Utilisation de l'outil d'ACV novaEquer pour le référentiel LEED

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English version follows

1 Contexte

LEED (Leadership in Energy and Environmental Design) est un système nord-américain de certification environnementale des bâtiments créé par l'US Green Building Council. Le présent document est basé sur le système d'évaluation utilisé pour les bâtiments neufs (BD+C « Building Design and Construction ») dans sa version V4 (avril 2016).
Dans le crédit « Building Life-Cycle Impact Reduction », catégorie « Materials and ressources », une des options est la réalisation d'une analyse de cycle de vie sur l'ensemble du bâtiment (option 4).
Le présent document reprend la description de la partie d'exigence concernée et son guide d'application tel que figurant dans le référentiel et les réponses qui peuvent y être apportées avec l'outil novaEQUER.

2 Présentation générale de l'exigence

2.1 Rédaction de l'exigence dans le référentiel

OPTION 4. WHOLE-BUILDING LIFE-CYCLE ASSESSMENT (3 POINTS)

For new construction (buildings or portions of buildings), conduct a life-cycle assessment of the project's structure and enclosure that demonstrates a minimum of 10% reduction, compared with a baseline building, in at least three of the six impact categories listed below, one of which must be global warming potential. No impact category assessed as part of the life-cycle assessment may increase by more than 5% compared with the baseline building.

The baseline and proposed buildings must be of comparable size, function, orientation, and operating energy performance as defined in EA Prerequisite Minimum Energy Performance. The service life of the baseline and proposed buildings must be the same and at least 60 years to fully account for maintenance and replacement. Use the same life-cycle assessment software tools and data sets to evaluate both the baseline building and the proposed building, and report all listed impact categories. Data sets must be compliant with ISO 14044.

Select at least three of the following impact categories for reduction:

- global warming potential (greenhouse gases), in CO_2e;
- depletion of the stratospheric ozone layer, in kg CFC-11;
- acidification of land and water sources, in moles H+ or kg SO_2;
- eutrophication, in kg nitrogen or kg phosphate;
- formation of tropospheric ozone, in kg NO_x or kg ethene; and
- depletion of nonrenewable energy resources, in MJ.

2.2 Réponses de novaEquer

Exigence	novaEquer
Pour les nouvelles constructions (bâtiments ou parties de bâtiments), conduire une analyse de cycle de vie de la structure et de l'enveloppe du projet qui démontre la réduction d'au moins 10 %, par rapport à un bâtiment de référence, d'au moins 3 des 6	5 des indicateurs demandés figurent parmi les 12 indicateurs évalués par novaEquer, dont le changement climatique : - demande cumulative d'énergie (MJ) - déchets produits (t)

indicateurs listés ci-dessous, l'un de ces indicateurs devant être la contribution à l'effet de serre. Aucun des indicateurs analysés ne devra augmenter de plus de 5 % par rapport au bâtiment de référence. Au moins 3 des indicateurs suivants doivent être diminués : - Contribution à l'effet de serre (CO_2 eq) - Destruction de la couche d'ozone (kg CFC-11) - Acidification (moles H+ ou kg SO_2) - Eutrophisation (kg d'azote ou kg de phosphates) - Ozone troposphérique (kg NO_x ou kg ethylene) - Energie primaire non renouvelable consommée (MJ)	- déchets radioactifs (dm^3) - effet de serre (kg CO_2 eq) - épuisement des ressources abiotiques (kg Sb eq) - odeur (m^3) - eau utilisée (l) - production d'ozone photochimique (kg C_2H_4 eq) - dommage à la santé (DALY) - dommage à la biodiversité (PDF.m².an) - eutrophisation (kg PO_4^{3-} eq) - acidification (kg SO_2 eq)
Les bâtiments de référence et projeté doivent avoir des caractéristiques comparables en termes de taille, d'usage, d'orientation et de performance énergétique, comme défini dans le prérequis EA « Minimum Energy Performance ».	Il est possible dans novaEquer de mener l'ACV en partant de deux bâtiments identiques, mais de caractéristiques constructives différentes. Leur performance énergétique est évaluée en amont de l'ACV en simulation énergétique dans Pleiades.
La durée de vie des bâtiments de référence et projeté doivent être les mêmes et d'au moins 60 ans pour prendre pleinement en compte la maintenance et le remplacement de certains éléments. Utiliser le même outil d'ACV et les mêmes bases de données environnementales pour évaluer les deux bâtiments et reporter tous les impacts.	La durée de vie du bâtiment est paramétrable dans novaEQUER. La maintenance et les remplacements d'éléments sont pris en compte dans l'étape « rénovation » : chaque élément a sa propre durée de vie typique, si celle-ci est inférieure à la durée de l'analyse, des remplacements sont comptabilisés.
Les bases de données doivent être compatibles avec l'ISO 14044.	novaEQUER utilise les bases de données Ecovinvent, compatibles avec l'ISO 14 044. La méthodologie de constitution de ces bases a fait l'objet de publications scientifiques publiquement disponibles et revues par des pairs.

