Fully Automated Sorting Plant for Municipal Solid Waste in Oslo with Recovery of Metals, Plastics, Paper and Refuse Derived Fuel

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In order to treat household waste Romerike Avfallsforedling (ROAF) located in Skedsmorkorset north of Oslo, Norway required the installation of a mechanical treatment facility to process 40,000 tpa. Together with a Norwegian based technical consultancy Mepex and German based technical consultancy EUG the project was tendered and the plant build against a technical specification. In 2013 the project was awarded to Stadler Anlagenbau and since April 2014 the plant is in operation with an hourly throughput of thirty tons. The input waste contains specific green coloured bags containing food waste which is collected together with the residual waste from the households. The process recovers successfully the green food bags before the remaining waste is mechanically pre-treated and screened to isolate a polymer rich fraction which is then fully segregated via NIR technology in to target polymers prior to fully automated product baling. Recoverable Fibre is optically targeted as well as ferrous and non-ferrous metals. All food waste is transported off site for further biological treatment and the remaining residual waste leaves site for thermal recovery. In 2015 the plant has been successfully upgraded to forty tons per hour and remains fully automated including material baling.

Project location – ROAF

The facility owner and operator is Romerike Avfallsforedling (ROAF) who currently owns and treats the waste of 10 municipalities around Oslo. These are Enebakk, Fet, Gjerdrum, Lørenskog, Nittedal, Rælingen, Skedsmo, Sørum, Aurskog-Høland and *Rømskog*. Together the municipalities represent 193,000 residents. There is a weekly collection of food waste and residual waste. Altogether there are 180 recycling points (bring systems) for glass and metal packaging. A four weekly paper collection round is also offered to the residents. Figure 1 below shows the waste quantities available to ROAF.

Site and ambitions

On the same site of an existing infrastructure for house hold waste recycling and an existing landfill, a dedicated new building was designed for the new facility. In order to maximise energy recovery, the building heating system for the processing hall is using heat recovery provided from the air compressors required for the recycling process.

The majority of the waste is collected directly from refuse collection vehicles picking up the waste directly from the households.

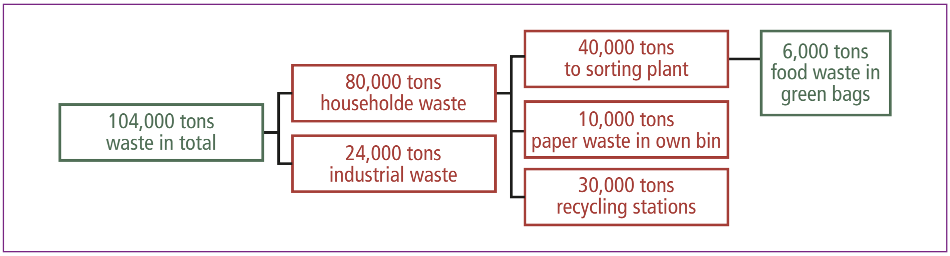

Figure 1: Waste quantities available to ROAF

Source: Brevik: ROAF Business Presentation. July 2016

Stadler Anlagenbau's involvement started with submitting a tender for the design and build of the process against a specification prepared by Norwegian based technical consultants MEPEX and German based technical consultants EUG.

1. Technical brief and solution

The overarching requirement for the process was to treat the waste without any manual labour other than feeding the plant and removing product and final residue.

The plant input consists of residue waste combined with food waste which is bagged by the residents in specific green bags provided by the waste municipality. A further characteristic of the household waste is, that its bagged content is extremely high, so that it is important to open the bags in order to recover the valuable recyclates contained within.

1.1. Input waste composition

The anticipated split between green (organic) waste bags and residue waste was approximately 20:80. Once the green bags would be removed a possible waste composition is as shown in Table 1 and also its changes post construction of the facility.

