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METHANE REDUCTIONS TO MODERATE THE GLOBAL WARMING EFFECTS

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Abstract: *The case-study overviews the possible reduction for the methane gas emission in order to avoid of the more global warming effects and climate change caused by the human activity at latest decades. To collect international data base is for analysing and valuing methane gas emission based on the different country-groups, emphasizing responsibility of developing countries and highly developed countries for gas emission, also the methane emission based is on the economic sectors. China and India have share 8% of China and 2% of India respectively of cumulative CO_2 emissions over the period 1900-2005, the US and the EU are responsible for more than half of emissions. Based on the estimation the global gas emissions of methane in the whole world has increased by 37% for period of 1990- 2030, as four decades, and this was 0,92% annual rate growth, while the OECD has increased the methane emission by 8,5% for this period, which means 0,21% growth rate annually.*

Scenario in developing countries for 2013-2020 the methane gas emission reduction could have been 8200 Mt of CO_2e (Equivalent) and less than 10 US dollar per ton in more cost financing.

Highly developed and developing economies (last one their methane emission share 56% in 1990, estimated 66,8% in 2030) increase their economic growth by mostly fossil energy resulted in increasing also methane gas emissions. The methane gas emission can be solved by those results-based-finance forms relevant to Kyoto Protocol, which can extend in the world by financial institutions.

Keywords: *Climate change, Results-based-finance, Scenario, Developing countries, World Bank*
(JEL classification: Q54)

Introduction

The methane gas emission is very actual issue at present, because the methane has considerably contributed to the global warming and climate change for the last decades. The environment friendly economic strategy and GDP growth focus on preventing the global warming by decreasing the gas emission including the methane emission.

The international cooperation can be stronger at latest time, which shows the UN Environment Program accepted in 2011 on the reducing the methane gas emission strongly in order to avoid of highly level rate of the climate change. According to the UN Environment Program Report (UNEP, 2011a; 2011b) the methane emission decrease can result about 0,4 – 0,5 ^{0}C reduction in direction to the avoiding global warming by 2050. Also additionally to the decreasing the methane emission the international cooperation should be forced to reduce CO_2 emission in order to avoid the critical climate change.

Some international data given by EEA (UNEP, 2011and 2011b) emphasize the correlations between the air pollutions and food security, which means that the cost efficiency methane reduction can ensure more air quality human health in positive direction, when they decrease the crop losses by about 27 million tons annually.

The US EP (US EP, 2010) reported that in developing countries for the period of 2013-2020 the gas emission reduction could have been 8200 Mt of CO_2e (Equivalent) and less than 10 US dollar per ton in more cost financing. The data show the main expected plan of the country-group to decrease gas emission. The methane emission can be considerable in spite that time length of methane emission is extending not too long, mainly short comparably to CO_2 gas emission effects.

Material and Method

The case-study analyses the gas emission from methane based on the methods, first how the methane emission is distributed by different economic sectors and different regions of the world economy, emphasizing the main country groups selected in highly developed economies and developing countries.

1. Hypothesis: The *highly developed and developing economies* increase their economic growth by increasing gas emissions including methane and also they try to reduce this gas emission by depending on *using innovative cost-effective methane reduction* measures to improve the air quality.

2. Hypothesis: The using innovative cost-effective methane reduction measures to improve the air quality is considerably depending on the *results-based-finance* relevant to Kyoto Protocol.

The statistical data are coming from different UN organizations and the international measuring systems and also different national environmental reports of different economies. The international reports also focus on the incentive the cost-effective methane reduction technology by using different financing resources from governmental, banking and private sectors. The prevention for the increasing gas emission needs for innovative investment and their financial background (US EP, 2012, EPA, 2012; UNEP, 2011ab).

Results and Discussion

Recently the developing countries have increased their economic growth by increasing gas emission including methane gas emission for the last two decades. The gas emission can increase the threaten level of the gas emission measure which can lead to the catastrophic climate change.

According to international data base coming oil-importing countries, poorer countries had greater reduction in GDP, which will be due to *high oil prices* (UNDP/ESMAP 2005). The *IMF estimated in 2004* that a sustained US$10 oil-price increase would lead to a reduction of 1.5 per cent in the GDP in those countries after one year. In Asia, this would induce an overall reduction of the GDP of 0.8 per cent after a year with some countries suffering more, such as the Philippines which could lose 1.6 per cent of its GDP (IEA 2007a; IEA 2007b). This means that mostly developing countries had less economic growth, which could decrease the gas emission of theirs because of the international oil price increase and not to use cost effective gas and methane reduction measure.

