HOUSEHOLD HEATING IN THE LIGHT OF CLIMATE CHANGE

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Abstract
Greenhouse gas emissions resulting from anthropogenic activities play a significant role in climate change. The residential heating should be mentioned one of the main polluting source of greenhouse gases.This paper aims to give a comprehensive view about the amount of CO_2 emission as well as objectives and strategies for reduction the GHG emission. In addition, we illustrate the example of an average Hungarian family house (100 m^2), that biomass-based energy production what extent can reduce the current very high degree carbon dioxide emissions. We prepared investment analysis, as to what kind of ecological and economic benefits may result in heating modernization projects of a four-member family home. Additionally, a calculation method of CO_2 emission from heating is demonstrated on the basis of IPPC report (2006); the role of biomass is explained in heating; furthermore I give an overview analysis about the significance of forests for reduction of CO_2 concentration.

Keywords: Hungary, climate change, firewood consumption, natural gas consumption

1. Introduction

Since the existence of the Earth, the climate has been constantly changing, sometimes faster, and sometimes slower. However the current change is unusually fast. The major causes of climate change are human activities (Rakonczai, 2003; Kerényi, 1995; Tamás – Szabó, 2001), which not only the macro-and micro-climate, but also the global climate is being increasingly influenced (Mezősi et al., 2012).

Urban sprawl increases energy consumption from both transportation and buildings, and also the release of climate change-inducing greenhouse gas (GHG) emissions (Brown et al., 2005; Stone et al., 2009).

International surveys show that the average temperature of the Earth's surface increased from 14.52 °C to 13.87 °C between 1950 and 2003 (Láng et al., 2006). In 1950, during the burning of fossil fuels 1612 million tons carbon got into the air, and in 2003, 6 999 million tons (IPCC, 2007). Due to the increasingly atmospheric level of GHG, the climate gradually warms (Thomas, 2000).

The change of the amount of greenhouse gases in the atmosphere modifies the energy balance of the Earth-atmosphere system, and therefore leads to inevitably climate change (Haszpra, 2004; Szabó, 2002).

Greenhouse gas emissions pass through smoothly the radiation from the sun, however some of the long wave radiation of the earth's surface absorb in a certain spectral ranges, so that is utilized in the form of heat radiation. The temperature of the atmosphere is greatly influenced by these gases, without the presence the earth's average temperature would be 18 °C (Ma, 1998). In the last few hundred years the increase of greenhouse gases occurred the human activity.

As a result of anthropogenic activities the greenhouse effect of the atmosphere is constantly increasing. By the middle of the next century the temperature of the atmosphere will have risen higher than ever in history. The most important greenhouse gases are the following: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halogenated hydrocarbons are classified here (Mika, 2011; Faragó, et al., 2003; Patocskai, 2011).

This paper aims to give a comprehensive view about the amount of CO_2 emission as well as objectives and strategies for reduction the GHG emission. In addition, we illustrate the example of an average Hungarian family house (100 m^2), that biomass-based energy production what extent can reduce the current very high degree carbon dioxide emissions. We prepared investment analysis, as to what kind of ecological and economic benefits may result in heating modernization projects of a four-member family home. Additionally, a calculation method of CO_2 emission from heating is demonstrated on the basis of IPPC report (2006); the role of biomass is explained in heating; furthermore I give an overview analysis about the significance of forests for reduction of CO_2 concentration.

2. CO_2-emission in the world and in Hungary

The CO_2 content of the atmosphere has increased significantly in recent decades, which is a major contributor to climate change. According to the research two-thirds of total global greenhouse gas emissions (between 1845 and 2010) is responsible for 81 companies and 9 countries. Nearly two-thirds of global emissions for 2010 originated from just ten countries, with the shares of China (23.8%) and the United States (17.7%) far surpassing those of all others. Combined, these two countries alone produced 12.6 Gt CO_2, 41.5% of world CO_2 emissions (IEA, 2012).

