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Potential Role of Nuclear Energy in Lithuania Under Various Post-Kyoto Climate Change Mitigation Regimes

(Post-Kyoto Climate Change Mitigation Regimes Impact on Energy Sector: Lithuanian Case)

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Post-Kyoto climate change mitigation regimes impact on energy sector: Lithuanian case

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The scope of presentation

- The objective and tasks of the presentation
- Lithuania: the main features
- Energy sector in Lithuania
- GHG emission reduction potentials and costs in Lithuania
- GHG emission projections in Lithuania according scenarios with measures and without measures
- Post-Kyoto climate change mitigation regimes
- Targets set by Post-Kyoto climate mitigation regimes for Lithuania
- Conclusions & findings

The main goals and tasks of presentation

- To analyse Lithuanian GHG emission projections scenarios “with measures” and “without measures”.
- To assess GHG emission reduction potentials and costs in various GHG emission reduction sectors in Lithuania.
- To analyse post-Kyoto climate change mitigation regimes and their requirements for GHG emission reduction in Lithuania.
- To evaluate feasibility to implement requirements of post-Kyoto climate change mitigation regimes in Lithuania under various energy options.

Country outline

LITHUANIA

EU member state since 2004

Territory: 65.3 thou km2

Capital: Vilnius

Population: 3.2 mln.

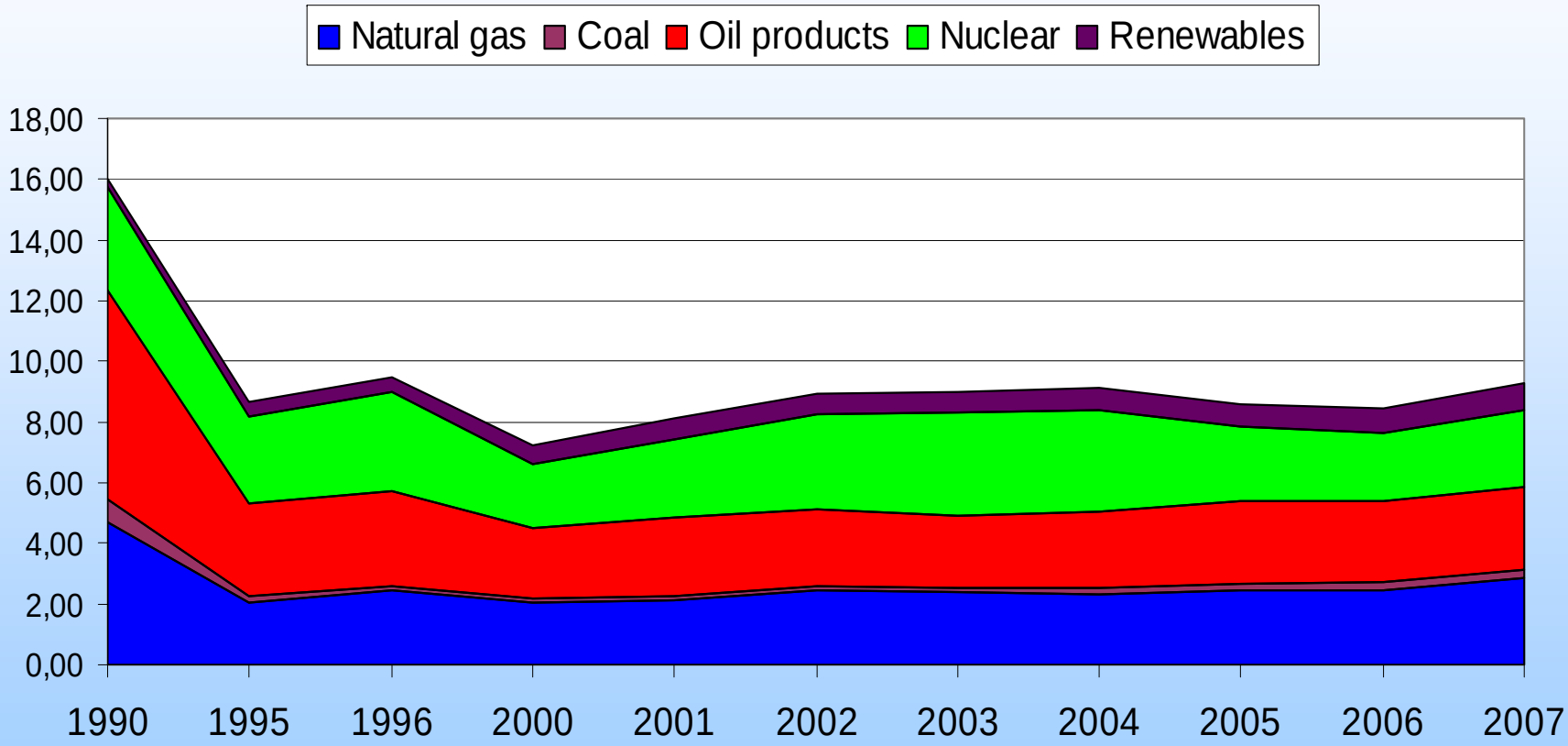
Population density:

