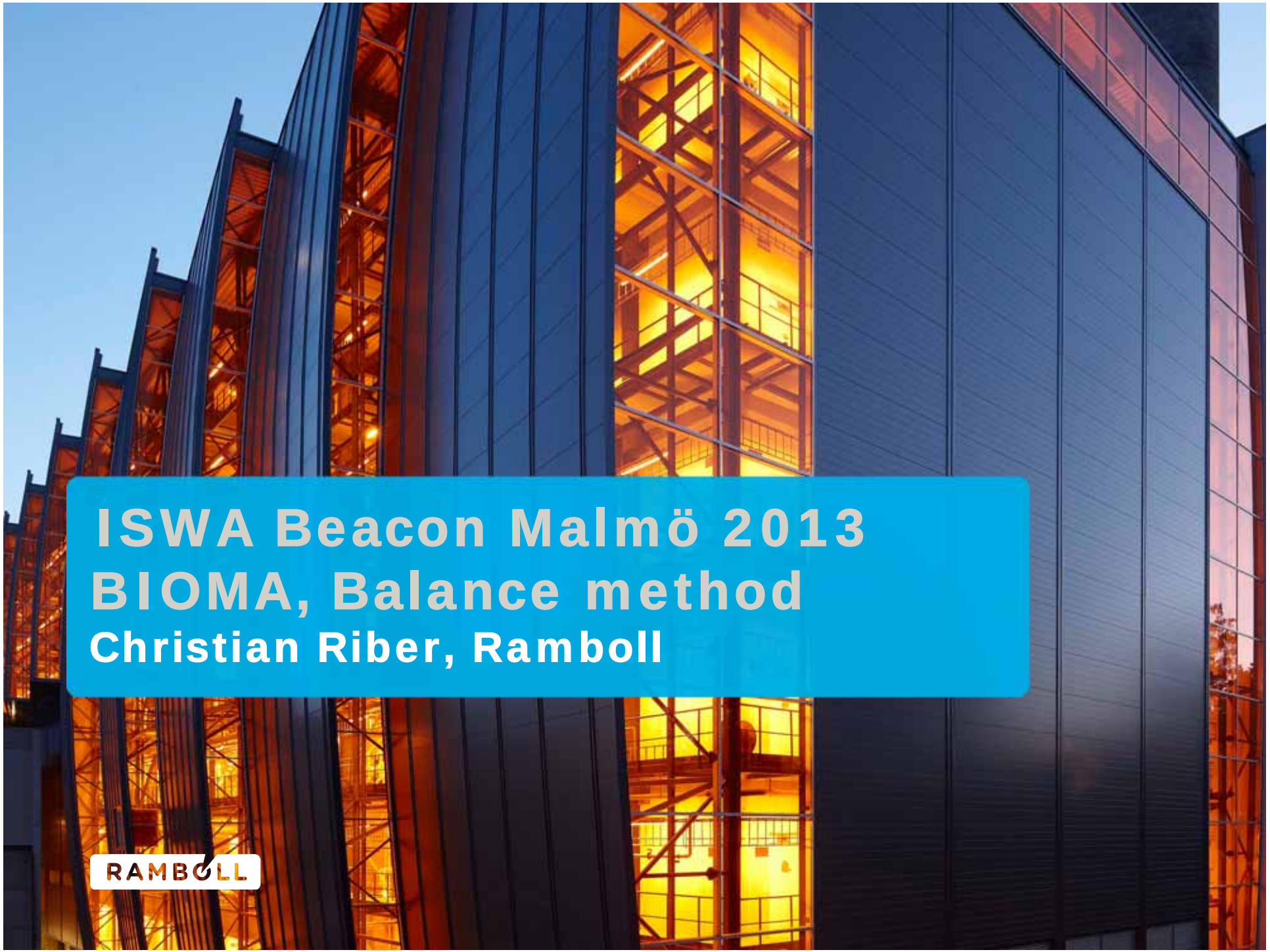

ISWA Beacon Malmö 2013
BIOMA, Balance method

Christian Riber, Ramboll

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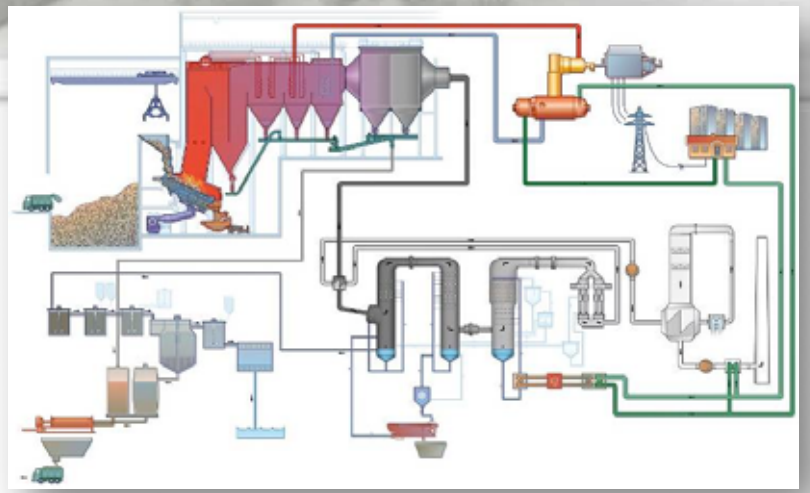
A FUTURE VISION