The seven main sources were assigned by experts. Today, the main sources of emissions are energy (35%), industry (18%), transport (13%), agriculture (11%), forestry (11%), buildings (8%) and waste (8%) (Jos et al., 2012). Generation of electricity and heat was by far the largest producer of CO_2 emissions and was responsible for 41% of world CO_2 emissions in 2010. Worldwide, this sector relies heavily on coal, the most carbon intensive of fossil fuels, amplifying its share in global emissions (IEA, 2012).

Global atmospheric concentration of carbon dioxide has been increasing by 40% since the pre-industrial period, so it had increased from 278 ppm to 390.5 ppm by 2011 (IPCC, 2013). However, according to NASA Report this value has been reached 400 ppm [1]. The anthropogenic CO_2 emission was 545 ± 85 PgC (1 PgC = 1015 gC) between 1750 and 2011 (IPCC, 2013). The burning of fossil fuels and cement production caused 365 ± 30 PgC. According to the IEA (2012) the global CO_2 emissions rose by 4.6% in 2010, and increased by 1.3 Gt CO_2 between 2009 and 2010. In 2010, 43% of CO_2 emissions from fuel combustion were produced from coal, 36% from oil and 20% from gas. Emissions of CO_2 from gas in 2010 represented 6.2 Gt CO_2, 7.1% higher than in the previous year. Again, the WEO 2012 projects emissions from gas will continue to grow, rising to 9.2 Gt CO_2 in 2035 (IEA, 2012).

In Hungary the CO_2-emission was decreasing from 60.3% to 48.9% between 1970 and 2010, thus the decrease was 23.6% (IEA, 2012). In Hungary the CO_2 emissions per capita was 5.82 tons in 1971, it reached a peak in 1980, when it increased to 7.82 tons CO_2. However, then decrease can be observed, which can be explained by significant decline of industry, agricultural and energetic performance (Kerényi – Szabó, 1999). Subsequently the CO_2 emission per capita has reduced to 4.89 by 2010 (IEA, 2012).

It was necessary to develop strategies and different regulations at the global and regional levels in order to reduce CO_2-emissions.

3. Objectives and strategies for reduction the GHG emission

Climate change is one of the biggest challenges facing mankind in the coming years. For several years now the European Union has been committed to tackling climate change both internally and internationally and has placed it high on the EU agenda, as reflected in European climate change policy [2].

Nowadays the fossil fuels still play a significant role in the energy production. Based on the IEA reporting (2010) in primary energy consumption 33% was oil, 27% was coal, 21% was natural gas, 13% was renewable energy and 6% was nuclear energy. Thus 80% of the global primary energy demand is provided by fossil fuels, the share of renewable and nuclear energy is negligible (National Energy Strategy 2030).

In the European Union the primary energy production was 831 Mtoe in 2010, of which 28.5% came from nuclear energy, 19.6% from solid fuels, 18.8% from natural gas, 11.7% from oil and 20.1% from renewable energy resources (EUROSTAT, 2012). Nowadays, coal and gas are the two most important fuels used in Europe in power production (Moiseyev et al., 2013). According to the IEA (2012), in the European Union the energy production changed considerably. The role of fossil fuels, except natural gas, reduced; however the role of renewable energy resources is increasing.

Following on from work under the European Climate Change Programme (ECCP), the European Union has come up with a realistic climate change strategy, advocating practical action to prevent temperatures from increasing to more than 2°C above pre-industrial levels. In the international arena, the EU is at the very forefront of the fight against climate change and takes an active part in negotiations on the subject. The EU signed up in 1998 to the Kyoto Protocol to the United Nations Framework Convention on Climate Change, which deals with six greenhouse gases. Moreover, to help developing countries meet the challenge of climate change [2].

The EU 2020 strategy defines important objective in connection with climate protection and sustainable energy management: by 2020 the EU will have decreased the GHG emission by 20% compared to the 1990 base year, the proportion of renewable energy resources will have been increased to 20%, as well as the energy efficiency will have been improved by 20% [3].

