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Societatea CET Govora S.A.
Râmnicu Vâlcea, str. Industriilor, nr. 1, cod postal 240050, C.I.F. RO10102377
Tel: +40250733601, +40250733602, Fax: +40250733603, Web: www.cetgovora.ro
Cont RO93 BUCU 1781 2159 4854 5RON Alpha Bank Sucursala Rm. Vâlcea
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Proiect CDI- innovation: „Innovation technology for the conservation of ENERGY at coal power plants - NOVENER"

SCIENTIFIC AND TECHNICAL REPORT

Monitoring stage no. 6 / 15th nov. 2016 – 15th nov. 2017

Contents

1. General presentation of the technological innovation achieved within the project NOVENER

CET Govora is an cogeneration plant that generate thermal energy as industrial steam and hot water for district heating of the municipality of Ramnicu Valcea and use as row material the lignite coal from Oltenia coal basin.

CET Govora operates three coal boilers, each having the 294 MW rated power and use annualy 2.0 - 2.2 millione tonnes of coal.

During the analyzed period (Nov. 2016-Oct. 2017) the total coal consumption was 2,011,941 tonnes.

The solig waste resulted from the coal burning are:

- bottom ash, or SLAG;
- fly ash;
- synthetic gypsum – product of chimical reaction in the FGD.

Bottom ash (SLAG) is a coarse solid waste resulting from the coal-firing process on the post grate from the base of the boilers. At the bottom side of the boilers the slag flows into the incandescent state and is colected with a hope filled with water placed under the furnace and evacuated by means of scraper chain conveyor belt (Kratzer). The design of the bilers provides that the bottom ash to be crashed before discharge into the ash evacuation channels and mixed with water in order to be pomped to the deposit.

There are several solid waste disposal systems in operation at CET Govora:

- Wet discharge of bottom ash and fly ash by pumping as slam (pumps Bagger) and disposal into the ash deposit;
- Drying of fly ash in dry silos - ash for delivery as construction material;
- Transport of synthetic gypsum in wet stage by trucks for disposal into the ash deposit.

By the designed ash evacuating system of the solid waste resulted from coal burning, the bottom ash with unburned coal particles is evacuated in the ash deposit.

The bottom ash contains combustible materials due to mechanical and chemical incomplete combustion. It is estimated that the total undurned coal mixed with slag is abot 3 % from the entired coal quantity used by the boilers.

The recovery of the combustible materials from the slag and recycling will reduce the amount of coal used and it represents an important result of increasing the thermal efficiency of any lignite power plant.

There are techologies of post-combustion systems that can achieve the burning of combustible materials contents in bottom bottom ash, but these technologies can be applied with significant costs only to newly designed or re-designed.

The NOVENER project has, at minimal cost, carried out a process for the recovery of unburned combustible materials from the slag. It was applied to two coal boilers (boilers C5 snd C6) by installing a recovery installations with a temporary bottom ash storage bins. A new conveyor belt doze the bottom ash as "Solid alternative fuel" to the coal feeding conveyors of the boilers. Prior to the NOVENER project, a similar installation was carried out at the third coal-fired (C7) coal boiler at CET Govora.

Because the bottom ash is recovery from the water it must disposal for minimum 12 hours on a paltform in order to decrease the wett contents before mixed with coal on the conveyor belts. Operating of the bottom ash recovery system is done under the internal procedure:

- Operational procedure second edition - **PO 072-2 -** „ Use of lignite mixed with solid alternative fuels to CET Govora",
- Internal technical instruction - **ITI-03-DEZ -** "Collection, transport and energy recovery of bottom ash".

1.1 The bottom ash recovery equipment

The bottom ash recovery is downstream to the Kratzer scraper chain conveyors before discharging into the ash technological channel by means of a conveyor belt installed in place of the slag crusher.

In case of unavailability of the bottom ash belt recovery it can be use as by-pass system the second slag crasher that in order to evacuate the bottom ash to the ash channel.

Directing the bottom ash to the conveyor belt or to the by-pass is done by the manual guiding flap.

The transportation of the recovery bottom ash to the alternative fuel deposit is done by trucks.

1.2 The platform for bottom ash deposit

The storage of bottom ash is done on the concrete platform placed close to the dosing equipment in order to avoid the expensive handling. The platform is provided with a drainage system in order to decrease de water content of the bottom ash. The supply of the bottom ash into the dozer is done by means of the wheel frontal loader.

The biomass or other solid alternative fuels can also be received on the concrete platform and mix with the bottom ash.

1.3 Alternative fuels dosing equipment

The dosing of the bottom ash or mixture of bottom ash with biomass or another type of solid alternative fuel is controlled on one of the two running coal feed conveyors 7A or 7B of the boilers.

The dosing equipment is composing of:

- Feed hopper;
- Conveyor belt;
- Flow control discharger of the bulk material.

The feed hopper is located on the ground and is provided with an extractor with two conveyor augers wich disharges the bottom ash to the conveyor that feed the dozer silo wich have a flow control discharger of the bulk to the running lignite supply conveyor of the boilers.

The mixet fuel of bottom ash and biomass from the silo is dosed on one of running boiler coal supply conveyor belt 7A or 7B.

Both supply belts 7A and 7B and the dosing device belt have weighting control in order to establish different ratio of alternativ fuel mixed with coal, from 3% to maximum 10%.

1.4 Tests

The alternative fuel mix initially proposed for the project was 50% bottom ash and 50% wood biomass. In period 2016 – 2017 of operation it was dosing only bottom ash, without biomass on the coal and it has been shown that the bottom ash can be recovered and recycled in boiler furnace only mixed with lignite. Lignite is a low-energy, low calorific power charcoal, but because of "the age" it have a high volatile content and the mixing with the bottom ash, without the volatile content, in maximum ratio of 10% it isn't influences significantly the ignition point of tne mixt fuel. The only downside to the original project: in the absence of biomass use it is impossible to achieve and report the reduction of greenhouse gas emissions - CO_2 - as a result of the introduction of renewable fuel into the power balance of the power plant.

For the qualitative monitoring of the bottom ash, it is tested samples of bottom ash taken regularly, respectively sample for the burning of 20,000 tonne of lignite and are analyzed in an accredited laboratory in order to determine the calorific value and its physical and chemical quality:

- Ash content;
- Wather content;

1.5 The innovative character of the project:

The innovative character is found in two components of the project:

A. Execution of unique type subassemblies based on the design theme and the resulting specification of the research activity;
B. Definition of alternative fuel and dosing recipe built on nomograms;
C. The solid alternative fuel assembler, the subassembly created during the project run phase, has a dual role during the CET Govora CDI's operating period:
    - the process of bottom ash recovery and reuse in the fuel supply system of the boiler which is the main issue of the project;
    - experimentally research of use new alternative fuels in coal co-burning deschibe in within of the document.

1.6 Project results

The results obtained at the end of the project are as follows:

A. Subansamble prototype for bottom ash recovery and dosing alternative fuel are compatible with the existing thermo – mechanic equipment, automated, local and remote commanded are operated by the existing staf (no any new job was created).

1.7 Equipment/subansamble prototip description

A.1. Bottom ash recovery equipment on the boilers C5 and C6

The bottom ash recovery equipment from the boilers C5 and C6 ensure the taken up and loaded of the bottom ash in a temporary storage silo. Unloading of the bunkers in truks is carried out by means of two pneumatically driven slaves with electrical control. The bottom ash is transported to the concrete platform close to the dosing device and the lignite deposit.

The bottom ash conveyors from the boilers C5 and C6 ensure the recovery of the wet bottom ash after burning of the coal in the furnaces and delivery it into the temporary silo. In order to recovery the bottom ash it was necesary an adjustment of the existing slag evacuation. The conveyor belt of the recovery system is type CHEVRON Rl 5/436, provided with scraping on the active face of the belt, powered by a electrical engine with gearbox.

The bottom ash conveyor characteristics:

- Lenght: 14,200 mm;
- Size of the stretch stroke: + 400 mm/ -400 mm – in total 800 mm;
- Level difference (high): 6,000 mm;
- Maximum flow: 10 t/h;
- Conveyed material (transportat): wet bottom ash (bulk material), density > 2,6 kg/dm^3.

Supporting the conveyor belt is done roll bars and roller bearings. The roll bars are fixed on the floor of the room pe podeaua incintei si pe stâlpii din construcţia existenta la cazanelor C5 si C6.

Supporting the conveyor are placed on the floor lateral side of the underground ash colector channel in order to not block the acces to the covers of the channel and to ensure the way of crossing.

The temporary silos are placed at hight, on the existing metalic vertical supporting pillars, the bottom side is 3,600 mm above the road.

The silos have a tonconic base with a knife gate valve. Actuatot of the valve is pmeumati air from the existing systemof the power plant.

On the lateral tronconic walls of each silo are mounted two electrical vibratory in order to detach the sticky bottom ash from the walls and unload the material on the trucks.

The discharge of the bottom ash into tracks is done regularly at a set interval decided by the chief foreman depending on boiler operation. Ordinary, the transportation is hourly, and the weight of one transport is about 5 t.

Each bottom ash recovery facility has its own automation system that ensures:

- variable speed of the belt;
- remote control of the unloading;
- remote control of the walls vibrator.

A.2. Equipment for dosing fuel

The installation was placed at an angle of 10 degree to the perpendicular to the belts 7A and 7B axis in order to ensure the space need for operating, maintenance, and unaffect the existing equipment. The dosing equipment ensures mixing of the alternative fuel (bottom ash + biomass) on the one of the running coal supply belt conveyors. This action is done in order to complet burning of the carbone undurnet evacuated in the slag.

Alternative fuel composed of bottom ash and biomass is obtained to the required proportion on the platform and is feed to the silo of the dosing device by the frontal wheel loaders.

The alternative fuel dosing device includes: the silo with the feeding hope, scrubber extractor and inclined conveyor belt.

The feedin hope has a tronconic shape base made from metalic sheets reinforced outside by steel profiles. On the bottom side there are four wheight sensors on the corners and the extracting scrubbers that move on the opposite directions at normal operation. Between silo and scrubber there is a free space in order to avoid influences of the vibration to the weight sensors.

