EUGEOS' 15804_A2-IA DATABASE: METHOD

EuGeos' 15804_A2-IA Database is a version of ecoinvent v3_6 extended to allow calculation of the indicators required in construction product EPD to meet European standard EN 15804. Impact assessment methods are included for both EN 15804+A1 and EN 15804+A2. The database has been used to produce verified EPD published in ISO14025-compliant EPD Programmes and registered on ECO Platform; it is not a pre-verified EPD tool.

The base ecoinvent version is that with "cut-off" allocation applied. This allocation is preserved in the 15804_A2-IA Database; no data point present in the base ecoinvent version is altered in any way.

The 15804_A2-IA Database uses ecoinvent's nomenclature.

EN 15804 OVERVIEW

European standard EN 15804:2012+A2:2019 is a core product category rule for environmental product declarations (EPD) of construction products and construction services. It has been widely adopted by EPD programmes in Europe to harmonise many aspects of the production and presentation of EPD for these goods. The earlier version, EN 15804:2012+A1:2013, remains in use for a transition period.

Both EN 15804+A1 and +A2 require compliant EPD to report a number of indicators (see below), not all of which are calculated by the standard LCIA methods supplied by the ecoinvent centre as part of the ecoinvent database package.

The 15804_A2-IA Database therefore includes impact assessment methods that may be used to calculate all of the indicators required by both versions of EN 15804, except the PERM and PENRM indicators (Primary energy, renewable or non-renewable, used as raw material (feedstock)), and biogenic carbon content (required by EN 15804+A2 only). According to CEN TC350 guidance, the PERM and PENRM indicators are counted as the relevant part of the net calorific value (NCV, also LHV) of the product. Similarly, the biogenic carbon content of a product can only be derived from its material composition, for example following a standard such as EN16449:2014 for wood. These indicators thus relate to inherent properties of individual products and will normally be obtained outside an LCA. Two impact assessment methods are included: one each for EN 15804+A1 and EN 15804+A2; key aspects are outlined below.

ENVIRONMENTAL INDICATORS FOR EN 15804

EN 15804 requires publication of a number of indicators. These may be considered in 5 groups:

- Group 1: Indicators derived from LCA
- Group 2: Energy indicators
- Group 3: Material and waste indicators
- Group 4: Flows leaving the product system
- Group 5: Additional impact categories and indicators

The approach taken to calculation of indicators in Groups 3 and 4 is the same as that taken in previous versions of the database. Some details have been changed, particularly to try to assign the flows counted as secondary materials, secondary fuels, materials for energy recovery and materials for recycling appropriately, in accordance with their status with respect to the "end of waste state".

GROUP 1: INDICATORS DERIVED FROM LCA

EN15804+A1

Indicator	Abbreviation	Units
Climate change - GWP100	GWP	kg CO_2 eq
Ozone layer depletion - ODP steady state	ODP	kg CFC-11 eq
Acidification potential - average Europe	AP	kg SO_2 eq
Eutrophication - generic	EP	kg PO_4^{3-} eq
Photochemical oxidant creation potential	POCP	kg ethylene eq
Depletion of abiotic resources - elements, ultimate reserves	ADPE	kg Sb eq
Depletion of abiotic resources - fossil fuels	ADPF	MJ

EN 15804+A1 specifies:

Characterisation Factors for Group 1 indicators are provided in the standard; they are taken from the CML Impact Assessment method version 4.1, published November 2012.

Our implementation:

Characterisation factors are from CML- IA v 4.1, 2012. Nomenclature is ecospold 2, as implemented in ecoinvent v3.2. Only the impact categories specified in EN 15804 are included: global warming, stratospheric ozone depletion, eutrophication, acidification of soil and water, abiotic resource depletion (elements and fossil fuels) photochemical ozone creation. Also as specified in EN 15804, only the variants designated by CML as "baseline" are included.

The CML method used for ADPE contains, in its original form as reproduced in EN15804+A1, contains characterisation factors (CF) for elements only. In the impact assessment we use the CF for elements as published in the standard, and the CF for their compounds where these CF are based on the proportion of the element in the compound according to its molecular formula. Neither the standard nor the original CML method contain a CF for every element in the periodic table.