- On line fuel analysis
- Fuel mixing evaluation
- On line boiler analysis
- On line measurement quality evaluation



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THE PLASTIC/BIOMASS EQUATION

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O_2 CONSUMPTION AND CO_2 PRODUCTION

Biomass (cellulose)

$$(C_6H_{10}O_5)_n + 6O_2 \rightarrow 6CO_2 + 5H_2O$$

O_2-use = CO_2-production

Fossil matter (Plastic, Polyethylene)

$$(-CH_2-CH_2-)_n + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

O_2-use > CO_2-production

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Just equations …

1. Mass balance	m_B	+	m_F	+	m_I	+	m_w	=	1
2. Ash balance	m_I							=	a_{waste}
3. Carbon balance	$c_B \cdot m_B$	+	$c_F \cdot m_F$					=	c_{waste}
4. Energy balance	$HV_B \cdot m_B$	+	$HV_F \cdot m_F$	-	2.45	·	m_W	=	HV_{waste}
5. O_2- balance	$O_2{}^c{}_{,B} \cdot m_B$	+	$O_2{}^c{}_{,F} \cdot m_F$					=	$O_2{}^c{}_{waste}$
6. Difference in O_2-consump. $+CO_2$-prod.	$d_{O_2\text{-}CO_2} \cdot m_B$	+	$d_{O_2\text{-}CO_2} \cdot m_F$					=	$d_{O_2\text{-}CO_2,waste}$

$$\dot{m}_B \cdot \left(\frac{c_{H_B}}{4 \cdot M_H} - \frac{c_{O_B}}{2 \cdot M_O} + \frac{c_{N_B}}{2 \cdot M_N} + \frac{c_{S_B}}{M_S} \right) \cdot 10^3 +$$

$$+ \dot{m}_F \cdot \left(\frac{c_{H_F} - \frac{c_{Cl_F}}{M_{Cl}}}{4 \cdot M_H} - \frac{c_{O_F}}{2 \cdot M_O} + \frac{c_{N_F}}{2 \cdot M_N} + \frac{c_{S_F}}{M_S} \right) \cdot 10^3 = d_{O_2-CO_2} =$$

$$= \frac{\frac{\dot{V}_{flue\ gas}}{10^3} \cdot \left(\left(c_{O_{2,a}} + c_{CO_{2,a}} \right) \cdot \left(\frac{100 - c_{O_{2,fg}} - c_{CO_{2,fg}}}{100 - c_{O_{2,a}} - c_{CO_{2,a}}} \right) - \left(c_{O_{2,fg}} + c_{CO_{2,fg}} \right) \right) \cdot \frac{1}{100} \cdot \frac{1}{V_m}}{\dot{M}_{waste}}$$