Based on the decarbonisation plan of the EU, by 2030 the GHG emission will have been reduced by 40-44%, and the CO_2 resulting from residential consumption and services by 37-53%.

Our country's energy policy corresponds with renewable energy exploitation directive of EU. In the last decades development of technologies using renewable energy sources come to the front again. In Hungary the greatest potential are solar-, geothermal- and biomass energy taking into account geographical circumstances (Szendrei, 2005; National Energy Strategy 2030; Zamárdi – Tóth, 2013).

In terms of implementation of long-term emission reduction targets are important policy documents and strategies, which influence the emissions in the short and medium term. Currently there are two key documents are available: the National Climate Change Strategy (2008-2025) and between 2008 and 2020 regulation for energy policy. In respect of the National Climate Change Strategy 2025 two emission reduction target intervals were defined:

- In case of 20 percent unilateral emission reduction commitments of the EU:16–25 percent reduction compared to 1990 emission levels;
- Comprehensive global framework that is in case of 30 percent reduction target of EU: 27–34 percent reduction compared to 1990 emission levels.

Regulation for energy policy can be stated that energy policy strategy aims to optimize the security of supply, competitiveness and sustainability, as joint enforcement of primary targets, considering the long-term aspects (Feiler – Ürge-Vorsatz, 2010).

In Hungary the two most important strategies show the commitment to the renewable energy and biomass. The strategies describe in detail future plans. These strategies are also very important in the fight against climate change, as renewable energy sources are much more environmentally friendly compared to fossil fuels. These two strategies are the following:

- Renewable Energy –Renewable Energy Action Plan of Hungary 2010-2020,
- National Energy Strategy to 2030.

Renewable Energy Action Plan of Hungary aimed to the renewable energy resources will have increased to 14.65% within the total energy consumption by 2020. According to the roadmap the proportion of solid biomass will produce a major increase in electricity and heating-cooling sector.

The National Energy Strategy aims to strengthen long-term sustainability, safety and economic competitiveness of the domestic energy supply to 2030. Five important objectives were defined to achieve these aims: to enhancement energy savings and energy efficiency, to increase the proportion of renewable energy, to integrate pipeline network of Central European, to preserve the existing nuclear capacity as well as to use the domestic coal and lignite in in electricity production environmentally friendly way.

4. Calculation method of the CO_2-emissions from heating based on the IPCC (2006) report

The domestic heating and CO_2 emissions are not insignificant issues, because the half of world's population uses firewood for cooking in their daily lives, but the most significant amount of firewood use for heating (He, et al., 2009). Nowadays 40% of consumed energy is used by operation of buildings in Hungary, two thirds of which means heating-cooling. In 2010, one thirds (16%) of emitted CO_2 (48.9%) is contained CO_2 resulting from power generation and heating (IEA, 2012). Compared to the average of EU 27, Hungary is the highest among the ten in point of residential energy consumption.

The IPCC has established different calculation processes for computation of GHG emission resulting from human activities. The emission factors for CO_2 from natural gas and fuelwood were obtained from IPCC (2006) Table 1. The calculation is based on common guidelines, so we have the opportunity to compare CO_2 emissions of different countries.

According to IPCC report (2006), the amount of emission mostly depends on the carbon content at burning of fuels. Most of this eliminate as CO_2, however, CO, CH_4, or methane are formed by the smaller proportion of this. CO_2 factors (EF) belonging to the fuels depends on the carbon content of burnt material, and not the combustion process and its conditions. Another important factor of the combustion process is the heating value of fuels, i.e. the energy content. This depends on the internal chemical properties of the material and composition of chemical bonds in the fuel.

In Hungary the two most significant energy source of residential heating are natural gas and firewood (Hungarian Central Statistical Office, 2010; Energy Centre Nonprofit LDT. 2009).

