The Potential for Sustainable Biomass in the Romanian Energy Sector

Activity 12: An examination of the sustainability and certification aspects of black pellets

Description of the activity: Using the information obtained in Activities 2-4 and 10-11, taking into account existing national legislation and the main parameters of the Romanian biomass market, we will examine to what extent the black pellets technology meet existing national sustainability/ traceability standards and criteria and what certification risks can occur if this technology were to be introduced on the local market.

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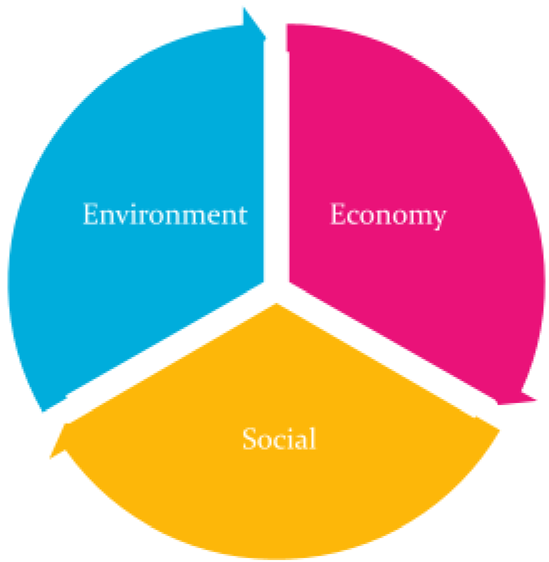
Contents

1. The environmental pillar of biomass

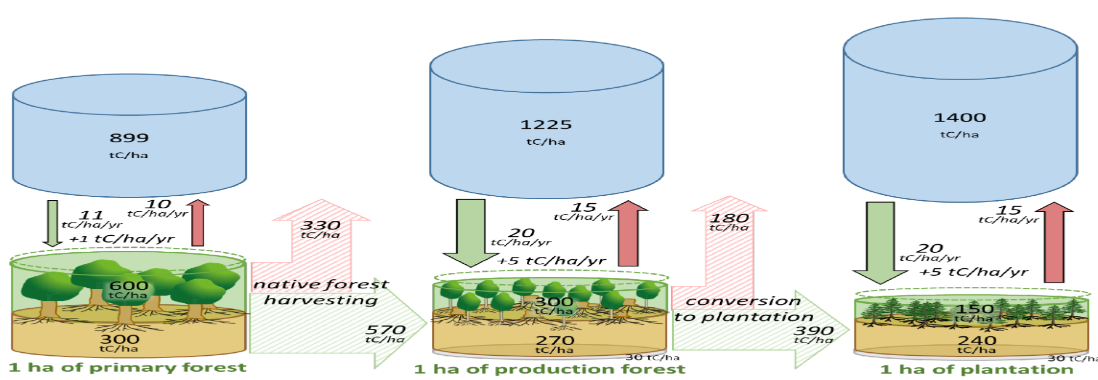
In order to prove the black pellets technology sustainability, we should start from the biomass usage for energy sustainability analysis.

Sustainability means tree pillars.



Biomass is currently considered a very important renewable resource that has two great advantages: it stores solar energy through biological processes, and it transfers carbon dioxide from the atmosphere to the biosphere, so by definition, biomass production is a carbon-neutral process.

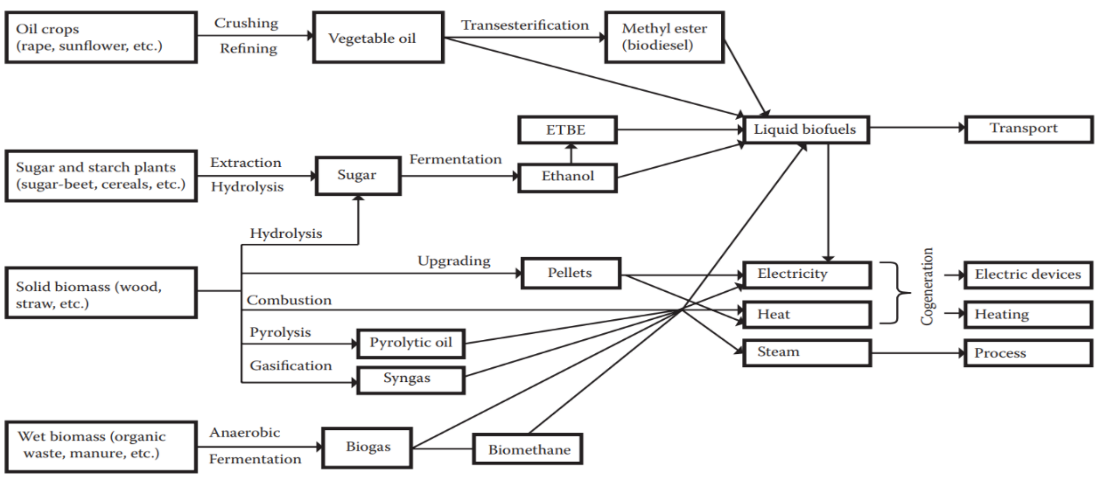
Carbon stocks (Roman characters) and fluxes (Italic characters) in a forest



Source: Keith și colab., în 2019

The agricultural biomass potential, represented mainly by stalks, including corn cobs, was estimated between 21.5 and 35.8 million tons, based on the production of 2017, according to the Fundulea National Agricultural Research and Development Institute.