49 inhab/km2

PPP GDP/capita in 2007:11.6 thou EUR

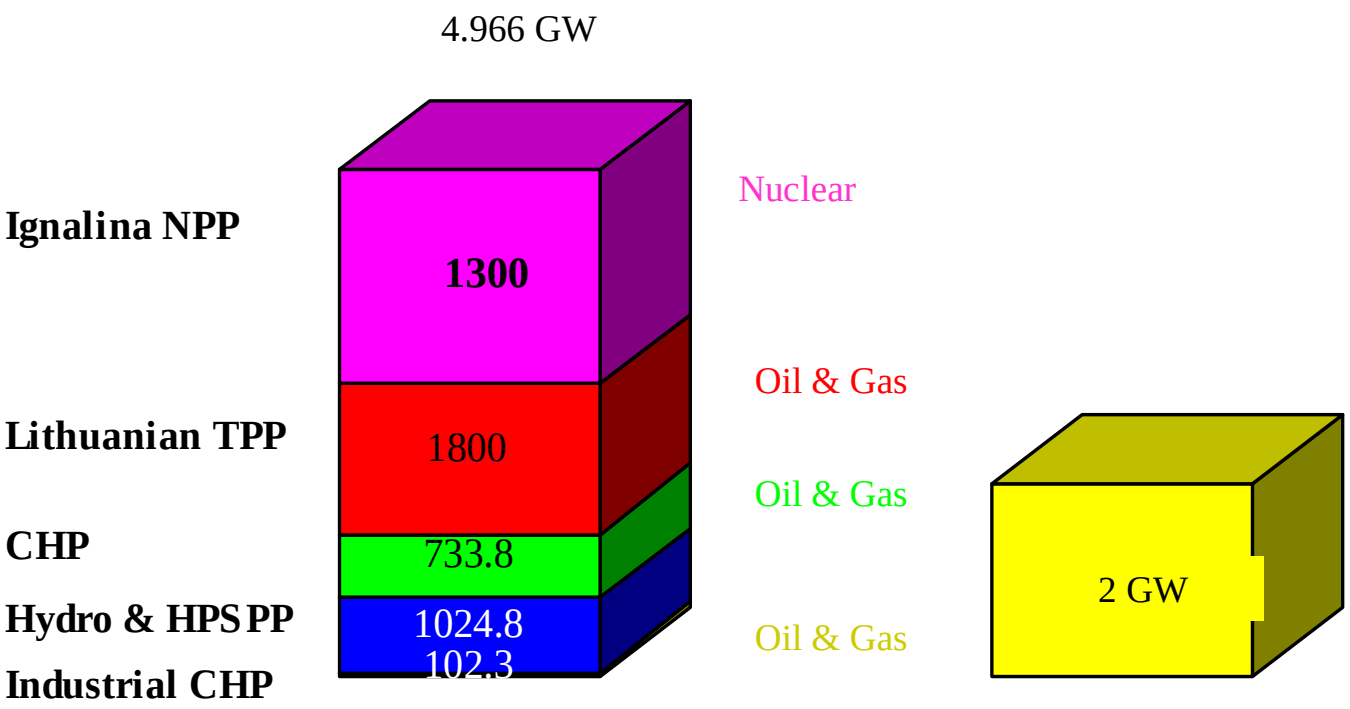
Bordered by Latvia to the north; Belarus to the east; Belarus, Poland, and Russia (Kaliningrad) to the south; and the Baltic Sea to the west

TPES, Mtoe


Natural gas
Coal
Oil products
Nuclear
Renewables
18,00
16,00
14,00
12,00
10,00
8,00
6,00
4,00
2,00
0,00
1990
1995
1996
2000
2001
2002
2003
2004
2005
2006
2007

Lithuanian power system in 2009

Installed capacity *Domestic demand*



Energy sector development scenarios

Several energy sector development scenarios were analysed in Lithuanian National Energy Strategy approved in 2007 and “Analysis and forecast of energy sector development trends up to 2025” by Lithuanian energy institute. 2006.