Failure to include compounds would lead to flawed assessments of resource depletion in many instances. Very few elements occur in an uncombined state in nature, and the resources in ground category of elementary flows in generic databases contain the compounds which do occur.

EN15804+A2

Indicator	Abbreviation	Units
Climate change (total)	GWP-total	kg CO_2 eq
Climate change (fossil)	GWP-fossil	kg CO_2 eq
Climate change (biogenic)	GWP-biogenic	kg CO_2 eq
Climate change (land use and land use change)	GWP-luluc	kg CO_2 eq
Ozone layer depletion (ODP steady state)	ODP	kg CFC-11 eq
Acidification potential (accumulated exceedance)	AP	mol H^+ eq
Eutrophication (aquatic freshwater)	EP-F	kg PO_4^{3-} eq
Eutrophication (aquatic marine)	EP-M	kg N^- eq
Eutrophication (terrestrial)	EP-T	mol N eq
Photochemical ozone creation potential (tropospheric ozone formation potential)	POCP	kg NMVOC eq
Depletion of abiotic resources - elements, ultimate reserves	ADPE	kg Sb eq
Depletion of abiotic resources - fossil fuels	ADPF	MJ
Water use (Water (user) deprivation potential - weighted water consumption	WDP	m^3 (world-equivalent deprived)

EN 15804+A2 specifies:

Characterisation Factors for Group 1 indicators are provided by the European Commissions' Joint Research Centre (EC-JRC) in an Excel file identified by the name EN_15804.

Our implementation:

The factors published by EC-JRC in the file named EN_15804, downloaded in January 2020 have been used. For the methods listed above, the characterisation factors are the same as those published in EF reference package 3.0

No change to the life cycle inventory data present in the ecoinvent database is required, or made, to deliver these indicators.

GROUP 2: ENERGY INDICATORS (EN15804+A1 AND EN15804+A2)

Indicator	Abbreviation	Units
Renewable primary energy as energy carrier	PERE	MJ
Renewable primary energy resources as material utilisation	PERM	MJ
Total renewable primary energy use (sum of the two parameters above)	PERT	MJ
Non-renewable primary energy as energy carrier	PENRE	MJ
Non-renewable primary energy resources as material utilisation	PENRM	MJ
Total non-renewable primary energy use (sum of the two parameters above)	PENRT	MJ

EN 15804 specifies:

PERT = PERE + PERM and PENRT = PENRE + PENRM.

No specific set of impact assessment factors is given in the standard. Guidance on the implementation of EN 15804 from the relevant CEN Technical Committee states that the "*primary energy as material utilisation*" indicators should be derived from the lower heating value (LHV or net calorific value, NCV) of the product itself.

Our approach

PERT and PENRT are calculated using a Cumulative Energy Demand (CED) method which uses net calorific value (NCV, LHV) as characterisation factors.

Our implementation:

The overall PE(N)RT indicator value is the sum of the total indicator values for the non-renewable and renewable categories respectively. Calculation uses the cumulative energy demand (CED) method as implemented in ecoinvent, with characterisation factors for fossil fuels changed to the net CV(LHV) based factors provided in the abiotic depletion (fossil fuels) impact assessment method. for consistency.

The PE(N)RM indicators (Primary energy, renewable or non-renewable, used as raw material (feedstock) must be derived from the net calorific value (NCV, also LHV) of the product, divided between fossil-derived materials (PENRM) and materials derived from biological sources (PERM); these indicator values should be obtained outside of the LCA.

PE(N)RE is then also obtained outside the LCA as PE(N)RT - PE(N)RM

GROUP 3: MATERIAL AND WASTE INDICATORS (EN15804+A1 AND EN15804+A2)

EN 15804 specifies:

The first four indicators in Group 3 are items from the life cycle inventory.

Guidance on the interpretation of the net use of fresh water indicator draws on ISO 14046:2015; for example water consumed is said to be "*the sum of water which evaporates, transpires from biomass, is incorporated into products or is discharged to a different drainage basin*".

The last three indicators are intermediate flows within the modelled system; some potential environmental impacts associated with their management are included in the indicators in Groups 1 and 2. Aggregated quantities for intermediate flows are not calculated by established life cycle impact assessment methods (because they do not represent impacts, as such).

