Food Residue Biomass Product as an Alternative Energy Source for the Cement Industry

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Waste4Think Objectives

- Reduction of the disposal of the fermentable fraction of municipal waste
- Reduction of total waste volume through drying and shredding to generate a food residue biomass product (FORBI)
- Assessment of the suitability of FORBI for the production of:
  - ✓ Biofuel (Methane, Hydrogen, HYTHANE)
  - ✓ Bioethanol
  - ✓ Compost
  - ✓ Electricity
  - ✓ Activated carbon
  - ✓ Animal Feed
  - ✓ Pellets
  - ✓ Alternative fuel for cement industry

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Alternative fuels in the cement industry

Replacement of fossil fuels has the following advantages:

- ✓ Reduction of energy costs
- ✓ Saving natural resources (fossil fuels & raw materials)
- ✓ Reduction of CO_2 emissions

<u>Examples of alternative fuels:</u>

Automotive tyres, used oils, sludge, refinery sludge, meat meal, agricultural residues, RDF (urban waste fuel), SRF (industrial waste fuel)

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Purpose of the study

- To assess the suitability of FORBI as an alternative fuel for the cement industry, through:
  - ✓ Determination of its physicochemical characteristics and comparison with existing alternative and conventional fuels
  - ✓ Classification according to EN 15359
  - ✓ Comparison of the energy required to produce FORBI with its energy content

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FORBI Production

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Standards used in the analysis of FORBI

Parameter	Measurement standard
Moisture	EN 15414-3
Ash	EN 15403
Volatile Compounds	EN 15402
Bulk density	EN 15401
Calorific Value	EN 15400
Metals (As, Cd,Co,Cr,Cu,Hg,K,Mn,Na,Ni,P,Pb,Sb,Tl,V,Zn)	EPA 200.7
F, Cl, S	EN 15408
C,H,N	EN 15407
O	ISO 16993

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Direct analysis results

	Moisture (%)	Ash(% dry basis)	Volatiles (% dry basis)	Fixed Carbon(% dry basis)
FORBI	1.1-1.4	8.0-8.7	75.3-78.1	13.2-16.4
SRF	3.0	11.4	82.1	6.5
RDF	30.4	23.3	66.2	10.5
Coal	6.2	12.2	35.2	52.7
Petcoke	7	0.7	12.1	87.4

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Elemental analysis, NCV and GCV

	C (%)	H(%)	N(%)	S (%)	O (%)	Cl (%)	NCV (MJ/Kg)	GCV (MJ/Kg)
FORBI	47.9-48.7	6.16-6.26	2.29-2.31	0.13-0.16	33.0-34.2	0.45-0.55	18.09-18.38	19.32-19.65
SRF	41.8	5.46	0.03	0.07	-	0.02	12.28	13.40
RDF	40.4	4.89	1.41	0.46	-	0.36	20.26	21.26
Coal	70.7	4.48	1.28	1.81	-	0.30	28.50	29.42
Petcoke	68.12	3.63	1.94	4.73	20.5	-	34.38	-

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Concentration of metals (on a dry matter basis)

	Cd	Hg	Tl	K	Na	Sum (As+Co+Cr+Cu+Sb+Pb+Mn+Ni+V)
FORBI	n.d.	n.d.	n.d.	15-16.5	3.7-4.6	49.3-57.4
SRF	0.05	0.07	<0.1	92	247	51.6
RDF	0.3	0.19	<0.1	3.45	5.4	329
Coal	0.07	0.3	<0.3	1.85	868	261
Petcoke	-	-	-	-	-	620

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Classification criteria for alternative solid fuels (EN 15359)

Classification characteristic	Statistic measure	Unit	Class				
			1	2	3	4	5
NCV	Mean	MJ/Kg (ar)	≥25	≥20	≥15	≥10	≥3
Chlorine	Mean	% w/w (d)	≤0.2	≤0.6	≤1.0	≤1.5	≤3
Mercury	Median 80%	mg/MJ (ar) mg/MJ (ar)	≤0.02 ≤0.04	≤0.03 ≤0.06	≤0.08 ≤0.16	≤0.15 ≤0.30	≤0.50 ≤1.00

- Class 3 with respect to NCV
- Class 2 with respect to Cl
- Class 1 with respect to Hg

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Examples of limit values for alternative fuels for different countries based on individual permits

