SYDDANSK UNVERSITET - UNIVERSITY OF SOUTHERN DENMARK

KISS waste tool Manual and Tutorial

Southern University of Denmark in the auspices of TOPWASTE

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Introduction

The Danish Municipalities have an obligation assure increasing recycling of resources from Danish households significantly under the framework of the European Waste framework directive and the Danish resource strategy. The Innovation Fund have funded the TOPWASTE project where the objective is to contribute to improved use of waste for energy or material recycling integrating economic and environmental considerations including resource scarcity. Aligned with the framework of the Danish resource strategy and as a part of this project the excel tool presented here has been developed.

Karbon **I**mplications of **S**ource **S**egregation of **Waste** (KISS waste) is an excel tool with the objective to support municipalities and other with the opportunity to evaluate/assess relevant future scenarios on carbon foot print and resource recovery goals and potentials.

It has been the objective to develop a tool that includes all relevant scenarios and relevant source segregation scenarios. The model includes 3 predefined scenarios

1. Danish Baseline (average Danish Scenario)
2. Mono stream collection at kerbside (collection separated waste from the households)
3. Comingled collection at kerbside (collection of comingled separated waste from the households)

The model includes a predefined waste composition based on Danish waste statistics (ISAG 2009).

On top of the predefined scenarios the model includes options for modelling other waste compositions, and other collection systems (user defined).

Structure

The excel model consist of a number of sheets with different functionalities.

Start sheet

First sheet is the named start. The Start sheet includes all options for selection when modelling the predefined scenarios.

Foreground system definitions:

1. Waste composition divided between multifamily and single family residences
2. Collection structure
3. Choices between different treatment types and techniques

Background system definitions:

1. Energy marginal used in the modelling (predefined or user defined)

Printing report sheet

The sheet for printing report includes all the framework conditions for the model setup. It has been setup for printing directly to A4. In the result sheet and compare systems sheet there are however other interesting graphical results not easily converted to A4. The graphs from those sheets and other sheets can be copied to work using normal copy paste functionalities.

User defined waste composition sheet

If the user wishes to model their own waste composition this sheets contains the functionality to do so based on the knowledge of collected waste fractions.

User defined collection system sheet

If the user wishes to model a collection system different from the predefined collection systems it is possible to setup a user defined collection system.

About sheet

This sheet contains the general information about the model an a list of references used for the data.

Result Sheet

The result sheet contain of relevant presentation of the results for the modeled scenario.

1. There is a graphical presentation of breakdowns on contributions from materials, energy and transport for the different waste flows in the model system
2. There is a graphical presentation of the breakdowns on contributions from materials energy and transport from the different waste fractions
3. There are 2 graphical presentations of the losses of resources for the collected waste flows. One based on wet weight and one based on dry weight
4. There is a graphical presentation of breakdown of the expenses for the sorting and handling of the waste
5. There is a graphical presentation of the overall resource recovery rate as defined by the Danish resource strategy

The graphical presentation can be copied using copy paste functionalities in Excel.

Comparison of 2 systems sheet

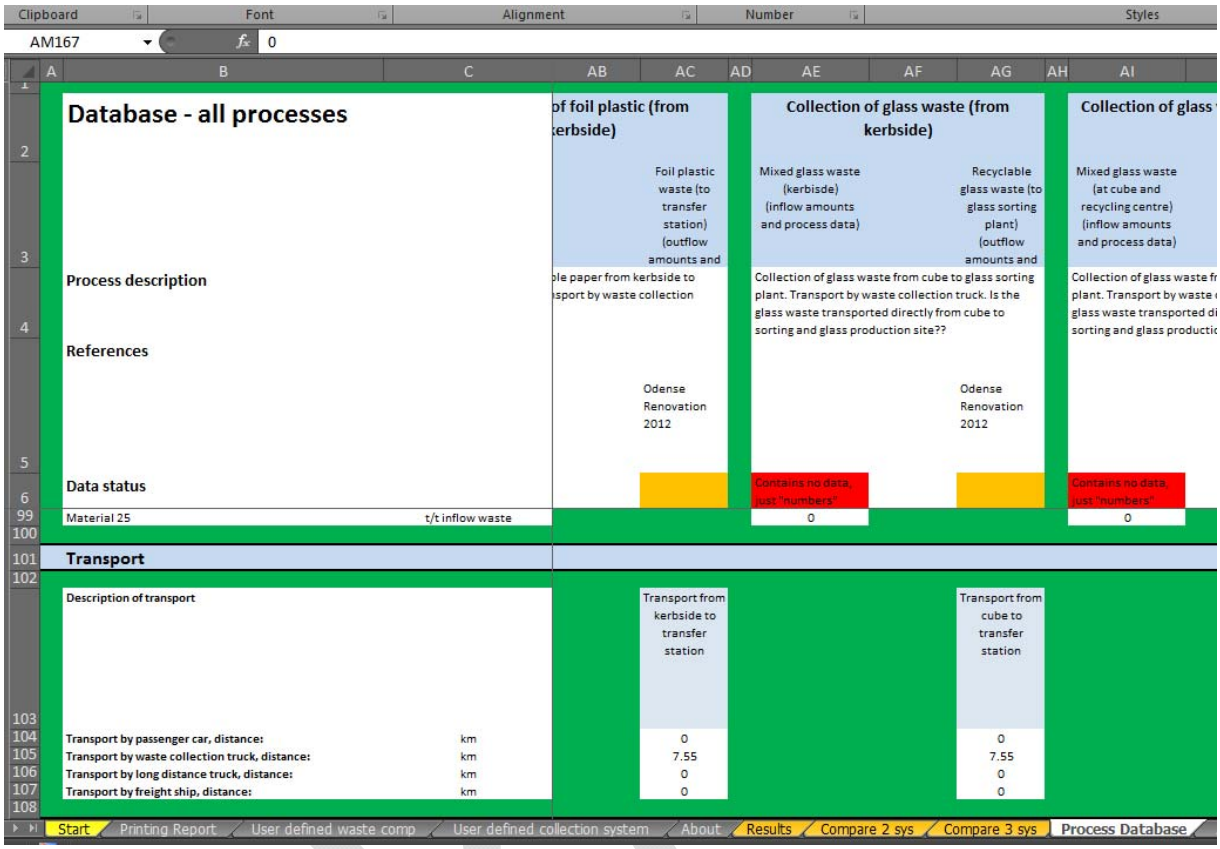
The graphical presentation of breakdowns on contribution from the different waste flows are shown here. If the results from 2 different modelled scenarios can be compared in this graphical presentation.

