

Guidance for integrating Orbae LUC emission factors into GFLI branded datasets

A step-by-step workflow for converting an Orbae-computed land use change (LUC) emission factor into the GFLI inventory structure

Audience: Companies and consultancies developing branded datasets

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What this document is for

This is a practical procedure. It shows how to take a single land use change (LUC) result produced with Orbae — whether a farm-specific dLUC value or a jurisdictional jdLUC value — and turn it into the set of elementary flows that constitute the GFLI datasets inventory. The same result can feed one dataset or several (for example, both the grain and the straw of a crop, or downstream products that use the crop). The reasoning and the transformations below mirror AdAstra's scalable pipeline deployed in 2026; here they are laid out so you can follow them by hand.

What you start with, and what you end with

You start with: an Orbae LUC result for a crop in a place — a land use change greenhouse gas figure (per kilogram of commodity) plus the areas of each land type that were converted.

You end with: a small set of elementary flows — three greenhouse gas emission flows, three land transformation flows — that you enter directly into your GFLI branded dataset. That is the finish line of this workflow.

Before you start · what you need

This workflow is applied at the inventory level of the GFLI unit process datasets, so before you begin make sure you have:

- **SimaPro.** The change is made inside SimaPro — it is where you open a dataset and edit its elementary flows (Steps 3–6).
- **The GFLI unit process dataset library, loaded in SimaPro.** The crop-production unit processes are the datasets whose inventories receive the flows. Without this library present you have nothing to edit.
- **Your Orbae result(s).** The jdLUC or dLUC output for the crop × geography you are working on (see Step 1).

The six steps: (1) understand the Orbae result and its scope; (2) decide which GFLI dataset(s) it applies to; (3) split the LUC figure into individual gases; (4) re-base the gases onto the GFLI dataset's own basis; (5) work out the land transformation flows; (6) enter all the flows into the dataset.

Note that step 5 is only relevant for a comprehensive life cycle inventory modeling, but optional if the purpose of the inventory creation is exclusively for GHG accounting and FLAG reporting.

Step 1 · Understand the Orbae result and its scope

Before converting anything, be clear about what the Orbae number represents and how complete it is. This step is about scope and a few generic principles — not about looking anything up yet.

- **One result, per crop and place.** An Orbae result is a LUC greenhouse gas value expressed per kilogram of commodity, for a specific crop in a specific geography. It comes from either a farm-specific dLUC computation, a sourcing region dLUC computation or a jurisdictional jdLUC computation — this workflow is identical for all.
- **Use the complete value.** The land use change total you carry forward includes three things: emissions from converting non-peat land, emissions from converting peat, and the ongoing yearly oxidation of peat that is farmed (labelled as “peat occupation”). Orbae’s LUC GHG value displayed on platform leaves out the ongoing peat occupation, so always take the complete value, not just the LUC GHG value displayed.
- **Pick one accounting basis and stay with it.** Orbae provides two ways of spreading a one-off forest-clearing event over time: “linear” (weighted towards recent years) and “equally allocated” (a flat share each year).
- **Orbae is the GFLI source of truth for LUC.** Where Orbae records no conversion of a land type, that means the emission is zero — not “unknown”. Any land use change value that a GFLI branded dataset carried before is replaced by the Orbae result (or set to zero).

Example — headline vs complete value, and how it splits into two flow families

A crop on partly-drained peat has an Orbae LUC GHG value of 0.80 kg CO₂-eq per kg.

The LUC GHG value = 0.30 (forest cleared) + 0.50 (peat drained once). It omits the *ongoing* peat oxidation of 0.05 each year.

Complete value to use: 0.30 + 0.50 + 0.05 = **0.85 kg CO₂-eq per kg**.

That complete value now splits into the two families of elementary flows you will write (see Steps 3–6):

- **Land transformation part = 0.30** (the non-peat forest clearing) → becomes the “land transformation” gas flows, and also drives the physical “Transformation, from forest” area flow in Step 5.
- **Peat part = 0.50 + 0.05 = 0.55** (one-off drainage + ongoing oxidation) → becomes the “peat oxidation” gas flows. Peat is captured entirely as emissions — it gets no land-area flow.