Sustainably managed biomass systems recycle the carbon that is taken in by photosynthesis and return it to the atmosphere during combustion (Gustavsson et al., 2007). Accordingly, the fuelwood use was considered to be carbon-neutral, yet would release gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), particularly if the combustion is incomplete for the latter two gases (Bhattacharya – Abdul Salam, 2002; Schwaiger – Schlamadinger, 1998). Fuelwood consumption that does not exceed the natural growth rate of the forest could potentially decrease net CO_2-emissions if fuelwood replaces the consumption of fossil fuels (Eriksson – Gustavsson, 2010). A

Table 1. CO_2-emission heating with natural gas and firewood (Source: Hungarian Statistical Yearbook, 2008; IPCC, 2006)

	Consumption (kg/year/capita)	Heating value (MJ/kg)	EF_{CO_2} (kg/TJ)	CO_2 emission (kg/year/capita)
natural gas	337.9	40.96	56100	776.5
firewood	85.5	14.4	112000	137.8

*EF=Emission Factor

potential reduction from 2 to 30% has been estimated for various European countries (Schwaiger – Schlamadinger, 1998).

Emission factor related to energy sources can be found in suitable main sector of Stationary Combustion of IPCC report (IPCC, 2006).

If we set GHG emission of heated by piped natural gas against GHG emission of heated by firewood based on the Hungarian Statistical Yearbook and IPPC report (2006), it can be concluded that the CO_2 emissions of gas is much higher than the firewood.

5. The role of biomass in heating

One type of renewable energy sources is biomass, which can be easily exploited and utilized in all countries. The biomass derive from biological organic mass; it is body mass of living and recently dead organisms (plants, animals, micro-organisms) being on land and in water, products of biotechnology industry, total biological origin products, waste, by-products of human, animal and manufacturing industry etc. (Láng, 2007).

The biomass is important in terms of energy management and global life sustainability, because sustainable energy use can be realized by them. A primary advantage of biomass is that it is usually reproduced within one year (Szendrei, 2005), and fossil fuels (coal, natural gas, oil) can be saved by using them (Tóth, 2013). The renewable energy resources are suited to trigger the fossil fuels (Büki, 2009). The CO_2 content of the atmosphere gradually increase by burning of fossil fuels, which is contribute to the problem of greenhouse effect and global warming [1]. Another advantage is to reduce the import dependency and to increase the security of energy supply (Szemmelveiszné, 2006, Zamárdi – Tóth, 2013).

The solar radiation creates a significant amount of biomass through photosynthesis (TÓTH et al., 2008). In Hungary 437 x 1018 J/year solar radiation produce 958 x 1015 J/year = 958 PJ biomass (Büki, 1997). The Subcommittee on Renewable Energies of Hungarian Sciences Academy was preparing theoretical potential of renewable energy between 2003 and 2005. According to the study the potential of theoretical biomass energy is 203.2 – 328 PJ/year in Hungary (MTA, 2006).

Summary it can be stated that Hungary has significant biomass energy potential. In this connection, different estimates are made, which summarized in Table 2.

Heat, electricity and fuel can be obtained from the biomass by the various transformations (Renewable Energy Handbook, 2012). The easiest way of energetic utilization of biomass is the firing (Pénzes et al., 2005; Tóth, 2011).The heating value of biomass depend on its moisture content, as the higher the moisture content is, the lower heating value is, because the water evaporates during combustion. The moisture content of fuelwood depend on several factors, e.g. when it is harvested; it is hard or soft tree (the moisture content of softwood is higher) etc. The moisture content of wood cut-out freshly is 50-60%, heating value of which 7.1 MJ/kg. The cut-out tree, which is stored through a summer, lose from its moisture content, therefore this value was reduced to 25-35%, the heating value increase to12.2 MJ/kg. The moisture content of wood stored for several years is about 15-25%, and the heating value is 14.4 MJ/kg (Tóth et al., 2008).

