

GREENHOUSE GASES

Combustion of any fuel results in greenhouse gas (GHG) emissions contributing in the climate change. Carbon dioxide (CO₂) make more than 99% of all GHG.

In order to limit the man-made impact on climatic system, in 1992 UN accepted the Convention on Climate Change (CCC), and in 1997 - the Kyoto Protocol to CCC, which came into force in the international scene in 2005. Russia is a member-state of CCC and Kyoto Protocol. As opposed to CCC, being of a frame character, the Kyoto Protocol established for the developed countries the certain responsibilities to limit GHG emissions for the period from 2008 to 2012 in comparison with the level of emissions for 1990, and also set the market oriented mechanisms of international cooperation for conducting the joint measures on GHG reduction. Texts of both documents, all decisions made, methodological, guideline and other materials are available on the site www.unfccc.int, which has a Russian version, and also on the Russian site www.climatechange.ru.

In the Russian Federation power engineering is a key industry relating to GHG generation; 81,5% out of all emissions are generated as a result of fuel combustion in different branches of power economy (power sector, housing and communal services, industrial power engineering, etc.). In this connection high-performance power technologies are concerned here in two aspects:

- as a mean of implementation by the Russian Federation of its responsibilities relating to both Kyoto Protocol and post-Kyoto Agreement (in 2008-2012 emissions should not exceed the level of 1990, in the post-Kyoto period the President of the RF agreed by 2020 to reduce emissions by 20% at the significant economic growth);
- introduction of measures and projects on reduction of GHG emissions allows to apply market mechanisms of handling the reduced emissions, save the state quotas for emissions and get additional incomes from their selling in the international carbon markets (see at the mentioned sites on application of article 6 of the Kyoto Protocol “projects of joint implementation” and article 17 “intergovernmental emission trading”, realized in a form of “schemes of green investments” or in other words “target ecological investments”).

The basic technologies on decrease/limitation of GHG emissions for the nearest 10 years in Russia will be efficient energy generation, energy saving, introduction of renewable energy sources, use of wastes as a fuel, reduction of losses at generation, transfer, distribution and consumption of energy. Technologies connected with CO₂ collecting, utilization of flue gases can be required in the Russian Federation only after economically reasonable measures on increase in power efficiency and energy saving, having a strong potential in our country, come to an end. These measures have considerable potential.

Note¹. Data from the Fifth National report of the Russian Federation for the leading bodies of the Frame Convention of UN on Climate Change and the Kyoto Protocol.

CARBON REVENUES FROM THE PROJECTS OF JOINT IMPLEMENTATION

An example of joint implementation project

Basic data of the project “Use of waste coke oven gas in the JSC “Khimprom” (Kemerovo, Russia). This investment project was realized at the beginning of 2008 and in the next period the project activity provided generation of the reduced emissions. This investment project was formalized as a project of joint implementation, it underwent the international expertise (determination) and was presented in 2010 to the specially authorized body of the Russian Federation in the sphere of joint implementation, Sberbank (named also for the present purposes as “the operator of carbon units”), for its consideration and further approval by the Ministry of Economic Development according to the procedures, established by a Decree of the RF Government №843 “On measures on realization of article 6 of the Kyoto Protocol to the Frame Convention of UN on Climate Change” dated 28.10.2009.

a) name of the project, purposes, tasks and terms of its realization;

Name of the project: “Use of waste coke oven gas in the JSC “Khimprom” (Kemerovo, Russia).

A task of the project is: contribution in raise of efficiency, profitability and reliability of power (steam) supply for technological installations of the JSC “Khimprom”, reduction of the local impact of common pollutants on environment and also decrease in GHG emissions.

A purpose of the project is: utilization as a fuel of waste coke oven gas from coke oven batteries of the next enterprise - JSC “Koks” in two new boilers of the JSC “Khimprom” for its own consumption. So, a part of extra coke oven gas will not be supplied “to the furnace” and combusted, but will be used in a boiler-house of the JSC “Khimprom”, and also co-combusted together with coal and natural gas at the closest Novo-Kemerovskaya TPP.