Comparison of 3 systems sheet

The graphical presentation of breakdowns on contribution from the different waste flows are shown here. If the results from 3 different modelled scenarios can be compared in this graphical presentation.

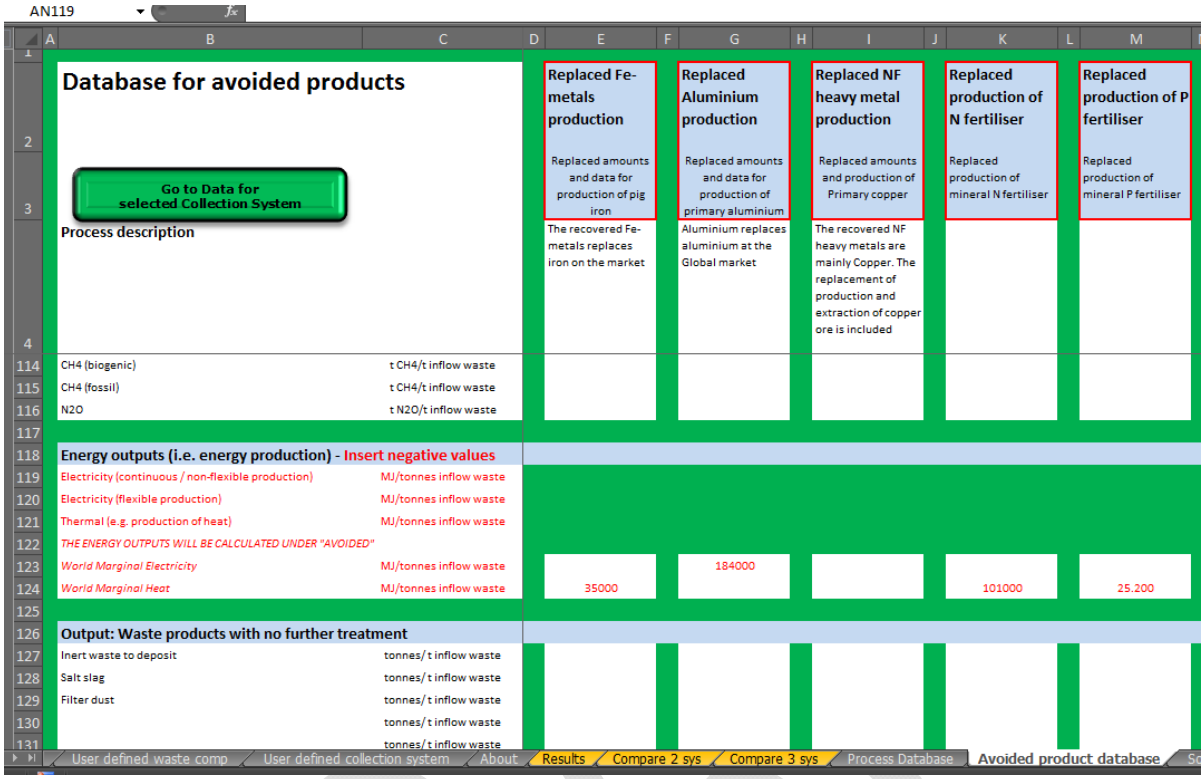
Process database sheet

The data for the different processes used for the modelling are documented her. If the user changes values in this sheet it will directly influence the modelling



