

## **Study for the determination of biomass content, carbon concentration (C%) and Net Calorific Value of Greek Tire Derived Fuels**

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Contract between Ecoelastika S.A. – Clean Energy Ltd.

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- Analyses results
  - Proximate analysis (Moisture, Ash)
  - Ultimate analysis (C, H, N, S)
  - Calorific Value
  - Biogenic Content Analysis



# Scope



## **Scope of study: Determination of a representative average of Greek TDF physical-chemical properties**

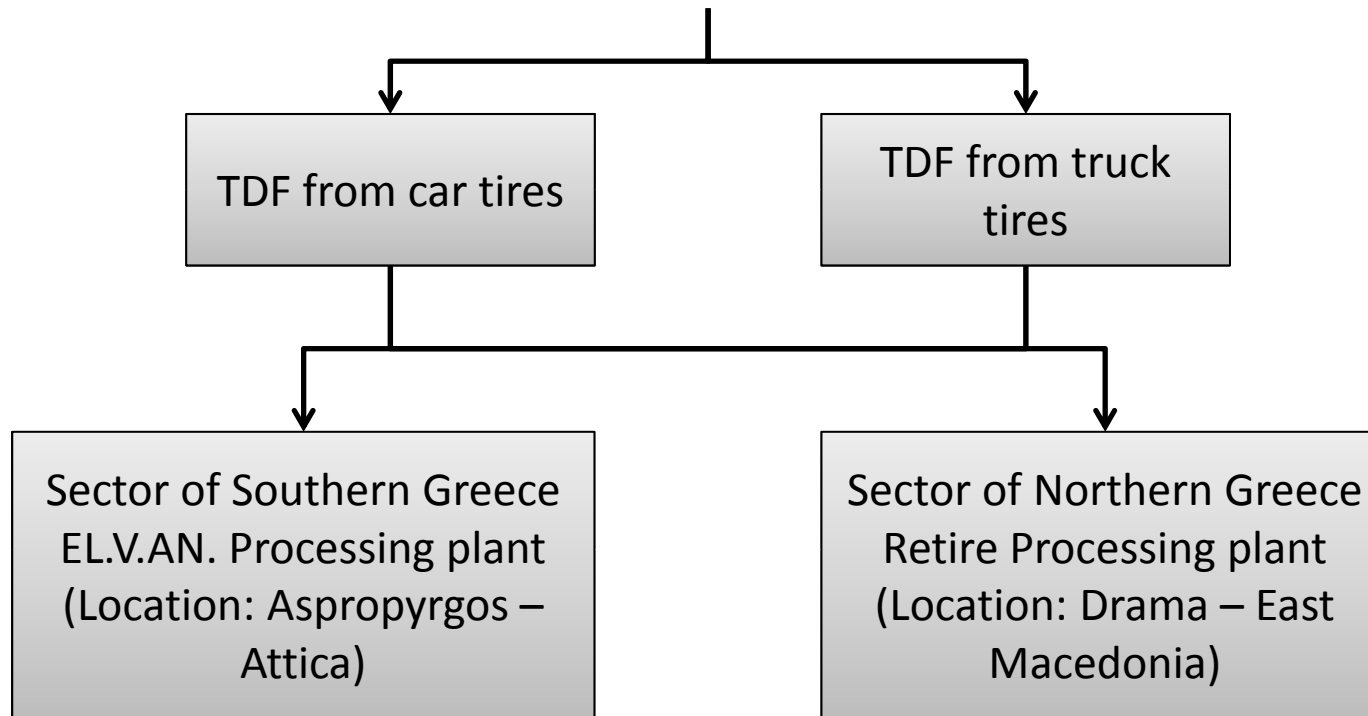
- Planning of appropriate sampling procedure for gathering a representative TDF sample from car and truck tires
- Analysis of the samples:
  - Carbon concentration (C %)
  - Calorific Value
  - Biogenic Content
- Statistical determination of representative Greek TDF (produced from car and truck tires) analyses values



# Sampling procedure



Planning of sampling procedure according to standard **EN 15442:2011** which is relevant to sampling of solid recovered fuels

