KZR INiG System /7

Guidance for proper functioning of mass balance system

by The Oil and Gas Institute – National Research Institute

The KZR INiG System/7

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1. Introduction

Economic operators participating in the KZR INiG System shall demonstrate compliance with the sustainability criteria through assurances of traceability of a given quantity of biomass (with the requisite certificate of compliance with the sustainability criteria) through the whole supply chain.

A mass balance system is a set of statements and data ensuring supervision over quantities of biomass flowing through the chain of supply and production, from an agricultural producer or first waste collection point, to the final biofuels or bioliquids producer. The mass balance must always start from the origin of the feedstock. e.g. for used cooking oil the first collector must be included in the scheme and must be able to provide evidence of the restaurants they collected from.

This document applies to all economic operators participating (*i.e. system participants*) in the *KZR INiG System* and at any sites where biomass, biofuel and bioliquids products are legally and physically controlled by system participants. Compliance with all requirements of this mass balance system is demonstrated by system participants during audits carried out by independent certification bodies. The system participants in the mass balance system are the:

- agricultural producers;
- first gathering points, middlemen, traders, brokers;
- intermediate producers (biomass processors);
- biofuel and bioliquids manufacturers;
- fuel producers, final suppliers, and:

any other economic operators involved in biomass/biofuel/bioliquid product handling, processing, conversion, transformation, manufacturing, trading, storage, first waste collection points, distribution of waste, residues and biomass, biofuel and bioliquid products and/or otherwise the way of handling.

To ensure proper supervision over these streams, article 18 of Directive 2009/28/EC **(RED)** requires enterprises to develop and apply a mass balance system. In accordance with the directive, EU member states require system participants to apply the mass balance system as the basis for demonstrating compliance with the sustainability criteria. The mass balance system:

a) allows consignments of raw material or biofuel with differing sustainability characteristics to be mixed;

b) requires information about the sustainability characteristics and sizes of the consignments referred to in point (a) to remain assigned to the mixture; and

c) provides for the sum of all consignments withdrawn from the mixture to be described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture.

2. Normative references

The normative references, covering all aspects of the KZR INiG System, are the following linked documents, which should be read in conjunction.

- *KZR INiG System /1/ Description of INiG System of Sustainability Criteria – general rules*
- *KZR INiG System /2/ Definitions*
- *KZR INiG System /3/ Reference with national legislation*
- *KZR INiG System /4/ Land use for raw materials production – lands with high carbon stock*
- *KZR INiG System /5/ Land use for raw materials production - biodiversity*
- *KZR INiG System /6/ Land use for raw materials production – agricultural and environmental requirements and standards*
- *KZR INiG System /7/ Guidance for proper functioning of mass balance system*
- *KZR INiG System /8/ Guidelines for the determination of the life cycle per unit values of GHG emissions for biofuels and bioliquids*

PrEN 16214-1 *Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifiers for biofuels and bioliquids – Part 1: Terminology.*

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

3. Definitions

KZR INiG System/2/ Definitions

4. Guidelines for the construction of a mass balance system

Economic operators must enforce a mass balance system, in accordance with the regulations of the KZR INiG System. Each system participant is obliged to introduce a mass balance system, which is assessed during audits. The mass balance system shall operate at least at the level of a site. Site is defined as a geographical location with precise boundaries within which products

can be mixed. The mass balance system shall operate at a level where consignments could normally be in contact, such as in a container, processing or logistical facility or site. If more than one legal entity operates on a site then each legal entity is required to operate its own mass balance system.

The mass balance system is to ensure traceability, supervision and management of the biomass streams (processed biomass) meeting the sustainability criteria.

The mass balance shall be consistent within a site, even if it is run according to more than one voluntary scheme.

In order to minimize the administrative burden for the economic operator (system participant), it is suggested that the operational system already existing in the company (financial bookkeeping system, storage system, etc.) be expanded, supplementing it with elements related to sustainability.

It must be emphasized that the introduction of the mass balance system, and likewise the whole system of sustainability criteria, should not significantly disturb the existing document flow within the company.

The first step is to define the system's boundaries and to designate points of raw material/feedstock (biomass, waste or residue) entry and final product exit. In order to run mass balance in an appropriate way, the economic operator is obliged to have a suitable documentation system.

