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Analysis of allocation approaches of animal by-product treatment in the context of life cycle assessments

on behalf of
EFPRA - European Fat Processors and Renderers Association

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1 Scope

In the context of increasing the share of renewable energy in the energy supply, biomass is of importance. Especially the production of biofuels will sustain being an essential measure to increase the use of energy from biomass in the transport sector. Due to the high greenhouse gas emission saving potential the use of waste and residues for biofuel production, such as the used cooking oils and animal fats, has significant environmental advantages compared to food grade biomass, avoiding the emissions from cultivation and the conflicts laded by indirect land-use change (ILUC).

Albeit the large number of life cycle assessments (LCA) done for second life balancing of such waste streams there is still a lack of clarity concerning the question: when does something start to be a waste and when does it end being waste.

In consequence, consistent methodology in LCA is of vital importance. This is particularly important in case where a specific waste/residue treatment is necessary or even mandatory before the further usage. In this context, the following pivotal question arises:

> To what extent should environmental burdens from upstream or downstream processes be allocated to the main system or the final product from secondary good processing?

In the present study, these questions should be answered with the focus on the collection and treatment of animal by-products.

For clarification of these questions, a number of seminal documents recommending differing approaches were analysed. The following sources were included:

- ILCD Handbook of the Joint Research Centre (JRC).
- The framework directive on resource efficiency (VDI 4597) *currently in the form of an internal draft only*
- ISO 14040/44 and ISO TS 14067

In reference to these sources, the approach of the JEC Consortium for the calculation of greenhouse gas balances for animal oil will be critically evaluated. Probably, these balances will act as reference data for the update of default values in the RED (Renewable Energies Directive 2009/28/EC).

As a result, recommendations are issued for an applicable course of action in the modelling of animal by-products disposal pathways.

2 Animal by-products and derived products

Animal by-products (ABP) arise mainly during the slaughter of animals for human consumption, during the production of products of animal origin and in the course of the disposal of dead animals and during disease control measures. Regardless of their source, without any strict treatment they pose a potential risk to public and animal health and the environment.

Within the European Union the Regulations 1069/2009 and 142/2011 set out health rules, to control the risk by directing such products towards safe means of disposal. Animal by-products and derived products fall under this regulation if they are excluded from or not intended for human consumption.

According to the degree of risk involved animal by-products are classified into three categories. Category 1 refers to the material with the highest risk and category 3 with the lowest. Furthermore the EU regulation defines different mandatory disposal and recovery options for the save elimination of animal by-products of each category (Figure 1).

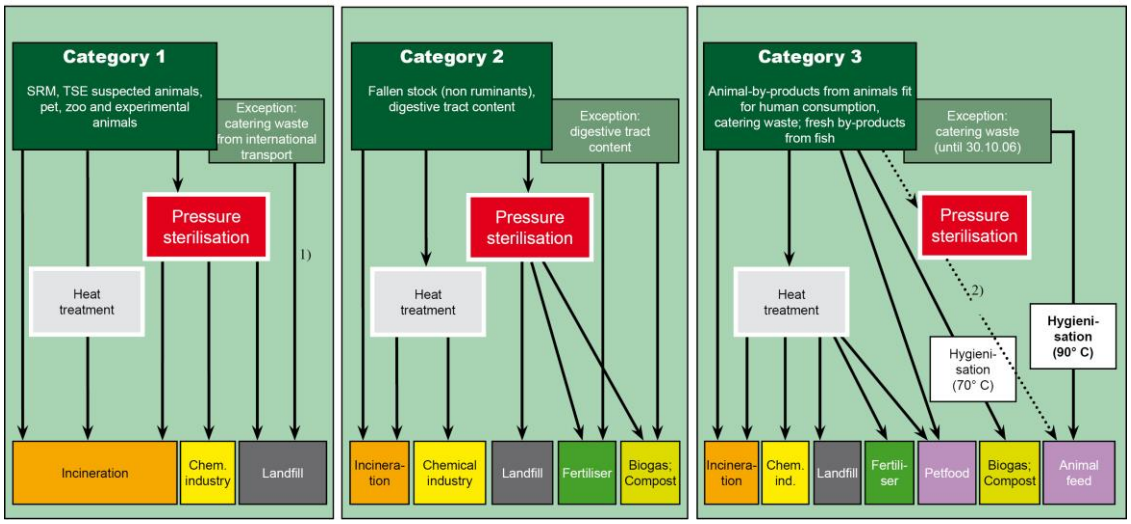

Figure 1 Categories and processing methods for animal by-products; Source EFPRA internal paper (2014)