Recently Asian countries realised considerable economic development using energy resources, but reports of different international organizations declared that while China and India have had share as *8% of China and 2% of India respectively of the cumulative CO_2 emissions over the period 1900-2005*, the US and the EU are responsible for more than half of these emissions (IEA 2007a).

But the international comparing data show completely different overview for two main gas emission countries, namely China and India. Because China has reached the first position for CO_2 emitter in the world economy and while Japan and India became already fourth and fifth position. Also China and India have accounted for 56 per cent of the increase in CO_2 emissions for period of 2005 and 2030 belonging to the scenario of the IEA (IEA, 2007a). Therefore Chinese emissions are forecasted to be 66 per cent higher than one of the US, ranked second. Therefore, challenges in terms of CO_2 mitigation are huge and should, at some point, take place in Asia.

The gas emission resulted pollution in air, therefore this polluted air leads, among other things, to respiratory illness, cancer, tuberculosis, and low birth weight and eye disease. For example, exposure to biomass smoke may explain 59 per cent of rural cases and 23 per cent of urban cases of tuberculosis in India. In China and India, it has been shown that two-thirds

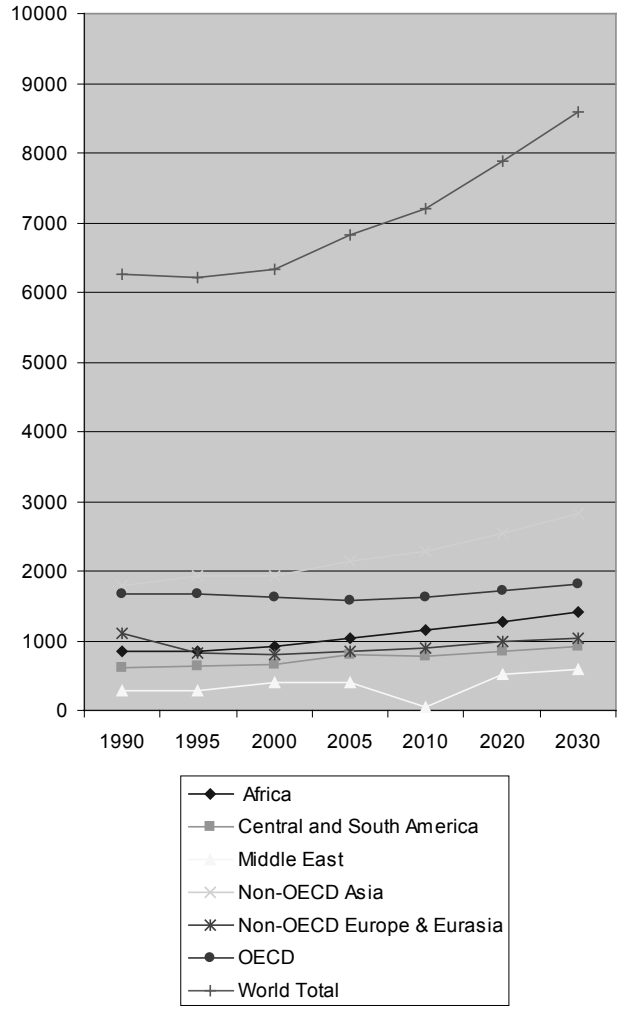
Table-1: Global Emissions of Methane by Regions, 1990-2030

Regions	1990	1995	2000	2005	2010	2020	2030
Africa	841	846	911	1037	1,154	1,275	1,409
Central and South America	606	639	663	795	784	856	911
Middle East	277	291	400	405	41	519	585
OECD	1,666	1,668	1,617	1,572	1,628	1,708	1,807
Non-OECD Asia	1,784	1,933	1,936	2,150	2,286	2,535	2,829
Non-OECD Europe and Eurasia	1,095	829	799	857	901	994	1,045
World Total	6,269	6,205	6.324	6,816	7,196	7,888	8,586

Source: EPA 2012. Global anthropogenic Non-CO2 Greenhouse Gas Emission: 1990-2030

of women with lung cancer were non-smokers (Bruce et al. 2000). And according to Zhang and Smith (2007), indoor air pollution is responsible for more than 400,000 premature deaths annually in China.