In accordance with the *KZR INiG System*, the moment of receipt of biomass (or processed biomass) is the entry point (or the exit point) of a stream in the mass balance system of a given economic operator.

A mass balance system means record-keeping such that "sustainability characteristics" remain ascribed to a given batch, lot or consignment of the raw material, allowing each economic operator that processes, converts, transforms, manufactures, trades, stores, distributes and/or otherwise handles the biomass (processed biomass) to ensure traceability of every batch, lot or consignment of product that goes through the processing unit.

The sustainability characteristics of given batch are described by input/output data (see point 5).

Biofuel type (see minimum input/output data - point 5) shall be recorded by scheme participant in the mass balance system.

Traceability shall be ensured at every stage of the chain of custody.

The mass balance system shall include data on GHG emissions of all compliant batches, lots or consignments in a given accounting period, excluding GHG emissions that are ascribed to those that do not comply with the sustainability requirements. Only compliant batches, lots or consignments shall be accounted for in the GHG balance. The KZR INiG System does not allow averaging of GHG emissions across different batches.

In the case of blending of batches, lots or consignments with identical sustainability characteristics, the total mass is taken into consideration in calculating GHG emissions. This means that, for the purpose of GHG emissions calculations, batches from different supply but with the same sustainability characteristics can be summed. Note that it is permitted if **all sustainability characteristics** are identical. Under the KZR INiG scheme, it is also permitted to allocate the worst GHG value to all batches that have otherwise the same sustainability characteristics.

When input batches, lots or consignments with various sustainability characteristics are blended (processed together), the individual sizes and sustainability characteristics of each batch remain assigned to the mixture. This information shall be documented in the mass balance system records.

If the mixture is split up, the quantity of the compliant batch taken out of this mixture shall not be greater than the quantity of the input compliant batch introduced into the mixture (taking into account an efficiency coefficient or a conversion coefficient).

The mass balance must be conducted in a defined time period and verified regularly. A three-month period is the maximum allowed in the KZR INiG System. Each individual producer shall design a mass balance method and adjust it to his operation profile, so as to allow monitoring and easy verification of the mass balance.

If in a given time period an economic operator purchased more sustainable raw material than was sold, the excess quantity may be transferred to the next time period. This is only allowed when the amount of transferred feedstock is physically located in the warehouse. It is not permitted to transfer documents confirming sustainability of biomass if there is no suitable amount of goods in stock.
The opposite situation, the sale of an amount of sustainable biomass exceeding the amount purchased (including existing stock), is a breach of the rules of mass balance and causes withdrawal of a certificate.