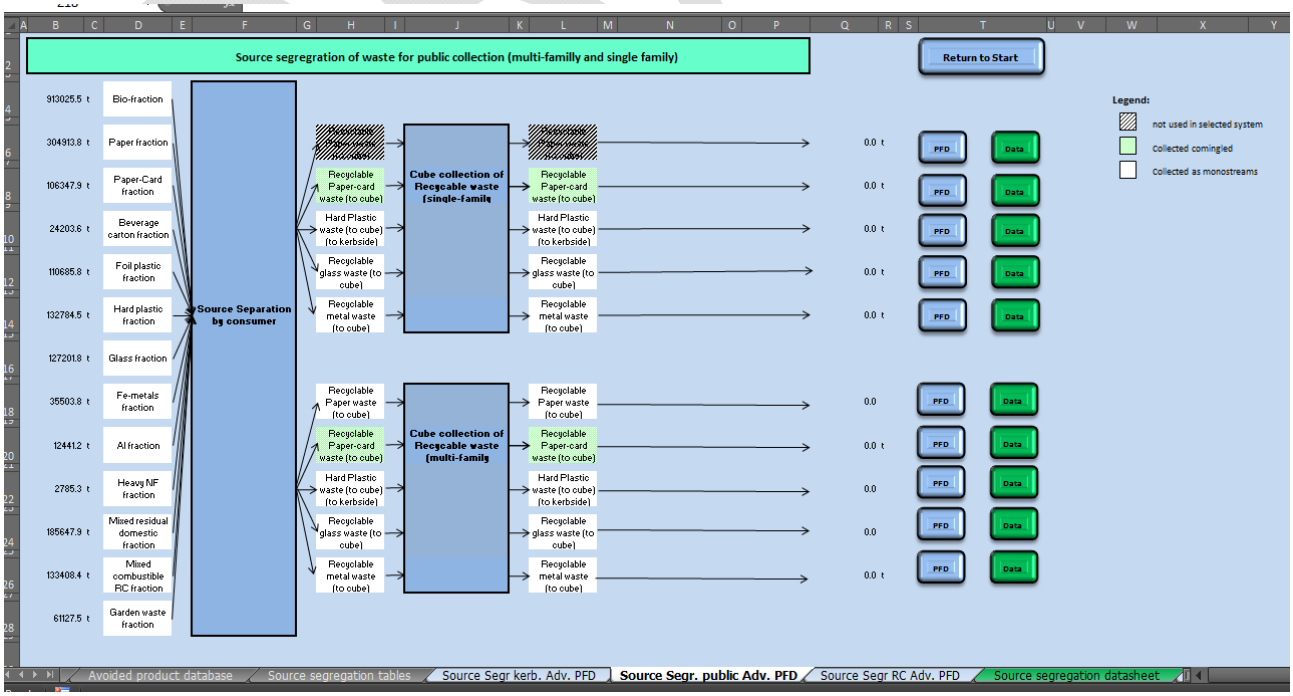
Avoided product database sheet

The data for the avoided materials used in the modelling is listed and documented here.



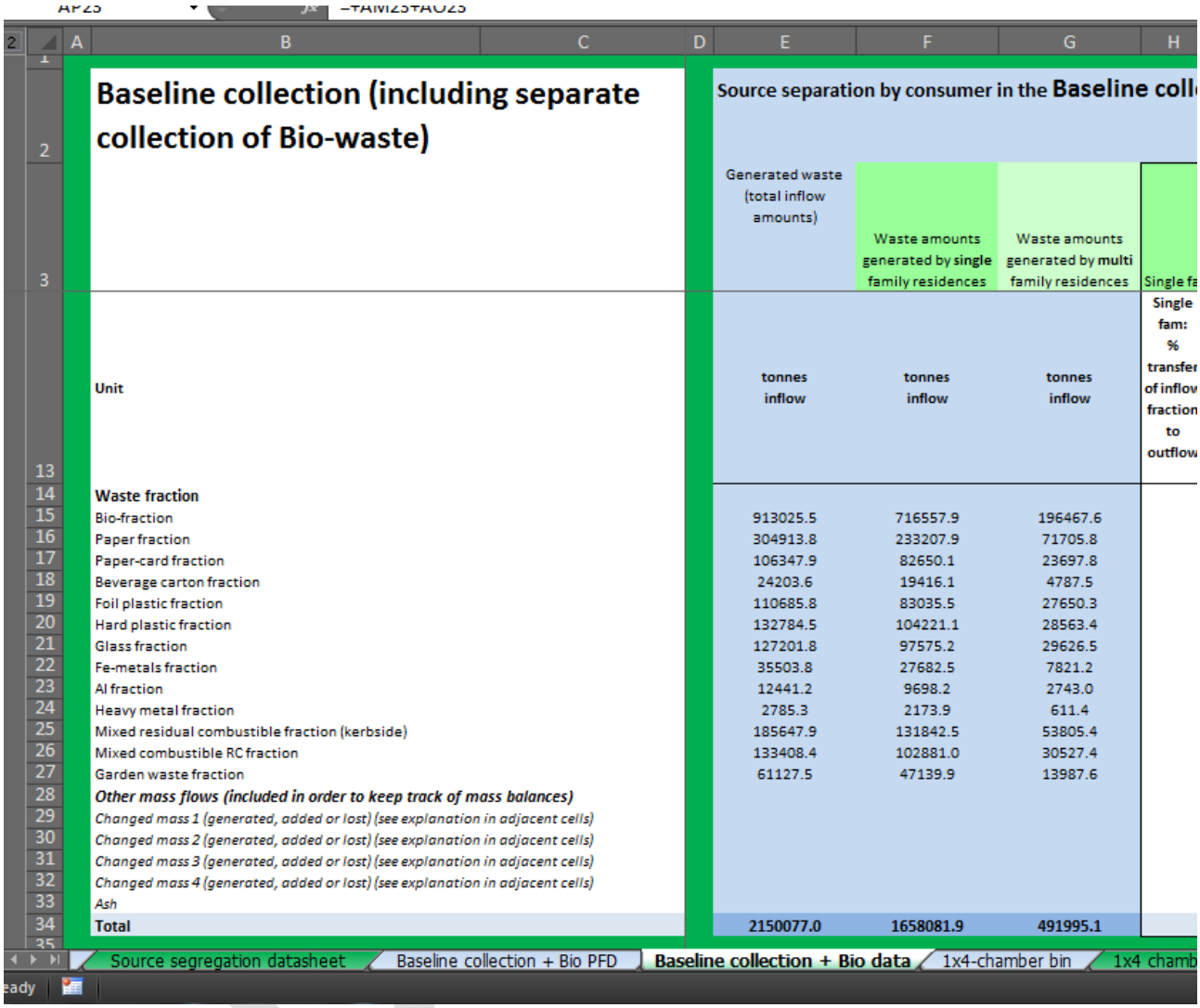
PFD sheets (light blue)

For all systems and different flow in the modeled scenarios the flow diagrams are shown in the sheets



Data sheets (green)

For all the systems and different flows in the modeled scenarios the calculations related to the modelling of masses and emissions are shown here.