Table 2. Bioenergy potential of Hungary based on different estimates (Source: Hajdú, 2006, Dinya, 2008, Büki, 2009)

Sources	Lower value (PJ/year)	Higher value (PJ/year)
MTA Subcommittee on Renewable Energies (2005 – 2006)	203	328
Energy Club (2006)	58	223
Hajdú (2006)	110	170
European Environment Agency (EEA) (2006)	145.5	
Ministry of Agriculture and Rural Development (2007.)	260	
Büki 2009	100	150
Extrema	58	328

In our work, we examined what kind of economic and ecological changes may result in an average four-member Hungarian family household, if we change from gas-powered heating to wood or straw.

In our study, we modelled the heating energy utilization of an average floor area (100 m^2) family house (Fig. 1.) We took into account temperature, energy utilization and gas price data of 2014 [4-6]. The parameters refer to combustion properties of different fuel materials were determined by Tóth (2011).

The heat demand of family house were estimated 72 GJ (2014), which contains energy which contains energy needed to domestic hot water of four people, and the amount of energy needed to keep 22 °C in the house during the heating season. It can be different combustion plants, thus our study 90% efficient, 24 kW gas boilers is considered average was assumed.

In determining the basic parameters of the model, during combustion of 1 m^3 natural gas generation of 1 m^3 carbon dioxide was assumed, which weight was taken 1.963 kg on frost point [7]. The temperature change is proportional with the mass of emitted the carbon dioxide; however in this study we disregard this factor. In the case of straw and firewood the carbon dioxide emission was determined 0, since these CO_2-balances are zero.

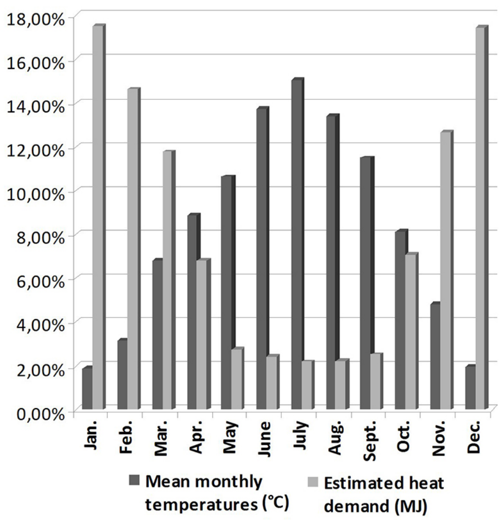

Fig. 1. Changes of estimated heat demand (2014) of the examined family house depending on the monthly average temperatures (Source: based on [4])

Based on our calculation we determined to satisfy the annual heating needs of a family house about 2 352.94 m3 natural gas is required, calculated with 24 kW to 90% efficient gas boiler, during which burning is approximately 4.619 tons carbon dioxide get into the atmosphere.

The price of natural gas used is 207 920 HUF (2014) [8]. The extremely low gas prices due to the overhead reduction since 2013, because the gas costs were much higher. In 2009, for example the same amount of gas has been 275 813 HUF into, due to the overhead reduction the gas prices decreased