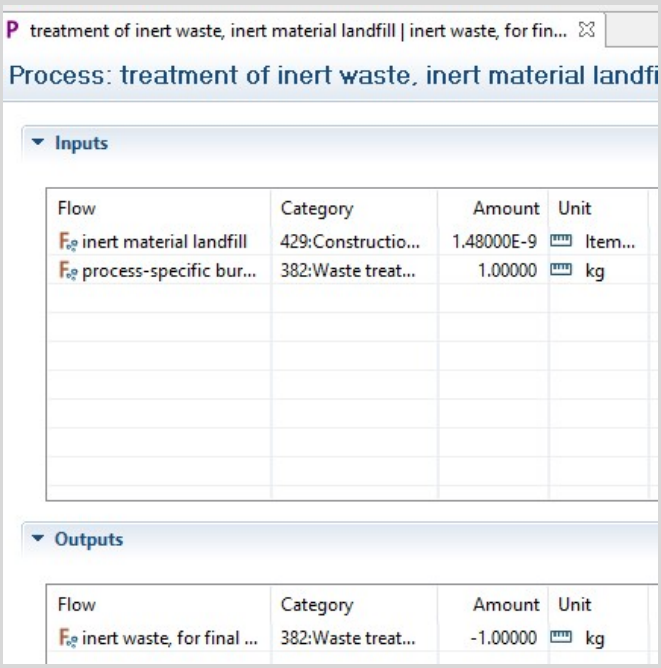
Indicator	Abbreviation	Units
Use of secondary material	SM	kg
Net use of fresh water	FW	m^3
Use of renewable secondary fuels	RSF	MJ
Use of non-renewable secondary fuels	NRSF	MJ
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
Radioactive waste disposed	TRWD	kg

Our implementation:

NON-HAZARDOUS AND HAZARDOUS WASTES

Wastes flowing into final treatment processes are classified as either non-hazardous or hazardous; the category indicator result in each case is the total waste being treated across the product system.

To calculate these indicators, an elementary flow (final waste; hazardous or non-hazardous; landfill, incineration or long-term storage) is introduced into each unit process that represents final treatment of a waste (after allocation). Adding this flow to the ecoinvent unit processes "*process-specific burdens,.....incineration plant*" and "*process-specific burdens,.....landfill*" achieves this for many final treatment processes, which draw on them to represent the operational burden of a landfill or incinerator as in the example below:

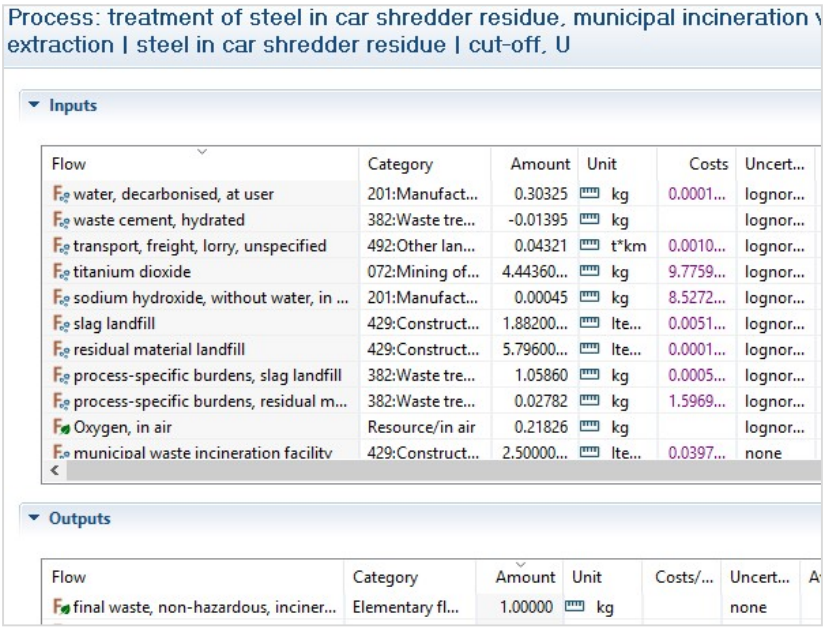


For final waste treatment processes that do not have a "*process-specific burdens..*" process representing the main treatment activity among the supplying processes, **and** that represent treatment of the waste itself after allocation between the outputs of multi-output processes (i.e. not the production of a co-product such as heat, as in single-output processes with names like: "*treatment of waste paint, municipal incineration | heat*,...) the relevant flow is added separately. An example is shown in the image on the following page for the process: "*treatment of steel in car shredder residue, municipal incineration with fly ash extraction | steel in car shredder residue | cut-off*"; in such cases, "*process-specific burdens..*" processes only supply the burdens of disposal of the slag and inert material produced by the incineration activity to landfill. The elementary flow "final waste, non-hazardous, incineration" is therefore added as an output so that the waste entering the incinerator is captured in the LCI. Of the processes of type "*treatment of waste xxx, municipal incineration... | waste xx"* only those for Switzerland and without fly ash extraction are linked to the *process-specific burdens, municipal incineration*" process.

The elementary flows are then aggregated using two LCIA methods, one for hazardous wastes, one for non-hazardous wastes.

The classification of wastes into hazardous or non-hazardous already present in the ecoinvent database is retained in almost all cases. However, wastes sent to long-term storage (*treatment of waste..., underground deposit....)* are all assumed to be hazardous because in our practical experience this disposal route is only used for hazardous wastes. Treatment of sludge by anaerobic digestion is not treated as disposal; landfarming is.

There is significant uncertainty associated with the classification of wastes from generic processes as "hazardous" or "non-hazardous"; many wastes with similar descriptions can be either hazardous or non-hazardous, and the European Waste Catalogue contains numerous mirror waste codes, where the same EWC code (i.e. waste with the same description from the same source activity) can apply to either hazardous or non-hazardous waste according to the waste's exact composition. Slightly different interpretations would therefore be equally justifiable.



RADIOACTIVE WASTE ARISINGS (AS MASS)

In principle, the radioactive waste indicator is calculated from the life cycle inventory item "volume of final storage occupied" by applying specific gravity. The densities used to convert from volumes to mass are those quoted in ecoinvent's documentation of the relevant unit process data. The densities are applied in the unit processes for final disposal of radioactive wastes *("treatment of....radioactive waste for final repository*" and "*treatment of low-level radioactive wastes, surface or trench deposit*"); an elementary flow is added to represent the appropriate amount of material as mass. According to the type of waste treated by the process, the introduced flow is selected from: "*final waste, radioactive, high-level"; "final waste, radioactive, HLW + ILW"; "final waste, radioactive, intermediate-level"; "final waste, radioactive, low-level*". These flows are not part of the native ecoinvent flow set.

SECONDARY MATERIAL

This indicator records the quantity of material that has passed the "end-of-waste" state and that is used in the modelled system as a material input. Material flows cut off by the cut-off allocation in ecoinvent are assumed to meet this criterion. To capture these using an LCIA method, an elementary flow "*secondary material (EN15804)"* is introduced to all the unit processes ".....Recycled Content cut-off" with two exceptions (see Secondary Fuel below). The total amount of secondary material is then present in the LCI and is obtained by applying an LCIA method. Ecoinvent processes are not all mass-balanced; negative values for this indicator are obtained in some instances if no significant recycled content is used in the foreground system. A negative result has no meaning and should be treated as zero; it should not be taken to represent an output of recyclable material.

SECONDARY FUEL (RENEWABLE AND NON-RENEWABLE)

These indicators reflect the quantities of material that have passed the "end-of-waste" state and are used in the modelled system as fuel inputs. Flows originally of plant origin (e.g. wood) are classed as renewable. Flows cut off by cut-off allocation in ecoinvent and almost certainly used as fuel (rather than material) are assumed to meet the criterion. The flows that meet this criterion are: "blast furnace gas" "biogas" and "log, energy wood". The relevant unit processes ending ".....Recycled Content cut-off" and processes consuming biogas are therefore amended to add an elementary flow. "*methane, 96% by volume*" from the waste treatment process "*biogas purification to methane 96 vol-%*" and "*light fuel oil*" from the process "*light fuel oil production, from waste polyethylene* are also counted as secondary fuels - renewable and non-renewable respectively.

contd.