	A	B	C	D	E	F	G	H
2		**Baseline collection (including separate collection of Bio-waste)**			**Source separation by consumer in the Baseline coll**			
3					Generated waste (total inflow amounts)	Waste amounts generated by single family residences	Waste amounts generated by multi family residences	Single fa
13		**Unit**			**tonnes inflow**	**tonnes inflow**	**tonnes inflow**	**Single fam: % transfer of inflow fraction to outflow**
14		**Waste fraction**						
15		Bio-fraction			913025.5	716557.9	196467.6	
16		Paper fraction			304913.8	233207.9	71705.8	
17		Paper-card fraction			106347.9	82650.1	23697.8	
18		Beverage carton fraction			24203.6	19416.1	4787.5	
19		Foil plastic fraction			110685.8	83035.5	27650.3	
20		Hard plastic fraction			132784.5	104221.1	28563.4	
21		Glass fraction			127201.8	97575.2	29626.5	
22		Fe-metals fraction			35503.8	27682.5	7821.2	
23		Al fraction			12441.2	9698.2	2743.0	
24		Heavy metal fraction			2785.3	2173.9	611.4	
25		Mixed residual combustible fraction (kerbside)			185647.9	131842.5	53805.4	
26		Mixed combustible RC fraction			133408.4	102881.0	30527.4	
27		Garden waste fraction			61127.5	47139.9	13987.6	
28		***Other mass flows (included in order to keep track of mass balances)***						
29		*Changed mass 1 (generated, added or lost) (see explanation in adjacent cells)*						
30		*Changed mass 2 (generated, added or lost) (see explanation in adjacent cells)*						
31		*Changed mass 3 (generated, added or lost) (see explanation in adjacent cells)*						
32		*Changed mass 4 (generated, added or lost) (see explanation in adjacent cells)*						
33		*Ash*						
34		**Total**			**2150077.0**	**1658081.9**	**491995.1**	

Source segregation datasheet | Baseline collection + Bio PFD | **Baseline collection + Bio data** | 1x4-chamber bin | 1x4 chamb

Background data sheet

All systems are based on a series of background data

- Composition of the waste fractions
- Emission of fuels and different types of energy production, consumption etc.

Other sheets (chemical composition, hidden sheets, etc.)

There are a series of other sheets used for the modelling and control of data. It is not recommended the user changes anything in those sheets.

Documentation for data used in the model

Description on the background for the different choices of data are found in Ciprian Cimpan (2015)

References

Ciprian Cimpan (2015) Foreground systems report. System descriptions and LCI data for the KiSS model

Tutorial for in using KISS waste tool

Here is a small guide/tutorial to try out some of the simple facilities in the tool.

SIMPLE APPROACH

The simple model approach calculates material re-use and carbon footprint from different waste sorting systems based on the waste composition. The composition of the waste is Danish Average (ISAG 2009).

There are 4 parameters to choose/insert as basis of the calculations

- Amount of waste collected in tonnes/year
- Distribution between single family and multi-family housing in percent %
- Choosing sorting system
- Choosing framework for the energy supply (background system), including biomass marginal

Exercise 1 (model the difference between 3 selected predefined Scenarios)

Go to **START** sheet

- Type the amount of waste collected in your case (municipality) (for example 86932 tons/år)
- Choose the distribution between the single family housing and multifamily housing (eks. 43%, 57%)
- Choose sorting system
- Select or deselect kerbside collection of biowaste
- Select treatment for mixed residual
- Choose background system Energy supply framework including biomass energy marginal
- Choose treatment technolology for biowaste
- Choose treatment technology for mixed residual treatment

Go to the sheet **RESULTS.** Here you can see the results shown of 4 different graph types.

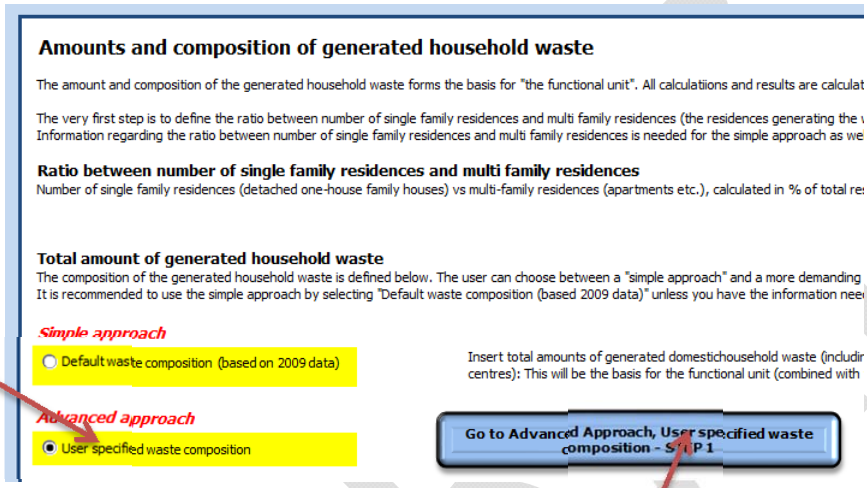
ADVANCED APPROACH

In the advanced part of the model, there are other parameters that can be adjusted/chosen.

- The system assessed can be modified to be exactly like the system you wish to model and closer to you specific case (municipality)
- The amounts collected per single family or multifamily can be adjusted
- The framework for the energy supply can be adjusted if the pre-chosen version is not covering your case

Exercise 2

Go to the **START** sheet



Choose advanced approach (stay in the **START** sheet)

- Choose sorting system
- Choose framework for the energy system (you can change the details on the right)

Then press the go to **user specified waste composition** – STEP 1

- Type the amounts of collected waste flows as shown here and
- Choose the distribution between single family and multi-family housing to (67%, 33%)

STEP 1: Calculation of generated waste composition based on existing collection system

Amounts and composition of generated household waste - Advanced approach

Ratio between number of single family residences and multi family residences
Number of single family residences (detached one-house family houses) vs multi-family residences (apartments etc.), calculated in % of total residences: Single family residentials: 73% %
Default value (Average for Denmark, 2009): 60% single family residences / 40% multi-family residences Multi-family residentials: 27% %

Ratio between amounts of kerbside collected mixed domestic residue waste from single family residences and from multi family residences:
Single family residentials: 9.92 [kg per week] (from Pedersen and Domela, 2003) 77.1% of the total domestic combustible residue comes from single-family residences
Multi-family residentials: 7.96 [kg per week] (from Pedersen and Domela, 2003) 22.9% of the total domestic combustible residue comes from multi-family residences

