



Waste biorefinery technologies for accelerating sustainable energy processes

# Refuse Derived Fuel Char - A promising energy resource.

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WG1



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## 01 Contextualization

## 02 What's Refuse Derived Fuel (RDF), its limitations and what it takes to overcome it?

Pelletization

Carbonization

## 03 Possible applications of RDF

Energy recovery

## 04 Perspectives of RDF in the energy sector and conclusions

# 01 Contextualization



The PhD project aims to develop an integrated gasification process for the conversion of refuse derived fuel (RDF) into renewable gases.

This study will also include the recovery of by-products such as tar and unconverted material.

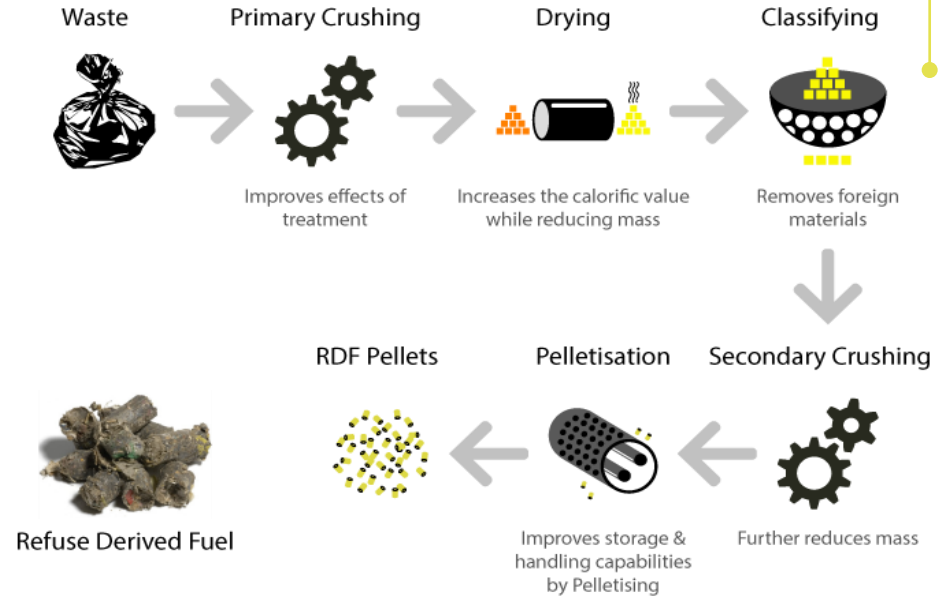


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# 02 Refuse Derived Fuel: what it is?

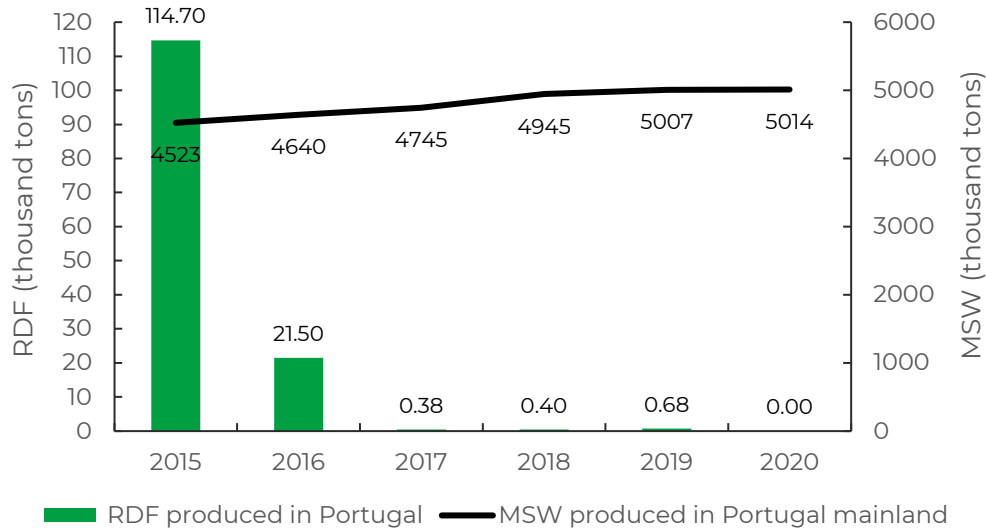
- **Alternative fuel** obtained from the processing of non-hazardous waste, such as **MSW**.
- **Produced at the mechanical-biological treatment plant**, through various sequential processes:



➔ These operations reduce the concentration of hazardous substances, such as inert materials, metallic materials, and those with high concentrations of chlorine (e.g., polyvinyl chloride (PVC)).