3 Guide d'application pas-à-pas

3.1 Objectif de l'analyse du cycle de vie

Option 4. Whole-Building Life-Cycle Assessment

This option has only one threshold. To achieve this option the proposed building must demonstrate at least a 10% reduction in global warming potential and a 10% reduction of two of five other impact measures (discussed below) when compared to a baseline building, without increasing any measure by more than 5%.

Exigence	novaEquer
Cette option est constituée d'un seuil unique. Pour être conforme, le bâtiment projeté doit démontrer une diminution d'au moins 10 % de 2 des 5 autres indicateurs, par rapport à un bâtiment de référence. Sans qu'aucun des indicateurs n'augmente de plus de 5 %.	Voir ci-dessus, 5 des indicateurs demandés figurent parmi les 12 indicateurs évalués par novaEquer.

3.2 Champ de l'analyse

3.2.1 Etapes du cycle de vie

STEP 1. CALCULATE EXISTING BUILDING SURFACE AREA AND REUSE EXISTING BUILDING

Ensure that the scope of the analysis is a cradle-to-grave assessment, which includes environmental impacts associated with all the life-cycle stages for the building structure and enclosure: resource extraction or harvest, building product manufacture, on-site construction, product maintenance and replacement (where warranted), and deconstruction or demolition and disposal over the assumed 60-year service life. The LCA must address the following:

Exigence	novaEquer
S'assurer que le champ de l'analyse est bien une analyse « cradle-to-grave », du berceau à la tombe, ce qui inclut les impacts associés à toutes les étapes de la vie de la structure et de l'enveloppe du bâtiment : extraction ou récolte des ressources, fabrication des produits de construction, chantier, maintenance et remplacement et déconstruction ou démolition et traitement des déchets après les 60 années de durée de vie.	L'analyse produite par novaEquer couvre 4 étapes de la vie du bâtiment et en donne les résultats de façon distincte : - Construction : ressources, fabrication des produits et phase chantier - Utilisation : utilisation du bâtiment (énergie, eau, déchets liés à son exploitation) - Rénovation : impact du remplacement périodique de certains éléments de construction - Démolition : traitement en fin de vie

3.2.2 Produits

- **Products.** The LCA must cover the complete building envelope and structural elements, including the material components of footings and foundations, structural wall assembly (from cladding to interior finishes), structural floors and ceilings (not including finishes), and roof assemblies.
  - Exclude electrical and mechanical equipment and controls, plumbing fixtures, fire detection and alarm system fixtures, elevators, and conveying systems.
  - Exclude excavation and other site development.
  - Include parking structures; exclude parking lots.
  - Additional building elements, such as interior nonstructural walls or finishes, may be included at the discretion of the project team but earn no additional credit.

Exigence	novaEquer
Produits. L'ACV doit couvrir l'ensemble de l'enveloppe et de la structure du bâtiment, y compris les matériaux de fondation, des murs structurels (du revêtement extérieur à la finition intérieure), des planchers et plafonds structurels (sans inclure les finitions) et des toitures. Exclure les équipements électriques et mécaniques et leurs contrôles, la plomberie, la détection incendie, les alarmes, ascenseurs et les systèmes de transport. Exclure les terrassements et les travaux de VRD Inclure les structures vouées au parking, exclure les parkings de surface Les éléments de bâtiment supplémentaires, comme les murs intérieurs non structurels et leurs finitions, peuvent être inclus par l'équipe de conception mais n'apportent pas de crédit supplémentaire.	L'inventaire des matériaux disponible dans novaEQUER permet de couvrir l'ensemble des éléments demandés par le référentiel. Les exclusions demandées peuvent également être respectées. Tous les matériaux saisis dans le modèle thermique dans Pleiades sont automatiquement repris dans l'ACV de novaEQUER. Cet inventaire automatique inclut les murs extérieurs, planchers bas, planchers et toitures, y compris leurs finitions. Afin de satisfaire au champ d'analyse demandé par le référentiel, cet inventaire automatique peut être corrigé dans novaEQUER pour y ajouter les éléments non saisis dans l'étude thermique (fondations, structures de parking), retirer les finitions des planchers et plafonds (c'est à dire associer "zero" impact aux états de surface correspondants) et retirer ou non les cloisons intérieures, selon le choix de l'équipe de conception.

