POTENTIAL ROLE OF BIOMASS AS A SOURCE OF RENEWABLE ENERGY IN THE FUTURE GLOBAL ENERGY MIX AND ITS POSSIBLE IMPACTS ON THE AIR QUALITY.

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Abstract

Global primary energy demand is projected to increase. Fossil fuels remain the dominant primary energy source. Renewable energy sources including biomass for energy production are expected to grow fastest but from a relatively small base. There is a significant potential on global scale for expanding energy from biomass and other renewable energy sources. Biomass production in the Slovak Republic is growing with policies and commitments primarily aimed at developing alternative sources of fuel. An important secondary objective is to reduce greenhouse gas emissions associated with fossil fuel combustion.

Key words: *Biomass, energy, renewables, electricity, heating, quality of air, emissions;*

KEY FACTORS INFLUENCING THE SIZE AND PATTER OF THE GLOBAL ENERGY DEMAND

Global population growth affects the size of energy demand. Global population is projected to grow by at least 1% per year on average, from some 6.6 billion in 2004 to over 8 billion in 2030, although the growths is assumed to slow progressively to 0.8% per year on average between 2015-2030.[1]

The rate of growth of the global GDP is expected to average 3.4% per year over the period 2004 - 2030 which is some 0.3% more than from 1980 to 2004. Demand for electricity-related services, the main determinant of how much fuel is needed to generate power, is closely linked to people's incomes.

The prices of crude oil and natural gas are assumed to rise slowly until 2050, reaching some 100 USD per barrel of crude oil in the nominal terms, however this prediction may be underestimated as prospects for oil prices are commonly uncertain.

In most cases the technological advances are expected to significantly cut down the current inefficiency of energy production and supply. About half of the energy investments is assumed to be done in developing countries, where demand and production are projected to

[1] International Energy Agency (IEA), World Energy Outlook 2009

increase fastest. Energy exports from developing countries to the OECD region are assumed to increase significantly until 2030.

CURRENT GLOBAL ENERGY TRENDS AND ASSUMPTIONS OF THEIR DEVELOPMENT

Global primary energy demand is projected to increase by some more than 50% until 2030, which means by some 1.6% annually. Over 70% of this increase is expected to come from developing countries. Almost 50% of that increase is caused by rapid growth of the power generation sector.

Fossil fuels remain the dominant primary energy source and their share of world demand for energy will be more than 80%. Share of coal and natural gas is increasing slightly. Renewables including biomass for energy are expected to grow fastest but from a relatively small base.

The global energy consumption is assumed to increase by some 1.6 % annually until 2030. This is related to all the end-use sectors but mainly to industry, transport, residential, agriculture and services.

Electricity is projected to grow rapidly by some 2.6 % yearly and its share of total final consumption is expected to grow to more than 20%. In 2030 per-capita consumption of electricity may reach some 27 kWh per day in developed and some 6 kWh in developing countries.

The share of traditional biomass (used for heating) in the global final consumption of the primary energy sources is assumed to slightly decline as numerous developing country households are on their way to switch from the traditional biomass stoves to modern (often natural gas driven) devices with higher efficiency.

Biomass for power is expected to increase from some 260 TWh in 2007 to 840 TWh in 2030. Most of this should come from combined heat and power plants (CHP). Other growing areas of biomass use in power generation include co-firing in coal based power plants and landfill gas[2]. The share of all other renewables is expected to increase, but is assumed to not overcome 2% of the global primary energy sources in 2030.

Proven reserves of natural gas and coal are equal to some 65 years of today's global consumption of natural gas and some 170 years of coal. Substantial new reserves are high probable to be added until 2030. Proven reserves of crude oil are much smaller taking into account current consumption, covering some more than 40 years only. There seem to be enough of uranium for projected nuclear power production for the next decades at least. Finally one should not ignore the significant potential for expanding energy from biomass, hydropower and other renewable energy sources.

[2] International Energy Agency (IEA), World Energy Outlook 2009

Investment in energy supply infrastructure including electrification of significant parts of Africa and some parts of Asia and Latin America[3] of some 20 trillion USD. Projected spending includes expansion of supply capacity to meet rising demand and also to replace existing supply capacities that will be retired until 2030. About half of this spending will go only to maintain the current level of supply capacity as some significant capacity to supply oil, gas, coal and electricity will need to be refurbished or replaced within the projected period, including numerous power plants, electricity and gas transmission and distribution facilities, and oil refineries.