Above the hope there is a frame made of HEA 100 profile to protect the equipment to the accidental contact of the weel load machine that can disregulate the weight sensors. The silo has on side a switchgear support for stability. On thew left side, under the silo it is placed the the electrical drive assembly and the drive roll of the dosing conveyor. Over the drive roll there is the screew conveyor which transfers the material to the conveyor belt.

Above screew conveyor there are three manual slide gates that allow adjustment of fuel flow from the silo to the screew extractor.

The two screews extractor have variable speed and movement in oposit direction, in order to ensure a steady layer of material on the dosing conveyor. Both screews extractor are independent movement one to another, as they can move in one or other direction in order to breack/separate the material to the walls of the silo. Screews extractor are running by a electrical engine – gearbox.

The belt conveyor of the dosing device ensures the flow of the alternative fuel related with the coal (lignite) flow done by the boilers supply conveyor belts 7A or 7B. For control of the flow, the automatisation of the dosing device controls the speed of the conveyor belt and the flow of the extracted material by the screews.

The conveyor belt of the dosing device is suported by a metalic frame and is inclined 18 degrees related to the horisonta.

The conveyor belt is in a enclosed space, sized walls are made from corrugated sheets and roof is made from sandwich panels with insulation placed on metalic frame. Sized walls have windows and door. Inside the belt room it is lighting as safety for a beter visibility of the moving equipment.

The conveyor belt is rigidly constructed and comprises drive head and track elements supporting the upper and lower roller bearings and at the top the discharge head comprises screws and belt tensioning mechanism which are disposed in the discharge hopper area. Under the spill bunker there is the switching flap in the half-moon placed in a casing, and underneath it is the "trouser" bunker which assures the spill on one of the conveyor belts 7A or 7B. The assembly consisting of the spill bunker, the half-hopper and the hopper is supported by a support skeleton that rests on the conveyor belts of the belt conveyors 7A and 7B.

The belt conveyor has the following features:

- Lenght of the conveyor belt: 18,500 mm;
- Size of the stretch stroke: + 500 mm/ -500 mm – in total 1000 mm;
- Level difference between drive drum axes: 6,000 mm;
- Level difference on extending +100 mm/- 100 mm- in total 200 mm

The main components of the belt conveyor are as follows: The drive drum and 12 upper rolls, 5 lower rolls, and the belt.

The drive of the conveyor is done by an electrical engine of 18.5 kW through a gearbox in three stages that include the break system, cooling fan, and frecvence variable speed that ensure operation of the engine at any desired rotation from minimum to maximum.

The frame of the dosing device includes:

- Longitudinal support over the entire length of the belt, made from steel profile UNP

- Support legs;
- Longitudinal longeron made from steel profile UNP 100 , 3 sections;
- Superior conveyor supports;

The load to the conveyor belt is controled by the weight by meand of electronic dosing system, which compares the coal quantity from the belts 7A or 7B (the working one) with the alternative fuel from the alternative fuel belt.

Driving the alternative fuel on the conveyor belt 7A or 7B is from the silo by means of a diverter.

The diverter is composed of:

- The sustaining frame placed on the concrete beams of conveyor 7A and 7B that fixes: capul the unloading drum of the conveyor, silo and diverter floap mechanism and its auctuator, walls and the walkway for maintenance acces. Strenght of the supporting frame is only outside because the existing conveyors 7A and 7B not allow placed it inside.
- Roof and floor with walkway for access to the equipments of diverter. The bottom side of it is at level +4,400 mm above the ground, overt the coal supply conveyors 7A and 7B. It have walkway around the silo and a platforme for sustaining of the driving mechanism of the reversing flap. The lateral walls are made from corrugated steel sheet with two windows.
- Tail pulley with silo that is into an enclosed chamber placed on the frame of the conveyor belt. The bottom side of it is placed on sustaining frame of the silo. Its components are: upper case, lower case, takes up weight.
- Silo with reversing flap which directs the material to the one of working coal supply conveyor 7A or 7B. There are maintenance visit hole on the walls of the silo.
- Flexible unloading trough that place the material on the conveyor belt 7A or 7B.
- Drive of reversing flap compused from electrical engine and gear reduction box and the actuator.

1.8 Definition and realization of an alternative combustible based on bottom ash.

Co-firing processes are assimilated to the best available techniques under certain conditions. In our case the quantity of co-fired fuel must not exceed 10% from the quantity of main fuel. It is also necessary that the proposed alternative fuel used to have similar properties with the main fuel. In our case it was chosen to mix bottom ash with biomass in order to improve two parameters: humidity and the volatile content. From the different experiences made with the bottom ash there is necesary for about 24 hours to stay on the deposit platform in order to loose the exces water. Because the volatile content of the bottom ash is very low, 40-50% biomass with high volatile content is add in order to obtain an alternative fuel similar with the main fuel coal (lignite). Because the dosing is made related to volume, the following are the mix of bottom ash with biomass graph on three scenaries: Interval 0-24 h; Interval 24- 48 h; Interval >48 h.

Chapter 4.4 graph show the dosing values of bottom ash / biomass, related to the time of keeping the bottom ash for drainage on the platform, implicitly absorption moisture reducing from maximum 60% to 30% in interval of 0- to 48+ hours, both sequential and general.

As it results from the description, slag extrusion systems and alternative fuel dosing ensure the functionality of the project idea as defined in the feasibility study.

2. NOVENER project and CDI activity in year 2 of operation / monitoring

2.1 CDI activity within CET Govora - Insolvency Company

On 9 May 2016 SC CET Govora SA entered the insolvency procedure and during this period several stages of company reorganization were carried out.

During the project monitoring period, decisions were taken to appoint a new management team for the project "Innovative technology for the conservation of energy in coal-fired power plants - NOVENER":

1) Decision 1327 / 31.10.2016 appointing the NOVENER Project Director of ing. Stoian Ion
2) Decision 1328 / 31.10.2016 appointing the management team of the NOVENER project consisting of:
   - Stoian Ion, inginer, Project Director;
   - Stefanoiu Felicia, Accounting Department
   - Udubasa Nicolae, IT Departament;
   - Vatafu Razvan, inginer, Boilers operation Departament;
   - Paraschiv Gheorghe, Coal preparation Department;
   - Neciu Daniela, Chemnical Department.

   observation. Mihaileanu Olivian, engineer, cheff of the Production Department died during 2017;

As we notified by the Address 33810/148.10.2017, following the internal reorganization of the company CET Govora SA, it was appointed, by Decision 738 / 06.10.2017, the new executive management of the company beginning from 06.10.2017, consisting of:

1. Juridical Administrator: EURO Insol SPRL, represented by av. Alexandru SCARLAT;
2. Special Administrator: av. Dinu CONSTANTINESCU; designated by the Decision No. 250 / 30.10.2017 of the Valcea County Council.
3. Production Manager and Interim General Manager eng. Ion ROESCU;
4. Financial Manager: ec. Constantin LAPADAT;

We mention that the change of management does't affect the purpose and objectives of the NOVENER project, the result indicators, the maximum amount of the non-reimbursable financing provided by the contract, or the assessment factors that are mandatory. Thus CET Govora SA meets the mandatory results from the contract 2DPST/20.08.2013 during monitoring period, including the commitment in annex 6.8 on ensuring the fiunds need of project during the monitoring period. Actual Executive Management supports the continued RDI activity in the field of alternative fuels, as reflected in the opportunity study currently underway and presented earlier in chapter 2.1.

2.2 Continue research for energy recovery of solid waste and use of alternative fuel

Raising non-reimbursable funds for Research, Development and Innovation in insolvency period have suplementary restrictions.

The company 's administrators have allowed from the company' s own funds the sum of 15,000 lei without VAT for financing a RDI project, based on the experience of current knowledge of NOVENER, for an Oportunity Study of **"Use of solid waste – alternative fuels – for co-burning with the coal at CET Govora"** which will be done in collaboration with Institutul National de Cercetare-Dezvoltare pentru Tehnologii Criogenice si Izotopice (the National Research and Development Lab for Cryogenic and Isotopic Technologies) – ICSI Ramnicu Valcea – Resarche – Development and Technology Transfer Department.

We quote the First Report of the Opportunity Study:

"First Report – Information on Solid Fuels Available. Analysis of the alternatives for the conversion of waste / solids with caloric content into alternative fuel for CET Govora.

1. Introduction

In recent years, population growth, urbanization, and accelerated industrialization which increased exponentially had as a consequence increasing the amount of waste. An essential element of the European Union's sustainable development policy is the efficient exploitation of alternative and renewable energy resources. Continued growth in energy demand necessitates the need to find viable alternatives for replacing / completing conventional sources (eg coal, oil or natural gas) by using locally available raw materials with energy potential and low negative environmental impacts.

The sustainability of the study is based on the need to create energy-efficient, innovative, relatively cheap products with a low CO_2 footprint and the availability of local alternative sources exploitable for the development of new alternative fuels. By the adopted solution of the use of raw materials - waste - with local traceability, it is possible to achieve low costs for the final product.

