



CO₂ Emissions with the Option of Reduce on the Example of the EDF Poland S.A.

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Summary

The main source of carbon dioxide emissions into the atmosphere is the energetics and industrial processes, and therefore the greatest potential for reduction in the reduction lies in those sectors of the economy. At the beginning of each year is increasing, although one of the objectives of EU energy package 3x20 is a 20% reduction in greenhouse gas emissions by 2020 in relation to 1990. Inherent in this package, which has an impact on the reduction of CO₂ emissions is an increase of 20% share of renewable EU's energy result in the same period of time. Electricity generation from renewable source is necessary in systems with high power due to the energy security needs of the country and especially the environment. In Poland, the increase in electricity production from renewable energy sources is mainly the result of increased use of biomass in coal-fired boilers using technology co. In order to meet the obligations set by the EU, power and heat plants use different types of combustion of solid biomass, the CO₂ balance is at zero. Currently, biomass co-firing with coal shall also be considered financially attractive way of using biomass for production of electricity generation. Prices of biomass fuel market becomes competitive because its combustion is more profitable for the further reason that the resources of fossil fuels are becoming smaller, and their prices rise. The reduction of carbon emissions can be achieved by increasing the efficiency of power plants, which is obtained by increasing steam parameters, co-firing of biomass with coal and widely developed combined production of electricity and heat. Countries which have free access to natural gas resources, can also afford the partial replacement of coal, which also contributes to excessive CO₂ emissions. For large power plants that use fossil fuels are being developed which reduce or even eliminate a large carbon vestige. Implemented new technologies which help to reduce the concentration of carbon in the fuel. Returning to the aims of the EU objectives of the energy package, EDF Poland S.A. decided to co-firing biomass with coal since 2007. Combustion of biomass is followed by directly adding it to coal. Effect of biomass co-firing in CO₂ missions is discussed in Chapter 6. In addition to the revenue derived from sales of electricity, there were also sales of certificates of origin, "green certificates". In order to increase the energy efficiency of electricity and heat are produced in high efficiency cogeneration in one of the technological processes. As a result, the method used in the EDF Poland S.A. is reduced fuel usage and therefore lower CO₂ emissions.

Keywords: dewatering, zeta-potential, silicates, flocculation, sedimentation

Electricity generation sector in Poland

In the last decade the production of electricity was higher than domestic consumption. Surplus electricity started to be used for export. Since 2007, electricity production is getting lower (Fig. 1) Despite the projected decline in the demand for electricity, the production is rising. Total balance of the electricity output for 2011 was 162 934 MWh. Comparing these figures with the previous year 2010 is 3.47% more [1].

The basic raw materials for the production of electricity in Poland 2010 were coal and lignite. Power plants fired by these energy carriers produced 150 TWh, which accounted for 85.8% of the total production. Part of renewables in energy balance for 2010 is nearly 7%. Half of the share accounted for biomass co-firing, mostly wood (5851 GWh). Another part of renewable energy sources are hydro plants (2925 GWh) and wind plants (1,620 GWh). The smallest share in electricity production attributable to gas-fired plants, representing 3.4% of the production. The above mentioned plants produced a total of 4 167 GWh of electricity [2].

Balance and carbon dioxide emissions

The greatest assemblage of CO₂ are the oceans and seas. In seawater, it is about 132 000 billion tons. It is estimated that in the year it is released to the atmosphere in the amount of 330 billion tons. A comparison of these values shows that this reservoir is sufficient even for a long time, even taking into account the uptake of carbon dioxide by marine plants (which is getting less). It is believed that Earth plants assimilate each year 400 billion tons of CO₂. In sectors such as industry, transport, services, human participation in the balance of carbon dioxide is about 24 billion tons. On the other hand, for many years in the atmosphere estimated level of CO₂ - 2 900 billion tons. Carbon dioxide is negligible because it amounts to less than 1%.

Carbon dioxide is emitted to the atmosphere mainly due to the combustion of fuels for energy purposes.

