



**Chemical Process and Energy Resources Institute  
Centre for Research and Technology Hellas**

# **Characterization and classification of Refuse Derived Fuel in the Materials Recovery Facility of EPANA S.A.**

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**ENERGY WASTE**





# Contents

- Scope
- Fuel Preparation
- Standard CEN/TC 343
- Sampling Procedure
- Sample Pre-Treatment
- Present RDF Classification
- Conclusions



# Scope

- Present work in the framework of LIFE09/ENV/GR000307 ENERGY WASTE
- Main objectives of the project
  - Erection of a CFB gasifier
    - Input fuel: RDF produced in EPANA's plant
    - Study RDF gasification parameters
    - Study syngas quality
    - Sustainability assessment
  - Sampling, Analysis and classification of RDF



# Fuel Preparation

- The fuel includes packaging waste:
  - cardboard
  - paper
  - various plastic streams
  - Tetra pack
  - glass
  - ferrous and non-ferrous metals
- The material streams produced from the process are the following:
  1. Large materials from the reception area
  2. Unwanted materials from the pre-sorting cabin
  3. Fine fraction (<65 mm) of the trommel screen
  4. Residues from the overflow (>280 mm) of the trommel screen
  5. Residues from the rest of the process.
- The non recyclable streams 4 and 5 could be used for the production of RDF/SRF able to be utilized as fuel.





# European Standard CEN/TC 343

- The European Standard CEN/TC 343 specifies all necessary standards regarding Solid Recovered Fuels (SRF).
- The work of CEN/TC 343 was organized by a Technical Committee and five Working Groups:
  - WG1 Terminology and quality management
  - WG2 Fuel specification and classes
  - WG3 Sampling, sample reduction, determination of biodegradable fraction
  - WG4 Physical parameters
  - WG5 Chemical parameters
- Latest version of Technical Specifications: 2010-2011



# Standards used for the Analyses

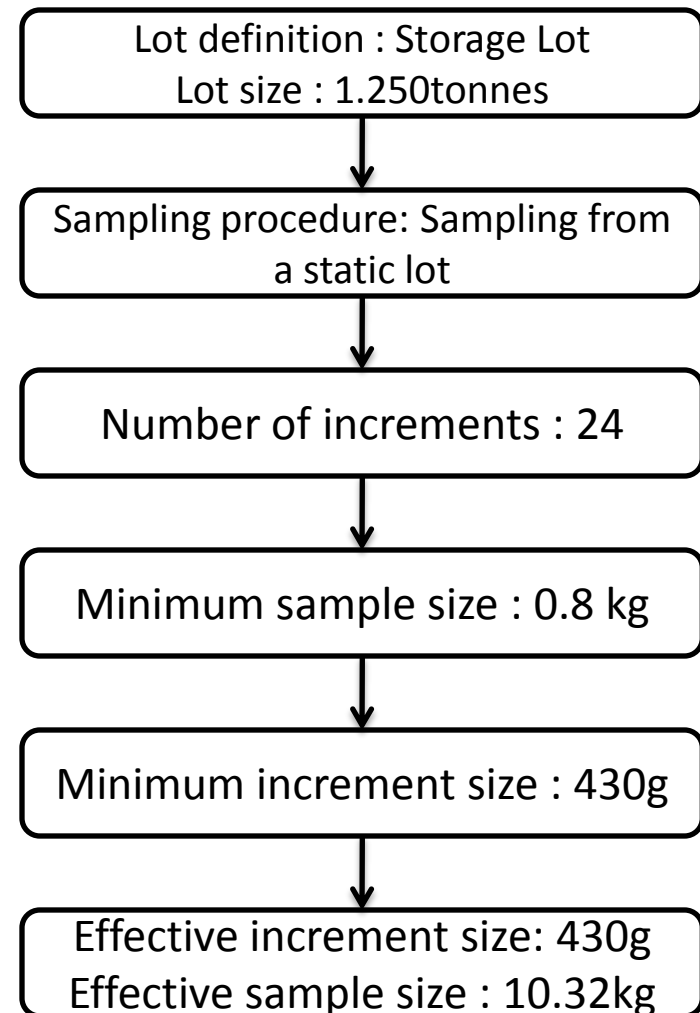
<b>Measured Parameters</b>	<b>European Standard</b>
Ash content	EN 15403:2011
Moisture Content: reference method	CEN/TS 15414-1:2010
Calorific Value	EN 15400:2011
Chlorine (Cl)	EN 15408:2011
Mercury (Hg)	EN 15411:2011
Heavy metals (Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Tl, V)	EN 15411:2011
Volatile matter	EN 15402:2011
Elementary analysis (C, H, N, S)	EN 15407:2011 / EN 15408:2011



