Programme Area: Bioenergy

Project: Characterisation of Feedstocks

Title: D6 Final Report (Phase 1) Appendix 6

Abstract:

The primary objective of this 2015/16/17 Project was to provide an understanding of UK produced biomass properties, how these vary and what causes this variability.
This document is one of the appendices to the Final Report from the first Phase (2015/16) of the Characterisation of Feedstocks (CofF) project, Deliverable D6. D6 is provided in a number of parts consisting of the main body text plus 13 Appendices, provided in 17 files. These 13 appendices are provided in 12 pdf files plus 46 data files in Microsoft Excel format. The purpose of this report plus its related parts is to report the variability in feedstock properties of UK produced energy biomass, the causes of these variations and the relationship between the feedstock properties and the provenance data collected. Five feedstocks were studied: Miscanthus, willow short rotation coppice (SRC), poplar SRC, poplar grown as short rotation forests (SRF), and spruce SRF, with poplar and Sitka spruce selected to represent broadleaved and coniferous biomass crops respectively. Provenance data include site properties (such as general climate zone and soil chemistry), the conditions at the time of sample collection, and past management of the site and crop with soil samples also collected for analysis. The feedstock samples were analysed in UKAS accredited laboratories.

Context:

The Characterisation of Feedstocks project provides an understanding of UK produced 2nd generation energy biomass properties, how these vary and what causes this variability. In this project, several types of UK-grown biomass, produced under varying conditions, were sampled. The biomass sampled included Miscanthus, Short Rotation Forestry (SRF) and Short Rotation Coppice (SRC) Willow. The samples were tested to an agreed schedule in an accredited laboratory. The results were analysed against the planting, growing, harvesting and storage conditions (i.e. the provenance) to understand what impacts different production and storage methods have on the biomass properties. The main outcome of this project is a better understanding of the key characteristics of UK biomass feedstocks (focusing on second generation) relevant in downstream energy conversion applications, and how these characteristics vary by provenance.

Appendix 6: Summary of statistics for fresh feedstocks

Fresh *Miscanthus* Study 1

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	12	26.5	23.2	10.3	44.4	10.9
	NCV	kJ/kg	12	12531	13301	8828	15924	2240
Dry Fuel Basis (d)	Ash	%wt	12	2.3	2.3	1.4	3.3	0.7
Dry Ash-free basis (DAF)	Volatile matter	%wt	12	82.7	82.9	79.8	85.2	1.6
	GCV	kJ/kg	12	19651	19633	19574	19830	75
	C	%wt	12	49.81	49.80	49.44	50.32	0.25
	H	%wt	12	6.04	6.03	5.99	6.14	0.04
	N	%wt	12	0.40	0.40	0.23	0.57	0.09
	S	%wt	12	0.01	0.01	0.01	0.02	0.00
	Cl	%wt	12	0.14	0.15	0.04	0.19	0.05
	O	%wt (by diff.)	12	43.62	43.65	42.84	44.06	0.34
Dry fuel basis	Ba	mg/kg	12	7.62	6.51	2.15	21.37	5.12
	Be	mg/kg	12	0.11	0.12	0.07	0.16	0.03
	Cr	mg/kg	12	0.23	0.16	0.07	0.79	0.21
	Co	mg/kg	12	0.11	0.12	0.07	0.16	0.03
	Cu	mg/kg	12	1.87	1.78	1.33	2.50	0.35
	Mo	mg/kg	12	0.21	0.18	0.07	0.44	0.13
	Ni	mg/kg	12	0.13	0.12	0.07	0.32	0.07
	V	mg/kg	11	0.12	0.12	0.07	0.17	0.03
	Zn	mg/kg	12	15.23	12.10	4.50	30.78	8.91
	Sb	mg/kg	5	0.04	0.05	0.01	0.08	0.03
	As	mg/kg	5	0.03	0.02	0.01	0.07	0.02
	Hg	mg/kg	5	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	5	2.43	2.08	1.96	4.00	1.36
	Br	mg/kg	5	7.24	3.92	2.03	23.98	6.79
	Se	mg/kg	5	0.40	0.40	0.39	0.42	0.21
	Cd	mg/kg	7	0.05	0.04	0.01	0.12	0.04
	Pb	mg/kg	7	0.38	0.27	0.15	0.76	0.27
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	12	0.48	0.35	0.14	2.00	0.50
	BaO	%wt (na)	12	0.05	0.05	0.01	0.13	0.03
	$CaCO_3$	%wt (na)	12	15.84	13.27	8.87	29.02	6.44
	Fe_2O_3	%wt (na)	12	0.31	0.24	0.11	0.70	0.21
	K_2O	%wt (na)	12	19.68	20.15	10.56	26.66	5.89
	MgO	%wt (na)	12	3.22	2.91	1.29	6.51	1.48
	Mn_3O_4	%wt (na)	12	0.32	0.24	0.05	1.08	0.30
	Na_2O	%wt (na)	11	0.84	0.68	0.54	1.57	0.35

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
	P_2O_5	%wt (na)	12	6.36	6.99	2.82	9.81	2.49
	SiO_2	%wt (na)	12	52.74	53.42	38.40	66.77	9.44
	TiO_2	%wt (na)	12	0.09	0.09	0.01	0.22	0.06