The yearly statistics of animal by-products in Europe is released by the "European Fat Processors and Renderers Association" (EFPRA). In 2013 a total of 16 million tons of raw materials have been treated of which 6 million tons are of category 1 and category 2. The two main substances after the required sterilisation and drying process of category 1 and 2 material, the so called rendering, are meat and bone meal (MBM) with a yield of approx. 22 % w/w and animal fat with a yield of approx. 12 % w/w. Although a few different usage options are available (figure 1), in 2013 almost 100 % of the animal fats and nearly 90 % of the MBM were used for energy purposes. Figure 2 shows the use of fat (combustion of fat in thermal boilers, biodiesel) and MBM (combustion of MBM, fertiliser and fur feed) derived from category 1 and 2.

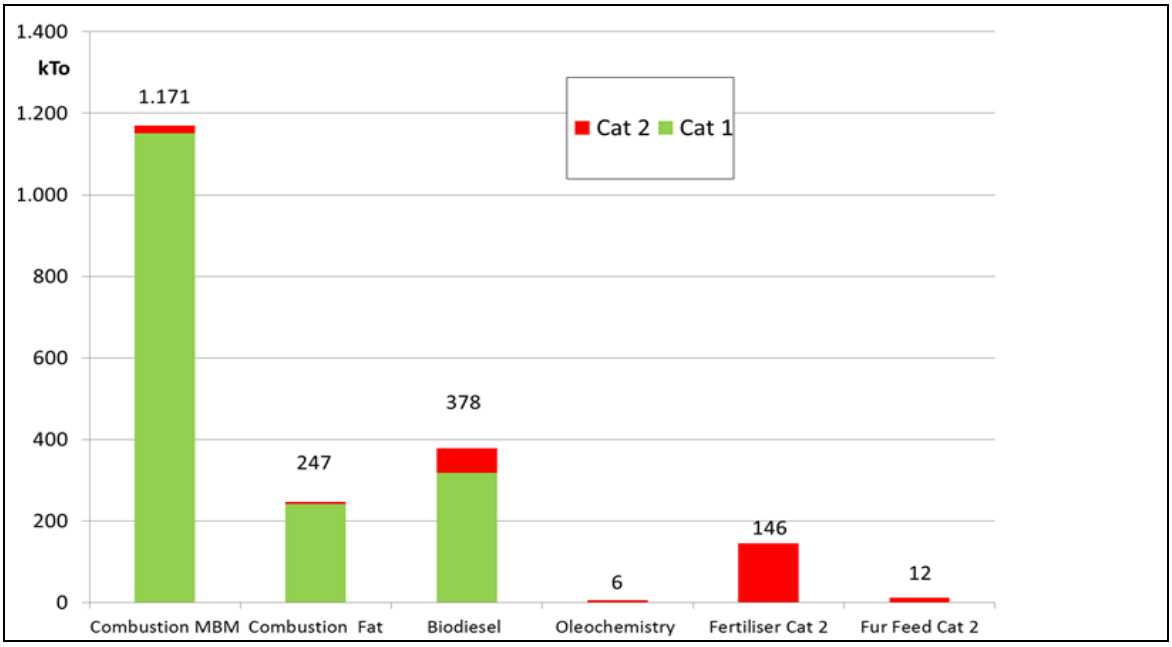

Figure 2 **Utilization of MBM and animal fats from category 1 and 2 in 2013, Source EFPRA (2014)**

3 ILCD Handbook

The ILCD Handbook (EC 2010) was developed by the JRC for the European Commission and represents a frequently cited reference for methodological details on life cycle assessments both in Europe and worldwide. The purpose of the handbook is that of a general guideline providing a *common consensus to ensure quality and consistency of life cycle data, methods and analyses.* Moreover, it aims to facilitate the convergence of different methodologies.

