24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

# GHG emission reduction costs and potentials and assessment of Post-Kyoto climate change mitigation regimes impact on energy options in Lithuania

**24th World Gas Conference 2009, 5-9 October 2009, La Rural Exhibition and Conference Centre, Buenos Aires**

**D. Štreimikienė**

**Lithuanian energy institute**

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

## Outline of presentation

- The objective
- Lithuania: the main features
- Energy sector in Lithuania
- GHG emission reduction potentials and costs
- 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 fo Lithuania;
- Conclusions & findings

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

# The objective

- 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

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas


## LITHUANIA

**EU member state since 2004**

**Territory: 65.3 thou km2**

**Capital: Vilnius**

**Population: 3.2 mln.**

**Population density:**

**49 inhab/km2**

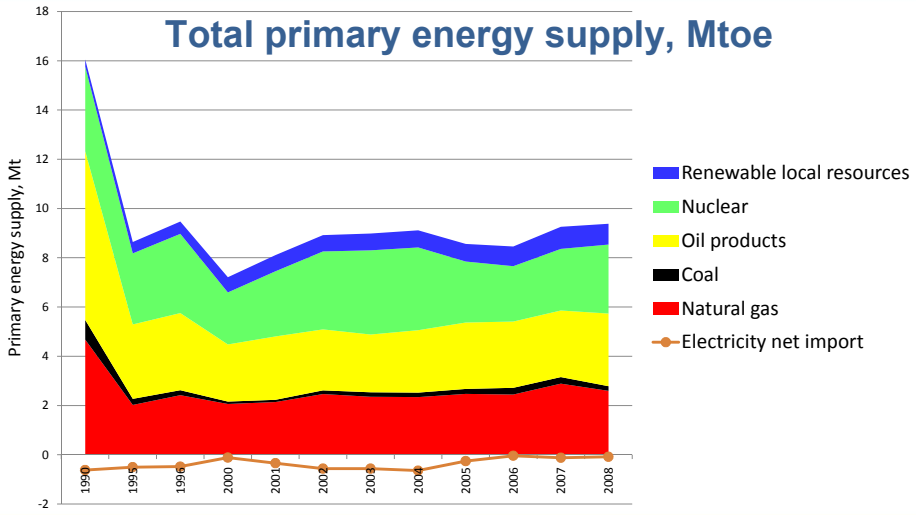
**PPP GDP/capita in 2008:11.6 thou EUR**

