LAVOISIER

Conversion Documentation

Specific for Ecospold 2 to ILCD
format conversion

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Lavoisier purpose

The conversion application Lavoisier was first created to bridge the Brazilian research community and the National Life Cycle Inventory Database (SICV Brasil). Still, it is rapidly evolving to be a suite of format conversions between Life Cycle Inventory (LCI) formats. The main issue at Lavoisier's start was that while SICV Brasil was built upon the ILCD format, the research done in the country was mainly ecoinvent-oriented, resulting in Ecospold 2 format inventories. In this context, to populate SICV Brasil and have a more comprehensive repository of LCI datasets for the country, the Lavoisier was proposed to solve the linking problem between database and research.

Lavoisier is an open-source python library and web application that handles the following conversions: Ecospold 2 to ILCD. Its primary goals are to be reliable (minimum loss of data and functionality), transparent (detailed documentation), accessible (for use by all practitioners and data hosts), and format-related (bound to the specificities of the formats it is converting) as a tool for LCI conversion.

Lavoisier is being developed by the Laboratory of Sustainable Life Cycle Assessment (GYRO) of the Federal Technological University - Paraná (UTFPR) in partnership with the Brazilian Institute of Information in Science and Technology (IBICT).

Summary

Lavoisier Ecospold 2 to ILCD conversion

1. Basic File Structures

Ecospold 2 and ILCD are two different formats to store the same type of data, the life cycle assessment inventory. Both are compliant with ISO 14048 requisites, but their approach to information storage yields different data structures and proposes a conversion challenge.

Both formats are based on the eXtensible Markup Language (XML), which can hierarchically store text data. Aside from that, their overall structure of files is remarkably different, as shown in Figure 1.
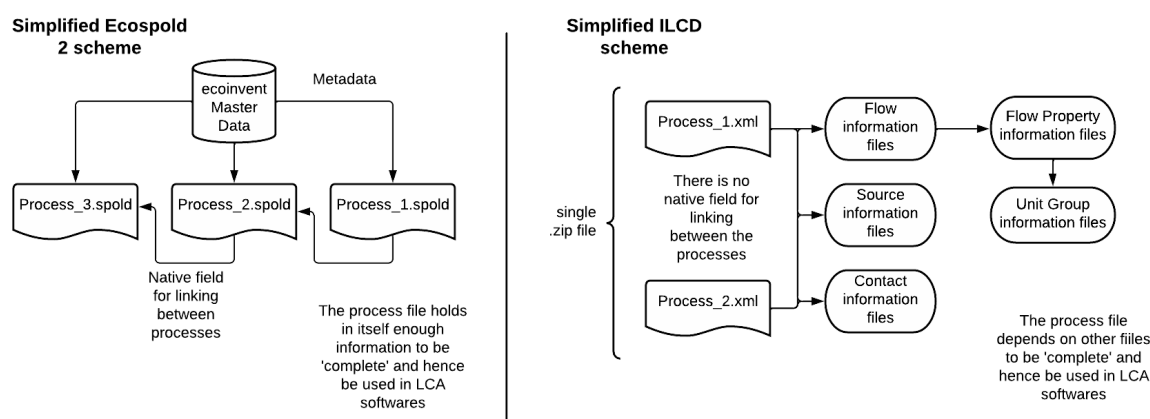
Figure 1: Ecospold 2 (left) and ILCD (right) file scheme

The Ecospold 2 file structure features a standalone process dataset containing all the LCA required information about the process. Although it is complete for LCA practice, it has additional metadata bound to the ecoinvent Master Data and can hold information about its linkage with other datasets employing unique identifications. As for the ILCD, its structure is composed of several files that represent a distinct part of the process dataset. The final process dataset is a compressed zip file containing all the information (and XML files) relative to the process and its connections. Although it is possible to have several process datasets inside the same ILCD zip file sharing other datasets, they are not linked in a way that could be considered a database.

Because they rely on ISO 14048 guidance for inventory data storage, both follow four main data structures inside their process XML files:

- Dataset description structure (dataSetInformation in ILCD and activityDescription in Ecospold 2): Holds general information about the dataset such as name and identification, and information about technological applicability, geography, and validity. It can have additional fields depending on the format.
- Modeling and validation structure: Holds information about the data modeling behind the inventory, its logic, sampling methods, approaches, and extrapolations. Aside from that, it has validation data, such as reviews done and a measure of the process representativeness.
- Administrative information: As the name suggests, it holds administrative information such as restrictions of access, copyright, and of the persons or entities that are related to the data research, upload to an LCI database, and ownership.
- Flow information (exchange in ILCD and flowData in Ecospold 2): Holds the quantitative characterization of the flows (amount and uncertainty) and general information such as unit, name, and identification. For Ecospold 2, the field supports production volume and property specification.

More information about the formats is in each format's description material. These are used as a basis for conversion explanations.

- Ecospold 2: https://ecoinvent.org/the-ecoinvent-database/data-formats/ecospold2/

- ILCD
  https://eplca.jrc.ec.europa.eu/LCDN/developerILCDDataFormat.xhtml

2. Conversion specifics

Although their primary structures are about the same, both represent the data inside in different ways. For this reason, Lavoisier's development required a more in-depth study of the formats. This in-depth study led to the specification of five different types of field conversion (specified in the field-by-field conversion section):

- Direct: The conversion is done by copying the Ecospold 2 field and pasting it into the correspondent ILCD field.
- Indirect: The conversion is done by copying the Ecospold 2 information, modifying it to an equivalent for ILCD, and pasting it into the correspondent ILCD field. Here we considered the fields in which information is not placed under an ILCD field but used as support information in other conversions.
- Incomplete: The Ecospold 2 field had no corresponding field in ILCD, so the information was allocated as text in the nearest (most related) comment field. A loss of functionality usually accompanies this conversion.
- Complex (structural): A structure of data in Ecospold 2 is converted to the corresponding structure in ILCD. This distinction is necessary as a set of fields can behave as one unique structure. An additional field-by-field separation using the other categories is made for further comparisons.
- Not converted: The Ecospold 2 field was not converted due to limitations of ILCD fields or because its data was inherent to the Ecospold 2 format.

For further performance analysis and comparison, all fields were classified as

- Essential data: Fields with data mandatory for LCA practice. Their lack of conversion induces a loss of data.
- Essential metadata: Fields with metadata mandatory for LCA practice. Their lack of conversion induces a loss of data. Essential dataset descriptors such as name, classification, and main comments are considered here.
- Other metadata: Fields with additional information about the dataset. Their lack of conversion reduces the completeness of the dataset but to a lower degree than essential information.
- Not used: Additional Ecospold 2 specific structures not yet actively used in the datasets.

3.   Lavoisier conversion flow

As Lavoisier aims for converting several LCI datasets, the conversion flow starts with general functions to identify and separate different conversions, redirecting them to their correct flow while doing basic path checking. The two general functions are 'convert_file', for converting a standalone file, and 'convert_dir', for converting an entire folder. Their parameters are:

- conv_type: [string] specifies the type of conversion being done. Currently, the conversion options are: "ECS2 to ILCD".
- path_to_file (only convert_file): [string] path to the Ecospold 2 file to be converted.
- path_to_dir (only convert_dir): [string] path to the Ecospold 2 folder to be converted.
- path_to_save_dir: [string] path to the folder where ILCD zip files will be saved.
- **kwargs for "ECS2 to ILCD" conversion:
  - use_ecoinvent_uuid: [bool] if True (Default), uses the Ecospold 2 'intermediateExchangeId' for intermediate

flow conversion. If False, it uses the Ecospold 2 'id' for intermediate flow conversion. The distinction is important since intermediate flows are linkable only by their 'intermediateExchangeId' in Ecospold 2, and the use of the 'id' field can lead to duplication of flows.

- check_missing_elem_flows: [bool] if True (Default), for any elementary flow outside the main flow mapping file, it checks for similar flow conversions that are inside the mapping file, giving the user a choice of ignoring the flow conversion or using the options inside the mapping file for the conversion. If False, it logs information about the elementary flow and ignores its conversion to avoid creating new flows outside the nomenclature of ILCD.

- hash: [string] additional hash for conversion identification. Designed for use in folder or database conversions.

- to_database (only convert_to_dir): [bool] if True, converts the folder into one ILCD zip file (a database). If False (Default), it converts each Ecospold 2 file into one ILCD zip file (standalone processes).

For the Ecospold 2 to ILCD conversion, the general functions read the file to be converted and use the library xmltodict to transform the Ecospold 2 XML structure into a python dictionary, which is more convenient to use. With their unique specification, the general functions call the specific conversion function designed for the type of conversion chosen. For Ecospold 2 to ILCD, this conversion function is the create_ILCD_from_ECS2.

The create_ILCD_from_ECS2 function is responsible for the initialization of the main conversion class object (namely ILCD), the creation of the basic folder structure (which will be compressed to a zip file afterward), and the call for initialization functions depending on the specification of a file or a folder to be converted. After the initialization, the function uses a mapping of instructions for chosen Ecospold 2

fields[1] that executes its commands using specific classes and functions bound to the main ILCD class object (a more detailed explanation of the instructions and support classes are given in the field-by-field conversion section).

The mapping of instructions is a python dictionary with keys as Ecospold 2 fields and values as lambda functions using the value from the Ecospold 2 field and methods from the main conversion class and its support classes.

When all fields are converted through the mapping, the create_ILCD_from_ECS2 function starts its end routines to create an ILCD zip file or reset the main conversion class for a new conversion (only if parameter database = True).

4.   Field-by-Field conversion

Before diving into the field conversion specifics, a few words are given about this section structure. As a field-by-field approach would not consider the complex conversions in a didactic way, the following section was separated into its description and the description of other types of conversion. In that way, both conversions are well separated and explained without duplication.

This section follows the Ecospold 2 fields throughout the conversions and is organized following their hierarchy whenever possible.

Glossary:
- @: stands for an XML attribute
- {r}: field is required in Ecospold 2
- {o}: field is optional in Ecospold 2
- UUID stands for Unique Identifier and is a fixed-format string-based identifier

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[1] The fields can represent the root of a structure in the case of a structural conversion

4.1. Complex (structural) conversions

4.1.1. Allocation

There are two main sources of allocation information in Ecospold 2: (i) the field masterAllocationPropertyId and (ii) the field specificAllocationPropertyId. To understand their importance and how their conversion is done, one should understand what a property is inside Ecospold 2. The property expands the characterization of a given flow by specifying additional quantitative features, such as density for a wood flow in kilograms or net energy for a diesel flow in kilograms. Each property carries a UUID bound to their names and can be used in different flows at the same process dataset. Allocation is done by searching for the masterAllocationPropertyId in the dataset allocatable flows or indications of the specificAllocationPropertyId.

For ILCD, the allocation information is stored into the flow as the fraction (percentage) of the flow considered for each allocation (there can be more than one) and for each reference product and by-product present in them. This structure allows for different allocations inside the same dataset and a direct allocation value for each flow.

A set of steps was carried out for the conversion:

- The masterAllocationPropertyId was identified and stored. (mapping of instructions)
- For each reference and by-product flow, the masterAllocationPropertyId was identified and the value stored. If a specificAllocationPropertyId was present, this property value was stored instead. (IntermediateFlow.__get_allocation)
- At the conversion's end, the allocation fraction of each reference and by-product flow was calculated and stored as a dictionary with the ILCD internal ID of the flow and its value. (Allocation class and ILCD.get_ilcd_dict)
- For each allocatable flow inside the ILCD, the dictionary was added with the allocation information. (ILCD.get_ilcd_dict)

The Ecospold 2 fields included in that conversion are:

- ../activity/@masterAllocationPropertyId {o}
    - Type if conversion: Complex (indirect). The field is used as support information.
    - Importance: Essential data. Allocation data is essential for LCI.
    - ILCD correspondent fields: for each allocatable flow
        - exchanges/exchange/allocations/allocation@internalReferenceToCoProduct
        - exchanges/exchange/allocations/allocation@allocatedFraction

- ../exchange/@specificAllocationPropertyId {o}
    - Type if conversion: Complex (indirect). The field is used as support information.
    - Importance: Essential data. Allocation data is essential for LCI.
    - ILCD correspondent fields: for each allocatable flow
    - exchanges/exchange/allocations/allocation@internalReferenceToCoProduct
    - exchanges/exchange/allocations/allocation@allocatedFraction

4.1.2. Classification

Ecospold 2 has default classification schemes usually implied to label processes and flows. These categories are

- International Standard Industrial Classification (ISIC): Used mainly to classify processes
- Ecospold 01 Categories: Used to carry on Ecospold 1 classification information for processes
- Central Product Classification (CPC): Used to classify flows

- By-Product Classification: Used to classify flows into allocatable products, waste or recyclable

All those classifications were translated accordingly to ILCD classification XML files in a way they do not lose functionality. Aside from that, every Ecospold 2 classification was subdivided so that the complete path to a specific key was identifiable and its levels used inside the ILCD classification (additional file ECS2Classes.csv).

