DECERNA

www.decerna.co.uk

Introduction to Life Cycle Assessments

Dr Tom Bradley
tom.bradley@decerna.co.uk

OUR HISTORY

- Originally founded as part of the UK National Renewable Energy Centre in 2009, in 2012, we became an independent company called Narec Distributed Energy and changed our name to Decerna in 2022.
- Decerna is a consultancy and developer focused on accelerating the global shift to a low-carbon economy driven by clean and affordable energy.
- Decerna's mission revolves around promoting this transition on a global scale through technical and strategic consultancy services
- We have grown to operate internationally, with involvement in projects in Europe, India and Africa.
- Decerna is now based in Decerna House in Cramlington, a retrofitted low-carbon commercial building, which signals Decerna's commitment to shaping the future and embracing change.
- Previously known as

OUR MISSION

Vision

We will partner with people who are committed to making a difference, sharing our knowledge and expertise and providing support and guidance.

Mission

We want to create a world that has moved beyond just talking about decarbonisation to one that is taking every opportunity to decarbonise.

Purpose

We are here to help our partners make a difference for their customers, their bottom line and the planet.

OUR SERVICES

Smart home field trials

We can take your field trial, from initial concept, through pilot phase, into a full city wide smart home trial.

Net Zero & Built Environment

Energy audits and technoeconomic feasibilities for a range of technologies to lower you costs and carbon footprint.

Utility Scale

We are heavily involved in the deployment of renewable energy and grid infrastructure, both clients and for ourselves.

Life Cycle Assessment (LCA)

Helping you understand your product or services environmental impacts, and creating strategies and plans to hit Net Zero.

LIFE CYCLE ASSESSMENT (LCA)

01 Full Life Cycle Assessment (LCA) following ISO 14040/44

02 Scope 1, 2, and 3 assessments

03 Hotspot analysis to find sources of impacts

04 Recommendations for reductions of impacts

05 Environmental Product Declarations (EPDs)

06 Carbon balances for carbon capture systems

07 Creation of new product specific methodologises

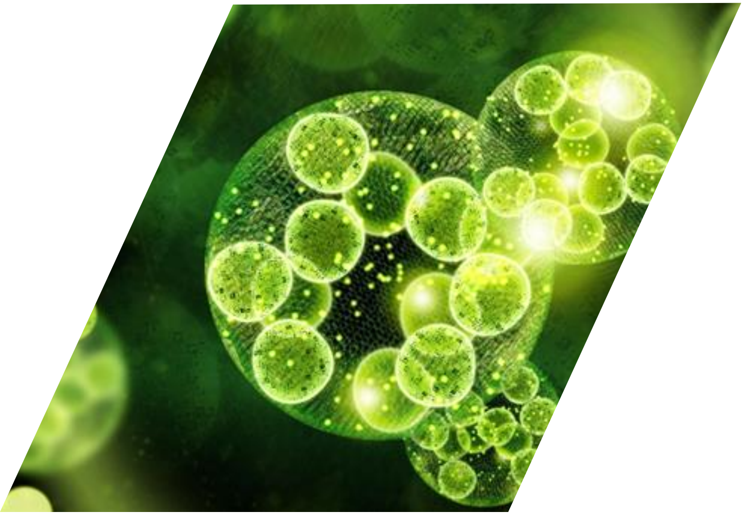
08 Evidence bases for tax and carbon credits

09 Creation of Net Zero plans

LIFE CYCLE ASSESSMENT (LCA)

Life Cycle Assessment (LCA) of Novel Wind Turbine Blades
Supporting improvements in the sustainability of offshore wind

Creation of Guidance for LCA of Carbon Capture
Building the scientific basis for LCA of Carbon Capture systems, on behalf of the European Commission



Circular Economy Food Production
Life Cycle Assessment of a novel microalgae system for agriculture

EXAMPLE PROJECT #1

Life Cycle Assessment (LCA) of Novel Wind Turbine Blades

- Disposal of wind turbine blades is a challenging problem, which is growing as wind turbine deployment increases
- The UK's Offshore Renewable Energy Catapult wished to understand the impacts of a range of different composites used for blades
- Decerna undertook a detailed ISO 14040/14044 compliant LCA study comparing the blade types
- This work included sensitivity analysis, hotspot analysis, and detailed recommendations for future blade technologies
- Models were constructed within OpenLCA, with the Ecoinvent database.

EXAMPLE PROJECT # 2

Creation of Guidance for LCA of Carbon Capture

- Carbon Capture is a growing market within the European Economic Area
- Life Cycle Assessment is the best existing method to understand if a carbon capture system really does take in more carbon than it emits
- The European Commission needed a scientific basis for Life Cycle Assessment of carbon capture systems
- Dr Tom Bradley from Decerna was part of a six person panel of experts, who created the European Commission's LCA4CCU Guidence
- This guidence ensures LCA for carbon capture systems is undertaken in a logical, fair and transparent manner
- Since then, Decerna has used this methodology for the LCA different clients who produce products via carbon Capture
- The latest example is the Brilliant Planet carbon capture system

DECERNA

EXAMPLE PROJECT # 3

Circular Economy Food Production

- As the global population increases, new methods for large scale production of affordable food are needed
- In addition, agriculture is responsible for a range of environmental issues
- The REALM system used run off fertilisers from agriculture to feed microalgae. This microalagae is then used to produce biopesticides, biofertilizers, and food for aquaculture
- The system is part of a multi-muillion euro project funded by the European Commission under Horizon Europe
- Decerna are undertaking a detailed LCA and Social LCA of the whole system, and comparing these with Business-as-Usual
- Decerna will be submitting papers to scientific journals, and speaking at international conferences on LCA as part of this project.

PLAN FOR TODAY

- What is LCA? What isn't LCA?
- History
- ISO Standards
- Software
- Databases
- Electricity grid impacts
- Impact Categories
- Climate Change
- Uncertainty
- Worked Example (OpenLCA)

WHAT IS LCA?
WHAT ISN'T LCA?