Terms of the project realization: end of the project implementation is 2008.

b) type of the project (reduction of GHG emissions from the source and (or) increase in its absorption by an absorbent)

Reduction of GHG emissions.

c) sector (category) of the source and (or) absorbent, selected for the project realization;

power sector;
waste utilization

d) project characteristics that definitely allow to correlate the source with the sector (category) of the source or identify the absorbent, selected for the project realization, including the source location address;

additional generation of thermal energy (steam of industrial parameters) for technological needs of the JSC “Khimprom” with the use of waste coke oven gas in the JSC “Koks”.

e) initial conditions for the project realization for the whole period of its implementation;

Data is resulted as of the moment of developing the technological documentation.

JSC "Khimprom" is the largest manufacturer of industrial and municipal chemical products in the Region. The company produces more than 20 products. For the majority of chemical technologies steam of industrial parameters is needed (2,4 MP, 270⁰C and lower). Steam is also used in the JSC "Khimprom" for heating and hot water supply. Production of steam is provided from two sources:

- own gas boiler-house of the JSC "Khimprom", including 3 boilers by 25 tones of steam per hour;
- Novo-Kemerovskaya CHPP, supplying steam by a steam pipeline to the JSC "Khimprom" on the distance of 3 km.

JSC "Koks" is located in the immediate proximity from "Khimprom". The main product is coke (several millions of tons per year). Technological process is accompanied by generation of coke oven gas. And after start-up of the new coke oven battery in 2007 the output of gas will reach at least 1300 million m³ per year. Approximately 50% of gas will be used as a fuel by the JSC "Koks" for its own needs, 30% will be supplied to Kemerovskaya SDPP and 20% will be combusted in the furnace. The quantity of waste gas will make 150-200 million m³.

f) the planned quantity of reduction of GHG emissions from the source and (or) increase in its absorption by the absorbent as a result of the project realization for the whole period of its execution.

The planned quantity of emissions reduction will make 70811 tons per year or 354055 tons for the period from 2008 to 2012.

g) description of actions, which should provide achievement of goals and solution of the project tasks (business plan).

The essence of the project measures covers the following:

- construction of two new boilers at "Khimprom", each boiler of 25 tons of steam per hour, which will combust coke oven gas from the JSC "Koks"; these two boilers should have their maximum load, combusting 64 million m³ of coke oven gas per year (8000 m³ per hour × 8000 hours per year). It will replace the corresponding amount of natural gas from 3 operating boilers (3×25 tons of steam per hour), keeping one of these boilers as a reserve boiler to cover peak loads, and one boiler as an emergency one;
- the increased capacity of "Khimprom" boiler-house allows to cancel steam supply from Novo-Kemerovskaya CHPP, combusting coal and natural gas.
- after realization of the project 100% of "Khimprom" demand in steam will be covered by its own sources, that is 2 boilers combusting coke oven gas (approximately 2/3 of need), the rest part will be covered by gas boilers.

For the project realization investments for the following actions were required:

- mounting of two boilers of 25 tons per hour each for combusting coke oven gas;
- widening of the boiler-house building to mount two new boilers;
- overpass construction with the length of 1,7 km for the coke oven gas pipeline;
- additional water-preparation plant in the new building;
- setting the measuring devices of commerce accounting of coke oven gas, equipment of new boilers with electrical control and instrumentation.

The total amount of investments made 2,7 million dollars.

h) description of technologies, production and also of measures, provided by the project.

The project technology provides generation of steam by industrial boilers, combusting coke oven gas. Under the project of "Khimprom" two new boilers are standard ones intended for combustion of natural gas and oil, marked as DE-25-24-380 GM-O produced by Biysk boiler manufacturer. The only difference is a special type of the burner, adapted for coke oven gas combustion. According to the technical passport, a capacity of the boiler is 25 tons per hour, parameters of steam are 2.3 MPa and 250 (+25/-10)⁰C.

i) phased plan of the project realization including the terms of purchasing and mounting the necessary equipment.