Carbon dioxide emissions in Poland

Slowly decreasing in Poland since 2007, CO₂ emissions according to preliminary data of the Nation-

al Centre for Emission Balancing and Management (KOBiZE) increased in 2010, about 5%. In 2012, the volume of emissions under the EU Emissions Trading Scheme (EU ETS) fell by 3.23% compared to 2011 – reported KOBiZE.

The main source of carbon dioxide emissions are the processes involved in the production of energy. Emissions associated with the combustion of fuels for energy is primarily concerned in economic sectors: energy, manufacturing and construction, transport and other sectors. The Energy sector is among the carbon dioxide emitted during storage, extraction and distribution of fuel. To the category “Energy” is classified the carbon dioxide emitted during storage, extraction and distribution of fuel. A detailed breakdown of carbon emissions in Energy are shown in Table 2 [4].

In terms of carbon emissions, industrial processes are the second category. It contains the carbon dioxide generated as a byproduct of various industrial processes associated with the production of energy [4].

Ways to reduce carbon dioxide emissions to the at-

mosphere

Global warming forces us to explore and introduce new technological solutions which reduce carbon dioxide emissions to the atmosphere and the development of the so-called, clean coal technologies. Methods that can be used to reduce carbon dioxide emissions to the atmosphere are:

- improve the efficiency of energy use
- capture and sequestration
- use of renewable energy sources

Energy in Poland is mainly based on the combustion of coal, reduce carbon emissions can also be achieved by:

- improve the quality of coal
- modernization of production equipment
- increase the efficiency of heating systems
- co-combustion of coal with other materials

Improving the efficiency of energy

Reduce carbon dioxide emissions by improving energy efficiency is based on a simple principle: the higher the efficiency of the installed equipment, the

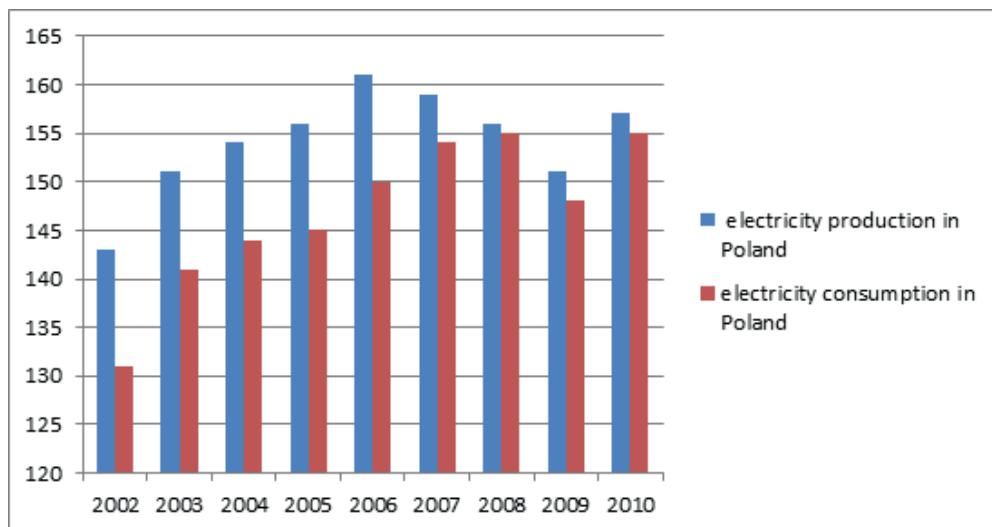


Fig.1 Production and consumption of electricity in Poland in the years 2002 – 2010

Rys.1 Produkcja i zużycie energii elektrycznej w Polsce w latach 2002 – 2010

Tab 1. CO₂ emissions from the combustion of fossil fuels per unit of heat energy.

Tab. 1 Emisja CO₂ ze spalania paliw kopalnych w przeliczeniu na jednostkę energii cieplnej.

