ACHIEVEMENTS AND FUTURE SOLUTIONS ON REINTRODUCING IN THE ECONOMIC CIRCUIT OF WASTE DUMPS AND DEGRADED TERAINS BY OPEN PITS FROM OLTENIA

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Abstract: The problem of reintroducing in the economic circuit the land affected by open pit mining have to be followed since the design phase because it has a marked influence on the quarry's limits, coefficient of stripping, and finally, the costs of extraction. Therefore, to determine the final contour of a quarry must be taken into account the interdependence between dimensions required for mining operations and the value of land expropriated, geometric parameters of the quarry and agrochemical characteristics of the surrounding and covering rocks.

This paper proposes a brief overview of current achievements in reintroducing in the economic circuit of areas degraded by quarrying activities in the basin Oltenia and identify solutions to meet the future needs of national and obligations incumbent on Romania after EU accession and the signing of numerous international environmental treaties.

Keywords: reintroducing in the economic circuit, waste dumps, quarries, degraded land, energy plants.

Introduction

Given that the tasks ahead for reuse degraded terrains by mining activities are very large and growing, especially in the mining basins of Oltenia, where open pit mining prevailed and which continues today, there must not be spared any effort to achieve high-quality work and achieve in this way, the maximum economic effect for reusing degraded lands in each variant.

The need and advantages of reintroducing degraded lands in the economic circuit

The entire mining activity carried out from the beginning in Oltenia considered the legislative provisions on advance planning of unproductive land in equivalent surface with the area removed from the circuit for mining needs. Unproductive land could exist in the mining area or other areas of the country where mining activity is not carried out, but there were terrains requiring accommodation.

Open pit mining, unlike the underground mining, is given options for improving the environment, particularly through development and optimal integration of waste dumps in the area's characteristic landscape, then a suitable and effective recultivation of land on these dumps.

Among the many reasons that support the need for remodeling and rehabilitation of land affected by human activities include:
- eliminating the risk of sliding the positive relief forms, occurred in an area by external storage of waste dumps;
- eliminate the negative visual impact of areas with lunar aspect;
- the need for reintegration of degraded lands in the circuit of production and/or ecological of the regions where they are, leading to regeneration of their economic potential;
- improving environmental quality;
- reduction of slopes and with it, reducing the intensity of erosion phenomena and accelerate the installation of vegetation;
- possibility to create new storage spaces for various types of waste in the pits remaining gaps [3].

Degraded lands and waste dumps restoration is based on the fundamental principles of ecological restoration, namely:
- the principle of globality or interdependency;
- the principle of ambiental autonomy;
- the principle of transparency and democracy;
- the principle of compliance with the population;
- the principle of economic efficiency;
- the principle of minimum size and reversibility;
- the principle of respect for tradition. [4]

Characterization of Oltenia region

The climate is temperate continental type with Mediterranean influences, with an average temperature of 10.3° C and an average annual precipitation of 753 mm, wind regime greatly influenced by the proximity of mountains and hills, the deforestation in the area, diversion of watercourses, the emergence of temporary or

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permanent artificial lakes and ponds, creating over time mutations in the microclimate in the mining basins of Oltenia.

The soils present in the region of Oltenia, fall in the class of low to high potential and they are selectively extracted and stored in warehouses before starting the actual extraction of overburden and lignite. Waste extracted and deposited in dumps, which has a moderate phosphorus content, moderate to high content in potassium and high pH, was shown to be suitable for restoring land made available after mining activities are stoped.

Because the chemical properties of waste materials fro the overburden is deposited in dumps, there was a rapid reinstallation of spontaneous vegetation on dumps surfaces released of technological tasks.

The first research on reintroducing in the economic circuitc of land degraded by mining in the Oltenia region began in 1968 and in 1972 was founded the first specialized unit area for redevelopment and recultivation with annual and multi-annual agricultural, forest, vine and different tree species of degraded lands by mining and their reintroduction in the production circuit.

Studies undertaken since 1968 and the results obtained led to a successful approach on land restoration activities.

Achievements on reintroducing in the economic circuit of waste dumps and degraded lands

Starting from the requirements of full and efficient use of land and taking into account the fundamental principles of ecological restoration specialists in the mining units, together with the territorial-administrative and representatives of public decided the restoration of degraded lands predominantly in agricultural and forestry puposes.