Biomass utilization flow



Source: Nelson and Starcher, 2016, p. 73

According to Minister of Environment in Romania, the biomass volume will rise from 2039 mil mc in 2015 to 2221 mil mc in 2050.

2. The economic pillar

Indicators of biomass production from lignocellulosic energy crops grown in short rotation cycle system (SRF – Short Rotation Forestry)

Energy crop type	Biomass type	Biomass production (t_{dm}/ha)	Moisture at harvest (%)	Lower calorific value (MJ/kg_{dm})	references

Poplars	wood	9-12,5	50-60	17,7-18	Candolo, 2006
		9-13	50	18,6-19,1	Foppa Pedretti și colab., 2009
		11,8-17	50	-	Ranalli, P., 2010
		9,56	-	-	Coaloa D. și colab., 2009
Willow	wood	10-15	50-60	17,8-18,4	Candolo, 2006
		10-15	50	18,4-19,2	Foppa Pedretti și colab., 2009
Acacia (Robinia pseudoacacia)	wood	5,6-17,1	-	-	Mardikis și colab., 2000
		10-13	50-60	17,7-17,8	Candolo, 2006
		10-15	50	17,8	Foppa Pedretti și colab., 2009
		8,75	-	-	Coaloa D. și colab., 2009
Coniferous forests	wood	35-60	40-50	18,8-19,8	Foppa Pedretti și colab., 2009

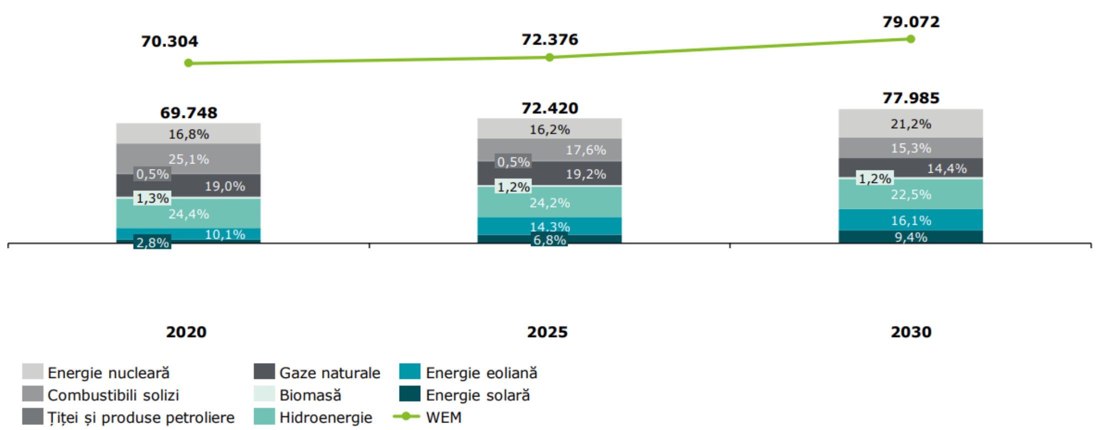
Deciduous forests	wood	36-60	40-50	18,5-19, 2	Foppa Pedretti și colab., 2009

Complete energy balance for primary solid biomass, Romania, Terajoule (TJ)

	1.I-31.III.2023	1.I-31.III.2023 față de 1.I-31.III.2022	
	milioane kWh	Diferențe (±) - milioane kWh -	%
Resurse – total	**17367,0**	**+363,8**	**102,1**
- Producţie	15680,5	+800,0	105,4
- în termocentrale clasice	5223,9	-409,6	92,7
- în hidrocentrale	4728,7	+1353,7	140,1
- în centrale nuclearo-electrice	2998,8	-22,3	99,3
- în centrale electrice eoliene	2431,0	-71,4	97,1
- în centrale solare fotovoltaice	298,1	-50,4	85,5
- Import	1686,5	-436,2	79,5
Destinaţii – total	**17367,0**	**+363,8**	**102,1**
- Consum final	12694,2	-1232,4	91,2
- în economie	9589,6	-653,7	93,6
- iluminat public	105,4	-43,2	70,9
- populaţie	2999,2	-535,5	84,9
- Consum propriu tehnologic în reţele şi staţii	1558,0	-58,2	96,4
- Export	3114,8	+1654,4	213,3