Miscanthus In-field Variation Site 1 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	20	38.3	39.0	31.9	42.6	3.0
	NCV	kJ/kg	20	10125	10042	9294	11345	617
Dry Fuel Basis (d)	Ash	%wt	20	2.4	2.4	1.6	2.8	0.3
Dry Ash-free basis (DAF)	Volatile matter	%wt	20	82.0	82.0	80.5	83.6	1.0
	GCV	kJ/kg	20	19669	19669	19508	19842	96
	C	%wt	20	50.14	50.16	49.90	50.33	0.12
	H	%wt	20	6.06	6.07	5.99	6.15	0.04
	N	%wt	20	0.53	0.55	0.38	0.61	0.06
	S	%wt	20	0.01	0.01	0.01	0.02	0.00
	Cl	%wt	20	0.20	0.21	0.15	0.25	0.03
	O	%wt (by diff.)	20	43.06	43.04	42.83	43.34	0.15
Dry fuel basis	Ba	mg/kg	20	2.73	2.55	1.87	3.94	0.58
	Be	mg/kg	20	0.13	0.13	0.10	0.16	0.02
	Cr	mg/kg	18	0.18	0.17	0.12	0.26	0.04
	Co	mg/kg	19	0.13	0.13	0.10	0.16	0.02
	Cu	mg/kg	18	1.94	1.91	1.59	2.41	0.23
	Mo	mg/kg	19	0.17	0.16	0.10	0.28	0.05
	Ni	mg/kg	19	0.13	0.13	0.10	0.16	0.02
	V	mg/kg	18	0.14	0.14	0.10	0.24	0.03
	Zn	mg/kg	20	8.02	7.44	4.63	11.16	1.87
	Sb	mg/kg	19	0.03	0.03	0.02	0.05	0.01
	As	mg/kg	19	0.03	0.03	0.02	0.04	0.01
	Hg	mg/kg	19	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	20	2.00	2.01	1.92	2.05	0.04
	Br	mg/kg	20	2.30	2.01	1.92	4.09	0.74
	Se	mg/kg	20	0.45	0.41	0.38	0.77	0.09
	Cd	mg/kg	20	0.02	0.01	0.01	0.08	0.02
	Pb	mg/kg	17	0.28	0.24	0.18	0.59	0.11
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	20	0.24	0.21	0.14	0.59	0.12
	BaO	%wt (na)	20	0.06	0.02	0.01	0.14	0.05
	$CaCO_3$	%wt (na)	20	22.29	23.06	15.96	25.63	2.52
	Fe_2O_3	%wt (na)	19	0.32	0.25	0.18	0.70	0.14
	K_2O	%wt (na)	20	24.20	24.30	18.86	28.35	2.62
	MgO	%wt (na)	19	3.76	3.73	3.02	4.38	0.38
	Mn_3O_4	%wt (na)	19	0.15	0.14	0.11	0.31	0.04
	Na_2O	%wt (na)	19	0.56	0.55	0.45	0.71	0.06
	P_2O_5	%wt (na)	20	7.20	7.01	4.98	10.66	1.54
	SiO_2	%wt (na)	19	40.52	40.53	36.62	44.69	2.50
	TiO_2	%wt (na)	20	0.08	0.09	0.01	0.14	0.04

Miscanthus In-field Variation Site 2 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	19	13.8	13.7	10.2	18.2	2.3
	NCV	kJ/kg	20	14829	15016	10948	15686	1025
Dry Fuel Basis (d)	Ash	%wt	20	2.3	2.3	1.9	2.9	0.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	20	82.4	82.5	81.2	83.9	0.7
	GCV	kJ/kg	20	19578	19573	19443	19813	90
	C	%wt	20	49.32	49.26	48.90	50.09	0.31
	H	%wt	20	6.07	6.07	5.94	6.21	0.08
	N	%wt	20	0.36	0.36	0.27	0.44	0.05
	S	%wt	20	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	20	0.15	0.15	0.10	0.20	0.03
	O	%wt (by diff.)	20	44.11	44.20	43.28	44.60	0.34
Dry fuel basis	Ba	mg/kg	20	6.93	7.00	4.66	8.28	0.93
	Be	mg/kg	20	0.12	0.12	0.10	0.13	0.01
	Cr	mg/kg	20	0.13	0.13	0.10	0.17	0.02
	Co	mg/kg	20	0.12	0.12	0.10	0.13	0.01
	Cu	mg/kg	20	2.09	2.13	1.71	2.38	0.17
	Mo	mg/kg	20	0.29	0.30	0.12	0.42	0.08
	Ni	mg/kg	20	0.12	0.12	0.10	0.13	0.01
	V	mg/kg	20	0.12	0.12	0.10	0.13	0.01
	Zn	mg/kg	20	23.37	23.17	14.85	30.91	3.29
	Sb	mg/kg	20	0.02	0.02	0.02	0.04	0.01
	As	mg/kg	20	0.02	0.02	0.02	0.03	0.00
	Hg	mg/kg	19	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	18	1.95	1.97	1.85	2.01	0.04
	Br	mg/kg	20	8.57	7.92	3.97	15.85	2.89
	Se	mg/kg	20	0.39	0.40	0.37	0.45	0.02
	Cd	mg/kg	20	0.09	0.11	0.04	0.13	0.03
	Pb	mg/kg	19	0.19	0.18	0.10	0.45	0.07
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	20	0.20	0.20	0.14	0.25	0.03
	BaO	%wt (na)	20	0.04	0.04	0.03	0.05	0.01
	$CaCO_3$	%wt (na)	20	11.28	11.03	8.93	14.07	1.39
	Fe_2O_3	%wt (na)	20	0.15	0.16	0.12	0.18	0.02
	K_2O	%wt (na)	20	25.11	25.66	19.57	31.88	3.17
	MgO	%wt (na)	20	3.87	3.80	3.18	4.84	0.46
	Mn_3O_4	%wt (na)	20	0.29	0.27	0.18	0.48	0.09
	Na_2O	%wt (na)	20	0.62	0.62	0.53	0.77	0.06
	P_2O_5	%wt (na)	20	7.26	7.52	3.41	8.36	1.11
	SiO_2	%wt (na)	20	51.15	51.54	42.74	58.99	4.25
	TiO_2	%wt (na)	20	0.04	0.02	0.01	0.22	0.05