In Annex C, the expansive document addresses the *Modelling of reuse, recycling and energetic recovery* from the perspective of the end-of-life product intended for recycling or reuse. In response to one of the pivotal questions characterised above, i.e. the establishment of system boundaries between the initial (primary) life cycle and subsequent stages derived from end-of-life products, the JRC proposes the following approach:

- The decisive indicator is the **market value** of the end-of-life product.
- In the case that the market value is positive (i.e. above zero), the product is considered a co-product of the preceding process or system.
- In the case that the market value is negative (i.e. below zero), the product is considered a waste material. Its processing is allocated to the producing system up to the point at which a product with a positive market value (secondary good) is produced.

Thus, the pivotal question is: where precisely should the appropriate boundary between environmental burdens from the primary pathway and the secondary good be drawn?

The JRC (page 353) elaborates:

> "It is argued that all treatment processes that are necessary until the treated waste / end-of-life product is achieving a market value of zero are within the responsibility of the first system (i.e. process steps P1 to including Pn-1 in Figure 33. This is because the waste or end-of-life product is generated by the first system, while a waste can per se not carry any burden of treatment. Furthermore is it considered inappropriate to attribute all preceding waste treatment processes to the eventually produced secondary good.
>
> An **allocation** of burdens to the secondary goods can plausibly therefore only be done **at that process step where a valuable secondary good is produced** (Pn).
>
> The following procedure shall be applied:
> Modelling firstly the waste / end-of-life management/treatment processes **until the treated waste crosses the "zero market value" border** (see Figure 33). Subsequently the two-step allocation procedure is to be applied on this process step."

In short, during the transition into a secondary life cycle, a material classified as waste must not carry over burdens from the waste-producing life cycle step. The border is crossed when the product generated from waste achieves 'zero market value'. Figure 3 illustrates the process (the figure corresponds to Figure 33 in the cited source).

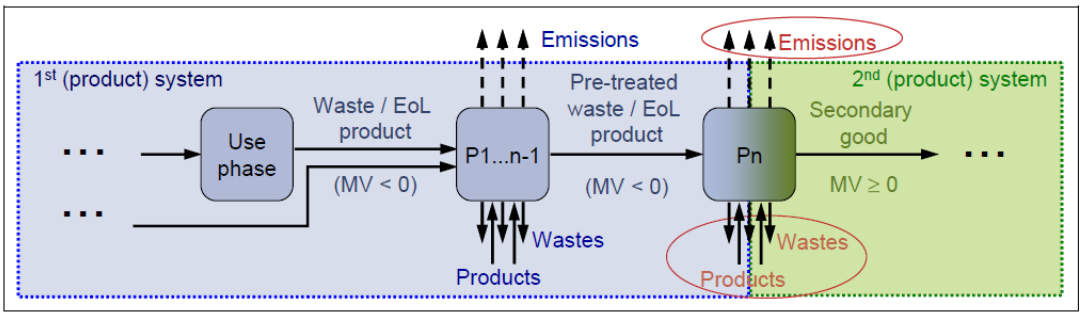

Figure 3 **Allocation of waste if the management / treatment processes result in a secondary good with market value: the inventory of the treatment process step Pn where the waste crosses the zero market value border (MV < 0 to MV 0) is to be allocated between the two life cycles: The encircled emissions, wastes etc. are to be shared between the 1st and 2nd (product) system); Source EC (2010)**

When applied to the calculation of greenhouse gas balances for biodiesel from animal oil, this suggests the approach illustrated in Figure 4. Two possible scenarios are considered:

Scenario 1: The ABP are associated with a **negative** market value, as is the case for the more hazardous materials (category 1 and 2).

Scenario 2: The ABP are associated with a **positive** market value, as is sometimes the case for the less hazardous materials (category 3).