The following energy sector development scenarios were selected representing the possible situation of energy sector in the future and to evaluate the impact of new nuclear power plant construction and energy price growth impact: ZK1, ZK2, ZK3, ZK 4 (including construction of new nuclear power plant) and ZK5, AK1, AK2, AK3 (without new nuclear power plant); These scenarios can be also grouped as scenarios “with measures”

From these 8 main energy sector development scenarios: maximal and minimal energy sector development scenarios can be constructed: ZK1 (basic economic growth and basic energy prices growth and construction of new nuclear power plant) and AK3 (fast economic growth and fast energy prices growth without construction of new nuclear power plant).

Energy sector development scenarios

Scenario	*Energy demand*	*Fuel prices*	*New NPP construction and other assumptions*
ZK1	Basic growth scenario	Basic scenario	New Nuclear Power plant (NPP) if according selected assumptions it is more competitive as other Power plants however it‘s maximal capacity is limited up to 500 MW in year 2015 and up to 1000 MW latter. This reflects the share of NPP capacities allocated to Lithuania.
ZK2	Fast growth scenario	Basic scenario	The same as for ZK1 scenario
ZK3- **minimal**	Basic growth scenario	Basic scenario	New NPP is commissioned in 2015 (500 MW), do not taking into account its competitiveness and in 2018 the capacity is limited to 1000 MW. This reflects the share of NPP capacities allocated to Lithuania.
ZK4-	Fast growth scenario	Basic scenario	The same as for scenario ZK3
ZK5	Fast growth scenario	Basic scenario	New NPP is not commissioned do not taking into account it‘s competitiveness. Natural gas is being replaced by heavy fuel oil.
AK1	Basic growth scenario	High prices scenario	Construction of new NPP is based on economic reasons. The capacity is limited to 500 MW in 2015 and to 1000 MW in 2018
AK2	Fast growth scenario	High prices scenario	The same as for scenario AK1
AK3- maximal	Fast growth scenario	High prices scenario	The same as for scenario ZK5

GHG emission projections in energy sector, Mt

Scenario	*2005*	*2010*	*2015*	*2020*
Energy or fuel combustion sector				
ZK1 – basic scenario	13.2	21.6	20.3	23.3
ZK2 – fast economic growth scenario	13.2	22.4	22.4	25.6
ZK3 – basic scenario (minimal energy sector scenario)	**13.2**	**21.6**	**18.9**	**19.8**
ZK4 – fast economic growth scenario	13.2	22.4	20.7	22.2
ZK5 – fast economic growth scenario	13.2	22.9	23.9	27.2
AK1 – basic economic growth scenario	13.2	21.8	19.2	20.4
AK2 – fast economic growth scenario	13.2	22.5	21.2	23.0
AK3 - fast economic growth (maximal energy scenario)	**13.2**	**23.2**	**24.5**	**29.3**

GHG emission reduction potentials and costs

GHG reduction measures	GHG reduction cost, Lt/tCO_2eq	Potential in 2008-2012, TWh	GHG emission reduction potential in 2008-2012, Mt CO_2eq/year
Fuel combustion sector: 1,9 Mt/year; average reduction costs 2-170 Lt/tCO_2eq			
Energy saving (primary energy)	2-20	0.8 TWh	0.18
Waste energy resources (conversion coefficient 0.5)	32.4	2 TWh	0.22
Use of biofuel in transport (conversion coefficient 1.076)	35.4	0.7 TWh	0.17
Renewable energy sources in electricity generation (conversion coefficient 2.707	170	0.9 TWh	0.54
Cogeneration (conversion coefficient 0.5)	125	2.6 TWh	0.29
Renewables in primary energy except mentioned categories		2.26 TWh	0.5
Agriculture: GHG reduction potential 0,1 Mt; average costs 1125 Lt/tCO_2eq			
State programme for water pollution from agriculture sources reduction	1125		0.1
Waste sector: GHG emission reduction potential 0,1 Mt; average costs 1370 Lt/tCO_2eq			
State strategic waste management plan	1370		0.1
Industrial processes: GHG emission reduction potential 2,4 Mt; average costs : 315-560 Lt/tCO_2eq			
Conversion of wet cement production technologies to dry cement production technologies	560		0.5
Modernization of technological processes in chemical industry	315		1.9
Total			4.2 Mt

GHG emission projections in energy sector and impact of new NPP

GHG emission projections in energy sector “with measures” are based on final energy demand and primary energy supply projections and, include already implemented and foreseen climate change mitigation measures in Lithuania. These measures are incorporated in the forecast of final energy demand and include energy saving potential, evaluated in the National energy efficiency programme, and other measures set by the National energy strategy, including measures to promote utilization of RES, promotion of CHP, fuel standards, etc.