In addition to all the adaptation done for the Ecospold 2 classification schemes, the ILCD classification scheme was maintained for other ILCD datasets (sources, contacts, flow properties, and unit groups).

The classification was done following the steps:

- The Ecospold 2 classification structure was identified in the process or flow. (mapping of instructions [process] or Flow.__fclassification [flow])
- The fields classificationSystem, classificationValue, and classificationId are used to identify the final class in the classification mapping file (ECS2Classes.csv). The class path is stored. (Classification class)
- The class path for the flow or process is converted to a python dictionary with the ILCD classification structure.

The By-Product classification is used afterward to assess the type of flow, which is not covered here. Similarly, elementary flows compartment classification is covered within the elementary flow-specific conversion.

The Ecospold 2 fields included in that conversion are:

- ../classification/classificationSystem {r}
  - Type if conversion: Complex (direct).
  - Importance: Essential metadata. The classification is used to organize and make data hierarchical.
  - ILCD correspondent fields: for process classification

■ processInformation/dataSetInformation/classificationIn formation/classification/@name
- ○ ILCD correspondent fields: for intermediate flow classification
  - ■ [flowDataSet] flowInformation/dataSetInformation/classificationInfor mation/classification/@name

- ../classification/classificationValue {r}
  - ○ Type if conversion: Complex (indirect). Information is used to match the complete class path.
  - ○ Importance: Essential metadata. The classification is used to organize and make data hierarchical.
  - ○ ILCD correspondent fields: for process classification
    - ■ processInformation/dataSetInformation/classificationIn formation/classification/@classes
  - ○ ILCD correspondent fields: for intermediate flow classification
    - ■ [flowDataSet] flowInformation/dataSetInformation/classificationInfor mation/classification/@classes

- ../classification/@classificationId {r}
  - ○ Type if conversion: Complex (indirect). Information is used to match the complete class path.
  - ○ Importance: Other metadata. The classification is used to organize and make data hierarchical.
  - ○ ILCD correspondent fields: Not placed in any ILCD field.

4.1.3. General comment sections

Although general comments in Ecospold 2 are textual fields to explain or characterize a certain aspect of the datasets; it has fields composed of a structure of other subfields. These fields have to be organized to convert them to ILCD since its general comment is just a

plain text structure without supporting the specific Ecospold 2 subfields. The Ecospold 2 general comment subfields are

- text: holds the actual text of the field
- imageURL: holds image information using an URL
- variable: holds a text that can be changed in child process datasets. This text is used inside the text subfield and is substituted when the dataset is used in the software.

In order to accommodate plain text fields in ILCD, the variables under the Ecospold 2 general comment were used to change their instances inside the text to its respective values. In this way, no textual information is lost for that dataset.

For imageURL, one source dataset was created for each instance with the URL information and this dataset was referenced in the referenceToExternalDocumentation field. This field points to source datasets that hold additional information about the dataset.

These conversions are all handled by the Text class.

The Ecospold 2 fields included in that conversion are:

- ../activity/generalComment {o}
  - Type of conversion: Complex (indirect). Different conversions for each subfield.
  - Importance: Essential metadata. General description of the process.
  - ILCD correspondent fields: text part
    - processInformation/dataSetInformation/generalComment
  - ILCD correspondent fields: imageURL
    - processInformation/dataSetInformation/referenceToExternalDocumentation

- ../activity/allocationComment {r}
  - Type of conversion: Complex (indirect). Different conversions for each subfield.

- ○ Importance: Essential metadata. General description of the allocation.
- ○ ILCD correspondent fields: text part
  - modellingAndValidation/LCIMethodAndAllocation/deviationsFromLCIMethodApproaches
- ○ ILCD correspondent fields: imageURL
  - processInformation/dataSetInformation/referenceToExternalDocumentation

- ● ../geography/comment {o}
  - ○ Type of conversion: Complex (indirect). Different conversions for each subfield.
  - ○ Importance: Essential metadata. General description of the process geography (location, regionalization).
  - ○ ILCD correspondent fields: text part
    - processInformation/geography/locationOfOperationSupplyOrProduction/descriptionOfRestrictions
  - ○ ILCD correspondent fields: imageURL
    - processInformation/dataSetInformation/referenceToExternalDocumentation

- ● ../technology/comment {o}
  - ○ Type of conversion: Complex (indirect). Different conversions for each subfield.
  - ○ Importance: Essential metadata. General description of the process geography (location, regionalization).
  - ○ ILCD correspondent fields: text part
    - processInformation/technology/technologyDescriptionAndIncludedProcesses
  - ○ ILCD correspondent fields: imageURL
    - processInformation/dataSetInformation/referenceToExternalDocumentation
  - ○ Obs: Although the technology comment could be placed under the technologyPurposeOfProductOrProcess ILCD field, it was not used since software tend to use the

technologyDescriptionAndIncludedProcesses to gather information.

- ../timePeriod/comment {o}
    - Type of conversion: Complex (indirect). Different conversions for each subfield.
    - Importance: Essential metadata. General description of the process geography (location, regionalization).
    - ILCD correspondent fields: text part
        - processInformation/time/timeRepresentativenessDescription
    - ILCD correspondent fields: imageURL
        - processInformation/dataSetInformation/referenceToExternalDocumentation

4.1.4. Sources and Contacts

Sources and contacts are one of the core metadata information inside an LCI dataset. While the sources behave like references in a bibliographical sense, with information about publications or documents related to the data, the contacts characterize important actors for the development, ownership, and other aspects of the data.

Although they carry different information, their structure follows similar paths within each format but differs significantly. For Ecospold 2, sources and contacts are given by a collection of fields that can hold enough information about them without relying on additional ecoinvent metadata. For the sources, the fields are as follows

- Source Id: UUID of the source, which can be crossed with ecoinvent Master Data for additional information (Lavoisier only uses the file data).
- Source Year: Year of the source publication.
- Source First Author: Main author of the publication.
- Source Page Numbers: (only one case) Page numbers of the publication.

For the contacts, the fields are as follows

- Person/Company Id: UUID linked to that person/company in the ecoinvent Master Data (Lavoisier only uses the file data).
- Person/Company Name: Name of the person/company
- Person/Company Email: Email of the person/company
- Person is an active author: (only one case) boolean with information if the author is still an active researcher

On the other side, ILCD treats sources and contacts as separated datasets that connect to others based on specific reference structures. These structures hold the UUID information and some basic metadata descriptors about the source or contact in a way software can easily identify it (as the XML name is the UUID) within the source or contact folder.

The conversion between both formats occurs in a direct form even with such differences. The fact is that the information rarely changes regarding both the structures, so the fields are roughly the same but in different places. For Lavoisier, the following steps are usually used:

- The information of a source or contact in Ecospold 2 is collected and stored in a dictionary.
- The Reference class is called with the dictionary of information for the new source or contact dataset and the required information for creating its reference structure.
- The Reference object method 'make_dataset' is called to create the new dataset using the dictionary information.
- The method 'make_reference' returns the reference structure as a dictionary so the created dataset can be linked to other datasets.

Some specific steps can be taken for specific cases, such as the source page numbers and if the contact is an active author.

Another two Ecospold 2 fields are mapped to ILCD sources inside Lavoisier: the imageURL (see general comment section) and the dataSetIcon (see indirect conversions). In a few words, both are URLs for images on the internet and are converted as source datasets using the URL as a generator seed for the source dataset UUID and using their metadata.

Lavoisier uses default files for ILCD sources and contacts that appear in every conversion. These files are listed below

- Ecoinvent: Overview and Methodology [source]:
    - ILCD Fields:
        - referenceToLCAMethodDetails
    - FRISCHKNECHT, Rolf et al. Overview and methodology. Data v2. 0 (2007). Ecoinvent report No. 1. Ecoinvent Centre, 2007.
- Ecospold Format [source]:
    - ILCD Fields:
        - referenceToDataSetFormat (process dataset)
    - HEDEMANN, Jan; MEINSHAUSEN, I. Ecoinvent; FRISCHKNECHT, Rolf. Documentation EcoSpold. Swiss Centre for Life Cycle Inventories, 2003.
- ILCD Format [source]:
    - ILCD Fields:
        - referenceToDataSetFormat (all datasets)
    - European Commission - Joint Research Centre - Institute for Environment and Sustainability: The international reference life cycle data system (ILCD) handbook. European Commission, Luxembourg, 2012.
- ILCD Data Network - compliance (non-Process) [source]:
    - ILCD Fields:
        - referenceToComplianceSystem (flow property and unit group datasets)
    - European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Data Network - Compliance rules and entry-level requirements. Version 1.1, 2012. EUR 24380 EN. Luxembourg. Publications Office of the European Union; 2012.

- Ecoinvent Centre: Swiss Centre for Life Cycle Inventories [contact]:
  - ILCD Fields:
    - referenceToContact (on Ecospold Format source dataset)
- EPLCA project team: "European Platform on Life Cycle Assessment" project team at: European Commission, Joint Research Centre (DG JRC), Institute for Environment and Sustainability (IES) [contact]:
  - ILCD Fields:
    - referenceToContact (on ILCD Format source dataset)

The source UUID for the ILCD field 'referenceToConvertedOriginalDataSetFrom' is generated using the name 'ecoinvent Database' and can be considered as an automatically generated default source file.

The Ecospold 2 fields included in that conversion are (for sources):

- ../@sourceId {o}
  - Type of conversion: Complex (direct).
  - Importance: Other metadata. Source information
  - ILCD correspondent fields: for ../exchange/property
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/@refObjectId
  - ILCD correspondent fields: for ../exchange/
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/@refObjectId
  - ILCD correspondent fields: for @productionVolumeSourceId
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/@refObjectId
  - ILCD correspondent fields: for @publishedSourceId
    - administrativeInformation/publicationAndOwnership/referenceToUnchangedRepublication/@refObjectId

- ../@sourceYear {o}
  - Type of conversion: Complex (direct).
  - Importance: Other metadata. Source information
  - ILCD correspondent fields: for ../exchange/property
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for ../exchange/
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for @productionVolumeSourceYear
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for @publishedSourceYear
    - administrativeInformation/publicationAndOwnership/referenceToUnchangedRepublication/shortDescription
  - Obs: The short description is given as [sourceFirstAuthor (sourceYear), pages: pageNumbers]

- ../@sourceFirstAuthor {o}
  - Type of conversion: Complex (direct).
  - Importance: Other metadata. Source information
  - ILCD correspondent fields: for ../exchange/property
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for ../exchange/
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for @productionVolumeSourceFirstAuthor
    - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
  - ILCD correspondent fields: for @publishedSourceFirstAuthor

- administrativeInformation/publicationAndOwnership/referenceToUnchangedRepublication/shortDescription
    - Obs: The short description is given as [sourceFirstAuthor (sourceYear), pages: pageNumbers]

- ../@pageNumbers {o}
    - Type of conversion: Complex (direct).
    - Importance: Other metadata. Source information
    - ILCD correspondent fields: for ../exchange/
        - exchanges/exchange/referencesToDataSource/referenceToDataSource/shortDescription
    - ILCD correspondent fields: for @publishedPageNumbers
        - administrativeInformation/publicationAndOwnership/referenceToUnchangedRepublication/shortDescription
    - Obs: The short description is given as [sourceFirstAuthor (sourceYear), pages: pageNumbers]

The Ecospold 2 fields included in that conversion are (for contacts):

- ../@personId {r}
    - Type of conversion: Complex (direct).
    - Importance: Other metadata. Contact information
    - ILCD correspondent fields: for all
        - [contactDataSet] contactInformation/dataSetInformation/UUID
    - ILCD correspondent fields: for @reviewerId
        - modellingAndValidation/validation/referenceToNameOfReviewerAndInstitution/@refObjectId
    - ILCD correspondent fields: for ../dataEntryBy/
        - administrativeInformation/dataGenerator/referenceToPersonOrEntityEnteringTheData/@refObjectId
    - ILCD correspondent fields: for ../dataGeneratorAndPublication/person
        - administrativeInformation/dataGenerator/referenceToPersonOrEntityGeneratingTheDataSet/@refObjectId

- ○ ILCD correspondent fields: for ../dataGeneratorAndPublication/company
    - ■ administrativeInformation/publicationAndOwnership/referenceToEntitiesWithExclusiveAccess/@refObjectId

- **../@personName {r}**
    - ○ Type of conversion: Complex (direct).
    - ○ Importance: Other metadata. Contact information
    - ○ ILCD correspondent fields: for all
        - ■ [contactDataSet] contactInformation/dataSetInformation/name
    - ○ ILCD correspondent fields: for @reviewerId
        - ■ modellingAndValidation/validation/referenceToNameOfReviewerAndInstitution//shortDescription
    - ○ ILCD correspondent fields: for ../dataEntryBy/
        - ■ administrativeInformation/dataGenerator/referenceToPersonOrEntityEnteringTheData//shortDescription
    - ○ ILCD correspondent fields: for ../dataGeneratorAndPublication/person
        - ■ administrativeInformation/dataGenerator/referenceToPersonOrEntityGeneratingTheDataSet//shortDescription
    - ○ ILCD correspondent fields: for ../dataGeneratorAndPublication/companyCode
        - ■ administrativeInformation/publicationAndOwnership/referenceToEntitiesWithExclusiveAccess/shortDescription
    - ○ Obs: Instead of name, the companies are named using their code (a seven-letter plaintext). Additionally, the company code is appended to the accesssRestrictions ILCD field indicating the exclusive access for the company.