3.2.3 Unité fonctionnelle

- **Functional equivalence.** The proposed and baseline buildings have to serve the same function and must have the same gross floor area, orientation, and operational energy usage.

Exigence	novaEquer
Unité fonctionnelle. Les bâtiments de référence et projeté doivent avoir des caractéristiques comparables en termes d'usage, de surface, d'orientation et de performance énergétique.	Il est possible dans novaEquer de mener l'ACV en partant de deux bâtiments identiques, mais de caractéristiques constructives différentes. Ces deux bâtiments devront avoir fait l'objet d'une simulation énergétique en amont de l'ACV dans Pleiades afin de comparer leur performance énergétique.

3.2.4 Durée de vie

- **Service life.** For LEED, the project team must take into account the entire building structure and enclosure, from design to demolition for an assumed 60-year service life.
  The assumed service life must be the same for the baseline and proposed buildings and must be at least 60 years to properly account for material maintenance and replacement (see *Further Explanation, Product Replacement*).

Exigence	novaEquer
Durée de vie L'équipe de conception doit prendre en compte la totalité de la structure et de l'enveloppe du bâtiment, de la conception à la fin de vie, pour une durée de vie de 60 ans. La durée de vie des bâtiments de référence et projeté doivent être les mêmes et d'au moins 60 ans pour prendre pleinement en compte la maintenance et le remplacement de certains éléments.	La durée de vie du bâtiment est paramétrable dans novaEQUER. La maintenance et les remplacements d'éléments sont pris en compte dans l'étape « rénovation » : chaque élément a sa propre durée de vie typique, si celle-ci est inférieure à la durée de l'analyse, des remplacements sont comptabilisés.

3.2.5 Frontières du système

- **System boundary.** The system boundary of the analysis must be defined to account for cradle-to-grave environmental impacts associated with all the life-cycle stages for the building structure and enclosure as defined in ISO 21930 sections A-1 thru A-4, B-1 thru B-7, and C-1 thru C-4.

Exigence	novaEquer
Frontières du système Les frontières du système analysé doivent être définies pour prendre en compte les impacts « du berceau à la tombe » associés à toutes les étapes de la vie du bâtiment (structure et enveloppe), comme défini dans l'ISO 21930, sections A1 à A4, B1 à B7 et C1 à C4.	L'analyse produite par novaEquer couvre 4 étapes de la vie du bâtiment et en donne les résultats de façon distincte : - Construction : ressources, fabrication des produits et phase chantier - Utilisation : utilisation du bâtiment (énergie, eau, déchets liés à son exploitation) - Rénovation : impact du remplacement périodique de certains éléments de construction - Démolition : traitement en fin de vie

3.3 Choix de l'outil d'ACV et des indicateurs

3.3.1 Choix du système de mesure des impacts

STEP 4. SELECT RELEVANT IMPACT MEASUREMENT SYSTEMS

Select the appropriate output units for each LCA impact indicator shown in Table 4 (see *Further Explanation, Life Cycle Impact Measures Or Indicators*).

TABLE 4. LCA impact indicator units

LCA Impact IndicatorS	TRACI 2.1	CML 2002	ReCIPe
Global warming potential	CO_2e	CO_2e	CO_2e
Ozone depletion potential	CFC-11-eq	CFC-11-eq	CFC-11-eq
Acidification potential (land)	SO_2e	SO_2e	SO_2e
Eutrophication potential (fresh water)	N eq	PO_4^3e	P eq
Formation of tropospheric ozone (photochemical oxidant formation)	NO_x eq	C_2H_4e	kg NMVOC
Depletion of nonrenewable energy resources	MJ	Weight or volume of raw material	Kg oil eq