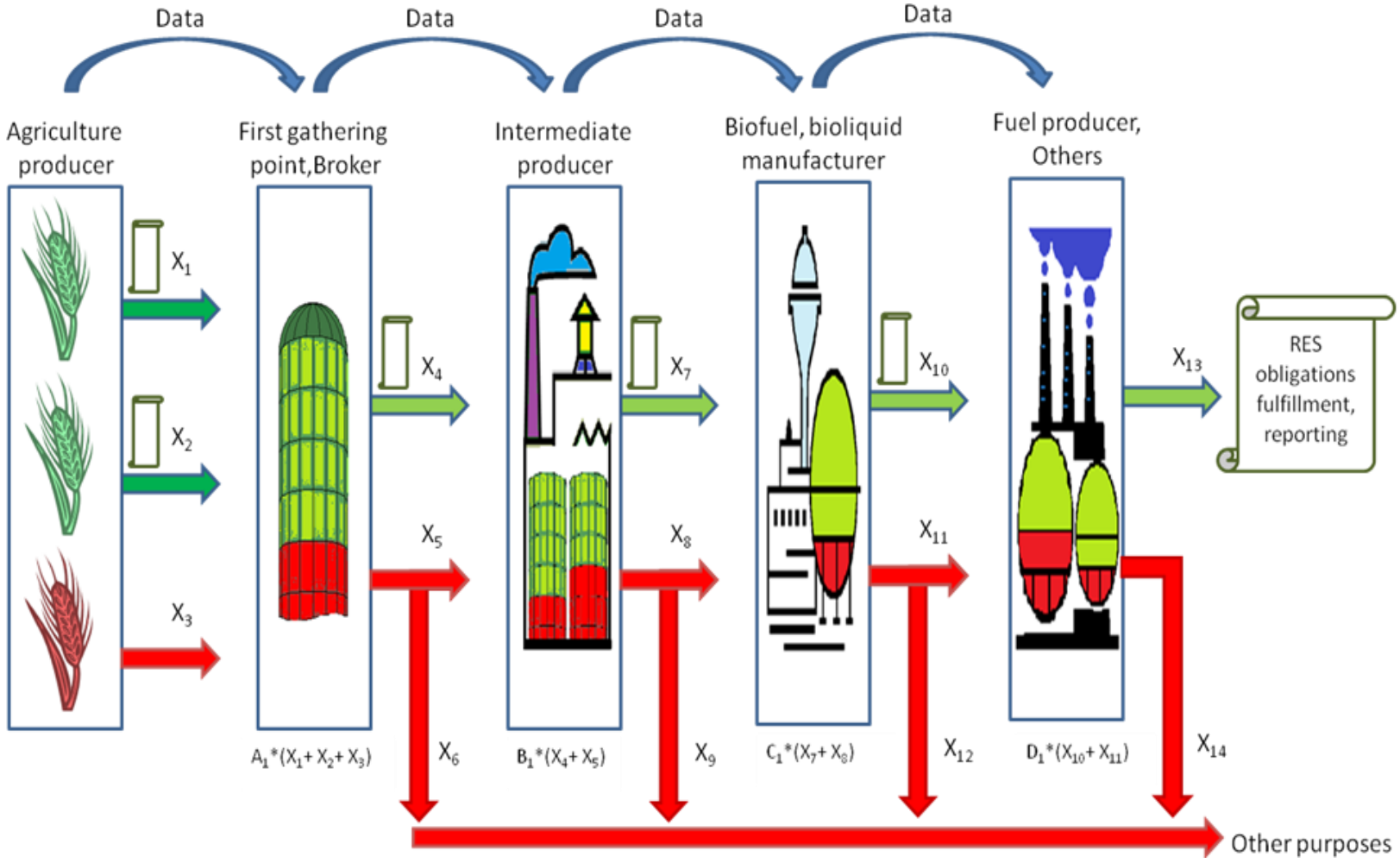
For correct implementation and usage of the mass balance, it is necessary to identify all processes occurring at the production plant, from the entry of the commodity to the moment of shipment to the customer. Development of a **process map** showing biomass pathways and connections between the individual processes will be helpful, ensuring traceability of biomass streams (thus complying with the sustainability criteria) and providing a basis for carrying out calculations of GHG emissions connected with this stage of the biofuel or bioliquids life cycle.

Ensuring traceability of the individual biomass batches, lots or consignments need not entail physical supervision over the individual shipments, but it must take place at the stage of purchase and sale of batches meeting sustainability criteria (defined points of entry to, and exit from, the system), and at the points of entry and exit to/from the individual processes, particularly those in which a change in mass or a conversion to another product occurs. Thus each system participant (economic operator) performs a mass balance based on invoices (reception documents) and records of the quantity of product (complying with the sustainability criteria) bought and sold.

An efficiency coefficient or conversion coefficient must be defined for each production process or other process where a change in mass of the biomass may occur. Whenever a processing step involves losses, appropriate conversion factors should be used to adjust the size of a consignment. In addition, it is important to note that, generally, the sustainability characteristics of the feedstock that is processed should be attributed to products and residues of that process equally. For instance, when 50% of a mixture has been certified as being sustainable, 50% of all products and residues from that mixture should also be considered sustainable. The only exception is the allocation of GHG emissions, which should follow the rules of Annex V RED.

The figure below shows diagrammatically a simple example of a mass balance throughout the whole life cycle (production chain) of a biofuel or bioliquid.

Fig. 1 Diagram of a mass balance under the INiG System



The above diagram presents a mass balance system in the whole production chain of biofuel and bioliquids in an illustrative and very simplified way.

The blue rectangles define the boundaries of a mass balance system at each production site.

Agricultural producer

The agricultural producer is the first link (in the chain of custody) obliged to introduce a mass balance system. He must define: the quantity of produced biomass and its sustainability characteristics (X_{1-3}),; information concerning land-use change; and all data required to verify GHG emissions calculations (if applicable). In order to confirm the data, the agricultural producer must declare the size of the field and its yield per hectare.