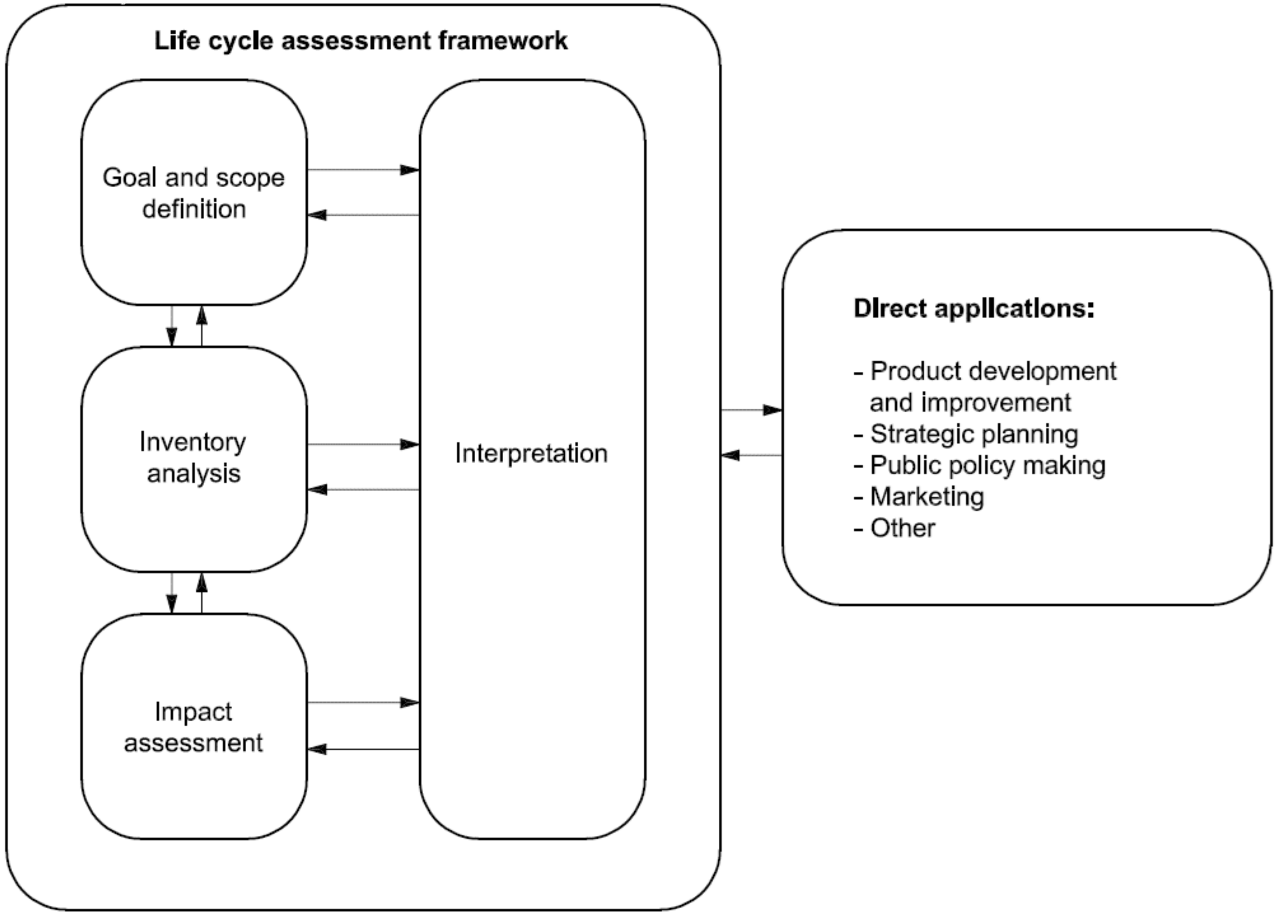
- LCA is the assessment of the environmental impacts of a product, throughout the entire supply chain to the eventual disposal or recycling.
- It includes a large number of environmental impacts, if something only calculates climate change impacts, it is not LCA
- Follows the standards ISO 14040 and ISO 14044, but there is a lot of methodological variation possible within these.
- Due to these differences, it is always more informative as a comparative assessment, rather than a straight up figure
- Useful to identify environmental hotspots
- Does not show one thing is good and one is bad, the broad spectrum of environmental impacts vary in a non-uniform manner

HISTORY OF LCA

- Created by Coal-Coal company in 1969 in order to understand the differences between plastic and glass bottles
- Industry worked without standards, with a range of methodologies in the 1970s and 1980s
- Society of Environmental Toxicology and Chemistry (SETAC) standards were developed in the 1990s
- Following this, the SETAC standards were amended and ISO 14040 - 14049 were first published
- ILCD handbook, by JRC, published in 2010
- In 2013, the Product Environmental Footprint pilot phase began, and this harmonised (but simplistic) method can be used for a wide range of products, to give comparable environmental impact studies.
- Now various supporting documents for LCA exist, including (ISO 14040-44, PAS 2050, BP X30, WRI/WBCSD GHG protocol, Sustainability Consortium, ISO 14025, Ecological Footprint, as well as other existing methodological standards and guidance documents (Global Reporting Initiative, WRI GHG Protocol, CDP Water Footprint, ISO 140064, DEFRA guidance on GHG reporting, ADEME Bilan Carbone, etc).

ISO STANDARDS

- ISO 14040/44 contain a basic methodology of four interrelated phases
- Large room for manoeuvre within these standards, leading to incomparable LCAs



ISO STANDARDS:
GOAL AND SCOPE (1 OF 2)

- The goal of an LCA states
  - the intended application,
  - the reasons for carrying out the study,
  - the intended audience, i.e. to whom the results of the study are intended to be communicated, and
  - whether the results are intended to be used in comparative assertions intended to be disclosed to the public.
- The scope should be sufficiently well defined to ensure that the breadth, depth and detail of the study are compatible and sufficient to address the stated goal.

ISO STANDARDS:
GOAL AND SCOPE (2 OF 2)

- The scope includes the following items:
  - the product system to be studied;
  - the functions of the product system or, in the case of comparative studies, the systems;
  - the functional unit;
  - the system boundary;
  - allocation procedures;
  - impact categories selected and methodology of impact assessment, and subsequent interpretation to be used;
  - data requirements;
  - assumptions;
  - limitations;
  - initial data quality requirements;
  - type of critical review, if any;
  - type and format of the report required for the study.

ISO STANDARDS:
LIFE CYCLE INVENTORY (1 OF 2)

- Inventory analysis involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system.
- The process of conducting an inventory analysis is iterative. As data are collected and more is learned about the system, new data requirements or limitations may be identified that require a change in the data collection procedures so that the goals of the study will still be met. Sometimes, issues may be identified that require revisions to the goal or scope of the study.
- Data for each unit process within the systems boundary can be classified under major headings, including
  - energy inputs, raw material inputs, ancillary inputs, other physical inputs,
  - products, co-products and waste,
  - emissions to air, discharges to water and soil, and
  - other environmental aspects.