Step 2 · Decide which GFLI branded dataset(s) receive the value

One Orbae result can apply to several datasets. This step is about the scope of that reach and the principles for matching — again, generic rules rather than a value-by-value lookup.

- **Only crop production datasets take LUC.** Land use change belongs on the primary crop production dataset (in GFLI terms, “Land management emissions – plant production”). Processing, drying and other downstream datasets do not receive LUC directly; they inherit it through the crop they use.
- **Match on crop and geography.** Link the Orbae result to a dataset by a shared crop name and a shared geography code. Use a common vocabulary on both sides (a canonical crop name and an ISO country / region code) so the two line up.
- **One result can feed many datasets (1 → N).** The same crop × place result applies to every dataset for that crop in that place — for example the grain and the straw (co-products from the same field), and any regional variants.
- **Geography, from precise to general.** Prefer the most specific geographic match available: an exact sub-national match first, then the country-level value, and only then a country average.
- **Source precedence.** Prefer a custom dLUC (“dLUC” in Orbae) or a jdLUC result (“jdLUC” in Orbae).

Example — one result, several datasets

An Orbae result for “wheat, Country X” can be applied to, for instance:

- Wheat grain, Country X — receives the LUC value
- Wheat straw, Country X — the co-product from the same hectares
- Downstream “wheat flour, Country X” — not entered directly; it picks up LUC via the grain it consumes

Step 3 · Split the LUC figure into individual gases (CO₂, CH₄, N₂O)

The Orbae LUC total is a single CO₂-equivalent figure. A dataset needs it broken into three different greenhouse gases. There are two methods, depending on whether the emission comes from peat or not — and the two methods also route the emission into two different families of elementary flows: the non-peat part becomes the “land transformation” gas flows, and the peat part becomes the “peat oxidation” gas flows (you will enter both in Step 6).

	Non-peat land (forest, pasture, grassland)	Peat
Method	Carbon-balance split	Fixed fraction split
How the gases are found	Start from the CO ₂ that the lost carbon becomes, then add small shares of CH ₄ and N ₂ O typical for that world region.	Apply a fixed CO ₂ / CH ₄ / N ₂ O split that depends on the crop type and whether the region is tropical or temperate.
Key rule	CH ₄ is taken OUT of the CO ₂ (methane carbon would otherwise be counted twice); N ₂ O is ADDED on top (it contains no carbon).	The three shares add up to 100% of the peat emission — nothing added or removed.
Carbon check	Carbon leaving as CO ₂ + carbon leaving as CH ₄ = carbon that was lost.	Not applicable — split is taken as measured.

Table A — Non-peat gas shares, single split.

	CO ₂ %	CH ₄ %	N ₂ O %
Single split	99	0.5	0.5

Reference: Simplified based on Fitts et al. (2025), World Resources Institute (GCSC), Table 4. These shares tell you how the non-peat CO₂-equivalent divides between the three gases; CO₂ dominates, so CH₄ and N₂O are small.

Table B — Peat gas split by climate (read the row that matches your region):

Climate group	CO ₂ %	CH ₄ %	N ₂ O %
Tropical	95.5	0.4	4.1
Temperate	78.9	5.2	16.0

Climate group - see map [here](#) for the IPCC climate zone map, split is based on IPCC 2019, annual crops.

Warming factors: keep them consistent with what the dataset applies later — in GFLI these are EF 3.1 (methane 29.8, nitrous oxide 273). You use these again in Step 6.

Example — carbon-balance split (round numbers)

Non-peat LUC on a plot releases carbon equal to 1.000 kg CO₂ (before any split).

- CH₄: a small share, say 0.004 kg CO₂-eq — its carbon comes *out of* the CO₂.
- CO₂: 1.000 minus the carbon now in CH₄ → about 0.999 kg CO₂-eq.
- N₂O: added on top, say 0.010 kg CO₂-eq (no carbon involved).