Collected waste amounts	Total amounts [tonnes per year]	Allocated to Domestic waste	Domestic waste
Mixed domestic combustible residual waste [Dagrenovation], kerbside collected	1040873	100%	1040873
Bio-waste, collected at kerbside	414380	100%	414380
Recyclable paper, collected at kerbside monostream or comingled incl residues	88951	100%	88951
Recyclable paper, public collection (cubes etc.)	68222	100%	68222
Recyclable paper, collected at recycling centre	17055	100%	17055
Paper-card waste, collected kerbside		100%	0
Paper-card waste, public collection (cubes etc.)		100%	0
Paper-card waste - collected at recycling centre (corrugated cardboard not included)	11731	100%	11731
Beverage cartons, collected at kerbside		100%	0
Foil Plastic, collected kerbside		100%	0
Foil Plastic, public collection		100%	0
Foil plastic, collected at recycling center	54815	100%	54815
Hard Plastic, collected kerbside		100%	0
Hard Plastic, public collection		100%	0
Hard plastic, collected at recycling center	87213	100%	87213
Glass, collected kerbside		100%	0
Glass, public collection (cubes etc.)		100%	0
Glass, public collection (cubes etc.) and at recycling centre	97976	100%	97976
Fe-NF metal waste, collected kerbside	5000	100%	5000
Fe-NF metal waste, public collection (cubes etc.)		100%	0
Fe-NF metal waste - collected at recycling centre	19966	25%	4992
Sorting residues from commingled streams	100	100%	100
Mixed combustible RC waste - collected at recycling centre	395284	50%	197642
Garden waste - collected at recycling centre	611275	10%	61128
TOTAL	**2912841**		**2150077**

Return to Start

Specifying collection system

SIMPLE

a) After specifying your waste composition (STEP 1), it is an option to choose an already specified waste collection system at the **START** sheet

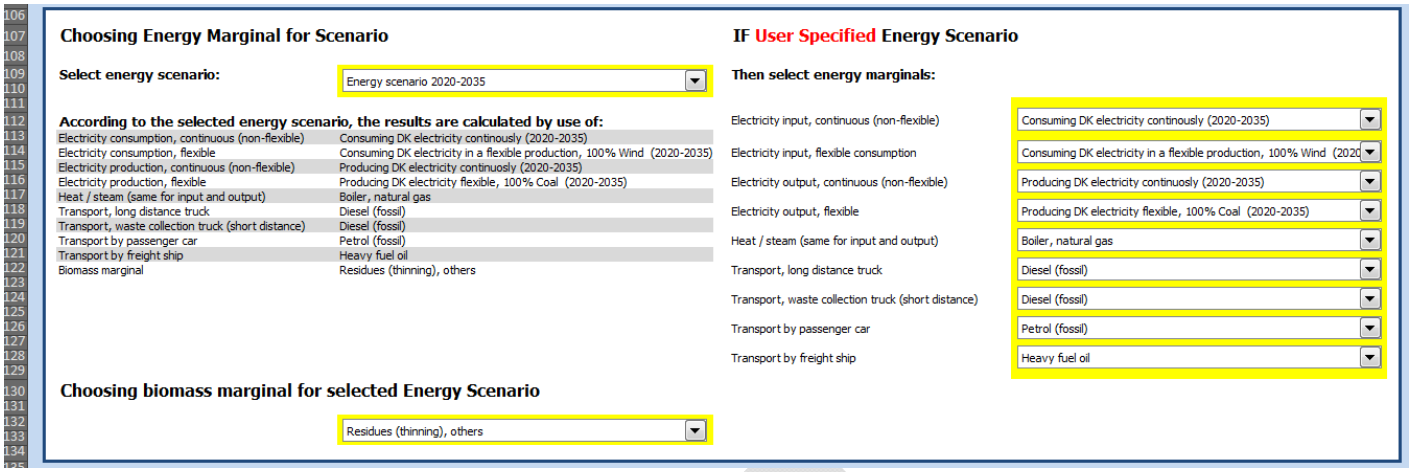
Waste collection system - simple approach and advanced approach (user defined)

Waste collection system
Select waste collection system:

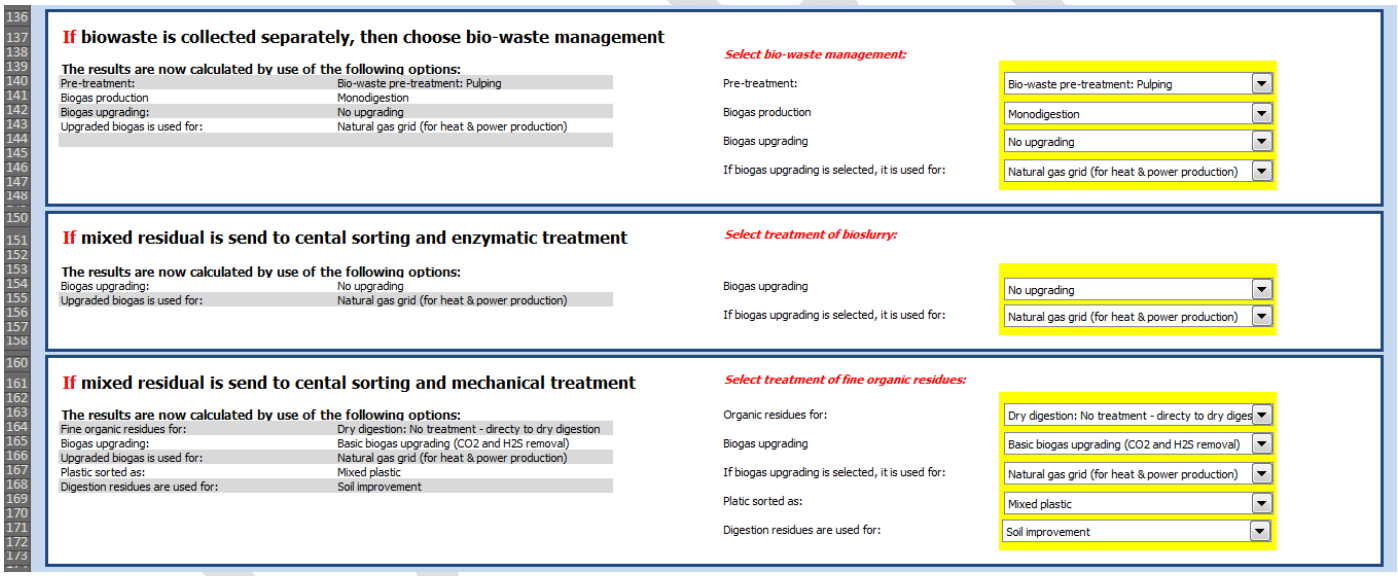
Choose Baseline Collection System | Choose Comingled - Dual bin - Collection System | Choose Monostream - 1*4 chamberbin - Collection System | Choose User defined Collection System