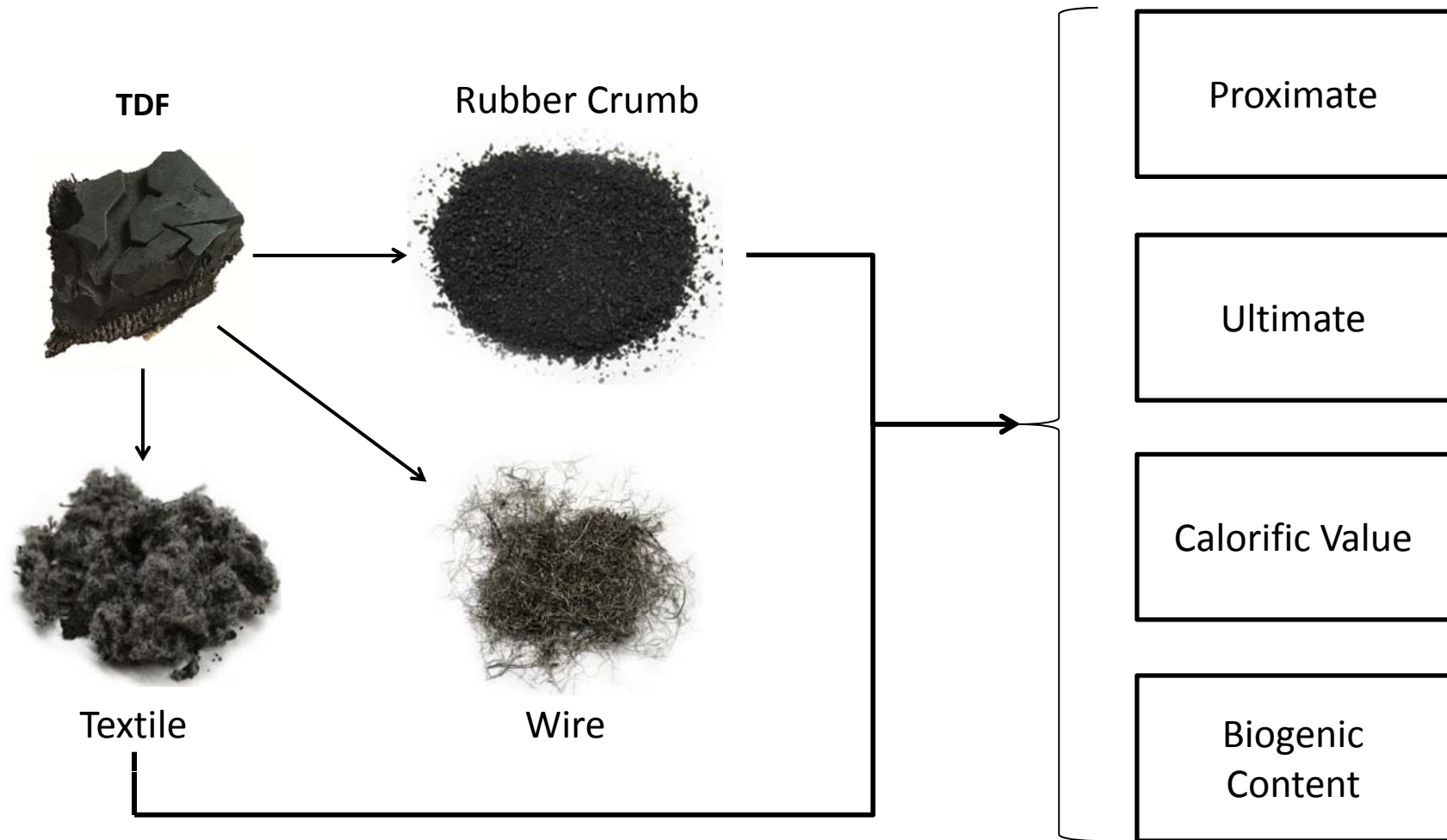




# Sampling procedure



- Material Identification





# Sampling procedure



## Material Identification



TDF from car tires (EL.V.AN)