Fuel	MgCO ₂ /TJ
lignite	101,2
Thermalcoal	96,1
cokingcoal	94,6
oil	77,4
diesel	74,1
naturalgas	56,1

less fuel you need to burn in order to obtain the same energy. Conclusion of this principle is obvious: the smaller the amount of fuel burned, the less gas produced goes into the atmosphere, including carbon dioxide.

The efficiency of electricity generation and heat can be increased by applying modern industrial practice solutions which include, among others:

- To use blocks operating at supercritical parameters (27-29 MPa i 580-620 °C),
- to use blocks operating at ultra-supercritical parameters (35 – 37,5 MPa i 700-720 °C) for which the expected efficiency is 52%,
- to use systems combined gas - steam (integrated gasification combined cycle) integrated with coal gasification, which increases the efficiency of electricity production to 48% and also locks up carbon dioxide
- to use fluidized- atmospheric boilers that are already in use, and their efficiency is about 45% [5]

Capture and sequestration of carbon dioxide

This action is intended to separate CO₂ from other flue gas, which is then transported and stored. It is a maturing process technology in industrial sectors and is very expensive. Although this process requires additional energy consumption, which is a reduction in energy efficiency by about 8-13% for coal and 9-12 in the case of gas, it allows almost entirely (99%) reduction of carbon dioxide emissions [3].

Methods for separation of carbon dioxide from other gases

The separation of carbon dioxide from other gases can be applied physical and chemical methods. They include:

- physical absorption
- Chemical absorption
- cryogenic separation
- membrane separation

The choice of method depends on the separation of CO₂ from the flue gas properties, mainly on the temperature and pressure of exhaust gas, and of the carbon dioxide content and the size of exhaust gas stream.

Carbon dioxide capture technologies

Removal of carbon dioxide can be performed by one of the two main technological variants:

- post-combustion
- oxy-fuel combustion
- pre-combustion [6].

Transport of carbon dioxide

The cheapest form of transport carbon dioxide pipeline. During its transport by pipeline gas is compressed to a pressure greater than 8 MPa in order to increase its density. This reduces transportation costs and has a positive effect on the transfer. Pipelines operate in the so-called. heavy phase where the gas phase gradually turns into a liquid phase without express its transformation. Carbon dioxide can also be transported by sea by tankers. Another alternative method of transport is by road and rail transport in liquefied form.

Storage of carbon dioxide

The most important problem of the process of carbon dioxide sequestration is the storage. There are two basic types of CO₂ storage.

- Storage of CO₂ in deep geological
- Storage of CO₂ in the oceans. [7]

Characteristics of EDF Poland S.A.

EDF Poland S.A. power plant is a professional power plant produces electricity and heat (steam and hot water) for the city. It is located in Cracow on the Wisła river's left bank, Nowa Huta district. The basic units of energy which constitute the installation of fuel combustion in power plant EDF Poland S.A. There are four power units and three water boiler peaks. The total installed capacity is:

- Heat 1118 [MWt]
- Electrical 460 [MWe]

The energy production is carried out based on the combustion of coal and a mixture of coal and biomass. [8]

General characteristics of used installation.

As a part of the fuel combustion installations located on the EDF Poland S.A. include:

- two steam boilers OP-380 with a capacity of 331 MWt,
- two steam boilers OP-430 with a capacity of 332 MWt,
- three water boilers WP-120 with a capacity of 166 MWt,

The main fuel used in the above-mentioned installation is pulverized coal with the addition of biomass. Used to fire the boilers is heavy or light fuel oil. Flue gas treatment implement installed on the boiler electrostatic filter with an average of 99.4% extraction efficiency. After leaving the electrostatic filter gases are introduced into the air two emitters:

- one with a height $h = 225$ m and a diameter outlet $d = 6.5$ m
- second with a height $h = 260$ m and a diam-

Tab. 2 CO₂ emissions from the Energy category in Poland 2000.Tab. 2 Emisja CO₂ z kategorii Energia w Polsce 2000r.