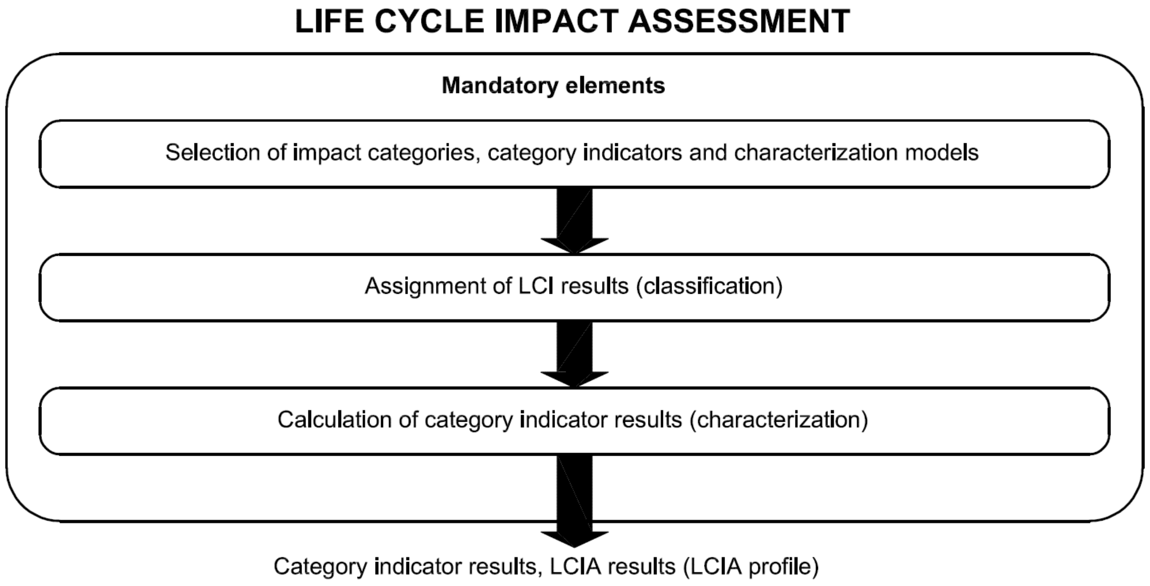
ISO STANDARDS:
LIFE CYCLE INVENTORY (2 OF 2)

- Practical constraints on data collection should be considered in the scope and documented in the study report.
- Following the data collection, calculation procedure are necessary, including
  - validation of data collected,
  - the relating of data to unit processes, and
  - the relating of data to the reference flow of the functional unit,
- Consideration should be given to the need for allocation procedures when dealing with systems involving multiple products and recycling systems

ISO STANDARDS:

LIFE CYCLE IMPACT ASSESSMENT

- This is the process of using the data from the LCI, following the methodology presented within the Goal and Scope, in order to analyse the data, and match the outputs to impact categories
- This can be undertaken using a spreadsheet, or a bespoke piece of LCA software
- This should be undertaken in a transparent manner, to allow for peer review of the models

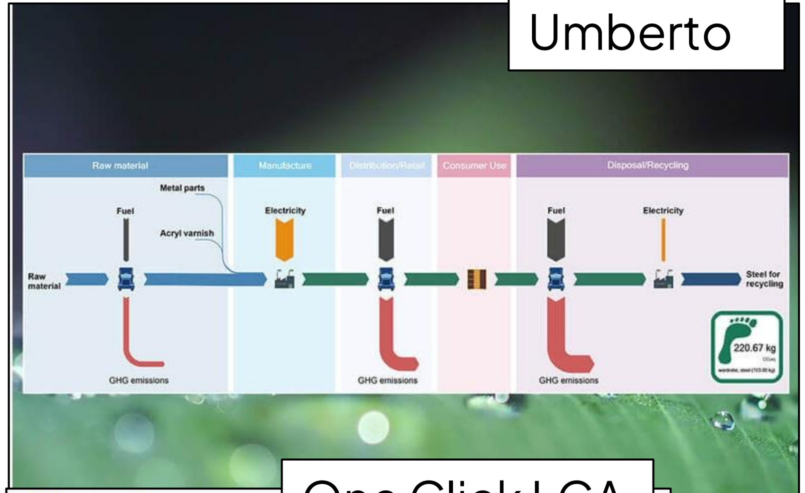


ISO STANDARDS:
LIFE CYCLE INTERPRETATION

- Provide an interpretation of the results
- Comment on limitations within the study (such as uncertainty, and lack of data) making the assumptions clear
- Provide conclusions and recommendations

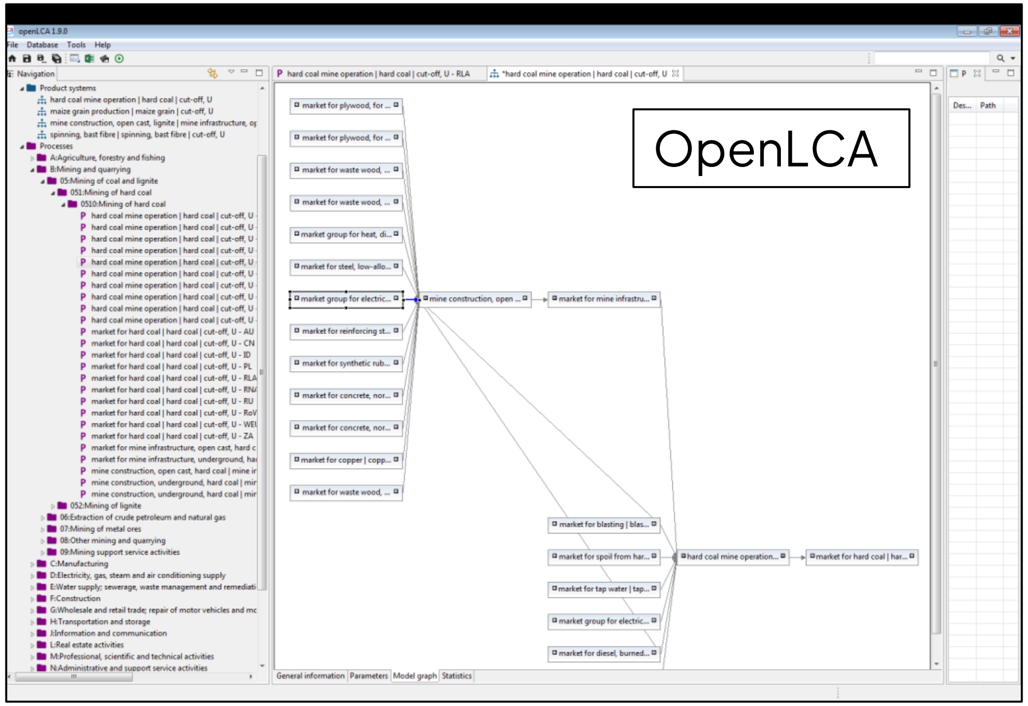
- Requirement of a report
  - the relationship with the LCI results;
  - a description of the data quality;
  - the category endpoints to be protected;
  - the selection of impact categories;
  - the characterization models;
  - the factors and environmental mechanisms;
  - the indicator results profile.