Through local traceability of raw materials used in this study, he explains the term waste as follows:

- *sewage sludge from wastewater treatment plants in Valcea County (and beyond), eg. SC Apavil SA;*
- *biomass of the type of sawdust / wood chips, but also from tree trimming, branches, vegetal remains, straw, saplings, shells, etc .; dedicated energy crops (willow, pawlonia) - in collaboration with local authorities through sanitation companies - ADI Salubrizare Valcea, Mayoralties - Ramnicu Valcea; Calimanesti; Govora; Dragasani; Olanesti, Valcea County Council and private canning companies - ex. SC Annabella SRL, ex. Fravil;*
- *animal waste - MBM[1]- and the flour of bones and flesh - **ex. SC Diana SRL; ex. SC La Provincia SRL (Avicola Babeni)***
- *bottom ash from lignite burning - the continuation of existing research to **CET Govora.***

[1] Meat and bone meal

The management of thermal / electric power plants based on solid fuel, especially coal has in recent years increasingly focused on the use of biomass and / or combustible waste as renewable energy sources, this being mainly dictated by: rising global fossil fuel prices - fossil fuel market, transport costs, labor costs, tense geopolitical contest, etc;

- *cresterea emisiilor de gaze cu efect de seră şi de preocupările pentru reducerea acestora.*
- *combustion and / or co-combustion of these materials is of particular interest, mainly due to:*
    - *of their flexibility;*
    - *high combustion efficiency through heat transfer;*
    - *low NO_x , SO_x emissionsand neutral CO_2.*

2. State brief presentation of scientific research and representative bibliography

In European countries, combustion and co-combustion of biomass and waste with coal in power or thermal power plants are expected to be widely applied in the near future. In Europe, but also in Japan and the USA, several types of additional / alternative fuels are tested to find out their combustion behavior in different combustion systems together with regular coal and lignite combustion fuels. Research was performed on a laboratory scale as basic research but also on pilot scale combustion plants. To obtain information on the destruction and formation of hazardous substances, multiple variations of combustion parameters have been applied in conditions such as those in industrial furnaces. Transforming energy from fossil fuels into heat and electricity necessarily involves the emission of CO_2, known as greenhouse gas. The intention to reduce the amount emitted in the atmosphere leads, first of all, to the reduction of energy consumption. An alternative would be the formation of a hybrid fuel such as biomass + coal ***[1]****. By effectively researching the technology of manufacturing and using solid fuel from sludge, they were dried and created fuel by anthracite combustion, and pyrolysis was used as the combustion method. In Japan there is a case of sewage sludge mixing with more than 4,000 kcal / kg, which is dried by spontaneous heat and used as fuel in the cement industry. In Europe, dry and combined sludge is used after pelletisation. There is an example of combining transformer oils and transforming sludge into fuel as "slurry". In this study, residual oils were used to dry sewage sludge. Over the slurry treatment sludge, the oil component of the waste oils will be added to allow the production of a high quality solid fuel which represents a process of using waste water and waste oils in the most environmentally friendly and economical solutions* ***[2]****. In recent years, rapid population growth, urbanization and industrialization have caused a significant increase in sewage sludge. Therefore, the development of new methods for the use of sewage sludge is an urgent matter to be solved. The most common discharge of sewage sludge is storage in landfills, agricultural applications and incineration. Sewage sludge can be treated as a potential energy resource, despite the fact that it contains a high level of pollutants. Nowadays, European legislation on treatment of sewage sludge has become very restrictive in imposing the rapid development of thermal methods for the use of sewage sludge. There are several thermal technologies for the use of municipal sewage sludge to obtain useful energy forms through proper pre-treatment. A promising option is the hydrothermal carbonation process, which is an effective way to densify the energy content of sewage sludge without the pre-drying process [3].* ***Bone meal and mechanically boned meat*** *(MBM) is a CO2-neutral fuel and is therefore a good candidate for the replacement of fossil fuels, such as pulverized coal, in rotary kiln burners used in cement kilns. MBM is used in several cement plants, but the* *optimal rate of substitution does not appear to have yet been fully investigated. A large-scale experiment was carried out in the rotary furnace of a cement plant by varying the MBM rate of substitution from 0 to 7 t / h. The clinker quality, emissions and other relevant operational data in the experiment were analyzed. Addition, coal and MBM were compared by laboratory experiments. The results showed that MBM could safely replace more than 40% of coal energy without giving any negative effects. The limiting factor is the free clinker content of the clinker. Possible explanations are given for the free growth of lime. If 40% of coal in the rotary kiln burner was replaced by long-term MBM, the total CO_2 emissions of the plant could be reduced by 10%* ***[4].***

3. Bibliography

[1]*Fuel characteristics of sewage sludge and other combustion process with coal supplemental fuels regarding their effect on the co-combustion process with coal Th. Gerhardt, R. Cenni, V. Siegle, H. Spliethoff, K.R.G. Hein University of Stuttgart, IVD, Pfaffenwaldring 23, 70569 Stuttgart, Germany,* ***2010.***

[2]*Study on the characteristic of sewage sludge dewatering using the fry-drying technology; Taein Ohm, Jongseong Chae, Dongyae Min, Jungeun Kim, Seunghyun Moon,* ***2009.***

[3]*A novel method of sewage sludge pre-treatment - HTC Małgorzata Wilk, Faculty of Metals Engineering and Industrial Computer Science, AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Krakow, Poland,* ***2016.***

[4]*Meat and Bone Meal as a Renewable Energy Source in Cement Kilns: Investigation of Optimum Feeding Rate; W.K. Hiromi Ariyaratne, Morten C. Melaaen, K. Eine, Lars-André Tokheim,* ***2010.***

4. Sewage sludge

Sewage sludge is an important biomass material, but it is also one of the most difficult in terms of potential emissions. Changes made in EU legislation have meant that sewage sludge can no longer be sent to landfill. Hence, there is a move towards optimizing sewage sludge for charging in coal combustion systems. High content of organic matter makes it ideal as a source of energy, but high moisture content is a technical challenge. Pre-treatment, such as drying and transformation into a "waste-derived fuel" is requiredThe most problematic, still under development, is waste management and the use of municipal sewage sludge. The sludge can be burned or co-incinerated. The thermal use of sewage sludge is determined by its caloric properties and composition (especially the volatile matter content). Particle emission is a significant issue in burning alternative fuels. The risk of emissions of heavy metals, dioxins, furans and ash should also be taken into account. Municipal sewage sludge also contains the same harmful components as municipal waste such as traces of metals such as zinc, copper and lead. Other elements in sewage sludge, including alkali metals (Na, K) as well as sulfur and chlorine, can lead to operational problems such as dirt and clogging of combustion furnaces. Most of the dry matter content of sewage sludge consists of non-toxic organic compounds, generally a combination of primary and secondary sludge microbiological sludge. There are several options for sludge management, where the production of energy is one of the main solutions. The purpose of the applied research in this project is to verify that sludge from sewage treatment plants can be used as a source of energy compliant with EU legislation that meets emission limits and / or the proposal to optimize a process of preparing a solid energy-capable mix in biomass / rust / vegetal remains or even mixed with lignite, a fossil fuel but affordable and inexpensive in different recipes. The combustion of sewage sludge is aimed at complete oxidation at *high temperature of organic compounds in the sludge, including toxic organic compounds. The process can be applied either mechanically dehydrated sludge or dry sludge. Potential environmental problems related to combustion of sewage sludge are related to gaseous emissions and gray quality. Coal-fired coal (lignite) sewage sludge in the form of pellets or biomass / sawdust / vegetal remains can be cost-effective as this type of blend can easily be used in classic fuel plants / installations solid.*

5. Bottom ash – from lignite burning

The bottom ash generated by the CET Govora plant (but also by other CETs in Romania, Turceni, Rovinari, Colterm Timisoara, etc.) by combustion of lignite is unusable for the companies producing the building materials and must be deposited in the permanent deposit. It is basically a waste that is harmful to both ambient air and ground and groundwater. This project aims at developing an efficient solution for the elimination of positive-impact slag. As waste from the combustion process, the alternative with a positive economic impact is the possibility of combustion with a mixture of wood biomass (sawdust) in order to form an alternative fuel that can be burned with lignite or in combination with the sludge. Coal as a coarse coal-burning product on the grates has 30% mechanical and chemical incomplete bits and represents an average of 3% of the amount of coal consumed by boilers on solid fuel and lignite. With an average calorific value of 1,200 kcal / kg, slag recycling can lead to a major energy efficiency of coal boilers at CETs in Romania.

6. Flour of bones and flesh - MBM

Because of changing regulations for the use of bone meal and meat (MBM), its demand as a fuel for energy production has gained a tremendous interest among states within the EU. However, initial experiences have shown that, due to its composition, "behavior" as fuel is not comparable to coal or wood. Generally, two different routes for generating bone meal energy - MBM, can be achievable:

- ***flour of bones - MBM*** *used as secondary fuel in combination with a clay coal or in combination with biomass / sawdust.*
- ***• Application of bone meal and meat - MBM as a primary combustion fuel dedicated to stand-alone plants.***

A variety of operational problems were found in combustion plants. For example, high alkali metal and chlorine in ash were found during demonstration tests. In addition, piping and piping blocking, corrosion of metal components and disintegration of ceramic parts have also been encountered. Possible problems still in the case of co-combustion with coal in the plant are the quality of ash, which can be negatively influenced by bone meal and meat and also a high nitrogen content in MBM that can easily cause problems in terms of NOx emissions.

Until now, bone meal and meat - MBM (mechanically boned meat) has been mainly applied as a component of farm animal feed. However, due to the threat resulting from the spread of ESB disease - cow disease and the likelihood of its effect on humans, feeding of farm animals to this product has been stopped. MBM - is still used in Romania in the food industry - sausages (pasta, canned food, etc.), although western European countries have stopped adding it to food for several years (see the Vest vs EST standard quality talks inferiority of food products even in eastern countries!). Research studies clearly show that MBM-mechanically boned meat by eating in chicken can cause serious behavioral problems in children (ADHD, concentration problems, possibly colon cancer!). Nowadays, a disposal option is combustion or co-combustion of bone meal - MBM with *coal / lignite or biomass / sawdust / residual / vegetal remains, which ensures that any living organism is totally destroyed while at the same time valorising the energy potential , one unchallengeable. The properties that promote the combustion of bone meal and meat - MBM in industrial processes include:*

- *moisture content low;*
- *high calorific value - which is similar to the calorific value of the quality coals;*
- *lower sulfur content compared to most brown coal types.*

7. Critical analysis of the current stage and identification of the research "niche", in which ICSI Ramnciu Valcea aims to contribute

Effective knowledge of the quality and efficiency of solid fuels used in various thermal / electrical power plants, with reference to an optimal quality / price / environmental impact, has become increasingly important for both energy producers and consumers, a major impact in assessing this situation involving well-documented and applied analytical techniques and a level of human resource excellence proven by participating in various intercomparison tests, applied research activities for the economic sector. And just as we have presented above, these wastes selected for study, and for which, according to the literature, there is no concrete practical use at this moment and which represents a source of pollution for the environment, would could be a research-development study, an alternative source of energy. Of course, there is a risk / danger that these materials, if not all, at least some of them do not meet the pellet / briquetting standards for energy recovery due to even more harmful effects to the environment by combustion. Niche research for this study is the development of solid energy-rich mixtures of waste. During the study, it is intended to perform and test, both from the energy point of view and from the combustion pollutant emissions, solid mixtures with energy potential that meet a number of criteria to fit into a new concept of "sustainable sustainable and energy:

- ***friendly with the environment**:*
    - *a) solve the impact of this waste (sewage sludge, MBM, bottom ash, biomass vegetal remains);*
    - *b) combustion of this wastes leads to a lower level of pollutant compared to that resulting from the combustion of classical fuels;*
- ***high energetic value** - compared to existing classical fuels;*
- ***economical sustenability***
    - *a) low price of the row material;*
    - *b) ilizarea energetica a namolului de epurare in amestecuri solide cu potential energetic poate scadea cu mai mult de 30% costurile energetice de exploatare in cadrul statiilor de epurare municipale;*
    - *c) can be a cheap alternative to warming greenhouses and solariums during the winter.*

8. The proposed research objectives

The present study, through its proposed objectives, is making a significant contribution to the elucidation of the issues raised above.