Miscanthus In-field Variation Site 3 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	20	20.7	20.1	18.4	24.1	1.8
	NCV	kJ/kg	20	13757	13833	12929	14343	388
Dry Fuel Basis (d)	Ash	%wt	20	2.0	2.0	1.7	2.3	0.1
Dry Ash-free basis (DAF)	Volatile matter	%wt	20	83.6	83.9	81.6	85.5	1.1
	GCV	kJ/kg	19	19691	19684	19559	19928	86
	C	%wt	20	49.29	49.15	48.77	50.22	0.46
	H	%wt	20	6.10	6.10	6.02	6.20	0.05
	N	%wt	20	0.40	0.39	0.28	0.58	0.08
	S	%wt	20	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	20	0.11	0.10	0.06	0.18	0.03
	O	%wt (by diff.)	20	44.10	44.29	43.12	44.69	0.48
Dry fuel basis	Ba	mg/kg	20	20.57	19.95	14.05	25.34	3.04
	Be	mg/kg	20	0.10	0.10	0.09	0.12	0.01
	Cr	mg/kg	20	0.13	0.12	0.10	0.22	0.03
	Co	mg/kg	20	0.10	0.10	0.09	0.12	0.01
	Cu	mg/kg	19	1.70	1.70	1.41	1.97	0.17
	Mo	mg/kg	20	0.10	0.10	0.09	0.12	0.01
	Ni	mg/kg	20	0.10	0.10	0.09	0.12	0.01
	V	mg/kg	20	0.10	0.10	0.09	0.12	0.01
	Zn	mg/kg	20	24.91	25.19	14.40	32.55	4.71
	Sb	mg/kg	20	0.02	0.02	0.02	0.04	0.01
	As	mg/kg	20	0.02	0.02	0.02	0.04	0.00
	Hg	mg/kg	20	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	20	1.98	1.98	1.93	2.06	0.04
	Br	mg/kg	20	4.06	3.95	1.93	6.03	1.21
	Se	mg/kg	20	0.40	0.40	0.39	0.41	0.01
	Cd	mg/kg	20	0.30	0.29	0.11	0.59	0.14
	Pb	mg/kg	17	0.32	0.29	0.17	0.60	0.12
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	19	0.12	0.12	0.08	0.16	0.02
	BaO	%wt (na)	19	0.12	0.12	0.08	0.15	0.02
	$CaCO_3$	%wt (na)	19	11.16	11.22	7.90	13.33	1.45
	Fe_2O_3	%wt (na)	19	0.11	0.10	0.08	0.21	0.03
	K_2O	%wt (na)	20	19.50	20.27	11.04	28.59	4.80
	MgO	%wt (na)	19	3.41	3.34	2.87	4.51	0.41
	Mn_3O_4	%wt (na)	20	0.97	0.99	0.45	1.75	0.34
	Na_2O	%wt (na)	20	0.62	0.62	0.43	0.88	0.13
	P_2O_5	%wt (na)	20	3.25	3.04	1.95	4.83	0.95
	SiO_2	%wt (na)	19	61.06	60.49	54.81	67.77	4.37
	TiO_2	%wt (na)	20	0.03	0.01	0.01	0.11	0.04

Fresh Willow SRC

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	6	52.6	50.4	48.1	65.1	6.4
	NCV	kJ/kg	6	7430	7825	4885	8426	1313
Dry Fuel Basis (d)	Ash	%wt	6	1.8	1.7	1.2	2.8	0.6
Dry Ash-free basis (DAF)	Volatile matter	%wt	6	82.9	83.2	79.6	84.9	2.0
	GCV	kJ/kg	6	20074	20064	19789	20438	265
	C	%wt	6	50.48	50.72	48.91	51.32	0.85
	H	%wt	6	6.19	6.19	6.11	6.28	0.06
	N	%wt	6	0.61	0.60	0.34	0.96	0.23
	S	%wt	6	0.01	0.01	0.01	0.02	0.01
	Cl	%wt	6	0.02	0.02	0.01	0.03	0.01
	O	%wt (by diff.)	6	42.71	42.47	41.80	44.40	0.95
Dry fuel basis	Ba	mg/kg	6	11.64	11.11	4.51	20.80	5.51
	Be	mg/kg	6	0.09	0.08	0.06	0.15	0.03
	Cr	mg/kg	6	0.22	0.20	0.09	0.52	0.16
	Co	mg/kg	6	0.21	0.20	0.10	0.37	0.10
	Cu	mg/kg	6	4.36	4.17	2.23	7.33	1.78
	Mo	mg/kg	6	0.09	0.08	0.06	0.15	0.03
	Ni	mg/kg	6	0.71	0.56	0.37	1.43	0.42
	V	mg/kg	6	0.17	0.09	0.06	0.59	0.21
	Zn	mg/kg	6	88.21	76.80	60.48	158.40	36.68
	Sb	mg/kg	3	0.02	0.02	0.01	0.03	0.01
	As	mg/kg	3	0.02	0.02	0.01	0.04	0.02
	Hg	mg/kg	3	0.01	0.02	0.00	0.02	0.01
	F	mg/kg	3	2.13	1.98	1.80	2.60	1.20
	Br	mg/kg	3	2.13	1.98	1.80	2.60	1.20
	Se	mg/kg	3	0.43	0.40	0.36	0.52	0.24
	Cd	mg/kg	5	0.96	0.39	0.00	2.07	0.97
	Pb	mg/kg	5	0.59	0.30	0.18	1.71	0.63
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	6	0.63	0.35	0.21	1.34	0.55
	BaO	%wt (na)	6	0.08	0.07	0.03	0.16	0.05
	$CaCO_3$	%wt (na)	6	61.45	60.65	49.20	70.37	7.42
	Fe_2O_3	%wt (na)	6	0.45	0.33	0.21	0.99	0.30
	K_2O	%wt (na)	6	16.29	15.77	12.03	23.81	4.29
	MgO	%wt (na)	6	5.35	5.19	3.30	7.54	1.65
	Mn_3O_4	%wt (na)	6	0.44	0.37	0.24	0.71	0.21
	Na_2O	%wt (na)	6	0.48	0.41	0.18	0.99	0.28
	P_2O_5	%wt (na)	6	11.26	10.74	9.78	14.33	1.58
	SiO_2	%wt (na)	6	3.50	2.68	1.55	6.68	2.14
	TiO_2	%wt (na)	6	0.07	0.05	0.02	0.19	0.07