Construction of new nuclear power plant in Lithuania in 2015-2017 foreseen in National energy strategy will cost about 2 bill. EUR. GHG emission reduction caused by new nuclear power plant about 7.5 Mt/year. Therefore GHG emission reduction costs makes more than 900 Lt/tCO2eq are one of the highest one comparing with other measures except Agriculture and Waste sector however potential – **7,5 Mt/year** is significant higher than in other GHG emission reduction options and even higher than total GHG emission reduction potential- **4,2 Mt/year.**

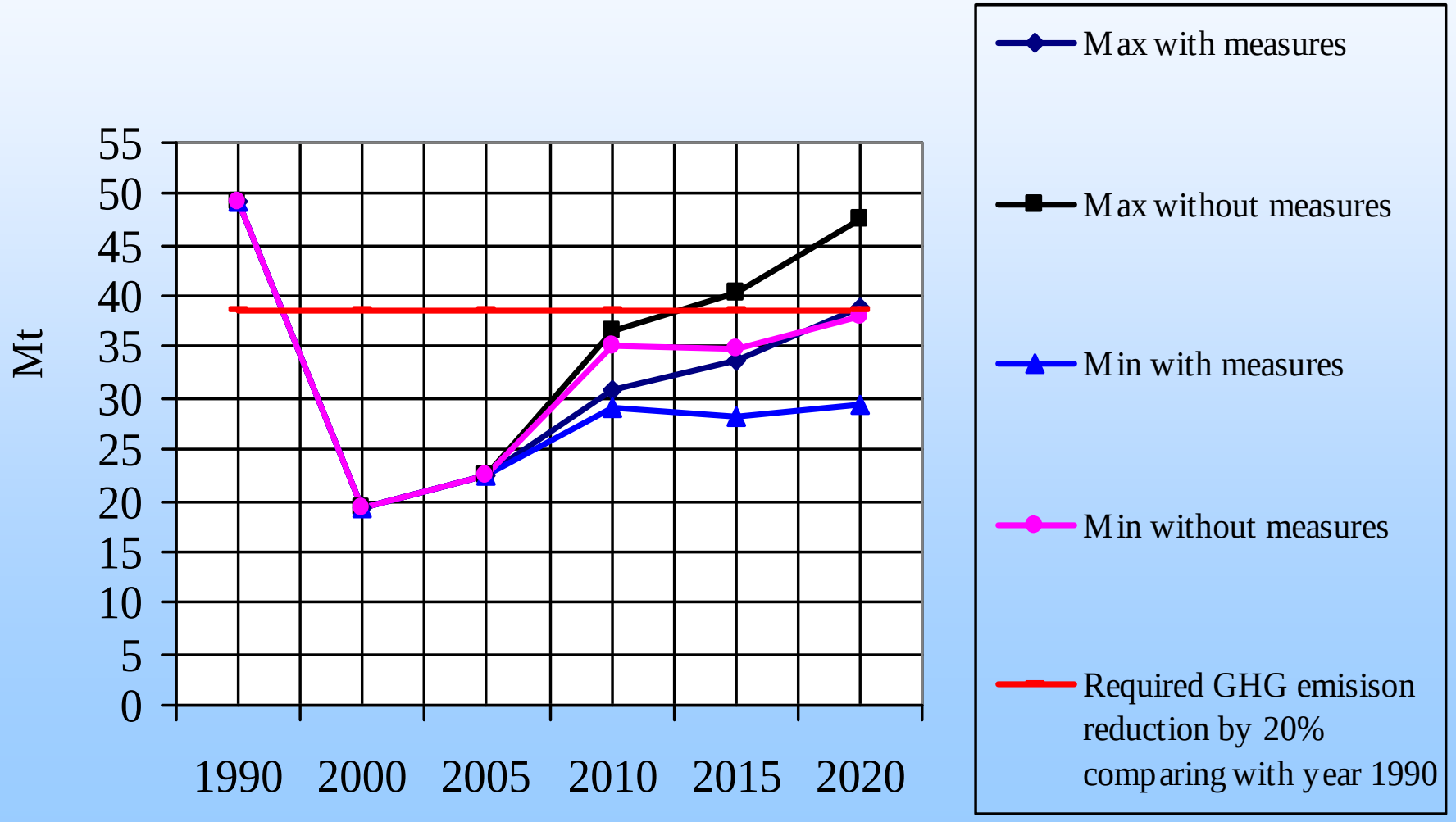
Impact of policies and measures

Climate change mitigation policies and measures	The average annual GHG emission reduction, Mt			
	2010	2015	2020	2025
Fuel combustion sector				
Energy savings	0.18	0.51	0.84	1.18
Use of waste energy resources (conversion factor to primary energy 0.5)	0.22	0.3	0.38	0.45
Use of biofuels in transport (conversion factor to primary energy 1.076)	0.17	0.32	0.47	0.62
RES in electricity generation (conversion factor from electricity to primary energy 2.707)	0.54	0.66	0.78	0.9
Cogeneration (conversion factor to primary energy 0.5)	0.29	0.36	0.43	0.51
RES in primary energy supply except categories already mentioned	0.5	0.61	0.72	0.84
Total in fuel combustion sector	**1.9**	**2.79**	**3.62**	**4.5**
Agriculture				
State programme for pollution to water reduction from agriculture sources	**0.7**	**1.2**	**1.7**	**2.2**
Waste				
National Strategic waste management plan	**0.94**	**0.31**	**0.81**	**2.44**
Industrial processes				
The wet cement production technology replacement by dry cement production technology	0.5	0.5	0.5	0.5
Modernization of technological processes in chemical industries of Achema	1.9	1.9	1.9	1.9
Total in industrial sector	2.4	2.4	2.4	2.4
Forestry Expansion Strategy for 2004-2020	**7**	**7.63**	**8.26**	**8.9**
LULUCF				
Total with LULUCF	**12.9**	**14.3**	**16.79**	**20.44**
Total without LULUCF	**5.94**	**6.67**	**8.53**	**11.54**

GHG projections “with measures” and “without measures

Scenario	*2005*	*2010*	*2015*	*2020*
GHG emissions in Fuel combustion sector				
ZK3 –basic growth (minimal energy) scenario with measures	13.2	21.6	18.9	19.8
AK3 - fast growth (maximal energy) scenario with measures	13.2	23.2	24.5	29.3