Reintroduction in the economic circuit of degraded lands by mining activity requires the redevelopment and modeling of areas and then their recultivation.

Mining redevelopment and modeling are activities that require several steps and technology, namely the recovery and conservation of topsoil, construction of waste dumps, dumps surface leveling, the improvement of the material stored in dumps, deposit the vegetal soil on the dumps leveled and improved surfaces.

General Information

Throughout the period when the quarrys were put into service in Oltenia, about 50 years, were affected and permanently occupied 17.432 ha of which 13.591 ha of agricultural land, respectively 78% and 3.841 ha of forest, belonging especialy to the mining basin Rovinari.

Area occupied structure is as follows: 49% respectively 8.144 ha is arable land, 22% respectively 3.841 ha of forest. It is noted that about 4.560 ha or 42% of the area occupied by mining have been a natural pastures and hay fields, categories of use that provides low and unstable production. Also throughout the duration of the mining activities were affected 362 ha (2.1%) orchards and 125 ha (0.07%) living hybrid culture with a great diversity of native species and varieties.

As utilities, 68% of the total land pased in the administration and heritage of SNLO Tg. Jiu, was designed for excavation work fronts and waste dumps, and only 32% for related activities, such as adjustments of watercourses, railways, electricity networks, roads, construction of a social nature, plants, etc. (example: for Jiu river regulation and construction of an artificial lake at Rovinari, were required surfaces amounted to 1,000 ha). [1]

Generally soils affected by mining activity differs depending on geological and geomorphological conditions, their productive potential is low to medium, so that they fall in reliability classes ranging from second to fifth.

In the mining activity the soil factor disappeared even if largely the arable horizon has been selectively exploited for later uses.

Materials deposited in waste dumps are very heterogeneous in terms of physical and chemicalcomposition, are generally devoid of biological activity and are extremely diverse in terms of mineralogical (sands, gravels, clays, marls) which makes the potential for fertility small, they fall in reliability classes fourth and fifth.

Agricultural recultivation

Following investigations, on the exterior dump of Tismana quarry were made between 1981-1983 viability experiments on four crops - wheat, corn, potatoes and clover - in terms of two types of clayey earth: yellow clay and blue clay, and during 1984-1985 was made another batch of experimental crops (four crops) on Cicani - Balta Unchiaşului waste dump, which consists predominantly of yellow clays: corn, wheat, oats and clover.

The experiments were placed in a 4 year rotation, and sola with clover aimed and contributing to the enrichment of organic matter and structure of land taken into cultivation. During 1993-1994 the experiments on Cicani waste dump were resumed, this time using six types of plants: potato, corn, oats, peas, barley and mash. [1, 5]

Viticulture and fruit growing tree recultivation

Waste dumps from Rovinari Mining Basin offers extremely favorable conditions for varieties of fruit trees in early adulthood or extraearly adulthood. The results achieved by the Research Station on Fruit Production Tg. Jiu on Cicani waste dump showed good behavior of apple and plum, at the age of 12 - 13 years the average productions obtained were of 24.9 t/ha, respectively 8.2 t / ha, cherry production was 4.1 t/ha, and for black cherry of 3.8 t / ha, for nuts the production was sporadic and hazel has been used successfully to stabilize slopes of the quarry and Gârla wast dump.

In terms of viticulture, vine plantations near Cicani have shown that good results can be achieved through proper preparation of land, which consists of basic and annual fertilization. Vine varieties grown in the Cicani – Gârla waste dumps area achieved normal production of qualitatively and quantitatively. Are noted Feteasca Royal 12.2 t/ha, Merlot with 11.7 t/ha and Italian Riesling with a production of 10.1 t/ha. [1, 6]

Forest recultivation

In the domain of forest recultivation is mentioned the afforestation done in the interior and exterior waste dumps of Gârla open pit, which occupies an area of 125 hectares, the plantation of pine in Tismana area who has 16 years of age and occupies an area of 32 ha of the external dump and 8 ha on slopes of the guard channel on the northern side of the pit, and the forests in Rovinari - Peşteana and Roşia de Jiu areas, which occupies 40 hectares.