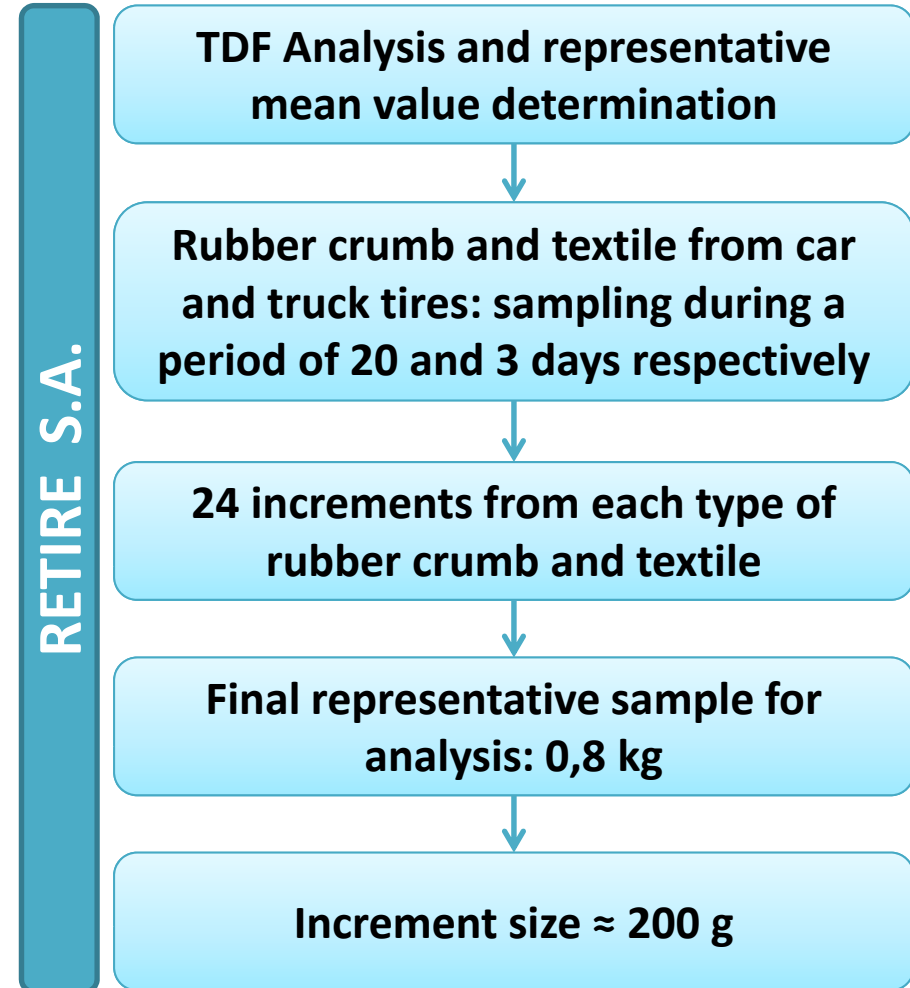
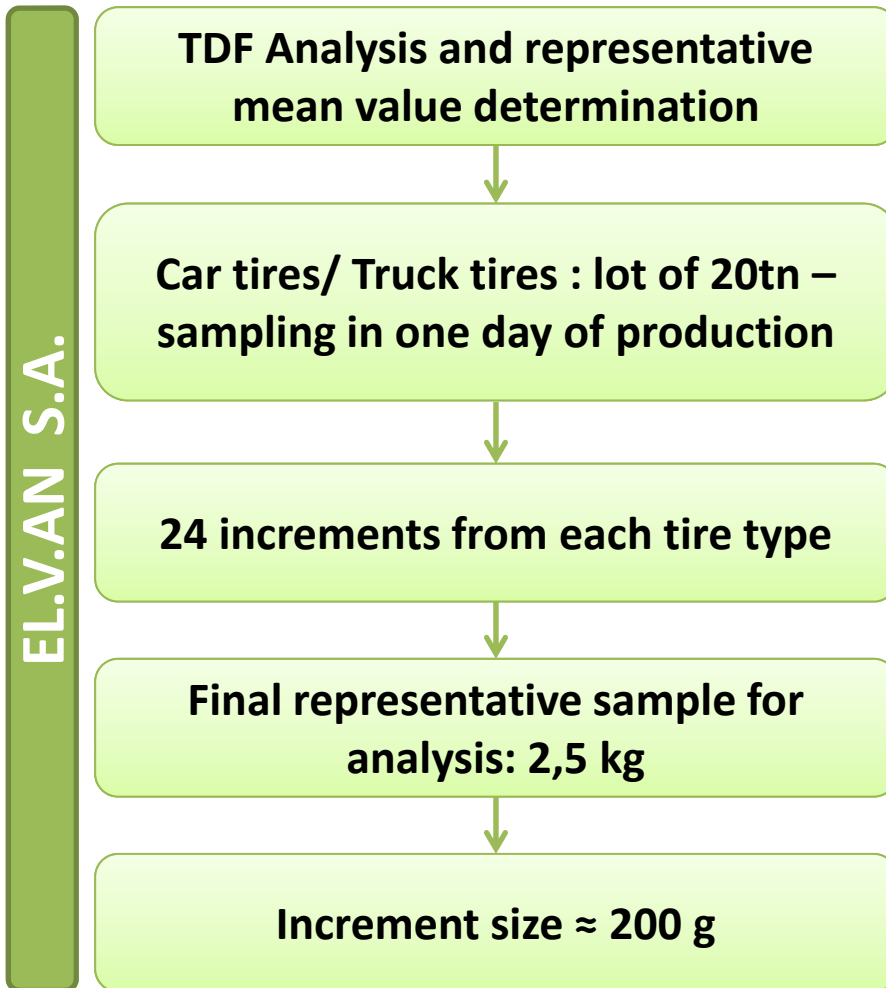