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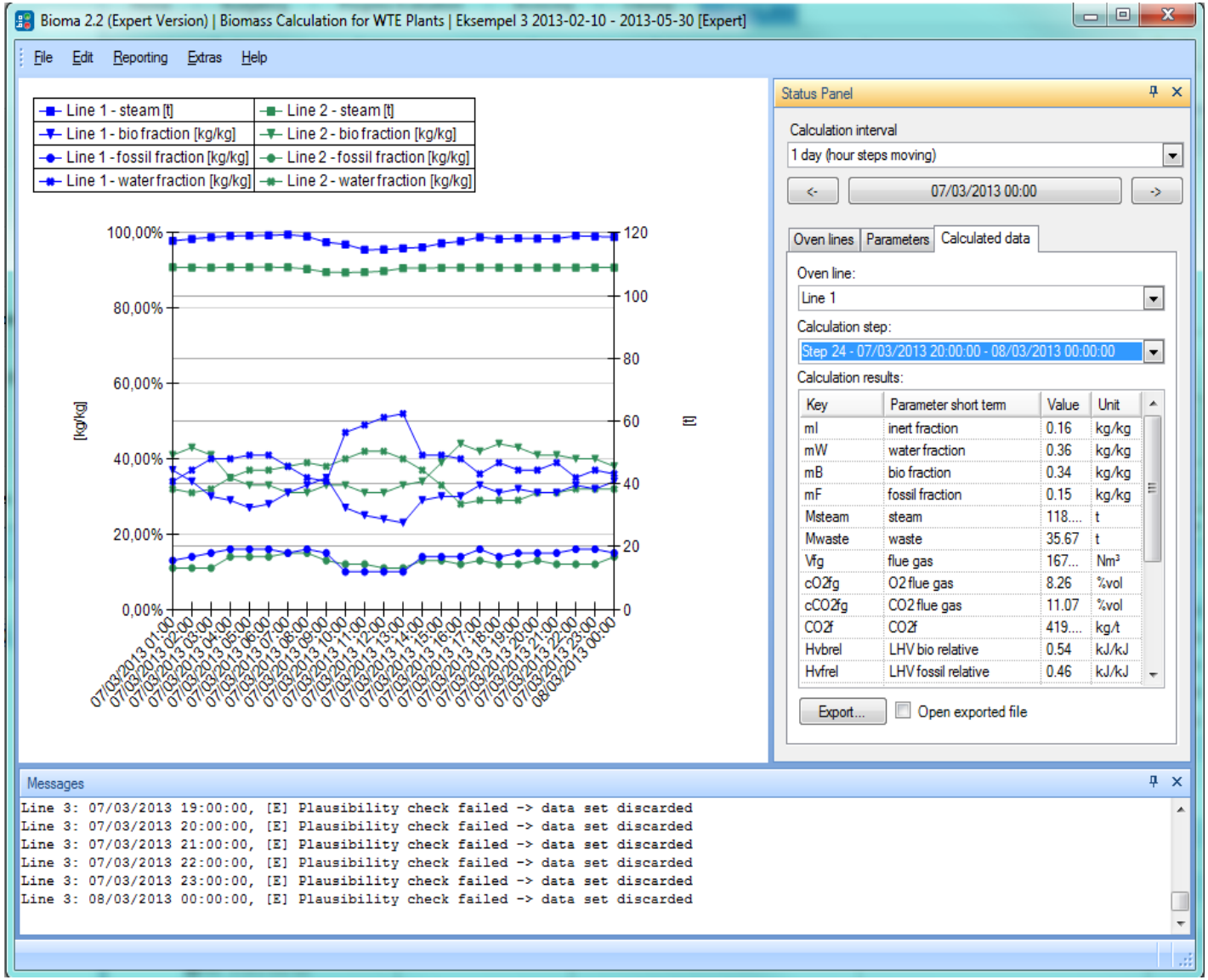
Bioma 2.2 (Expert Version) | Biomass Calculation for WTE Plants | Eksempel 3 2013-02-10 - 2013-05-30 [Expert]
File
Edit
Reporting
Extras
Help
Line 1 - steam [t]
Line 2 - steam [t]
Line 1 - bio fraction [kg/kg]
Line 2 - bio fraction [kg/kg]
Line 1 - fossil fraction [kg/kg]
Line 2 - fossil fraction [kg/kg]
Line 1 - water fraction [kg/kg]
Line 2 - water fraction [kg/kg]
100,00%
80,00%
60,00%
40,00%
20,00%
0,00%
[kg/kg]
120
100
80
60
40
20
0
[t]
07/03/2013 01:00
07/03/2013 02:00
07/03/2013 03:00
07/03/2013 04:00
07/03/2013 05:00
07/03/2013 06:00
07/03/2013 07:00
07/03/2013 08:00
07/03/2013 09:00
07/03/2013 10:00
07/03/2013 11:00
07/03/2013 12:00
07/03/2013 13:00
07/03/2013 14:00
07/03/2013 15:00
07/03/2013 16:00
07/03/2013 17:00
07/03/2013 18:00
07/03/2013 19:00
07/03/2013 20:00
07/03/2013 21:00
07/03/2013 22:00
07/03/2013 23:00
08/03/2013 00:00
Status Panel
Calculation interval
1 day (hour steps moving)
<-
07/03/2013 00:00
->
Oven lines
Parameters
Calculated data
Oven line:
Line 1
Calculation step:
Step 24 - 07/03/2013 20:00:00 - 08/03/2013 00:00:00
Calculation results:
Key
Parameter short term
Value
Unit
mI
inert fraction
0.16
kg/kg
mW
water fraction
0.36
kg/kg
mB
bio fraction
0.34
kg/kg
mF
fossil fraction
0.15
kg/kg
Msteam
steam
118....
t
Mwaste
waste
35.67
t
Vfg
flue gas
167...
Nm³
cO2fg
O2 flue gas
8.26
%vol
cCO2fg
CO2 flue gas
11.07
%vol
CO2f
CO2f
419....
kg/t
Hvbrel
LHV bio relative
0.54
kJ/kJ
Hvfrel
LHV fossil relative
0.46
kJ/kJ
Export...
Open exported file
Messages
Line 3: 07/03/2013 19:00:00, [E] Plausibility check failed -> data set discarded
Line 3: 07/03/2013 20:00:00, [E] Plausibility check failed -> data set discarded
Line 3: 07/03/2013 21:00:00, [E] Plausibility check failed -> data set discarded
Line 3: 07/03/2013 22:00:00, [E] Plausibility check failed -> data set discarded
Line 3: 07/03/2013 23:00:00, [E] Plausibility check failed -> data set discarded
Line 3: 08/03/2013 00:00:00, [E] Plausibility check failed -> data set discarded

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WHAT THE SOFTWARE BOIMA IS USED FOR