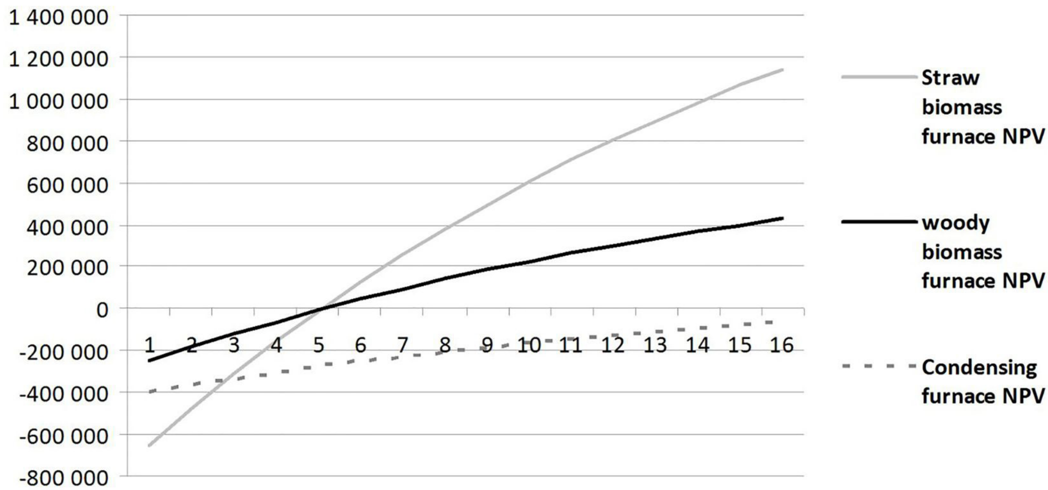

Fig. 2. The payback period of three investments, depending on the net present value HUF

to 24.61% [9].

In the case if estimated energy demand of the average house investigated in the study were replaced wood-burning system, whose efficiency is around 80%, then 90 GJ energy content firewood would be needed to produce 64 GJ heat energy. If the firewood calorific value is considered 18.5 GJ / t in absolute dry state, then 4.86atro fuel raw materials would be needed. Naturally, such properties firewood can be produced artificially only; however, in Hungary there is some forestry, where the purchased fuels are HUF/tatro. In the case of wood heating the prices of the annual fuel raw materials is favourable compared to the natural gas, since to produce 64 GJ it would be 138 203 HUF [10], thus the heating expenses would be reduced by 34%.

The efficiency of straw-burning boiler system is 78%, so to satisfy thermal energy needs of the family house would need about 5.34 tatro straws. It is difficult to determine the price of investigated agricultural by-product, since the difference can be up to 300% between straw purchased from the house and straw produced by farmers at first cost. Because of the significant role in animal husbandry it is difficult to obtain, therefore in this model I expect the price of straw at first cost. So 23 477 HUF worth straw would be needed to produce the heat energy of the house. It would be cheaper by 184 443 HUF (88.71%) compared to the existing heating.

We have examined if the current gas fired heating were replaced modern condensing gas boiler, how changes the heating costs and how much carbon dioxide emissions of households would be reduced. The efficiency of the modern condensing gas boiler was determined 108%. It can be said that it would be able to cover the same heat demand by about 392 m^3 less natural gas as the current boiler. The heating expenses would be reduced approximately 34 653 HUF (17%), and 769 kilograms less CO_2 would be in the atmosphere.

We prepared investment analysis to compare the economics of three combustion installations (Fig. 2.). The value of the condensing boiler has been estimated 400 000 HUF, the wood-fired boiler is 250 000 HUF; the straw-burning boiler is 650 000 HUF. The net present value of condensing boiler (NPV) will be no positive after 15 years, calculated at a 6% calculative interest rate. Thus, this investment should be dismissed in the case of the examined house. The wood-fired boiler is recovered between 4 and 5 years, and during 15 years it will result in approximately 427 112 HUF savings. In the case of straw-burning boiler and the wood-fired boiler the net present value will be positive between 4 and 5 years, however during 15 years it will result in 1,141,355 HUF savings additional to the investment expense.

The CO_2 emission of the investments modernizing heating is significantly different (Fig. 3.). If there is no investment, then over the next 15 years, the house is about 69.282 t CO_2 get into the atmosphere, if it became a modern condensing boiler then this value may decline to 57.735 t. In contrast to gas fired use of wood and straw carbon balance is 0. Thus, the carbon dioxide released during the incineration plants have already concluded their lifetime.