Exigence	novaEquer		
Choisir les unités appropriées pour les indicateurs environnementaux choisis.	Unités et méthode utilisées dans novaEQUER :		
	Effet de serre	kg CO_2 eq	GIEQ 2007
	Destruction de la couche d'ozone	*Non évaluée*	
	Acidification	kg SO_2 eq	CML 2002
	Eutrophisation	kg PO_4^{3-} eq	CML 2002
	Ozone troposphérique	kg C_2H_4 eq	CML 2002
	Energie primaire non renouvelable consommée	MJ	inventaire ecoinvent

3.3.2 Choix de l'outil d'ACV

LCA TOOLS SELECTION

This credit does not require design professionals to become LCA experts, but the choice of tool can determine whether an LCA specialist is required. Every LCA tool is populated with background data sets that form the basis of the assessment. Some LCA data are specific to the location of the building construction or the location of product manufacture because of the region's electric grid, for example. Different types of tools require varying levels of data set manipulation. There are two types of tools to consider.

Design team LCA tools simplify and streamline the LCA process for non-LCA practitioners. They manage the data and calculations in the background and do not allow the user to add or customize data. The user inputs material selections consistent with the building design and can then explore the environmental effects of design modifications by changing materials, floor area, or other aspects of the building.

Design team LCA tools have calculation factors specific to the country or region for which they were designed. Examples include the following:

- North America: ATHENA® Impact Estimator, athenasmi.org/our-software-data/impact-estimator/. This tool can import a bill of materials from a CAD system.
- United Kingdom: Envest 2, envest2.bre.co.uk/
- Australia: LCADesign. This tool can import a bill of materials from a CAD system.

LCA practitioner tools require the user to select the appropriate data sets and calculation factors. They typically conduct LCAs on a product-by-product basis and may require different methodological decisions for the products being examined. The practitioner then aggregates the results to the whole building level. Examples include the following:

- SimaPro, simapro.co.uk/
- GaBi, gabi-software.com/america/index/

Project teams that choose LCA practitioner tools will likely need to bring in an LCA specialist.

Exigence	novaEquer
Choix de l'outil d'ACV Deux types d'outils d'ACV doivent être considérés : Les outils d'ACV pour concepteurs simplifient le processus d'ACV pour des non spécialistes de l'ACV. Les données et les calculs sont transparents pour l'utilisateur et celui-ci ne peut pas personnaliser les données. Dans ce type d'outil, les paramètres de calcul sont adaptés à un pays ou région pour lequel ils sont conçus. Les outils experts demandent à l'utilisateur de choisir les bases de données appropriées et d'ajuster les paramètres de calcul. L'ACV est conduite produit par produit et demandent des choix méthodologiques qui peuvent varier d'un produit à l'autre. L'utilisateur agrège en suite les résultats au niveau du bâtiment.	novaEQUER est un outil pour concepteur, adapté à un usage sur le territoire français. La base de données ecoinvent utilisée a en effet fait l'objet d'une contextualisation, notamment pour les consommations d'électricité comprises dans les données de fabrication des matériaux, adaptées pour prendre en compte le mix électrique français.

3.3.3 Choix des indicateurs

LIFE CYCLE IMPACT MEASURES OR INDICATORS

The impacts measured in LCA are divided into two categories, as described in ISO 21930–2007, which deals with EPDs for building products. Impacts are either expressed in terms of the categories of life-cycle impact assessments (LCIA) or derived from a life-cycle inventory (LCI) and not assigned to impact categories.

LCIA is an additional step in analysis that interprets and quantifies the resulting ecological effects of resources used and waste emitted over the life-cycle of the product. In contrast, LCI simply quantifies flows in and out of the process in terms of resources used and depleted and waste created.

The first five measures specified in the credit requirements are impact categories of LCIA; they are the only LCIA categories cited in ISO 21930. Other LCIA measures are in use or being developed (e.g., human health and ecotoxicity measures) but are less quantifiable than the measures required for LEED, although they may be reported separately. Other impact assessment methods not listed in Table 4 may be used if the reasons are justified and documented.

The sixth measure in the list, depletion of nonrenewable energy resources, is in the second category because it is derived directly from the LCI (defined in the ISO standard as "phase of life-cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life-cycle").

Several other LCI aggregations are cited in ISO 21930 (e.g., depletion of nonrenewable material resources, use of renewable materials, and consumption of freshwater). These additional measures have not been included in the credit for the sake of simplicity. Teams may take these indicators into account in the LCA but are not required to submit them to meet the credit requirements.

For all the measures listed in Table 4 except depletion of nonrenewable energy resources, the software tool categorizes emissions and then applies characterization factors to create equivalence measures in the units shown in the table.