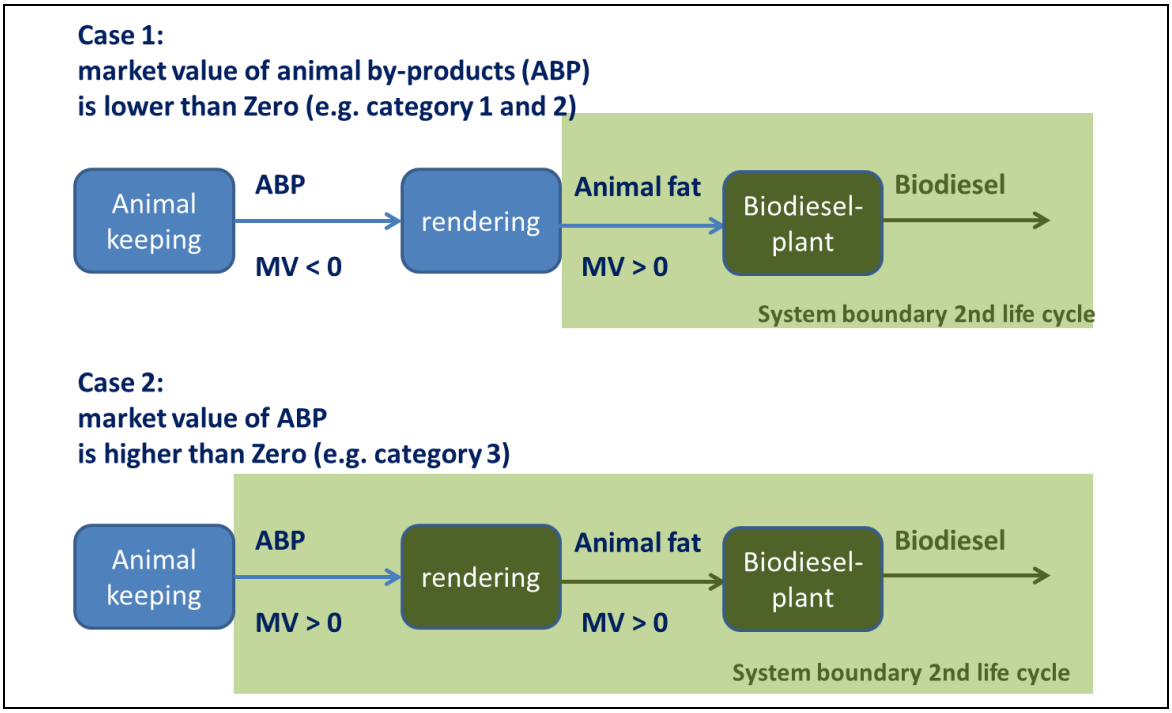

Figure 4 **Application of the methodology stipulated in the ILCD Handbook to the production of biodiesel from animal oil, simplified schematic omitting all additional material flows.**
Illustration by IFEU.

In the first scenario, the market value of the animal by-product at the slaughterhouse or the farmstead is negative. That means, only the resulting substances (cleaned animal fat or defatted MBM) after the rendering process are ready for the use in other processes and have then a positive market value. The collection, the rendering process and the associated burdens are thus part of the first life cycle (animal husbandry, production of animal products like meat, milk, eggs, wool etc.) and have to be allocated to them.

The disposal fees for the slaughterhouses and farmers for animal by-products of category 1 and 2 vary a lot in the different member states of the European Union. This mainly depends on the different national supporting schemes for the disposal of these materials. In some countries the producer of animal by-products has to pay the whole cost for collection and treatment whereas in other member states the cost are partly borne by local authorities (animal diseases funds, etc.). In this respect the following table can only be seen as an example of the disposal cost variety in the different member states. It has furthermore to be acknowledged that costs borne by funds etc. are not always available (see Table 1).

Table 1 Fallen stock collection fees in selected EU member states; Source: see table, illustration IFEU

COUNTRY	REGION	ANIMAL BY-PRODUCT	COST PER ANIMAL €	TRAVEL COST €	SOURCE
Netherlands	whole country	Bovine > 12 mon.	11,90	12,98 - 17,95	Rendac NL[1]
Germany	Rhineland-Palatinate	Bovine > 12 mon.	86,45	39,20	Staatsanzeiger Rheinland Pfalz[2]
Germany	Saxony	Bovine > 12 mon.	22,20	-	TBA-Sachsen [3]
Denmark	whole country	Bovine > 12 mon.	65,19	-	SecAnim DK [4]
Spain	Asturias	Bovine	260 [5]	-	Agroseguro[6]
Spain	Castilla la Mancha	Bovine	110 [7]	-	Agroseguro
United Kingdom	whole country	Bovine 13 – 23 mon.	95 £	-	National Fallen Stock Company[8]