1. Waste characteristics (plastic and water in the waste and biomass composition)
2. Green/biogenic/sustainable electricity
3. CO_2 emission trading and CO_2 tax
4. Monitor measurements (e.g. O_2, flow)
5. Increase steam production
6. Evaluate if mixing of waste is sufficient

bioma TU WIEN
software zur bilanzenmethode

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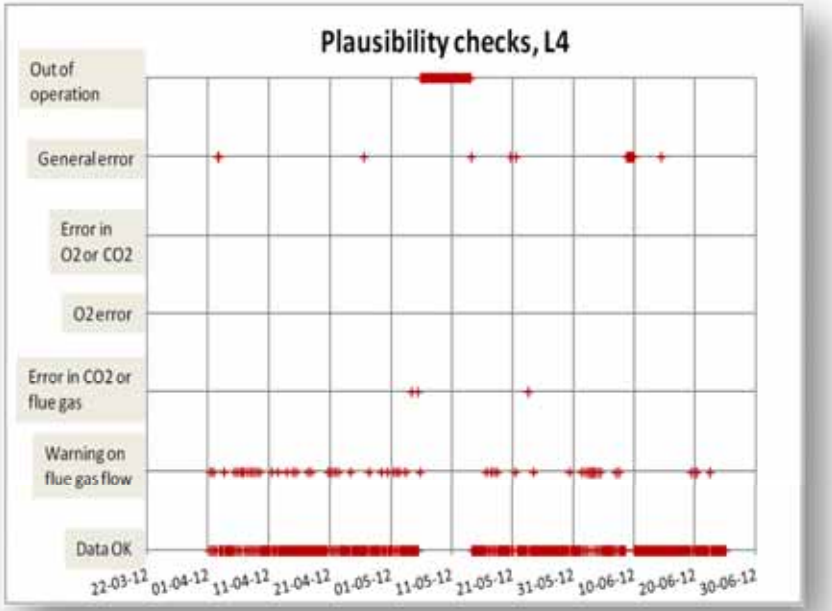
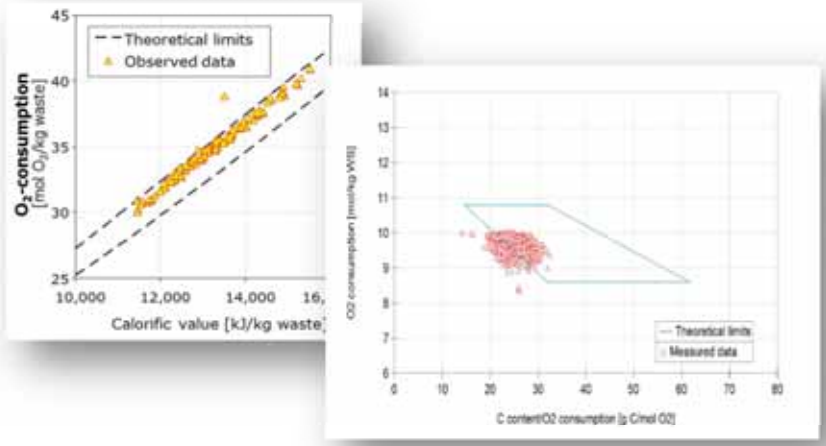
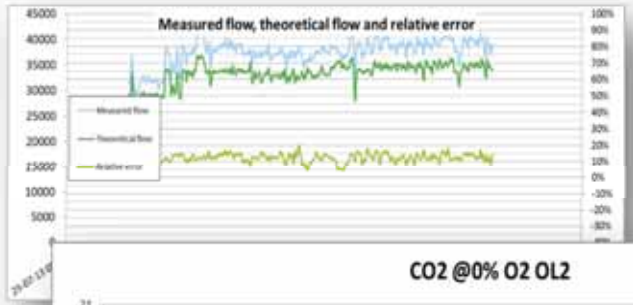
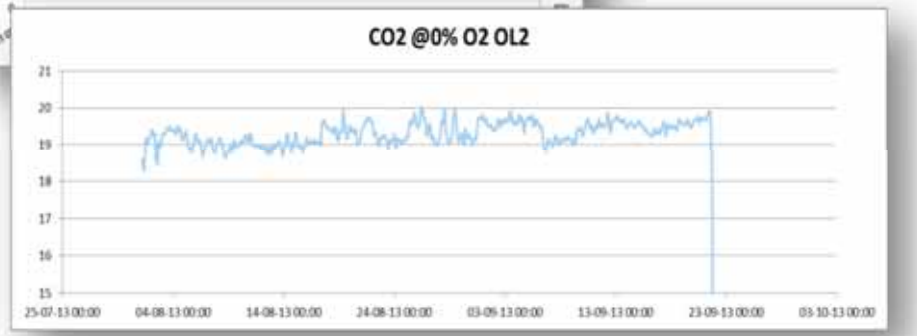
BIOMA – QUALITY ASSURANCE