Table 1 contains the area reintroduced in the economic circuit up to 2010, and in Table 2 the situation of the waste dumps from Oltenia and the areas occupied by them. [5, 6]

Table 1. Surfaces reintroduced in the economic circuit (2010)

No.	Mining unit	Total	Surface (ha)	
			From wich	
			agriculture	forest
1	E.M.C. Roşia	820,42	547,81	272,61
	Cariera Roşia	460,64	309,23	151,41
	Cariera Peşteana Nord	99,50	57,30	42,20
	Cariera Peşteana Sud	119,66	119,66	0,00
	Cariera Urdari	140,62	61,62	79,00
2	E.M.C. Motru	676,44	466,91	209,53
	Cariera Lupoaia	256,97	163,64	93,33
	Cariera Rosiuta	419,47	303,27	116,20
3	E.M.C. Berbeşti	303,80	303,80	0,00
	Cariera Berbeşti Vest	75,00	75,00	0,00
	Cariera Panga	185,33	185,33	0,00
	Cariera Olteț	43,47	43,47	0,00
4	E.M. Mehedinți	217,98	0,00	217,98
	Cariera Husnicioara	217,98	0.00	21798
TOTAL S.N.L.O.		1963,25	1097,38	865,87

Table 2. External waste dumps from Oltenia and the surfaces occupied by them

Crt. no.	Mining unit	Exterior waste dump	Surface	From wich		Surface	From wich		Suprafață	From wich	
			Provided in SET* or PE**	Forest	Agriculture	Occupied	Forest	Agriculture	To be occupied	Forest	Agriculture
1.	EMC Motru	Lupoița	69,14	32,15	36,99	69,14	32,15	36,99	0	0	0
		Valea Mănăstirii	558,95	0	558,95	403,39	0	403,39	155,56	0	155,56
		Steic (Lupoaia V-VI)	40,18	19,60	20,58	33,70	19,60	14,1	6,46	0	6,46
		Valea Cerveniei	40,53	32,41	8,12	40,53	32,41	8,12	0	0	0
		Bujorăscu	130,27	73,11	57,16	91,06	33,90	57,16	39,21	33,90	5,31
		Valea Rogoazelor	174,64	137,00	37,64	123,00	85,36	37,64	51,64	37,64	14,00
		Valea Ştiucani	119,32	69,04	50,28	119,32	69,04	50,28	0	0	0
		Potângu	64,02	0	64,02	64,02	0	64,02	0	0	0
	Total		1197,05	363,31	833,74	944,16	272,46	671,70	254,87	73,54	181,33
2.	EMC Peşteana	Peşteaua Sud	91,79	0	91,79	91,79	0	91,79	0	0	0
		Peşteana Nord	195,67	0	195,67	192,30	0	192,30	3,37	0	3,37
		Urdari	86,73	15,09	71,64	30,72	30,72	0	56,01	56.01	0
	Total		374,19	15,09	359,10	314,81	30,72	284,09	59,38	56,01	3,37
3.	EMC Jilț	Jilț Sud	660,73	193,48	467,25	344,00	42,00	302,00	326,73	42,00	284,73
		Jilț Nord	172,74	68,06	104,68	137,74	65,00	72,74	35,00	0	35,00
	Total		833,47	261,54	571,93	481,74	107,00	374,74	361,73	42,00	319,73
4.	EMC Pinoasa	Valea Negomir	667,93	133,89	534,04	197,00	85,28	111,72	470,77	337,04	133,73
Total			667,93	133,89	534,04	197,00	85,28	111,72	470,77	337,04	133,73
5.	EMC Roşia	Roşia	498,00	0	498,00	141,02	127,02	14,00	356,98	229,96	127,02
Total			498,00	0	498,00	141,02	127,02	14,00	356,98	229,96	127,02
6.	EM Mehedinți	Husnicioara Vest	282,64	0	0	120,42	81,99	38,43	160,22	80,23	79,99
	Total		282,64	0	0	120,42	81,99	38,43	160,22	80,23	79,99
7.	EM Berbeşti	Rugct	134,00	69,00	65,00	87,00	47,00	47,00	47,00	0	47,00
		Olteț	146,00	0,00	146,00	146,00	66,00	146,00	0	0	0
		Berbeşti Vest	85,00	66,00	19,00	75,00	37,00	9,00	10,00	0	10,00
		Panga Sud	48,00	0,00	48,00	48,00	0	48,00	49,00	0	49,00
		Panga Nord	137,00	37,00	100,00	88,00	0	88,00	0	0	O
Total			550,00	172,00	378,00	444,00	150,00	338,00	106,00	0	106,00
Total general			4403,26	945,83	3174,8	2643,14	854,47	1832,68	1769,95	818,78	951,17