Source: Country Analysis – Romania BIO SCREEN CEE

Gross Electricity Production WAM vs. WEM [GWh]



Sursă: Calcule Deloitte pe baza informațiilor transmise de Grupul de lucru interinstituțional PNIESC și a recomandărilor COM

Source: Deloitte

Characteristics of agricultural residues and dedicated energy crops

The raw materia	**Dry mass production**	**Lower calorific value**	**Energy produced**	**Water content at harvest**	**Ash content at harvest**
	tone/hectar/an	MJ/kgDM	GJ/hectar	%	
Herbaceous biomass					
Pai	2-4	15-18.1	35-70	14.5	5.0
Culturile erbacee					
Miscanthus	8-32	17.5-18.1	140-560	15.0	3.7
Switchgrass	9-18	16.8-18.6	150-335	15.0	6.0
Giant reed	15-35	16.3-18	245-570	50.0	5.0
Canary grass	6-12	16.3	100-130	13.0	4.0
Wood crops					
Wilow	8-15	16.7-18.5	280-315	53.0	2.0
Poplar	9-16	18.7	170-300	49.0	1.5
Acacia	5-10	18.5-19.5	100-200	35.0	N/A
Wood	3-14	18.7	56-262	50.0	1-1.5

Source: IRENA (2018), Solid biomass supply for heat and power: Technology brief, International Renewable Energy Agency, Abu Dhabi

Potential for net biomass energy gain for COP farms in Romania in millions of kWh

Mărimea medie a fermei în hectare	20	200	1000	Estimare totală ferme COP din România
Număr de ferme	60000	8000	850	
Câștigul net de energie din biomasă	**6231,1**	**7839,7**	**4050,8**	**18121,6**

Source: Evaluation of the potential of solid non-forest biomass stocks in Romania, Lazăr Cătălin, Petcu Elena, Cizmaș George, Petcu Victor, Partal Elena

3. The social pillar – ideas

Comparative table of social benefits on different alternative energy sources

Photovoltaic panels/ Windmills	Biomass
- - Manpower required in the design; - - Labor required in construction;	- Manpower required in the preparation of the land; - Labor required in the etablishment of the plantation; - Labor required in the agricultural works of the culture; - Manpower required in handling the crop

The social pillar is an important one for communities in rural areas where poplar or willow crops can be established.

For 250 hectares dedicated to such crops, approximately 10-15 people are involved in most production stages: planting, maintenance, harvesting, distribution. Moreover, the human factor also intervenes in the case of subsequent heating activities. The establishment of specific biomass crops diversifies the rural economy and contributes to the decrease of the unemployment rate, migration and ensures sustainable development from the perspective of all three pillars: economic, social and environmental.

4. Leopold matrix for biomass – initiation

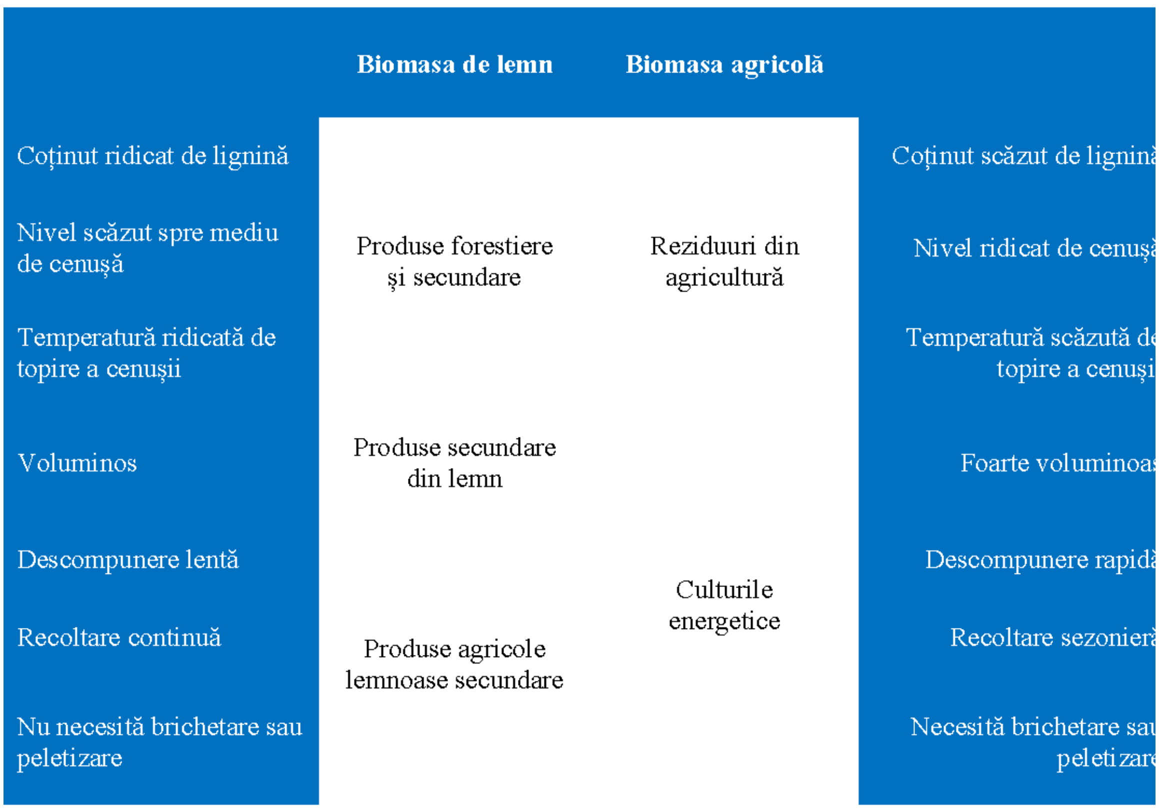
Residual biomass that comes from economic activities in which it is used as a raw material, for example: vegetable residues resulting from the harvesting of the main agricultural products (straw, cobs, stalks, etc.); lignocellulosic residues from forestry and wood processing; by-products and residues from the food industry (fruit pulp, beet pulp, pulp, whey, animal fats, brewer's yeast, sludge from treatment plants from the food industry, etc.).