Parameter	Unit	Spain	Belgium	France	FORBI
Halogens (exp .as Cl)	%	2	2	2	0.49
F	%	0.20	-	-	<0.10
S	%	3	3	3	0.14
Hg	mg/Kg	10	5	10	n.d*
Cd	mg/Kg	100	70	-	n.d*
Tl	mg/Kg	100	30	-	n.d*
Sum Hg + Cd + Tl	mg/Kg	100	-	100	n.d*
Sb	mg/Kg	-	200	-	<2.00
Sum(Sb+As+Co+Ni+ Pb+Sn+V+Cr)	mg/Kg	5000	2500	2500	18.4
As	mg/Kg	-	200	-	<2.00
Co	mg/Kg	-	200	-	2.13
Ni	mg/Kg	-	1000	-	6.05
Cu	mg/Kg	-	1000	-	7.19
Cr	mg/Kg	-	1000	-	4.25
V	mg/Kg	-	1000	-	<2.00
Pb	mg/Kg	-	1000	-	12.1
Mn	mg/Kg	-	2000	-	21.4
Zn	mg/Kg	-	5000		20.9

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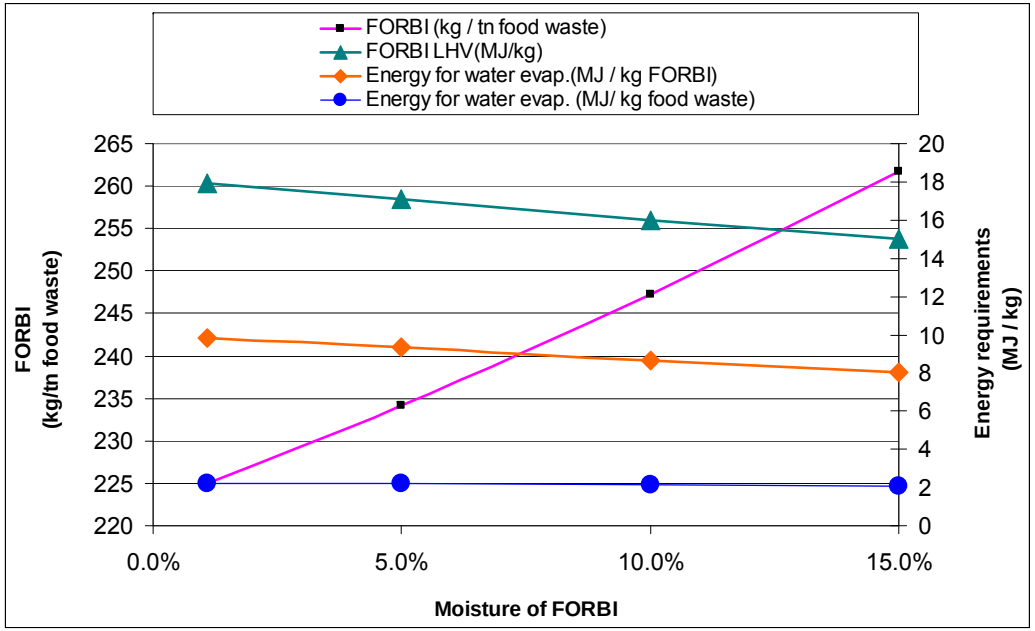
Energy requirements for the production of FORBI



➢The energy content of FORBI is approximately twice the energy required for its production

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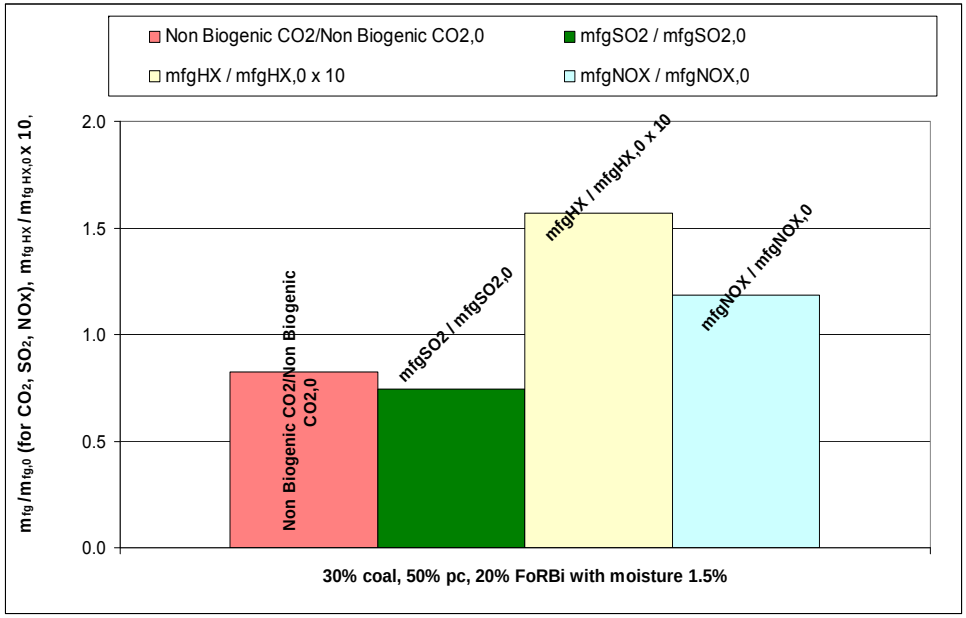
FORBI's effect in flue gases and fuel mixture