# 02 Refuse Derived Fuel: production

- RDF is mainly composed of carbon derivatives. Plastic, textiles, and paper were the main components.

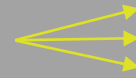


**Figure 1:** Production of MSW and RDF in Portugal (thousand tons)

- **Since 2019, the RDF has not been officially produced** in Portugal;
- **64 % of MSW** in Portugal is **landfilled**;
- If 1 ton of MSW can generate 500 to 600 KWh of electricity, **Portugal is wasting approximately 1604 GWh of electricity**. This energy could be used to supply **486,000 Portuguese family homes**.

# 02 Refuse Derived Fuel: composition

Variability



Production source  
Seasonality  
Production line

**Table 2:** Chemical characteristics of different RDF.

Samples	Fluxo de resíduos	Moisture (%ar)	Ashes (%db)	Volatile matter (%db)	Fixed carbon (%db)	Higher heating value (MJ/Kg)
RDF	MSW	0.99	10.04	79.10	9.60	23.90
RDF	CIW	1.30	16.10	71.90	10.70	22.35
RDF	MSW	3.70	18.90	67.60	9.80	22.30
RDF	MSW	1.70	17.70	73.60	7.00	24.60
RDF	MSW	19.70	20.40	49.10	10.80	13.90
SRF	MSW	28.11	9.65	55.99	6.36	14.78

**RDF:** refuse derived fuel; **SRF:** solid recovered fuel; **MSW:** municipal solid waste; **CIW:** common industrial waste

## RDF has high variability in its morphological composition:

- Heterogeneity;
- Rich in different polymers;
- Low density;
- Low grindability;
- High moisture content;
- High ash content;
- Significant chlorine content.



... which limits its application.

## Pelletization

This is a process of compacting loose materials (such as, RDF fluff) by extrusion to form a densified and homogeneous product (pellets). It allows...



### Volume reduction

Lower transportation and storage costs



### Moisture reduction

Lower transportation costs and storage can be extended



### Density increase

Lower transportation and storage costs, easier handling, and feeding into energy systems



### Greater homogeneity

Uniform kinetics and energy requirements during the conversion process



# 02 Refuse Derived Fuel: Pelletization



RDF



Crusher



Pelletizer



RDF Pellets

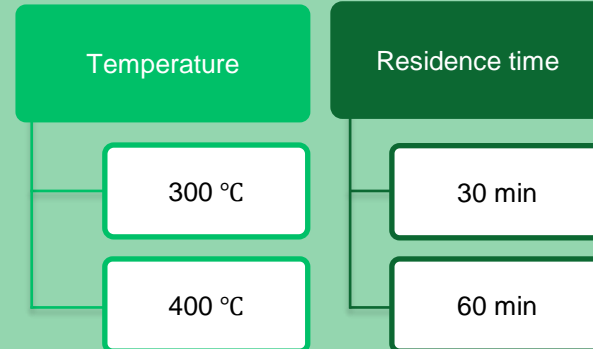
Parameters	Units	RDF pellets	Wood Pellets ENplus B
Bulk density	(kg/m <sup>3</sup> )	698.80 ± 1.70	600 ≤ BD ≤ 750
Durability	(% ar)	99.60	≥97.5
Amount of fines(< 3,15 mm)	(% ar)	0.46	≤1.0 or ≤ 0.5

# 02 Refuse Derived Fuel: solutions

It is the heating of organic matter in the absence of oxygen at atmospheric pressure to a temperature of 300-500°C, in order to obtain a value-added product (char).