HIGH DEGREE OF SUSTAINABILITY, BUT NOT ENOUGH

Biomass from energy crops specifically intended for processing to obtain energy and non-food products, for example: corn for the production of bioethanol, rapeseed for the production of biodiesel, energy willow for the production of solid biofuel, etc. There are agricultural lands, which, although they are classified in higher creditworthiness classes, may contain pollutants that are found in the food products obtained in these areas.

(Source: The role of biomass in environmental conservation, rural development and farm resilience. Cost-benefit analysis regarding the cultivation of plant matter specific to biomass)

Diferența dintre biomasa de lemn și biomasa agricolă



Sursa: IRENA (2018), Solid biomass supply for heat and power: Technology brief, International Renewable Energy Agency, Abu Dhabi

Socio-economic impact - categories:

- employment and economic income;

- food security;

-macroeconomic development;

- rural economic development;

- access to energy;

-energy independence;

- economic feasibility;

- health and safety;

- land rights;

- working conditions;

-social acceptability;

-equal opportunities and community impact.

(Source: The role of biomass in environmental conservation, rural development and farm resilience. Cost-benefit analysis regarding the cultivation of plant matter specific to biomass)

IMPACT MATRIX

The impact on ecosystem services generated by the production of electricity through coal combustion and biomass combustion – comparative approach

The ecosystem service	**Impact matrix**	
	Electricity by burning coal	Electricity by burning biomass
Supply services		
Animal products	=	--
Vegetable products (harvests)	=	--

Aquaculture, fishing	-	=
Wood	=	--
Peat	=	=
The water	--	=
Genetic resources	-	-
Support services		
Soil formation	-	=
Nutrient recycling	=	+
Primary production	=	++
Habitat	--	+
Production of atmospheric oxygen	--	++
Regulation services		
Mitigation of natural hazards	--	=
Climate control	--	++
Regulation of pathogens	-	=
Regulation of pest populations	=	=
Pollination	=	=
Water purification	--	+

Air quality	--	-
Soil quality	-	+
Cultural services		
Religious beliefs, spirituality	-	=
Education and inspiration	=	=
Recreation and aesthetic values	-	-
Note: "=" - without impact; "+" - positive impact; "++" – highly positive impact; "-" - negativ impact; "—" – highly negative impact.		