- **../@personEmail {r}**
    - ○ Type of conversion: Complex (direct).
    - ○ Importance: Other metadata. Contact information
    - ○ ILCD correspondent fields:

- - ■ [contactDataSet]
      contactInformation/dataSetInformation/email

- ../@isActiveAuthor {o}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Other metadata. Contact information
  - ○ ILCD correspondent fields:
    - ■ [contactDataSet]
      contactInformation/dataSetInformation/contactDescriptionComment
  - ○ Obs: There is no specific field for this information in the ILCD contact data set, but the comment serves as a good place to maintain that information with no loss of functionality.

4.1.5. Variables and formulas

In LCI, it is common that the inventories have calculations and parametrization done to get to the final result. This mathematical information is conserved under both formats and is bound to the values of certain flows to preserve the underlying relations that lead to a certain value.

Keep in mind that quantity structures (entities) are referenced in this section as any structure that has a name, amount, uncertainty, comment, and can have a variable associated. These structures are the flow, the property, the parameter, and the productionVolume.

As in other cases, although the same functionality is archived, the structure is different among the formats. Ecospold 2 uses two sets of fields that can result in a mathematical variable. The first set of fields can be used by the following quantity entity inside Ecospold 2: flow, properties, and product volumes, and is characterized by the fields

- Mathematical Relation: The formula used to calculate the amount of the quantity entity. It can reference other variables established in the process dataset.

- Boolean isCalculatedAmount: Certifies if the amount is calculated by a formula.
- Variable Name: Name of the variable that carries the amount of the quantity entity. It can be used in other quantity entities' formulas to calculate their amount.

To facilitate the understanding of this first set of fields, one can think of them as extensions of the quantity structure for calculations done inside the dataset. These fields hold information about how the amount is calculated using other variables (the formula) and how a given quantity entity's amount (and uncertainty) is referenced by other formulas that calculate the value of other quantity entities throughout the dataset.

This first set of fields enables the use of values of a flow, property of production volume in calculating other flows, properties, or production volumes' values. Although a great start, this feature has to be complemented by the second set of fields, the parameter structure, to enable the specification of parameters or values that are not an amount of flow, property, or production volume but are still used in the calculations inside the dataset. This parameter structure reassembles other quantity structures as it defines name, unit, comment, uncertainty, identification, amount, and the first set of fields for variables (it can have a formula and a variable name to be referenced by other calculations).

Three types of variable structures can be drawn from Ecospold 2: (i) having a variable name bound to the amount and a formula that calculates it; (ii) having only a variable name bound to the amount and (iii) having only a formula that calculates the amount. This distinction will be used for further explanation of the conversion.

The ILCD structure has a distinct space for all the mathematical relations and variable distinction, the mathematicalRelations field under the process dataset. Any entrance to this field can be referenced directly by the flow, and this reference is used to calculate the flow amount (resultingValue; see details on the uncertainty section).

The conversion has some details to consider. Most of them are related to the unit conversion of flow amounts and uncertainty to match

ILCD default units and the relativization of Ecospold 2 properties to match the ILCD flow property's constraint of only using scalar units with a linear relationship with the flow they're characterizing. In that way, variables here are separated between the different types of structure that can happen in Ecospold 2. Keep in mind that this section only refers to the first set of fields.

4.1.5.1. Flows

Flows start the variable conversion by identifying the variable structure type. Before entering the conversion, flows without a variable structure type of (ii) pass the first check to see if they have any unit conversion done for their amount. Upon having, an additional variable for the unit conversion (in the form X_to_Y) is created with the conversion factor. This additional variable will be used in the formula used to calculate this flow amount as it will have to pass through the unit conversion too.

With the type of variable structure and the first check, the flow gets the conversion based on their type of variable structure and if it has a unit conversion done:

Type	Conversion
(i) with unit conversion	Two ILCD parameters are created: the first is used by the ILCD flow as a reference to its amount and has both formulae, variable name and value adapted to account for the unit conversion (uncertainty, if any, is converted considering the unit conversion; see uncertainty section); the second is used by other formulas and does not have any unit conversion applied since other formulas use the variable as it is conceived on Ecospold 2 (formula, variable name, and value are unchanged and uncertainty is converted as usual as a quantity entity; see uncertainty section).
(i) without unit	One ILCD parameter is created. The variable name and formula are converted directly. Uncertainty is

conversion	converted as usual as a quantity entity (see uncertainty section).
(ii) with unit conversion	Two ILCD parameters are created: the first is used by the ILCD flow as a reference to its amount and has the variable name and value adapted to account for the unit conversion (uncertainty, if any, is converted considering the unit conversion; see uncertainty section); the second is used by other formulas and does not have any unit conversion applied since other formulas use the variable as it is conceived on Ecospold 2 (variable name and value are unchanged and uncertainty is converted as usual as a quantity entity; see uncertainty section).
(ii) without unit conversion	One ILCD parameter is created. The variable name is converted directly. Uncertainty is converted as usual as a quantity entity (see uncertainty section).
(iii) with unit conversion	One ILCD parameter is created. The formula and value are adapted to account for the unit conversion, and uncertainty, if any, is converted considering the unit conversion (see uncertainty section). This is possible since the type (iii) does not have a variable referenced by other formulas, so there is no need for an additional ILCD parameter. The name is generated as the construct [Eq_type_id].
(iii) without unit conversion	One ILCD parameter is created. The formula is converted directly. Uncertainty is converted as usual as a quantity entity (see uncertainty section). The name is generated as the construct [Eq_type_id].

This way, when no unit conversion is done on the flow, the variable structures are converted to one ILCD parameter field with their names and formulas. When the unit conversion is present for the flow, cases (i) and (ii) receive, aside from the unit conversion corrected variable for the flow amount, an additional ILCD parameter that has the sole purpose of being the unchanged value used by other formulas in the dataset.

4.1.5.2. Parameters (second set of fields), production volumes, and properties

Different from the flow structure, parameters, production volumes, and properties do not have issues concerning unit conversions on their variables. Properties have conversions done to scalar units, but they do not affect the variables bound to their amounts as only that original Ecospold 2 amount is used by other formulas (via the variable name) on their calculations. With that, the conversion of such structures is done more straightforwardly.

Type	Conversion
(i)	One ILCD parameter is created with the name as the variable name, the formula as the Ecospold 2 formula, and the value as the Ecospold 2 amount
(ii)	One ILCD parameter is created with the name as the variable name and the value as the Ecospold 2 amount
(iii)	One ILCD parameter is created with name as a generated name [Eq_type_id], the formula as the Ecospold 2 formula and the value as the Ecospold 2 amount

It is highlighted that parameters, aside from being a second set of fields that could hold variable information, can be converted as variables the same way as other quantity structures because of the similarity of fields.

4.1.5.3. Final remarks on variable conversion

Some points require a further explanation. First, the ILCD parameter structure consists of the following fields:

- Name: The variable's name. Used in other formulas or used as a value reference for a flow
- Formula: The mathematical equation for the parameter. Can use other variables listed in the dataset.
- Uncertainty fields: Mean, minimum, maximum amount, and relative standard deviation (see uncertainty section). The mean value is the most important as it holds the value bound to the variable, which will be used whenever this variable is referenced.

With this information, it is clearer that the variable name, formula, and uncertainty information are converted from Ecospold 2 to ILCD straightforwardly. The complexity lies in the different structures that can hold the variable information in Ecospold 2.

The second point is that the conversion adds to the number of parameters when adding a unit conversion variable that will only be referenced by other variables and formulas that passed through this conversion. This additional variable has the simple name of 'X_to_Y' and has as its mean value the conversion factor. It is used only in other formulas for flows that had unit conversions as an encapsulating factor (such as in (1+2)*X_to_Y).

The third point is that case (iii) of having only a formula receives a generated name that is referenced by the flow structure. This name starts with 'Eq_' plus a two-digit type of the structure (fl for flow, pr for property and production volume, and pa for parameter) plus the identification value of the structure.

The fourth point is that formulas on Ecospold 2 have two specific equation structures used to facilitate formula insertion by practitioners. The first equation structure is the Unit Conversion, an alias for a unit conversion inside the formula. This equation structure is usually represented as UnitConversion(value, original unit, unit to convert to) inside an equation and is converted accordingly using the python 'pint' library[2]. The second equation structure is the reference, usually written as Ref('another-structure-identification'), which references the amount

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[2] Ecospold 2 specific units were added to the units.txt file so that 'pint' can actively use them in conversions

of other Ecospold 2 quantitative structures inside a formula. This chunk was converted by finding the structure being referenced by the identification and using its value inside the formula. Other minor corrections were done to ensure the usability of the Ecospold 2 formulas, such as using points instead of commas for decimals and substituting the percentage symbol for a division by 100.

The fifth point is that the basic Ecospold 2 comment (without the appending of additional information by the conversion) of the quantitative structures is added to the variables by direct conversion. For the parameter structure, which is a variable, this is the only conversion of its comment section.

The sixth point is that parameter structures sometimes present no unit, indicating that the value is dimensionless. In this case, a specific check is done to consider the parameter with a dimensionless unit instead of being ignored.

The Ecospold 2 fields included in the conversion of the first set of fields are

- ../@isCalculatedAmount {o}
    - Type of conversion: Complex (indirect)
    - Importance: Other metadata
    - Obs: Field is used to assess the presence or not of a formula bound to the mean value of a quantitative structure.

- ../@mathematicalRelation {o}
    - Type of conversion: Complex (direct)
    - Importance: Essential
    - ILCD correspondent fields:
        - processInformation/mathematicalRelations/variablePar ameter/formula

- ../@variableName {o}
    - Type of conversion: Complex (direct)
    - Importance: Essential
    - ILCD correspondent fields:

- processInformation/mathematicalRelations/variableParameter/name

The Ecospold 2 fields included additionally in the conversion of the second set of fields are (parameter structure)

- ../parameter/name {r}
  - Type of conversion: Complex (not converted). Duplicate of the variableName parameter
  - Importance: Other metadata
  - Obs: Field identifies the parameter, but the variableName identifies the parameter for other formulas (which is the purpose of the structure)

- ../parameter/comment {o}
  - Type of conversion: Complex (direct)
  - Importance: Other metadata
  - ILCD correspondent fields:
    - processInformation/mathematicalRelations/variableParameter/comment

- ../parameter/@amount {r}
  - Type of conversion: Complex (direct)
  - Importance: Essential
  - ILCD correspondent fields:
    - processInformation/mathematicalRelations/variableParameter/meanValue

4.1.6. Units and Properties

The definition of properties and units is essential for any quantitative value in LCI datasets. As such, both formats have different ways of structuring this information inside their datasets.

Ecospold 2 has what can be called the quantity structure (entity), which holds a set of quantitative information fields (identification,

name, amount, uncertainty in its basic form). One of these is the property structure, which is always a subfield of the flow structure and carries information about additional quantities related to that flow, such as density or water content. This subfield can appear indefinitely for any flow inside the Ecospold 2 process dataset.

For units, Ecospold 2 quantity structures almost always carry two specific fields called unitName and unitId (production volume information uses the flow unit fields). While unitId is useful to work with additional ecoinvent metadata, the main information used to assess units throughout the conversion is the unitName field. Lavoisier works with the pint library, which can bound a unit to a value and work with conversions of units easily when necessary. This process of attributing a unit to a value is done with every quantity structure of Ecospold 2. It results in a mutable amount that goes through unit conversions when necessary and an original amount that consists of the original Ecospold 2 value for the quantity structure.

Although present in almost every quantity structure, the unitName field is not required, so additional functions were specified to handle exceptions for that case: for properties, the property is ignored if it has no unit, and for parameters, the parameter is considered dimensionless as the parameter unit can be ignored in favor of maintaining the parameter as a variable in ILCD. For Ecospold 2 flows, the field is mandatory.