LIFE CYCLE ASSESSMENT SOFTWARE

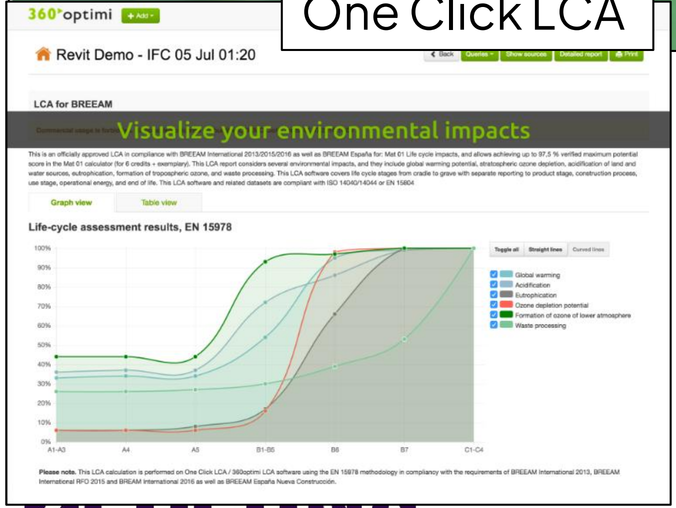


Umberto

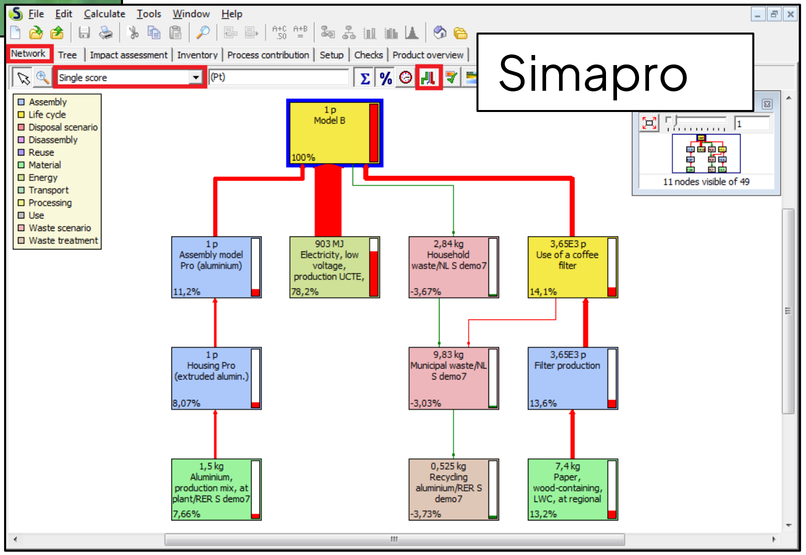
eToolLCD



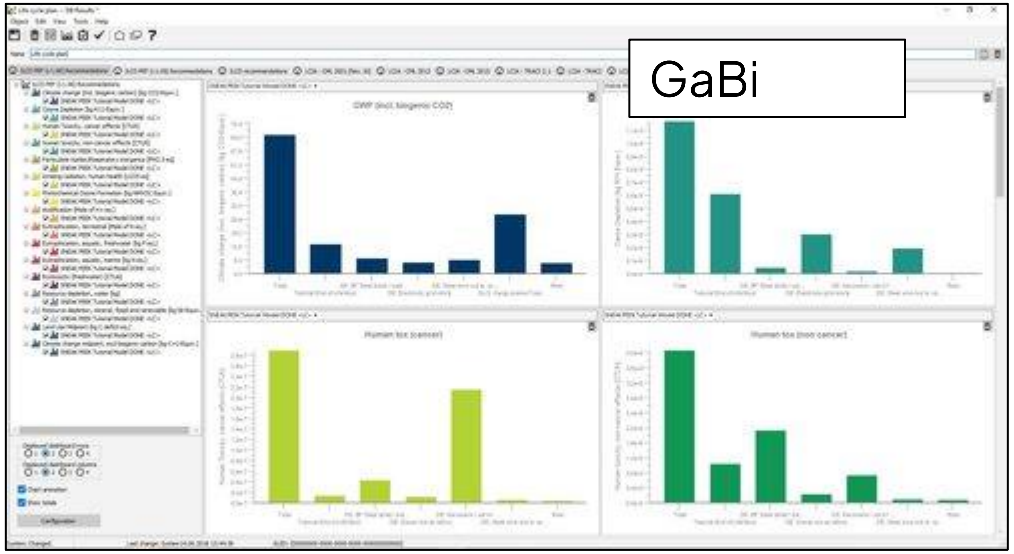
OpenLCA



One Click LCA



Simapro



GaBi

Delivering, unlocking, advancing the low-carbon economy

DATABASES: PAID

Name	Description
EN15804 add-on	Environmental Product Declarations (EPDs)
Ecoinvent	Leading database used in academia and industry
Circularity Package	Enhanced version of Ecoinvent for the circular economy
UVEK LCI Data	Based on Ecoinvent 2.2 and was updated in relevant sections, namely crude oil, gas, nuclear fuel, electricity provision, transport and end of life and waste treatment services.
The Evah Pigments Database	Pigment database
LCA Commons (complete)	US representative LCA data
IDEMAT	LCI data of the Sustainable Impact Metrics Foundation
Carbon Minds	Plastics and chemicals
IDEA	Japan based data
Circularity Food	Modified version of Agribalyse for the circular economy
GaBi	Data as used within GaBi
Agri-footprint	Agriculture and food secto
EuGeos' 15804-IA	Modified version of Ecoinvent 3.6 to allow for EPD calculations
ESU World Food	2100 processes related to agriculture, food processing and consumption activities.
LC-Inventories.ch	Corrections, updates and extensions of Ecoinvent data v2.2 created by ESU-services and others authors
ProBas	German database of energy, materials & products, transportation services and waste
Worldsteel	World Steel Association database
Ökobaudat	Construction materials database, provided by the German Federal Ministry of Transport, Building and Urban Development (EPD compliant)