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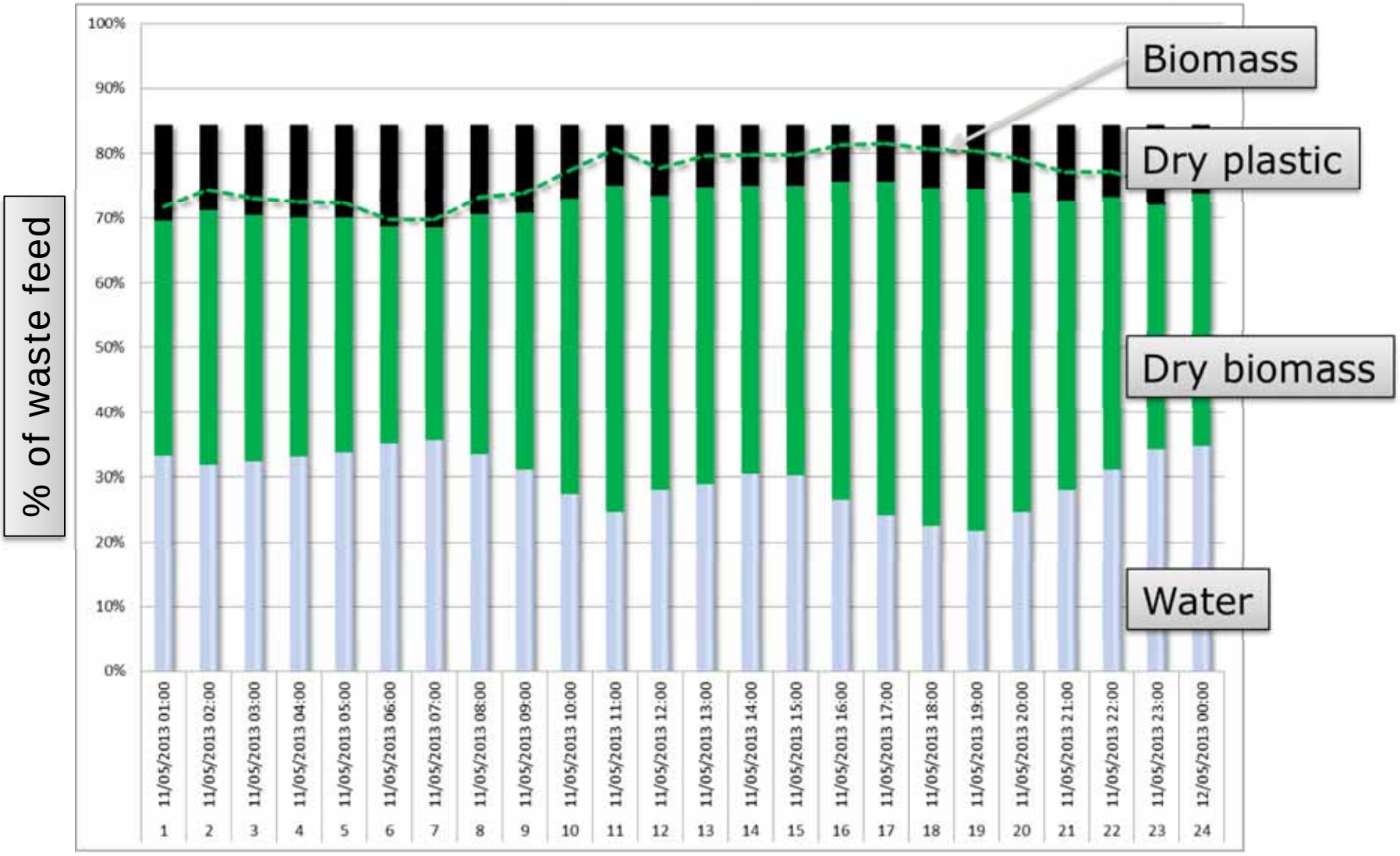
FUEL ANALYSIS



