	min	Sv (Bq)
4.2	Radiation (land contamination) due to nuclear sector on normal operation	min	Sv (Bq)
4.3	Hazards due natural disasters (extreme winds, external fire, external flooding and extreme showers, etc.)	min	Probability
`			
4.4	The resources of nuclear fuel	max	MJ/kWh
4.5	Reprocessed nuclear fuel	max	Part
4.6	SO_2 emissions	max	Ktn/MWh

Estimation of threshold values

Expert assessment method	Functional interdependencies method

Threshold values of all indicators are determined using expert judgment.

Weights of all indicators are determined using expert judgment.

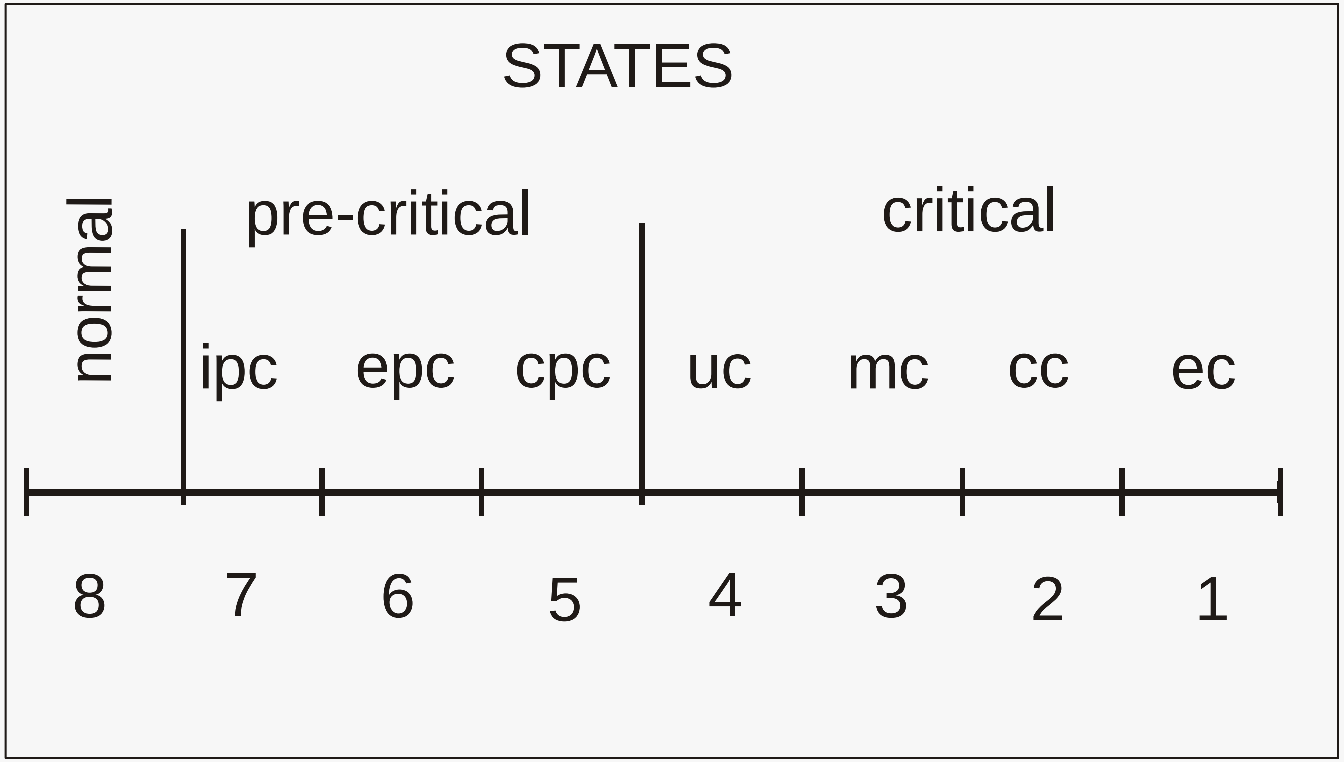
Main indicators

Basic scenario of energy development

Correlation matrix

Determined according to the interdependency level between blocks and indicators.

Classification of indicators states



Conclusion remarks

- Nuclear energy plays positive role in the energy security.

- Now nuclear energy is under pressure of serious threats.

- Future of the nuclear energy mainly depends on energy policies (USA, EU, separate countries) and public opinion.

Thank you for Your attention!

juozas@mail.lei.lt