General objectives of research and development:

I)

- *reducing dependence on fossil fuels (resource sustainability);*
- *crincreasing the diversity of alternative fuels and eliminating waste;*
- *reducing greenhouse gas emissions.*

II)

- *prospecting and careful inventory of sources and presumptive resources of raw material to reach the goal;*
- *contributing to the development of a market from an economic point of view and*
- *environmentally sustainable, renewable energy resources in Valcea County;*

III)

- *laboratory assessment of the energy potential of selected raw materials;*
- *recipes of new fuels obtained and testing their energy potential;*
- *biological / bacteriological risk testing, environmental risk, emissions / immissions in air;*

IV)

- *practical way and energy efficiency of drying of sewage sludge. Doing SERA - "efficient sewage sludge solar dry ";*

V)

- *making pellets / briquettes from newly obtained alternative fuels;*

VI)

- *validation of energy potential of alternative fuels obtained through practical tests - combustion with a laboratory burner.*

9. The proposed research methodology

The research methodology, ie the techniques of field data collection, processing and analysis are in line with the objectives of the study. The study addresses a new exploratory issue involving specific research / development methods. Characterization of raw material - waste itself - and alternative fuels newly created by:

I) gravimetric methods:

- *Humidity, hygroscopic W_h^a and imbibation W_i^i;*
- *determination of volatile matter content V;*
- *determination ash content A.*

II) gas chromatography:

- *+ combustion method, for qualitative and quantitative determination of C-N-H-S;*
- *+ pyrolysis method, for qualitative and quantitative determination of the content of O;*
- *determination of the dioxins and furans content, PAH-uri.*

III) calorimetry - combustion:

- *determining the high calorific value Q_{sup} and*

- *calculation of lower calorific value Q_{inf};*

IV) atomic adsorption - AAS:

- *determination of heavy metal content, Pd, Zn, Cr, Cd, Si, Fe, and Hg;*

10. Innovative aspect of the study

Absolute novelty / innovation elements in Romania, compared to existing products (eg wood pellets / sawdust briquettes):

I. *the concept of energy sustainability - through local traceability - the exploration of local energy resources (example: Valcea County);*
II. *use of waste type:*
    - *a sewage sludge;*
    - *bone meal and meat /MBM;*
    - *bottom ash from lignite burning;*
    - *a vegetable residue - pits, peel, straw, leaves, branches;*
III. *the use of lignite as main element in some alternative fuels or NO;*
IV. *the use of R & D instruments through specific laboratory tests / techniques to validate the energy potential of alternative fuels from waste;*
V. *development / creation of alternative fuels from waste as well:*
    - ***L-Z*** *(composition: lignit + bottom ash);*
    - ***MBM-B*** *(composition: bone meal + biomass-waste);*
    - ***MBM-Z*** *(composition: bone meal + bottom ash);*
    - ***SS-B*** *(composition: sewage sludge + biomass vegetal remains); and*
    - ***SS-L-Z*** *(composition: sewage sludge + lignite + bottom ash).*

***Risk management** can be defined, both qualitatively and quantitatively. From a qualitative point of view, it is appreciated that there may be risks in using bone / MBM flour and sludge mud. In fact, in an existing boiler in a lignite-fired power station, the combustion time of boilers in the boiler is greater than 2.5 seconds, in which case it is considered that dioxins and furans can not be formed. In this case there is no possibility of environmental damage or a possible risk of biological / bacteriological contamination. The possible risk of heavy metal contamination that can occur at the combustion of sewage sludge can be canceled by tests on various compositional grades and by laboratory assessments. From a quantitative point of view, there is a probability that, during the project period, a major damage or a major crash event, ie a lack of raw material, will occur at the system level. This type of risk can easily be canceled because most of the products of the proposed sorts develop and test in this project are relatively cheap waste and products from local sources. However, the quantitative technological risk is minimized by the positive impact on climate change.*

Renewable energy technologies offer investment opportunities and potential labor potential. At this time, the use of waste for energy purposes represents the new "El Dorado" in Europe and the US, thereby understanding the huge potential in terms of financial benefits. Most investments in the renewable energy sector cover the costs of materials and labor needed to build and maintain facilities compared to expensive energy imports (eg coal, oil, natural gas, shale gas). It is obvious that with the launch on the Romanian market of new solid energy products, there will be a number of advantages: cheaper energy, cleaner energy, jobs. Renewable energy can provide income in rural areas as well. Some renewable energy initiatives offer authentic and beneficial alternatives by using conventional agricultural land. For example, farmers in the southern area of Valcea County can *generate income by using land to grow energy willow. This example of renewable energy bussines can be an engine, a generator of innovative ideas in an area of Romania with serious job problems and especially value-added jobs. The social aspects of developing a business linked to the creation of alternative waste fuels lead to a high living standard with relatively cheap energy and can also generate a clean environment, education, social cohesion and stability, but also a limitation the migration effect - alleviating the depopulation of rural areas through regional development.*

The final conclusion that could be born on a scientific basis, validated during this study, will be able to reveal the fact that by combustion of these new alternative fuels it can be an alternative niche fuel, a good and promising alternative for the correct management of waste, respectively, in the environmentally and economically efficient disposal.„

End of quote

Part of the opportunity study will be laboratory analyzes and tests performed with the alternative fuel dispenser made under the NOVENER project. The opportunity study will be taught / completed in December 2017.

3. Operation of bottom ash energy recovery installations

3.1 Internal regulation of the newly created technological process

For the efficient and safe operation of the installations were elaborated documents of the integrated quality management system:

- issued new release of the Operational Procedure: **PO 072 – editia 2** „ Use of lignite mixed with solid alternative fuels at CET Govora", in force from 15.01.2016 regulates the activities for the production of lignite mixtures with other solid fuels used at CET Govora: high-carbon coal, biomass-wood chips and recovered bottom ash.
- it is applied Internal Technical Instruction **ITI-03-DEZ**: "Collecting, transporting and recovering the energy of the bottom ash" in force since 01.07.2016 si which details the operation of the equipments that perform the energy recovery of the bottom ash and monitoring the energy and mass flows associated with its use.

The purpose of the instruction is to explain the technological flow and to make the necessary recordings regarding the energy recovery of bottom ash from the coal boilers of CET Govora.

The continuous operation of the bottom ash energy recovery systems is defined as the normal operating regime of the equipment and bypassing its and flows the bottom ash to the solid waste channel in the suction pump is the emergency mode considering the following aspects:

- increases the energy efficiency of fuel use,
- avoid blocking channels and pipes by slag,
- reduce the erosion of slurry pumps
- the costs associated with the storage of the slag in the solid waste landfill are reduced.

Energy recovery of the bottom ash produces benefits by reducing proportionally the amount of coal consumed, but it did not proceed to its value registration in accounting as it is an internal recirculation of resources.

If the slag is destined for sale, the estimated price of the slag is 55 lei / t. We mention that there were no requests for the acquisition of slag between May 2016 and October 2017.

3.2 Carrying out the technological process of energy recovery of the slag

Starting with May 2016, all three sub-assemblies under the NOVENER project are in normal operation:

- Bottom ash reclamation plant from the C5 boiler
- Bottom ash reclamation plant from the C6 boiler
- Equipment for dosing alternative fuel on the coal boilers supply coal 7A and 7B
- Bottom ash recovery equipment for boiler C7 put back into operation, project finaced from own funds, as part of the same project - NOVENER.

They form together The innovative technological process of energy recovery of the incomplete mechanical and chemical inerts from the slag discharged from the LVT boilers of CET Govora schematically presented as follows:

FIGURA 1. SCHEMA PROCESULUI TEHNOLOGIC DE RECUPERARE ENERGETICA A ZFGURII

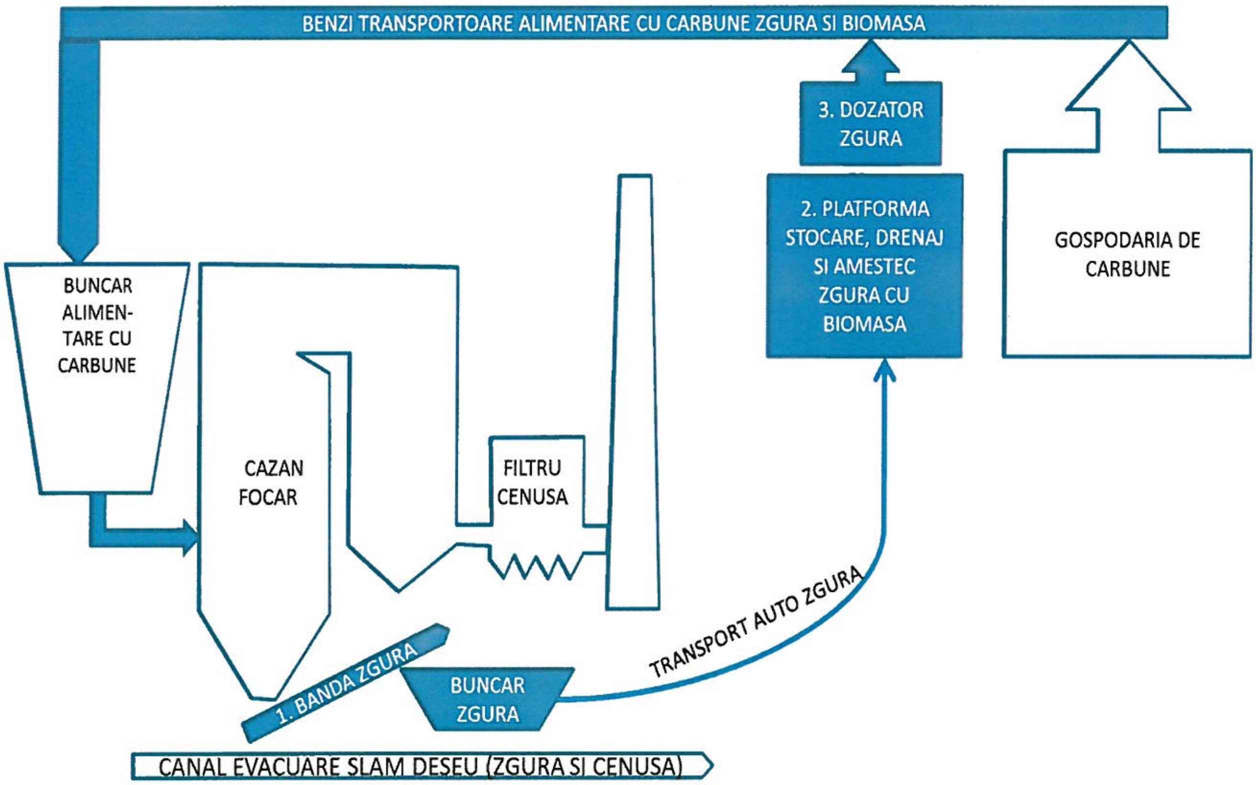

Photo 1 – Transport of bottom ash from the temporary storage silo to alternative fuel deposit

Photo 2 – The platforme of the deposit and supply the dosing equipment

Between 15th November 2016 and 10th August 2017 recovery and dosing equipment of the bottom ash work normal depending on the energetic instalations of the power plant, acording to the procedures PO 072-1 and ITI–03-Dez. It is mentioned that these documents state the normal operating regime of the plant is with the bottom ash recovery systems in operation. Removing them out of service is considered to be a fail-safe mode ITI – 03 - DEZ

The average amount of decanted bottom ash recovered este de 5t/h for each operational boilers and between 15 November 2016 - 10 August 2017 it was recovered o total quantity of 36,650 t.

Between 10 August 2017 and 31 October 2017 the dosing equipment wasn't availamble due to failure of the electrical power supply and regulate of the engine (frequency converter) that drives the belt conveyer of the alternative fuel. The engine and the frecvency converter are in service now to the company that delivery – GRIMEX Tg. Jiu, for fixing in the warranty period.

The recovery bottom ash after 11 August 2017 is stored on the coal deposit – pile no. 4 next to the dosing equipment. The total amount of stored bottom ash is estimated to 6,570 t, which will be used between December 2017 and March 2018 when the coal consumption is increasing and in the same time the bottom ash recovery too.

In analyzed period the bottom ash was succesfully used as antiadhesive layer on the trucks tilt that carry the wet syntetic gypsum from FGD of boiler C7. The unloading of the sticky gypsum is done much easier having the bottom ash layer on the bottom side of the truck tilt.

In the second year of operation of the NOVENER project equipment CET Govora didn't use biomass for improving the quality of the bottom ash as alternative fuel. Even so, has been demonstrated on 10 months of operation that use of the bottom ash after 12 hours of draining mixed with lignite doesn't cause any anomalous operation of the.

3.3 Technical and economic analysis of the process during the monitoring period

Recycling of the lignite boilers bottom ash is a solution to increase the thermal efficiency and to reduce the cost of storing solid waste products. The slag incorporates to the greatest extent the residual mass of unburnt fuel in the boiler as a result of incomplete grinding or incomplete combustion.

The carbon content in the slag, measured in 2017, is between minimum 12%, and maximum 36%, and the average is 22.5%. This data confirms excuses in the Feasibility Study.

The combustible materials from the bottom ash burn completely in the focus of the second cycle of use, so the content of coarse inorganic materials in slag turns into fly ash and is retained in the normal way in the boiler electrofilters. The amount of recovered bottom ash from each boiler during the operation period is on average 5 tons / h / boiler and represents 43,220 tons of in year 2 of operation. The amount is higher than estimated in the Feasibility Study (37,000 t / year) but the amount of actually recycled slag is 36,650 tons; not the entire amount of recovered slag was recycled due to the failure and unavailability of dosing equipment after August 10th and the difference of 6,570 t of bottom ash is in stock. We estimate that during the 3rd year of operation a quantity of about 45,000 t of slag will be recycled, ie a larger quantity than the estimated annual quantity in the feasibility study.

The calorific power of the slag is about 1950 kcal / kg and accounts for over 90% of the calorific power of the superficial coal of which it comes from.

The inferior calorific value of the slag recorded after excess water drainage is at least 1,268 kcal / kg and maximum 1,470 kcal / kg and the average is 1,284 kcal / kg, which represents 79% of the average lower calorific value of the lignite used.

Even if it has an average carbon content of 23.02%, it is higher than the carbon content of the coal from which the slag is derived, the net calorific value of the slag is lower than that of the coal, which is due to the excess moisture from slag that can not be eliminated by drainage and the depletion of other combustible materials: hydrogen and sulfur.

The primary energy recovered and recycled bottom ash in the 2nd year of operation is 47,656 Gcal, which equates to 28,666 t of coal avoided from burning.

Boiler energy efficiency increased by 1.97% on average per year. The increase yield is lower than 3%, the one estimated in the Feasibility Study. The explanation is that the slag recovery period accounts for only 78% of the reporting time: we report bottom ash actually recovered during 9 months and 10 days at a quantity of coal consumed in 12 months. We estimate that in the 3rd year of operation, the slag recovery facility will achieve the 3% Feasibility Study target.

Reducing carbon dioxide emissions due to the use of bottom ash versus slag-free operation resulted in 18,920 t_{CO2}. This value can be increased by the dosing of biomass or other alternative fuels that are neutral compared to CO_2 emission in the mixture with bottom ash, a mixture that will replace a larger amount of coal.

Recovering the slag and converting it from an alternative fuel waste reduces the amount of solid waste deposited by 23,502 thousand tons in the monitoring second year. The amount of unspent waste and the costs associated with this activity are higher than those in the Feasibility Study. The combustible material in the slag burns completely in suspension in the furnace and does not cause the slag agglomeration in the cold boiler. This risk, estimated in the feasibility study, is not confirmed after the 18 months of continuous plant operation.

The energy recovery process of the slag from the slag is achieved with minimal transport and investment costs, it can be applied to all lower-grade coal boilers in the country but must take into account certain identified technological restrictions:

- the evacuated bottom ash have excese water content due to the cooling process which must be drained to prevent it from being reintroduced into the furnace;
- the combustible mass content of the slag is variable depending on the quality of the burned coal, the efficiency of the coal grinding process and the loading regime of the boiler; Bottom ash has an important content of combustible matter but does not contain enough volatile matter to contribute to ignition so that the dosage should not exceed 10% mixed with lignite.

Restrictions are defined in the internal procedures of CET Govora.

Procesul tehnologic creat raspunde la aceste restrictii functionale prin urmatoarele componente:

- the recovery of the bottom ash is done in a semi-wett regime in a separate stream, to a temporary storage facility that is supplied with each boiler;
- the bottom ash is transported by trucks and stored for a minimum of 12 hours on a platform provided with drainage ditches for draining and evacuation of the water of imbibition;
- periodic laboratory analyzes are required to determine the carbon and moisture content of the slag;
- it is advise to prepare a homogeneous mixture with biomass to create a lignite-compatible fuel mixture; chipps of biomass brings a significantly volatile contribution to mixture fuel -

alternative fuel. The bottom ash can be recirculated without biomass if the slag + lignite mixture is controled;

- the bottom ash level is monitored in the boiler hopper to avoid excessive accumulation of the slag.

Applying primary measures to reduce pollutant emissions with nitrogen oxides, respectively reducing the excess combustion air in the furnace at the upgraded C7 boiler, results in a slight reduction in the amount of slag discharged as a result of finer grinding of coal and a rise in calorific value of the slag recovered as a result of the reduction of the combustion air in the area of the burner stove.

4. Patenting the innovative technological process

Based on the Law no. 64/1991 on patents for invention, republished, modified by Law no. 83/2014 on inventions CET Govora applied for a patent for the invention entitled: **"Process / Technological Process of Energy Recovery of Mechanical and Chemical Incomplete from the Lignite Boiler Discharged bottom ash".**

The patent application was filed with OSIM under the number "a201600603" on 01.11.2016 and its publication was made until 28.02.2017. The application is in the examination procedure on the merits of the examiner's response Marina Anca, seChimical department - OSIM on 06.11.2017:

"In response to your address no. OSIM 213461 dated 18.10.2017, we hereby notify you that the above-mentioned patent application is undergoing a substantive examination procedure, in accordance with Law no. 64/1991, republished in MO 471 / 26.06.2014, on Patents for Invention and the Law on the Application of the Law, published in Official Gazette no.456 / 18.06.2008.

The substantive examination procedure may take place within 18 to 30 months, depending on the date of payment of the examination and the amount of the fee paid, in accordance with art. 24 of the Law and of the OG 41/1998 regarding the taxes on the protection of industrial property. The file with no. a 2016 00603 (deposit date 31.08.2016, payment date examination fee 17.11.2016, tax assessment 264.6 lei (20%)) will be notified during 2018, the completion of the examination being carried out according to the speed of the answers coming from applicant.
Thank you for understanding. Best regards, A. Marina".

Official notification of OSIM is not yet received, it shall be transmitted as an annex to this.
We also attach the notification regarding the registration of patent application 201600603.