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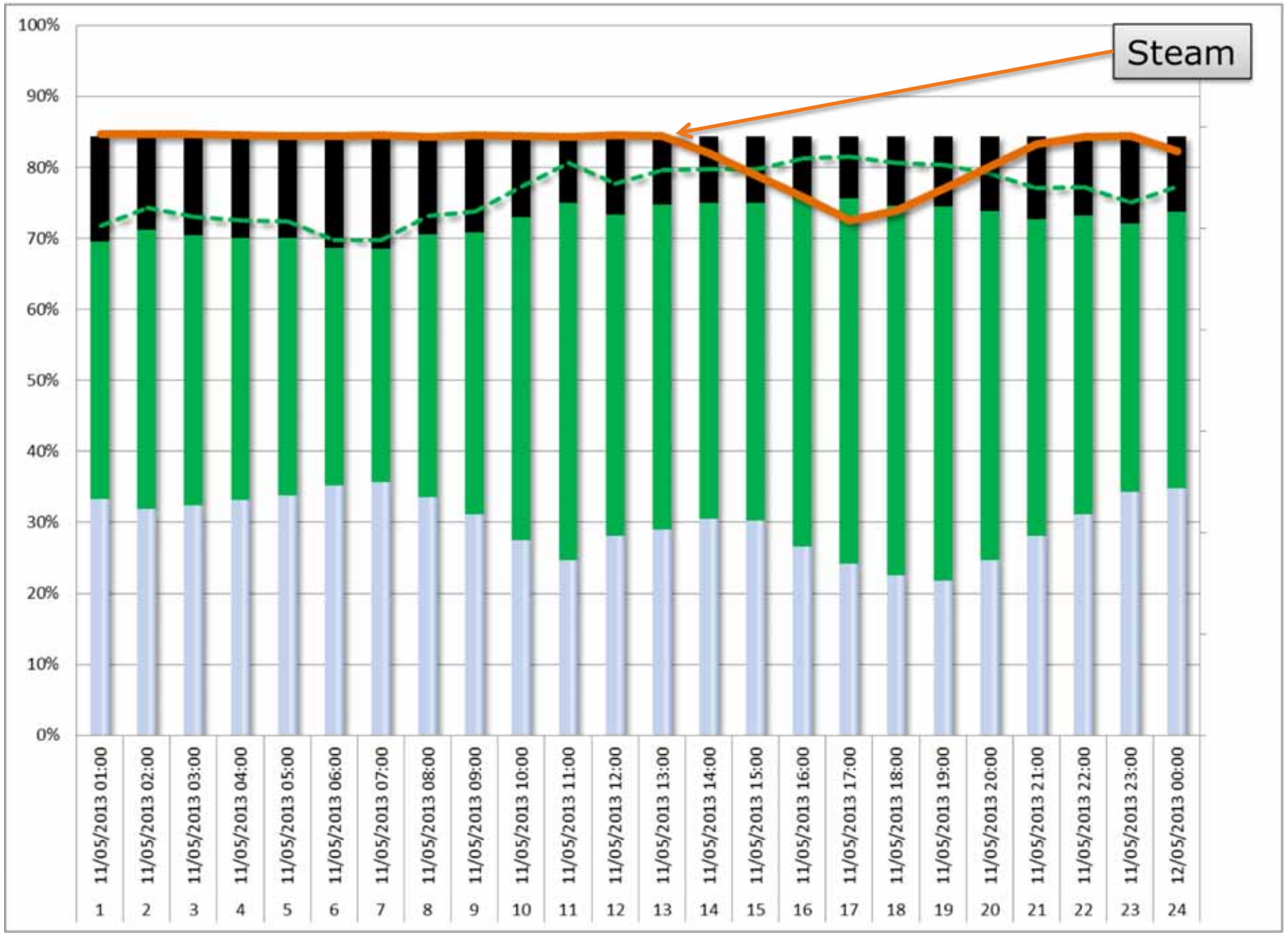
Steam
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
11/05/2013 01:00
11/05/2013 02:00
11/05/2013 03:00
11/05/2013 04:00
11/05/2013 05:00
11/05/2013 06:00
11/05/2013 07:00
11/05/2013 08:00
11/05/2013 09:00
11/05/2013 10:00
11/05/2013 11:00
11/05/2013 12:00