Figure-1: Global Emissions of Methane by Regions, 1990-2030



Source: EPA 2012. Global anthropogenic Non-CO_2 Greenhouse Gas Emission: 1990-2030

The considerable role of oil price increase is in increasing the gas emission in spite that the use of oil considerable decreased. The oil price decrease did not result decreasing gas emission because this leaded to diversified energy resource use in order to compensate the oil price increases. According to the CO_2 emission the methane gas emission has increased by performance of China, India and Japan, which CO_2 gas emission resulted considerable threat for increasing the global climate change.

The data of *Table-1* provided proof the trend of gas emission even in case of the methane. The global gas emissions of methane in the whole world has increased by 37% for period of 1990- 2030, as four decades, and this was 0,92% annual rate growth, while the OECD has increased the methane gas emission by 8,5% for this period, which means 0,21% growth rate annually. The Non-OECD Asia has reached the highest level of methane gas emission by 58,6% and 1,46% annual methane emission growth for the same period in the world. The data base can show the dominant role of the developing countries in increasing methane gas emission by share of each country-group.

In this case share of *developing countries including Africa, C-S America, Middle East, Non-OECD Asia including China and India* was 56% in 1990, 54,7% in 2010, estimated forecast data 66,8% closed to about 70% in 2030 according to the international possible future review. This data clearly show how the share of developing countries could increase their methane emission. After the economic crisis of 1998 and financial bank-crisis of 2008 the developing countries decreased their economic growth, which was also seen in the reduction of the methane emission, namely this decreased from level of 56% share of developing countries in 1990 to level of 54,7% in 2010. But the international estimation shows a considerable share increase of developing countries in methane emission by 2030. This means that mostly the Non-OECD Asia including China will realise a considerable economic growth based on the fossil energy uses stimulating gas emission and increasing the climate change possibility resulting global warming.

The *strategy of China based on the diversified energy resource use* can make less vulnerable to the world price increase of each energy resource. The diversified energy resource use can also contribute to the more oil energy resource use in cases of Chine and India, which can lead to increase of the oil world price level. Two countries are considerable crude oil importers in the world economy and for the last decade China and India have increased their crud oil import. The world price of crude oil contributed to the increase of input price increase of production and services in both of countries.

Mostly China has a considerable economic growth based on the oil energy resource use, which also contributed to increasing gas emission including the methane as first responsible for the global warming. China is basically export oriented economies; therefore the input cost is vulnerable to energy price in export oriented sectors including mostly manufacturing industries. So the increasing oil price results in increasing input price of exported processed products in China. Based on the international compare the labour force input price is lower in China, therefore in spite of the increasing oil price the Chinese export can be competitive on the world market. Additionally to low labour force input price the innovative advanced technology also contributes to the competitiveness of China in the world economy.

The oil price increase more impacted on the increasing price input of processing industry than gross household consumption. The gross household consumption is kept somehow at low level results low level of domestic national consumption level, therefore as little narrow domestic consuming market. The more processed products and services can be transferred to the world market. The oil price increase leads to decrease gross household consumption to keep the level of export orientation, and for example, by assumption, the oil price decrease leads

to little increase gross household consumption at the given level of export orientation. Also there is a possibility for increasing the exported products and services at remaining level of the domestic gross household consumption. China can make foreign consumers on the world market pay increase oil price by increasing input price of export oriented sectors and oil costs embedded in gross exports of China.

In the half of 2000s according to UNDP one of the adjustments available to reduce the effects of an oil-price increase relates to the price elasticity. Indeed, in non-OECD countries this price elasticity tends to be much lower in absolute value than in OECD countries, lowering the reduction in consumption that follows such a price increase (UNDP/ESMAP 2005).

Methane Emissions by Sector

The other considerable issue for the methane is the Global Anthropogenic Methane Emissions by sector at present, which shows the considerable share of enteric fermentation with its 26,9% and oil-gas share with its 23,4% resulting ethane gas emission in 2010. These two main shares of methane gas emission is amount for at least half of all methane gas emission. The other considerable shares are landfills, rice cultivation, wastewater, combustion and livestock waste producing methane emission, also coal mines according to the industry contribute to methane emission. This clearly shows that the methane gas emission share of industrial development is dominant and also the agriculture and some economic activities according to this sector has important role for increasing methane gas emission (Table-2 and Figure-1).