Energy Category	Emission [Gg]	Part [%]
A. Combustion of fuels (sectoral approach)	302 281,50	
1. energy	176 324,20	
a. Production of electricity and heat	164 691 ,90	54,45
b. refinery	5 321,40	1,76
c. Production of processed solid fuels and OtherEnergyIndustries	6 310,90	2,09
2. Manufacturing Industries and Construction	52 055,70	
a. Iron and steel industry	20 041,00	6,63
b. Non-ferrous metal industry	1 327,20	0,44
c. chemicalIndustry	6 437,50	2,13
d. Pulp, Paper and Printing	1 666,50	0,55
e. food Industry	5 777, 70	1,91
f. other	16 805,80	5,56
3. Transport	28 206,90	
a. Aviation	478,80	0,16
b. road transport	26 919,80	8,90
c. Railways	436,40	0,14
d.shipping	79,50	0,03
e. Other transport	292,40	0,10
4. Othersectors	45 400,00	
a. Trade organizations and public	7 413,40	2,45
b. Households	27 012,40	8,93
c. Agriculture / Fisheries / Forestry	10 974,20	3,63
5. Other	294,70	0,10

Tab. 3 The actions and effects to reduce CO₂ emissions into the atmosphere at EDF Poland S.A.

Tab. 3 Działania i efekty ograniczające emisję CO₂ do atmosfery w EDF Polska S.A.

LP.	Equipment and measures to reduce emissions	Date of commencement of work	The effect of reducing
1.	Start of biomass co-firing and construction of the biomass installation II (direct injection)	2007 Biomass II:2010	With the co-firing of biomass CO ₂ emissions avoided from 5% in 2007 to 15% in 2011
2.	Installation of biomass co-firing - direct injection	2010	Reduction of CO ₂ emissions by the zero index of CO ₂ emissions from biomass
3.	Installation of a heat accumulator	2011	Reduction of emissions to air: - CO ₂ – 1 829,67 t/year,

Tab. 4 CO₂ emissions from biomass (avoided) in [Mg / year] and the reduction of CO₂ emissions [%] in 2008-2012.

Tab. 4 Emisja CO₂ z biomasy (uniknięta) w [Mg/rok] oraz redukcja emisji CO₂ w [%] w latach 2008-2012.

Year	Emission of CO ₂	Reduction of CO ₂ emissions
2008	107 948	5,7
2009	136 606	7,4
2010	166 038	8,0
2011	322 682	15,5
2012	323 280	15,8

eter outlet d = 7.0 m

The main measures to reduce CO₂ emissions

EDF Poland S.A. after obtaining the license for the production of electricity in co-firing, constructed installation that allows adding biomass. In August 2007, we started producing the so-called. "Green energy". To the combustion are mainly used: palette of sunflower hulls, wood, rapeseed bagasse and rapeseed-barley straw.

With a view to increasing the efficiency of energy production in EDF Poland S.A., the end of 2011 was launched a heat accumulator. Heat accumulation system in the heating system allows heat storage in the form of a large quantity of hot water and makes it possible to increase the efficiency of energy generation by means of:

- reduce uneven loading of the power block
- increasing the degree of association
- the possibility of eliminating the boiler water during peak periods
- provide heat supply in case of failure of the block

Analysis of the impact of energy use of biomass on emissions CO₂

EDF Poland S.A.

During the combustion of biomass CO₂ balance is zero. It is assumed that the emitted is only the amount that consumed plants through photosynthesis. Since 2007, during which they commenced biomass burning in the EDF Poland SA., shows the lower emissions of carbon dioxide produced from burning coal. The higher the share of biomass, the lower the CO₂ emissions.

Table 4. CO₂ emissions from biomass (avoided) in [Mg / year] and the reduction of CO₂ emissions [%] in 2008-2012.