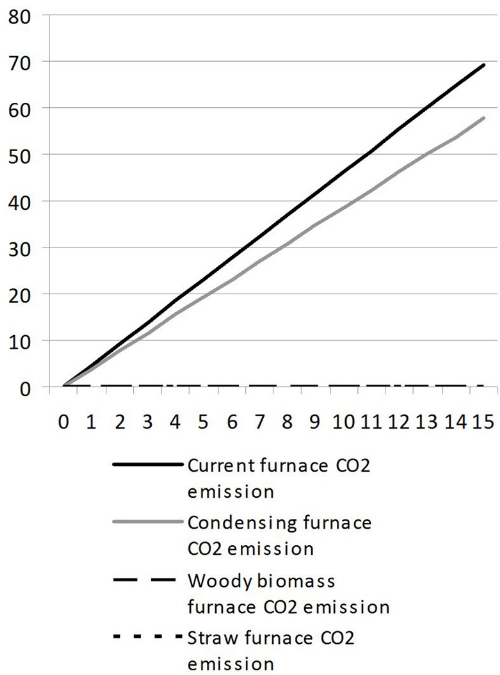

Fig. 3. Changes in the carbon dioxide emissions (t) of three investments in 15 years

If we examine CO_2 savings of the three investments (Table 3.), it can be stated that in a family house the most cost-effective CO_2 savings method can be achieved by the wood-fired boiler. Since 1000 HUF worth of investment has 277.129 kg CO_2 saving.

Table 3. Carbon dioxide cost efficiency index of three investments

1000 HUF per CO_2 saving	kg
Condensing furnace	28.868
Wood-fired furnace	277.129
Straw-burning furnace	106.588

6. The significance of forests for reduction of CO_2 concentration

Forests currently cover about 4 billion hectares, about 31 % of the earth's surface (FAO, 2010). As human population and economic activity have increased, humans' also have the ability to manipulate the natural world. This manipulation is most evident in the clearing of forests.

Two thousand years ago, forests covered an estimated 80 % of the land in Europe; today they cover 34 % (FAO, 2012). The total area of wooded land in the EU was 177.8 million hectares in 2010 (EUROSTAT, 2011). Between 2000 and 2010, wooded area in the EU increased through natural expansion and afforestation by a total of 3.5 million hectares, a rise of 2% (EUROSTAT, 2011).

In 2000, the forest area of Hungary was 18 660 km_2, which increased by 5 000 hectare in 2010. By the end of 2010, the forest cover has reached 20.7%, which means about 2 million hectares (Fatáj, 2012).

The development of civilization has been powered by wood energy. Today wood is still the most important single source of renewable energy, providing more than 9 % of the global total primary energy supply. Household cooking and heating with wood fuels accounts for one-third of global consumption of renewable energy sources (FAO, 2010). Forests also release carbon naturally through decomposition and forest fires; carbon dioxide is also released when wood that has been harvested is broken down, for example through combustion (EUROSTAT, 2011). Forest biomass in the EU contained 9 800 million tonnes of carbon in 2010, an increase of 5.1 % compared with 2005 (FAO, 2010). In Hungary the carbon stocks in the living biomass was 117 million tonnes carbon in 1990, which mainly due to the increasing forestation have risen to 142 million tonnes by 2010 (FAO, 2010). In the past ten years, the importance of forests in mitigating climate change through carbon sequestration has become widely understood and accepted (FAO, 2012).

The current C stock in the world's forests is estimated to be 861 ± 66 Pg C, with 383 ± 30 Pg C (44%) in soil (to 1-m depth), 363 ± 28 Pg C (42%) in live biomass (above and below ground), 73 ± 6 Pg C (8%) in deadwood, and 43 ± 3 Pg C (5%) in litter. Geographically, 471 ± 93 Pg C (55%) is stored in tropical forests, 272 ± 23 Pg C (32%) in boreal and 119 ± 6 Pg C (14%) in temperate forests (Yude Pan et al., 2011).