MBT and SRF

Table 1: Design waste input composition

Composition household waste (rest)				
Waste fraction (kg/inhabitant/year)	**2010**	**2012**	**2014**	**2015**
Food waste in rest waste (inc. tissues)	102.9	112.2	44.5	46.5
Source separated food waste	0	0	43.4	36.0
Recyclable paper, card and tetras	21.4	18.5	14.1	19.3
Plastic packaging	26.5	23.0	20.5	23.8
Other plastic	1.6	2.1	3.2	2.5
Glass	9.4	5.9	7.5	7.1
Metals	3.1	4.1	3.9	3.9
Textiles	6.5	6.9	7.8	6.6
Chemical waste og EE-waste	5.0	3.9	3.6	2.4
Rest	53.6	37.9	57.6	51.9
Total	**230.0**	**214.5**	**206.2**	**200.1**

Source: Fredrikson: MEPEX, Presentation. April 2016

Data from 2010 and 2012 shows food waste within rest waste, but since 2014 food is collected separately in green bags and as a result the figure reduces. Overall the total waste produced reduces within the five year period from 2010 to 2015 by 13 percent from 230 kg/inhabitant and year to around 200 kg/inhabitant and year.

1.2. Throughput

The initial design plant throughput of the facility was thirty tons per hour with a mechanical availability of 85 percent. Plant capacity tests have shown that the plant can operate at higher than 38 tons per hour whilst still achieving plant availability of lager than 85 percent. During a plant upgrade in autumn 2015 the plant throughput has been increased to forty tons per hour. For both of these figures the plant throughput includes the weight of the green bags (food waste).

Table 2: Output product quality requirements

	Purity	**Recovery**
	%	%
Category	**Contract**	**Contract**
Green Bags	97	95
Ferrous 0 – 60 mm (< 100)	90	95
Ferrous > 60 mm (> 100)	88	95
Non Ferrous	85	85
Polymers	75	90
PET	97	90
PP	97	80
PE Containers	97	85
PE Film	96	80
Paper	95	85

2. Output quality

Parameters for the output quality are focusing primarily on Polymers and Metals. The process is set out to recover polymers (film and rigid) early in the process and then use ballistic and optical separation to isolate target polymers without the need of manual quality control. The following parameters were required to be achieved whilst the plant was operated at its design throughput and values for purity and recovery are shown in Table 2.

3. Design

As basis of the plant and process design it needed to be considered first how the waste is collected and presented to the facility, second what the main outputs and products (available markets) would be available and third that the process was as fully automated as possible.

Figure 2 shows that the input waste is from household collection via wheelie bins and that it contains refuse with an element of plastics and food waste in green bags. A key requirement was therefore to isolate the green bags containing food waste from the mix of input material before trying to mechanically recover the valuable plastics contained within the refuse bags.

This is achieved by screening the input waste with the least amount of impact to isolate the green bags as much as possible before they are exposed to valve blocks selecting the green bags based on near infrared detection. Two units in series are positively targeting green bags to maximise recovery, whereas a third unit is cleaning the combined flows from unit one and two positively to increase purity of the green bag fraction. The bags are then stored in roro bins and transported off site for further organic treatment processes. The process is further illustrated in Figure 3.

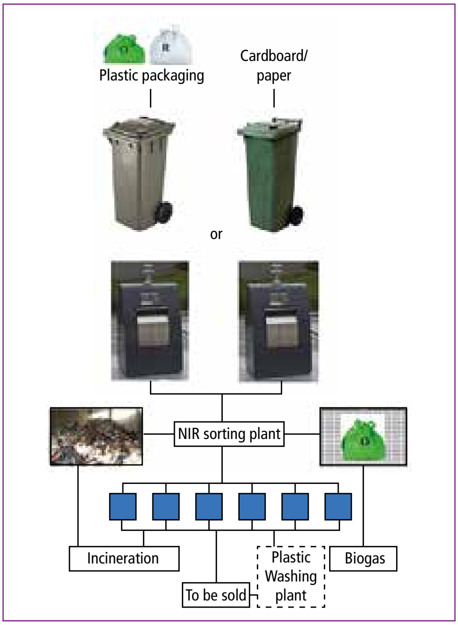

Figure 2: Waste collection principle

Source: Fredrikson: MEPEX, Presentation. April 2016

With the food waste (green bags) removed it is now possible to prepare the remaining waste more aggressively in order to make recyclates such as polymers, fibre and metals available. This is achieved with a combination of bag openers, shredders and trommel screens which are also sizing the material to isolate recoverable material from residue.