- In design team LCA tools, the characterization factors for the country or region are automatically generated.
- In LCA practitioner tools, the user must select the characterization factors and corresponding units for the country or region.

North American projects typically use the U.S. Environmental Protection Agency's TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) system. Projects in other parts of the world use the CML (Institute of Environmental Sciences) or ReCiPe system.

The impact assessment method must be no older than the most current version available on the LEED project registration date:

- TRACI, version 2.1 or newer
- CML, version 2001–November 2012 or newer
- ReCiPe, version 1.07 (midpoints) or newer

If these versions are not available in the chosen LCA tool, the project team must explain and justify the use of an alternative. Other impact assessment methods are available. If the chosen LCA tool offers options, the project team should weigh their pros and cons and choose the most appropriate method.

The same assessment method must be used for the baseline and proposed buildings.

For the purposes of complying with this credit, *depletion* means "the amount used," as opposed to more complex measures involving calculation of the amount used relative to existing physical or economic reserves.

Exigence	novaEquer
Type d'indicateur Les indicateurs environnementaux fournis par une ACV peuvent être divisés en deux types : Un indicateur peut être exprimé en termes d'évaluation des impacts du cycle de vie (EICV) Un indicateur peut être directement issu de l'analyse de l'inventaire du cycle de vie (ICV), sans être affecté à un impact. L'évaluation des impacts du cycle de vie (EICV) est une étape supplémentaire dans l'analyse qui interprète et quantifie les effets écologiques des ressources utilisées et des émissions tout au long du cycle de vie. L'analyse de l'inventaire du cycle de vie (ICV) ne fait que quantifier les flux entrant et sortant du système en termes de ressources utilisées et de déchets créés. Les cinq premiers indicateurs listés dans ce crédit sont de type évaluation de l'impact du cycle de vie. Le dernier (Energie primaire non renouvelable consommée) est directement issu de l'analyse de l'inventaire du cycle de vie. D'autres indicateurs de type ICV sont présents dans l'ISO 21930 mais n'ont pas été retenus pour des raisons de simplicité. Les équipes de conception peuvent les utiliser mais elles ne sont pas exigées pour l'obtention du crédit. Pour les 5 premiers indicateurs listés dans ce crédit, l'outil catégorise les émissions et applique un facteur de caractérisation pour créer une équivalence avec l'unité choisie. Dans les outils d'ACV pour concepteurs, ces facteurs de caractérisation sont automatiquement générés. Pour les projets hors Amérique du nord, les systèmes CML ou ReCiPe sont habituellement retenus. La méthode d'évaluation des impacts ne doit pas être plus ancienne que la plus récente version disponible à la date d'enregistrement du projet LEED : - CML, version 2001-november 2012 ou plus récente	Parmi les 12 indicateurs évalués par novaEQUER, quatre sont de directement issus de l'inventaire du cycle de vie (ICV) : - demande cumulative d'énergie (MJ) - déchets produits (t) - déchets radioactifs (dm^3) - eau utilisée (l) Les 8 autres sont exprimés en termes d'évaluation des impacts du cycle de vie (EICV) : - effet de serre (kg CO_2 eq) - épuisement des ressources abiotiques (kg Sb eq) - odeur (m^3) - production d'ozone photochimique (kg C_2H_4 eq) - dommage à la santé (DALY) - dommage à la biodiversité (PDF.m².an) - eutrophisation (kg PO_4^{3-} eq) - acidification (kg SO_2 eq) Comme indiqué précédemment novaEQUER est un outil pour concepteur. Pour ces 8 indicateurs, les facteurs de caractérisation sont automatiquement fixés en utilisant les méthodologies suivantes : CML 2002 : - acidification (kg SO_2 eq) - eutrophisation (kg PO_4^{3-} eq) - production d'ozone photochimique (kg C_2H_4 eq) - odeur (m^3) (indicateur « malodorous air ») Ecoindicator99 : - dommage à la santé (DALY) (« Human Health ») - dommage à la biodiversité (PDF.m².an) (« Ecosystem quality") GIEC 2007 : - effet de serre (kg CO_2 eq)

Using novaEquer LCA software for LEED

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1 Context

LEED (Leadership in Energy and Environmental Design) is a north-American green building certification developed by US Green Building Council. This document is based on « Building Design and Construction » rating system, v4.