Sustainability of biomass used for energy

CASE STUDIES - biomass from agriculture

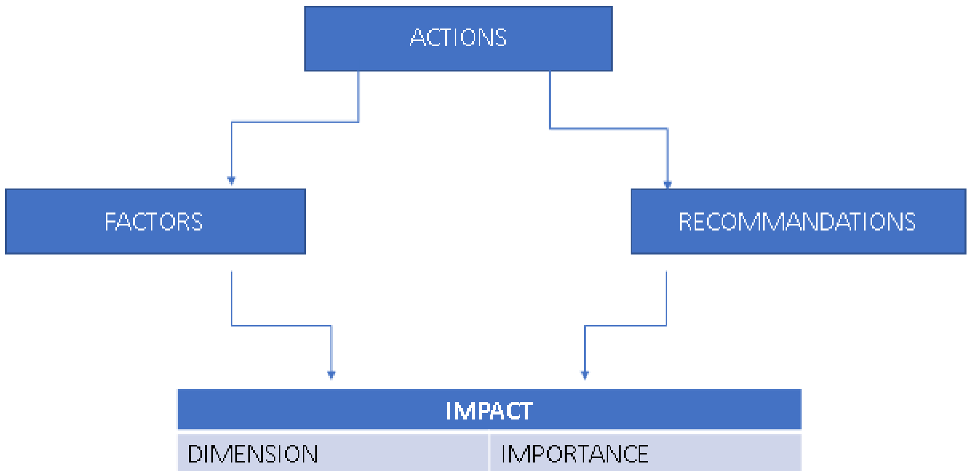
With a declared non-cultivated subsidized area (including protected areas) of 38,688.26 hectares at the level of 2021 according to APIA, Romania could increase the degree of energy security by dedicating these areas to biomass-specific crops.

Thus, in the context where these areas would be cultivated with poplars, (a) with a duration of 5 years per rotation, and (b) a productivity of 12.5 dry tons per hectare per year in the case of the first rotation and 14, 4 dry tons per hectare per year, then in the first year of harvesting, a quantity of 483,603 tons would be obtained, corresponding to 8,946,660 GJ.

Economically exploited, revenues of EUR 74,083,768 could be generated, given that the price per ton is EUR 153 and the price per GJ is EUR 8.3.

In addition to the economic and environmental benefits, these activities would engage more than 1,500 people from the countryside in order to cultivate the 38,688.26 hectares of hectares and achieve the estimated production of 483,603 tons, in the first harvest year alone. Against the backdrop of energy price volatility, the allocation of as many hectares as possible for such crops is economically opportune, financially necessary, ensures sustainable development and increases the level of energy security in Romania.

LEOPOLD MATRIX



RECOMMANDATIONS:	- Modification of the current format of Annex no. 4 of the Procedure for issuing certificates of origin for biomass originating from forestry and related industries and used in the production of electricity from renewable energy sources in order to achieve a traceability of the wood material to be exploited. Moreover, it would be important to determine the primary and secondary processing at the level of the previously mentioned procedure, so that certain raw materials resulting from biomass from the forestry sector are no longer confused with agricultural biomass willy-nilly or by necessity by the competent control authorities. - Within the Order on the amendment and completion of the Procedure for issuing the certificate of origin for biomass from agriculture and related industries,

	used as fuel or raw material for the production of electricity, issued by MADR there is no clear delimitation at the level of the vegetation cycle in the function of the energy crop cultivated by the farmer. Practically, poplar and energy willow can be harvested after 4 or 5 years, the maximum production value being approx. 48-52 tons/ha. There should be a column in the annexes where an annual distribution of at least 8 tons/ha can be achieved. We are talking about an agricultural crop, but not one that enjoys the cultivation-harvest process over the course of a maximum of 12 months. - The importance of creating a legislation dedicated to biomass in order to avoid residues resulting from the processing and full utilization of this resource. - Sustainability criteria should be carefully redefined - Biomass from both the forestry and agricultural sectors whose processed trees have a diameter between 12-14 cm must be registered in the application of the Ministry of Environment, Water and Forests - SUMAL 2.0. Practically, an APV must be carried out by the Forest Department before each harvest. Thus, in the case of agricultural biomass that is produced in a large amount, but not with an annual regularity, I consider that it represents nothing more than an additional bureaucratic aspect for the farmers' activity. The proposal aims at the possibility of making a report at the plot level in which the volume of the harvest, made by the farmer and entered in SUMAL 2.0, is mentioned.

	- Biomass from both the forestry - Certificates for agricultural biomass - must meet sustainability criteria for which they are not known - Energy efficiency program - Wreck Programme for an efficient pellet boiler, since there are 3 thousand household stoves with combustion efficiency 15%, and one stove consumes 5-6 cubic meters of wood/year
ACTIONS	To promote the use of biomass for energy - Proposal 1 – biomass from agriculture - Proposal 2 – biomass from forestry - Proposal 3 – biomass from waste
FACTORS	To promote the use of biomass for energy - Economical – opportunity of use - Social – the attractiveness and stability of new jobs - Environmental – the net positive effect for environmental factors
IMPACT	To promote the use of biomass for energy - Economic – new businesses, new sectors, new market opportunities - Social – the attractiveness and stability of new jobs - Environmental – the net positive effect for the environment