One of the main issues regarding converting quantity structures is that flows in Ecospold 2 can be bound to several different units of the same dimension (like m² and ha for the area). In contrast, ILCD can use only a standard unit for each dimensionality (flows can only be assessed in m², not in ha). In that context, a whole unit conversion structure was implemented on Lavoisier to handle it not only for the flow's amount but also for their uncertainties dependent variables and properties.

Another issue regarding properties is that ILCD only accepts scalar flow properties that are linearly related to the flow they are referenced. At the same time, Ecospold 2 goes for a broader definition of properties, letting them not be linear and be relative. Due to it, all the Ecospold 2 properties pass through a series of checkings to assess and enforce the linearity and scalar-like characteristics whenever

possible. Aside from that, this checking considers the unit conversions done in the flow that these properties are bound to, as it can affect the property units as well.

- See if the property is dry mass, wet mass, water in wet mass, price, or carbon allocation. If yes, do a correction for a flow unit conversion if necessary.
- See if the property is water content, carbon content, fossil or carbon content, non-fossil. If yes, correct the contents for the value of the dry matter (as they all are related to it).
- Loop through all the properties for the flow (including the already corrected ones) for additional checkings
  - If the property has 'content' in the name, it is considered relative and three options follow
    - If the property unit is kilogram or megajoule (relative to the flow), correct for the flow unit conversions
    - If the property is dimensionless, correct for the dry mass values
    - Else the property is not converted
  - If the property is relative and its denominator matches the flow unit, then convert it to a scalar form
  - If the property has 'heating value' in the name and its unit is megajoule, correct it for the flow unit conversion
  - Else the property is not converted

Although some properties can't be converted, Lavoisier manages to convert most of the common properties used in Ecospold 2 like the dry and wet mass and water and carbon content, which are useful for water and carbon balancing and allocation.

All these constraints required to fulfill the ILCD requirements are done to adjust the values for the process and flow datasets that compose part of the ILCD file structure. In other words, this information is only a part of the unit group and flow property conversion that has an additional constraint for the datasets.

The ILCD format has standard flow property and unit group datasets, so every flow only has to have a property on the ILCD default flow property list. Each of these properties only has to have a unit group on the ILCD default unit group list. As in Figure 1, it is highlighted that a flow does not directly reference the unit groups but only by a flow property dataset.

To assess this additional matter, a mapping of Ecospold 2 properties to the existing ILCD flow properties was done. This mapping was used in Lavoisier as the only way to convert an Ecospold 2 property to a flow property and its specific unit group, using the default identifications. Unfortunately, this hinders the conversion of important properties such as dry and wet mass that are not on ILCD default ones. This matter is being discussed for these properties to be included on the ILCD default datasets.

Although a great part of the conversion, the Ecospold 2 properties are not the only thing considered as a flow property in ILCD. As flows have to be bound to a unit, the ILCD considers the unit assignment to be a flow property; thus, the flow datasets are bound to a flow property that is bound to a unit group. With that, all the Ecospold 2 quantity structures' units have to be mapped to an ILCD flow property to function as a unit in the ILCD structure (called, from now on, unit property). The UnitProperty class carries out this process, and it uses the unit dimensionality to search for the right flow property in a mapping. Similarly, the ILCD flow property and unit group ids are gathered for conversion.

The final list of flow properties for each dataset is copied and pasted at the ILCD flowproperties folder at the end of the code and the final list of unit groups (at the ILCD unitgroups folder).

The collection of properties and unit properties for a given flow is stored in the flow dataset as a list of references to flow property datasets, with the main reference being the unit property. Aside from the main value, uncertainty and comment information about the properties were stored in the reference.

The Ecospold 2 fields included in that conversion are

- ../exchange/@amount {r}

- ○ Type of conversion: Complex (direct).
- ○ Importance: Essential data.
- ○ ILCD correspondent fields:
  - ■ exchanges/exchange/resultingAmount
- ○ Obs: Conversion done directly to the resultingValue field as it indicates the final quantitative result for the flow in ILCD.

- ● ../unitName {r}
  - ○ Type of conversion: Complex (indirect).
  - ○ Importance: Essential data.
  - ○ Obs: As the conversion is based on ILCD default files and unit conversion can occur for given flows, the Ecospold 2 field is not matched by an ILCD field. Still, as the functionality and the data are maintained through the conversion, it is considered indirect.

- ● ../@unitId {o}
  - ○ Type of conversion: Complex (not converted).
  - ○ Importance: Other metadata
  - ○ Obs: Can be used to assess additional unit information on the ecoinvent Master Data. Not used by Lavoisier, as it uses only the Ecospold 2 file information to assess the unit (via the unitName field)

- ● ../exchange/property@propertyId {r}
  - ○ Type of conversion: Complex (indirect).
  - ○ Importance: Other metadata
  - ○ Obs: Used to find in mapping the corresponding ILCD flow property identification.

- ● ../exchange/property/name {r}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Essential metadata
  - ○ ILCD correspondent fields:

- ■ [flowDataSet]
flowInformation/flowProperties/flowProperty/referenceToFlowPropertyDataSet/shortDescription
  - ○ Obs: Its information is used for the flowDataSet. The flow property dataset is copied from the ILCD default, so no information is converted to it.

- ../exchange/property@amount {r}
  - ○ Type of conversion: Complex (indirect).
  - ○ Importance: Essential data
  - ○ ILCD correspondent fields:
    - ■ [flowDataSet]
flowInformation/flowProperties/flowProperty/meanValue
  - ○ Obs: Its information is used for the flowDataSet. The flow property dataset is copied from the ILCD default, so no information is converted to it.

- ../exchange/property/comment {o}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Other metadata
  - ○ ILCD correspondent fields:
    - ■ [flowDataSet]
flowInformation/flowProperties/flowProperty/generalComment

- ../exchange/property/@isDefiningValue {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other metadata
  - ○ Obs: Field is related to the definition of a non-changing property value that can't be changed by other instances of the flow (a constant property). It is not useful information in the conversion to ILCD, and there is no data loss since Lavoisier deals with the diverse types of properties (see units and properties section).

4.1.7. Uncertainty

The uncertainty fields appear for every quantitative structure inside Ecospold 2, including flows, parameters, properties, and production values. Its structure includes defining a distribution that brings its specific set of subfields (related to their specific parametrization). Because the conversion approach is different for each distribution, they are treated as different sections.

The 'value' for ILCD flow structures is divided into the meanValue (or amount) and the resultingValue (or amount). The resultingValue is defined as the multiplication of the meanValue by the reference variable. When a reference variable is present, the meanValue is assigned to 1, and the resultingValue is assigned to the variable's value (Ecospold 2 amount). When there is no variable, both meanValue and resultingValue receive the amount from Ecospold 2 to maintain their definitions. For uncertainties, the resultingValue is always used to reflect the true 'value' for a given quantity structure.

Unit conversion factors (due to default unit problems, see intermediate exchange section) were considered for every uncertainty calculation. They shift the mean value and median by their factor and shift the variance by the square of their factor.

Another detail is that the relative standard deviation for 95% interpercentile range (an ILCD uncertainty field) is given with a limitation of 6 significant digits and can affect further uncertainty calculations.

Uncertainty conversion for the productVolume fields of Ecospold 2 follows the same conversion indicated in this section. As the production volume does not have a proper correspondent field in ILCD, the converted information (mean, minimum, maximum amount, and relative standard deviation) is allocated as text. More details can be seen under the intermediate flow section.

The Uncertainty class carries out the uncertainty conversion.

4.1.7.1. Lognormal

One of the staple distributions in LCA, the lognormal is widely used by ecoinvent association, especially regarding the Pedigree Matrix uncertainty attribution.

Inside Ecospold 2, the lognormal is parametrized by its median (or geometric mean; field meanValue) and the underlying normal distribution mean (mu), variance (variance), and variance with the Pedigree matrix (varianceWithPedigreeUncertainty) accounted.

For the ILCD format, the distribution is characterized by the relative standard deviation for 95% range (for lognormal, it can be approximated as the square of its geometric standard deviation), the mean (median for lognormal), minimum and maximum values (considering 95% interpercentile range and calculated using the relative standard deviation).

The underlying normal variance with Pedigree was used to calculate the geometric standard deviation using Equation 1:

$$GSD(X) = e^{\sqrt{Var_{ped}(X)*uf^2}} \tag{1}$$

Where 'uf' stands for unit conversion factor. Then, the relative standard deviation for 95% range was calculated using Equation 2:

$$\sigma_{95ln} = GSD^2 \tag{2}$$

Using the relative standard deviation, the minimum and maximum values were calculated by Equations 3 and 4:

$$MaximumValue = resultingValue * \sigma_{95ln} \tag{3}$$

$$MinimumValue = resultingValue / \sigma_{95ln} \tag{4}$$

The median was not converted to the ILCD resultingValue field since it would be a duplicate of the Ecospold 2 amount field conversion.

The Ecospold 2 fields included in that conversion are (for details about parameter and property conversions, see the intermediate exchange section):

- ../uncertainty/lognormal/@meanValue {r}
  - Type of conversion: Complex (not converted). Same information as the 'amount' field.
  - Importance: Not used. Duplicate value.

- ../uncertainty/lognormal/@mu {r}
  - Type of conversion: Complex (not converted). Same information for the 'amount' field.
  - Importance: Not used. Duplicate value.

- ../uncertainty/lognormal/@variance {o}
  - Type of conversion: Complex (not converted). The varianceWithPedigreeUncertainty field covers this variance and is used for standard deviation calculations.
  - Importance: Essential data. Loss of data due to lack of structural support in ILCD.
  - Obs: This variance as essential data considers that it carries the information about the basic uncertainty of the parameter, which is totally covered by the Pedigree matrix-based variance.

- ../uncertainty/lognormal/@varianceWithPedigreeUncertainty {r}
  - Type of conversion: Complex (indirect). Converted using equations to ILCD uncertainty.
  - Importance: Essential data. It represents the uncertainty for conversions.
  - ILCD correspondent fields: for flows
    - exchanges/exchange/relativeStandardDeviation95In
    - exchanges/exchange/minimumValue

- exchanges/exchange/maximumValue
- ○ ILCD correspondent fields: for properties
  - [flowDataSet] flowProperties/flowProperty/relativeStandardDeviation95In
  - flowProperties/flowProperty/minimumValue
  - flowProperties/flowProperty/maximumValue
- ○ ILCD correspondent fields: for parameters
  - mathematicalRelations/variableParameter/relativeStandardDeviation95In
  - mathematicalRelations/variableParameter/minimumValue
  - mathematicalRelations/variableParameter/maximumValue
- ○ ILCD correspondent fields: for variables
  - processInformation/mathematicalRelations/variableParameter/relativeStandardDeviation95In
  - processInformation/mathematicalRelations/variableParameter/minimumValue
  - processInformation/mathematicalRelations/variableParameter/maximumValue
- ○ Obs: This conversion has the same issue that the variance field has as it uncovers the uncertainty related to the Pedigree matrix. Nevertheless, the conversion is considered indirect as the value itself is already a sum of the variances, and it is used actively to convert the uncertainty to ILCD.

4.1.7.2.   Normal

Inside Ecospold 2, the normal distribution is parametrized by its mean (field meanValue), the variance relative to the mean (variance), and the variance relative to the mean with the Pedigree matrix (varianceWithPedigreeUncertainty) accounted.

For the ILCD format, the distribution is characterized by the relative standard deviation for 95% range (for normals, it can be

approximated as two times the standard deviation), the mean (median for lognormal), minimum and maximum values (considering 95% interpercentile range and calculated using the relative standard deviation).

The variance relative to the mean with Pedigree was used to calculate the relative standard deviation using Equation 5:

$$\sigma_{95ln} = 2 * e^{\sqrt{Var_{ped}(X)*uf^2}} * resultingValue \qquad (5)$$

Where 'uf' stands for unit conversion factor. Then, the minimum and maximum values were calculated by Equations 6 and 7:

$$MaximumValue = resultingValue + \sigma_{95ln} \qquad (6)$$

$$MinimumValue = resultingValue - \sigma_{95ln} \qquad (7)$$

The mean was not converted to the ILCD resultingValue field since it would be a duplicate of the Ecospold 2 amount field conversion.

The Ecospold 2 fields included in that conversion are (for details about parameter and property conversions, see the intermediate exchange section):

- ../uncertainty/normal/@meanValue {r}
    - Type of conversion: Complex (not converted). Same information as the 'amount' field.
    - Importance: Not used. Duplicate value.

- ../uncertainty/normal/@variance {o}
    - Type of conversion: Complex (not converted). The varianceWithPedigreeUncertainty field covers this variance and is used for standard deviation calculations.

- ○ Importance: Essential data. Loss of data due to lack of structural support in ILCD.
- ○ Obs: This variance as essential data considers that it carries the information about the basic uncertainty of the parameter, which is totally covered by the Pedigree matrix-based variance.