# Sampling Procedure

- Sampling procedure designed and executed according to **EN 15442:2011**
- Sampling duration from June 2011 – January 2012
- Sampling June 2011 – and is still ongoing:
  - Season variance
  - Weather variance
  - Customs variance

Seasonality





# Sample Treatment till Analyses



Sample Increment



Air drying in oven



Air tight sealing



Long – term storage



Sample Preparation



Sample drying



Analyses



Hg Analysis

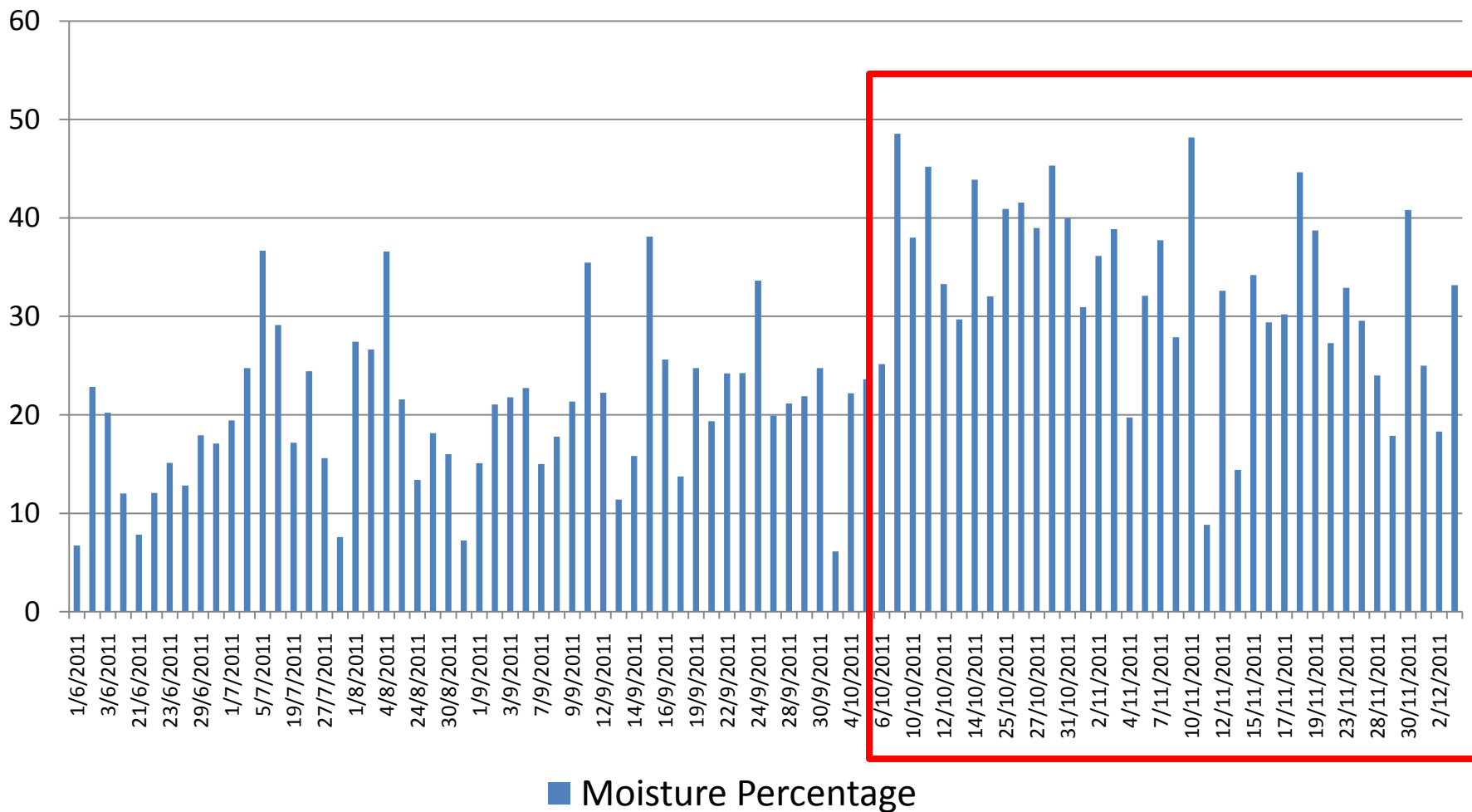
Sample grinding







# Moisture percentage Variance





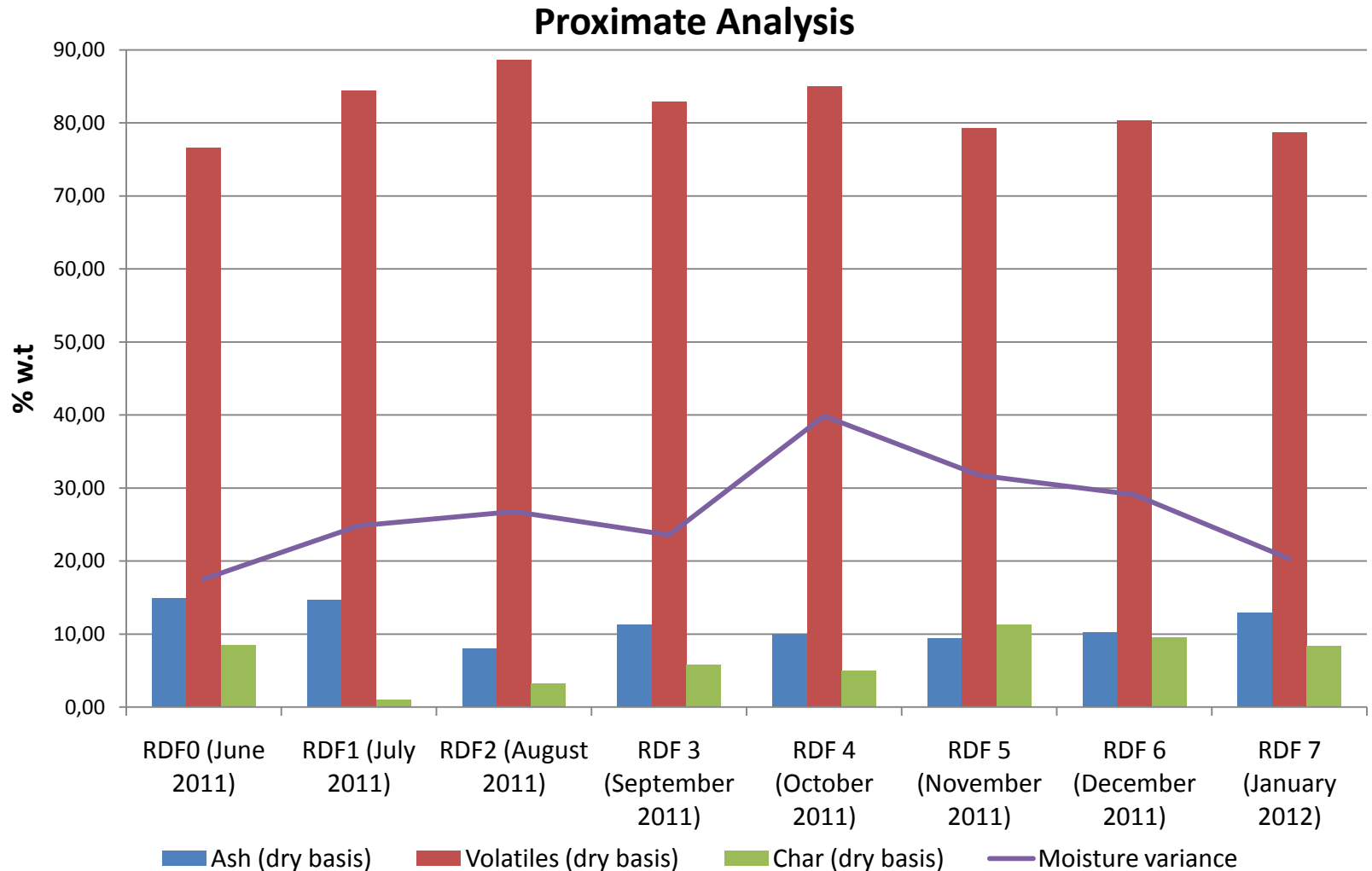
# Proximate Analysis – Calorific Value

	Average ( % w.t.)	Standard Deviation
Moisture	26,72	6,99
Ash (as received)	8,39	2,47
Volatiles (as received)	60,01	5,18
Char (as received)	4,21	2,55

	Average	Standard Deviation
HHV (MJ/kg)	20,70	2,50
LHV (MJ/kg dry)	19,31	2,35
LHV (MJ/kg raw)	13,43	1,71