Willow IFV Site 1 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	20	52.3	52.4	49.6	54.7	1.4
	NCV	kJ/kg	20	7462	7461	6946	7942	267
Dry Fuel Basis (d)	Ash	%wt	20	1.3	1.3	1.0	2.1	0.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	20	84.0	84.0	83.3	84.9	0.4
	GCV	kJ/kg	20	19904	19874	19695	20205	138
	C	%wt	20	50.42	50.49	49.65	51.12	0.40
	H	%wt	20	6.18	6.18	6.10	6.31	0.07
	N	%wt	20	0.38	0.38	0.28	0.46	0.05
	S	%wt	20	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	20	0.01	0.01	0.01	0.04	0.01
	O	%wt (by diff.)	20	43.01	42.96	42.38	43.73	0.34
Dry fuel basis	Ba	mg/kg	20	52.29	58.36	16.52	77.26	14.81
	Be	mg/kg	20	0.08	0.08	0.07	0.13	0.01
	Cr	mg/kg	19	0.18	0.18	0.12	0.27	0.04
	Co	mg/kg	19	0.33	0.36	0.15	0.55	0.12
	Cu	mg/kg	19	3.61	3.53	3.03	4.45	0.38
	Mo	mg/kg	19	0.08	0.08	0.07	0.13	0.01
	Ni	mg/kg	18	0.41	0.43	0.13	0.67	0.15
	V	mg/kg	19	0.09	0.08	0.07	0.17	0.02
	Zn	mg/kg	18	88.67	86.01	70.28	130.58	15.06
	Sb	mg/kg	17	0.02	0.02	0.01	0.03	0.00
	As	mg/kg	19	0.05	0.05	0.01	0.09	0.02
	Hg	mg/kg	19	0.00	0.00	0.00	0.00	0.00
	F	mg/kg	19	1.98	1.98	1.93	2.08	0.04
	Br	mg/kg	20	1.98	1.98	1.93	2.08	0.04
	Se	mg/kg	20	0.40	0.40	0.39	0.42	0.01
	Cd	mg/kg	20	1.50	1.22	0.33	3.15	0.85
	Pb	mg/kg	18	0.73	0.52	0.24	2.53	0.60
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	19	0.18	0.17	0.13	0.24	0.03
	BaO	%wt (na)	20	0.39	0.42	0.07	0.63	0.12
	$CaCO_3$	%wt (na)	20	61.52	61.19	53.70	77.13	4.75
	Fe_2O_3	%wt (na)	19	0.30	0.27	0.19	0.54	0.08
	K_2O	%wt (na)	20	17.41	17.23	11.16	24.45	2.56
	MgO	%wt (na)	20	5.77	5.86	2.57	6.75	0.95
	Mn_3O_4	%wt (na)	20	1.11	1.16	0.15	2.38	0.46
	Na_2O	%wt (na)	19	0.49	0.48	0.33	0.62	0.08
	P_2O_5	%wt (na)	20	11.27	11.64	6.88	14.74	1.73
	SiO_2	%wt (na)	19	1.16	1.17	0.72	1.93	0.34
	TiO_2	%wt (na)	19	0.07	0.06	0.05	0.15	0.03

Willow IFV Site 2 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	20	51.4	51.5	49.4	54.0	1.2
	NCV	kJ/kg	20	7641	7628	7126	8066	244
Dry Fuel Basis (d)	Ash	%wt	20	1.6	1.6	1.4	1.9	0.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	19	84.0	83.8	83.4	84.7	0.4
	GCV	kJ/kg	20	19940	19929	19727	20172	113
	C	%wt	20	50.39	50.32	49.88	51.16	0.33
	H	%wt	20	6.14	6.15	6.07	6.18	0.03
	N	%wt	20	0.54	0.54	0.43	0.73	0.07
	S	%wt	20	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	20	0.01	0.01	0.01	0.02	0.00
	O	%wt (by diff.)	20	42.93	42.90	42.24	43.45	0.32
Dry fuel basis	Ba	mg/kg	20	9.04	8.82	5.13	14.17	2.58
	Be	mg/kg	20	0.09	0.09	0.08	0.12	0.01
	Cr	mg/kg	19	0.28	0.27	0.15	0.45	0.07
	Co	mg/kg	20	0.14	0.12	0.08	0.26	0.05
	Cu	mg/kg	19	4.79	4.79	3.56	5.78	0.47
	Mo	mg/kg	20	0.09	0.09	0.08	0.12	0.01
	Ni	mg/kg	20	1.19	1.13	0.60	2.20	0.42
	V	mg/kg	19	0.14	0.10	0.08	0.31	0.07
	Zn	mg/kg	20	99.55	95.89	78.75	134.55	13.80
	Sb	mg/kg	20	0.02	0.02	0.02	0.05	0.01
	As	mg/kg	19	0.04	0.03	0.02	0.07	0.02
	Hg	mg/kg	20	0.00	0.00	0.00	0.00	0.00
	F	mg/kg	19	2.00	2.00	1.93	2.07	0.04
	Br	mg/kg	20	2.00	2.00	1.93	2.12	0.05
	Se	mg/kg	20	0.40	0.40	0.39	0.41	0.00
	Cd	mg/kg	20	1.43	1.42	0.75	2.16	0.44
	Pb	mg/kg	19	0.39	0.39	0.17	0.71	0.13
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	19	0.90	0.71	0.30	2.45	0.63
	BaO	%wt (na)	20	0.06	0.06	0.03	0.09	0.02
	$CaCO_3$	%wt (na)	20	60.25	61.14	51.58	66.92	4.46
	Fe_2O_3	%wt (na)	18	0.45	0.39	0.20	0.98	0.22
	K_2O	%wt (na)	20	16.55	16.49	13.72	19.37	1.92
	MgO	%wt (na)	20	4.16	4.16	3.60	4.81	0.28
	Mn_3O_4	%wt (na)	20	0.16	0.17	0.07	0.30	0.05
	Na_2O	%wt (na)	20	0.33	0.34	0.24	0.46	0.05
	P_2O_5	%wt (na)	20	11.91	12.27	9.88	13.46	1.05
	SiO_2	%wt (na)	19	3.73	3.43	1.57	9.28	2.22
	TiO_2	%wt (na)	19	0.12	0.10	0.07	0.19	0.03

Willow IFV Site 3 (Study 2)