- ● ../uncertainty/normal/@varianceWithPedigreeUncertainty {r}
  - ○ Type of conversion: Complex (indirect). Converted using equations to ILCD uncertainty.
  - ○ Importance: Essential data. It represents the uncertainty for conversions.
  - ○ ILCD correspondent fields: for flows
    - ■ exchanges/exchange/relativeStandardDeviation95In
    - ■ exchanges/exchange/minimumValue
    - ■ exchanges/exchange/maximumValue
  - ○ ILCD correspondent fields: for properties
    - ■ [flowDataSet] flowProperties/flowProperty/relativeStandardDeviation95In
    - ■ flowProperties/flowProperty/minimumValue
    - ■ flowProperties/flowProperty/maximumValue
  - ○ ILCD correspondent fields: for parameters
    - ■ mathematicalRelations/variableParameter/relativeStandardDeviation95In
    - ■ mathematicalRelations/variableParameter/minimumValue
    - ■ mathematicalRelations/variableParameter/maximumValue
  - ○ ILCD correspondent fields: for variables
    - ■ processInformation/mathematicalRelations/variableParameter/relativeStandardDeviation95In
    - ■ processInformation/mathematicalRelations/variableParameter/minimumValue
    - ■ processInformation/mathematicalRelations/variableParameter/maximumValue

○ Obs: This conversion has the same issue that the variance field has as it uncovers the uncertainty related to the Pedigree matrix. Nevertheless, the conversion is considered indirect as the value itself is already a sum of the variances and it is used actively to convert the uncertainty to ILCD.

4.1.7.3. Triangular and uniform

Inside Ecospold 2, the triangular distribution is parametrized by its mode (field mostLikelyValue), maximum and minimum values. Similarly, the uniform distribution is parametrized by its minimum and maximum values. Both distributions are parametrized in a similar manner in ILCD, so their conversion is direct.

The Ecospold 2 fields included in that conversion are (for details about parameter and property conversions, see the intermediate exchange section):

- ../uncertainty/triangular/@minValue {r}
    - Type of conversion: Complex (direct).
    - Importance: Essential data.
    - ILCD correspondent fields: for flow
        - exchanges/exchange/minimumValue
    - ILCD correspondent fields: for parameters
        - mathematicalRelations/variableParameter/minimumValue
    - ILCD correspondent fields: for properties
        - [flowDataSet] flowProperties/flowProperty/minimumValue
    - ILCD correspondent fields: for variables
        - processInformation/mathematicalRelations/variableParameter/minimumValue

- ../uncertainty/triangular/@maxValue {r}
    - Type of conversion: Complex (direct).
    - Importance: Essential data.

- ○ ILCD correspondent fields: for flow
    - ■ exchanges/exchange/maximumValue
  - ○ ILCD correspondent fields: for parameters
    - ■ mathematicalRelations/variableParameter/maximumValue
  - ○ ILCD correspondent fields: for properties
    - ■ [flowDataSet] flowProperties/flowProperty/maximumValue
  - ○ ILCD correspondent fields: for variables
    - ■ processInformation/mathematicalRelations/variableParameter/maximumValue

- ● ../uncertainty/triangular/@mostLikelyValue {r}
  - ○ Type of conversion: Complex (not converted). Duplicate information for the 'amount' field.
  - ○ Importance: Not used. Duplicate value.

- ● ../uncertainty/uniform/@minValue {r}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Essential data.
  - ○ ILCD correspondent fields: for flow
    - ■ exchanges/exchange/minimumValue
  - ○ ILCD correspondent fields: for parameters
    - ■ mathematicalRelations/variableParameter/minimumValue
  - ○ ILCD correspondent fields: for properties
    - ■ [flowDataSet] flowProperties/flowProperty/minimumValue
  - ○ ILCD correspondent fields: for variables
    - ■ processInformation/mathematicalRelations/variableParameter/minimumValue

- ● ../uncertainty/uniform/@maxValue {r}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Essential data.
  - ○ ILCD correspondent fields: for flow

- exchanges/exchange/maximumValue
  - ○ ILCD correspondent fields: for parameters
    - mathematicalRelations/variableParameter/maximumValue
  - ○ ILCD correspondent fields: for properties
    - [flowDataSet] flowProperties/flowProperty/maximumValue
  - ○ ILCD correspondent fields: for variables
    - processInformation/mathematicalRelations/variableParameter/maximumValue

4.1.7.4. Undefined

For both formats, the undefined distribution is parameterized by its minimum, maximum and relative standard deviation for 95% range such that all conversion is done directly.

The Ecospold 2 fields included in that conversion are (for details about parameter and property conversions, see the intermediate exchange section):

- ../uncertainty/undefined/@minValue {r}
  - ○ Type of conversion: Complex (direct).
  - ○ Importance: Essential data.
  - ○ ILCD correspondent fields: for flow
    - exchanges/exchange/minimumValue
  - ○ ILCD correspondent fields: for parameters
    - mathematicalRelations/variableParameter/minimumValue
  - ○ ILCD correspondent fields: for properties
    - [flowDataSet] flowProperties/flowProperty/minimumValue
  - ○ ILCD correspondent fields: for variables
    - processInformation/mathematicalRelations/variableParameter/minimumValue

- ../uncertainty/undefined/@maxValue {r}
    - Type of conversion: Complex (direct).
    - Importance: Essential data.
    - ILCD correspondent fields: for flow
        - exchanges/exchange/maximumValue
    - ILCD correspondent fields: for parameters
        - mathematicalRelations/variableParameter/maximumValue
    - ILCD correspondent fields: for properties
        - [flowDataSet] flowProperties/flowProperty/maximumValue
    - ILCD correspondent fields: for variables
        - processInformation/mathematicalRelations/variableParameter/maximumValue

- ../uncertainty/undefined/@standardDeviation95 {r}
    - Type of conversion: Complex (direct).
    - Importance: Essential data.
    - ILCD correspondent fields: for flow
        - exchanges/exchange/relativeStandardDeviation95In
    - ILCD correspondent fields: for properties
        - [flowDataSet] flowProperties/flowProperty/relativeStandardDeviation95In
    - ILCD correspondent fields: for parameters
        - mathematicalRelations/variableParameter/relativeStandardDeviation95In
    - ILCD correspondent fields: for variables
        - processInformation/mathematicalRelations/variableParameter/relativeStandardDeviation95In

4.1.7.5.   Beta, Gamma, and Binomial

Although defined under the scope of Ecospold 2, the three distributions don't have a proper field under the ILCD. In being so, all

three distributions are not converted to ILCD, but their parameterization is placed under the flow comment section as a way to preserve the textual information. This is considered to be a loss of data due to a lack of structural support in ILCD.

Although these fields are important in a format uncertainty structure sense, the beta, gamma, and binomial distributions are rarely used in Ecospold 2 datasets (such as the ecoinvent database) and, thus, have minimal influence on overall real dataset conversion results.

The Ecospold 2 fields included in that conversion are:

- ../uncertainty/beta/@minValue {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/beta/@maxValue {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/beta/@mostFrequentValue {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/gamma/@shape {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/gamma/@scale {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/gamma/@minValue {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Essential data.

- ../uncertainty/binomial/@n {r}
    - Type of conversion: Complex (incomplete).

○ Importance: Essential data.

- ../uncertainty/binomial/@p {r}
    - ○ Type of conversion: Complex (incomplete).
    - ○ Importance: Essential data.

4.1.7.6.   Uncertainty metadata

Ecospold 2's uncertainty structure contains information about the Pedigree matrix coefficients. This information is appended to the flow's general comment and isn't considered a loss of information, since both are text metadata fields.

The Ecospold 2 fields included in that conversion are:

- ../uncertainty/pedigreeMatrix/@reliability {r}
    - ○ Type of conversion: Complex (indirect).
    - ○ Importance: Essential metadata.
    - ○ ILCD correspondent fields: for flow
        - ■ exchanges/exchange/generalComment
    - ○ ILCD correspondent fields: for properties
        - ■ [flowDataSet] flowProperties/flowProperty/generalComment
    - ○ ILCD correspondent fields: for parameters
        - ■ mathematicalRelations/variableParameter/comment

- ../uncertainty/pedigreeMatrix/@completeness {r}
    - ○ Type of conversion: Complex (indirect).
    - ○ Importance: Essential metadata.
    - ○ ILCD correspondent fields: for flow
        - ■ exchanges/exchange/generalComment
    - ○ ILCD correspondent fields: for properties
        - ■ [flowDataSet] flowProperties/flowProperty/generalComment
    - ○ ILCD correspondent fields: for parameters
        - ■ mathematicalRelations/variableParameter/comment

- ../uncertainty/pedigreeMatrix/@temporalCorrelation {r}
  - Type of conversion: Complex (indirect).
  - Importance: Essential metadata.
  - ILCD correspondent fields: for flow
    - exchanges/exchange/generalComment
  - ILCD correspondent fields: for properties
    - [flowDataSet] flowProperties/flowProperty/generalComment
  - ILCD correspondent fields: for parameters
    - mathematicalRelations/variableParameter/comment

- ../uncertainty/pedigreeMatrix/@geographicalCorrelation {r}
  - Type of conversion: Complex (indirect).
  - Importance: Essential metadata.
  - ILCD correspondent fields: for flow
    - exchanges/exchange/generalComment
  - ILCD correspondent fields: for properties
    - [flowDataSet] flowProperties/flowProperty/generalComment
  - ILCD correspondent fields: for parameters
    - mathematicalRelations/variableParameter/comment

- ../uncertainty/pedigreeMatrix/@furtherTechnologyCorrelation {r}
  - Type of conversion: Complex (indirect).
  - Importance: Essential metadata.
  - ILCD correspondent fields: for flow
    - exchanges/exchange/generalComment
  - ILCD correspondent fields: for properties
    - [flowDataSet] flowProperties/flowProperty/generalComment
  - ILCD correspondent fields: for parameters
    - mathematicalRelations/variableParameter/comment

Additionally, the uncertainty in Ecospold 2 has its own comment section. This comment field is directly converted to the flow's general comment section.

- ../uncertainty/comment {o}
    - Type of conversion: Complex (direct).
    - Importance: Other metadata.
    - ILCD correspondent fields: for flow
        - exchanges/exchange/generalComment
    - ILCD correspondent fields: for properties
        - [flowDataSet] flowProperties/flowProperty/generalComment
    - ILCD correspondent fields: for parameters
        - mathematicalRelations/variableParameter/comment
    - ILCD correspondent fields: for variables
        - processInformation/mathematicalRelations/variablePar ameter/comment

4.1.8.   Timestamp and Versioning

To maintain the file versioning for the ILCD file, some considerations had to be done during the conversion. File versions are handled in Ecospold 2 as four integer fields with minor and major revisions and releases. For ILCD, the field dataSetVersion uses a string for versioning in which the two first numbers are for major updates, the two middle numbers are for minor revisions, and the final three numbers are for automatic counting (01.01.001, for example).

To consider the string limitation of ILCD that only has two digits for major and minor updates, only one of the Ecospold 2 integers was considered for each. For the ILCD major updates (two first digits), the Ecospold 2 minorRelease attribute was used, and for the ILCD minor revisions (two middle digits), the Ecospold 2 majorRevision was used. The three remaining digits were assigned to 0.

It is highlighted here that the use of only major fields in the conversion comes from their resetting property over the minor fields

every time they update. As the other minor fields are not converted, there is a chance of two datasets with different ecoinvent versions having the same version in ILCD.

The Ecospold 2 fields included in that conversion are (here we include the ones that were not converted but are related to the conversion too):

- ../fileAttributes/@majorRelease {r}
    - Type of conversion: Complex (direct).
    - Importance: Other metadata. Part of the Ecospold 2 versioning
    - ILCD correspondent fields:
        - administrativeInformation/publicationAndOwnership/ dataSetVersion

- ../fileAttributes/@minorRelease {r}
    - Type of conversion: Complex (not converted).
    - Importance: Other metadata. Part of the Ecospold 2 versioning
    - Obs: Not considered in ILCD versioning

- ../fileAttributes/@majorRevision {r}
    - Type of conversion: Complex (direct).
    - Importance: Other metadata. Part of the Ecospold 2 versioning
    - ILCD correspondent fields:
        - administrativeInformation/publicationAndOwnership/ dataSetVersion

- ../fileAttributes/@minorRevision {r}
    - Type of conversion: Complex (not converted).
    - Importance: Other metadata. Part of the Ecospold 2 versioning
    - Obs: Not considered in ILCD versioning

Other version fields that could appear under the Ecospold 2 structure are those related to the reviews done in the dataset. These version fields have the same structure as the dataset version fields (major and minor releases and revisions), but they have no corresponding field in ILCD. For those, the conversion is done by appending them to the review comment section in ILCD, thus being considered incomplete conversions.