In « Materials and ressources » section of this rating system, « Building Life-Cycle Impact Reduction » credit can be assessed by conducting a whole-building life-cycle assessment (option 4).

Based on the detailed requirements and step-by-step guidance for this credit, this document shows how novaEquer software can meet this credit's requirements.

2 Requirements

OPTION 4. WHOLE-BUILDING LIFE-CYCLE ASSESSMENT (3 POINTS)

For new construction (buildings or portions of buildings), conduct a life-cycle assessment of the project's structure and enclosure that demonstrates a minimum of 10% reduction, compared with a baseline building, in at least three of the six impact categories listed below, one of which must be global warming potential. No impact category assessed as part of the life-cycle assessment may increase by more than 5% compared with the baseline building.

The baseline and proposed buildings must be of comparable size, function, orientation, and operating energy performance as defined in EA Prerequisite Minimum Energy Performance. The service life of the baseline and proposed buildings must be the same and at least 60 years to fully account for maintenance and replacement. Use the same life-cycle assessment software tools and data sets to evaluate both the baseline building and the proposed building, and report all listed impact categories. Data sets must be compliant with ISO 14044.

Select at least three of the following impact categories for reduction:

- global warming potential (greenhouse gases), in CO_2e;
- depletion of the stratospheric ozone layer, in kg CFC-11;
- acidification of land and water sources, in moles H+ or kg SO_2;
- eutrophication, in kg nitrogen or kg phosphate;
- formation of tropospheric ozone, in kg NO_x or kg ethene; and
- depletion of nonrenewable energy resources, in MJ.

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5 out of the required impacts are present in the 12 indicators evaluated by novaEquer, including climate change :

- Climate change (kg CO_2 eq)
- Air acidification (kg SO_2 eq)
- Cumulative energy demand (MJ)
- Water consumption (l)
- Waste (t)
- Depletion of resources (kg Sb eq)
- Eutrophication (kg PO_4^{3-} eq)
- Photochemical ozone formation (kg C_2H_4 eq)
- Ecosystem quality (PDF.m².an)
- Radioactive waste (dm^3)
- Human health (DALY)
- Malodorous air (m^3 of air)

It is possible to assess two identical buildings, with different constructive characteristics. Their energy performance is previously assessed by thermal simulation using Pleiades software.
Service life is configurable in novaEQUER. Maintenance and replacements are accounted for in the "renovation" step: each element has its own service life duration, if it is shorter than building service life, replacements are accounted for.
Ecovinvent 2010 (and 2014) datasets used in novaEquer are assessed to publicly available and peer reviewed methodology, compliant with ISO 14044.

3 Step-by-step guidance

3.1 Aim of life cycle analysis assessment

Option 4. Whole-Building Life-Cycle Assessment

This option has only one threshold. To achieve this option the proposed building must demonstrate at least a 10% reduction in global warming potential and a 10% reduction of two of five other impact measures (discussed below) when compared to a baseline building, without increasing any measure by more than 5%.

novaEquer
See above, 5 out of the required impacts are present in the 12 indicators evaluated by novaEquer, including climate change.

3.2 Scope

3.2.1 Life stages

STEP 1. CALCULATE EXISTING BUILDING SURFACE AREA AND REUSE EXISTING BUILDING

Ensure that the scope of the analysis is a cradle-to-grave assessment, which includes environmental impacts associated with all the life-cycle stages for the building structure and enclosure: resource extraction or harvest, building product manufacture, on-site construction, product maintenance and replacement (where warranted), and deconstruction or demolition and disposal over the assumed 60-year service life. The LCA must address the following:

novaEquer
novaEquer analysis scope is a cradle-to-grave assessment : for all 12 indicators, outputs are available for 4 life cycle stages : - « Construction » : Construction (product stage + construction process stage) - « Utilisation » : Including separate reporting of operationnal energy - « Renovation » : Use stage (impact of periodic replacement of construction elements) - « Demolition » : End of life

3.2.2 Products

- **Products.** The LCA must cover the complete building envelope and structural elements, including the material components of footings and foundations, structural wall assembly (from cladding to interior finishes), structural floors and ceilings (not including finishes), and roof assemblies.