TDF from truck tires (EL.V.AN.)

Mechanical treatment for separation  
in rubber crumb, textile and wire



# Sampling procedure





# Analyses Standards



Analysis	CEN/TC 343 Standard
Moisture	15414:2011
Ash	15403:2011
Ultimate (C, H, N, S)	15407:2011
Calorific Value	15400:2011
Biogenic Content	15440:2011

Emerging standard for quality assurance of recycled tire products  
CEN/TC 366





# Abbreviations - Definitions



- GCV: Gross Calorific Value
- NCV: Net Calorific Value
- a.r: as received
- Biogenic Carbon: Defined according to EN 15440:2011 “Produced in natural processes by living organisms but not fossilized or derived from fossil resources”
- Biomass Content: Defined according to EN 15440:2011 and 2007/589/EC “Biomass means non-fossilised and biodegradable organic material originating from plants, animals and micro-organisms, including products, by products, residues and waste from agriculture, forestry and related”.



# Results from Southern Greece sector (EL.V.AN)



## Car Tires

	Rubber Crumb	Textile
Moisture	0,96	1,11
Ash (% w.t. dry)	4,97	9,78
C (% w.t. dry)	84,24	74,01
H (% w.t. dry)	7,6	6,65
N (% w.t. dry)	2,17	2,61
S (% w.t. dry)	0,94	-
GCV (MJ/kg dry)	35,02	31,16
NCV (MJ/kg a.r.)	33,06	29,39
Biomass content (% w.t. dry)	44,54	43,21
Biomass Content (% of TC - dry)	33,78	46,43
Biogenic Carbon	28,46	33,24

## Truck tires

	Rubber Crumb	Textile
Moisture	0,65	1,19
Ash (% w.t. dry)	5,47	8,91
C (% w.t. dry)	86,94	75,45
H (% w.t. dry)	7,76	6,75
N (% w.t. dry)	1,89	1,91
S (% w.t. dry)	1,56	-
GCV (MJ/kg dry)	36,92	31,95
NCV (MJ/kg a.r.)	35,03	30,09
Biomass content (% w.t. dry)	58,34	43,21
Biomass Content (% of TC - dry)	48,95	46,43
Biogenic Carbon	42,56	33,70



# Results from Northern Greece sector (Retire)



## Car Tires

	Rubber Crumb	Textile
Moisture	0,59	2,18
Ash (% w.t. dry)	8,65	5,31
C (% w.t. dry)	85,59	73,56
H (% w.t. dry)	7,13	7,00
N (% w.t. dry)	0,85	2,46
S (% w.t. dry)	1,57	0,85
GCV (MJ/kg dry)	36,40	29,95
NCV (MJ/kg a.r.)	34,68	27,79
Biomass content (% w.t. dry)	31,3	53,71
Biomass Content (% of TC - dry) – chemical dissolution method	26,05	58,22
Biogenic Carbon	22,30	42,83
Biomass Content (% of TC - dry) BETA ANALYTICS – <sup>14</sup> C method	36,00	