First gathering point/ broker

The raw material batches purchased from the agricultural producer together with their characteristics are the input data. The first gathering point may accept biomass also from agricultural producers that do not declare meeting the sustainability criteria. In the above diagram, "X_3" is the raw material quantity from an agricultural producer that does not declare meeting the sustainability criteria, while X_1 and X_2 quantities come from an agricultural producer declaring meeting the sustainability criteria. Supply size shall be adjusted to storage parameters. It is proposed that the following values should be assumed for grain storage parameters in the KZR INiG System:

- content of impurities not more than 3%;
- moisture content for oily seeds 7%, grains 14%, maize 15%.

To these quantities, GHG emission values gCO_{2eq}/MJ (gCO_{2eq}/mass or volume unit) are ascribed, determined according to the methodology of a given system. The first gathering point identifies processes that the biomass undergoes within its boundaries. Energy demand necessary for calculating GHG emissions of the identified processes, and for processes that involve a change in biomass quantity, is determined (coefficient marked A_1 in the diagram above).

It is left to the discretion of the first gathering point to plan the document flow in a way ensuring that information on quantities of the raw material meeting and not meeting sustainability criteria and currently stored is available at every moment.

The simplest way to meet this requirement is a proper differentiation in the financial-bookkeeping system of the economic operators subject to audit. In cases where an invoice correction of biomass sold has occurred, proper changes in the mass balance must be introduced.

Intermediate producer

The next system participant shall, like the first gathering point, identify pathways and processes that the biomass is undergoing, and define the performance coefficient or conversion coefficient (B_1 in the above diagram) for these processes. Given the fact that raw materials for biofuels and bioliquids production may have various GHG emissions indices, calculations of GHG emissions must be performed based on the intermediate producer's mass balance with regard to emissivity and energy consumption of the individual processes, and also after allocation of emissions to the individual products.
In the diagram above, X_4 and X_5 represent the quantities of compliant and non-compliant biomass entering the producer's mass balance system. The corresponding values in the output streams are X_7 and X_8. To these quantities, emission values gCO_{2eq}/MJ (gCO_{2eq}/mass or volume unit) are ascribed, determined according to the methodology of the KZR INiG System or another recognized EU system.

Biofuel/bioliquids manufacturer

An analogous procedure takes place at the subsequent stages, where „X_7","X_8" are biomass quantity defined based on purchase – sale documents and an input data in the mass balance system at the system participant, and an input data in the mass balance system at the manufacturer of the biofuel/bioliquids. To these quantities emission values gCO_{2eq}/MJ (gCO_{2eq}/mass or volume unit) are ascribed, determined according to the methodology of the KZR INiG System or another recognized EU system. As in the previous stages, the manufacturer of the biofuel/bioliquids is required to:

- identify the biomass pathway in the production plant,
- develop a process map indicating the efficiency coefficient or a conversion coefficient (C_1), ensuring traceability of the product meeting the sustainability criteria,
- allocate emissions to the individual products.

In the above diagram, the efficiency coefficient or conversion coefficient is marked in a general way as C_1. Depending on the type of biofuel/bioliquids manufactured and the technology used, the $C_1*(X_7 + X_8)$ equation will have a more complex, extended form.

Fuel producer, final supplier, others

To ensure traceability of meeting the sustainability criteria of a biofuel, each economic operator shall introduce a mass balance system. A fuel producer, final supplier or other economic operator handling biomass (processed biomass, biofuel, bioliquids) is obliged to define input (X_{10}, X_{11}) and output (X_{13}, X_{14}) streams. To these quantities, emissions values gCO_{2eq}/MJ (gCO_{2eq}/mass or volume unit) are ascribed, determined according to the methodology of the KZR INiG System or another recognized EU system. In the above diagram, the efficiency coefficient or conversion coefficient is marked in a general way as D_1. Depending on the type of

fuel production, and on other economic operators' activities, the $D_1*(X_{10} + X_{11})$ equation will have a more complex, extended form.

Co-processing of biomass with fossil raw material

Some processes of biomass conversion may be carried out simultaneously with the processing of fossil raw material. In such cases, it is necessary to define the share of the product of biological origin in the total amount of co-product at a given stage of processing. GHG emissions generated at this and the following stages of processing shall be allocated to both the product of biological origin, and the fractions from fossil parts.