ZK3 – basic growth (minimal energy) scenario without measures	13.2	23.5	21.7	23.5
AK3 - fast growth (maximal energy) energy scenario without measures	13.2	25.1	27.3	32.9
GHG emissions in other sectors				
Industrial processes without measures	3.9	5.3	6.7	7.9
Agricultural sector without measures	4	4.9	5.3	5.8
Waste sector without measures	1.5	1.3	1.2	0.8
Total GHG emissions in other sectors without measures	**9.4**	**11.5**	**13.1**	**14.5**
Total GHG emissions without measures				
GHG emissions according maximal energy scenario	22.6	36.6	40.4	47.4
GHG emissions according minimal energy scenario	22.6	35.0	34.8	38.0
Total GHG emissions with measures				
GHG emissions according maximal energy scenario	22.6	30.7	33.7	38.9
GHG emissions according minimal energy scenario	22.6	29.1	28.1	29.47
Impact of policies and measures	-	5.94	6.67	8.53

GHG emission projections “with measures” and “without measures”



Post-Kyoto climate regimes

The GHG emission reduction requirements under these regimes were identified for Lithuania for 2020 and 2050 based on results of various studies.

- **Brazilian proposal**
- **Continuing Kyoto, EU target to reduce GHG by 20% and 30%**
- **Multistage Approach,**
- **Contraction and Convergence**
- **Triptych Approach**
- **Preference Score**
- **Jacoby Rule**

Brazilian proposal

The Brazilian Proposal was suggested by Brazilian Government in the negotiations of the Kyoto Protocol.

The Brazilian government suggested a specific method to share emission reductions amongst countries based on historical responsibility. It was proposed to attribute responsibilities to countries according to the impact of their historical emissions on the surface temperature change and to share emission reduction efforts proportional to their historical contribution.

This approach include several options with regards of participation threshold and with regards of burden sharing which can be based on temperature increase (BP 1) and also temperature increase per capita (BP 2) or on contribution to CO2 concentrations (BP 3). Reference approach includes participation threshold of 40% of 1990 Annex I per capita income and burden sharing based on contributions to temperature increase (BP Ref).