5. Matrix of potential effects on the environment

AER (sursele de poluare pentru aer sunt reprezentate de surse staționare nedirijate reprezentate de totalitatea utilajelor de pe amplasament) și surse mobile reprezentate de mijloacele de transport utilizate pentru transportul materialului la beneficiari)	IMPACT CU EFECTE NEGATIVE NETE	IMPACT CU EFECTE POZITIVE NETE	Nr. Crt.
-Emisii de pulberi în suspensii și pulberi sedimentabile datorate activității de exploatare și circulației mijloacelor de transport se va situa sub limita maximă	N	Impactul activității desfășurate prin emisiile generate (gaze de eșapament și pulberi în suspensie și sedimentabile) nu va avea influențe majore asupra calității aerului, limitele în care se vor situa fiind admisibile	1
-Emisii de noxe provenite de la gazele de eșapament ale motoarelor utilajelor de extracție și transport se situează sub valorile maxime admise	N		2
Impact general	**NEGLIJABIL**		

Nr. Crt.	APA	IMPACT CU EFECTE NEGATIVE NETE	IMPACT CU EFECTE POZITIVE NETE
1	asupra apelor de suprafață	N	- nu rezultă ape uzate menajere sau industriale;
2	asupra apelor subterane	N	
3	asupra apelor pluviale	N	
	Impact general	**NEGLIJABIL**	

SOL SI SUBSOL	IMPACT CU EFECTE NEGATI-VE NETE	IMPACT CU EFECTE POZITIVE NETE	
-Modificarea proceselor pedogenetice	N		1
-Modificarea proprietăților fizico-mecanice ale solului	N		2
-Modificarea proprietăților hidrofizice, de aerare și termice	N		3
-Scoaterea temporară din circuitul agricol	N		4
-Ocuparea și impermeabilizarea suprafețelor afectate	N		5
-Manipularea cobustibililor și lubrifianților	N		6
Impact general	**NEGLIJABIL**		

	ECO-SISTEM (disturbarea speciilor de interes conservativ)	IMPACT CU EFECTE NEGATIVE NETE	IMPACT CU EFECTE POZITIVE NETE
1	Emisii atmosferice	N	Implementarea măsurilor tehnice propuse pentru reducerea emisiilor atmosferice, respectiv reducerea zgomotului generat de exploatare vor reduce apariția unui eventual impact negativ
2	Zgomot și vibrații în exploatare	N	
	Impact general	**NEGLIJABIL**	

ECONOMIC ȘI SOCIAL (referitor la ocuparea forței de muncă din zonă și a veniturilor la bugetul local)	IMPACT CU EFECTE NEGATI-VE NETE	IMPACT CU EFECTE POZITIVE NETE	
Crearea de noi locuri de muncă	=	Se creeaza locuri de munca, se deschid noi oportunitati pentru Consiliul Local, se colecteaza taxe și impozite	1
Venituri ale bugetului local și aportul la bugetul national	=		2
Impact general	**MEDIU**		

Matrix of potential effects on the environment

ENVIRONMENTAL ASPECTS	POLLUTANT EFFECTS ON THE ENVIRONMENT									
	Significant	Secondary	Summary	Synergy	Short	Medium	Longte	Perma	temporary	Positive	Negative

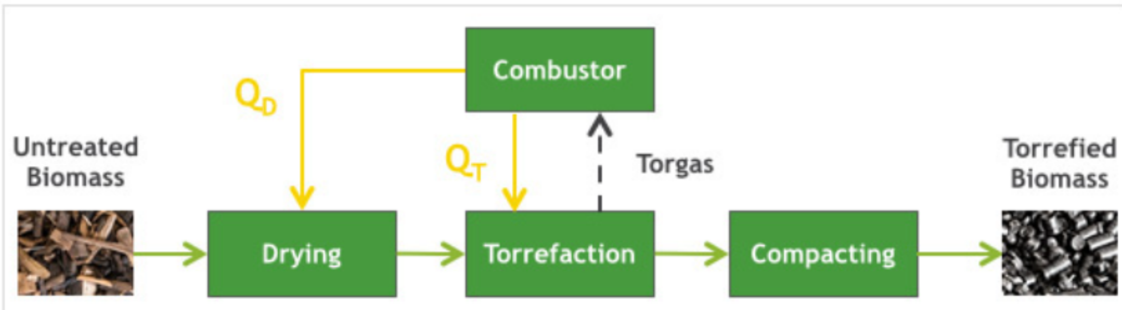
AFFECTED					**te r m**	**ter m**	**r m**	**ne nte**			
1. Water	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0**	**0**
2. Air	**-**	*	**-**	**-**	*	*	**-**	**-**	**-**	**0**	**3**
3. Ground + basement	**-**	*	**-**	**-**	**-**	**-**	**-**	**-**	*	**2**	**2**
4. Biodiversity	**-**	*		**-**	**-**	**-**	**-**	**-**	*	**2**	**2**
5. Landscape	**-**	**-**	**-**	**-**	**-**	*	*	*	**-**	**0**	**3**
6. Social and economic environment	**-**	**-**	*	**-**	**-**	*	*	**-**	**-**	**0**	**3**
7. Population	**-**	**-**	**-**	**-**	**-**	*	**-**	**-**	**-**	**1**	**1**
TOTAL	**0**	**3**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**5**	**14**

6. Black pellets technology

One of the black pellets tehnology is TERREFACTION (https://www.blackwood-technology.com/) .