11/05/2013 13:00
11/05/2013 14:00
11/05/2013 15:00
11/05/2013 16:00
11/05/2013 17:00
11/05/2013 18:00
11/05/2013 19:00
11/05/2013 20:00
11/05/2013 21:00
11/05/2013 22:00
11/05/2013 23:00
12/05/2013 00:00
1
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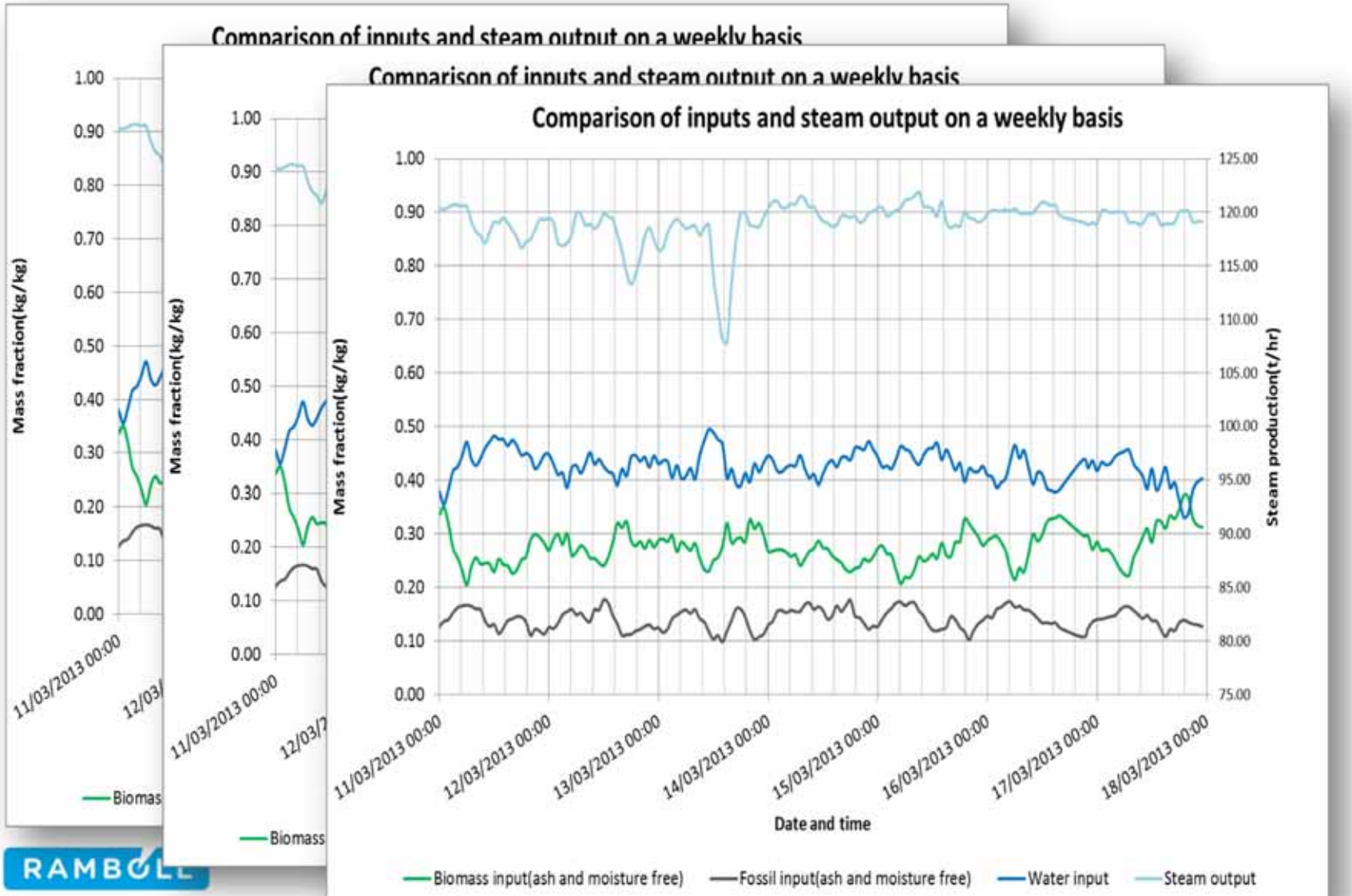
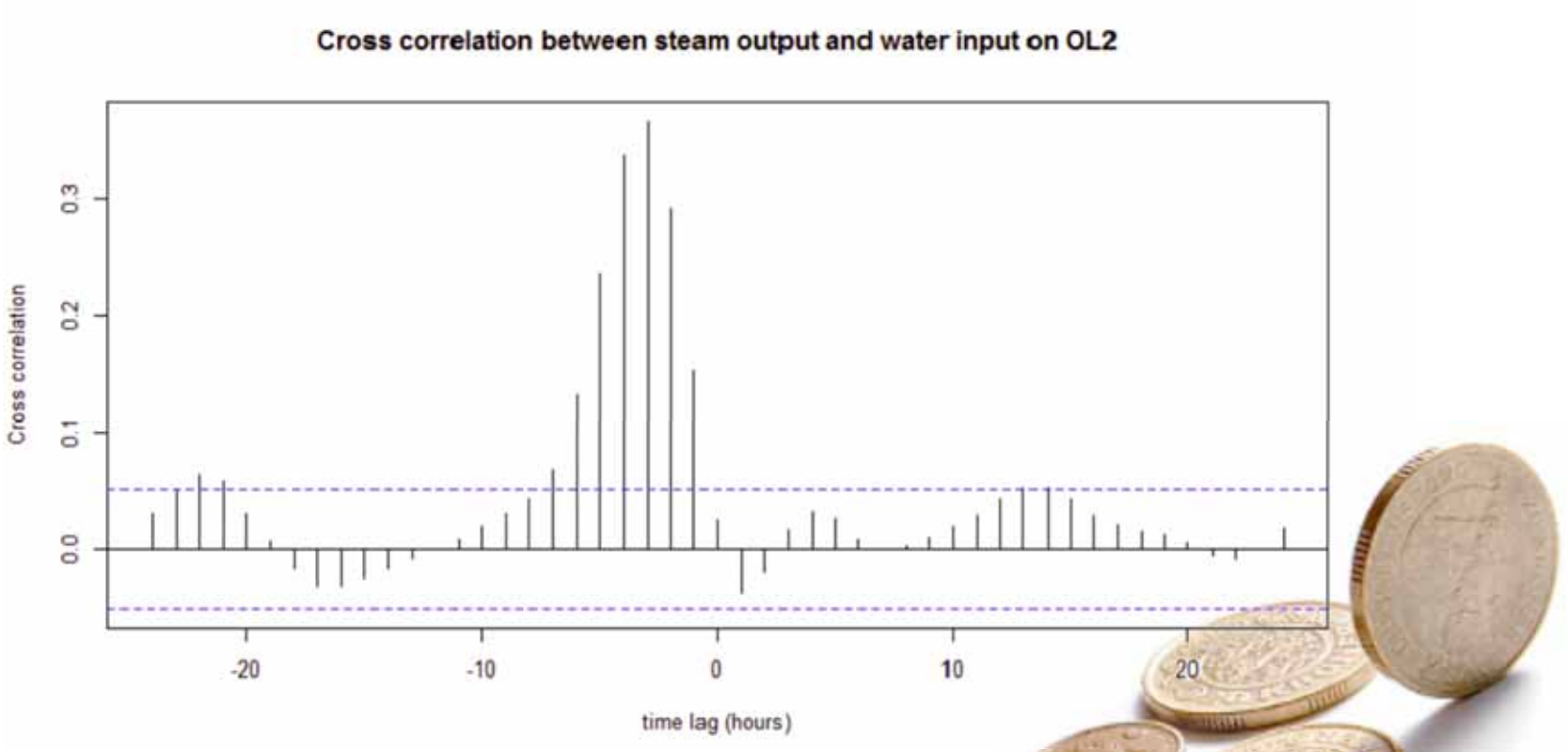
24