The Ecospold 2 fields included in that conversion are (here we include the ones that were not converted but are related to the conversion too):

- ../review/@majorRelease {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Other metadata. Review versioning
    - ILCD correspondent fields:
        - modellingAndValidation/validation/reviewDetails

- ../review/@minorRelease {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Other metadata. Review versioning
    - ILCD correspondent fields:
        - modellingAndValidation/validation/reviewDetails

- ../review/@majorRevision {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Other metadata. Review versioning
    - ILCD correspondent fields:
        - modellingAndValidation/validation/reviewDetails

- ../review/@minorRevision {r}
    - Type of conversion: Complex (incomplete).
    - Importance: Other metadata. Review versioning
    - ILCD correspondent fields:
        - modellingAndValidation/validation/reviewDetails

ILCD has two major timestamps: the timeStamp field and the dateOfLastReview field. The timeStamp has the time of last modification on the dataset, and it is always set to the current time at conversion. For dateOfLastReview, a loop over Ecospold 2's review fields is done, and the date of the last one is assigned to the field. If no review was done in the Ecospold 2 file, then the ILCD field is ignored.

The Ecospold 2 fields included in that conversion are (here we include the ones that were not converted but are related to the conversion too):

- ../review/@reviewDate {r}
  - Type of conversion: Complex (incomplete).
  - Importance: Other metadata. Date of the reviews done for the dataset
  - ILCD correspondent fields: for the timestamp
    - administrativeInformation/publicationAndOwnership/ dateOfLastRevision
  - ILCD correspondent fields: for the date information
    - modellingAndValidation/validation/reviewDetails
  - Obs: The review date doesn't have a corresponding field in ILCD, so for each review, the information is stored as an additional text in the reviewDetails comment field. The conversion is considered incomplete, although it can be considered indirect as the review date values are used to assess the dateOfLastReview timestamp field.

- ../fileAttributes/@creationTimestamp {o}
  - Type of conversion: Complex (not converted).
  - Importance: Other metadata. Timestamp of Ecospold 2 dataset creation
  - Obs: Structure-related field in Ecospold 2. Not used in ILCD.

- ../fileAttributes/@lastEditTimestamp {o}
  - Type of conversion: Complex (not converted).

○ Importance: Other metadata. Timestamp of Ecospold 2 dataset last edit

○ Obs: Structure-related field in Ecospold 2. Not used in ILCD.

- ../fileAttributes/@fileTimestamp {o}
    ○ Type of conversion: Complex (not converted).
    ○ Importance: Other metadata. Timestamp of Ecospold 2 dataset file creation
    ○ Obs: Structure-related field in Ecospold 2. Not used in ILCD.

4.1.9. Flow type and direction, reference, and by-product identification

The majority of the conversions for intermediate and elementary exchanges differ due to the need for nomenclature assessment of elementary flows only. Nevertheless, the flow type conversion and the identification of reference and by-product are made the same way for both.

An enumerated value gives the flow type value in ILCD (a choice between Elementary flow, Product flow, Waste flow, or Other flow). Several fields of Ecospold 2 are used to assess this information for ILCD. The first ones are the inputGroup and outputGroup that indicate if the flow is an input or an output and an additional classification of those groups given by an integer (enumeration).

Ecospold 2 field	Ecospold 2 Enumeration	Ecospold 2 information
inputGroup	1	Materials/Fuels
inputGroup	2	Electricity/Heat
inputGroup	3	Services

inputGroup	5	From Technosphere (unspecified)
inputGroup	4	From Environment
outputGroup	0	Reference Product
outputGroup	2	By-product
outputGroup	3	Material for Treatment
outputGroup	4	To Environment
outputGroup	5	Stock Additions

Although useful, the inputGroup and outputGroup information is not enough to assess the information about flow type. For example, a treatment process in which a waste flow is considered a reference flow, the outputGroup value of 0 cannot fully identify the waste flow. To check for these, the By-product classification of the flows was considered as it is distinct between the flow types (its classes are 'allocatable product', 'recycled' and 'waste').

The identification of reference and by-products considers both the inputGroup, outputGroup, and classification information. The detailed steps carried out to evaluate the type, direction, and reference and by-product information are given below

- The fields inputGroup or outputGroup (given once per Ecospold 2 flow) were gathered, and their information was converted to ILCD information (Input or Output) (Flow class method __get_direction)
- If the flow had an outputGroup equal to 0, the field was considered (via a boolean) as a reference field. Take note that more than one field could be a reference field (Flow class method __get_direction)
- If the flow had an outputGroup equal to 2 or 5, the field was considered (via a boolean) as a by-product. (Flow class method __get_direction)
- The By-product classification for the flow was gathered. (Flow class method __fclassification)

- If the flow had a by-product classification of 'waste', the flow was considered a waste flow. If the flow had a by-product classification other than waste, it was considered to be a product flow. (Flow class method __get_flow_type)
- If the flow did not have a By-product classification, the inputGroup and outputGroup values were used. For inputs, the value 4 was mapped to an elementary flow and other values to a product flow. For outputs, the values 0, 2, and 5 were mapped to product flows, the value 3 was mapped to a waste flow, and the value 4 was mapped to an elementary flow. (Flow class method __get_flow_type)

This information of flow direction, type, and booleans indicating reference and by-product flows are used for other conversions like the allocation one.

As ILCD does not make the distinctions of inputs and outputs like the Ecospold 2 format, the enumeration information is transcribed as text to the flow's general comment section.

The Ecospold 2 fields included in that conversion are:

- ../exchange/inputGroup {r}
  - Type of conversion: Indirect
  - Importance: Essential data. Flow direction information
  - ILCD correspondent fields: as direction information
    - exchanges/exchange/exchangeDirection
  - ILCD correspondent fields: as text
    - exchanges/exchange/generalComment
  - ILCD correspondent fields: as flow type information
    - [flowDataSet] modellingAndValidation/LCIMethod/typeOfDataSet

- ../exchange/outputGroup {r}
  - Type of conversion: Indirect
  - Importance: Essential data. Flow direction information
  - ILCD correspondent fields: as direction information
    - exchanges/exchange/exchangeDirection

- ○ ILCD correspondent fields: as text
  - ■ exchanges/exchange/generalComment
- ○ ILCD correspondent fields: as flow type information
  - ■ [flowDataSet] modellingAndValidation/LCIMethod/typeOfDataSet

4.1.10.   Intermediate flow

The intermediate flow specificities about where to hold information, the presence of a chain of additional files for its conversion (Figure 1), the different approaches to properties, uncertainties, units, mathematical variables, and equations all contributed to the difficulty of conversion. Nevertheless, the conversion here was done to the tiniest details as it holds the most important information of an inventory, the characterization of the flows themselves.

To make the conversion more palatable, the specific substructure conversions of this section are divided into subsections.

4.1.10.1.   Identification

One of the specific characteristics of Ecospold 2 flows is that they have two identification fields, one for the flow itself, used to characterize the flow regardless of the process it is in (the attribute intermediateExchangeId) and the other for the identification of the flow in the process (the attribute id). The problem of using the id for the conversion is that it starts to duplicate the flow when different processes with the same flow are converted. This problem leads to a converted database that is non-linkable since all equal flows are considered with different identifications. Nevertheless, an option is maintained in code in the general functions for the practitioner to choose the identification used to convert intermediate flows. The default option is the conversion using the intermediateExchangeId.

The Ecospold 2 fields included in that conversion are:

- ../intermediateExchange/@id {r}
  - Type of conversion: Complex (not converted). Default conversion uses the intermediateExchangeId
  - Importance: Other metadata. The id is used to identify the flow in the specific process.
  - ILCD correspondent fields: for the option of using this field, see ../intermediateExchange/@intermediateExchangeId

- ../intermediateExchange/@intermediateExchangeId {r}
  - Type of conversion: Complex (indirect). Used to generate a new UUID for conversion.
  - Importance: Essential metadata. The id is used to identify the linkable flow.
  - ILCD correspondent fields: for the process
    - exchanges/exchange/referenceToFlowDataSet/@refObjectId
  - ILCD correspondent fields: for the flow
    - [flowDataSet] flowInformation/dataSetInformation/UUID
  - ILCD correspondent fields: as text
    - exchanges/exchange/generalComment

Another identification present for intermediate exchanges is the UUID of the activity that produces that flow inside the ecoinvent database. The following is important as it is the main linking information between the Ecospold 2 datasets and enables them to be structured as a database (as an intermediate flow is always produced by a process). The ILCD does not have a field for that purpose inside the format, so this information is converted as a text to the general comment to indicate the connection link informed in the Ecospold 2 file.

- ../exchange/@activityLinkId {o}
  - Type of conversion: Complex (incomplete). No field in ILCD
  - Importance: Essential data. The id is used to identify the activity that produces the intermediate flow.

- ○ ILCD correspondent fields:
  - ■ exchanges/exchange/generalComment

4.1.10.2. Production Volume quantitative information

Ecospold 2 holds more than a single amount for the production volume information. In fact, this value has an entire quantitative structure with the amount, variables, source, and uncertainty. Here, we focus on the amount and uncertainty conversions, as they receive a different treatment beyond the described in the uncertainty section for other quantities.

The ILCD field that holds the information about the production volume is used only for reference and by-products and does it in a textual manner (the field is a plain-text one). The following steps are carried out to assess this matter

- The production volume amount for reference and by-products is gathered and stored (ProductionVolume class)
- If uncertainty is present for the production volume, it undergoes the same process done for other quantitative uncertainties (described in the uncertainty section) and is stored (ProductionVolume class)
- The ILCD field receives, for each production volume stored, a text with the indication of the amount and relative standard deviation for the 95% interpercentile range. (main ILCD class)

Although other uncertainty conversions can be done without loss of information (other than the specific beta, gamma, and binomial distributions), the conversion for production volume infers an incomplete conversion. This incomplete conversion happens as information is gathered from an uncertainty structure and placed under a plain-text field as textual information. As with other indirect

conversions, this one has a loss of functionality due to the lack of specific fields for production volume uncertainty in ILCD.

Further comment on the production volume is not converted as the ILCD field is specific for values and not for additional text information about the production volume and is considered a loss of data.

The Ecospold 2 fields included in that conversion are:

- ../exchange/@productionVolumeAmount {o}
  - Type of conversion: Complex (indirect). Converted to text
  - Importance: Other metadata
  - ILCD correspondent fields:
    - modellingAndValidation/dataSourcesTreatmentAndRe presentativeness/annualSupplyOrProductionVolume

- ../exchange/productionVolumeUncertainty {o}
  - Type of conversion: Incomplete
  - Importance: Other metadata
  - ILCD correspondent fields:
    - modellingAndValidation/dataSourcesTreatmentAndRe presentativeness/annualSupplyOrProductionVolume
  - Obs: Converted as any other uncertainty following the uncertainty section steps. Only the relative standard deviation is converted to textual information in the ILCD field.

- ../exchange/productionVolumeComment {o}
  - Type of conversion: Not converted
  - Importance: Other metadata
  - Obs: Lack of ILCD field for the comments of the production volume of flows

4.1.10.3. Additional conversions for intermediate flows

Some of the Ecospold 2 fields are shared between intermediate and elementary exchanges, but they have different approaches for conversion. Due to their specifics, a separation was necessary to assess their differences. Below are the conversions done in the intermediate flow perspective:

- ../exchange/name {r}
  - Type of conversion: Direct
  - Importance: Essential metadata
  - ILCD correspondent fields:
    - exchanges/exchange/referenceToFlowDataSet/shortDescription
    - [flowDataSet] flowInformation/dataSetInformation/name

- ../exchange/@casNumber {o}
  - Type of conversion: Complex (direct)
  - Importance: Other metadata
  - ILCD correspondent fields:
    - [flowDataSet] flowInformation/dataSetInformation/CASNumber

4.1.11. Elementary flow

Elementary and intermediate flows share a common structure inside Ecospold 2. However, while conversion for intermediate flows is done by using the Ecospold 2 file information, the elementary flows require a change to ILCD nomenclature, which has its own set of standardized elementary flows. In a way, this is like translating words from one language to another; both mean the same thing (in this case, the same elementary flow) but are written and expressed in different ways.

A mapping table of elementary flow information from Ecospold 2 (currently for ecoinvent 3.7) to ILCD (specifically the nomenclature version from the Environmental Footprint 3.0) was used to achieve the

nomenclature conversion. This table was produced by GLAD's Nomenclature Working Group (Global LCA Data Access Network) using their expertise and scripts.

In Lavoisier, the conversion uses the mapping files to check for the Ecospold 2 elementaryExchangeId and, upon matching, gathers the respective ILCD information about that flow to create its dataset and structures inside the process dataset. The information gathered by the mapping is the following

- ILCD's UUID and name for the elementary flow.
- ILCD's compartment (or context) for the elementary flow.
- Unit conversion factors for cases where the ILCD default unit for the flow is different from that used in Ecospold 2.
- ILCD's elementary flow-related Metadata (synonyms, CAS number, and sum formula)

It's highlighted that no information is changed from the original mapping from the GLAD Nomenclature Working Group in Lavoisier.