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

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

## Total primary energy supply, Mtoe




24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

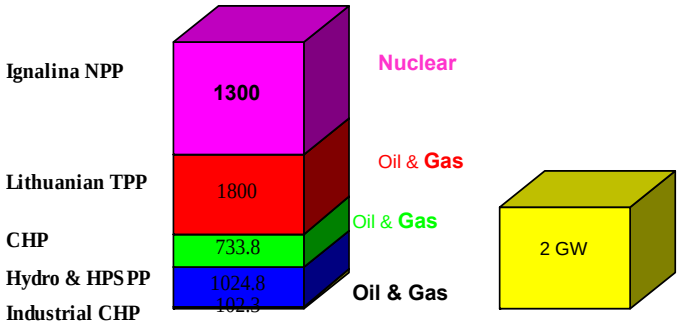
## Lithuanian power system in 2009

*Installed capacity*

**4.966 GW**

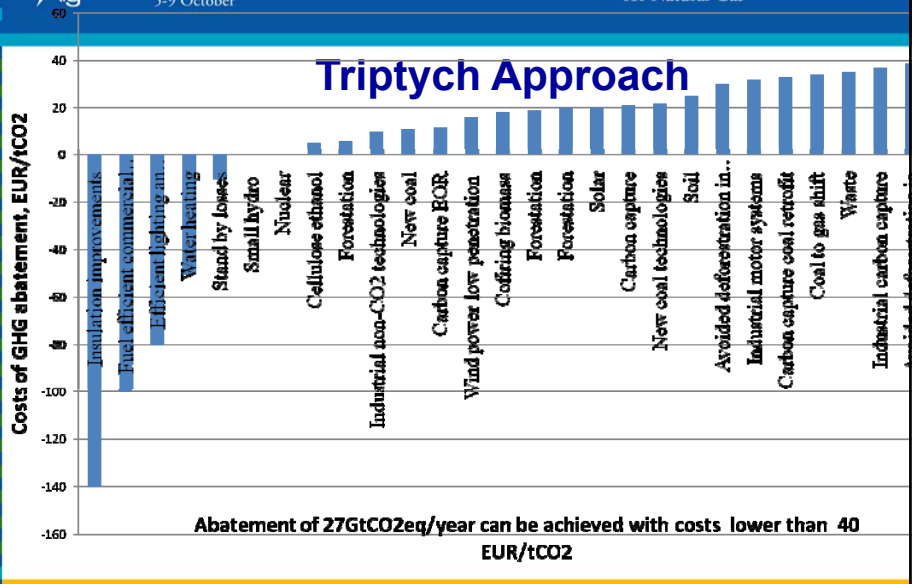
*Domestic demand*

**2 GW**



24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge: Reviewing the Strategies for Natural Gas




24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge: Reviewing the Strategies for Natural Gas

| GHG reduction measures | Reduction costs, Lt/tCO2eq | GHG reduction potential 2008-2012, MtCO2eq/yea |
|---|---|---|
| **Fuel combustion sector: GHG reduction potential: 1.9 Mt/year; average costs 2-170 Lt/tCO$_2$** | | |
| Energy savings (primary energy) | 2-20 | 0.18 |
| Waste energy resources | 32.4 | 0.22 |
| Use of biofuels in transport | 35.4 | 0.17 |
| Use of renewables in power generation | 170 | 0.54 |
| Use of cogeneration | 125 | 0.29 |
| Use of renewables in primary energy except of listed | | 0.5 |
| **Agriculture: GHG reduction potential: 0.1 Mt; average costs 1125 Lt/tCO2eq** | | |
| State programme for water pollution from agriculture | 1125 | 0.1 |
| **Waste sector: GHG reduction potential 0.1 Mt; average costs 1370 Lt/CO2eq** | | |
| State strategic waste management plan | 1370 | 0.1 |
| **Industrial processes: GHG reduction potential: 2.4 Mt; average costs: 315-560 Lt/tCO2 eq** | | |
| Conversion of wet cement production to dry | 560 | 0.5 |
| Modernization of technology in chemical industry | 315 | 1.9 |
| **Total** | | **4.2** |

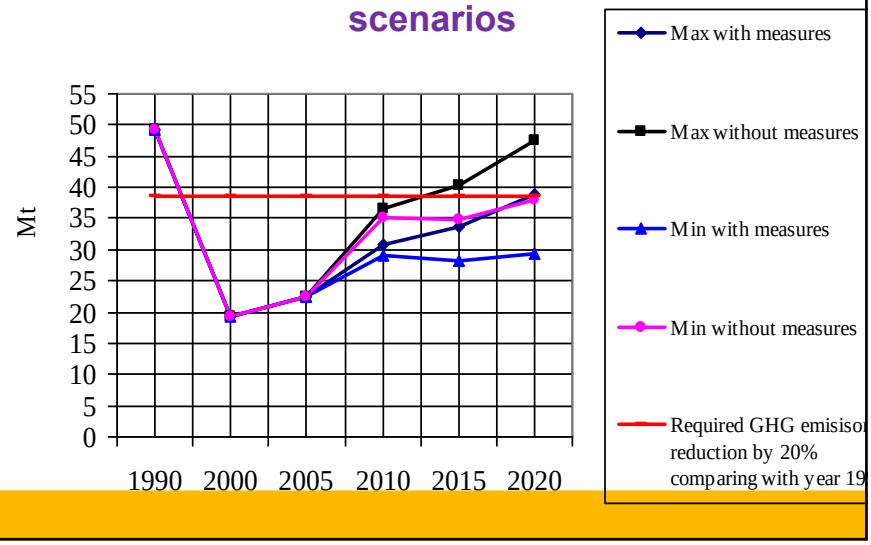
# Impact of GHG reduction policies and measures