The project realization practically completed in 2008, when the second boiler combusting coke oven gas was started-up and took the operating load.

j) expected revenues from selling of the reduced emission units.

According to recommendations of Sberbank a price for 1 ton of CO₂ reduction shouldn't be less than 10 euro. Therefore, utilization of coke oven gas at the design level and design efficiency of boilers of the JSC "Khimprom" can result in the annual revenue of more than 700 thousands of euros per year for 5 years of the Kyoto Protocol operation. Accepting the post-Kyoto agreement, operation of joint realization projects can be prolonged; accordingly to that selling of the reduced emission units will continue.

Projects of joint realization, approved by the order №326 of the Ministry of Economic Development of Russia dated 23.07.2010 by results of the first competitive selection (extract containing only power engineering projects)

By the order №326 "On approval of the list of projects, realized according to the article 6 of the Kyoto Protocol of the Frame Convention of UN on climate change" of the Ministry of Economic Development of the RF dated 23.07.2010 the first 15 projects of joint realization were approved. Among them there were 3 projects directly relating to power engineering:

- construction of the steam-gas plant of 400 MW at Shaturskaya SDPP;
- efficiency increase of water resource consumption at Bratskaya HPP (replacement of rotor wheels at 6 hydroelectric generators with more efficient ones);
- transfer of two coal-fired boilers of Amurskaya CHPP-1 to natural gas combustion installing ecologically sound equipment.

Among the approved projects there are also 5 of them relating to utilization of the associated oil gas and one project on mine methane utilization.

A list of applications, accepted for the second competitive selection of joint realization projects, and projects approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010 by results of the second competitive selection (extract containing only power engineering projects)

1. Transfer from coal combustion to wood waste combustion in the city of Onega, JSC "Onega-Energy", volume of emission reduction is 788 054 tons of CO₂ equivalent – **ap-**

proved by the order №709 of the Ministry of Economic Development dated 30.12.2010.

2. KronoClimate – replacement of fuel types and waste liquidation monitoring, volume of emission reduction is 2 470 865 tons of CO₂ equivalent.

3. Use of organic waste products from oil-processing production for generation of technological steam and electricity at the JSC “Aston” - 229 827 tons of CO₂ equivalent.

4. Accumulation and utilization of waste gas at the solid municipal waste landfill “Shirokorechenskiy”, Yekaterinburg, RF - 958 868 tons of CO₂ equivalent – **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

5. Construction of steam-gas plant (SGP) of 410 MW at Nevinnomysskaya SDPP - 1 296 735 tons of CO₂ equivalent.

6. Construction of steam-gas unit of 410 MW at Sredneuralskaya SDPP - 1 322 177 tons of CO₂ equivalent.

7. Use of waste coke oven gas in the JSC “Khimprom” - 354 055 tons of CO₂ equivalent.

8. Construction of gas-turbine TPP “Kozhuhovo”, Moscow, RF - 809 849 tons of CO₂ equivalent.

9. Construction of gas-turbine TPP “Tereshkovo”, Moscow, RF - 627 472 tons of CO₂ equivalent.

10. Reconstruction of the central heating station (CHS) in the city of Strezhevoy, Tomsk Region, West Siberia - 69 698 tons of CO₂ equivalent.

11. Utilization of bark-wood wastes from power generation at the Closed JSC “Lesozavod-25”, Archangelsk - 215 362 tons of CO₂ equivalent – **approved by the order №709 of the Ministry of Economic Development dated 30.12.2010.**

12. Construction of steam-gas plant of 400 MW at Yayvinskaya SDPP, WGC-4, Perm Region, Russia - 924 364 tons of CO₂ equivalent.

13. Construction of steam-gas plant of 400 MW at Surgutskaya SDPP-2 WGC-4, Tumen Region, Russia - 2 344 040 tons of CO₂ equivalent.

14. Reduction of flaring the associated oil gas and electricity generation at Khasyreykskoe oil field - 711 277 tons of CO₂ equivalent.