Continuing Kyoto

This regime provides a very flexible structure, which could incorporate many of the approaches. When referring to "Continuing Kyoto" or "increasing participation", often the key features of the Kyoto Protocol are meant, which include: maintaining two groups of countries, Annex I and Non-Annex; binding absolute emissions reduction targets for Annex I; flexibility through Kyoto Mechanisms. Some also refer to a "Kyoto Plus" approach, where the main features are kept and only minor additional changes are made.

EU commitment under this approach is to reduce GHG emissions by 20% or 30% in 2020 comparing with base year emissions.

Convergence approach

The Convergence approach defines emission permits on the basis of a convergence of capita emissions under a contracting global GHG emission profile. Several options based on convergence date and agreed global target are available. Within "Contraction and Convergence" all countries would agree on a global target of, e.g., 450 (C&C 450) or 550 ppmv (C&C 550) stable concentration of carbon dioxide in the atmosphere.

They would also agree on a path of yearly global emissions that lead to that concentration level (contraction). In a second step, the global emission limit for each year would be shared among all countries, including developing countries, so that per-capita emissions converge by a specific date, e.g. 2040.

Convergence approach

There are few options of Contraction and Convergence approach based on convergence year: Linear per capita convergence by 2050 (Conv 1); linear per capita convergence by 2030 (Conv 2); non-linear per capita convergence by 2050 (Conv 3); and linear per capita convergence by 2050 with population cut-off year 2010 (Conv 4).

Common but Differentiated Convergence approach is very similar and also applies to different global targets of stable concentrations of carbon dioxide in the atmosphere: 550 ppvm (CDC 550) or 650 ppvm (CDC 650).

Triptych Approach

The Triptych approach originally distinguished three broad emission sectors: the power sector, the sector of energy-intensive industries and the 'domestic' sectors (e.g. residential and transport emissions). The emissions of the sectors are treated differently: For electricity production and industrial production, a growth in the physical production is assumed together with an improvement in production efficiency. This takes into account the need for economic development. For the 'domestic' sectors, convergence of per-capita emissions is assumed.

The allowances of the sectors are added up to a fixed national allowance for each country. The different requirements are set based on agreed global target of, e.g., 550 ppmv (Trip 550) or 450 (Trip 450) stable concentration of carbon dioxide.

Multistage Approach

The Multistage Approach consists of a system to divide countries into groups with different levels of responsibility or types of commitments (4 stages). The approach results over time in a gradual movement from first stage to forth stage of developing countries. They level of commitment depends on differentiation rules on the basis of criteria such as per capita income or per capita emissions.

Multi-Stage reference (MS Ref) case include participation threshold of de-carbonisation stage 2: 30% of Annex I per capita income, stabilization period of 10 years, participation threshold of burden sharing stage 40% of Annex I per capita income and burden sharing based on contributions to per capita fossil CO2 emissions. There are few possible options in his approach based on base for burden sharing: per capita income (MS 1), contribution to fossil CO2 emission intensity (MS 2) and per capita fossil CO2 emissions (MS 3).

Preference score

This approach is based on a voting procedure that combines preferences for a distribution of emissions rights according to emission levels (grandfathering) or population levels (a per capita allocation).