Chosen Collection system: Baseline collection system

b) Then choose the details for your system
   a. Energy marginals

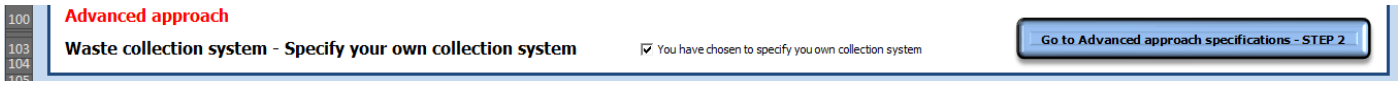


b. Treatment of biowaste



ADVANCED APPROACH

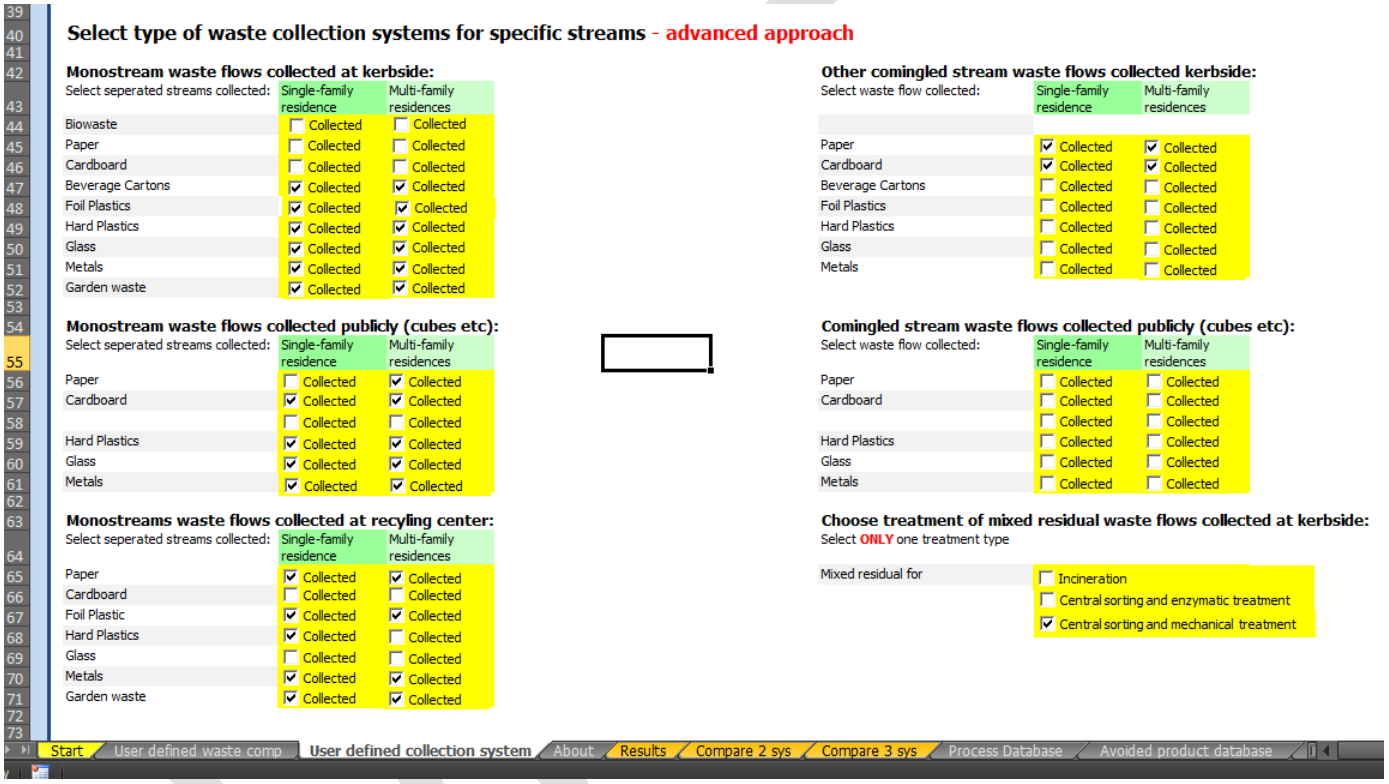
c) I is also an option to specify your own system the next **Advanced Approach** option is to specify you own collection system



Specify Type of collection

a. Specifying you own collection system requires data on

i. Collection types (kerbside (mono/comingeled), cube, recycling center), efficiencies (% of available fraction) and purities



d) Secondly you have to specify collection efficiency :

Type selected source separation efficiencies for modelled waste collection system

Source separation efficiencies are given as: % of available potential for system specific collection procedure of the specific waste type

Source separation efficiencies for monostreams collected waste:

	Source separation effiecency for biowaste, collected kerbside	Source separation efficiencies for paper waste, kerbside collected	Source separation efficiencies for papercard waste, kerbside collected	Source separation efficiencies for beverage carton waste, kerbside collected	Source separation efficiencies for foil plastic waste, kerbside collected	Source separation efficiencies for hard plastic waste, kerbside collected	Source separation efficiencies for Glass waste, kerbside collected	Source separation efficiencies for Fe- & Non-fereous metal waste, kerbside collected	Source separation efficiencies for garden waste, kerbside collected
Single-family residences, kerbside:	60.0%	99.0%	60.0%	1.0%	60.0%	60.0%	90.0%	60.0%	
Multi-family residences, kerbside:	50.0%	50.0%	50.0%	2.0%	50.0%	50.0%	80.0%	50.0%	

Source separation efficiencies for public collected waste (cubes etc):

	Source separation efficiencies for paper waste, public collected	Source separation efficiencies for papercard waste, public collected	Source separation efficiencies for hard plastic waste, public collected	Source separation efficiencies for Glass waste, public collected	Source separation efficiencies for Fe- & Non-fereous metal waste, public collected	Source separation efficiencies for garden waste, public collected
Single-family residences,public:	60.0%	60.0%	60.0%	90.0%	60.0%	1.0%
Multi-family residences,public:	50.0%	50.0%	50.0%	80.0%	50.0%	2.0%

Source separation efficiencies for waste at recycling center:

	Source separation efficiencies for paper waste, collected at RC	Source separation efficiencies for papercard waste, collected at RC	Source separation efficiencies for foil plastic waste, collected at RC	Source separation efficiencies for hard plastic waste, collected at RC	Source separation efficiencies for Glass waste, collected at RC	Source separation efficiencies for Fe- & Non-fereous metal waste, collected at RC	Source separation efficiencies for garden waste, collected at RC
Single-family residences, RC:	60.0%	60.0%	60.0%	60.0%	90.0%	60.0%	1.0%
Multi-family residences, RC:	10.0%	5.0%	50.0%	50.0%	5.0%	67.0%	2.0%

Source separation efficiencies for comingled kerbside collected waste:

	Source separation efficiencies for comingled paper waste, kerbside collected	Source separation efficiencies for comingled papercard waste, kerbside collected	Source separation efficiencies for comingled beverage carton waste, kerbside	Source separation efficiencies for foil plastic waste, kerbside collected	Source separation efficiencies for comingled hard plastic waste, kerbside collected	Source separation efficiencies for comingled Glass waste, kerbside collected	Source separation efficiencies for comingled Fe- & Non-fereous metal waste,
Single-family residences, kerbside:	60.0%	60.0%	1.0%	60.0%	60.0%	90.0%	60.0%
Multi-family residences, kerbside:	50.0%	50.0%	2.0%	50.0%	50.0%	80.0%	50.0%

Source separation efficiencies for comingled public collected waste (cubes etc):

	Source separation efficiencies for paper waste, public collected	Source separation efficiencies for papercard waste, comingled public collected	Source separation efficiencies for hard plastic waste, comingled public collected	Source separation efficiencies for Glass waste, comingled public collected	Source separation efficiencies for Fe- & Non-fereous metal waste, comingled public collected	Source separation efficiencies for garden waste, comingled public collected
Single-family residences,public:	60.0%	60.0%	2.0%	90.0%	60.0%	1.0%
Multi-family residences,public:	50.0%	50.0%	50.0%	80.0%	50.0%	2.0%

And finally purity of collected fractions:

Composition of collected waste

Single-family

	Bio-waste, collected at kerbside	Recyclable paper, collected at kerbside	Recyclable paper, public collection (cubes etc.)	Recyclable paper, collected at recycling centre	Paper-card waste, collected kerbside	Paper-card waste, public collection (cubes etc.)	Paper-card waste - collected at recycling centre	Beverage Cartons, collected kerbside	Foil Plastic, collected kerbside	Foil Plastic, public collection	Foil plastic, collected at recycling center	Hard Pla collected k
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
Bio-fraction	93.0%											
Paper fraction		98.00%	98.00%	98.00%								
Paper-card fraction	2.0%				98.00%	98.00%	98.00%					
Beverage carton fraction								95.00%				
Foil plastic fraction									95.00%	95.00%	95.00%	
Hard plastic fraction	1.0%											9
Glass fraction	0.3%											
Fe-metals fraction	0.2%											
Al fraction												
Heavy metal fraction												
Mixed combustible residual domestic fraction (kerbside)	3.5%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	5.00%	5.00%	5.00%	5.00%	
Mixed combustible RC fraction												
Garden waste fraction												
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0**