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	20	55.7	55.8	53.5	57.1	1.0
	NCV	kJ/kg	20	6751	6708	6498	7169	210
Dry Fuel Basis (d)	Ash	%wt	20	1.7	1.7	1.4	2.0	0.1
Dry Ash-free basis (DAF)	Volatile matter	%wt	20	84.1	84.1	83.1	85.1	0.4
	GCV	kJ/kg	19	19973	19967	19886	20074	53
	C	%wt	20	49.87	49.94	49.10	50.27	0.37
	H	%wt	20	6.19	6.21	6.02	6.29	0.09
	N	%wt	20	0.39	0.41	0.22	0.51	0.07
	S	%wt	20	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	20	0.01	0.01	0.01	0.01	0.00
	O	%wt (by diff.)	20	43.56	43.46	43.02	44.28	0.48
Dry fuel basis	Ba	mg/kg	20	3.04	3.12	1.85	4.41	0.68
	Be	mg/kg	20	0.10	0.10	0.08	0.11	0.01
	Cr	mg/kg	20	0.11	0.10	0.09	0.15	0.01
	Co	mg/kg	20	0.12	0.11	0.09	0.17	0.02
	Cu	mg/kg	20	3.76	3.73	3.16	4.42	0.40
	Mo	mg/kg	20	0.10	0.10	0.08	0.11	0.01
	Ni	mg/kg	20	0.50	0.53	0.24	0.69	0.13
	V	mg/kg	20	0.10	0.10	0.08	0.12	0.01
	Zn	mg/kg	20	52.63	53.03	40.83	61.41	5.11
	Sb	mg/kg	20	0.02	0.02	0.02	0.02	0.00
	As	mg/kg	20	0.02	0.02	0.02	0.02	0.00
	Hg	mg/kg	19	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	20	1.99	1.98	1.95	2.08	0.04
	Br	mg/kg	20	1.99	1.98	1.95	2.08	0.04
	Se	mg/kg	20	0.40	0.40	0.39	0.42	0.01
	Cd	mg/kg	20	1.58	1.64	0.35	3.18	0.91
	Pb	mg/kg	20	0.16	0.13	0.07	0.38	0.09
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	20	0.10	0.09	0.07	0.29	0.05
	BaO	%wt (na)	20	0.02	0.02	0.01	0.03	0.01
	$CaCO_3$	%wt (na)	20	76.68	76.07	73.37	80.48	2.18
	Fe_2O_3	%wt (na)	20	0.12	0.12	0.09	0.14	0.01
	K_2O	%wt (na)	20	11.85	11.90	9.96	13.29	0.91
	MgO	%wt (na)	20	2.19	2.26	1.86	2.51	0.21
	Mn_3O_4	%wt (na)	20	0.34	0.33	0.05	0.74	0.19
	Na_2O	%wt (na)	20	0.28	0.28	0.21	0.37	0.04
	P_2O_5	%wt (na)	20	7.64	7.84	6.25	8.78	0.85
	SiO_2	%wt (na)	20	0.76	0.75	0.50	1.22	0.19
	TiO_2	%wt (na)	20	0.01	0.01	0.01	0.01	0.00

Willow Leaves

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	9	63.7	64.3	54.6	68.5	3.9
	NCV	kJ/kg	9	5305	5248	4187	6997	765
Dry Fuel Basis (d)	Ash	%wt	9	8.0	8.2	6.7	9.9	1.0
Dry Ash-free basis (DAF)	Volatile matter	%wt	9	78.3	78.3	77.0	80.0	1.1
	GCV	kJ/kg	9	21997	22042	21445	22450	327
	C	%wt	9	54.29	54.25	53.54	55.72	0.67
	H	%wt	9	6.46	6.51	6.28	6.62	0.11
	N	%wt	9	2.85	2.94	2.11	3.55	0.46
	S	%wt	9	0.45	0.41	0.36	0.66	0.09
	Cl	%wt	9	0.16	0.16	0.14	0.18	0.02
	O	%wt (by diff.)	9	35.78	35.59	34.79	37.49	0.78
Dry fuel basis	Ba	mg/kg	9	26.90	22.55	4.27	60.67	18.44
	Be	mg/kg	9	0.42	0.41	0.35	0.53	0.05
	Cr	mg/kg	9	0.66	0.67	0.38	0.99	0.20
	Co	mg/kg	9	0.87	0.68	0.40	1.58	0.45
	Cu	mg/kg	9	8.03	7.76	5.65	10.80	1.54
	Mo	mg/kg	9	0.60	0.42	0.35	1.44	0.36
	Ni	mg/kg	9	9.05	6.76	1.90	19.90	5.56
	V	mg/kg	9	0.43	0.41	0.35	0.58	0.08
	Zn	mg/kg	9	209.95	191.53	56.24	424.74	119.48
	Sb	mg/kg	9	0.12	0.11	0.07	0.26	0.06
	As	mg/kg	9	0.10	0.08	0.07	0.17	0.03
	Hg	mg/kg	9	0.02	0.02	0.01	0.02	0.00
	F	mg/kg	9	2.97	3.09	1.95	4.06	0.98
	Br	mg/kg	9	18.61	19.84	2.06	27.26	6.70
	Se	mg/kg	9	0.43	0.40	0.38	0.70	0.10
	Cd	mg/kg	9	4.36	4.06	0.89	8.88	2.64
	Pb	mg/kg	9	0.81	0.64	0.35	1.89	0.56
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	9	0.25	0.23	0.15	0.54	0.12
	BaO	%wt (na)	9	0.04	0.03	0.01	0.08	0.03
	$CaCO_3$	%wt (na)	9	58.52	56.61	49.02	69.92	6.94
	Fe_2O_3	%wt (na)	9	0.24	0.23	0.16	0.38	0.06
	K_2O	%wt (na)	9	19.86	20.74	9.02	26.54	5.85
	MgO	%wt (na)	9	7.03	7.18	1.98	11.92	2.90
	Mn_3O_4	%wt (na)	9	0.56	0.40	0.22	1.15	0.35
	Na_2O	%wt (na)	9	0.35	0.35	0.28	0.47	0.06
	P_2O_5	%wt (na)	9	11.39	10.43	9.00	17.78	2.73
	SiO_2	%wt (na)	9	1.74	1.55	1.07	3.35	0.69
	TiO_2	%wt (na)	9	0.03	0.03	0.01	0.08	0.02