1 www.rendac.nl/nl/footer-quicklinks/rendac-tarieven/asset/tarieven-april-2014-webpdf/download.file

2 Staatsanzeiger Rheinland Pfalz 22.04.2014

3 www.tba-sachsen.de/leistungen/img/Gebuehrenverzeichnis_Stand_010112.pdf

4 www.secanim.dk/fileadmin/user_upload/secanim_dk/downloads/Indsamling_forarbejdning_enhedspris.pdf

5 In the source the price is listed with 0,52 €/kg. The price in table 1 is based on an average weight of a cattle 500 kg.

6 web.unionduero.es/agroDocs/pdf/agroDocs/732.pdf

7 In the source the price is listed with 0,22 €/kg. The price in table 1 is based on an average weight of a cattle 500 kg.

8 http://www.iwight.com/azservices/documents/2477-Defra-NFSCo-Letter-to-farmers-on-IOW-wef30.11.11.pdf

Thus, it can be stated, that within the European Union all producers of animal by-products of category 1 and 2, i.e. slaughterhouses and farmers, have to pay a certain disposal fee for the safe elimination of these substances.

In the case that the costs achieve a positive market value of animal by-products, the balance boundary should be shifted in that way that the collection and the process of rendering are included. This is e.g. the case for ABP of category 3, which have a positive market value at the gate of bigger slaughterhouses. The main reason for this is the higher value of feed grade PAP (processed animal proteins) and the feed grade animal fat from the animal by-products of category 3.

4 Additional normative references

4.1 ISO and CEN standards

In general, questions pertaining to LCA should be addressed in compliance with the international standard for life cycle assessments **ISO 14040/44.** However, precise specifications are not stipulated in the norms. On the contrary, the standards are limited to the following wording:

> "Consideration should be given to the need for allocation procedures when dealing with systems involving multiple products and recycling systems. (ISO 14040, clause 5.3.4)
>
> In addition, particularly for the recovery processes between the original and subsequent product system, the system boundary shall be identified and explained, ensuring that the allocation principles are observed as described in 4.3.4.2. (ISO 14044, clause 4.3.4.3.1)
>
> Specific care should be taken when defining system boundary with regard to recovery processes" (ISO 14044, clause 4.3.4.3.2)
>
> "An open-loop allocation procedure applies to open-loop product systems where the material is **recycled into other product systems** and the material undergoes a change to its inherent properties." (ISO 14044, clause 4.3.4.3.3)
>
> The allocation procedures for the shared unit processes mentioned in 4.3.4.3 should use, as the basis for allocation, …" (ISO 14044, clause 4.3.4.3.4)

The **Technical Specification ISO/TS 14067** (*Carbon Footprint of Products*) mostly reiterates the contents of the standard introduced above. However, several additional explanations are provided in an informative appendix (C). There, the question of avoiding allocation for end-of-life stages through subdivision of processes is addressed. One recommendation suggests:

> "One possible way of process subdivision is for the GHG emissions tied to final disposal/recycling to be **split into a component E_{EoL}** charged to the product system under study **and a component E_{PP}** charged to the product system which uses the recycled material. **E_{PP}** are the GHG emissions **tied to the pre-processing of the recycled material** in order to fulfil the quality requirements of the substituted primary material."

The European Standard **EN 16214** ("Sustainably produced biomass for energy applications") defines in Part 4 ("Calculation methods of the greenhouse gas emission balance using a life cycle analysis") under clause 4.8 ("Allocation rules"):

> The total GHG emissions incurred in all upstream steps of the chain and up to the point where co-products are separated, are allocated between the biofuel/bioliquid or intermediate and the co-products. **Wastes and residues** do not share the burden of allocation i.e. **none of the GHG emissions incurred up to the point at which they are produced are allocated to them**.

The "point of collection" is defined within Part 1 ("Terminology") of this Standard:

"point from which waste, agricultural crop residues or residues from processing can be **directly used as raw material** for biofuel or bioliquid production.

NOTE 1: If an additional recovery process for a waste or residue is required before further use, the material is a waste or residue from processing until the recycling or recovery operation has been completed." (clause 2.58)

NOTE 2: The point of collection is the end point of the process of collection mentioned in 2009/28/EC [1].