Biomass torrefaction is a thermal process used to produce high-grade solid biofuels from various streams of woody biomass or agro residues. The end product is a stable, homogeneous, high quality solid biofuel with far greater energy density and calorific value than the original feedstock. This provides significant benefits in logistics, handling and storage. It also opens up a wide range of potential uses for biomass.

Basic Torrefaction principle



Source: https://www.blackwood-technology.com/

According to this licensed technology, typically the torrefaction process results in a mass loss (dry basis) of 20-30% and an energy loss of 10-15%. To make a biomass torrefaction plant economically viable it is crucial to use the energy released in the volatiles. This can be done by burning the volatiles (torgas) in a lean gas combustor. The combustor can provide the heat for the drying and torrefaction. When the input feedstock has a moisture content of 35-45% the torrefaction process can be run auto-thermal. At higher mopisture content extra support fuel is needed to produce all the energy needed for the drying process.

State-of-the-art biomass torrefaction technologies, like Blackwood's *FlashTor®* technology, are able to burn the torgas and control the torrefaction process in such a way that the energy released in the torgas does not exceed the energy needed for drying and torrefaction.

Main benefits of the torrefied pellets over regular wood pellets

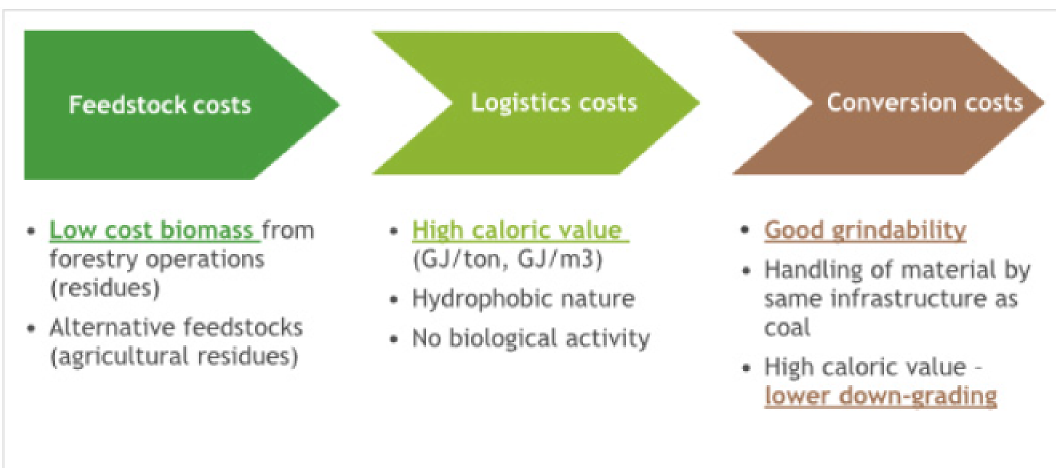
- Higher calorific value
- More homogeneous product
- Higher bulk density
- Excellent grindability
- Higher durability

- Hydrophobic nature/water resistance
- No biological activity

Torrefied pellets are the ideal coal replacement:

- Grinds & burns like coal – existing coal infrastructure can be used
- Lower feedstock costs
- Lower shipping and transport costs
- Minimal de-rating of the power plant
- Provides non-intermittent renewable energy
- Lower sulfur and ash content (compared with coal)

When we discuss about this technology sustainability, the owner emphases its cost reduction.



Sursa: https://www.blackwood-technology.com/

The second technology for black pellets is steam explosion method.

The steam explosion method of pretreatment of wood fibers involves exposing the material to saturated steam. The temperature and steam pressure as well as the time spent in the reaction vessel determine the amount of hemicellulose that is degraded and what fraction of the raw material is converted to volatiles and biochemical compounds. The subsequent explosion of steam represents the rapid release of pressure. This explosive expansion of the water in the cell walls of the lignocellulosic raw materials causes a breakdown of the wood fibers into very small particles. The severity of the steam treatment is controlled so that the cellulose and lignin are affected to a minimum, while the hemicellulose is partially degraded. Compared to white pellets, the resulting material after densification in a pellet press has a higher specific energy content (gigajoules per cubic meter, GJ/m3), improved grinding, is hard and produces fewer fines, and its affinity for water changes from hygroscopic to hydrophobic. The steam explosion process causes the lignin to rise to the surface of the fine wood fibers in the form of small balls. When the fiber is densified in the pellet press, these pearls form a film-like surface layer covering the decomposed wood fibers, resulting in hard, highly water-resistant pellets that produce almost no fines.