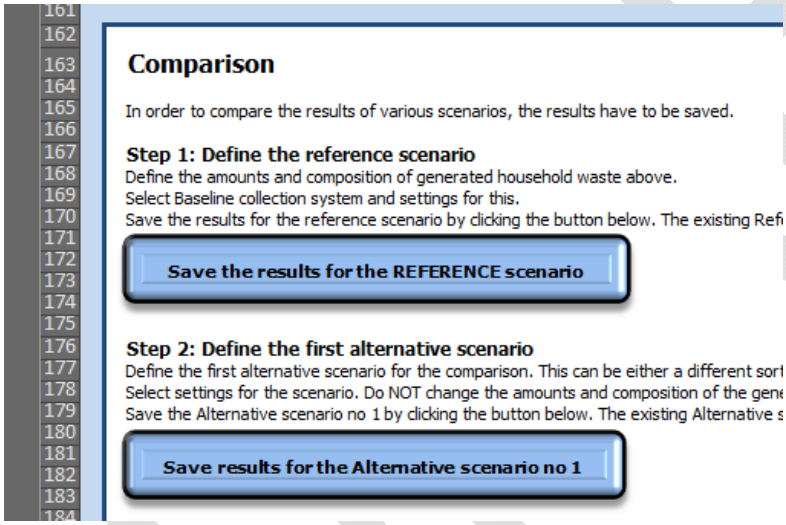
Multi-family

	Bio-waste, collected at kerbside	Recyclable paper, collected at kerbside	Recyclable paper, public collection (cubes etc.)	Recyclable paper, collected at recycling centre	Paper-card waste, collected kerbside	Paper-card waste, public collection (cubes etc.)	Paper-card waste - collected at recycling centre	Beverage Cartons, collected kerbside	Foil Plastic, collected kerbside	Foil Plastic, public collection	Foil plastic, collected at recycling center	Hard Pla collected k
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
Bio-fraction	88.0%											
Paper fraction		98.00%	98.00%	98.00%								
Paper-card fraction	2.0%				98.00%	98.00%	98.00%					
Beverage carton fraction								95.00%				
Foil plastic fraction	0.5%								95.00%	95.00%	95.00%	
Hard plastic fraction	1.0%											9
Glass fraction	0.5%											
Fe-metals fraction	0.2%											
Al fraction												
Heavy metal fraction												
Mixed combustible residual domestic fraction (kerbside)	7.8%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	5.00%	5.00%	5.00%	5.00%	
Mixed combustible RC fraction												
Garden waste fraction												
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0**

RESULTS

a) On the sheet **RESULTS** you can find a graphical presentation of the results.

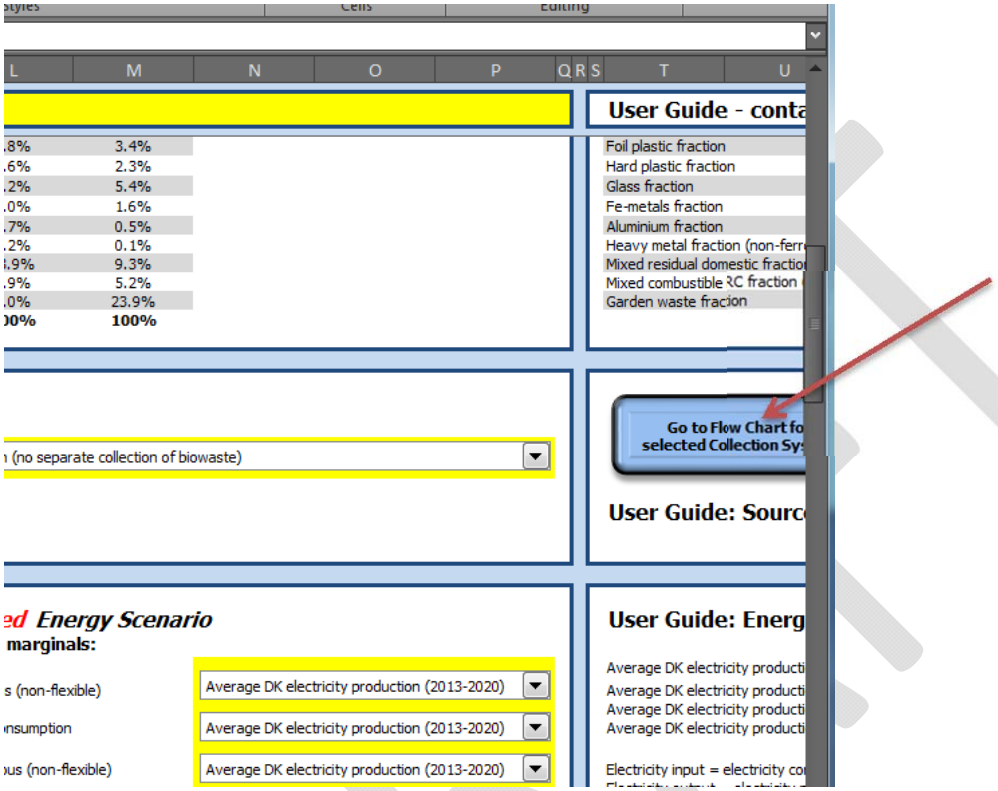
b) When all choices have been made, you can go to the sheet **START** and save the results by pressing the button **SAVE results for REFERENCE Scenario**. Then change a parameter like "collection system" and save the results by pressing **SAVE Results for Alternative 1.** Then you can compare the 2 systems when looking at the graphical presentation of the results in the sheet **COMPARE 2 SYS.**



Exercise 3

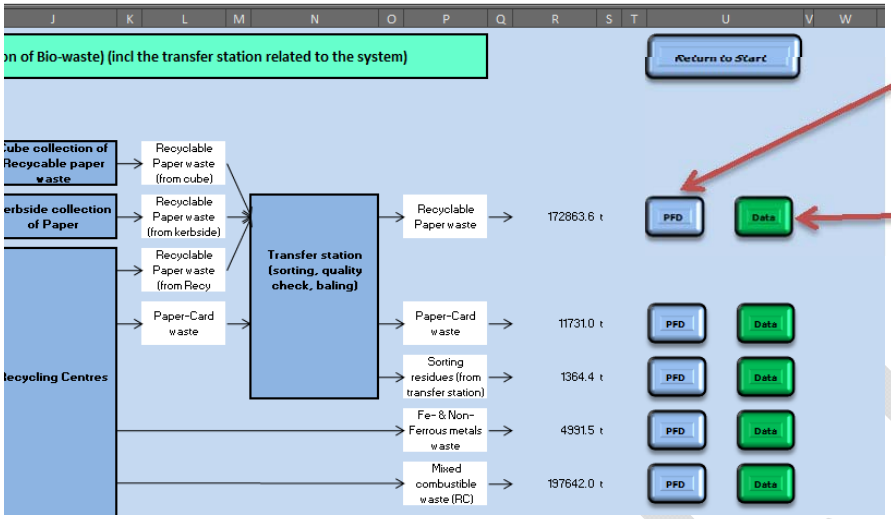
The design of the different systems can be seen in the PROCES FLOW DIAGRAMS **(PFD)**. The details of the calculations are found in the DATA sheets.

- As an example try and choose GO TO selected waste collection system via **START** sheet



Green buttons leads to **Data sheet, calculations for the specific waste flow**

Blue buttons leads to a **PFD** for the specific waste flow.



Blue button, PFD

Green button, Data

Try to press some of the buttons yourself ☺