Summation

The demand for energy in the world is increasing. This is mainly due to the industrialization of the less developed countries. Unfortunately, an integral part of the production of energy is the emission of carbon dioxide. The share of renewable energy sources continues to grow, but it is not yet sufficient to meet the demand for energy. Carbon dioxide is a gas that contributes significantly to the formation of the green-

house effect, so you should limit its emissions to the atmosphere. Combining high-performance power generation technologies with carbon capture and sequestration of carbon dioxide, can significantly reduce the emission of this gas into the atmosphere. Co-firing of biomass with coal at EDF Poland S.A., resulted in a reduction of carbon dioxide emissions into the

atmosphere by about 16%. With the increasing participation of biomass supply, reduced CO₂ emissions, through zero emission balance of biomass. Construction of the power plant heat accumulator at the end of 2011, increasing the efficiency of energy production, reduces energy consumption and therefore reduces carbon emissions.

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Streszczenie

Głównym źródłem emisji dwutlenku węgla do atmosfery jest energetyka i procesy przemysłowe, dlatego największy potencjał redukcji w jego obniżeniu tkwi w tych sektorach gospodarki. Z początkiem każdego roku jest ona coraz większa chociaż jednym z celów unijnego pakietu energetycznego 3x20 jest 20% redukcja emisji gazów cieplarnianych do 2020 roku w odniesieniu do 1990r. Nieodłącznym elementem tego pakietu mającym wpływ na obniżenie emisji CO₂ jest wzrost w zakresie 20% udziału energii odnawialnych w bilansie energetycznym UE w tym samym przedziale czasowym. Wytwarzanie energii elektrycznej z udziałem odnawialnych źródeł energii jest konieczne w instalacjach o dużej mocy co wynika z potrzeb bezpieczeństwa energetycznego w kraju i przede wszystkim ochrony środowiska. W Polsce przyrost produkcji energii elektrycznej z OZE to wynik głównie zwiększenia wykorzystania biomasy w kotłach węglowych przy zastosowaniu technologii współspalania. Aby wypełnić zobowiązania postawione przez UE, elektrownie i elektrociepłownie wykorzystują do spalania różne rodzaje biomasy stałej, której bilans emisji CO₂ jest na poziomie zerowym. Obecnie współspalanie biomasy z węglem uznaje się także za atrakcyjny finansowo sposób wykorzystania biomasy przy produkcji energii elektrycznej. Ceny biomasy na rynku paliw stają się konkurencyjne dlatego jej spalanie jest bardziej opłacalne, również z tego względu że zasoby złóż paliw kopalnych stają się coraz mniejsze, a ich ceny rosną. Redukcję emisji dwutlenku węgla można osiągnąć przez podwyższenie sprawności elektrowni, którą uzyskuje się dzięki podnoszeniu parametrów pary, współspalaniu biomasy z węglem oraz szeroko rozwiniętym skojarzeniu wytwarzanie energii elektrycznej i ciepła. Kraje które dysponują swobodnym dostępem do zasobów gazu ziemnego, mogą również pozwolić sobie na częściowe zastąpienie nim węgla, co również przyczynia się do nadmiernej emisji CO₂. W przypadku dużych zakładów energetycznych, które wykorzystują paliwa kopalne, opracowywane są rozwiązania pozwalające zmniejszyć a nawet wyeliminować dużą emisję dwutlenku węgla. Wdrażane są nowe technologie pozwalające ograniczyć koncentrację węgla pierwiastkowego w paliwie. Wracając do założonych przez UE celów z pakietu energetycznego, EDF Polska S.A. zdecydowała o współspalaniu biomasy z węglem od 2007 r. Spalanie biomasy następuje w wyniku bezpośredniego podawania jej do węgla. Wpływ współspalania biomasy na wielkość emisji CO₂ został omówiony w rozdziale 6. Oprócz przychodów czerpanych ze sprzedaży energii elektrycznej, pojawiły się także przychody ze sprzedaży świadectw pochodzenia, „zielone certyfikaty”. W celu zwiększenia efektywności energetycznej energia elektryczna i ciepło wytwarzane są w wysokosprawnej kogeneracji w jednym z procesów technologicznych. Skutkiem stosowania takiej metody w EDF Polska jest obniżona ilość zużytego paliwa i tym samym niższa emisja CO₂.

Słowa kluczowe: odwadnianie, potencjału zeta, krzemiany, flokulacji, sedymentacji