NET USE OF FRESH WATER

This is calculated as the difference between inflows of water resources and outflows of water returned to the freshwater environment that are registered in the life cycle inventory (LCI). Classification of water types as "used" water follows CEN TC350 guidance, and ISO 14046:2014. The flows included are shown in the table below, with characterisation factors. All regionally-specific versions of each flow listed attract the same characterisation factor:

Flow	Category	Factor	Unit
Water	*Emission to water/surface water*	*-0.001*	*m3FW/kg*
Water	*Emission to water/unspecified*	*-0.001*	*m3FW/kg*
Water	*Emission to water/unspecified*	*-1*	*m3FW/m3*
Water	*Resource*	*0.001*	*m3FW/kg*
Water (fresh water)	*Resource*	*0.001*	*m3FW/kg*
Water (groundwater from technosphere, waste water)	*Emission to water/fresh water*	*0.001*	*m3FW/kg*
Water (river water from technosphere cooling water)	*Emission to water/fresh water*	*-0.001*	*m3FW/kg*
Water (river water from technosphere turbined)	*Emission to water/fresh water*	*-0.001*	*m3FW/kg*
Water (river water from technosphere, waste water)	*Emission to water/fresh water*	*-0.001*	*m3FW/kg*
Water Cooling fresh	*Resource*	*0.001*	*m3FW/kg*
Water, barrage	*Resource*	*0.001*	*m3FW/kg*
Water, cooling, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, feed	*Resource*	*0.001*	*m3FW/kg*
Water, ground	*Resource*	*0.001*	*m3FW/kg*
Water, lake	*Resource*	*1*	*m3FW/m3*
Water, process and cooling, surface	*Emission to water/unspecified*	*-1*	*m3FW/m3*
Water, process and cooling, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, process, drinking	*Resource*	*0.001*	*m3FW/kg*
Water, process, unspecified natural origin	*Emission to water/unspecified*	*-1*	*m3FW/m3*
Water, process, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, rain	*Resource*	*0.001*	*m3FW/kg*
Water, river	*Resource*	*1*	*m3FW/m3*
Water, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, surface	*Resource*	*0.001*	*m3FW/kg*
Water, turbine use, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, unspecified natural origin	*Resource*	*1*	*m3FW/m3*
Water, unspecified origin	*Resource*	*1*	*m3FW/m3*
Water, well, ...	*Resource*	*1*	*m3FW/m3*
Water, with river silt	*Resource*	*0.001*	*m3FW/kg*
Water, cooling,...			

GROUP 4: FLOWS LEAVING THE PRODUCT SYSTEM (EN15804+A1 AND EN15804+A2)

Indicator	Abbreviation	Units
Components for re-use	CRU	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ per energy carrier

EN 15804 specifies:

Group 4 indicators are reported where the relevant items leave the modelled system boundary. Flows such as production scrap sent for recycling or "waste" heat exported from production facilities for use may be included, as well as specific flows defined in scenarios covering the use and end-of-life phases of product life cycles.

Refer to Life Cycle Stages (see below) for more detail on how the life cycle is characterised in EN 15804; the standard itself should be consulted for exact information about flows covered by these indicators.

Our implementation:

Methods are provided in the EuGeos database to generate an aggregated quantity for each type of qualifying non-elementary flows leaving the modelled product system. In theory there are no such flows relevant to "components for re-use", or "exported energy" when systems are modelled in ecoinvent, except those subject to cut-off allocation. Values of zero should be obtained when products already present in ecoinvent are calculated for all indicators except "materials for recycling" (MFR) and "materials for energy recovery" (MER). MFR and MER are calculated using an approach similar to that adopted for the waste to final disposal indicators. An elementary flow is added to relevant processes to enable the required quantities to be calculated as part of the LCI and thus captured by an LCIA method.

For MFR the "relevant quantities" are outputs of processes classed as materials recovery (ISIC no. 3830) that treat neither capital items (vehicles, buildings, etc.) nor obvious construction materials (assumed to come from buildings and infrastructure) and that do not produce waste.

For MER the included flows are "*ethanol, without water, in 95% solution state, from fermentation", "biogas" (*prior to purification*) and "poultry manure, dried*".

Other interpretations for the calculation of these indicators are possible, and values of 0 are found in many EPD for these indicators for the A1 - A3 modules.