- Exclude electrical and mechanical equipment and controls, plumbing fixtures, fire detection and alarm system fixtures, elevators, and conveying systems.
- Exclude excavation and other site development.
- Include parking structures; exclude parking lots.
- Additional building elements, such as interior nonstructural walls or finishes, may be included at the discretion of the project team but earn no additional credit.

novaEquer
Materials inventory available in novaEQUER covers all elements requested. The requested exclusions can also be met. All materials from the thermal model in Pleiades are automatically included in novaEQUER LCA. This inventory includes automatically: exterior walls, floors and roofs, including their finishes. To meet the required scope, this automatic inventory can be corrected in novaEQUER by adding the elements not included in the thermal model (foundations, parking structures), removing floor and ceiling finishes ("zero" impact associated to the corresponding materials) and removing interior partitions or not, depending on the choice of the design team.

3.2.3 Functionnal equivalence

- **Functional equivalence.** The proposed and baseline buildings have to serve the same function and must have the same gross floor area, orientation, and operational energy usage.

novaEquer
It is possible to assess two identical buildings, with different constructive characteristics. Their energy performance is previously assessed and compared by thermal simulation using Pleiades software.

3.2.4 Service life

- **Service life.** For LEED, the project team must take into account the entire building structure and enclosure, from design to demolition for an assumed 60-year service life.
  The assumed service life must be the same for the baseline and proposed buildings and must be at least 60 years to properly account for material maintenance and replacement (see *Further Explanation, Product Replacement*).

novaEquer
Service life is configurable in novaEQUER. Maintenance and replacements are accounted for in the "renovation" step: each element has its own service life duration, if it is shorter than building service life, replacements are accounted for.

3.2.5 System boundary

- **System boundary.** The system boundary of the analysis must be defined to account for cradle-to-grave environmental impacts associated with all the life-cycle stages for the building structure and enclosure as defined in ISO 21930 sections A-1 thru A-4, B-1 thru B-7, and C-1 thru C-4.

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For all 12 indicators, outputs are available for 4 life cycle stages : - « Construction » : ressources, building product manufacture, on-site construction - « Utilisation » : Use stage (operational energy and water consumption, waste production, transports) - « Renovation » : Product maintenance and replacement - « Demolition » : Deconstruction or demolition and disposal

3.3 Choice of LCA tool and indicators

3.3.1 Select relevant impact measurement systems

STEP 4. SELECT RELEVANT IMPACT MEASUREMENT SYSTEMS

Select the appropriate output units for each LCA impact indicator shown in Table 4 (see *Further Explanation, Life Cycle Impact Measures Or Indicators*).

TABLE 4. LCA impact indicator units

LCA Impact Indicators	TRACI 2.1	CML 2002	ReCIPe
Global warming potential	CO_2e	CO_2e	CO_2e
Ozone depletion potential	CFC-11-eq	CFC-11-eq	CFC-11-eq
Acidification potential (land)	SO_2e	SO_2e	SO_2e
Eutrophication potential (fresh water)	N eq	$PO_4^{3}e$	P eq
Formation of tropospheric ozone (photochemical oxidant formation)	NO_x eq	C_2H_4e	kg NMVOC
Depletion of nonrenewable energy resources	MJ	Weight or volume of raw material	Kg oil eq

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Output units and methodologies used in novaEQUER :		
Climate change	kg CO_2 eq	GIEQ 2007
Ozone depletion potential	*Not evaluated*	
Air acidification	kg SO_2 eq	CML 2002
Eutrophication	kg PO_4^{3-} eq	CML 2002
Photochemical ozone formation	kg C_2H_4 eq	CML 2002
Cumulative energy demand	MJ	ecoinvent inventory

3.3.2 LCA tool selection

LCA TOOLS SELECTION

This credit does not require design professionals to become LCA experts, but the choice of tool can determine whether an LCA specialist is required. Every LCA tool is populated with background data sets that form the basis of the assessment. Some LCA data are specific to the location of the building construction or the location of product manufacture because of the region's electric grid, for example. Different types of tools require varying levels of data set manipulation. There are two types of tools to consider.

Design team LCA tools simplify and streamline the LCA process for non-LCA practitioners. They manage the data and calculations in the background and do not allow the user to add or customize data. The user inputs material selections consistent with the building design and can then explore the environmental effects of design modifications by changing materials, floor area, or other aspects of the building.

Design team LCA tools have calculation factors specific to the country or region for which they were designed. Examples include the following:

- North America: ATHENA® Impact Estimator, athenasmi.org/our-software-data/impact-estimator/. This tool can import a bill of materials from a CAD system.
- United Kingdom: Envest 2, envest2.bre.co.uk/
- Australia: LCADesign. This tool can import a bill of materials from a CAD system.