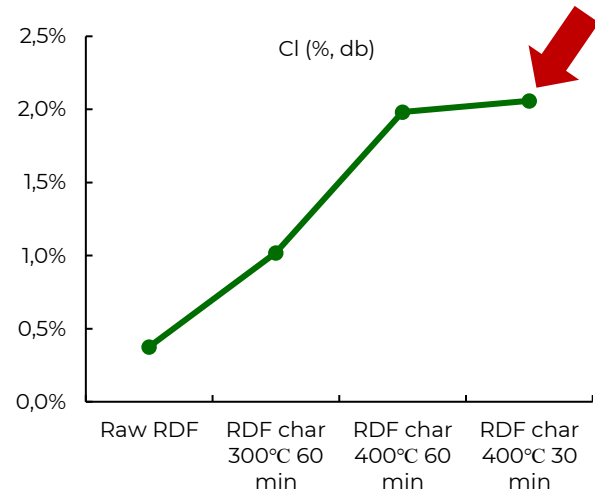
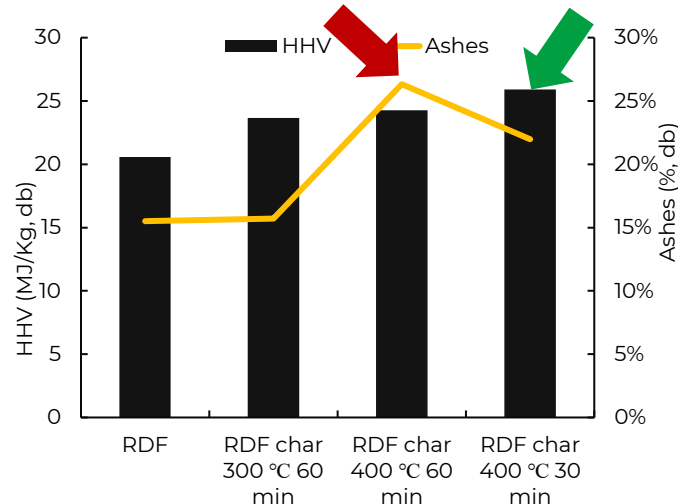
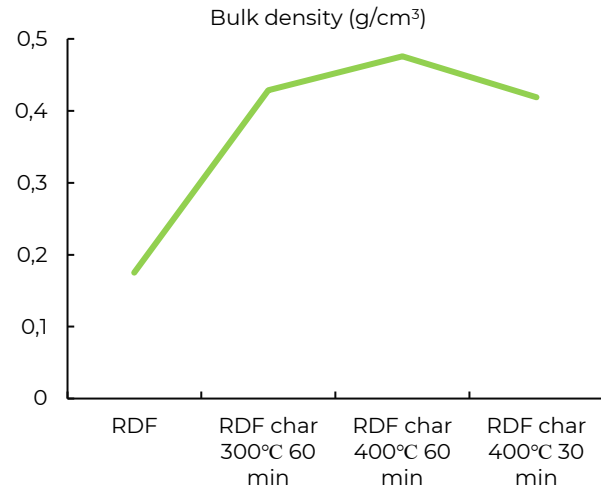
## Carbonization



# O2 Refuse Derived Fuel: Carbonization W I R E

**Table 1:** Results of mass yield, energy density and characterization of raw RDF and RDF chars.

Sample	Operating conditions	Yield (%)	Moisture (%)	Volatile matter (% db)	Fixed carbon (% db)	Energy density
RDF char	300°C 60 min	74.27 ± 0.23	2.23 ± 0.50	77.83 ± 4.39	6.45 ± 4.04	1.15
	400°C 60 min	58.77 ± 3.09	2.86 ± 0.22	63.24 ± 2.64	10.43 ± 1.33	1.18
	400°C 30 min	64,30 ± 1,47	3.03 ± 0.28	66.30 ± 5.19	11.72 ± 4.65	1.26
Raw RDF			10.72 ± 1.04	78.94 ± 0.77	5.87 ± 0.64	1.00