Future solutions for reintroducing in the economic circuit of waste dumps and degraded lands

During the next decade, quarrys in mining basins of Oltenia will record notable changes in their overall geometry, due to changes in the method of operation by switching to interior waste deposits and also by using a higher proportion of transhipment of waste materials in dumps. Meanwhile, some quarrys will be closed due to depletion of reserves from the fields and we will see greater concentration of production in several bigger ones. This will result in reduction of areas taken out of the economic circuit and an increase of the surfaces rehabilitated and reintroduced in the economic circuit.

In conjunction with the production needed to be ensured for national economy and with the concrete technical and mining operation conditions in the quarrys, the dynamic of the occupied land and the reclaimed one for economic purposeis presented in Table 3. [2]

The analysis of the table shows that surfaces arranged and reintroduced in the economic circuit will be larger by 4.000 ha, compared to those occupied by mining activities in the period under review.

Reintroduction of degraded lands in the economic cycle will always respond to local owners interests and will be based on experience gained so far by the authorities and Romanian specialists in this field.

Selecting crops and plantations possible to apply in the future will be made taking into account the climate, the nature of the land and the positive experience gained in the field so far.

Talel 3. Dynamic of occupied lands and surfaces reintegraed in thr economic circuit (2009 - 2017)

Specification	Existent 31.12.2008	Period 2009 - 2017									Total
		2009	2010	2011	2012	2013	2014	2015	2016	2017	
New area occupied [ha]	18622	370	370	345	325	325	315	300	300	270	2902
Rehabilitated area [ha]	2990	594	573	586	597	795	790	801	1400	1400	6986
Total area occupied at the end of the year	15632	15408	15187	14946	14674	14204	13729	13228	12678	11548	125602

Alternatively to the set presented (agricultural, forestry, vine or fruit growing recultivation) is the technical crops.

Of these a category with high potential for cultivation in Oltenia and a more wide-scale use in developed countries are the energy plants, namely energy willow.

The opportunity to cultivate energy plants

Energy plants are used as fuel in heat/electric power generation.

By replacing fossil fuels they have the potential to reduce carbon dioxide emissions of greenhouse gases. Growing energy plants is required for Romania because:

- is part of the Kyoto Protocol to reduce greenhouse gas emissions by 12.5% in 2012 compared to 1990;
- must meet targets on shares of electricity production from renewable sources.

These things provide a significant opportunity for energy crop industry.

At this moment in Romania there are no wood energy crops planted, if not taken into account forest lands with various species of trees for industrial exploitation of which must pass dozens of years of their establishment. This proposal is primarily concerned with the energy willow crops, giving so far the best annual returns per hectare and allowing timber harvesting annualy or biennialy in good economic conditions.

As part of the complete chain of energy production from renewable sources, must be taken into account that is allocated three green certificates for electricity from biomass, according to Law 220/2008. which finally brings a significant added value for the entire system plantation - energy delivery.

Figure 1 shows the general scheme of power generation using energy plants (biomass).