In order to determine the share of the fraction of biological origin (β) in the product obtained in co-processing, the following equation shall be used [1]:

$$\beta = \frac{\Sigma(Q_{b,in}i * LHV_{b,in}i)}{\Sigma(Q_{in}j * LHV_{in}j)} \qquad \textbf{[1]}$$

where:

$Q_{b,in}i$ *- mass of* i^{th} *biomass directed to conversion process; expressed in mass unit;*

$LHV_{b,in}i$ *- lower heating value of* i^{th} *biomass directed to conversion process, expressed as energy unit per mass unit;*

$Q_{in}j$ *- quantity of* j^{th} *stream (of both biological and fossil origins) introduced into the process, expressed in mass units;*

$LHV_{in}j$ *- lower heating value of* j^{th} *stream (of both biological and fossil origins) expressed as energy unit per mass unit.*

The quantity of the co-processed biofuel is determined according to the energy balance and efficiency of the co-processing process as set out in Council Directive (EU) 2015/652. The energy content and energy balance affect the quantity as well as the GHG intensity of the biogenic component. The national regulations apply when crediting the biogenic component from co-processing of biofuels and fossil fuels in the respective member states. After issuance by the European Commission of any further guidance/rules regarding co-processing (e.g. on determining the biogenic content of a fuel, or on GHG emissions calculation), these will be incorporated into the KZR INiG System with immediate effect

5. Documenting the verified data

The document PrEN 16214-2 *Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifiers for biofuels and bioliquids – Part 2: Conformity assessment including chain of custody and mass balance* does not provide procedures and guidelines for building a mass balance system. The latter may be based on another system already in place in a processing unit. It is important that the introduction of a system for evaluating the sustainability criteria does not cause excessive administrative difficulties for the system participant. For the reason it is impossible to build one simple evaluation algorithm for the introduced mass

balance system. However, immediate identification of the data to be collected by the system participant is critical.

A map of processes performed in the production unit, together with definition of input and output data for each process, is a starting point for the development of inventory tables. If, during the process, a change in mass or conversion to another product occurs, it is necessary to provide corresponding coefficients in the mass balance calculation.

In order to ensure traceability of product batches meeting the sustainability criteria, economic operators shall provide to the next operator the following information about input and output data that he is obliged to report, demonstrate during audit, and exchange and collect within the mass balance system.

Required minimum input data:

- data identifying the economic operator (supplier of the raw material)
- whether "a recognised voluntary scheme" certified the supplier and, if so, the name of this voluntary scheme
- the name of the purchased product
- biofuel type[a] data confirming sustainability of the biomass/processed biomass (including number and date of the certificate, name of the recognized certification scheme, and related contract number),
- type of raw material/feedstock (name of raw material of the purchased product, e.g. rapeseed oil, sunflower oil, rapeseed methyl ester, corn, etc.)
- shipment destination, date and supply size
- country of origin of the biomass and the NUTS2 region, if available
- originating from waste and residue, the name of waste feedstock (e.g. UCO, etc.), waste code, category for animal fats, if applicable
- whether the bonus for degraded land has been applied (Yes/No/No data)
- GHG emission data characterizing the batch (actual, default, disaggregated default value or regional default value), expressed in gCO2eq/MJ (for final fuel) or gCO2eq/t dry basis (for raw materials and intermediate products), calculated according to the RED methodology (given in KZR INiG System/8/ Guidelines for determination of life cycle per unit values of GHG emissions for biofuels and bioliquids), including emissions received from the preceding economic operators (see note 1 for further requirements)

[a] Biofuel type means a biofuel production process and/or a biofuel production pathway defined by the RED

- annualised emissions from carbon stock changes caused by land-use change[b]
- delivery date and unique identification number,
- statement by the economic operator that delivered biofuel/bioliquids has been produced in an installation that was in operation on / before 5 October 2015[c]
- statement by the economic operator that delivered raw material/feedstock (other than waste and processing residue, but including agricultural, aquaculture, fisheries and forestry residues) complies with the land-use requirements specified in the RED and in KZR INiG System documents
- statement by the economic operator that delivered wastes/residues raw material, feedstock or biofuels produced from wastes/residues was not deliberately modified to meet wastes/residue definition[d]
- name, function and signature of authorized person confirming the data.