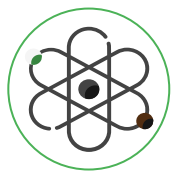
# 03 Possible applications of RDF



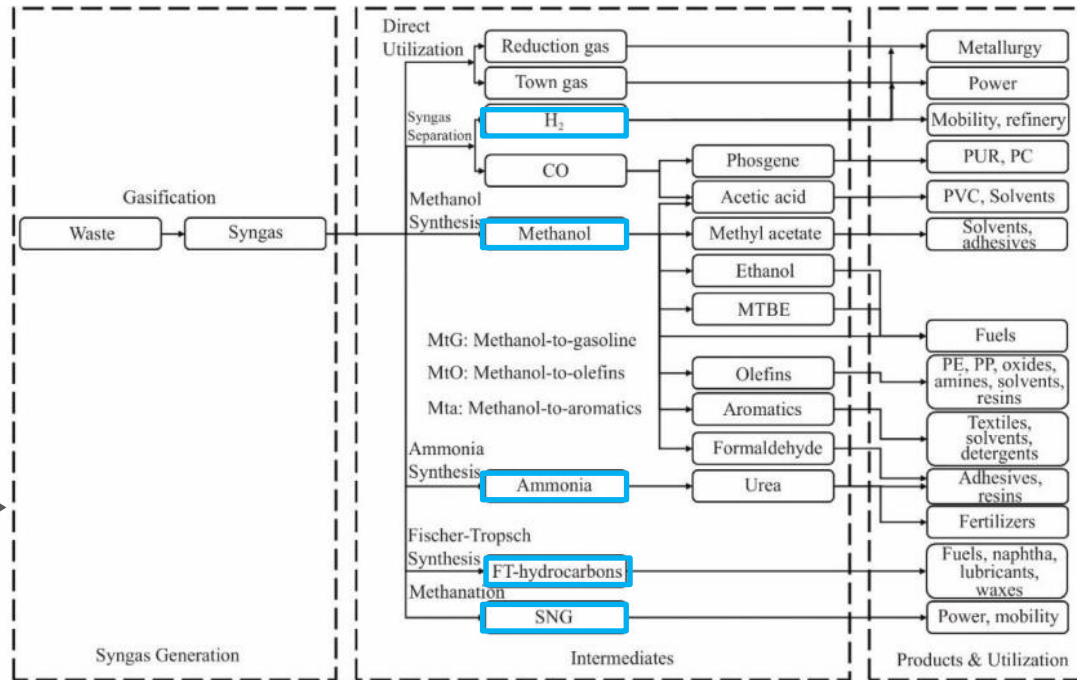
Landfill  
(>56% in Portugal)



Incineration  
(20% in Portugal)



Gasification  
(no information in Portugal)

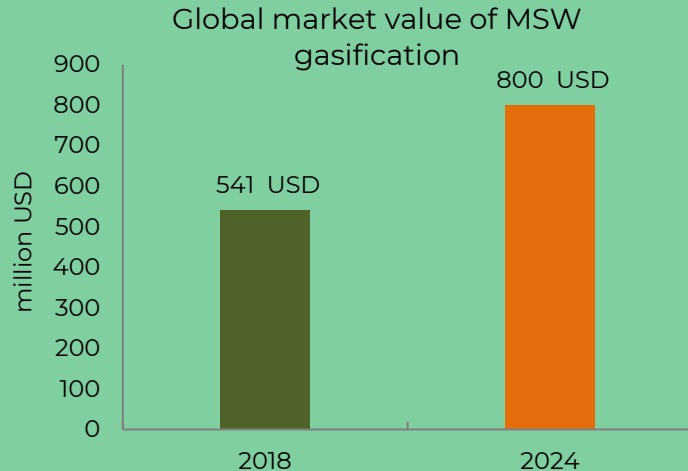


# 04 Perspectives of RDF in the energy sector

Under the NET ZERO SCENARIO by 2030 it is expected that

of bioenergy will come from **waste** and **residues**, an increase of 43% compared to 2020.

# 63%,



**Waste-to-Gas** has received a lot of attention, as gas has become a crucial fuel and energy vector for the world economy and has great flexibility in end applications. It **is expected an increase** in the global **MSW gasification market value** by **47% in 2024** compared to 2018 data.

# Conclusions

- ✓ Pretreatment processes (**peletization and carbonization**) can improve the quality of RDF, making it an **attractive feedstock** for the energy sector, contributing to the circular economy and reducing the disposal of this waste in landfills;
- ✓ Recent improvements in government policies and the need to improve waste management could potentiate the **waste-to-energy** and **waste-to-chemicals** industries, essentially based on **gasification**.





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# Thank you for your attention.

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