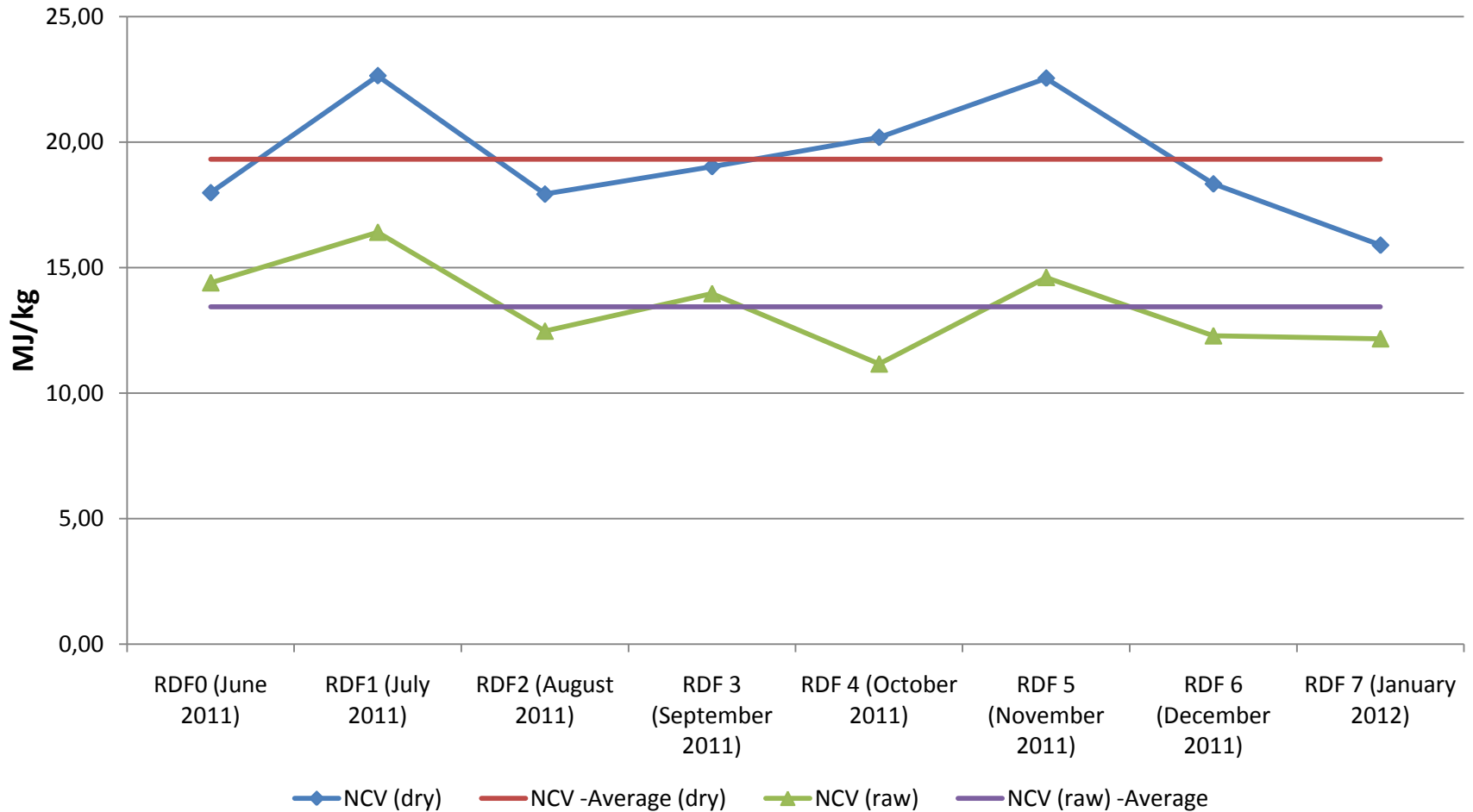
# Proximate Analysis Variance





# Calorific Value Variance

## Net Calorific Value Variance





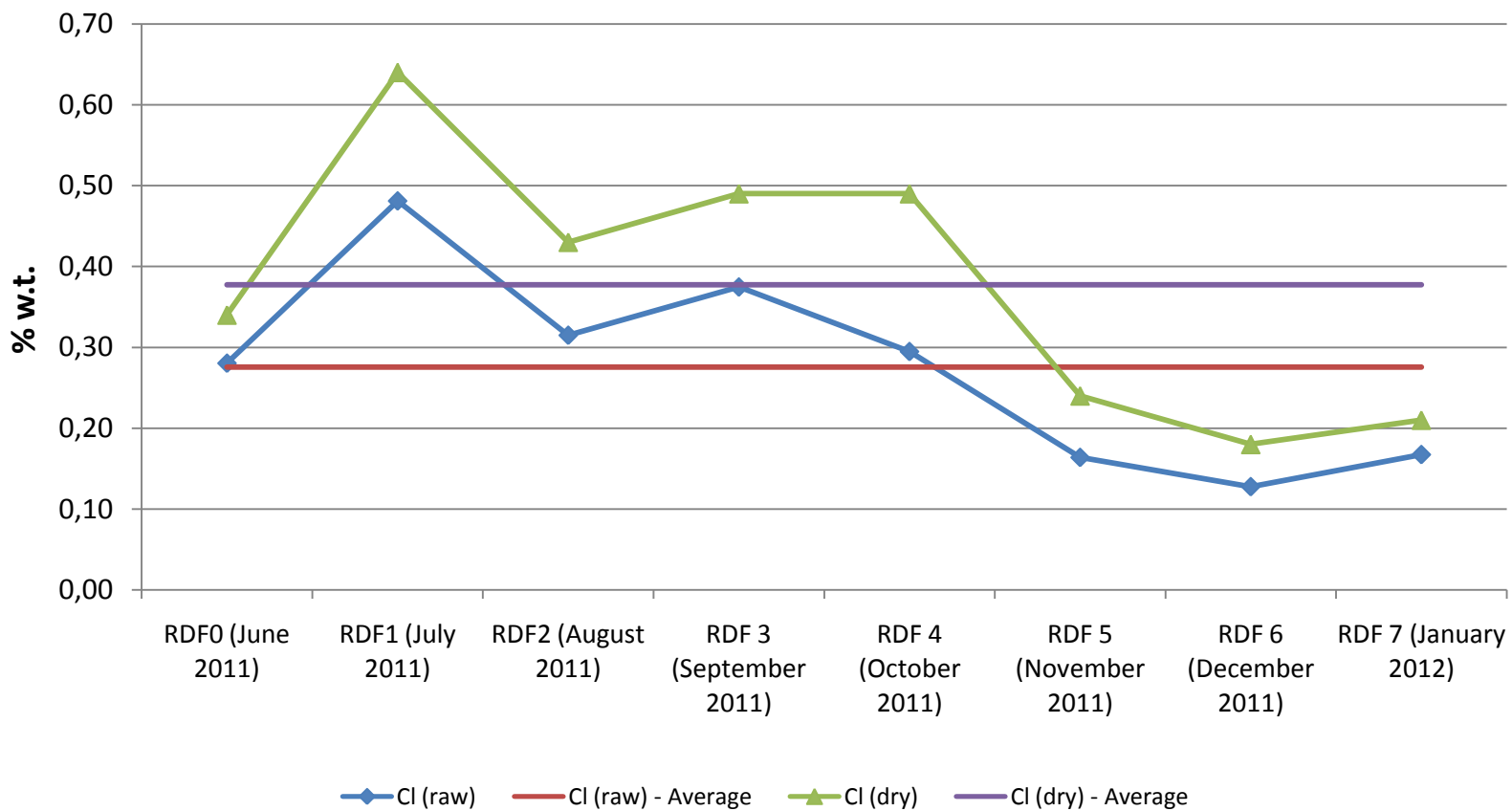
# Ultimate Analysis

	Average ( % w.t.)	Standard Deviation
C (d.a.f)	55,26	5,72
H (d.a.f)	7,21	1,10
N (d.a.f)	1,32	0,62
S (d.a.f)	0,25	0,19
O (d.a.f)	35,53	6,97
Cl (d.a.f)	0,43	0,19
Cl (dry)	0,38	0,16



# Chlorine Variance

## Chlorine Variance





# Heavy Metals

	Average	Standard Deviation	Median	Proposed values (median) Remondis	Proposed values (median) RAL GZ - 724
Cd (mg/kg dry)	5,63	3,11	5,51	<250	125
Cr (mg/kg dry)	20,65	12,59	21,61	<12	6
Co (mg/kg dry)	5,87	6,78	2,06	<1000	400
Cu (mg/kg dry)	76,25	67,24	43,48	-	-
Pb (mg/kg dry)	110,52	132,31	16,51	<400	250
Mn (mg/kg dry)	54,64	30,56	55,43	-	-
Hg(mg/kg dry)	0,69	0,69	0,34	<160	80
Ni (mg/kg dry)	23,49	15,07	26,00	<1	1
Tl (mg/kg dry)	8,65	11,60	0,00	<250	125