DATABASES: FREE

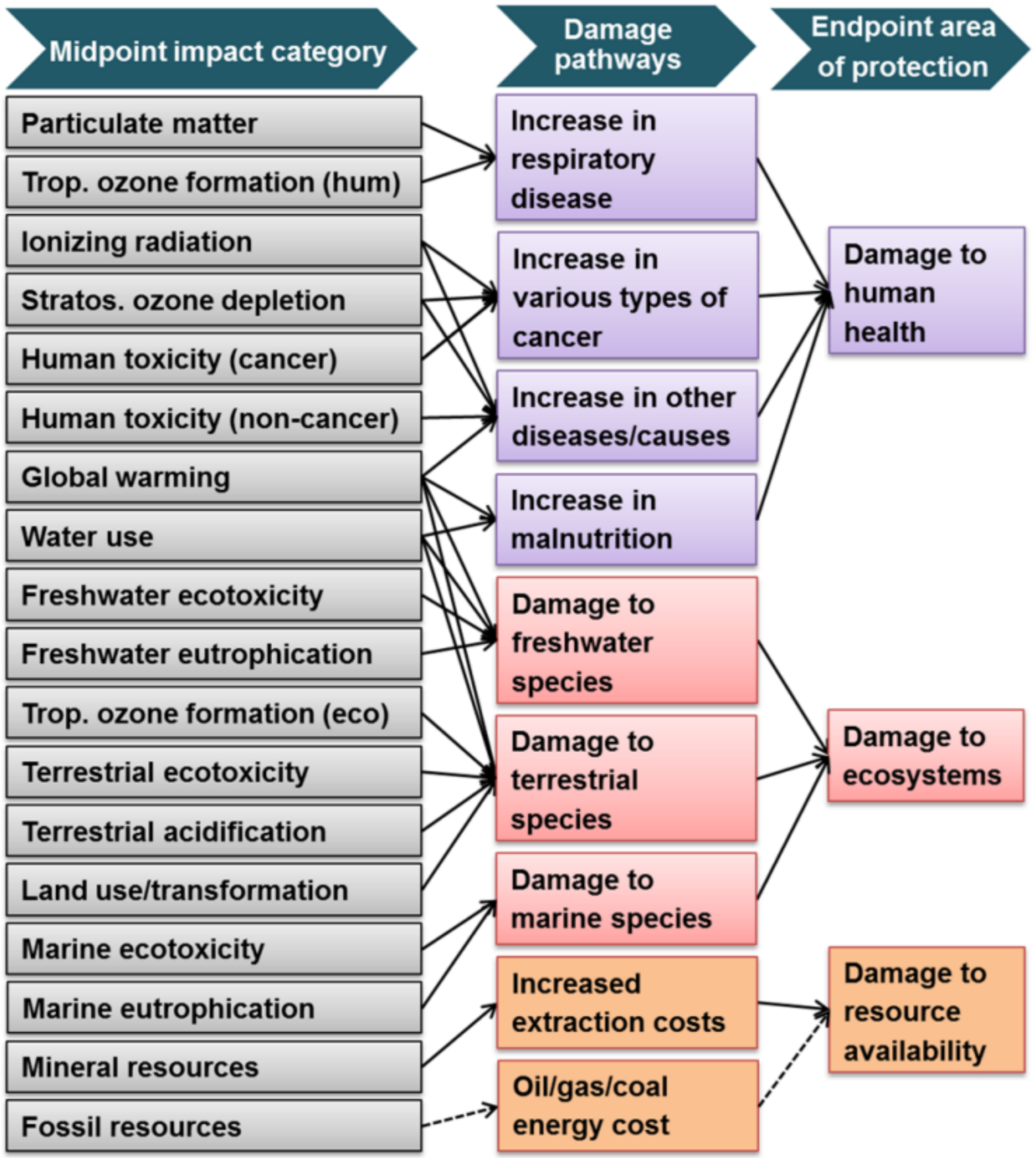
Name	Description
IMPACT World+	Regionalised data
Environmental Footprints	The Environmental Footprint (EF) database is designed to support the use of PEF category rules and organisation environmental footprint sector rules.
OzLCI2019	Australasian regional supply including imports and has been developed by using openLCA.
Exiobase	Global, detailed Multi-regional Environmentally Extended Supply and Use / Input Output (MR EE SUT/IOT) database.
ARVI	Value chain of wood-polymer composite production, designed to work with Ecoinvent 3
Agribalyse	French agricultural products at the farm gate
NEEDS	Database created by the NEEDS (New Energy Externalities Developments for Sustainability) project: Life cycle inventories of future electricity supply in Europe.
ELCD	European reference Life Cycle Database of the Joint Research Centre. Version 3.2 from October 2015.
bioenergiedat	Processes for bioenergy supply chains, with German background.
Q45	Produced by the US department for Energy and the IRS