Required minimum output data:

- data identifying the seller
- confirmation of the operator's KZR INiG Scheme certification, certificate number and name of certification body
- name of the sold product
- biofuel type [e]
- confirmation that the batch meets the sustainability criteria specified by the RED
- type of raw material/feedstock, The name of raw material of the sold product (e.g. rapeseed oil, sunflower oil, rapeseed methyl ester, corn etc.)
- originating from waste and residue, the name of waste feedstock e.g. UCO, etc.), waste code, category for animal fats, if applicable,
- shipment size, destination and date
- country of origin of the biomass and the NUTS2 region, if available

[b] For data collected at the FGP stage, if no value is specified it means that the amount is zero.
[c] This concerns only biofuel/bioliquids producers and operators after biofuel/bioliquids producer in a supply chain. An installation shall be considered to be in operation if the physical production of biofuel has taken place.

[d] Apply only for wastes/residues biofuel supply chain. Certification of wastes/residues collection point is unambiguous with the confirmation of no intentional contamination, but some schemes (national or voluntary) may require such additional confirmation. Therefore, placing this information on the delivery document is strongly recommended but not needed.
[e] Biofuel type means a biofuel production process and/or a biofuel production pathway defined by the RED

- whether the bonus for degraded land has been applied (Yes/No/ No data)
- GHG emission data characterizing the batch (actual, default, disaggregated default value or regional default value), expressed in gCO2eq/MJ (for final fuel) or gCO2eq/t dry basis (for raw materials and intermediate products), calculated according to the RED methodology (given in KZR INiG System/8/ Guidelines for determination of life cycle per unit values of GHG emissions for biofuels and bioliquids), including emissions received from the preceding economic operators (see note 1 for further requirements)
- annualised emissions from carbon stock changes caused by land-use change[f],
- delivery date and unique identification number
- statement by the economic operator that delivered raw material/feedstock (other than waste processing residue, but including agricultural, aquaculture, fisheries and forestry residues) complies with the land-use requirements described specified in the RED and in KZR INiG System documents
- statement by the economic operator that delivered wastes/residues raw material, feedstock or biofuels produced from wastes/residues was not deliberately modified to meet wastes/residue definition[g]
- statement by the economic operator that delivered biofuel/bioliquids has been produced in an installation that was in operation on / before 5 October 2015[h],
- name, function and signature of authorized person confirming the data.

NOTE 1

If the actual (not default) value of GHG emissions for the transport stage is used, it must take into account GHG emissions from all stages of transportation. If the default value is used, "default value for GHG emissions from transport" should be entered. Similarly, if the actual (not default) value of GHG emissions for the transport stage is used, it must take into account GHG emissions from all stages of processing. If the default value is used, "default value for GHG emissions from processing" should be entered.

Information on GHG emissions must include accurate data on all relevant elements of the emissions calculation formula. When default values are used, information on GHG emissions should only be reported for final biofuels and can be reported as an aggregate. When actual

[f] For data collected at the FGP stage, if no value is specified it means the amounts is zero.

[g] Apply only for wastes/residues biofuel supply chain. Certification of wastes/residues collection point is unambiguous with the confirmation of no intentional contamination, but some schemes (national or voluntary) may require such additional confirmation. Therefore, placing this information on the delivery document is strongly recommended but not needed.

[h] This concerns only biofuel/bioliquids producers and operators after biofuel/bioliquids producers in a supply chain. An installation shall be considered to be in operation if the physical production of biofuel has taken place.

values are calculated, it is necessary to split the total amount of emissions into all elements of the GHG emission calculation formula that are relevant. This applies also to the elements of the formula that are not included in the default values, such as e_l, e_{sca}, e_{ccr}, e_{ccs} and e_{ee}.

In cases where actual values are not used, information on the amount of GHG emissions should not be transmitted through the chain of custody (before the last processing step) as it would be difficult to know, at later stages of the chain, whether these emissions represent actual values or are derived from (disaggregated) default values.

Actual value of GHG emissions shall always be expressed in relation to dry product.

In the case of using a default value of GHG emissions, the biofuel production path shall be consistent with that given in the RED Directive.

NOTE 2
Input/output minimum data shall be recorded by the system participants in their mass balances.