15. Construction of Kurganskaya CHPP-2 - 849 422 tons of CO₂ equivalent.

16. Utilization of bark-wood wastes for thermal energy generation at the JSC “Novovyatskiy ski works” - 172 705 tons of CO₂ equivalent.

17. Utilization of bark-wood wastes in the branch of the JSC “Ilim Group” in Ust-Ilimsk - 612 590 tons of CO₂ equivalent – **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

18. Use of wood wastes for heating supply of Severonezhsk settlement of Archangelsk Region - 130 277 tons of CO₂ equivalent - **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

19. Utilization of biomass wastes at the JSC “Archangelsk Pulp and Paper Mill” - 1 021 452 tons of CO₂ equivalent.

20. Technical re-equipping of Tumenskaya CHPP-1 due to start-up of steam-gas plant - 997 625 tons of CO₂ equivalent – **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

21. Reduction of flaring the associated oil gas and electricity generation at Yuzhno-Khylchuyskoe field, Nenets Federal District, RF - 1 000 000 tons of CO₂ equivalent.

22. Complex project on fuel replacement and power efficiency increase in Priozersk city, Russia - 100 000 tons of CO₂ equivalent – **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

23. Retrofitting of HPP of “Nevskiy” branch - 659 914 tons of CO₂ equivalent. Extension of Yuzhnaya TPP–22 in Saint-Petersburg. Construction of the unit № 4 - 1 603 439 tons of CO₂ equivalent – **approved by the order № 709 of the Ministry of Economic Development dated 30.12.2010.**

24. Retrofitting of Pervomayskaya CHPP–14 with installation of combined cycle power units - 986 501 tons of CO₂ equivalent.

Technologies/projects on increase in power efficiency and energy saving introduced in joint implementation projects in power engineering