# Comparison with other countries standards

EPANAs RDF	
NCV (MJ/kg ar)	13,43
Moisture (% ar)	26,72
Ash (% dry)	11,45
Cl (% dry)	0,38
Hg (mg/kg dry)	0,69
Cd + Tl (mg/kg dry)	14,28
Sum HM (mg/kg dry)	291,43

## Other EU countries standards for RDF

	Unit	Finland			Germany		Italy		
		Class I	Class II	Class III	median	80 <sup>th</sup> perc.	Units standard	High qual.	
NCV							MJ/kg ar	>15	>19
Moisture							% ar	<25	<15
Ash							% d	<20	<15
Cl	% d	<0.15	<0.5	<1.5			% ar	<0.9	<0.7
Hg	mg/kg d	<0.1	<0.2	<0.5	0.6	1.2	mg/kg d	<7 ***	<1
Cd + Tl	mg/kg d	<1.0	<4.0	<5.0	5	11		-	<4
Sum HM	mg/kg d				351*/1049**	1080*/2460**	mg/kg d	<1040	<350

\*SRF produced from specific wastes,\*\*SRF produced from MSW

Source: ERFO





# Harmonization of RDF/SRF properties according to EN/TC 343

## Classification of RDF according to EN 15359:2011

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Net calorific value (NCV)	Mean	MJ/kg (ar)	$\geq 25$	$\geq 20$	$\geq 15$	$\geq 10$	$\geq 3$

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Chlorine (Cl)	Mean	% (d)	$\leq 0,2$	$\leq 0,6$	$\leq 1,0$	$\leq 1,5$	$\leq 3$

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Mercury (Hg)	Median	mg/MJ (ar)	$\leq 0,02$	$\leq 0,03$	$\leq 0,08$	$\leq 0,15$	$\leq 0,50$
	80 <sup>th</sup> percentile	mg/MJ (ar)	$\leq 0,04$	$\leq 0,06$	$\leq 0,16$	$\leq 0,30$	$\leq 1,00$



# Conclusions

- ❑ The procedure of sampling, analysis and classification of RDF produced in EPANA's facility is done according to CEN/TC 343
- ❑ Effect of time period/other parameters (customs, events etc.) on sample composition
- ❑ Cl content measured is not expected to cause technical or operational problems
- ❑ Heavy metals content within normal standards with few exceptions
- ❑ EPANA's RDF classification according to CEN/TC 343 -> 4,2,2

Thank you