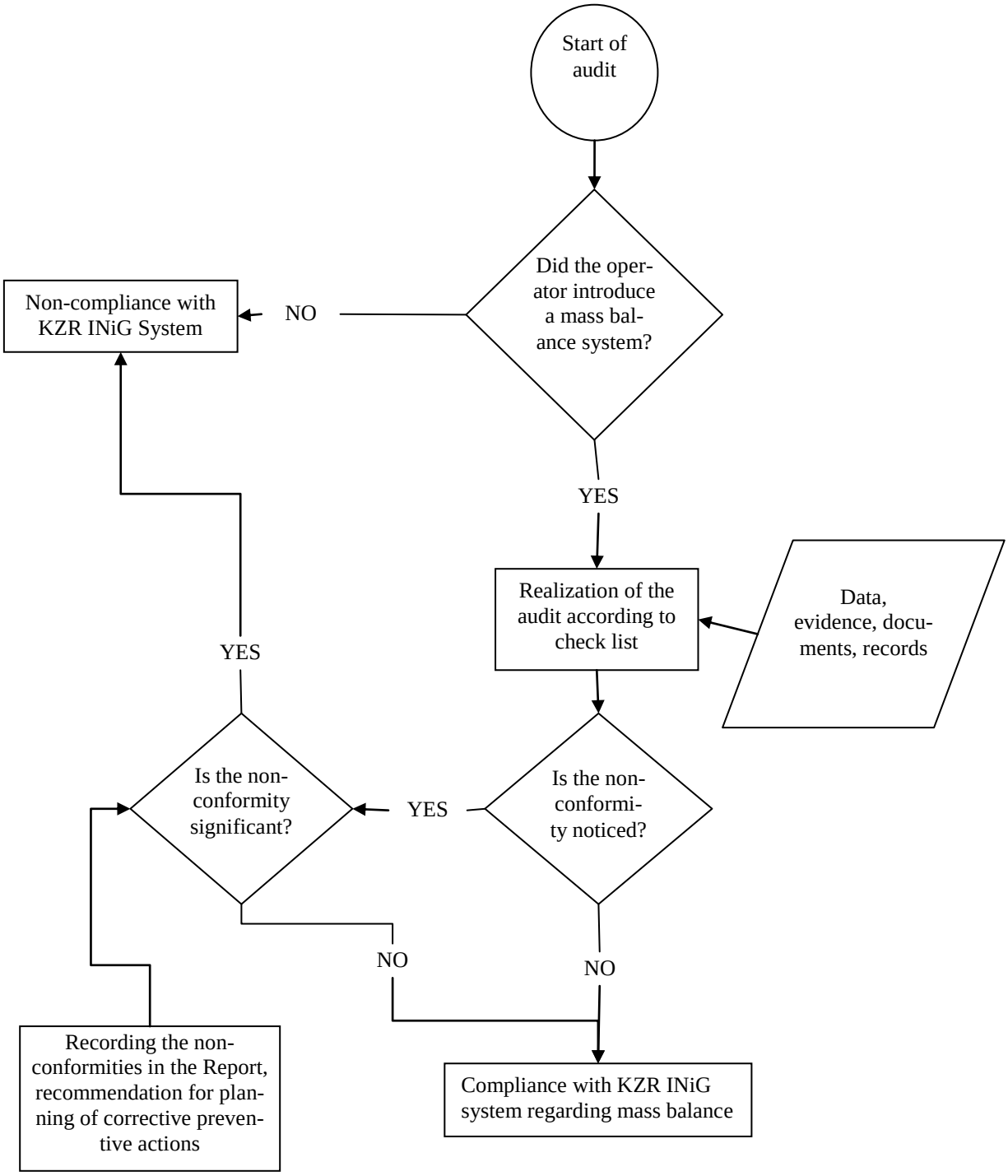
NOTE 3
A confirmation of sustainability of a given biofuel supply should not be issued for deliveries or sales of sustainable biofuel if the biofuel has already been used for any of the purposes specified in Article 17 (1) of the RED, including the fulfillment of a national quota obligation.

Output minimum data cannot be assigned to a lot if a receiver lacks a valid certificate.

6. Decision tree

The diagram below shows a decision tree of the procedure for verifying the correctness of a mass balance system.

Figure 2.Procedure for verifying a mass balance system introduced into a processing unit



7. Checklist

The verification list with guidelines for auditors is given in the document *KZR INiG System/10/ Guidelines to auditors and conduct of audits*.