GROUP 5: ADDITIONAL IMPACT CATEGORIES AND INDICATORS (EN15804+A2 ONLY)

EN 15804+A2 requires the LCA underpinning any EPD to include calculation of a number of additional indicators obtained using the LCIA methods listed in the table below. These indicators must be reported in the LCA project report that is produced as background to the EPD. Their inclusion in the EPD is not mandatory.

Indicator	Abbreviation	Units
Particulate matter emissions (potential incidence of disease due to PM emissions)	PM	Disease incidence
Ionising radiation (potential human exposure efficiency relative to U235)	IRP	kBq U235 eq.
Ecotoxicity (freshwater, as potential comparative toxicity unit for ecosystems)	ETP-fw	CTUe
Human toxicity, cancer effects (HTP-c)	HTP-c	CTUh
Human toxicity, non-cancer effects (HTP-nc)	HTP-nc	CTUh
Land use related impacts / soil quality (potential soil quality index)	SQP	dimensionless

EN 15804 specifies:

Characterisation Factors for Group 5 indicators are provided by the European Commissions' Joint Research Centre (EC-JRC) in an Excel file identified by the name EN_15804.

Our implementation:

The factors published by EC-JRC in the file named EN_15804, downloaded in January 2020 have been applied, **for the flows present in ecoinvent v3.6 ONLY**. The characterisation factors applied to these are the same as those published in EF reference package 3.0. **To ensure correct calculation of LCIA results, users should either use only elementary flows already present in ecoinvent v3.6, or - if other flows are used - check that the characterisation factors for them in the toxicity LCIA methods correspond to those in the EF reference package 3.0, updating those factors if necessary.**

No change to the life cycle inventory data present in the ecoinvent database is required, or made, to deliver these indicators.

LIFE CYCLE STAGES (INFORMATION MODULES) IN EN 15804

The product category rules for environmental product declarations of construction products and construction services as brought forward by EN 15804:2012+A1:2013 adopt an “information modules” approach with respect to the life cycle stages covered by an EPD.

The environmental information in a cradle to grave EPD shall therefore be subdivided into the following life cycle stages and information module groups:

THE ‘PRODUCT STAGE’

comprising: A1 – raw material supply, including processing of secondary material input

A2 – transport of raw material and secondary material to the manufacturer

A3 – manufacture of the construction products, and all upstream processes from cradle to grave

Modules A1-A3 thereby account for all upstream processes for the production stage of a given building material, including raw material extraction, manufacture and transport of intermediate products, processing of secondary input materials once they have past the "end-of-waste state" and their transport to the production plant, provision of all auxiliary and operation materials and energy, the actual manufacturing process of the product at hand, as well as for the complete waste treatment or landfilling of waste streams arising along the entire production phase (cradle to gate). The “product stage” (modules A1-A3) represents the minimum number of processes that must be covered by an EPD.

Note: modules A1, A2, and A3 may be declared as one aggregated module A1 - A3.

THE 'CONSTRUCTION PROCESS STAGE'

comprising: A4 – transport of construction products to the building site

A5 – the building installation/ construction

THE 'USE STAGE' - RELATED TO THE BUILDING FABRIC

comprising: B1 – use of the installed product, service or appliance (refers to e.g. the release of substances from painted surfaces over the use phase; emissions arising during assembly/ application phase – e.g. emissions during application of facade paints – are counted in module A5)

B2 – maintenance of the product

B3 – repair of the product

B4 – replacement of the product

B5 – refurbishment of the construction product

THE 'USE STAGE' – RELATED TO THE OPERATION OF BUILDING

comprising: B6 – operational energy

B7 – operational water use

This use stage also includes processing and transportation of any waste arising on site from the use of energy/water.

THE 'END-OF-LIFE STAGE'

comprising: C1 – demolition of the building/building product

C2 – transport of the demolition waste or the end-of-life construction product to waste processing facility

C3 – waste processing operations for reuse, recovery or recycling

A further module, "Module D", allows the potential benefits that may arise when the product or its constituent materials are recycled to be presented. Calculation of Module D is mandatory under EN15804+A2.

EuGeos Limited
www.eugeos.co.uk
tel: +44(0)1625 434423
email: lca@eugeos.co.uk