Serv. Strategie

OFICIUL DE STAT PENTRU INVENŢII ŞI MĂRCI

OSIM

Cont IBAN: RO29 TREZ 7032 0F36 5000 XXXX
Trezoreria Sector 3, Bucureşti
Cod fiscal: 4266081

Către,
CET GOVORA S.A., STR. INDUSTRIILOR NR. 1, 240050, RÂMNICU VÂLCEA', VL, RO

O.S.I.M.
REGISTRATURA GENERALĂ
14 DEC 2016
NR.: 10 49695

NOTIFICARE

Vă transmitem în anexă rezumatul invenţiei(ilor) care face (fac) obiectul(ele) cererii de brevet de invenţie nr **a 2016 00603**, cu dată de depozit din **31/08/2016**, şi cu titlul **PROCES TEHNOLOGIC DE RECUPERARE ENERGETICĂ A NEARSELOR MECANIC ŞI CHIMIC INCOMPLETE DIN ZGURA EVACUATA DE LA CAZANELE DE LIGNIT** , reformulat de către OSIM, care urmează să fie publicat în Buletinul Oficial de Proprietate Industrială-Secţiunea Invenţii Nr.2 din 2017, conform art.22* alin.1; descrierea, revendicările şi, dacă este cazul, desenele sunt puse la dispoziţia publicului la sediul OSIM începând cu data de 28.02.2017.

Vă rugăm să îl consultaţi şi, în cazul în care sunteţi de acord cu conţinutul şi forma de redactare propuse, să îl semnaţi şi să-l transmiteţi la OSIM în termen de 30 de zile de la data prezentei sau, în caz contrar, să ne trimiteţi în acelaşi termen rezumatul cu conţinutul care doriţi să fie făcut public.

În situaţia în care nu se primeşte răspuns în termenul acordat sau dacă notificarea este returnată la OSIM, rezumatul se va publica în forma propusă de OSIM.

Obs.

1. Pentru continuarea procedurilor legale, conf.OG nr.41/1998, privind taxele, trebuie să achitaţi taxa de examinare în valoare de 1323 lei pentru examinarea cererii de brevet în termen de 18 luni de la data plăţii sau 2206 lei pentru examinarea în termen de 18 luni de la data de depozit.

EXAMINATOR,
DRAGOMIRESCU OCTAVIAN

Anexă.......A0............

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* Legea nr. 64/1991 republicată în Monitorul Oficial al României nr. 613 din 19 august 2014.
** Ordonanţa Guvernului nr.41/1998 privind taxele în domeniul protecţiei proprietăţii industriale şi regimul de utilizare a acestora, republicată în Monitorul Oficial nr. 959 din 29 noiembrie 2006.

(19) OFICIUL DE STAT
PENTRU INVENŢII ŞI MĂRCI
Bucureşti

ROMÂNIA

(11) RO A0

(51) Int.Cl.
C10L 5/48 (2006.01)

(12) **CERERE DE BREVET DE INVENŢIE**

(21) Nr. cerere: **a 2016 00603**

(22) Data de depozit: **31/08/2016**

(41) Data publicării cererii: 28.02.2017
BOPI nr. 2/2017

(71) Solicitant:
• **CET GOVORA S.A.**, *STR. INDUSTRIILOR NR. 1, RÂMNICU VÂLCEA', VL, RO*

(72) Inventatori:
• **AVRAM ION**, *CALEA LUI TRAIAN NR. 114, BL. L, SC. C, AP. 10, RÂMNICU VÂLCEA, VL, RO;*
• **STOIAN ION**, *STR. HENRI COANDĂ NR. 10, BL. R10, SC. B, AP. 14, RÂMNICU VÂLCEA, VL, RO;*
• **POPESCU NICOLAE**, *STR. GENERAL MAGHERU NR. 11, BL. G, SC. C, AP. 9, RÂMNICU VÂLCEA, VL, RO;*
• **PARASCHIV GHEORGHE**, *STR. LINIA NR. 366, SAT PRIPORU, COMUNA VLĂDEŞTI, VL, RO*

(54) **~~PROCES TEHNOLOGIC~~ [PROCEDEU] DE RECUPERARE ENERGETICĂ A NEARSELOR MECANIC ŞI CHIMIC INCOMPLETE DIN ZGURA EVACUATA DE LA CAZANELE DE LIGNIT**

(57) Rezumat:

Invenţia se referă la un procedeu, la o instalaţie de preluare a zgurii, la o platformă de drenaj şi la o instalaţie de dozare, utilizate pentru recuperarea energetică a nearselor incomplete, mecanic şi chimic, din zgura evacuată de la cazanele energetice pe lignit. Procedeul conform invenţiei constă în preluarea zgurii de la cazan, înainte de deversarea acesteia în canalul de şlam, pe o bandă transportoare înclinată cu racleţi, deversarea acesteia într-un buncăr de stocare temporară, urmată de descărcarea zgurii din buncăr în mijloacele auto de transport cu care aceasta este transportată către o platformă betonată, aflată în gospodăria de combustibil solid a centralei electrice, prevăzută cu rigole de drenaj pentru evacuarea apei de îmbibaţie a zgurii, stocarea zgurii cel puţin 24 h pentru eliminarea apei, după care se prepară un amestec cât mai omogen de zgură şi biomasă tocată, conform unor diagrame de amestec obţinute experimental, cu ajutorul unui încărcător frontal cu cupă de cel puţin 3 m^3, amestecul fiind transportat către o instalaţie de dozare de unde este reintrodusă controlat în focar împreună cu cărbunele. Instalaţie de preluare a zgurii conform invenţiei este compusă dintr-o bandă transportoare cu racleţi înclinată la 21...24°, cu un debit de 8 t/h, care transportă zgura către un buncăr de stocare temporară cu capacitatea de 18 m^3, prevăzut cu şibăr şi cu instalaţie de vibrare. Platforma conform invenţiei este realizată din beton având o suprafaţă de 180 m^2 care asigură un volum de stocare de 600 m^3 fiind împărţită longitudinal în şase părţi egale: trei stochează zgura şi trei pentru biomasă. Instalaţia de dozare conform invenţiei este constituită dintr-un buncăr de alimentare de 10 m^3 prevăzut cu cântar de 10 t şi extractor cu şnec cu turaţie variabilă, are un transportor cu bandă de cauciuc prevăzut cu cântar, debitul volumetric nominal al extractorului fiind de 115 m^3/h iar cel minim de 15% din cel nominal.

Revendicări: 3
Figuri: 4

(Se publică figura 1)

De acord cu Rezumatul. CET Govora

Director General
Ludovic ZELICI

Director Proiect
Ion STOIAN

RO A0

4.1 Procesul tehnologic inovativ supus brevetarii - cererea de brevet

5. SUMMARY

PROCESS OF ENERGY RECOVERY OF MECHANICAL AND CHEMICAL INCOMPLETE BURNING OF THE BOTTOM ASH EXTRACTED FROM BOILERS BASED ON LIGNIT

The invention relates to a process for separating the bottom ash from the solid waste disposal of an energy coal boiler, conditioning and recirculation thereof in the coal supply of the boilers. By means of experimentation and statistical analysis, the recipe for the formation of alternative fuel by mixing bottom ash with cipped biomass for dosing up to 10% of masse with lignite. By recirculation of the bottom ash, the energetic efficiency of coal-fired power plants increases by 1.5-3% and sterile matters are converted into fly ash following the combustion gas path from where it is retained in the dust filters, thus avoiding the bottom ash depositing as coarse slag waste.

The process consists of the following functional sub-assemblies represented schematically and numbered in Figure 1 thus:

1. There is a silo for receiving the bottom ash that is extracted from each boiler. Prior to discharge into the waste slam channel, the slag is picked up on a conveyor belt inclined with scrapers, shown at position 1.1. in Figure 1 and is discharged into a temporary storage hopper shown in position 1.2 of Figure 1, a bunker provided with a discharge sibar and a vibration installation. The slag is transported by car and is unloaded on a concrete platform.

2. The concrete platform, position 2 of Figure 1, with drainage channels is sized for storing the bottom ash for at least 24 hours before it is reused. From here, samples for laboratory analysis are taken periodically and the lower calorific value of the slag is determined. In order to achieve a combustible fuel comparable to combustion in the boilers, add the chopped biomass that brings a significant volatile intake. The volumetric ratio between biomass and slag is determined using the "Volumetric Mixtures of slag and biomass" made available to the operator of the boiler coal supply system.

3. A dosing plant, a position 3 in Figure 1, consisting of a feed hopper, a conveyor belt provided with a tape counter, and a spill system which achieves controlled alternate fuel metering on the charcoal conveyor belts of the boilers. Thus the slag is reintroduced controlled in the furnace, its fuel content is burned in suspension and the tailings content of the slag turns into the fly ash, following the way of the combustion gases without causing agglomerations on the exhaust flow at the base of the boiler.

4.2. Description of the invention:

PROCESS OF ENERGY RECOVERY OF MECHANICAL AND CHEMICAL INCOMPLETE BURNING OF THE BOTTOM ASH EXTRACTED FROM BOILERS BASED ON LIGNIT

The invention relates to a process for recovering in the form of a useful thermal energy the content of non-combustible combustible materials from the slag, which is currently discharged as waste from the coal-fired power boilers as well as to the installations that contribute to this process. More specifically, the newly created process consists in the recovery of the slag prior to its discharge into slag and ash sludge channels at the base of the lignite boilers, its separation from the waste stream to be transported and conditioned for recirculation in the lignite feed stream of the boilers.

Curent stage of the technology

In the system known and previously used for burning lignite, bottom ash is mixed with ash and water and is discharged as slurry to industrial waste landfills along with other coal-firing products. Storage of these wastes has a significant impact on the environment, and the cost of ecological storage of slag as waste is important.

The bottom ash incorporates to the greatest extent the residual mass of unburnt fuel in the boiler as a result of incomplete grinding or incomplete combustion. Incomplete combustion is particularly present in coal boilers where excess air is kept to a minimum to reduce polluting emissions of nitrogen oxides. At CET Govora, during the mentioned period, two non-technological boilers and a refurbished boiler for the control of NOx emissions were in operation. We have carried out comparative analyzes between the two types of installations and concluded that after refurbishment, by the discharge to the slag landfill, the content of combustible materials and carbon up to 35% of the slag is lost. The thermal efficiency of coal boilers decreases by up to 3% due to the loss of combustible materials from the slag.