Databases: Types of Ecoinvent Model

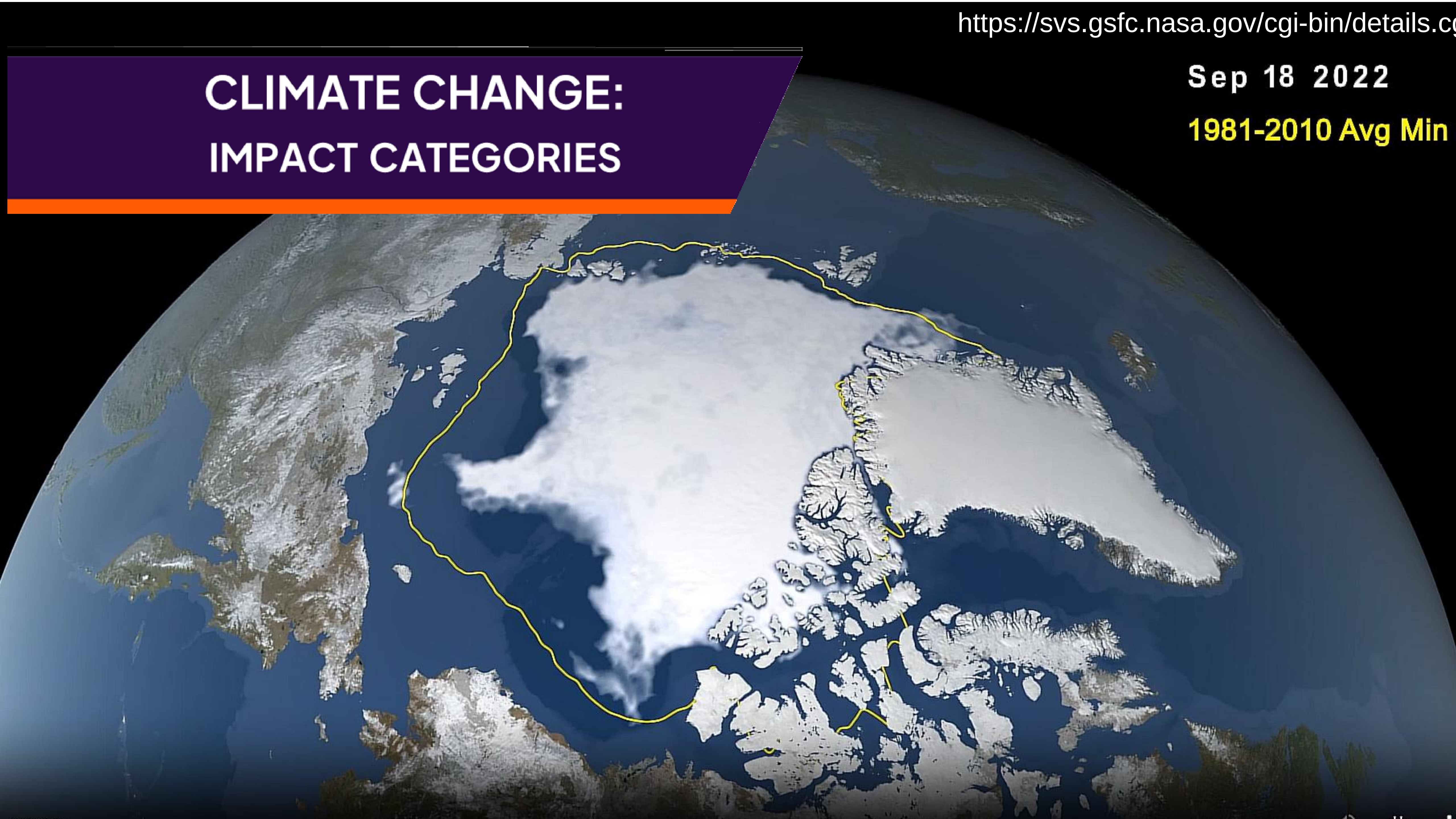
- Cut-Off System Model
  - The system model Allocation, cut-off by classification, or cut-off system model in short, is based on the recycled content, or cut-off, approach.
  - The underlying philosophy is that a producer is fully responsible for the disposal of its wastes, and that he does not receive any credit for the provision of any recyclable materials.
- APOS System Model
  - The system model Allocation at the point of substitution is also simply know as APOS system model.
  - The APOS system model follows the attributional approach in which burdens are attributed proportionally to specific processes.
- Consequential System Model
  - The system model substitution, consequential, long-term is also know as consequential system model.
  - The consequential system model uses different basic assumptions to assess the consequences of a change in an existing system.

Impact Categories

- Numerous sources of impact categories
- These are either Mid-point or End-point based
- Always ensure whichever one you are using is fully up to date
- Options include CML, ReCiPe and PEF, and others…
- If an LCA does not include a wide range of impact categories, it is not an LCA
- Some are less accurate than others, toxicity has serious uncertainty issues

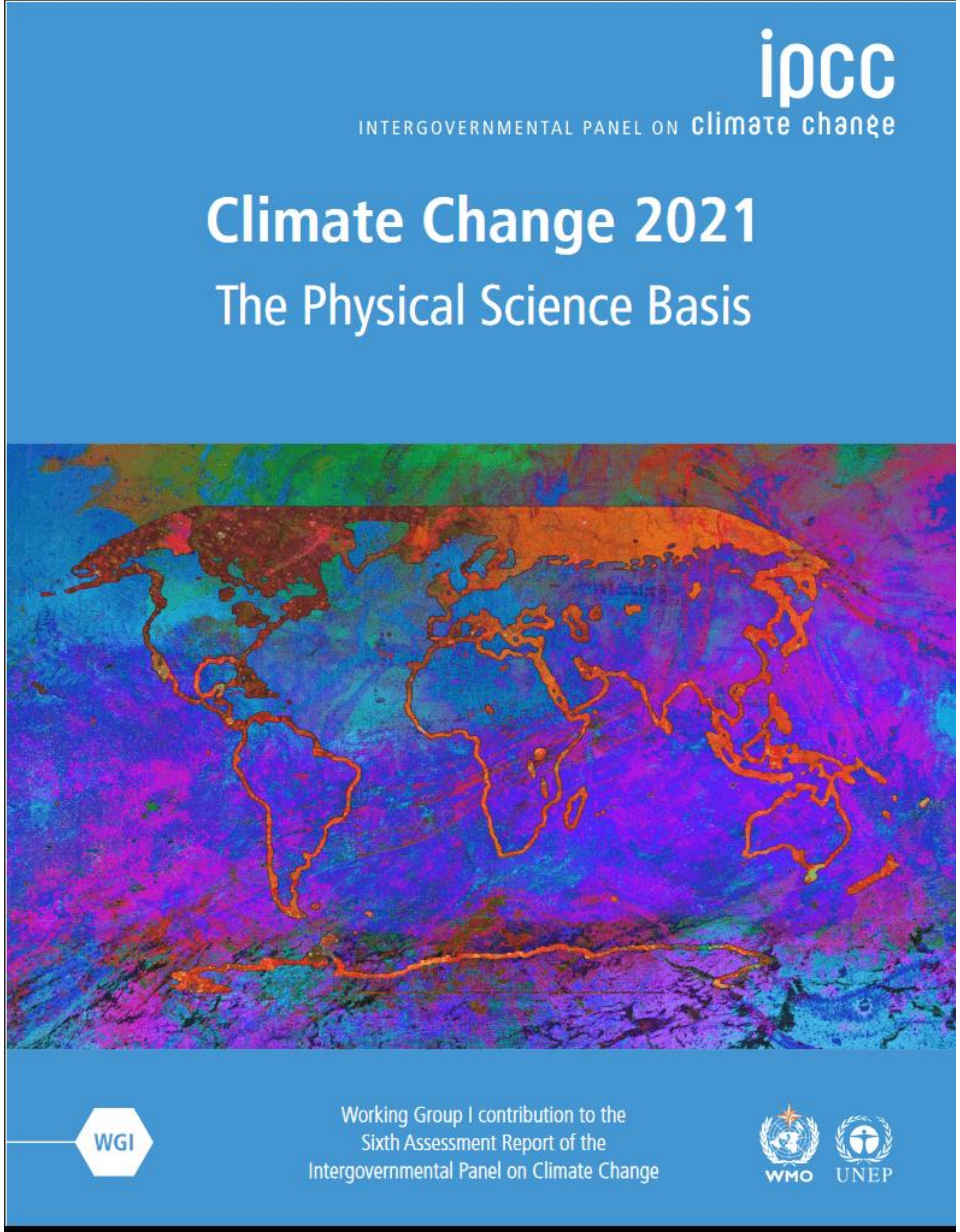


CLIMATE CHANGE:
IMPACT CATEGORIES



CLIMATE CHANGE: IMPACT CATEGORIES

- Numerous climate change indicators
- Extremely important that you use up to date figures (Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6) from 2021)
- All LCA databases made mistakes when creating the IPCC impact category databases
- Some methods still use old data from 2007 or 2001, this is not useful
- Two methods to consider, Global Warming Potential (GWP) and Global Temperature Potential (GTP)