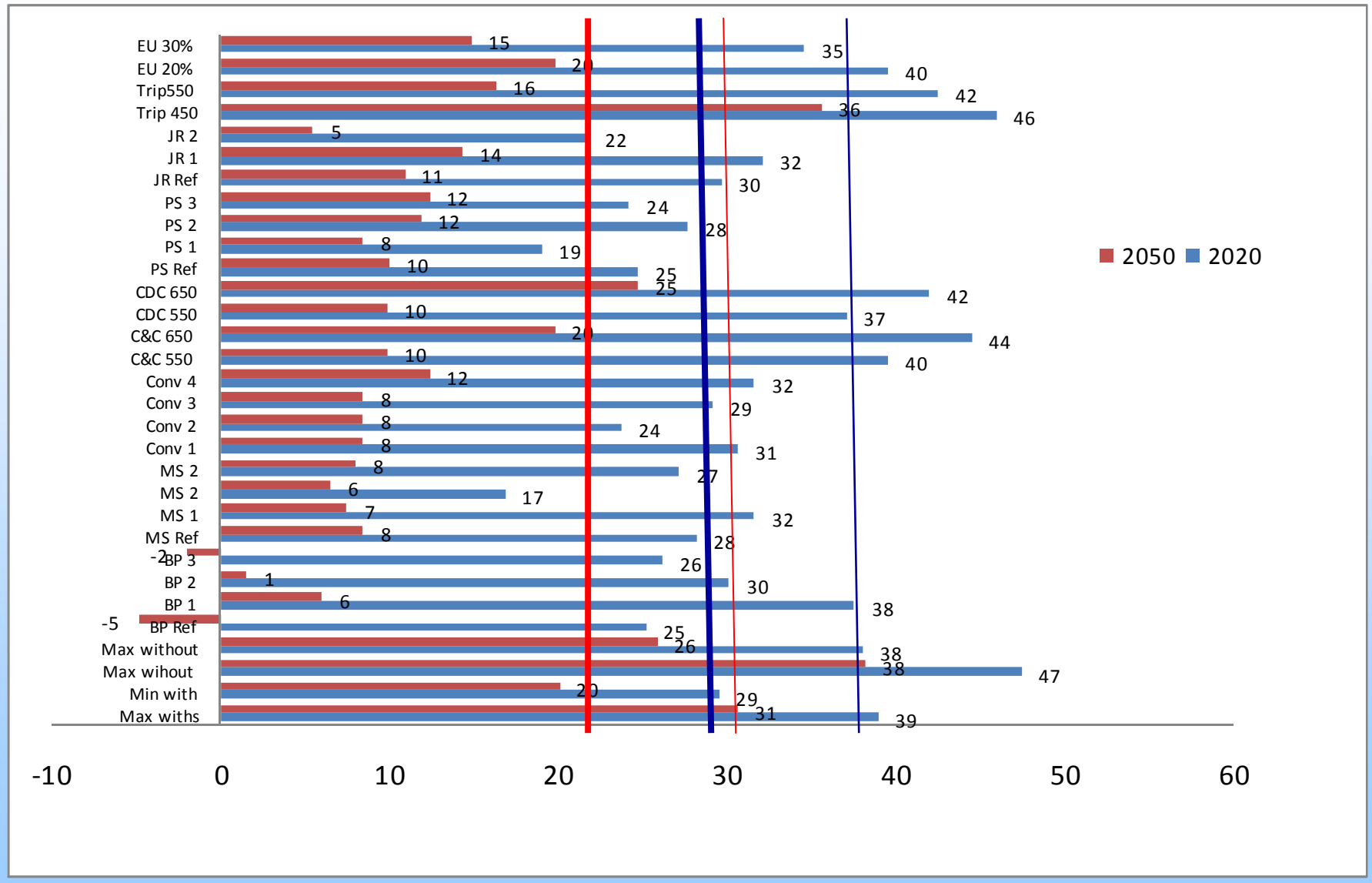
A Preference Score share is being calculated for each country by adding up the relative emission shares of either options weighted by the share of world population preferring either first or second approach. Reference case include policy delay for 10 years (PS Ref). Other options: no policy delay (PS 1); policy delay – 20 years (PS 2); cap population case which include population cut-off year 2010 (PS 3).

Jacoby Rule

This approach consists of a system for progressively integrating non-Annex I countries into a system of global emission reduction and defining subsequent levels of reduction commitments for meeting long-term climate targets, which will basically depend on the GDP per capita levels of countries.

There are several options developed for Jacoby rule approach: reference case (JR Ref); Jacoby rule low welfare trigger (JR 1); Jacoby rule high welfare trigger (JR 2).

GHG emission reduction targets



Lithuanian GHG minimal scenario2020: 29,5Mt and 2050: 22,5Mt

Lithuanian GHG maximal scenario 2020: 38,9 Mt and 2050: 31 Mt

Acronym	Regime	Reduction to 1990, %	
		2020	2050
BP Ref	Brazilian Proposal: reference case	-49	-110
BP 1	Brazilian Proposal: no participation threshold case	-24	-88
BP 2	Brazilian Proposal: burden-sharing key: temperature increase per capita case	-39	-97
BP 3	Brazilian Proposal: burden-sharing key: CO_2 concentration case	-47	-104
MS Ref	Multi-Stage: reference case	-43	-83
MS 1	Multi-Stage: burden-sharing key per capita income case	-36	-85
MS 2	Multi-Stage: burden-sharing key based fossil CO_2 emissions intensity case	-66	-87
MS 3	Multi-Stage: participation threshold: world average per capita emissions case	-45	-84
Conv 1	Per capita convergence: reference case	-38	-83
Conv 2	Early convergence 2030 case	-52	-83
Conv 3	Non-linear convergence case	-41	-83
Conv 4	Cap population case	-36	-75
C&C 550	Contraction and convergence: 550 ppvm case	-20	-80
C&C 650	Contraction and convergence : 650 ppvm case	-10	-60
CDC 550	Common but Differentiated Convergence: 550 ppvm CO_2 case	-25	-80
CDC 650	Common but Differentiated Convergence: 650 ppvm CO_2 case	-15	-50
PS Ref	Preference Score: reference case	-50	-80
PS 1	Preference Score: no policy delay case	-61	-83
PS 2	Preference Score: twenty year policy delay case	-44	-76
PS 3	Preference Score: cap population case	-51	-75
JR Ref	Jacoby Rule: reference case	-40	-78
JR 1	Jacoby Rule: low welfare trigger case	-35	-71
JR 2	Jacoby Rule : high welfare trigger case	-56	-89
Trip 550	Triptych: 550 ppvm CO_2 case	-7	-28
Trip 650	Triptych: 450 ppvm CO_2 case	-14	-67
EU 20%	EU target to reduce GHG emission by 20% comparing with year 1990	-20	-60
EU 30%	EU target to reduce GHG emission by 30% comparing with year 1990	-30	-70