Short description of the invention

Non-carbonized particles are concentrated in molten slag discharged to the bottom of the furnace into a special vat where it is cooled in the water stream and continuously evacuated with help of skidding strips.

The physico-chemical analyzes carried out systematically for 3 years (2013-2015) on CKT Govora's recovery coal tar slag reveal a carbon content in the range of 25-35% of the dry weight of the slag.

Recycling of boiler slag in various forms is a theoretical solution for increasing the efficiency of coal-fired power plants by reducing the costs of storing waste, and several processes involving its advanced processing for transformation into by-products for construction, household use, etc. are mentioned.

The proposed process of energy recovery of the bricks from the slag, by creating a flow of recycling it into the main fuel supply flow, is achieved with minimum transportation and investment costs can be applied to all low-lignite-fired boilers but must take into account certain technological restrictions:

- *The bottom ash discharged under the furnace is immersed in a cooling water tank; the excess water contained in the recovered slag must be drained for a certain amount of time so that it is not reintroduced into the outbreak with it;*
- *The fuel mass content of the bottom ash is variable depending on the quality of the burned coal, the efficiency of the grinding process and the loading regime of each boiler. Bottom ash has a high content of combustible materials but does not contain enough volatile substances to contribute to ignition so it can not be used as a single fuel in these boilers;*
- *The energy recovery process of the bottom ash does not have to reduce the reliability and safety of the energy boilers or create blockages;*
- *The newly created process responds to these functional restrictions through the following components:*
    - *Recovery of the bottom ash is done in a semi-wett mode in a separate, newly created stream, to a temporary storage silo that is supplied from each boiler;*
    - *The bottom ash is transported by truks and is usually stored for 24 hours on a concrete and covered platform provided with drainage drains for the drainage and evacuation of the soaking water;*
    - *Periodic laboratory analyzes are required to determine the lower calorific value and the moisture content of the slag;*
    - *A more homogeneous mixture of crushed biomass slag is made to create a lignite-compatible fuel mix starting from the finding that chopped biomass brings a significantly volatile contribution to the newly created alternative fuel;*
    - *The alternate fuel thus carried out on the charcoal supply of the boilers is controlled;*
    - *Follow the slag level in the cold storage under the boiler shell to avoid excessive slag accumulation;*

In a homogeneous mixture with biomass and coal, when the bottom ash is introduced continuously controlled in the furnace, the mass of the slag burns in suspension and its sterile content is converted into the fly ash following the path of the combustion gases without causing agglomerations on the exhaust stream at the base of the boiler. Thus the energy content of the entire content of non-combustible materials from the slag is recovered at minimum cost.

The process consists of the following steps:

1. The first stage of the process, schematically represented by the installations numbered 1.1. and 1.2 in figure 1, is the taking over of the slag in the hydraulic exhaust system, from the discharge of the scraper band at the bottom of the boiler through a routing system provided with a manual flap towards a discharge to a conveyor belt rubber that drives the slag to a temporary slurry storage facility in each boiler. In addition to this, a reserve or slag disposal pathway is provided, consisting of a slag crusher and a hydraulic routing channel at the slam pumps. This double slag evacuation system enables the boiler to function even in the event of a failure of the conveyor belt for the recovery of the slag. The planned automation and signaling systems, indicating the non-functioning of the belt, allow the timetable and the slag crusher to operate in a timely manner while maintaining the boiler's safe operation without clogging the slag in the cold.

The dimensioning of the conveyor and the temporary storage hopper takes into account the average and maximum flows of materials and the amount of slag discharged in various boiler loading regimes. The slag conveyor is sized to discharge the largest slag flow but will be provided with a belt drive speed control system for situations where this flow is lower. The temporary storage hopper of the slag has a volume so dimensioned and is located at a height that allows the slag gravity to be discharged into a truck at 2 hour average intervals.

For the coal boilers at CET Govora, the following main construction characteristics were established for the conveyor belts and for the boiler slag hopper:

Rubber sloping conveyor belt with wett bottom ash scraper:

- *Lenght 15 m;*
- *Tilt 21-24 grd;*
- *Witth 600 mm;*
- *Maximum flow 8 t/h;*
- *Min level of the belt: +0.0 m;*
- *Max level of the belt: +6.5 m;*
- *Maximum speed 1 m/s. The speed of the conveyer is ajustable by the frecvency convertisor;*

Silo:

- *The total capacity 18 m^3;*
- *The level of the unloading door 3.5 m.*

2. The second component of the process, numbered 2 in Figure 1, is the slag water storage and drainage platform that has a storage capacity for the entire amount of slag and biomass required for the process for 24 hours. The surface area of the platform is 180 m2 and provides a storage volume of 600 m3. The platform is longitudinally divided into 6 equal parts with transversal access of the mechanical loading / unloading means which allows working with high-capacity storage facilities and good management of the slag, biomass and alternative fuel prepared for metering in the coal flow. For the servicing of the storage platform, use of a mechanical front loader with bucket volume of 3 m^3.

The first three compartments of the platform are for slag storage and are alternate in one of the regimes: Loading / Drainage / Download.

The other three compartments store cipped biomass (sawdust, or other solid chopped biomass) in order to make the mixture with bottom ash.

The most available in the biomass market is the green wood chips and the optimal recipe for making combustible mixtures of sawdust and slag have already been set out are detailed in the alternative fuel schemes and briefly defined:

Chipped wet biomass (about 50% humidity) is combined in a volumetric ratio of about 50% with the bottom ash stored for drainage for 24 hours;

Chipped dry biomass (about 30% humidity) is combined in a volumetric ratio of about 33% with the bottom ash stored for drainage for 24 hours.

The charcoal boilers operate continuously, the planned slag storage capabilities allow alternative fuel to be made in discontinuous operation depending on the boiler coal supply program.
In a stable working regime, a blend of up to 10% of alternative fuel in the coal flow will not be exceeded.

3. The third component of the process, numbered 3 in Figure 1, is carried out by the controlled alternate fuel metering installation in the coal feed of the boilers comprising:

- *The feed hopper provided with a scale and variable speed windscreen extractor;*
- *Conveyor with rubber band having the speed (drive motor speed) correlated with that of the extractor; the conveyor is provided with a tape lug;*
- *Alternate fuel splitter on the moving carbon bands and each fitted with tape.*

The metering, automation and dispenser control system allows alternate fueling only after the charging of coal flows, the distribution of alternative fuel on the charcoal already loaded and the continuous measurement of the quantities of fuels transported to the boiler bunkers.
In the studied case, the dispenser has the following technical characteristics:

- *Minimum load capacity of the silo = 10 m^3;*
- *The maximum weighing capacity =10 t;*
- *Maximum overload >150% on a corner and >250% an a side;*
- *Accuracy of measurement = 2%;*
- *Nominal volumetric flow rate of the extractor =115 m^3/h;*
- *Minimum volumetric flow rate of the extractor = 15% from the nominal;*
- *Nominal drive torque = 700 Nm;*
- *The belt conveyor is equipped with safty for reverse rotation.*

4. The fourth component of the process is represented by the simple system of setting the mixing recipe using the "Slag and biomass volumetric dosing diagrams" presented in Figures 2.1, 2.2. and 2.3. and which are created for efficiency in the composition of alternative fuel.
The diagram is based on laboratory measurements made over the period 2012-2015 on coal, slag, and biomass, on the experiments conducted at CET Govora boilers, on analyzes and technical or statistical calculations made during the period.
The charts are operational by being made available to the operator / dispatcher of the coal feed bands of the boiler bunkers.

4.3. CET Govora requests:

1. A process of energy recovery of the incomplete mechanical and chemical unburned from the lignite boiler slag, characterized in that the coarse slag product of coal which is discharged as sludge in the conventional system is routed on a strip conveyor to a storage hopper in each boiler from where it is transported by means of a vehicle to a concrete platform where an alternate fuel is created by draining the water of imbibation and mixing the slag with the biomass. The realized fuel is dosed in the main feed stream with coal of boilers;
2. Apparatus for applying the first process step according to claim 1, characterized in that, from the conveyor belt with slag exhaust scraps, before it is discharged into the sludge channel, slag is recovered by a filler provided with a manual flap (position 1.1 in Figure 1) which rises from a 0.00 m elevation and unloads it at a height of 6.00 m in a storage hopper (position 1.2 of Figure 1), which is provided with 2 pneumatically driven unloading sieve and located at the base of the hopper at a height of 3.5 m;

3. Automation installation for applying the first process step according to claim 2, characterized in that the speed of the conveyor belt is adjustable according to the amount of slag which is recovered from the boiler and its working condition is signaled;
4. A storage hopper for applying the first step of the process according to claim 2, characterized in that it has a volume of 18 m3, sized for storage for at least 2 hours of slag and its positioning from a minimum height of 3.5 m to a maximum 6 m allows gravity unloading of the slag in the means of transport;
5. Slag routing installation for applying the first step of the process according to claim 1, characterized in that it also provides a reserve discharge path of the slag by means of a second slag crusher to the flue gas outlet sludge central;
6. The storage platform for applying the second phase of the process according to claim 1, characterized in that it has an area of 180 m2, is divided into six equal rectangular sectors and allows the storage of slag and solid biomass, drainage of the water of imbibition from the slag for 24 hours and the creation of a homogeneous mixture of biomass slag;
7. Simultaneous system for determining the amount of biomass that mixes with slag for the application of the second phase of the process according to claim 1, characterized in that it is based on the biomass humidity measurement and the assessment of the humidity in the slag depending on the drainage duration and on three volumetric dose diagrams to determine the volume of biomass required for the available volume of already drained slag for 24 hours (Figure 2.1) or for 48 hours (Figure 2.2) or more than 48 hours (figure 2.3);
8. A plant for the application of the third phase of the process according to claim 1, characterized in that it is loaded from the alternative fueling platform into a 10 m3 feed hopper provided with a sink extractor an automatic dispenser (position 3 in Figure 1) consisting of a sloping conveyor belt and a discharge pantry hopper provided with an electrically operated guiding Siber and automatically controlled to discharge the alternate fuel to the coal feed strips on the run;
9. An automation installation for the application of the third phase of the process according to claim 8, characterized in that the amount of alternative fuel and coal with the tapping is measured and the speed of the metering conveyor belt is automatically adjusted according to the dosage set by Dispatch between 3% and 10% of alternative fuel in the coal flow;
10. An automation installation for the application of the third phase of the process according to claim 8, characterized in that it is automatically controlled the discharge of the alternate fuel only on the moving coal and loaded charcoal bands

1.4 Desene anexate cererii de brevet

Figura 1.