Conclusion

The ISO standards do not specify at which point to split the system boundary between a process system producing a residue and the second life cycle system recycling the residue. Both cited norms include many instances in which the decision to follow a certain course of action in practice requires fundamental justification and careful consideration of goals and general stipulations of the relevant studies.

Instead the EN Standard defines the point of collection as the starting point of the second life cycle system. Based on this, the allocation for the second life cycle starts where the waste/residue could be **directly used as raw material** for biofuel or bioliquid production. In the case of biodiesel production from animal fat this would be after the necessary recycling or recovery operation, what means after the rendering process of ABP.

4.2 VDI Framework Directive Resource efficiency (VDI 4800)

The distinction between primary and secondary production systems in life cycle assessments and greenhouse gas balances may also be defined in reference to the official draft of the VDI (Association of German Engineers) directive 4800 ('Framework Directive Resource efficiency'). In the context of resource efficiency, the focus of this directive is on approaches differentiating appropriately between primary and secondary material cycles.

Paragraph 5.2.2 of the directive discusses the treatment of utilisation and disposal and thus, utilisation of secondary raw materials and feedstocks. The following is stated:

Recycling leads to the utilisation of materials in several subsequent product systems. In consequence, rules are required for the allocation of the associated consumption of resources. The definition of system boundaries should factor in the utilisation of secondary raw materials/ feedstocks according to the following principles.

- **The system boundary for the utilisation of recycling materials (secondary raw materials/ feedstocks) commences with the collection of waste materials (point of collection).**
- The utilisation of a waste material through recycling or energy recovery is credited as such within the system.
- The disposal of a waste material is also to be accounted for within the system.
- **A waste material that is utilised in a subsequent product system departs from the original product system when collected.**

The points 1 and 4 are relevant for the matter in hand. They emphasise more explicitly the step when waste materials enter the subsequent product system. Widely in line with the EN 16124 this Framework Directive specifies that the transport from the location (“point of collection”) where waste materials arise to the waste treatment location should be attributed to the subsequent system.

5 Approach of the JEC Well-to-Tank Report 4.0

The consortium of JRC, EUCAR and Concawe explicitly distinguishes between the system boundaries for biodiesel from used cooking oil (WOFA)[9] and biodiesel from animal oil (TOFA) in the latest revision of their WELL-TO-TANK report Version 4.0. This is illustrated in Figure 5 below, revised slightly from the original report. The figure suggests that the only difference between the two materials is that TOFA is associated with the additional transport to the rendering facility. However, in fact additional efforts for tallow production are also factored in.

This is illustrated in the data adopted from the WTT study, as exemplified in Figure 6. It is evident that lower burdens are associated with biodiesel production from used cooking oils due to the fact that the purification procedures required for animal oil are obsolete. In paragraph 3.4.10.7 of the WTT report, the authors provide the following explanation:

> "Biodiesel can also be produced from a number of **waste materials**, notably **used cooking oils** and **tallow** (one of the **products** of the rendering process which processes animal carcasses from slaughterhouses).
> …
> Used cooking oils need to be collected in any case so that they are deemed to be available at the processing plant with a zero energy and GHG footprint. They need to be cleaned and refined before the esterification step which is similar but slightly different from the process used for virgin oils.
>
> Animal carcasses are deemed to be waste and have therefore a zero footprint. They need to be collected and transported to the rendering plant, while the rendering process uses some energy. As a result tallow comes with a small but significant energy and GHG cost."

The JEC attributes animal carcasses **waste material** status, whereas animal oil is classified as waste material yet also a **product** in one and the same sentence. In consistency with the latter, the JEC treats animal oil as a product of the rendering process.

The JEC classify animal oil as a product merely due to the fact that is represents a material output from a production process, as opposed to a production residue. The following essential aspects are not considered:

1. The main purpose of rendering is the correct and safe disposal of animal carcasses. As such it is legally required and mandatory without alternative, as described in chapter 2. This applies to hazardous C1 and C2 materials in particular. The goal is the conversion of carcasses into harmless and recyclable materials flows. Depending on the rendering procedure, the arising materials are animal oil and meat and bone meal.
2. The market value of ABP from hazardous sources is below zero, e.g. no positive market value.