| Climate change mitigation policies and measures | The average GHG emission reduction, Mt | | | |
|---|---|---|---|---|
| | 2010 | 2012 | 2020 | 2025 |
| Energy saving | 0.18 | 0.51 | 0.84 | 1.18 |
| Use of waste energy resources | 0.22 | 0.3 | 0.38 | 0.45 |
| Use of biofuels in transport | 0.17 | 0.32 | 0.47 | 0.62 |
| Renewables in power generation | 0.54 | 0.66 | 0.78 | 0.9 |
| Use of cogeneration | 0.29 | 0.36 | 0.43 | 0.51 |
| Renewables in primary energy except mentioned | 0.5 | 0.61 | 0.72 | 0.84 |
| **Total in Fuel combustion sector** | **1.9** | **2.79** | **3.62** | **4.5** |
| **Total in Agriculture sector** | **0.7** | **1.2** | **1.7** | **2.2** |
| **Total in Waste sector** | **0.94** | **0.31** | **0.81** | **2.44** |
| **Total in Industrial processes sector** | **2.4** | **2.4** | **2.4** | **2.4** |
| **Forestry expansion strategy for 2004-2020** | **7** | **7.63** | **8.26** | **8.9** |
| **Total with LULUCUF** | **12.9** | **14.3** | **16.79** | **20.44** |
| **Total without LULUCUF** | **5.94** | **6.67** | **8.53** | **11.54** |

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

# GHG emission projections according 4 main scenarios



## Post-Kyoto climate regimes

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

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

24th World Gas Conference
ARGENTINA | 2009
5-9 October
The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

## Continuing Kyoto

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

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

## Convergence Approach

•Emission permits are distributed based on convergence of p capita emissions under a contracting global GHG profile. Fe options based on convergence date and agreed global targ exist. Within "Contraction and Convergence" all countries wou agree on a global target of, e.g., 450 (C&C 450) or 550 ppn (C&C 550) stable concentration of CO2 in the atmosphere.
•They would also agree on a path of yearly global emissions th lead to that concentration level (contraction). In a second ste the global emission limit for each year would be shared amor all countries, including developing countries, so that per-capi emissions converge by a specific date, e.g. 2040.
•There are few options of C&C approach based on convergen year: Linear per capita convergence by 2050 (Conv 1); linear p capita convergence by 2030 (Conv 2); non-linear per capi convergence by 2050 (Conv 3); and linear per capi convergence by 2050 with population cut-off year 2010 (Conv 4

24th World Gas Conference
ARGENTINA | 2009
5-9 October
The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

## Triptych Approach

•It 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). Th 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, convergenc of per-capita emissions is assumed.
• The allowances of the sectors fixes national allowance for eac country. The different requirements are set based on agreed global target of, e.g., 550 ppmv (Trip 550) or 450 ppmv (Trip 450).

## 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 etc. There are 4 stages: No commitments; decarbonization; stabilization and burden sharing.

There are few possible options in this approach based on base for burden sharing: per capita CO2 emissions (MS Ref); per capita income (MS 1), contribution to fossil CO2 emission intensity (MS 2) and per capita fossil CO2 emissions (MS 3).

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

## Preference Score Approach

•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 & Brasialian proposal

•Jacoby rule 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.