WASTE COMPOSITION AND STEAM



CORRELATION TEST



Loss of steam $* \mu * €/MWh = > 100.000$ €

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REFERENCES

In use for CO_2 accounting

- Aarhus, linie 1, 2 and 4 (Denmark)
- Horsens (DONG) linie 1, 2 (Denmark)
- Maabjerg (DONG) linie 1, 2 (Denmark)
- KARA/Noveren, Roskilde linie 4 (Denmark)
- RenoNord, Aalborg linie 4 (Denmark)
- Högdalen, Stockholm (FORTUM) linie 1, 2, 3, 4 and 6

Under installation:

- Brista II, Stockholm
- Kara 6, Roskilde
- AffaldPlus, Naestved
- REFA, Nykoebing F

In use for CO_2 and LEC

- Vestforbrænding, Copenhagen, linie 4, 5 (Denmark)

In use for energy accounting

- Wels, Line 1 and 2 (Austria)
- Arnoldstein, Line 1 (Austria)
- Dürnrohr, Line 1, 2 and 3 (Austria)

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BIOMA RESULTS

Parameter	Biogenic	Fossil
CO_2	37 – 76 %	24 – 63 %
Energy	30 – 70 %	30 – 70 %
Waste (dry ash free)	50 – 78 %	22 – 50 %

- Variations between plants
- Variation over time

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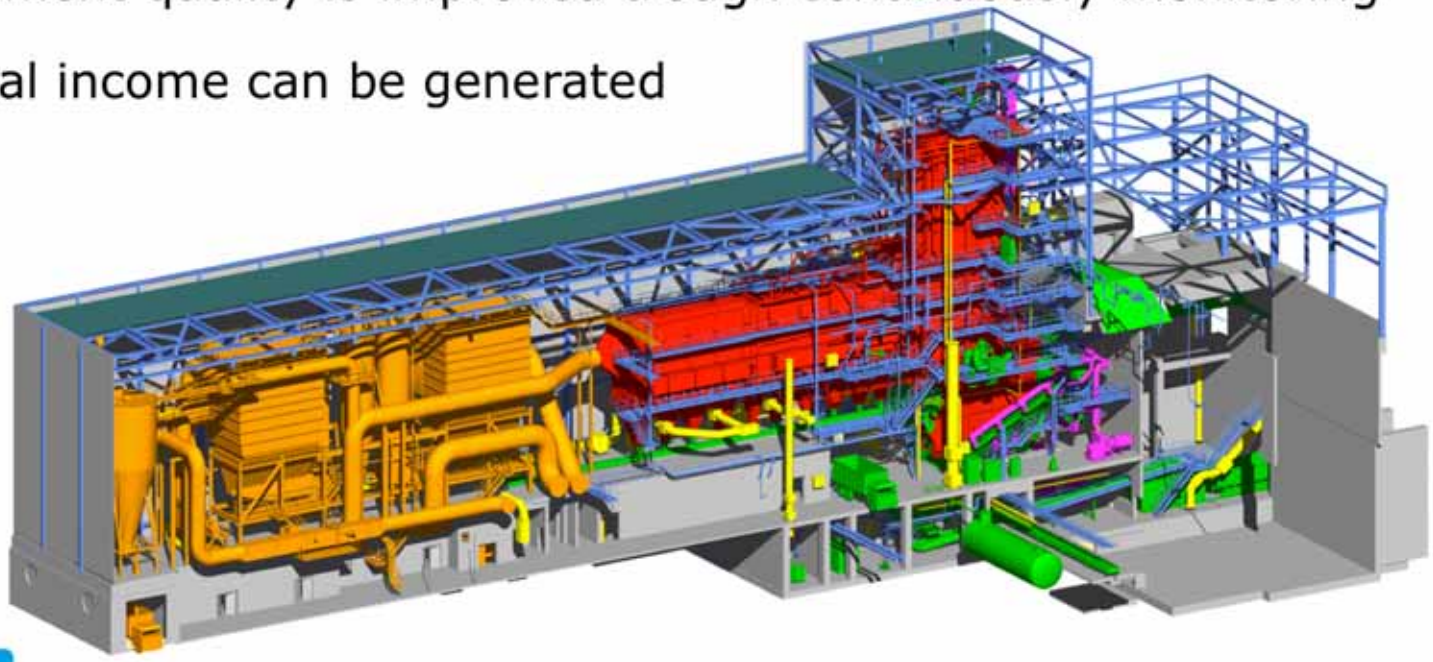
EXPERIENCE SO FAR

- Some plants have unrecognised measurements challanges
- QAL 2 can be incorrect
- Better results are obtained with focus on quality
- Economical risk is minimised when using BIOMA
- Information on waste composition is important
- Additional income from green electricity certificates have been achieved with BIOMA

CONCLUSION

- With BIOMA waste mixing can be quantified and influenced
- Waste - Steam relations can be detected and production loss avoided
- Measurement quality is improved trough continuously monitoring
- Additional income can be generated



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THE FUTURE IS NOT FAR AWAY ...

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www.ramboll.com/wte

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