Total after the split ≈ **1.013 kg CO₂-eq** — slightly higher than 1.000 because N₂O is genuinely extra.

Step 4 • Re-base the gases onto the GFLI dataset's own inventory

Orbae's LUC values are calculated using a particular crop yield and before any co-product allocation. A GFLI dataset uses its own declared yield and applies its own allocation between co-products. So the split greenhouse gas values must be re-stated on GFLI's terms before they go in.

The rule

$$\text{GFLI value} = \text{Orbae value} \times (\text{Orbae yield} \div \text{GFLI yield}) \times \text{allocation factor}$$

The yield ratio moves the value from Orbae's reference to GFLI's. The allocation factor is the share of the field's burden GFLI assigns to this co-product — and it is recorded in the SimaPro unit process dataset itself (see below). This is the only step where the economic, mass and energy versions differ — they use different allocation factors.

- **You read the allocation factor off the SimaPro dataset — you do not invent it.** Every GFLI unit process records its co-product allocation in its own Products / co-products section: each co-product line carries an allocation percentage. Open the dataset in SimaPro and read that

percentage for the co-product you are editing (for example, the grain line of a grain-and-straw process).

- **Economic, mass and energy are separate SimaPro libraries.** Each system model is its own set of GFLI unit process datasets, and each records its own allocation percentages. That is why this is the only step where the three models diverge — the factor you read depends on which library you are working in.
- **Only the GHG flows are re-based.** The land transformation flows in Step 5 are NOT adjusted here — land area is anchored to the crop's own occupation in the dataset and is already consistent with the allocation.

Example — re-basing one gas value

Orbae CO₂ value: 1.00 kg CO₂-eq per kg (on Orbae's yield).

- Orbae yield 2,000 kg/ha; GFLI yield 2,500 kg/ha → ratio = $2,000 \div 2,500 = 0.80$.
- GFLI allocates 90% of the field to the grain → allocation factor = 0.90.

GFLI value = $1.00 \times 0.80 \times 0.90 = 0.72$ kg CO₂-eq per kg. Repeat for CH₄ and N₂O.

Step 5 • Work out the land transformation flows

This step deserves special attention: it is how we express, physically, which land types the crop's area came from. A GFLI dataset already states how much land the crop occupies; your job is to re-describe the origin of that land using Orbae's land conversion figures.

The method, in three moves:

- **1. Take the transformation total as the anchor.** The dataset already contains a “Transformation, to crop” flow — the total area the crop occupies per kilogram produced. Leave this number unchanged; it is the total that the “from” flows must add up to.
- **2. Split that total by origin, using Orbae's converted-area shares.** For each land type, multiply the anchor by Orbae's share of area converted from it:
from grassland = (pasture share + natural-grassland share) × anchor
from forest = forest share × anchor
residual (crop-on-crop, no conversion) = anchor – from grassland – from forest
- **3. Keep the areas balanced.** The three “from” flows must sum exactly to the anchor. First clear any “Transformation, from...” flows the dataset already had. If Orbae's shares add up to more than the whole area, scale the grassland and forest parts down proportionally so they just fill the anchor (residual becomes zero).

Occupation vs. transformation: “transformation” is the one-off change of a hectare from one land type to another; “occupation” is holding that hectare in use. The flows above are transformations. Peat is the case where ongoing occupation also matters (see Step 1) — its gases are already handled in Step 3.

Flow names to use: “Transformation, from forest, extensive, {geography}” and “Transformation, from grassland/pasture/meadow, {geography}”; the residual is a transformation from the same crop land (no net change).

Example — splitting a 1.0 m² anchor by origin

The dataset says the crop occupies 1.00 m² per kg (the anchor).

Orbae shares: 20% of that area came from forest, 30% from pasture/grassland, the rest was already cropland.

- from forest = $0.20 \times 1.00 = 0.20 \text{ m}^2$
- from grassland = $0.30 \times 1.00 = 0.30 \text{ m}^2$
- residual (crop-on-crop) = $1.00 - 0.20 - 0.30 = 0.50 \text{ m}^2$

Check: $0.20 + 0.30 + 0.50 = 1.00 \text{ m}^2 = \text{the anchor}$. Balanced.