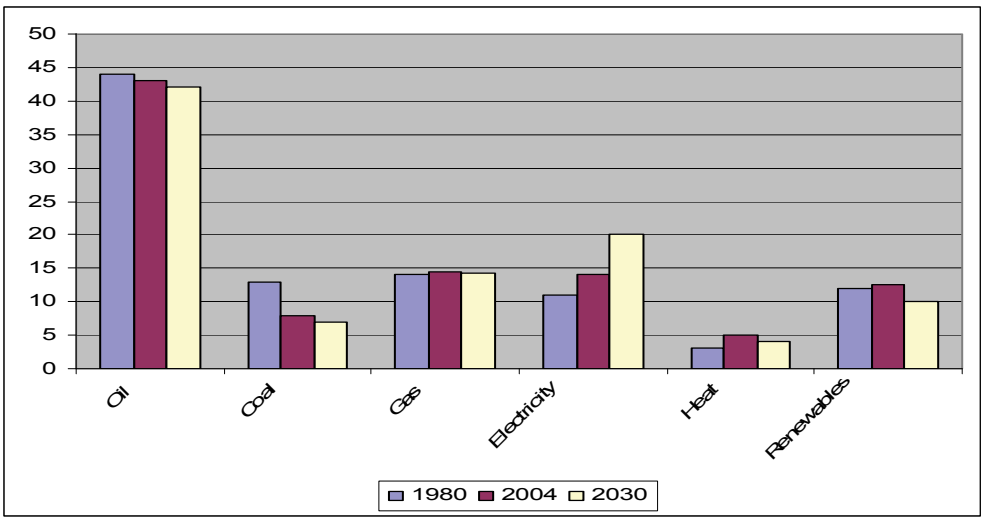

Figure 1: Primary and secondary energy sources shares on global scale (1980, 2004, 2030) (Source - IEA, World Energy Outlook 2006)

ENERGY RELATED CARBON DIOXIDE AND NITROUS OXIDES EMISSIONS

Global energy related carbon oxides are assumed to increase faster than primary energy use, what means higher share of carbon in energy mix. Other Greenhouse gas emissions (GHG), mainly nitrous oxides and methane are assumed to grow by some 0.1 - 0.2 % per year. By 2010 the global GHG emissions are assumed to be some 48% higher than in 1990.

Coal will remain the leading contributor to global carbon emissions until 2030 mainly due to strong demand for electricity. Energy and transport will remain the largest source of nitrous oxides emissions. On the national level China is expected to overtake the USA as the world biggest emitter of GHG already before 2020.

To compare pollutants in volumes, energy related global CO_2 emissions are projected to reach some 40.200 Million tonnes in 2030, and energy related global NO_X emissions are projected to reach some 83 Million tonnes in 2030. However considered over a 100 year

[3] Around 1.6 billion people around the world live with no electricity at all and have to rely on wood, dung and agricultural wastes, which have made indoor air pollution one of the world's top 10 causes of mortality or premature death. (source: United Nations)

period, NO_X should be having about 298 times more impact on global warming per unit weight than CO_2.[4]

NO_X	2007	2015	2030
OECD	32.7	22.1	16.6
Non-OECD	49.1	53.6	67.1
Eastern Europe	7.8	7.0	6.9
Asia	27.3	32.5	42.7
China	*16.9*	*21.3*	*24.3*
India	*4.1*	*5.0*	*9.5*
ASEAN	*4.5*	*4.3*	*5.9*
Middle East	4.0	4.2	5.6
Africa	4.4	4.5	5.8
Latin America	5.5	5.5	6.2
WORLD	**81.8**	**75.7**	**83.7**

Table 1: Emissions of Nitrogen oxides (NO_X) by region (Mt) (Source - IEA, World Energy Outlook 2009)

ENERGY RELATED CARBON DIOXIDE AND NITROUS OXIDES EMISSIONS OF THE SLOVAK REPUBLIC AND OF THE NEIGHBOURING COUNTRIES

The most important anthropogenic source of carbon dioxide emissions in the atmosphere is combustion and transformation of fossil fuels, which account for about 95% of the total CO_2 emissions in Slovakia. The primary source of NO_X in the Slovak Republic is production of electricity and heat through combustion of fuels[5] including biomass (mainly it's bark and green substance), and transport.