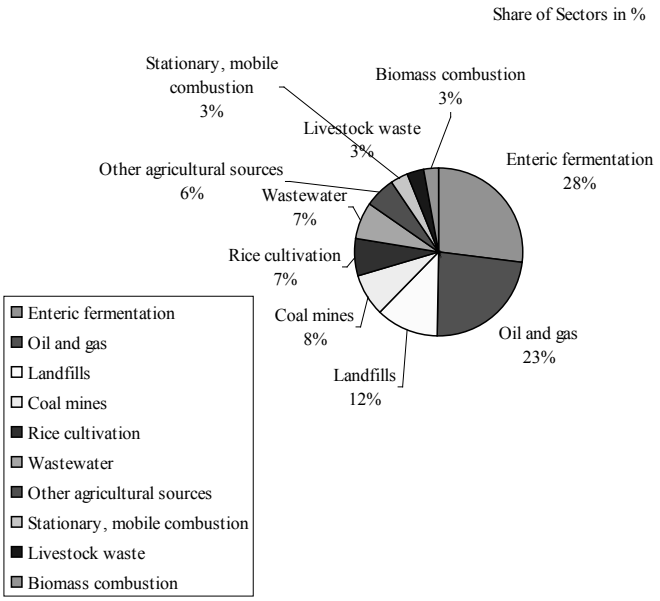
In case of the EU there are some difficulties connecting with methane emission, even in agricultural sector, for example waste in soil and water. Therefore the EU aims at restricting untreated municipal solid waste from landfills leads to significant reduction in greenhouse gas (GHG) emission, while this contributes to the more satisfactory resource-use efficiency and cost-effective methane reduction (EEA, 2011; UBA, 2010).

Table-2: Global Anthropogenic Methane Emissions by Sector, in %, in 2010

Sector	Share of Sectors in %
Enteric fermentation	26,9
Oil and gas	23,4
Landfills	11,8
Coal mines	8,2
Rice cultivation	7,2
Wastewater	7,1
Other agricultural sources	5,9
Stationary, mobile combustion	3,4
Livestock waste	3,2
Biomass combustion	2,8

Source: US EPA 2012. Summary Report: Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030

Figure-2: Global Anthropogenic Methane Emissions by Sector, in %, in 2010



Source: US EPA 2012. Summary Report: Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030

Table-3: Needed Incremental cost Finance to Incentive Abatement Mt CO_2e Abatement Potential in Developing Countries' by Sector at Break-Even Price \$/tCO_2e (Cumulative 2013-2030)

Sector	$0	$5	$10	$15
Coal Mine	404	1,763	1,902	2,088
Landfills / Waste Management	814	1,293	1,581	1,776
Wastewater	6	10	13	27
Oil & Gas[b]	2,647	3,427	4,122	4,368
Livestock Management[b]	357	450	538	633
Approximate Total	**4,200**	**6,900**	**8,200**	**8,900**

Source: EPA 2012. Preliminary Draft Global Mitigation of Non-CO_2 Greenhouse Gases Report, March, 2012

The Table-3 shows that the how developing countries can decrease the methane emission cumulatively between 2013 and 2020 with policy intensive for methane reduction as a price per ton of CO_2e (equivalent). In case of coal mine by 10 US Dollar per tone added, therefore 1.900 million tons of CO_2e methane gas emission reduction can possibly be realised between 2013 and 2020 based on the scenario of EPA (2012). In general there are some difficulties for realising this scenario in the practice, mostly the financial barriers probably cannot solve and implement the methane reduction meeting the strategic climate aims. Therefore the banking sector should follow the *pay-for-performance mechanism*, which performance of firms can be also adequate for the strategic climate aims and these aims followed by firm performance.