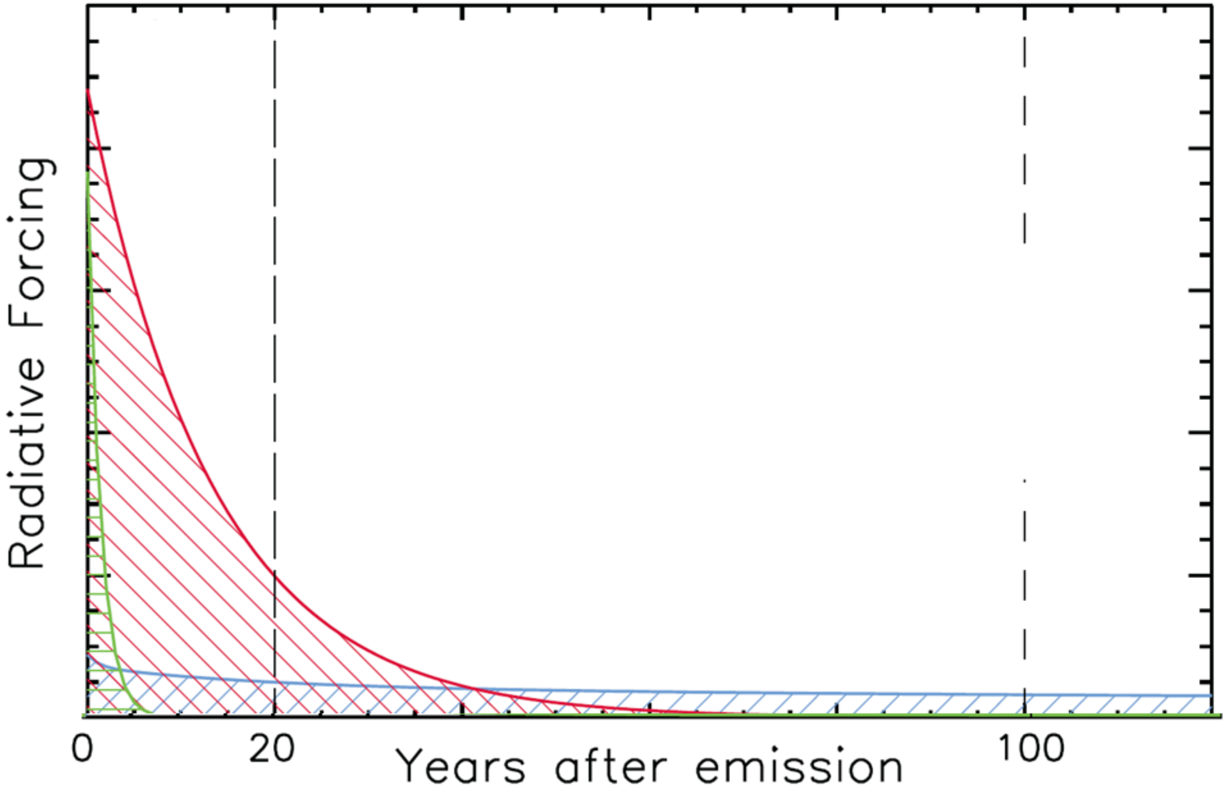


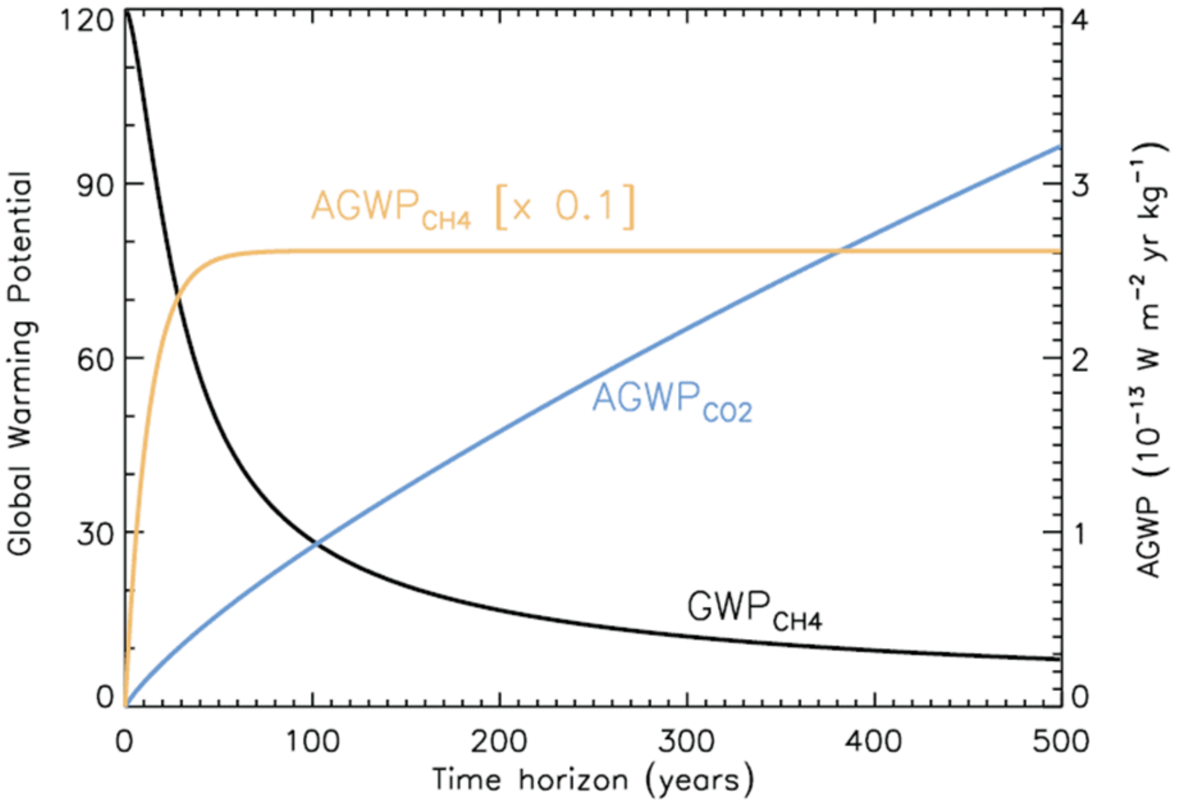
DECERNA

CLIMATE CHANGE:
GLOBAL WARMING POTENTIAL

- Different greenhouse gases have different perturbation lifetimes
- This does not mean the lifetime of the gas in the atmosphere, but the lifetime of the perturbation caused by this additional gas
- Different gases absorb and emit ultraviolet radiation by different amounts