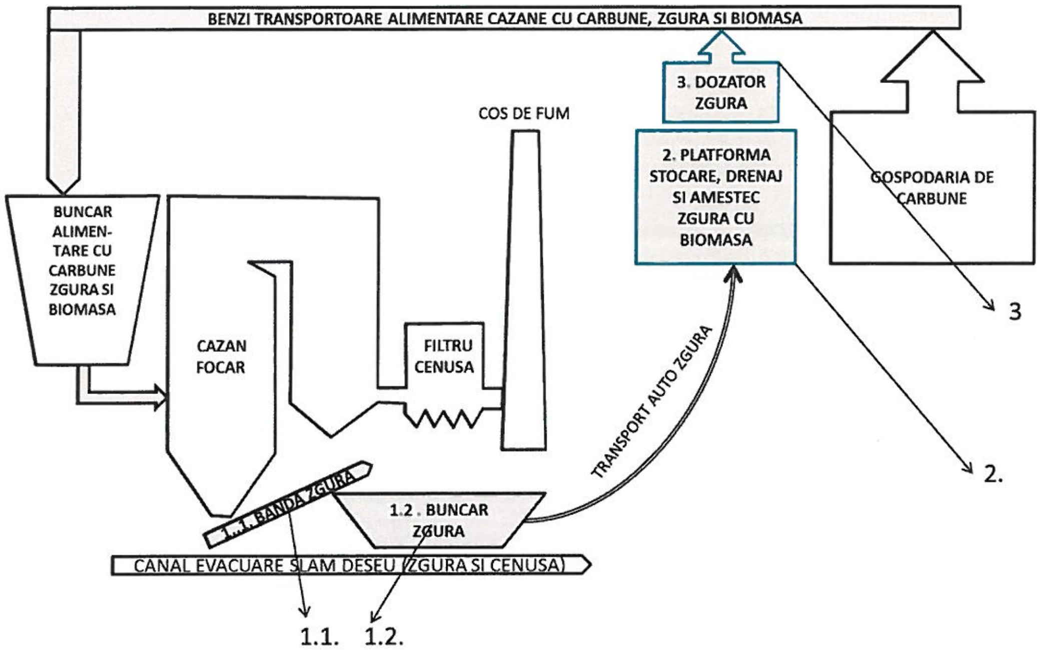


Figura 2.1. Diagrame de dozaj volumetric zgura si biomasa

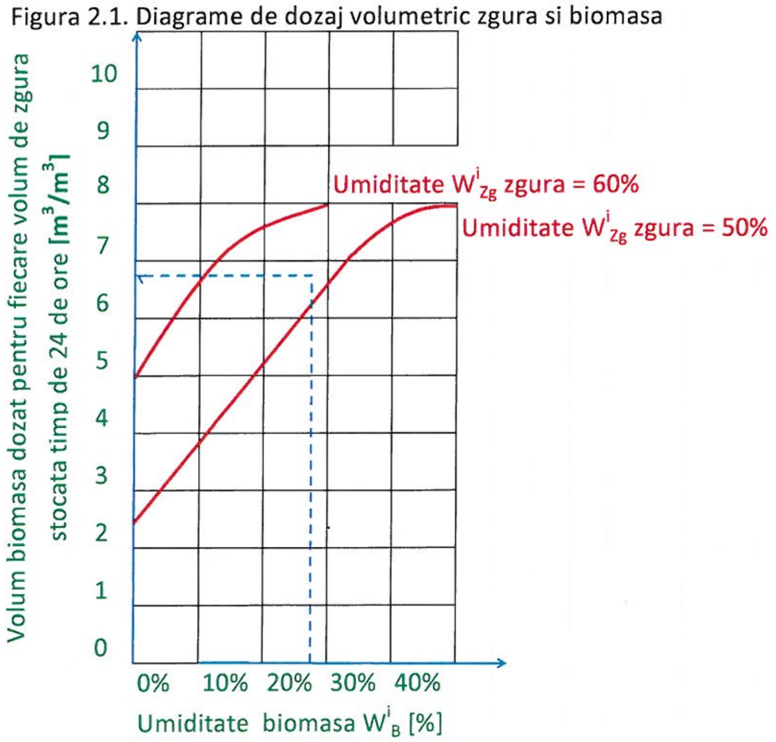


Figura 2.2. Diagrame de dozaj volumetric zgura si biomasa

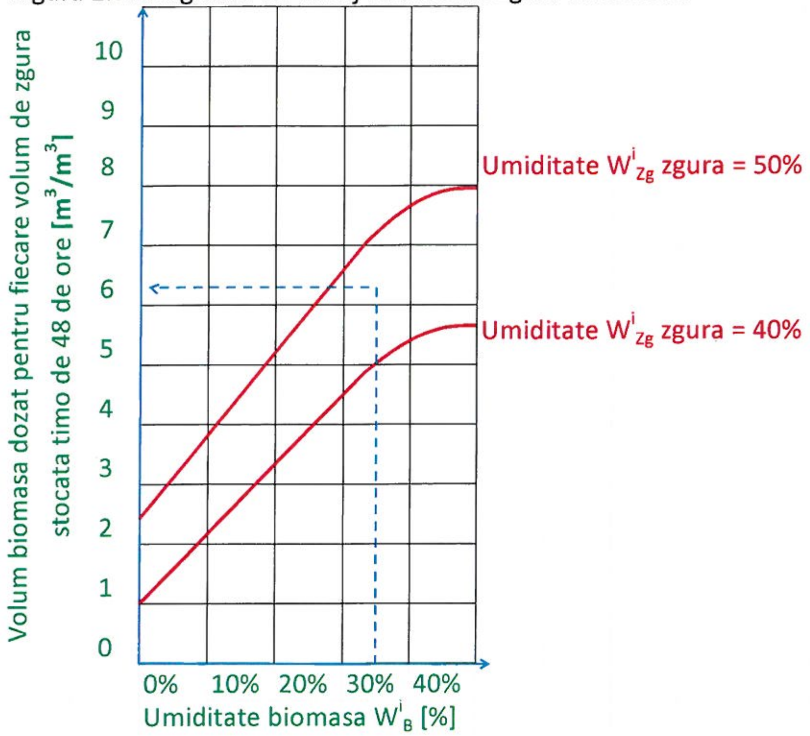
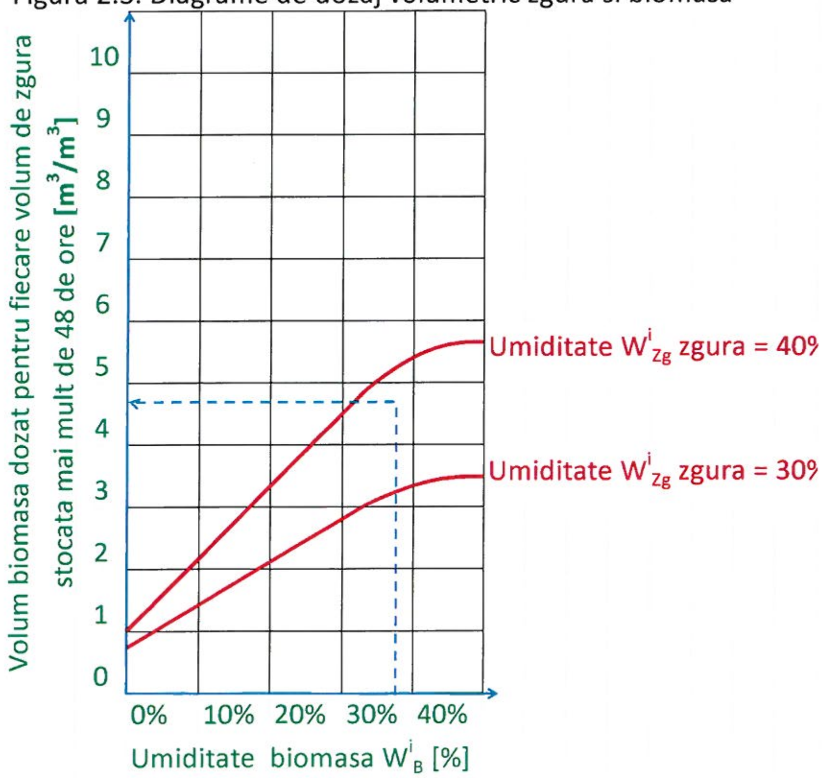


Figura 2.3. Diagrame de dozaj volumetric zgura si biomasa



2. Conclusions

After two years of operation of the slag energy recovery installations, the conclusion is that the bottom ash recycling determines the increase of the energy efficiency of the lignite boilers by about 2-3% depending on the technical possibility of maintaining the continuity of the entire energy recovery process of the bottom ash. It is more efficient and necessary for boilers that are refurbished to control nitrogen oxide emissions (primary combustion control measures required by environmental legislation have been applied - eg C7 boiler at Govora CET) as the measures applied reduces the combustion air flow to the minimum (1.05 x stoiochiometric), so that the recovered bottom ash from the refurbished boiler has a higher content of unburned and higher calorific power than that recovered from untechnological boilers (C5 and C6) which works with excess air in the furnace.

As it results from the description, slag extrusion systems and alternative fuel dosing ensure the functionality of the project idea as defined and the project objectives have been achieved.

Director General Ion ROESCU	Departament STRATEGIE Ramona MARTIN	Director proiect Ion STOIAN