Poplar SRF Trunk

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	22	56.5	56.7	50.4	59.9	2.6
	NCV	kJ/kg	22	6543	6496	5870	6722	523
Dry Fuel Basis (d)	Ash	%wt	22	1.6	1.6	1.2	1.8	0.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	22	84.4	84.3	83.5	84.5	0.5
	GCV	kJ/kg	22	19817	19838	19587	19963	99
	C	%wt	22	50.15	50.13	49.55	50.30	0.36
	H	%wt	22	6.12	6.14	6.02	6.19	0.05
	N	%wt	22	0.31	0.31	0.26	0.34	0.03
	S	%wt	22	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	22	0.01	0.01	0.01	0.01	0.00
	O	%wt (by diff.)	22	43.42	43.46	42.75	44.02	0.40
Dry fuel basis	Ba	mg/kg	21	6.60	5.28	0.89	17.72	5.12
	Be	mg/kg	22	0.09	0.09	0.08	0.10	0.01
	Cr	mg/kg	22	0.15	0.11	0.08	0.28	0.08
	Co	mg/kg	22	0.13	0.11	0.08	0.22	0.05
	Cu	mg/kg	22	2.68	2.39	1.65	4.99	0.87
	Mo	mg/kg	22	0.09	0.09	0.08	0.10	0.01
	Ni	mg/kg	22	0.30	0.29	0.11	0.50	0.12
	V	mg/kg	21	0.12	0.09	0.08	0.19	0.06
	Zn	mg/kg	22	35.41	35.63	19.33	46.77	7.74
	Sb	mg/kg	10	0.02	0.02	0.02	0.03	0.01
	As	mg/kg	10	0.02	0.02	0.02	0.03	0.01
	Hg	mg/kg	10	0.01	0.00	0.00	0.03	0.01
	F	mg/kg	10	2.03	1.95	1.86	1.96	1.04
	Br	mg/kg	10	1.96	1.91	1.85	1.96	1.00
	Se	mg/kg	10	0.39	0.38	0.37	0.39	0.20
	Cd	mg/kg	20	0.43	0.45	0.04	0.59	0.27
	Pb	mg/kg	21	0.34	0.23	0.10	0.37	0.30
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	21	0.82	0.69	0.20	2.38	0.53
	BaO	%wt (na)	21	0.05	0.04	0.01	0.12	0.04
	$CaCO_3$	%wt (na)	21	69.12	69.19	58.05	76.03	5.14
	Fe_2O_3	%wt (na)	21	0.35	0.22	0.09	0.99	0.28
	K_2O	%wt (na)	21	15.54	14.05	9.85	22.91	4.03
	MgO	%wt (na)	21	5.33	5.01	3.44	8.10	1.39
	Mn_3O_4	%wt (na)	21	0.10	0.09	0.02	0.48	0.09
	Na_2O	%wt (na)	20	0.49	0.45	0.20	0.99	0.22
	P_2O_5	%wt (na)	21	5.63	5.71	4.13	6.72	0.80
	SiO_2	%wt (na)	21	2.54	1.97	0.32	9.90	2.37
	TiO_2	%wt (na)	20	0.04	0.03	0.01	0.11	0.04

Poplar SRF Tops

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	22	56.4	55.8	44.6	68.4	5.6
	NCV	kJ/kg	22	6648	6850	4106	9141	1193
Dry Fuel Basis (d)	Ash	%wt	22	4.5	4.6	2.5	6.7	1.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	22	80.8	80.7	79.5	82.0	0.6
	GCV	kJ/kg	22	20642	20649	20280	21116	200
	C	%wt	21	51.64	51.65	50.37	52.77	0.70
	H	%wt	21	6.24	6.25	6.11	6.33	0.05
	N	%wt	21	1.11	1.18	0.75	1.81	0.33
	S	%wt	22	0.07	0.04	0.01	0.17	0.06
	Cl	%wt	22	0.03	0.03	0.01	0.06	0.01
	O	%wt (by diff.)	21	40.91	41.16	39.08	42.51	1.03
Dry fuel basis	Ba	mg/kg	22	11.86	10.50	1.74	43.90	8.92
	Be	mg/kg	22	0.23	0.24	0.13	0.33	0.06
	Cr	mg/kg	22	0.25	0.27	0.13	0.47	0.08
	Co	mg/kg	21	0.36	0.29	0.13	1.10	0.26
	Cu	mg/kg	22	7.33	7.09	3.47	11.07	2.18
	Mo	mg/kg	22	0.23	0.24	0.13	0.33	0.06
	Ni	mg/kg	22	1.58	1.28	0.46	4.88	1.14
	V	mg/kg	21	0.24	0.24	0.13	0.33	0.06
	Zn	mg/kg	22	82.12	80.27	32.04	157.20	29.48
	Sb	mg/kg	10	0.05	0.05	0.04	0.06	0.03
	As	mg/kg	10	0.06	0.06	0.04	0.08	0.03
	Hg	mg/kg	10	0.01	0.00	0.00	0.03	0.01
	F	mg/kg	10	2.11	1.96	1.91	2.59	1.09
	Br	mg/kg	10	3.64	1.93	1.84	19.05	4.00
	Se	mg/kg	10	0.39	0.39	0.37	0.41	0.20
	Cd	mg/kg	21	0.73	0.64	0.20	1.50	0.38
	Pb	mg/kg	20	0.43	0.29	0.13	1.44	0.38
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	22	0.24	0.25	0.09	0.48	0.11
	BaO	%wt (na)	22	0.03	0.03	0.00	0.08	0.02
	$CaCO_3$	%wt (na)	22	66.28	65.53	58.17	77.28	4.99
	Fe_2O_3	%wt (na)	22	0.16	0.15	0.07	0.36	0.07
	K_2O	%wt (na)	22	16.35	17.11	10.15	24.51	3.66
	MgO	%wt (na)	22	5.50	4.91	2.77	9.61	2.01
	Mn_3O_4	%wt (na)	22	0.10	0.10	0.03	0.25	0.05
	Na_2O	%wt (na)	22	0.60	0.61	0.15	1.10	0.27
	P_2O_5	%wt (na)	22	7.93	7.66	5.38	11.66	1.61
	SiO_2	%wt (na)	22	2.80	2.50	0.63	7.17	1.97
	TiO_2	%wt (na)	22	0.02	0.01	0.01	0.06	0.01