LCA practitioner tools require the user to select the appropriate data sets and calculation factors. They typically conduct LCAs on a product-by-product basis and may require different methodological decisions for the products being examined. The practitioner then aggregates the results to the whole building level. Examples include the following:

- SimaPro, simapro.co.uk/
- GaBi, gabi-software.com/america/index/

Project teams that choose LCA practitioner tools will likely need to bring in an LCA specialist.

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novaEQUER is a design team LCA tool, adapted to use on French territory. ecoinvent datasets nave been contextualized, especially for electricity consumption included in materials manufacturing data, adapted to take into account the French electricity mix.

3.3.3 Indicators

LIFE CYCLE IMPACT MEASURES OR INDICATORS

The impacts measured in LCA are divided into two categories, as described in ISO 21930–2007, which deals with EPDs for building products. Impacts are either expressed in terms of the categories of life-cycle impact assessments (LCIA) or derived from a life-cycle inventory (LCI) and not assigned to impact categories.

LCIA is an additional step in analysis that interprets and quantifies the resulting ecological effects of resources used and waste emitted over the life-cycle of the product. In contrast, LCI simply quantifies flows in and out of the process in terms of resources used and depleted and waste created.

The first five measures specified in the credit requirements are impact categories of LCIA; they are the only LCIA categories cited in ISO 21930. Other LCIA measures are in use or being developed (e.g., human health and ecotoxicity measures) but are less quantifiable than the measures required for LEED, although they may be reported separately. Other impact assessment methods not listed in Table 4 may be used if the reasons are justified and documented.

The sixth measure in the list, depletion of nonrenewable energy resources, is in the second category because it is derived directly from the LCI (defined in the ISO standard as "phase of life-cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life-cycle").

Several other LCI aggregations are cited in ISO 21930 (e.g., depletion of nonrenewable material resources, use of renewable materials, and consumption of freshwater). These additional measures have not been included in the credit for the sake of simplicity. Teams may take these indicators into account in the LCA but are not required to submit them to meet the credit requirements.

For all the measures listed in Table 4 except depletion of nonrenewable energy resources, the software tool categorizes emissions and then applies characterization factors to create equivalence measures in the units shown in the table.

- In design team LCA tools, the characterization factors for the country or region are automatically generated.
- In LCA practitioner tools, the user must select the characterization factors and corresponding units for the country or region.

North American projects typically use the U.S. Environmental Protection Agency's TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) system. Projects in other parts of the world use the CML (Institute of Environmental Sciences) or ReCiPe system.

The impact assessment method must be no older than the most current version available on the LEED project registration date:

- TRACI, version 2.1 or newer
- CML, version 2001–November 2012 or newer
- ReCiPe, version 1.07 (midpoints) or newer

If these versions are not available in the chosen LCA tool, the project team must explain and justify the use of an alternative. Other impact assessment methods are available. If the chosen LCA tool offers options, the project team should weigh their pros and cons and choose the most appropriate method.

The same assessment method must be used for the baseline and proposed buildings.

For the purposes of complying with this credit, *depletion* means "the amount used," as opposed to more complex measures involving calculation of the amount used relative to existing physical or economic reserves.

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4 out of the 12 indicators assessed by novaEQUER, are directly derived from lifecycle inventory (LCI) :
- Cumulative energy demand (MJ)
- Waste (t)
- Radioactive waste (dm^3)
- Water consumption (l)

The 8 other are expressed in terms of life cycle impact assessments (LCIA) :
- Climate change (kg CO_2 eq)
- Depletion of resources (kg Sb eq)
- Malodorous air (m^3)
- Photochemical ozone formation (kg eq C_2H_4)
- Human health (DALY)
- Ecosystem quality ($PDF.m^2.an$)

- Eutrophication (kg eq PO_4^{3-})
- Air acidification (kg SO_2 eq)

As indicated above novaEQUER is design team LCA tool. For these 8 indicators, characterization factors are automatically generated using the following methodologies:

2002 CML:
- Air acidification (kg SO_2 eq)
- Eutrophication (kg eq PO_4^{3-})
- Photochemical ozone formation(kg eq C_2H_4)
- Malodorous air (m^3)

Ecoindicator99:
- Human Health (DALYs)
- Ecosystem quality (PDF.m².an)

IPCC 2007:
- Climate change (kg CO_2 eq)