As of November, 2010

Technology/project	Information of technologies appliance in joint realization projects (JRP)
Construction of new high-performance power units at TPPs (using gas turbines and steam-gas plants - SGP in most cases)	Construction of SGP-400 at Shaturskaya SDPP of WGC-4, approved by the Ministry of Economic Development by the order №326 dated 23.07.2010. Production and technical documents were designed for the projects relating to SGPs and gas turbines at Sredneuralskaya SDPP, Nevinnomyskaya SDPP, Yayvinskaya SDPP, Surgutskaya SDPP-2, Tumenskaya CHPP-1, Yuzhnaya CHPP-2, (S-Petersburg), CHPP "Luch", Mednogorskaya CHPP, Permskaya CHPP-3, gas-turbine TPP "Kozhuhovo, Tereshkovo" and at a number of other power plants
Technology/project	Information on application of technologies in joint realization projects (JRP)
Retrofit/modernization of TPPs/HPPs/boiler-houses increasing their efficiency	Increase in water consumption efficiency at Bratskaya HPP (replacement of turbine wheels at six hydroelectric generators by more efficient ones), approved by the Ministry of Economic Development by the order №326 dated 23.07.2010. Production and technical documents were designed for the projects on retrofitting of boiler-houses in Taganrog, Murmansk, retrofitting of steam turbines at Konakovskaya SDPP
Use of wood wastes, pellets, straw, husk and other similar wastes as a fuel	Production and technical documents for the projects on usage of wood waste and/or biomass at Archangelsk, Senezh Pulp and Paper Mills, in Onega city, at the JSC "Aston", closed JSC "Lesozavod", JSC "Novovyatskiy ski works", etc.
Utilization of mine methane for energy generation	Utilization of decontamination methane in mines of the JSC "SUEK – Kuzbass", approved by the Ministry of Economic Development by the order №326 dated 23.07.2010
Utilization of bio-gas at solid municipal waste sites. (Note: technology should be accompanied by beneficial use of bio-gas, but not by its flaring)	Production and technical documents were designed for the projects on methane accumulation at solid municipal waste sites in Khmetyevo, Dmitrov, Timokhovo of the Moscow Region and in Yekaterinburg, but without beneficial bio-gas utilization for today
Use of the associated oil, coke oven and other waste gases as a fuel	Joint implementation project on utilization of the associated oil gas at Samotlorskoe, Ety-purovskoe, Komsomolskoe, Vostochno-perevalnoe, Sredne-Khulymskoe fields, approved by the Ministry of Economic Development by the order №326 dated 23.07.2010. The projects "Use of waste coke oven gas in the JSC "Khimprom" (Kemerovo), use of the associated oil gas at Yarakinskoe, Serginskoe and other fields were developed and taken to approval
Transfer of coal-fired/oil-fired boilers to natural gas combustion	Joint implementation project "Transfer of two coal-fired boilers of Amurskaya CHPP-1 to natural gas combustion with installation of ecologically sound equipment" is approved by the Ministry of Economic Development by the order №326 dated 23.07.2010. Production and technical documents were developed for the project on gas transfer at Khabarovskaya CHPP-1.
All types of renewable sources (wind, solar, geothermal, hydropower, including small HPPs, biofuel, etc.)	Joint implementation project concepts were developed for the projects on construction of Mutnovskaya GeoTPP, heat supply of Elizovo city using geothermal sources, construction of the sea-based wind power station of 50 MW in Kaliningrad Region, retrofitting of Pravdinskaya mini-HPP in Kaliningrad Region, etc.
Replacement of the worn-out pipes of heating systems by high-performance ones, installation/reconstruction of heat stations, measures for scale prevention in water-heating boilers	Production and technical documents, and/or joint implementation project concept were designed for the projects on modernization of heat supply systems in Mytishchi, Kazan, Taganrog, Novgorod and Strezhevoy cities.
Introduction of frequency drive	Production and technical documents, and/or joint implementation project concept were designed for the projects for Konakovskaya SDPP (blow fan frequency drive of power unit of 300 MW), heat supply enterprise in Taganrog, pump stations of Perm water canal.
Reconstruction/replacement of inefficient water-heating boilers by the modern ones	Production and technical documents, and/or joint implementation project concept were designed for the projects for heat supply enterprises in Mytishchi, Kazan, Taganrog, Murmansk.
Reconstruction of heat supply systems applying more effective sources (for example, CHPP) instead of the outdate boiler-houses	Joint implementation project concept was designed for the project on modernization of heat supply system in Novgorod
Reconstruction of hydroelectric generators/replacement of turbine wheels at HPP by more efficient ones	Joint implementation project "Increase in water consumption efficiency at Bratskaya HPP (replacement of turbine wheels at six hydroelectric generators by more effective ones)", approved by the Ministry of Economic Development by the order №326 dated 23.07.2010. Joint implementation project concept was designed for HPPs of Verhnevolzhsky Cascade

Manure treatment and use of the generated bio gas at mini-CHPPs. Use of broiler plant wastes as a fuel	Companies of Sverdlovsk Region consider proposals on introduction of Joint implementation projects for cowsheds of 10 thousands cattle heads. Production and technical documents were developed for the typical project
Treatment of organic wastes from purification plants, utilization of the generated bio gas at mini-CHPPs or boiler-houses	Joint implementation project concept was designed for the projects on waste utilization at Kuryanovo aeration station, bio gas generation and of its utilization at mini-CHPP
Creation of turbo-expanders, using excess pressure of natural gas for power generation at the TPP input	Joint implementation project concept was designed, production and technical documents were developed for the project "Creation of turbo-expander plant of 5 MW at Konakovskaya SDPP"

Notes:

1. Documentation for the joint implementation project is developed using the approved international methodologies published at the site: www.unfccc.int/methodologies. Totally there are 100 methodologies for different technologies and types of projects.

2. The present list does not claim to be exhaustive relating to measures/projects in the field of increase in power efficiency and energy saving in power industry.

Technologies on CO₂ recovery and burial of flue gases, being under development and pilot testing

Technologies connected with CO₂ recovery, flue gas burial can be called-for in the Russian Federation only after economically sound measures on increase in power efficiency and energy saving, having in our country a strong potential, are coming to an end. The basic reason of it is that these new technologies significantly improve technical and economic indices of TPPs and raise the cost price of energy generation.