NOx	1990	2000	2003
Stationary	165	71	59
Transport	57	38	39
Combustion of biomass and forest fires	0.35	0.33	0.36
Slovakia	**222**	**109**	**98**

Table 2: Anthropogenic emissions of Nitrogen oxides (NO_X) in the Slovak Republic (Gg) (Source - The Fourth National Communication of the Slovak Republic on Climate Change, 2005)

[4] 2007 IPCC Fourth Assessment Report (AR4) by Working Group 1 (WG1), Chapter 2 "Changes in Atmospheric Constituents and in Radioactive Forcing" which contains information on global warming potential (GWP) of greenhouse gases.

[5] Source: The Fourth National Communication of the Slovak Republic on Climate Change and Report on Demonstrable Progress under the Kyoto Protocol, 2005

MEDIUM TO LARGE SIZE BIOMASS COMBUSTION AND ITS POTENTIAL IMPACTS ON THE AIR QUALITY

Expanding the use of biomass for energy purposes is considered a need by many of the EU countries including the Slovak Republic. Biomass is supposed to hit countries' targets for renewables and to decrease production of CO_2 emissions for the way they heat and power their homes and businesses.

Although carbon emissions values from combustion of biomass are marginal, there may be hotspots, particularly around power plants, which would deserve some attention.[6] Those pollutants causing concern may be nitrogen dioxide (NO_2) which can cause some health problems, especially for young children and the elderly and for those with conditions such as asthma and bronchitis. Nitrogen oxides are also partly responsible for other environmental problems, such as acid rain and urban haze.

Some emission assessment studies undertaken in medium to large size biomass power plants fuelled predominantly by wood chips, energy crops and recovered timber which operate in the EU territory found biomass combustion increases amount of NO_2 and other particulates (PM10) in the air.

SOME ADDITIONAL POTENTIAL NITROGEN OXIDES PRODUCTION RELATED TO BIOMASS CULTIVATION

Biomass as fuel can potentially reduce GHG because crops are a renewable resource of energy that absorbs carbon emitted through the combustion process in subsequent growing seasons. However, GHG emissions are generated with crop production, such as fuel use during cultivation, planting, harvest, and transportation; as well as production of inputs such as fertilizer and herbicides.

Soil nitrous oxide (N_2O) emissions are likely to be the largest source of GHG emissions associated with biomass crop production, but soil N_2O is also probably the least well quantified at larger regional scales. Soil N_2O emissions from biomass crop production may become so large that there will be almost no GHG mitigation associated with replacing fossil fuels with biomass.[7]

CONCLUSIONS

Biomass production for energy purposes in the Slovak Republic is growing hand in hand with policies and commitments primarily aimed at developing alternative sources of fuel. An important secondary objective is to reduce greenhouse gas emissions associated with fossil fuel combustion. Biomass for energy purposes can potentially reduce greenhouse

[6] Source: The Courier, UK; http://www.thecourier.co.uk/News/Dundee/article/2787/biomass-study-scotches-myths-about-air-quality-says-renewables-chief.html

[7] Stephen M. Ogle, Stephen J. Del Grosso, Paul R. Adler and William J. Parton, http://www.farmfoundation.org/news/articlefiles/371-2-Ogle.pdf

gases because it is a renewable resource of energy that absorbs carbon emitted through the combustion process in subsequent growing seasons.[8]

However it should be noted that the greenhouse gas emissions may be generated also by combustion of biomass including bark and green substance as a potential parts of a wood chips, and greenhouse gas emissions may be generated also with the crop production itself by fuel use during cultivation, planting, harvest, and transportation, as well as by production of inputs such as fertilizers and herbicides. In order to avoid these unnecessary side effects sufficient attention should be given on the ways of growing and harvesting of this important source of renewable energy.

[8] Stephen M. Ogle, Stephen J. Del Grosso, Paul R. Adler and William J. Parton, http://www.farmfoundation.org/news/articlefiles/371-2-Ogle.pdf