[9] WOFA in this case includes animal oil from the catering sector.

Figure 4.5.1: Bio-diesel pathways

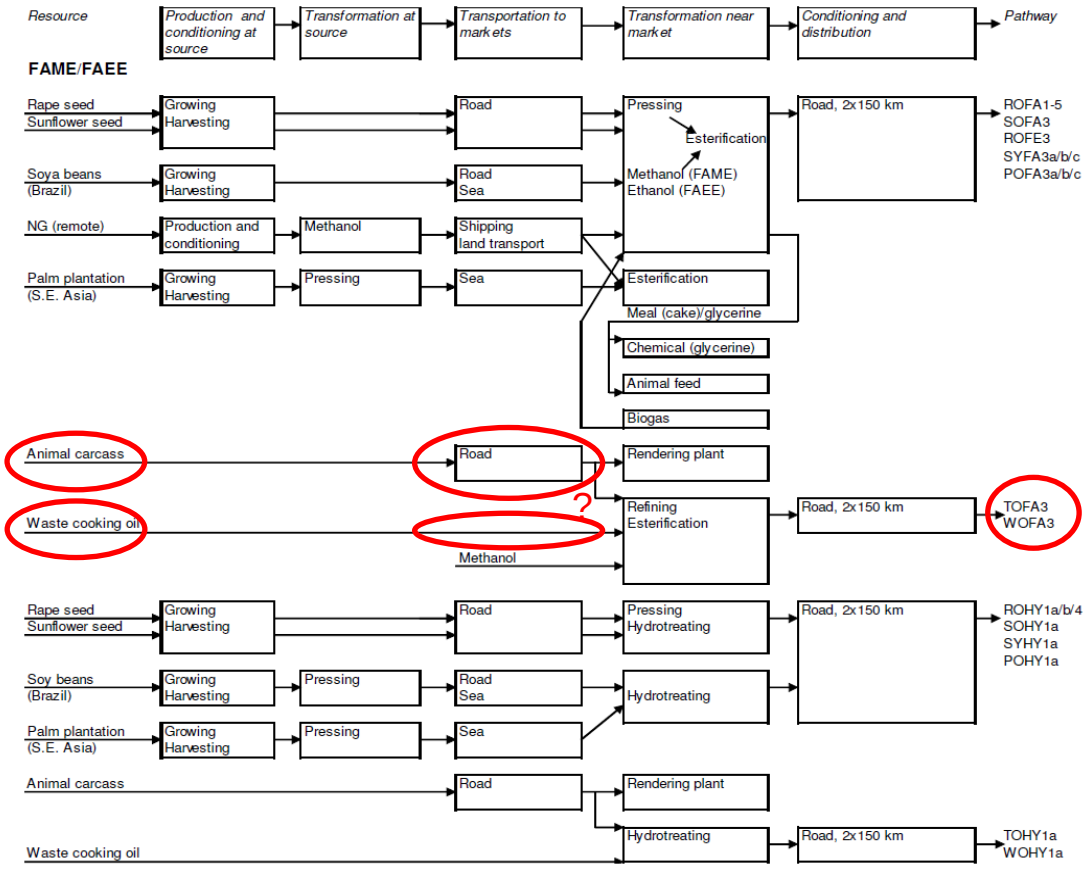

Figure 5 **Structure of the biodiesel pathways of the WTT Report Version 4.0 Source JEC 2013, red elements added by IFEU**