After the mechanical preparation and pre sorting Tomra NIR technology is used to remove target polymers, such as of film and rigid plastic whilst suppressing unwanted material containing parts or composites of polymers, such as textiles, nappies and composite plastics. The isolated polymers are then further segregated via ballistic separation technology from Stadler into 2D polymers – such as film and flat packaging – and 3D polymers – such as plastic bottles and rigid packaging. Once isolated, the polymers cascade through a two stage optical sortation for either positive/positive for the 2D or positive/negative for the 3D materials. Products are then conveyed directly to fully automated storage bunkers without any quality control picking or manual intervention. Based on weighing information and volume calculation the product baler calls automatically for bunker material and produces only full bales with the correct length.

Medium size – larger than 120 mm – material that has not been targeted by the polymer sorters flows through a 2 stage NIR assembly to recover paper before metal recovery in form of overband magnets and eddy current separation in order to recover non-ferrous materials.

All untargeted remaining material is collected and transported off site for thermal recovery.

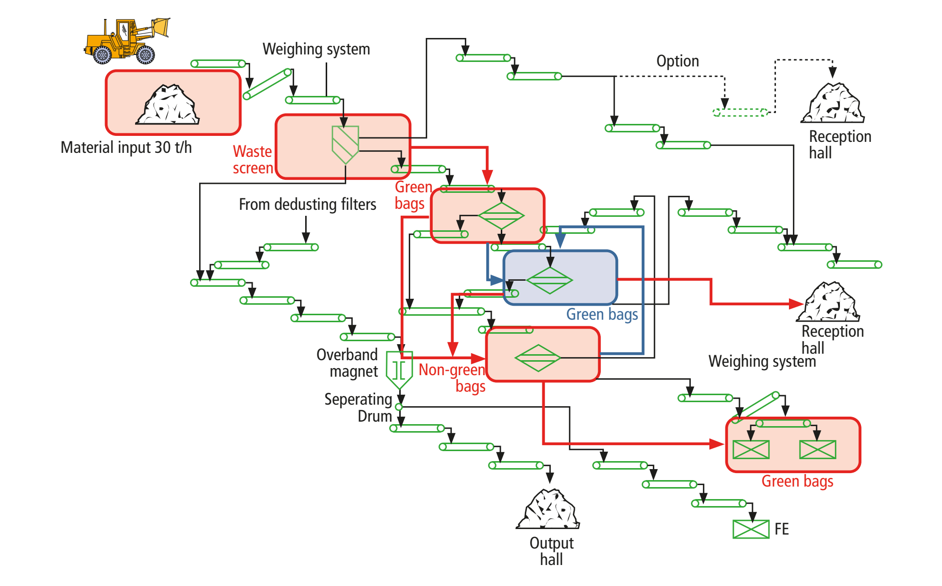

Figure 3: NIR arrangement for green bag separation

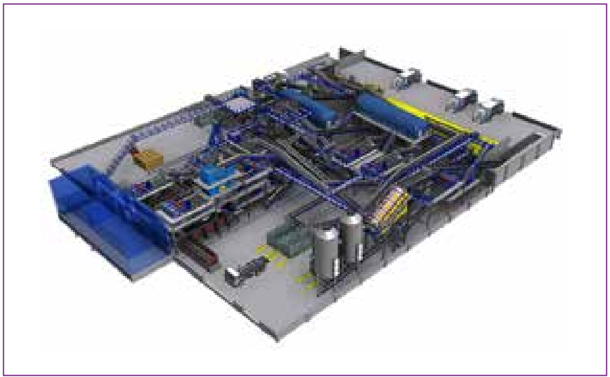

Figure 4:

Conceptual design 3D model

4. Performance

The performance of the plant has been tested over a number of periods by recording daily plant activity logs and product mass balance assessments. Product recovery has been calculated via mass balance recordings combined with product and non product material analysis to establish purity.