After gathering this information, Ecospold 2's elementary flow structure is used to assess the quantitative information of the flow inside the process (its amount, properties, variables, uncertainty, comments, and sources). This information is combined with the mapping information (including further unit conversions necessary and the specific processes for uncertainty, variables, and properties, all explained in their sections) and stored inside the Elementary flow class of Lavoisier. This class is used later by Lavoisier's main class to create the files for each of the elementary flows and their reference inside the process dataset.

Although comprehensive, the mapping file does not have conversions for all the Ecospold 2 elementary flows to ILCD ones due to differences in each format's default flow list. Since the ILCD format has a constraint that no additional elementary flow can be created (or added) to the default list, this situation can lead to a loss of information. Lavoisier deals with this matter in two ways

- Lavoisier evaluates the user input of the parameter 'check_missing_elem_flows', which is True if the user wants to assess not converted elementary flows and False if the user prefers not converting these flows, letting them be indicated on the conversion log file (general functions).
- If 'check_missing_elem_flows' is True, every time the conversion of an elementary flow fails because there is no matching in the mapping file, Lavoisier loops through the mapping file, searching for similar flows that could replace it. On not finding, Lavoisier does not convert the flow and warns the user both by console and in the logging file. On finding, Lavoisier shows the possible options and lets the user decide if to choose one of the options (in this case, the information of the option is used for the conversion) or not convert the flow (adding a warning in the log file). (ElementaryFlow class).

Lavoisier finds secondary options for a flow by comparing its name with others in the mapping with a string comparison function that evaluates how much two strings are equal.

Using this approach, Lavoisier grants that the conversion creates no additional ILCD elementary flow.

The Ecospold 2 fields included in that conversion are below. Although conversions are done only using the elementaryExchangeId from the Ecospold2, they were considered indirect, as information and functionality are not lost, only converted indirectly through mapping:

- ../exchange/@elementaryExchangeId {r}
  - Type of conversion: Complex (indirect). Mapping of elementary flows.
  - Importance: Essential metadata
  - ILCD correspondent fields:
    - exchanges/exchange/generalComment
  - Obs: Used directly in the mapping file of elementary flows for conversion. It is appended additionally to the flow section (same as intermediate exchanges).

- ../exchange/name {r}
  - Type of conversion: Complex (indirect). Mapping of elementary flows.
  - Importance: Essential metadata
  - ILCD correspondent fields:
    - exchanges/exchange/referenceToFlowDataSet/shortDescription
    - [flowDataSet] flowInformation/dataSetInformation/name

- ../exchange/@casNumber {o}
  - Type of conversion: Complex (indirect)
  - Importance: Other metadata
  - ILCD correspondent fields:
    - [flowDataSet] flowInformation/dataSetInformation/CASNumber

- ../exchange/@formula {o}
  - Type of conversion: Complex (indirect)
  - Importance: Other metadata
  - ILCD correspondent fields:
    - [flowDataSet] flowInformation/dataSetInformation/sumFormula

- ../exchange/compartment/compartment {r}
  - Type if conversion: Complex (indirect).
  - Importance: Essential metadata. The compartment is used to classify the ILCD elementary flow.
  - ILCD correspondent fields:
    - [flowDataSet] flowInformation/dataSetInformation/classificationInformation/elementaryFlowCategorization

- ../exchange/compartment/subcompartment {r}

- ○ Type if conversion: Complex (indirect). Information is used to match the complete class path.
- ○ Importance: Essential metadata. The compartment is used to classify the ILCD elementary flow.
- ○ ILCD correspondent fields:
  - ■ [flowDataSet] flowInformation/dataSetInformation/classificationInformation/elementaryFlowCategorization

- ../exchange/compartment/@subcompartmentId {r}
  - ○ Type if conversion: Complex (indirect). Information is used to match the complete class path.
  - ○ Importance: Other metadata. The classification is used to organize and make data hierarchical.

4.2. Direct conversions

These fields are converted simply by copy-pasting the Ecospold 2 field text in an ILCD field. The Ecospold 2 fields that underwent that type of conversion in Lavoisier are the following:

- ../activity/activityName {r}
  - ○ Type of conversion: Direct
  - ○ Importance: Essential metadata. The name is used to identify the process
  - ○ ILCD correspondent fields:
    - ■ processInformation/dataSetInformation/name/baseName
  - ○ Obs: The ILCD name field comprises several subfields that identify the process, but the baseName is the one that reassembles the most the Ecospold 2 name field

- ../activity/@id {r}
  - ○ Type of conversion: Direct

- ○ Importance: Essential data. The id is used to identify the process
  - ○ ILCD correspondent fields:
    - processInformation/dataSetInformation/UUID
  - ○ Obs: This UUID identifies the process in itself whereas the field activityNameId identifies the name of the process, no matter the system model it is inscribed on.

- ../geography/shortname {r}
  - ○ Type of conversion: Direct
  - ○ Importance: Essential data. Location of the dataset
  - ○ ILCD correspondent fields:
    - processInformation/geography/locationOfOperationSupplyOrProduction/@location
  - ○ Obs: This is the only attribute required for geography information conversion.

- ../representativeness/samplingProcedure {r}
  - ○ Type of conversion: Direct
  - ○ Importance: Other metadata. How the sampling was done
  - ○ ILCD correspondent fields:
    - modellingAndValidation/dataSourcesTreatmentAndRepresentativeness/samplingProcedure

- ../representativeness/extrapolations {o}
  - ○ Type of conversion: Direct
  - ○ Importance: Other metadata. Extrapolations of data from other contexts (geographical, technological or temporal)
  - ○ ILCD correspondent fields:
    - modellingAndValidation/dataSourcesTreatmentAndRepresentativeness/dataTreatmentAndExtrapolationsPrinciples

- ../representativeness/@percent {o}
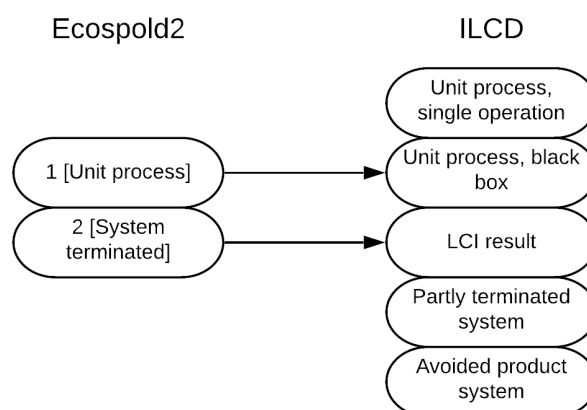 - ○ Type of conversion: Direct

- ○ Importance: Other metadata. Percentage of the market covered
- ○ ILCD correspondent fields:
  - modellingAndValidation/dataSourcesTreatmentAndRepresentativeness/percentageSupplyOrProductionCovered

- ../review/details {o}
  - ○ Type of conversion: Direct
  - ○ Importance: Other metadata. Review details
  - ○ ILCD correspondent fields:
    - modellingAndValidation/validation/reviewDetails

- ../review/otherDetails {o}
  - ○ Type of conversion: Direct
  - ○ Importance: Other metadata. Additional review details
  - ○ ILCD correspondent fields:
    - modellingAndValidation/validation/otherReviewDetails

- ../dataGeneratorAndPublication/@isCopyrightProtected {r}
  - ○ Type of conversion: Direct
  - ○ Importance: Essential metadata. Boolean that indicates if the dataset is protected by copyright
  - ○ ILCD correspondent fields:
    - administrativeInformation/publicationAndOwnership/copyright

- ../exchange/comment {o}
  - ○ Type of conversion: Direct
  - ○ Importance: Other metadata
  - ○ ILCD correspondent fields:
    - exchanges/exchange/generalComment

4.3.   Indirect conversions

Lavoisier uses mappings or data modifications for indirect conversions of fields. As such, the information in these fields undergo some transformation before their assignment to an ILCD field or serve as supporting information for other field conversions. The Ecospold 2 fields that underwent that type of conversion in Lavoisier are the following:

- ../activity/includedActivitiesStart {r}
  - Type of conversion: Indirect
  - Importance: Essential metadata. Describes the process' boundaries with the field includedActivitiesEnd
  - ILCD correspondent fields:
    - processInformation/technology/technologyDescriptionAndIncludedProcesses
  - Obs: The conversion is considered incomplete due to the need to join two fields. Although two fields are considered, their functionality is maintained as the ILCD field encompasses included processes information.

- ../activity/includedActivitiesEnd {r}
  - Type of conversion: Indirect
  - Importance: Essential metadata. Describes the process' boundaries with the field includedActivitiesStart
  - ILCD correspondent fields:
    - processInformation/technology/technologyDescriptionAndIncludedProcesses
  - Obs: The conversion is considered incomplete due to the need to join two fields. Although two fields are considered, their functionality is maintained as the ILCD field encompasses included processes information.

- ../synonym {o}
  - Type of conversion: Indirect
  - Importance: Other metadata. Dataset name synonyms

- ○ ILCD correspondent fields: for processes
    - ■ processInformation/dataSetInformation/synonyms
- ○ ILCD correspondent fields: for flows
    - ■ [flowDataSet]
      flowInformation/dataSetInformation/synonyms
- ○ Obs: As the synonym field is unique for ILCD datasets, the several synonyms fields on Ecospold 2 were separated by ";" and joined into one text field.

- ● ../activity/@type {r}
    - ○ Type of conversion: Indirect
    - ○ Importance: Essential metadata. Type of the dataset
    - ○ ILCD correspondent fields:
        - ■ modellingAndValidation/LCIMethodAndAllocation/typeOfDataSet
    - ○ Obs: Conversion made with the mapping of Ecospold 2 integer values to ILCD strings. The Ecospold 2 option of '1' (Unit process) was converted conservatively to 'Unit process, black box' in ILCD.

- ● ../activity/@energyValues {o}
    - ○ Type of conversion: Indirect

- - Importance: Essential metadata. Information if energy is considered as gross or net values
  - Mapping: [0: undefined; 1: net calorific value; 2: gross calorific value]
  - ILCD correspondent fields:
    - modellingAndValidation/LCIMethodAndAllocation/modellingConstants
  - Obs: No loss of information is considered because the ILCD field description encompasses the description of energy values. The field is converted through a simple mapping of values to text. This information is used when choosing the right flow property between gross and net energy when any flow has a property or unit related to energy.

- ../activity/@datasetIcon {o}
  - Type of conversion: Indirect
  - Importance: Other metadata. Image to serve as an icon for the process
  - ILCD correspondent fields:
    - processInformation/dataSetInformation/referenceToExternalDocumentation
  - Obs: The conversion reassembles the one done by the imageURL in the general comments section as both are URL to internet images.

- ../technology/@technologyLevel {o}
  - Type of conversion: Indirect
  - Importance: Essential metadata. Classifies the technology of the process
  - Mapping: [0: undefined; 1: New; 2: Modern; 3: Current; 4: Old; 5: Outdated]
  - ILCD correspondent fields:
    - processInformation/technology/technologyDescriptionAndIncludedProcesses

- ○ Obs: The ILCD field can hold this type of information without loss of functionality. The field is converted via mapping of Ecospold 2 integer values to text.

- ../timePeriod/@startDate {r}
  - ○ Type of conversion: Indirect
  - ○ Importance: Essential metadata. Date when dataset starts to be valid
  - ○ ILCD correspondent fields: year
    - ■ processInformation/time/referenceYear
  - ○ ILCD correspondent fields: text date
    - ■ processInformation/time/timeRepresentativenessDescription
  - ○ Obs: Field is indirectly converted since only the year is used as information in ILCD's referenceYear field.

- ../timePeriod/@endDate {r}
  - ○ Type of conversion: Indirect
  - ○ Importance: Essential metadata. Date when dataset starts to be valid
  - ○ ILCD correspondent fields: year
    - ■ processInformation/time/dataSetValidUntil
  - ○ ILCD correspondent fields: text date
    - ■ processInformation/time/timeRepresentativenessDescription
  - ○ Obs: Field is indirectly converted since only the year is used as information in ILCD's dataSetValidUntil field. For this field, the month is considered when accounting for the year. When the month is before June (6), the year is not modified, but when the month is higher than June (6), the year is considered the next year.

- ../timePeriod/@isDataValidForEntirePeriod {r}
  - ○ Type of conversion: Indirect

- ○ Importance: Other metadata. Boolean that indicates if the dataset is valid for the entire period between startDate and endDate attributes
- ○ ILCD correspondent fields:
  - ■ processInformation/time/timeRepresentativenessDescription
- ○ Obs: Although with different data types, the ILCD text field admits this type of information. Because only the year is accepted as time information for ILCD (modifying the start and end date information), this boolean is not used to assess the validity of the dataset. Instead, the value is used with the start and end date to inform the original Ecospold 2 period and infer data validity within that period.