Poplar Leaves

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	11	69.3	69.6	61.7	73.1	3.1
	NCV	kJ/kg	11	3848	3790	3024	5396	618
Dry Fuel Basis (d)	Ash	%wt	11	9.1	9.1	7.6	10.9	0.9
Dry Ash-free basis (DAF)	Volatile matter	%wt	11	81.2	81.5	78.6	83.0	1.4
	GCV	kJ/kg	11	21216	21247	20838	21795	275
	C	%wt	11	53.43	53.42	52.63	54.62	0.61
	H	%wt	11	6.24	6.29	5.75	6.41	0.18
	N	%wt	11	2.69	2.63	2.38	3.30	0.30
	S	%wt	11	0.39	0.39	0.28	0.46	0.05
	Cl	%wt	11	0.09	0.08	0.06	0.12	0.02
	O	%wt (by diff.)	11	37.16	37.03	35.45	37.90	0.71
Dry fuel basis	Ba	mg/kg	11	11.72	9.17	2.64	27.06	7.73
	Be	mg/kg	11	0.46	0.47	0.37	0.56	0.05
	Cr	mg/kg	11	0.49	0.47	0.37	0.75	0.10
	Co	mg/kg	11	1.22	0.94	0.47	2.53	0.74
	Cu	mg/kg	11	9.29	9.15	6.94	11.93	1.46
	Mo	mg/kg	11	0.46	0.47	0.37	0.56	0.05
	Ni	mg/kg	11	4.02	3.95	1.21	7.76	1.89
	V	mg/kg	11	0.46	0.47	0.37	0.56	0.05
	Zn	mg/kg	11	157.82	158.18	82.00	229.42	45.53
	Sb	mg/kg	11	0.09	0.09	0.07	0.11	0.01
	As	mg/kg	11	0.09	0.09	0.07	0.11	0.01
	Hg	mg/kg	11	0.01	0.01	0.01	0.01	0.00
	F	mg/kg	11	2.30	2.09	1.91	3.34	0.49
	Br	mg/kg	11	10.04	2.58	1.91	19.99	9.07
	Se	mg/kg	11	0.42	0.39	0.38	0.55	0.06
	Cd	mg/kg	11	1.39	1.47	0.50	3.10	0.79
	Pb	mg/kg	11	0.21	0.20	0.09	0.40	0.10
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	11	0.28	0.28	0.23	0.34	0.03
	BaO	%wt (na)	11	0.02	0.01	0.00	0.04	0.01
	$CaCO_3$	%wt (na)	11	55.79	53.74	48.19	64.53	5.49
	Fe_2O_3	%wt (na)	11	0.11	0.11	0.07	0.19	0.03
	K_2O	%wt (na)	11	22.17	20.45	17.75	27.41	3.54
	MgO	%wt (na)	11	6.00	5.00	2.86	12.17	3.01
	Mn_3O_4	%wt (na)	11	0.14	0.14	0.06	0.23	0.06
	Na_2O	%wt (na)	11	0.26	0.21	0.06	0.49	0.14
	P_2O_5	%wt (na)	11	7.16	7.23	5.25	9.07	1.16
	SiO_2	%wt (na)	11	8.05	6.71	4.57	12.77	2.83
	TiO_2	%wt (na)	11	0.02	0.02	0.01	0.03	0.01

Spruce SRF trunk

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	23	59.9	60.0	56.1	62.8	1.8
	NCV	kJ/kg	23	6019	5983	5406	6871	383
Dry Fuel Basis (d)	Ash	%wt	24	0.4	0.4	0.2	0.8	0.2
Dry Ash-free basis (DAF)	Volatile matter	%wt	24	84.6	84.5	83.6	85.8	0.6
	GCV	kJ/kg	24	20116	20111	19960	20337	87
	C	%wt	24	50.23	50.43	48.74	50.92	0.56
	H	%wt	24	6.22	6.21	6.14	6.41	0.07
	N	%wt	24	0.26	0.25	0.17	0.45	0.08
	S	%wt	24	0.01	0.01	0.01	0.01	0.00
	Cl	%wt	24	0.01	0.01	0.01	0.03	0.01
	O	%wt (by diff.)	24	43.29	43.14	42.69	44.65	0.50
Dry fuel basis	Ba	mg/kg	24	16.27	15.60	5.90	40.13	8.03
	Be	mg/kg	24	0.02	0.02	0.01	0.04	0.01
	Cr	mg/kg	23	0.12	0.12	0.05	0.27	0.06
	Co	mg/kg	24	0.03	0.02	0.01	0.10	0.02
	Cu	mg/kg	23	1.50	1.34	0.82	2.55	0.50
	Mo	mg/kg	24	0.02	0.02	0.01	0.04	0.01
	Ni	mg/kg	24	0.13	0.11	0.03	0.30	0.07
	V	mg/kg	23	0.04	0.03	0.01	0.16	0.03
	Zn	mg/kg	24	8.22	7.74	4.78	12.90	2.66
	Sb	mg/kg	8	0.02	0.01	0.00	0.04	0.01
	As	mg/kg	8	0.01	0.01	0.00	0.02	0.01
	Hg	mg/kg	8	0.00	0.00	0.00	0.01	0.00
	F	mg/kg	8	2.30	1.96	1.93	3.87	1.17
	Br	mg/kg	8	1.94	1.94	1.92	1.96	0.93
	Se	mg/kg	8	0.39	0.39	0.39	0.39	0.19
	Cd	mg/kg	16	0.03	0.02	0.01	0.08	0.02
	Pb	mg/kg	16	0.28	0.14	0.08	1.31	0.31
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	22	1.94	1.61	0.64	6.11	1.23
	BaO	%wt (na)	23	0.56	0.52	0.26	1.10	0.22
	$CaCO_3$	%wt (na)	23	53.51	54.72	44.53	60.73	4.82
	Fe_2O_3	%wt (na)	22	1.12	0.97	0.09	3.07	0.65
	K_2O	%wt (na)	22	20.18	20.15	13.59	29.88	4.17
	MgO	%wt (na)	23	7.60	8.20	5.18	9.19	1.31
	Mn_3O_4	%wt (na)	23	2.57	2.09	0.81	6.72	1.57
	Na_2O	%wt (na)	22	0.31	0.27	0.18	0.63	0.12
	P_2O_5	%wt (na)	23	6.36	6.53	3.86	8.42	1.35
	SiO_2	%wt (na)	23	5.85	4.67	2.27	15.33	3.78
	TiO_2	%wt (na)	22	0.07	0.05	0.01	0.27	0.07