- Two scenaria for the assessment of FORBI's effect in the production of flue gases and fuel mixture
  - ✓ Scenario 0 (base case): 30% calorific coal - 70% petcoke
  - ✓ Scenario 1: 30% coal, 50% petcoke, **20% FORBI** (1.5% moisture)



A 20 % calorific substitution of petcoke by FORBI leads to:
reduced CO_2 and SO_2 emissions
and
higher halogen and NO_x emissions

- 20% lower CO_2
- 30% lower SO_2
- 16 times higher HX
- 20% higher NO_X

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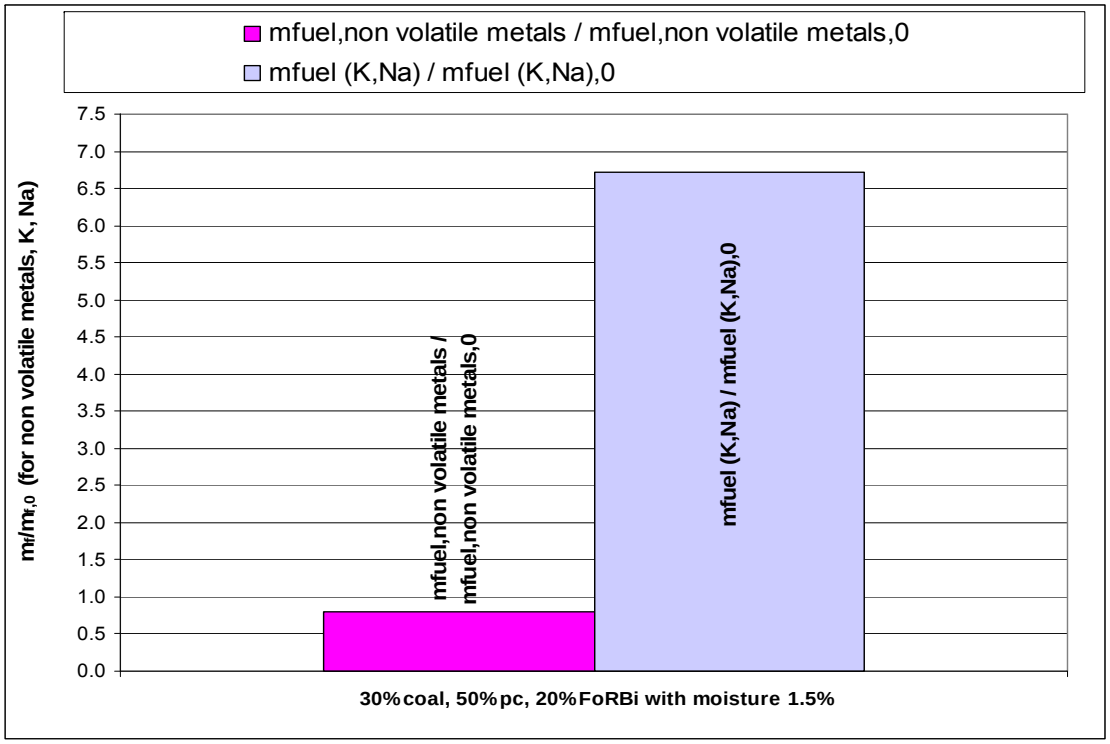
FORBI's effect in flue gases and fuel mixture



- 20% lower non-volatile metals and
- 6.7 times higher K, Na

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Conclusions

- FORBI is classified as non-hazardous waste (EC 20 01 08, in accordance with Decision 2000/532/EC)
- It is more environmentally friendly in comparison with other alternative fuels that are currently in use
- CO_2 and SO_2 emissions are lower while HX and NO_x levels are higher when substituting pet coke with FORBI
- The substitution leads to lower non- volatile metals and higher K and Na concentrations

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Conclusions (cont.)

- Cl content in FORBI is relatively high, but is within the acceptable values for alternative fuels of 3 EU countries
- NO_x emissions may be reduced with appropriate air pollution control equipment
- The energy required for the production of FORBI is less than half its energy content
- Techniques for reduced drying costs should be investigated

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Thank you for your attention!

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