Capital expenses can grow by 20-30%, the finished price of electricity - by 30-40%.

Nevertheless, in the developed countries, where power efficiency potential is used to a considerable degree, new technologies on CO₂ recovery and burial of flue gases are being developed and tested at a growing rate. Investigations, developments and creation of demonstration plants are being conducted under directions and programs, information of which is given below (data of All-Russia Thermal Power Institute, June, 2009).

EU programs on recovery and burial of CO₂

Acronym	Tasks of the projects	EU financing, Million euro	Duration, month	Start	Number of partners	Number of countries-members
CO2SINK	Investigation of possibilities of CO ₂ geological burial	8,7	60	1/4/04	18	8
ENCAP	Improvement of CO ₂ removal technologies before fuel combustion	10,7	60	1/3/04	33	9
CASTOR	Recovery of CO ₂ from flue gases; provision of reliable and safe burial	8,5	48	1/2/04	30	12
CO2GEONET	Investigation of possibilities of CO ₂ geological burial in Europe	6,0	60	1/4/04	13	7
ISCC	Designing of new technologies on CO ₂ removal directly at solid fuel gasification	1,9	36	1/1/04	14	7

By results of fulfillment of the mentioned and other programs, by 2015 EU plans to start-up operation of 12 demonstrative units

Works in the U.S. and Canada

In the U.S.:

- Presidential initiative "clean coal" (2 billion US \$ per 10 years since 2002)
- Project FutureGen (\$1,5 billion)
- Project SECARB – burial in geological rocks – up to 1,5 million tons of CO₂ a year
- Ministry of Energy of the U.S. finances 90 projects (as of March, 2007), particularly stand and laboratory works on creation of new absorbents, membranes, combustion in the CO₂/O₂ environment and new methods of recovery
- At present the projects of demonstration units for a sum of more than 4 billion US \$ are under realization stage
- Projects of private firms

In Canada:

- Project Wayburn, 1,5 million tons of CO₂ a year for oil recovery increase (\$1,1 billion);
- In Alberth province the largest project ASAP is being realized. At the starting stage 1000 tons per day and after 2015 up to 10 thousand tons per day will be dumped to the layers with salted water;
- 48 projects, connected with recovery and burial, are being realized.

Since 2012 Canada is intended to equip all new coal-fired power plants with installations of CO₂ recovery.

Totally in 10 countries, including Australia and China, more than 70 pilot and demonstration projects on CO₂ recovery and burial are under realization or planned at their implementation presently. Cost of the largest one is 4,9 billion US \$ (Australia: generation of synthetic fluid from coal, 15 million tons of CO₂ a year, a beginning of the first stage is in 2011).

Some examples of developing technologies on recovery and burial of CO₂.