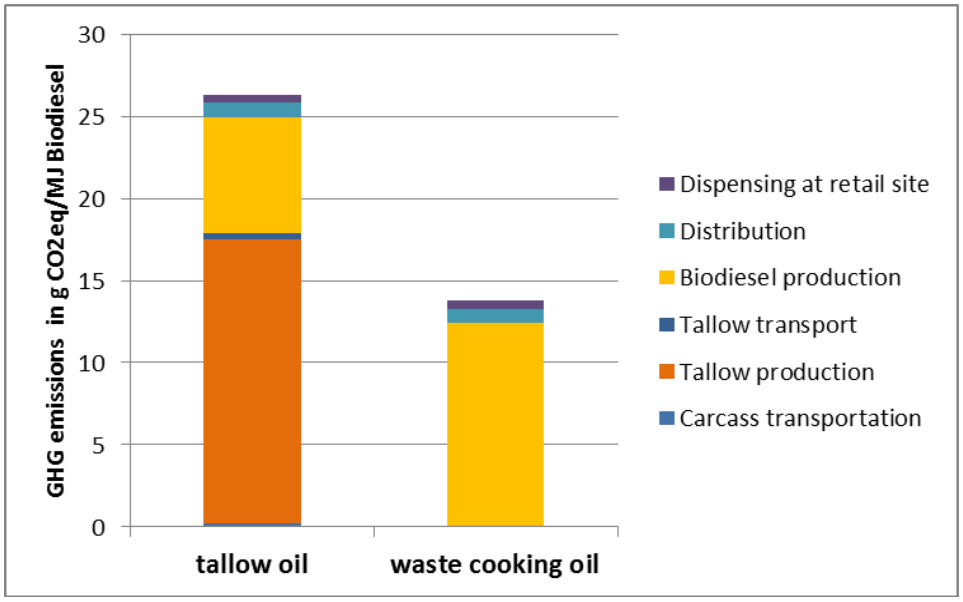

Figure 6 **Greenhouse gas balance for biodiesel from animal oil (TOFA) and used cooking oil (WOFA); Source: data JEC 2013, illustration IFEU**

JRC's argumentation is adopted by Oehmichen und Majer (2013) stating in their study for UFOP (Union zur Förderung von Oel- und Proteinpflanzen e.V.):

> "Whereas biodiesel from used cooking oils is associated with the upstream biodiesel production processes collection and transport only, the process chain of biodiesel from animal oil includes expenditures for both oil transport to the production facility and rendering. This process is integrated into the carcass rendering facility and is carried out **exclusively for the purpose of oil production** for subsequent use. Thus, it **has to be** included for LCA purposes"

This statement evokes reply on two counts. The main purpose of the rendering process is not the oil production. The thermal treatment of carcasses is a legal obligation in the European Community and necessary to reach the hygiene requirement and thus part of EU disease prophylaxis. Therefore the primary purpose is compliance with these obligations.

Moreover, as long as a process output is not associated with any positive market value, the intensity of its processing in a preceding step remains irrelevant. The line of argument above is incorrect unless the product already qualifies as a marketable (pre-) product.

6 Recommendations

The analyses of the different documents and studies above allow the following conclusions:

- There is no debate that a clear boundary is required between one life cycle that concludes with a waste material fit for secondary processing and the subsequent life cycle that encompasses treatment and utilisation of the secondary good. All relevant reference documents concur on this point.
- The pivotal question is: To what extent should environmental burdens from upstream or downstream processes be allocated to the main system or the final product from secondary good processing? The ILCD Handbook provides guidance and direction in this context: **the marketability of a material is decisive and may be assessed with a convenient and practicable indicator**, i.e. a positive market value per collection classifies a given material as a secondary good. But under no circumstances should environmental burdens from upstream life cycle processes be applied to materials without any market value.
- In consequence this defines the starting point of the subsequent life cycle boundary. In case of ABP with a positive market value, as is sometimes the case for ABP of category 3, the burden of the transport to the rendering plant as well as the burden of the rendering process should be attributed to the second life cycle. In case of ABP with a negative market value, as is typically the case for APB of category 1 and 2, all environmental burden starting after the rendering process should be allocated to the second life cycle.

There may be materials that are legally categorised as waste, yet they may have a positive market value. In these cases, there are usually competing consumers (otherwise a positive market value would be unlikely). Where applicable, upstream processes should be considered as the waste material in all likelihood qualifies as a co-product.

In the case that the expected revision of the default values in Annex V of the RED should distinguish between waste oil biodiesel from used cooking oils versus animal fat, the quality of the animal fat has to be clarified for this input. The following categories could adequately serve the purpose:

One default value for used cooking oil/ animal fat from categories 1 and 2 staring with the produced fat (categories 1 and 2) or with the collection of used cooking oil and one default value for animal fat classified as category 3 staring with the collection of ABP (as long as the market value of ABP is positive).

7 Literature

EC (2010): European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010

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