While white pellets are the main type currently used, black pellets offer significant advantages such as reduced moisture content and higher calorific value, bulk density, energy density and water repellency – reducing losses during storage. Steam explosion pellets offer the additional advantage of producing almost no dust in handling, reducing explosion risk.

Other technologies are for pellets for non-industrial use are under Standard EN 14961-2. This European standard determines the fuel quality classes and specifications of wood pellets for non-industrial use. This European standard covers only wood pellets produced from the following raw materials

1.1 Forest, plantation and other virgin wood;

1.2 By-products and residues from wood processing industry;

1.3 Used wood.

For the avoidance of doubt, demolition wood is not included in the scope of this European Standard. Demolition wood is “used wood arising from demolition of buildings or civil engineering installations” (EN 14588:2010, 4.52). Torrefied pellets are not included in the scope of this European Standard. Torrefaction is a mild pre-treatment of biomass at a temperature between 200 °C to 300 °C.

In Romania there is no factory for black pellets yet.

7. Black pellets sustainability analysis

Economic:

The cost of producing pellets is dependent on a number of factors. A typical breakdown of cash flows for a facility producing pellets for domestic consumption suggests that procurement of the fibre is the most costly component, at around AU$60-75 per tonne of pellet fibre produced. Operational costs vary depending on the energy source for drying and the initial moisture content of the feedstock and may range between AU$25-40. Assuming use for local power generation, the costs of moving the pellets from the mill to the power plant may be AU$10-20. An economically viable pellet mill project must typically generate at least AU$26-$33 in EBITDA (earnings before interest, taxes, depreciation and amortization) per tonne produced (State of New South Wales through the Department of Industry, 2019).

Key characteristics of fuels for power generation

	Wood chips	White pellets	Torrefied pellets	SE pellets	Charcoal	Coal
Moisture content (wt%)	30-55	7-10	1-5	4-6	1-5	10-15
Calorific value (LHV, MJ/kg)	7-12	15-17	18-22	19-20	30-32	23-28
Volatile matter (wt%, db)	75-84	75-84	55-80	70-80	10-12	15-30
Fixed carbon (wt%, db)	16-25	16-25	22-35	23-30	85-87	50-55
Bulk density (kg/l)	0.20-0.30	0.55-0.65	0.65-0.80	0.75-0.80	0.18-0.24	0.80-0.85
Vol. energy density (GJ/m³)	1.4-3.6	8-11	12-19	12-15	5.4-7.7	18.24
Hygroscopic properties	Hydrophilic	Hydrophilic	Moderately Hydrophobic	Hydrophobic	Hydrophobic	Hydrophobic
Biological degradation	Fast	Moderate	Slow	None	None	None
Product consistency	Limited	High	High	High	High	High
Transport cost	High	Medium	Low	Low	Medium	Low

Source: State of New South Wales through the Department of Industry, 2019

Environment:

Use of coal and biomass pellets to generate electricity involves combustion, which results in carbon dioxide (CO_2) emissions. However burning biomass emits carbon that is part of the natural, short-term carbon cycle, whereas burning coal releases carbon that has been buried in the ground for millions of years. The release of the carbon from a fossil fuel source has a known negative impact on the climate. The energy generated from biomass is considered renewable, provided the biomass used is derived from sustainably managed systems where the biomass removed is replaced by new growth. In order to ensure the sustainable nature of biomass used for energy generation, it is important that rigorous sustainability governance is in place. Similar systems are already in place for a range of different industries (e.g. certification systems for the timber industry) (State of New South Wales through the Department of Industry, 2019).

Social:

Look of what is obvious: All factories involved in such technologies are safer for their employees. The social benefits are clear against all classic energy plant.

8. Sustainability criteria for black pellets

The RED II defines a series of sustainability and GHG emission criteria that bioliquids used in transport must comply with to be counted towards the overall 14% target and to be eligible for financial support by public authorities. Some of these criteria are the same as in the original RED, while others are new or reformulated. In particular, the RED II introduces sustainability for forestry feedstocks as well as GHG criteria for solid and gaseous biomass fuels.

Plant operation start date	Transport biofuels	Transport renewable fuels of non-biological origin	Electricity, heating and cooling
Before October 2015	50%	-	-
After October 2015	60%	-	-
After January 2021	65%	70%	70%
After January 2026	65%	70%	80%

Default GHG emission values and calculation rules are provided in Annex V (for liquid biofuels) and Annex VI (for solid and gaseous biomass for power and heat production) of the RED II. The Commission can revise and update the default values of GHG emissions when technological developments make it necessary. Economic operators have the option to either use default GHG intensity values provided in RED II or to calculate actual values for their pathway.

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