In Hungary the forest management is considered to be the only GHG absorber (KIS-Kovács et al., 2011). In our country, several experts have dealt with carbon sequestration capacity of forests (pl. Führer – Molnár, 2003; Balázs et al., 2008; Juhász et al., 2008; Kiss et al., 2011). Most effective carbon capture can be achieved by installation of new forests.

In the foliage of the forest cover about 2.4 million tonnes carbon absorb during the growing season, which is degraded and returned to the atmosphere in every year, similarly foliage of herbaceous plants, however its volume is relatively small. From annual growth of stump root system (it is estimated about 1.3 million tonnes) pass the proportion in accordance with logging (0.97 million tons). It degrades during shorter or longer term, and also returns to the atmosphere. However the residual (0.33 million tons) accumulates in organic matter of live trees from year to year (Führer – Mátyás, 2005). The national forests are important in absorption of carbon-dioxide (Somogyi, 2008). According to the analyses, the amount of carbon absorbed in the domestic forest is 35 Mt. Annually the forests in Hungary, about 6.9 million tons carbon absorb in the ecosystem (Mátyás – Czimber, 2007). However, this amount is not sufficient to compensate anthropogenic carbon emissions. This is well illustrated by the role of forest in carbon cycle. In Hungary, the elemental carbon content of emitted carbon dioxide is approximately 16 million tons per year that is about eight times more than the amount in wood (Führer – Mátyás, 2005). According to the article 3.3 of the Kyoto Protocol net absorption of forest management activities (including forestation and forest land-cessation were carried out since 1990) was 1.25 million tons CO_2 in 2010, while according to Article 3.4 during the other forest management activities net 1.7 million tons CO_2 carbon capture was established (NIR Hungary, 2013).

7. Conclusion

- Climate change is one of the most popular scientific topics in the present period. In this regard, several studies were prepared about the amount of greenhouse gases in the atmosphere, and main sources. One of the main sources is anthropogenic activities (e.g. transport, industry, burning of fossil fuels).
- The burning of fossil fuels contributes significantly to increase CO_2 concentrations in atmosphere. According to the IPCC (2013) report, the global atmospheric concentration of carbon dioxide has changed from 278 ppm to 390.5 ppm by 2011. On the basis of NASA report this value has been reached 400 ppm by 2013.Globally, the atmospheric concentration of carbon dioxide has increased by 40% since pre-industrial period. In Hungary, CO_2 emissions decreased by 23.6% between 1970 and 2010, which is due to the significant decline in industrial, agricultural and energy performance.
- One of the fundamental objectives of the European Union is reduction of CO_2 emissions; with this object numbers of measures were introduced: decarbonisation plan of the EU, the EU 2020 strategy, the National Climate Change Strategy, and the decision on energy policy.

- The amount of CO_2 emission from residential heating (worldwide approximately 6%) contributes significantly to the increase concentrations in atmosphere. In our country, the two most important energy source of residential heating is gas and firewood. The IPCC has established different computational processes to calculate the greenhouse gas emissions from anthropogenic activities. So it can be concluded that in our country the CO_2 emissions of gas is much higher than the firewood.
- The firewood is a solid biomass, which is a conditionally renewable energy source. Heat can be obtained from biomass by conversions; the easiest way of energy recovery is combustion. The advantage, against fossil energy sources, is to get into the atmosphere less CO_2. In the case of gas an average family house emits about 4.619 tonnes CO_2 into the atmosphere annually, which reduction or even completely stopping is available by biomass-based heating. In additional to reduce the carbon dioxide emissions, even significant savings can be realized. Since a 250 000 HUF worth of investment would mitigate the heating cost about 34%.
- Both the Earth and one-third of Europe's surface are covered by forests. In Hungary, this value is less than approx. 21%. Carbon sequestration capacity of forests plays an important role in mitigating climate change. According to an investigation the Hungarian forests absorb 8.6 million tons carbon per year. Unfortunately, this is not balanced the emission: in Hungary the amount of emitted CO_2 is eight times more than the absorption. Higher carbon absorption can be achieved by more forest management.

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