Table 3: Product purities results June 2014/ December 2015

Test December 2015	Guarantee %	Measured %
PE Film*	96	96.3
HDPE	97	97.2
PP	97	97.6
PET	97	97.2
Magnetic metal*	90	94.1
Non magnetic metal*	85	94.1
Paper/card/tetra*	95	96.2

* Test June 2014

Table 4: Product recovery results June 2014/ December 2015

Test December 2015	Guarantee %	Measured %
PE Film	72	83.6
HDPE, Total	60	79.8
PP, Total		65.7
PP bottle	68	69.2
PP flat	45	51.7
PET, Total		65.4
PET bottle	68	70.1
PET trays	45	62.1
Magnetic metal*	95	98
Non magnetic metal* [1)]	85	80
Paper/card/tetra	No	52
Jan. to Febr. 2016	guarantee	

[1)] EC adjusted due to plastic packaging

The data [3, 4] shown above in Table 3 and Table 4 shows that all required guarantees have been met by the process. The slightly measured deviation in the recovery calculation of non-ferrous metal is a result of including the non-ferrous content of multilayer metallic layers within some of the plastic packaging.

Mechanical plant availability was measured around 95 percent over the testing period with throughput constantly exceeding thirty tons per hour which satisfied the required guarantees from the design brief.

5. Plant upgrade

In 2015 the decision was taken to further upgrade the plant to increase its capacity to forty tons per hour. This was triggered by the potential to have more input waste available to the facility and by a discovered change of rigid polymers in the waste from 2012 to 2014 as shown in Figure 5. In particular PP and PET had increased whilst HDPE, PS and Other were decreasing.

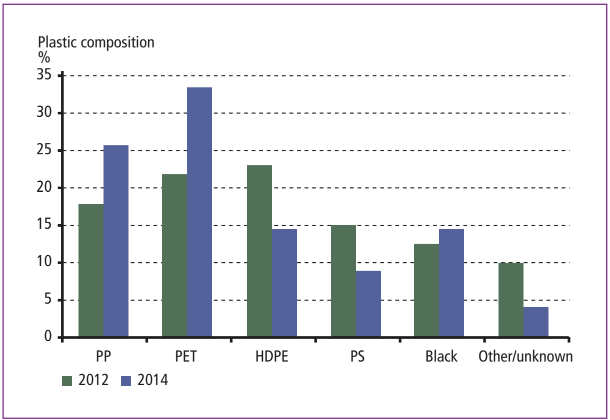

Figure 5: Rigid plastic composition 2012 and 2014

Source: Fredrikson: MEPEX, Presentation. April 2016

In order to increase the throughput a second bag opener was added to the system together with an additional screen for fines material to recover smaller rigid plastic and a wind shifter to balance plastic film volume.

6. References

[1] Brevik: ROAF Business Presentation. July 2016

[2] Fredrikson: MEPEX, Presentation. April 2016

[3] Frederikson; Ostermann; Eule et al.: MEPEX, Presentation. April 2016

[4] Stadler Anlagenbau: Performance Test Report 2 and 3, June 2014 and December 2015

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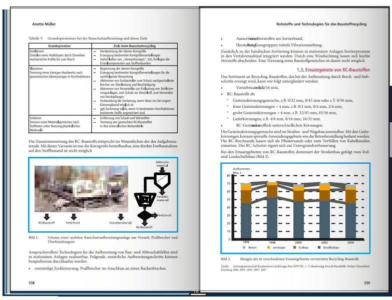

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