## Truck Tires

	Rubber Crumb	Textile
Moisture	0,58	1,74
Ash (% w.t. dry)	7,57	6,18
C (% w.t. dry)	86,17	76,00
H (% w.t. dry)	7,17	6,84
N (% w.t. dry)	0,67	2,06
S (% w.t. dry)	1,24	0,97
GCV (MJ/kg dry)	36,02	31,29
NCV (MJ/kg a.r.)	34,29	29,28
Biomass content (% w.t. dry)	41,45	52,67
Biomass Content (% of TC - dry) – chemical dissolution method	38,11	56,13
Biogenic Carbon	32,84	42,66
Biomass Content (% of TC - dry) BETA ANALYTICS – <sup>14</sup> C method	33,00	



# Results for car TDF



	Southern Greece TDF*	Northern Greece TDF*	Weighted Average Value in Greece**
Moisture	0.82	0.58	0.75
Ash (% w.t. dry)	4.47	7.19	5.33
C (% w.t. dry)	70.97	72.15	71.35
H (% w.t. dry)	6.41	6.05	6.30
N (% w.t. dry)	1.87	0.80	1.53
S (% w.t. dry)	0.75	1.30	0.93
GCV (MJ/kg dry)	29.57	30.62	29.91
NCV (MJ/kg a.r.)	27.91	29.13	28.30
Biomass content (% w.t. dry)	37.79	27.73	34.57
Biomass Content (% of TC - dry) – chemical dissolution method	29.35	23.75	27.56
Biogenic Carbon	24.43	27.37	23.00

\* Obtained results from components weighted average according to ETRMA data (80% rubber., 5% textile, 15% wire)

\*\* Obtained results from weighted average according to Ecoelastika data (68.03% South Greece , 31.97% North Greece tires)



# Results for truck TDF



	Southern Greece TDF*	Northern Greece TDF*	Weighted Average Value in Greece**
Moisture	0,49	0,44	0,48
Ash (% w.t. dry)	4,15	5,71	4,65
C (% w.t. dry)	65,57	65,01	65,39
H (% w.t. dry)	5,85	5,41	5,71
N (% w.t. dry)	1,43	0,51	1,13
S (% w.t. dry)	1,17	0,93	1,09
GCV (MJ/kg dry)	27,85	27,17	27,63
NCV (MJ/kg a.r.)	26,43	25,86	26,25
Biomass content (% w.t. dry)	43,97	31,35	39,94
Biomass Content (% of TC - dry) – chemical dissolution method	36,94	28,86	34,36
Biogenic Carbon	32,09	26,90	29,77

\* Obtained results from components weighted average according to ETRMA data (75% rubber., <0, 5% textile, 25% wire)

\*\* Obtained results from weighted average according to Ecoelastika data (68.03% South Greece , 31.97% North Greece tires)



## Comparing results with Aliapur 2009 report



	Weighted Average Greece for Car TDF	Aliapur car TDF	Weighted Average Greece for truck TDF	Aliapur truck TDF
Moisture	0,75	-	0,48	-
Ash (% w.t. a.r.)	5,29	-	4,62	-
C (% w.t. a.r.)	70,73	69,00	64,98	61,1
H (% w.t. a.r.)	6,24	6,2	5,68	5,5
N (% w.t. a.r.)	1,51	-	1,13	-
S (% w.t. a.r.)	0,92	1,30	1,09	1,4
GCV (MJ/kg dry)	29,65	-	27,63	-
NCV (MJ/kg a.r.)	28,30	30,2	26,25	26,1
Biomass content (% w.t. dry)	34,57		39,94	
Biomass Content (% of TC - dry)	27,56		34,36	
Biogenic Carbon	23,00	18,3	29,77	29,1



# Conclusions



- Small deviations between analyses results for Southern and Northern Greece TDF
- Small deviations between car TDF in Greece and Aliapur car TDF
- Small deviations between truck TDF in Greece and Aliapur truck TDF
- Deviations in biogenic content analyses between different methods