The international practise in case of the *pay-for-performance mechanism, by the other words as results-based-finance*, which means given by the OECD (2011) and World Bank

(2011) that performance risk is shifted from the founder to the project implementer concerning the investments for methane reduction, which *results-based-finance* also stimulates projects to be success. This *results-based-finance* originally was created within the Clean Development Mechanism (CDM) of the Kyoto Protocol with its qualified demands for reducing greenhouse gas (GHG) emissions equivalent to one ton of CO_2. This CDM has positive and considerable results, which has registration of 6,500 projects and the issuance of 1,2 Gt of CO_2e from nearly 2,100 projects, of which more than 300 are in methane sectors (World Bank, 2011).

According to the OECD (2011) the Official Development Assistance provided 134 billion US dollar for different economic investments to improve performance of firms for reduction of methane emission, strengthening multilateral institutions and cooperations based on *results-based-finance* concerning the Kyoto Protocol. The amount of financial resources is at very low level comparably to the global foreign direct investment (FDI), of which value is 1,6 trillion US dollar. Also the World Bank (2011) has provided 1,2 billion US dollar for managing manure, municipal solid waste and gas emission reduction for period of 2007-2012.

According to the *first Hypothesis*, that it is proofed that the highly developed and developing economies increases their economic growth by mostly fossil energy resulted in increasing gas emissions including methane. This event is proofed by statistical data provided by the Table-1, and Figure-1. Developed and developing countries should use *innovative cost-effective methane reduction measures* represented by scenario of Table-3, to decrease the gas emission.

According to the *second Hypothesis*, it is proofed that the energy use of *different economic sector*s mainly comes from the fossil energy resources use including methane (Table-2; Figure-2). The methane emission can be solved by *results-based-finance* forms relevant to Kyoto Protocol, which can also be more extended at the world-wide side by different financial institutions. Naturally this scenario is a possibility for accounting the innovative cost-effective methane reduction, but firms and governments are responsible for that how they use possibilities of scenario. Because firms should overcome financial, technical and international market obstacles, for example duty on the international markets.

Also the international attention should be paid for Sustainability Innovative Low-Carbon investments which were analysed by principles for "Rubik's Cube" solution (Fogarassy, et al. 2014a; Fogarassy, et al. 2014b). Also in stead of fossil energy resources including methane the firms should use renewable energy resources for reduction of methane and other gas emissions.

Renewable energy resources should be more used for solving energy demands of firms and generally for performance of the nations. Main renewable resources are water resources, of which importance is declared by some experts, the "present appointed target … is monetary valuation of the link between human economic activity and water. Evaluation of water as natural resource could raise numerous questions at theoretical level" (Fogarassy, et al. 2014c, p 2.). The other renewable common resource is the wind, of which about experts declared that this needs for increasing the better capacity use of water and extending water use in performance for energy supply (Fogarassy, et al. 2014d).

Conclusions

Recently the Asian countries achieved important economic development process by using mostly fossil energy resources, which could considerably contribute to global warming and climate change. Therefore this country group at present also became responsibly to the climate change additionally to the OECD and other highly developed economies. Because the developing countries cannot own enough developed technology to decrease gas emission including methane, they are pressed to create strong cooperation with highly developed economies to improve innovative environment friendly technology for reduction of gas emission.

The financial cooperation also needs for introducing financial support or supplying financial resources for implementers investing for technology using renewable energy resources for reduction of gas emission. This financial cooperation can extend in *results-based-finance* as a form of Kyoto Protocol to create direct connection among founder of financial institutions and implementer-investor to realise successful investment for reduction of methane emission measured in ton of CO_2e. A payment program would also rely on existing offset standards' systems for monitoring, reporting and independently verifying emission reductions, thereby minimizing administrative costs. This results based approach would use a competitive action to determine the level of funding each project will receive, guaranteeing the lowest possible cost to the founder (World Bank, 2011; Zéman et al, 2000).

The renewable energy resource use can be solved by active strong cooperation among governments and private firms, either transnational corporation, international companies and small and medium scale firms at both of macroeconomic, microeconomic levels and also international cooperations given by international organizations as EU, OECD, and also financial institutions as World Bank, International Monetary Fund, and in case of firm level see in detailed in Zéman, et al, 2013.

Also when companies need for financial resources, even for investment relevant to the reducing gas emission, in any case the financial institutes should follow the financial conditions and risk management of the firms or small-medium enterprises, for example analyse all business cycles, evaluate the risks and determine risk sensitivity of company (see detailed in Zéman at al, 2014, p. 196 and Végh et al, 2014, p. 184.).

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