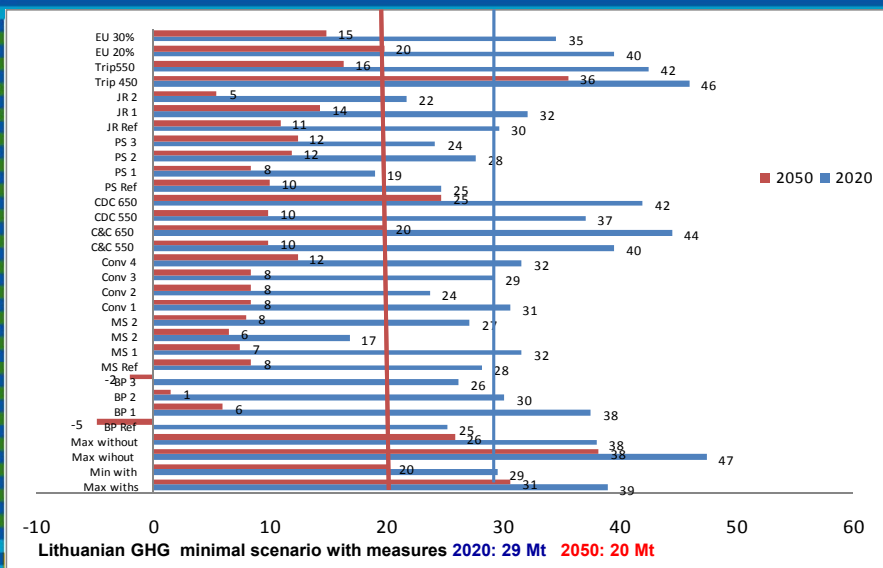
•There are several options developed for Jacoby rule approach: reference case (JR Ref); Jacoby rule low welfare trigger (JR 1); Jacoby rule high welfare trigger (JR 2).

•Brasilian proposal is based on the countries historical responsibility in GHG emissions and subsequent impact on changes of global CO2 concentrations in atmosphere.

24th World Gas Conference
ARGENTINA | 2009
5-9 October

The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

| Acronym | Regime | Reduction to 1990, % | |
|---|---|---|---|
| | | 2020 | 2050 |
| BP 1 | Brazilian Proposal: no participation threshold case | -24 | -88 |
| BP 2 | Brazilian Proposal: burden-sharing key: temperature increase per capita case | -39 | -97 |
| 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 |
| 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 |




Lithuanian GHG minimal scenario with measures 2020: 29 Mt 2050: 20 Mt

24th World Gas Conference
ARGENTINA | 2009
5-9 October
The Global Energy Challenge: Reviewing the Strategies for Natural Gas

## Conclusions

•4 main possible GHG emission projection scenarios we developed in Lithuania based on assumptions about econom growth, energy prices and construction of new NPP a implemented GHG emission reduction measures: GHG emissi minimal and maximal scenarios "with measures" and "witho measures"

•Analysis of GHG emission reduction costs and potentials perform indicated that construction of new NPP in Lithuania is one of t possible GHG emission reduction options. The average annual GH emission reduction potential makes about 7.5 Mt/year and GH emission reduction costs – 250 EUR/tCO2eq.

•GHG emissions according maximal scenario (without constructi of new nuclear PP) with measures (38.9 Mt) are similar than GH emissions according minimal scenario (with new nuclear PP) witho measures (38.0 Mt) in 2020.

# Conclusions

•According Maximal Scenario "without measures" considering that new NP will not be built Lithuania will not be able to **implement any of post-Kyo climate change regimes analyzed in 2020 and 2050.**

•If new NPP will not be built but with implementation of climate chan mitigation measures foreseen in official Lithuanian policy documents Lithua will be able to comply with commitments set by **very few** post-Kyoto regim **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 measur will be implemented Lithuania will comply **in 2020** with almost all post-Kyo climate regimes, except the most strict cases of **Preference Score and Mu Stage (burden sharing key based fossil fuel CO2 emission intensity a world average per capita emissions) and Brazilian Proposal (referen case, burden sharing key: CO2 concentrations), Jacoby Rule high welfa trigger**

•**However requirements set by climate regimes for 2050 are very str and Lithuania would not be able to comply with these even und minimal scenario with measures** therefore additional climate chan mitigation will be necessary after 2020, fossil fuel burning with CCS.

24th World Gas Conference
ARGENTINA | 2009
5-9 October
The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas

•**Thank you for your attention**