Conclusions (1)

- 4 main possible GHG emission projection scenarios were developed in Lithuania based on assumptions about economic growth, energy prices and construction of new nuclear power plant and based on implemented GHG emission reduction measures: GHG emission minimal and maximal scenarios “with measures” and “without measures”

- Analysis of GHG emission reduction costs and potentials performed indicated that the average annual GHG emission reduction potential makes about 7.5 Mt/year and GHG emission reduction costs makes more than 900 Lt/tCO2eq.

- In Agriculture and Waste sector GHG emission reduction costs are even higher and total GHG emission reduction potential in Lithuania is just 4.2 Mt therefore construction of new nuclear power plant provides 3.3 Mt higher GHG emission reduction potential then total GHG emission reduction potential in Lithuania**.**

Conclusions (2)

- The main conclusions form analysis performed is that according Maximal Scenario “without measures” considering that new NPP will not be built during investigate period GHG emissions in Lithuania will reach 47 Mt and 38 Mt in 2020 and 2050 and Lithuania will not be able to implement any of post-Kyoto climate change regimes analyzed.

- If new NPP will not be built but with implementation of climate change mitigation measures foreseen in official Lithuanian policy documents GHG emissions in 2020 and 2050 will reach 38.9 and 31 Mt accordingly and country will be able to comply with commitments set by few post-Kyoto regimes for 2020: EU GHG reduction target of 20%, Triptych, Contraction & Convergence, Common but Differentiated target 650 ppm.

- Just if new NPP will be constructed and climate change mitigation measures will be implemented GHG emissions in Lithuania in 2020 will be (29,5 Mt) by 40% lower than in 1990 and allow to comply almost with all post-Kyoto climate regimes, except Preference Score and several cases of Multi Stage (burden sharing key based fossil fuel CO2 emission intensity and world average per capita emissions) and Brazilian Proposal (reference case, burden sharing key: CO2 concentrations), Jacoby Rule high welfare trigger.

Conclusions (3)

- However requirements set by climate regimes for 2050 are very strict and Lithuania would not be able to comply with these even under minimal scenario with measures (22.5 Mt) therefore additional climate change mitigation will be necessary after 2020 to comply these GHG emission reduction requirements.

- Analysis of GHG emission reduction costs and potentials performed indicated that construction of new nuclear power plant in Lithuania is one of the most efficient GHG emission reduction options. The average annual GHG emission reduction potential makes about 7.5 Mt/year and GHG emission reduction costs makes more than 900 Lt/tCO2eq. GHG emissions according maximal scenario (without construction of new nuclear PP) with measures (38.9 Mt) are higher than GHG emissions according minimal scenario (with new nuclear PP) without measures (38.0 Mt) in 2020 therefore just construction of new nuclear power plant can guarantee lower GHG emissions in 2020 comparing with other scenarios including all foreseen and implemented GHG emissions reduction measures.

Conclusions (4)

- Analysis of GHG emission reduction costs and potentials performed indicated that construction of new nuclear power plant in Lithuania is one of the most efficient GHG emission reduction options.

  The average annual GHG emission reduction potential makes about 7.5 Mt/year and GHG emission reduction costs makes more than 900 Lt/tCO2eq. GHG emissions according maximal scenario (without construction of new nuclear PP) with measures (38.9 Mt) are higher than GHG emissions according minimal scenario (with new nuclear PP) without measures (38.0 Mt) in 2020 therefore just construction of new nuclear power plant can guarantee lower GHG emissions in 2020 comparing with other scenarios including all foreseen and implemented GHG emissions reduction measures.