Spruce SRF Tops

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	24	55.9	54.6	48.0	67.9	4.4
	NCV	kJ/kg	24	7398	7716	4723	9110	1008
Dry Fuel Basis (d)	Ash	%wt	24	2.4	2.3	1.8	3.2	0.4
Dry Ash-free basis (DAF)	Volatile matter	%wt	24	78.5	78.5	76.8	79.8	0.9
	GCV	kJ/kg	24	21758	21769	21292	22144	231
	C	%wt	24	53.63	53.62	52.63	54.44	0.43
	H	%wt	24	6.46	6.45	6.35	6.59	0.07
	N	%wt	24	0.93	0.91	0.62	1.41	0.20
	S	%wt	24	0.04	0.04	0.02	0.07	0.01
	Cl	%wt	24	0.04	0.04	0.03	0.08	0.01
	O	%wt (by diff.)	24	38.90	39.01	37.90	40.12	0.54
Dry fuel basis	Ba	mg/kg	24	32.01	28.47	11.04	73.10	19.28
	Be	mg/kg	24	0.12	0.12	0.09	0.17	0.02
	Cr	mg/kg	24	0.37	0.32	0.21	0.70	0.12
	Co	mg/kg	24	0.12	0.12	0.09	0.17	0.03
	Cu	mg/kg	24	3.85	3.71	2.68	5.64	0.81
	Mo	mg/kg	24	0.12	0.12	0.09	0.17	0.02
	Ni	mg/kg	24	0.70	0.67	0.39	1.11	0.19
	V	mg/kg	24	0.22	0.22	0.12	0.36	0.07
	Zn	mg/kg	24	32.29	31.24	22.20	51.37	6.88
	Sb	mg/kg	9	0.04	0.03	0.02	0.11	0.03
	As	mg/kg	9	0.04	0.03	0.02	0.10	0.02
	Hg	mg/kg	8	0.02	0.02	0.02	0.02	0.01
	F	mg/kg	8	1.98	1.97	1.89	2.16	0.96
	Br	mg/kg	8	1.97	1.97	1.89	2.03	0.95
	Se	mg/kg	8	0.39	0.39	0.38	0.41	0.19
	Cd	mg/kg	16	0.08	0.09	0.02	0.16	0.06
	Pb	mg/kg	16	0.49	0.42	0.21	0.99	0.30
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	24	1.13	1.01	0.46	2.47	0.46
	BaO	%wt (na)	24	0.17	0.17	0.06	0.37	0.09
	$CaCO_3$	%wt (na)	24	45.41	44.65	38.67	53.33	3.91
	Fe_2O_3	%wt (na)	24	0.52	0.50	0.26	1.03	0.20
	K_2O	%wt (na)	24	19.82	20.44	14.19	24.53	3.09
	MgO	%wt (na)	24	7.60	8.03	4.57	10.50	1.43
	Mn_3O_4	%wt (na)	24	2.75	2.37	0.93	7.48	1.68
	Na_2O	%wt (na)	23	0.79	0.72	0.46	1.69	0.29
	P_2O_5	%wt (na)	23	10.32	10.88	5.78	15.25	2.73
	SiO_2	%wt (na)	23	11.20	10.14	7.25	21.11	3.98
	TiO_2	%wt (na)	24	0.04	0.02	0.01	0.15	0.04

Spruce SRF Bark

Analysis group	Variable	Units	No. of obs.	Mean	Median	Min	Max	Standard deviation
As Received fuel basis (ar)	Moisture content	%wt	24	58.2	58.9	53.0	64.5	2.9
	NCV	kJ/kg	24	6772	6649	5306	7919	729
Dry Fuel Basis (d)	Ash	%wt	24	2.3	2.3	1.8	2.9	0.3
Dry Ash-free basis (DAF)	Volatile matter	%wt	24	74.4	74.6	72.2	76.3	1.1
	GCV	kJ/kg	24	21392	21388	20852	22137	372
	C	%wt	24	53.94	54.01	51.53	55.36	0.75
	H	%wt	24	6.10	6.12	5.82	6.30	0.12
	N	%wt	24	0.58	0.57	0.40	0.87	0.11
	S	%wt	24	0.02	0.01	0.01	0.03	0.01
	Cl	%wt	24	0.04	0.04	0.02	0.05	0.01
	O	%wt (by diff.)	24	39.33	39.28	37.79	41.79	0.80
Dry fuel basis	Ba	mg/kg	24	132.50	113.85	58.19	243.51	60.74
	Be	mg/kg	24	0.12	0.12	0.09	0.14	0.01
	Cr	mg/kg	24	0.47	0.46	0.25	0.78	0.16
	Co	mg/kg	24	0.12	0.12	0.09	0.14	0.01
	Cu	mg/kg	24	4.35	4.15	2.57	6.27	1.00
	Mo	mg/kg	24	0.12	0.12	0.09	0.14	0.01
	Ni	mg/kg	24	0.82	0.84	0.40	1.23	0.24
	V	mg/kg	23	0.30	0.28	0.14	0.48	0.10
	Zn	mg/kg	24	66.19	63.90	50.60	90.04	11.24
	Sb	mg/kg	9	0.04	0.04	0.02	0.08	0.02
	As	mg/kg	9	0.05	0.03	0.02	0.13	0.03
	Hg	mg/kg	8	0.02	0.02	0.01	0.02	0.01
	F	mg/kg	8	2.02	2.04	1.93	2.11	0.97
	Br	mg/kg	8	4.81	4.16	3.86	6.28	2.39
	Se	mg/kg	8	0.41	0.41	0.39	0.45	0.20
	Cd	mg/kg	17	0.15	0.14	0.01	0.28	0.09
	Pb	mg/kg	18	0.50	0.43	0.14	1.41	0.32
Calculated ash oxides, %wt dry ash normalised for SO3 and Ca expressed as CaCO3	Al_2O_3	%wt (na)	24	0.96	0.90	0.55	1.89	0.34
	BaO	%wt (na)	24	0.69	0.60	0.30	1.25	0.30
	$CaCO_3$	%wt (na)	24	63.36	64.17	53.94	69.16	3.46
	Fe_2O_3	%wt (na)	24	0.38	0.36	0.23	0.70	0.12
	K_2O	%wt (na)	23	15.31	14.90	10.24	21.96	3.11
	MgO	%wt (na)	24	5.97	6.06	4.17	7.95	1.04
	Mn_3O_4	%wt (na)	22	2.73	2.17	1.39	5.81	1.25
	Na_2O	%wt (na)	24	0.78	0.73	0.35	1.59	0.29
	P_2O_5	%wt (na)	24	6.73	6.65	4.65	9.41	1.31
	SiO_2	%wt (na)	24	2.95	2.61	1.61	6.03	1.09
	TiO_2	%wt (na)	24	0.04	0.04	0.01	0.13	0.03