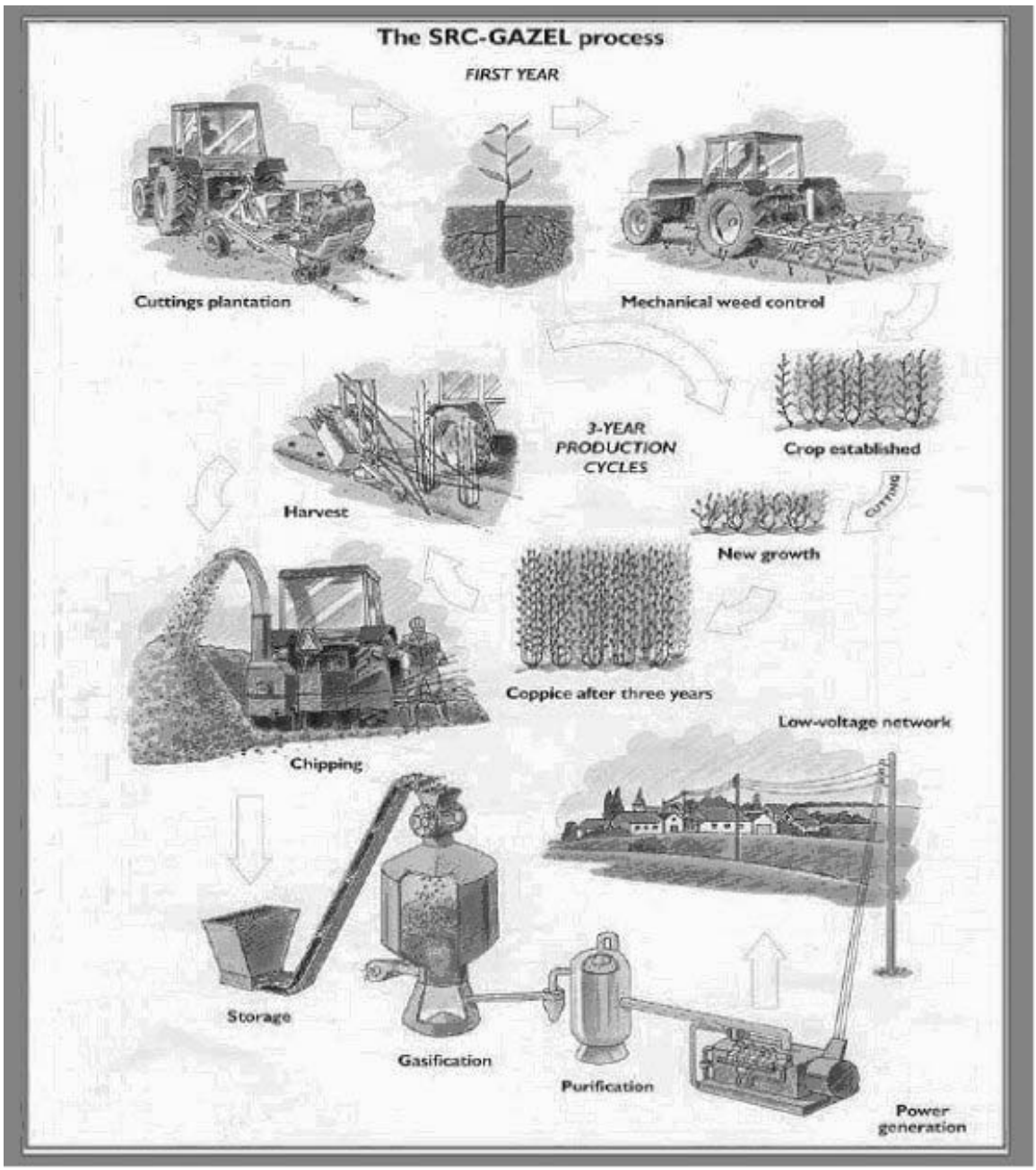

Fig. 1. The process of power generation using biomass

Proposals on the recultivation of degraded land with dumps and power plants

Energy crops consisting of varieties of willow ,dense planted, with a high yield with a harvest cycle of 1-2 years are most suitable for dumps and degraded lands from activities in the Oltenia mining basin.

Osier, a willow variety that grows in the form of a bush (Fig. 2.), is the basis of most varieties of willow planted for energy purposes. Energy willow is a wood culture, perennial, rhizomes or shoots remaining in soil after harvest, growing new branches next spring.

A plantation can be viable for 30 years before the need for replanting, this is according to productivity stalks.

Energy willow is planted in spring using planting material from specialist manufacturers and equipment for these purposes.