Step 6 • Enter the elementary flows into the dataset

This is the finish line. With the gases (Steps 3–4) and the land-transformation flows (Step 5) in hand, enter them into each target GFLI dataset. The table below is the exact list of elementary flows you touch — enter each one by its precise substance name.

The flows written into the inventory (per kilogram of commodity):

Elementary flow (exact name)	Compartment	Unit	From	Enter as	Action
Carbon dioxide, land transformation	Emission to air	kg	non-peat CO ₂	value ÷ 1	Set, or zero
Methane, land transformation	Emission to air	kg	non-peat CH ₄	value ÷ 29.8	Set, or zero
Dinitrogen monoxide (generic)	Emission to air	kg	non-peat N ₂ O	value ÷ 273	ADD (never overwrite)
Carbon dioxide, peat oxidation	Emission to air	kg	peat CO ₂	value ÷ 1	Set, or zero
Methane, peat oxidation	Emission to air	kg	peat CH ₄	value ÷ 29.8	Set, or zero
Dinitrogen monoxide, peat oxidation	Emission to air	kg	peat N ₂ O	value ÷ 273	Set, or zero
Transformation, from forest, extensive, {geo}	Land	m ²	forest area (Step 5)	area value	Set (after clearing old)
Transformation, from grassland/pasture/meadow, {geo}	Land	m ²	pasture + grassland area (Step 5)	area value	Set (after clearing old)
Transformation, from {crop}, {geo} (residual)	Land	m ²	crop-on-crop, no LUC (Step 5)	area value	Set (after clearing old)

The matching “Transformation, to {crop}, {geo}” occupation anchor is left unchanged. There is deliberately no “Dinitrogen monoxide, land transformation” flow (it does not exist in the flow list), which is why non-peat N₂O goes onto the generic Dinitrogen monoxide flow, and no “Transformation, from peat” flow (peat is captured only in the peat-oxidation emissions above).

- **Dedicated emission flows — set them, or set them to zero.** The five dedicated flows (CO₂ and CH₄ land transformation; CO₂, CH₄ and N₂O peat oxidation) are set from Orbae. Where Orbae records nothing for one of them, set it to zero — do not leave whatever the dataset carried before.
- **The non-peat N₂O flow — ADD, never overwrite.** There is no dedicated “land-transformation N₂O” flow, so the non-peat N₂O goes onto the general nitrous oxide flow. That flow also carries fertiliser N₂O, so add your value to it rather than replacing it.
- **Land transformation flows.** Enter the three “Transformation, from ...” flows from Step 5 (forest; grassland/pasture/meadow; residual crop), having first cleared any old “from” flows in the dataset. Leave the “Transformation, to ...” anchor unchanged.

Enter gases as gas mass, not CO₂-equivalents

A dataset stores the physical gas and applies the warming factor itself. So divide each CO₂-eq value by its warming factor before entering it: methane ÷ 29.8, nitrous oxide ÷ 273, carbon dioxide ÷ 1. This way the dataset’s own calculation reproduces the Orbae CO₂-eq exactly.

Example — what goes into one dataset

For “wheat grain, Country X” you would enter, per kg:

- Carbon dioxide, land transformation = 0.72 kg (0.72 CO₂-eq ÷ 1)
- Methane, land transformation = 0.004 ÷ 29.8 ≈ 0.00013 kg
- Dinitrogen monoxide (generic): ADD 0.010 ÷ 273 ≈ 0.000037 kg to the existing value
- Peat-oxidation flows (CO₂, CH₄, N₂O): 0 (no peat here)
- Transformation, from forest = 0.20 m²; from grassland/pasture/meadow = 0.30 m²; residual (from wheat) = 0.50 m²

Repeat for every dataset the result applies to (grain, straw, ...).

At this point the branded dataset carries GFLI-aligned land use change values. Everything after this — running the impact calculation and comparing results against the GFLI baseline — is a downstream activity and is not part of this conversion workflow.