Ecologically sound coal-fired TPP



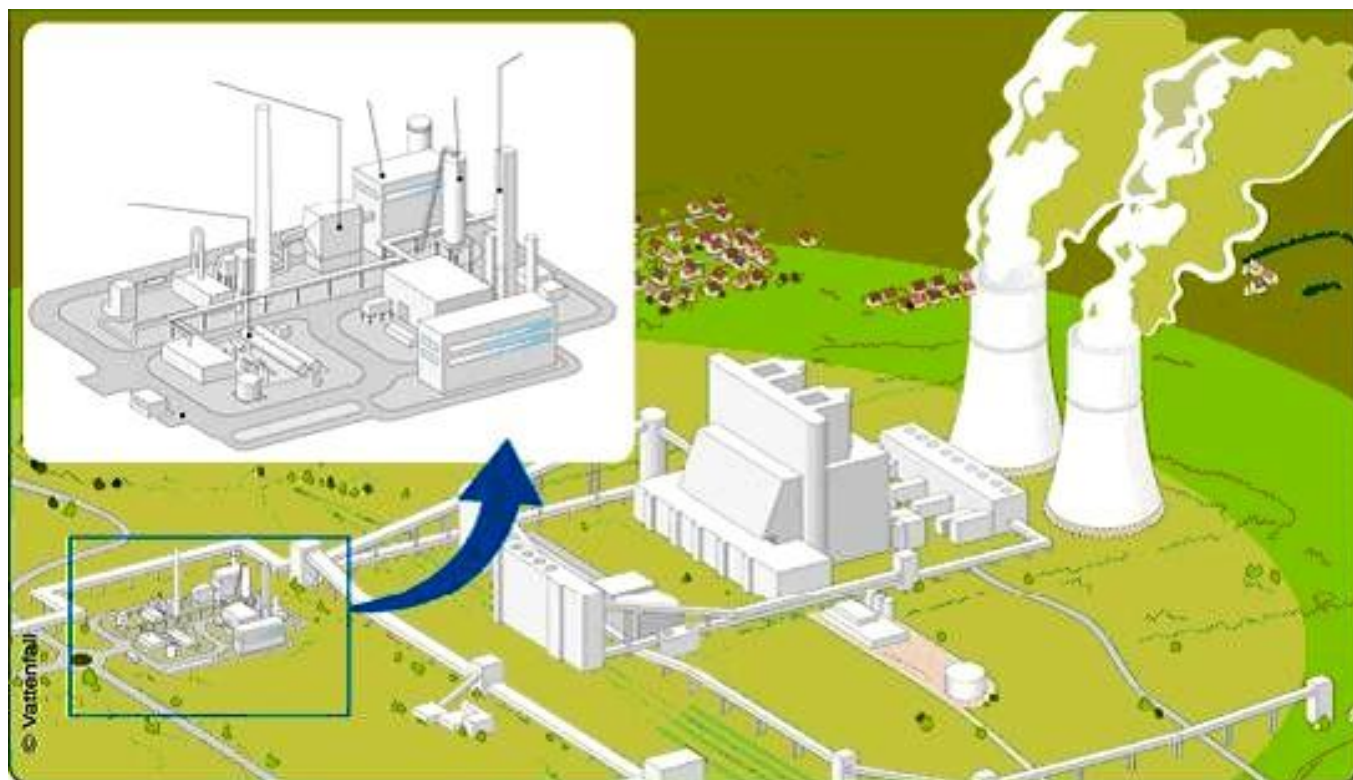
Public and private partnership of U.S. Ministry of Energy with industrial alliance FutureGen (12 companies). Cost of the project makes 1,5 billion US \$. The share of U.S. Ministry of Energy is 74%. Conduction of researchers means simultaneous electricity generation at the unit of nominal capacity of 275 MW - at the base technological line at recovery of more than 1 million ton of CO₂ a year. In addition, these new technologies are planned for investigation at bypasses of the total capacity up to 20 MW at the capacity of separate bypasses of 1-5MW.

RWE pilot plant for recovery of CO₂ from flue gases (in cooperation with BASF and Linde)



- Location – HPP Nideraussem
- Flue gas volume 1500 m³/h,
- 300 kg/h of CO₂, recovery of 90%
- Height - 40 m
- Operation – since the beginning of 2009. Testing duration is 18 months.
- Capital expenses –9 million €.
- By results of tests in 2010 the decision was made to create by 2016 a full-scale plant as a prototype for modernization of the operating TPPs.

Combustion in the oxygen environment



Pilot installation of Vattenfall of 30MW at TPP Schwarze Pumpe (brown coal)
Put into operation in September, 2008. Output of CO₂ is 10 t/h. Cost - more than 100 million US \$. Purpose of the project is investigating a concept of the unit of 250-350 MW for its construction in 2015-2020.

RWE project: steam-gas plant with inner-cycle gasification combusting brown coal (2014)



Capacity of the unit – 450 MW (net capacity of 330 MW). Efficiency factor - 35%, including transport and burial of CO₂. Volume of CO₂ – 2,6 million tons a year. Capital expenses - 1,7 billion € (2007), including transport and burial of CO₂.