- ● ../representativeness/systemModelName {r}
  - ○ Type of conversion: Indirect
  - ○ Importance: Essential metadata. Name of the system model in which the process is modeled.
  - ○ ILCD correspondent fields: as an appended comment
    - ■ modellingAndValidation/LCIMethodAndAllocation/deviationsFromLCIMethodPrinciple
  - ○ ILCD correspondent fields: through a mapping
    - ■ modellingAndValidation/LCIMethodAndAllocation/LCIMethodPrinciple
    - ■ modellingAndValidation/LCIMethodAndAllocation/LCIMethodApproaches
  - ○ Obs: The system model name is what defines the system model parameters for the conversion. The field is added as plain text inside the deviationsFromLCIMethodPrinciple ILCD field and is mapped to ILCD enumerations for the fields LCIMethodPrinciple and LCIMethodApproaches.

Ecospold 2	LCIMethodPrinciple	LCIMethodApproaches
Undefined	Not applicable	Not applicable

Allocation, manually linked	Attributional	Allocation - other explicit assignment
Allocation by dry mass	Attributional	Allocation - mass
Allocation at the point of substitution	Attributional	Substitution - average, market price correction
Allocation, legacy	Attributional	Allocation - other explicit assignment
Allocation by carbon	Attributional	Allocation - element content
Allocation by revenue	Attributional	Allocation - market value
Allocation, cut-off by classification	Attributional	Allocation - 100% to main function
Substitution, consequential, long-term	Consequential	Substitution - specific
Substitution, constrained by-products	Consequential	Substitution - specific

- ../dataGeneratorAndPublication/@dataPublishedIn {o}
  - Type of conversion: Indirect
  - Importance: Other metadata. Information about the data publication.
  - Mapping: [0: Data set finalised; unpublished | 1: Data set finalised; subsystems published | 2: Data set finalised; entirely published]
  - ILCD correspondent fields:
    - administrativeInformation/publicationAndOwnership/ workflowAndPublicationStatus

- ○ Obs: The Ecospold 2 field is mapped to a text before being converted to ILCD.

- ● ../dataGeneratorAndPublication/@accessRestrictedTo {o}
  - ○ Type of conversion: Indirect
  - ○ Importance: Essential metadata. Indicates dataset access restrictions
  - ○ Mapping: [0: Free of charge for all users and uses; 1: License fee; 2: Other; 3: Other]
  - ○ ILCD correspondent fields: as text
    - ■ administrativeInformation/publicationAndOwnership/accessRestrictions
  - ○ ILCD correspondent fields: through mapping
    - ■ administrativeInformation/publicationAndOwnership/licenseType
  - ○ Obs: The Ecospold 2 enumerated values are mapped to ILCD enumeration for the licenceType field. A text equivalent is used in the accessRestriction field.

- ● ../fileAttributes/@defaultLanguage {o}
  - ○ Type of conversion: Indirect
  - ○ Importance: Other metadata. The default language of text fields in the Ecospold 2 field
  - ○ Obs: This field is used to fill all the language attributes for text-based fields in ILCD (xml:lang).

4.4. Incomplete conversions

Incomplete conversions are defined as reallocation of Ecospold 2 information that has no corresponding field in ILCD to related comment sections. This is related to the loss of functionality due to the specific field purposes in Ecospold 2 that could not be matched in ILCD's structure. Lavoisier uses this type of conversion as a workaround since the direct or indirect conversion is not possible due to the lack of proper ILCD fields that could encompass the same information. The

Ecospold 2 fields that underwent that type of conversion in Lavoisier are the following:

- ../tag {o}
  - Type if conversion: Incomplete
  - Importance: Other metadata. Dataset tags for better identification when searched
  - ILCD correspondent fields: for processes
    - processInformation/dataSetInformation/generalComment
  - ILCD correspondent fields: for flows
    - [flowDataSet] flowInformation/dataSetInformation/generalComment
  - Obs: The several tag fields on Ecospold 2 were separated by ";" and joined into one text field.

- ../activity/@activityNameId {r}
  - Type of conversion: Incomplete
  - Importance: Other metadata. The id is used to identify the name of the process
  - ILCD correspondent fields:
    - processInformation/dataSetInformation/generalComment
  - Obs: This UUID identifies the name of the process, no matter the system model it is inscribed on. Although important, the id field was used as the main identifier for the dataset due to problems with duplication. This field is used in flow information as a reference to the activity producing that flow. As ILCD doesn't have a proper field to encompass this information, it is assigned to the general comment.

- ../activity/@specialActivityType {r}
  - Type of conversion: Incomplete
  - Importance: Other metadata. Information about the subtype of the process

- ○ Mapping: [0: ordinary transforming activity; 1: market activity; 2: IO activity; 3: residual activity; 4: production mix; 5: import activity; 6: supply mix; 7: export activity; 8: re-Export activity; 9: correction activity; 10: market group]
  - ○ ILCD correspondent fields:
    - ■ processInformation/dataSetInformation/generalComment
  - ○ Obs: The field is specific for ecoinvent classification of types such as market, market groups and so on. It is generated through the linking process done by the ecoinvent database. The enumeration of Ecospold 2 is mapped to a text before converting it to the general comment.

- ● ../activity/@parentActivityId {o}
  - ○ Type of conversion: Incomplete
  - ○ Importance: Other metadata. Information about the parent-child relationship of the dataset
  - ○ ILCD correspondent fields:
    - ■ processInformation/dataSetInformation/generalComment
  - ○ Obs: This field, in addition to the inheritanceDepth field, adds inheritance information (if the data is inherited partly from other parent datasets). The information is converted as text to indicate possible parent datasets.

- ● ../activity/@inheritanceDepth {o}
  - ○ Type of conversion: Incomplete
  - ○ Importance: Other metadata. Information about the parent-child relationship of the dataset
  - ○ ILCD correspondent fields:
    - ■ processInformation/dataSetInformation/generalComment
  - ○ Obs: This field, in addition to the parentActivityId field, adds inheritance information (if the data is inherited partly from other parent datasets). The information is converted as text to indicate possible parent datasets. The field is

transformed into a sentence that indicates the context of the inheritance.

- ../macroEconomicScenario/name {r}
  - Type of conversion: Incomplete
  - Importance: Other metadata. Name of macro-economic scenario in which the process is inserted
  - ILCD correspondent fields:
    - processInformation/dataSetInformation/generalComment

- ../macroEconomicScenario/comment {o}
  - Type of conversion: Incomplete
  - Importance: Other metadata. comment about the macro-economic scenario in which the process is inserted
  - ILCD correspondent fields:
    - processInformation/dataSetInformation/generalComment

4.5. Not converted

This field's information was not converted to ILCD. They are represented by 3 classes:

- Ecospold 2 structural fields, context-specific fields, and parent-child relationship fields for inheritance identification that are only valuable information for Ecospold 2 (doesn't change dataset LCI information)
- Specific identifications (such as the macroEconomicScenarioId) that could be used to assess ecoinvent Master Data for further information but weren't used as part of the philosophy of only using file information for the conversion
- Ecospold 2 structures that are not yet used in the format (such as transferCoefficients).

All fields that were not converted presented no loss of LCA functionality and were not considered data loss either.

Some fields related to timestamp and versioning for the ILCD process dataset were not converted but were better explained and presented in the section 'Timestamp and Versoning' in the complex structure conversions.

The Ecospold 2 fields that underwent that type of conversion in Lavoisier are the following:

- ../activity/@activityNameContextId {o}
    - Type of conversion: Not converted
    - Importance: Not used
    - Obs: Context-specific field in Ecospold 2

- ../activity/@masterAllocationPropertyContextId {o}
    - Type of conversion: Not converted
    - Importance: Not used
    - Obs: Field not yet used in Ecospold 2

- ../exchange/@specificAllocationPropertyContextId {o}
    - Type of conversion: Not converted
    - Importance: Not used
    - Obs: Field not yet used in Ecospold 2

- ../activity/@masterAllocationPropertyIdOverwrittenByChild {o}
    - Type of conversion: Not converted
    - Importance: Other Metadata
    - Obs: Parent-child relationship field in Ecospold 2

- ../exchange/@specificAllocationPropertyIdOverwrittenByChild {o}
    - Type of conversion: Not converted
    - Importance: Other Metadata
    - Obs: Parent-child relationship field in Ecospold 2

- ../classification/@classificationContextId {o}
    - Type of conversion: Not converted

- ○ Importance: Not used
- ○ Obs: Context-specific field in Ecospold 2

- **../representativeness/@systemModelId {r}**
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Attribute could be used to assess additional information for the system model in ecoinvent Master Data, but Lavoisier doesn't use it as it relies only on the information of the file for conversion. For system model information, the field systemModelName is used instead.

- **../parameter/@parameterId {r}**
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Attribute could be used to assess additional information for the parameter in ecoinvent Master Data, but Lavoisier does not use it as it relies only on the information of the file for conversion. For parameter information, the field variableName and mathematicalRelation are used.

- **../geography/@geographyId {r}**
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Attribute could be used to assess additional information for geography in ecoinvent Master Data, but Lavoisier does not use it as it relies only on the information of the file for conversion. For geography information, the field shortname and comment are used instead.

- **../geography/@geographyContextId {o}**
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- **../macroEconomicScenario/@macroEconomicScenarioId {r}**

- ○ Type of conversion: Not converted
- ○ Importance: Other Metadata
- ○ Obs: Attribute could be used to assess additional information for macro-economic scenarios in ecoinvent Master Data, but Lavoisier doesn't use it as it relies only on the information of the file for conversion. The macro-economic scenario structure is often underused with the only option being 'Business-as-Usual'.

- ../macroEconomicScenario/@macroEconomicScenarioContextId {o}
    - ○ Type of conversion: Not converted
    - ○ Importance: Not used
    - ○ Obs: Context-specific field in Ecospold 2

- ../exchange/transferCoefficient {o}
    - ○ Type of conversion: Not converted
    - ○ Importance: Not used
    - ○ Obs: Field not yet used in Ecospold 2

- ../impactIndicatorResults {o}
    - ○ Type of conversion: Not converted
    - ○ Importance: Not used
    - ○ Obs: Field not yet used in Ecospold 2

- ../exchange/@intermediateExchangeContextId {o}
    - ○ Type of conversion: Not converted
    - ○ Importance: Not used
    - ○ Obs: Context-specific field in Ecospold 2

- ../exchange/@elementaryExchangeContextId {o}
    - ○ Type of conversion: Not converted
    - ○ Importance: Not used
    - ○ Obs: Context-specific field in Ecospold 2

- ../exchange/property@propertyContextId {o}

- ○ Type of conversion: Not converted
- ○ Importance: Not used
- ○ Obs: Context-specific field in Ecospold 2

- ● ../exchange/@activityLinkContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../exchange/@activityLinkIdOverwrittenByChild {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Parent-child relationship field in Ecospold 2

- ● ../@unitContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../@sourceContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../exchange/@productionVolumeSourceContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../exchange/compartment/subcompartmentContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../dataGeneratorAndPublication/@publishedSourceContextId {o}
  - ○ Type of conversion: Not converted

- ○ Importance: Not used
- ○ Obs: Context-specific field in Ecospold 2

- ../@sourceIdOverwrittenByChild {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Parent-child relationship field in Ecospold 2

- ../exchange/@productionVolumeSourceIdOverwrittenByChild {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Parent-child relationship field in Ecospold 2

- ../dataGeneratorAndPublication/@publishedSourceIdOverwrittenByChild {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Parent-child relationship field in Ecospold 2

- ../representativeness/@systemModelContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ../review/reviewerContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ../@personContextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ../dataGeneratorAndPublication/@companyContextId {o}
  - ○ Type of conversion: Not converted

- ○ Importance: Not used
- ○ Obs: Context-specific field in Ecospold 2

- ● ../dataGeneratorAndPublication/@companyIdOverwrittenByChild {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other Metadata
  - ○ Obs: Parent-child relationship field in Ecospold 2

- ● ../fileAttributes/contextName {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../fileAttributes/requiredContext {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../fileAttributes/@contextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../fileAttributes/@contextId {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Not used
  - ○ Obs: Context-specific field in Ecospold 2

- ● ../fileAttributes/@internalSchemaVersion {o}
  - ○ Type of conversion: Not converted
  - ○ Importance: Other metadata
  - ○ Obs: Format-related field in Ecospold 2

- ● ../fileAttributes/@fileGenerator {o}
  - ○ Type of conversion: Not converted

- Importance: Other metadata
- Obs: Format-related field in Ecospold 2