Willow will grow rapidly in the first year, reaching up to 4 m high. In the winter after planting, the stalks are cut from the ground to encourage the growth of several shoots, like a bush. Thr harvest normally occurs in winter, two years after the first cutting. The equipment used for harvesting is specially designed for such purposes and depends on the specifications required by the end customer in terms of biomass used. Most operations, except for planting and harvesting, are carried aut by using ordinary farm equipment.

Efficiency will depend very much on the type of soil and crop establishment efficiency.

Fig. 2. Plantations of energy willow and harvesting method

Willow roots, which are fibrous in nature, they penetrate deep into lands drainage and therefore it is recommended that willow to be planted at least at 30 m away from any drains which are considered important. When choosing an area must be considerd the life of the drainage system in connection with a projected life of willow culture.

To ensure economic efficiency of the culture must consider at least 3 ha for each plot. The best plots are those that minimize the need for short lengths of the lines or require changes in direction during field operations. The choice of lands that can be economically harvested is crucial. For easy operations would be ideal a plane terrain or with a slope of max. 7%. It is recommended that the slope of the land does not exceed 15%.

There must be ways to access for all the necessary equipment available during the establishment or harvesting of culture (Fig. 2). Width of access roads must be at least 4.5 m, but if it creates new ways to access it is recommended that this width to be 7.5 m. It must be taken into account the height of bridges or weight supported by access roads where necessary. The ideal areas for the transfer or storage of the crop must be adjacent to plantation areas.

Requirements on the structure of planting site

The structure of the planting site must take account of operational requirements. Wedge heads are required of min. 8 m in width at both ends to allow vehicles to turn. Where will be used a single trailer, or the harvesters have included a trailer, the length of rows should be restricted to max. 200 m to avoid the need to go in reverse along the rows for download. Where there will be present two or more trailers teh rows can be longer. However, where applicable treatments using liquid sludge from a cord, the maximum line length should be 400 m.

Accessibility of 4 m must be left along the plot edges to allow access for vehicles that spreads insecticides against willow beetles.

The effective preparation of the soil for willow planting is considered important. Considering that this culture is spread over a long period, is perennial, providing ideal conditions for its establishment will benefit by having good first and following harvests.

Weed control is a critical part of crop establishing. The complete eradication of all invasive perennial weeds is essential before planting. One or two applications of herbicide based on glyphosat in concentrations well established, must be made in summer/autumn prior to planting. Ideal first application of herbicide should be mid-summer followed by another application to control any renewal fall weeds. An additional application before spring planting may be needed on some lands. Appling herbicides only in spring will not be highly efficient.

If the land required will be needed scarifying to a depth of 40 cm to decompact the soil. Then it is needed to be make a plowing to a depth of 25 cm and leave during autumn/winter.

On light land a spring plowing is better to be done. Loosening the soil should be done immediately before planting.

Sludge, prepared manure, or other organic fertilizer with low nitrogen content can be incorporated into the soil before plowing. This is especially beneficial on light soils where moisture will increase retention and help conditioning the soil.

If rabbits are present, they must be kept away from the plantation at least the first two years until the first harvest, to allow the crop to mature after the stage when is vulnerable. In this purpose special fences may be raised against rabbits.

Conclusions

In Romania there are over 40 years experience in planning and reintroducing in the economic circuit of areas degraded by mining.

So far there have been reintroduced in the economic cycle, with good results, only in the mining basins of Oltenia, over 3.000 ha.

There have been studied over the years plantings and adequate crops to the new climate and soil conditions, establishing the best species of

trees and plants that will be used in future, in areas rebuilt after mining.

Depending on the necessary production of lignite to achieve and concrete conditions that will perform the work of extraction, were planned for the next ten years to be reintroduced in the economic circle of surfaces, so as to significantly reduce the gap between the areas of degraded lands and those introduced into the economic circuit.

It is expected that future technical plant crops (energy plants in this case) will replace traditional crops (agricultural, orchards, vineyards and forest) as the best option for rehabilitation of degraded lands and waste dumps from Oltenia mining basin.

This version has some economic advantages but also presents an advantage to align the environmental and energy policies from Romania to those in European Union in compliance with international agreements signed in the last 21 years.

The recovery of land affected by open pit lignite exploitation in Oltenia - Romania is in progress, so that problems of environmental restoration for the Romanian state is one of the key concerns.

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