CLIMATE CHANGE:
GLOBAL WARMING POTENTIAL





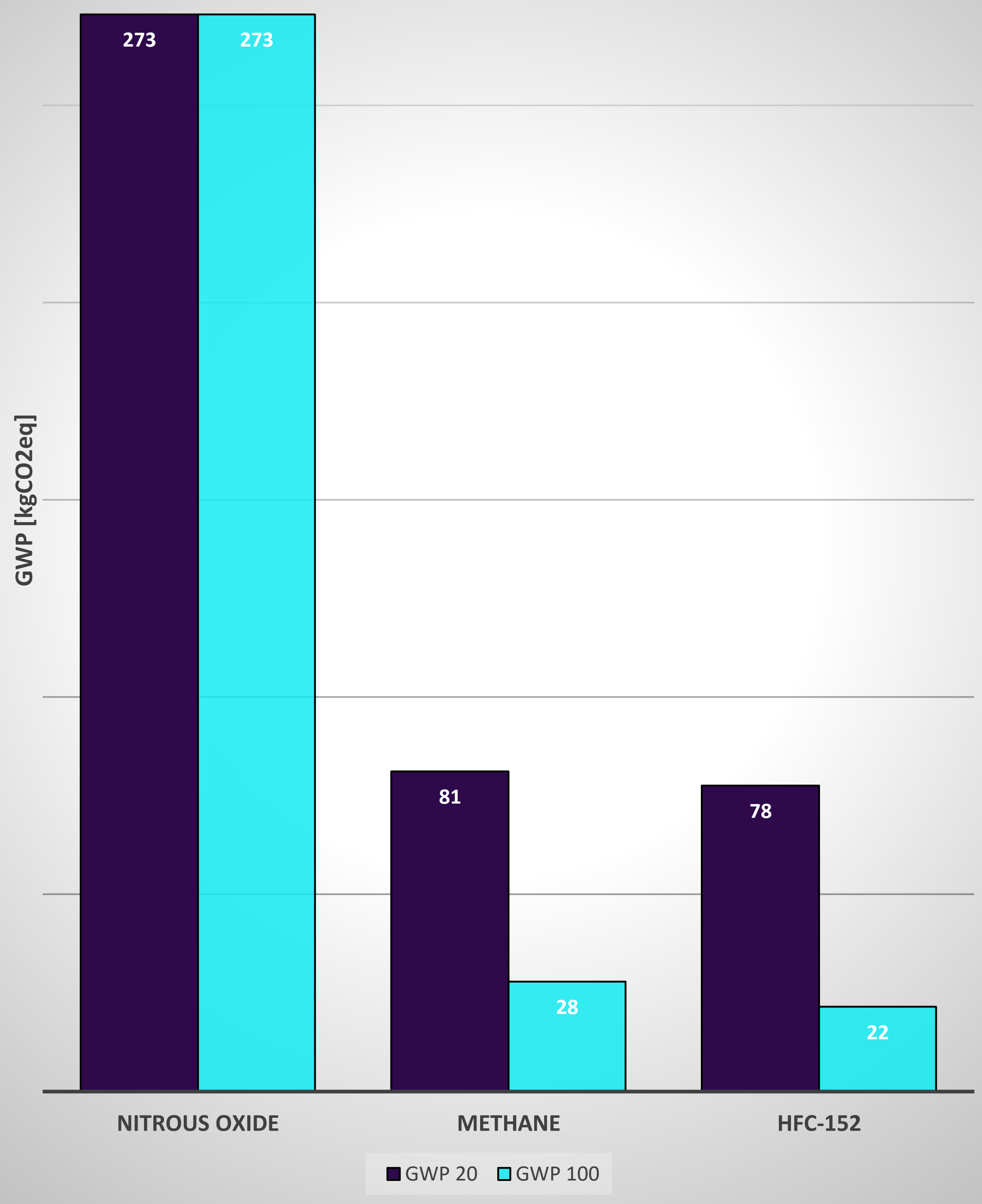
CLIMATE CHANGE:
GLOBAL WARMING POTENTIAL

Acronym, Common Name or Chemical Name	Lifetime (Years)	Radiative Efficiency (W m−2 ppb−1)	AGWP 20-year (W m−2 yr kg−1)	GWP 20-year	AGWP 100-year (W m−2 yr kg−1)	GWP 100-year	AGTP 20-year (K kg−1)	GTP 20-year	AGTP 50-year (K kg−1)	GTP 50-year	AGTP 100-year (K kg−1)	GTP 100-year
Carbon dioxide		1.33×10^{-5}	0.0243	1	0.0895	1	0.314	1	0.000428	1	0.000395	1
Methane	11.8	0.000388	1.98	81.2	2.49	27.9	2.5	7.95	0.00473	11	0.00212	5.38
Nitrous Oxide	109	0.0032	6.65	273	24.5	273	40.7	130	0.124	290	0.0919	233
Chlorofluorocarbons												
CFC-11	52	0.259	181	7430	497	5560	586	1870	2.43	5670	1.25	3160
CFC-12	102	0.32	277	11400	998	11200	1600	5100	5.06	11800	3.66	9270
CFC-13	640	0.278	301	12400	1450	16200	5500	17500	7.26	17000	7.4	18800
CFC-112	63.6	0.282	137	5620	413	4620	525	1670	2.06	4810	1.19	3020
CFC-112a	52	0.246	115	4740	317	3550	374	1190	1.55	3620	0.795	2010
CFC-113	93	0.301	167	6860	583	6520	890	2830	2.96	6910	2.06	5210

CLIMATE CHANGE:
GLOBAL WARMING POTENTIAL

- Some gases, such as methane, have very different impacts over 20 years compared with CO_2
- It is very important to consider this short term impact, as the global climate system is on the edge of numerous positive feedback cycles
- GWP100 is still important, and the method used by most government policies, but to undertake a proper scientific analysis, both GWP20 and GWP100 should be considered
- Always ensure the latest data is used, software refers to this as AR6.

DECERNA



UNCERTAINTY APPROACHES

- Data inaccuracy: concerns the empirical accuracy of measurements that are used to derive the numerical parameter values
- Data gaps: missing parameter values may leave the model with data gaps
- Model uncertainty: model uncertainty is due to simplifications of aspects that cannot be modelled within the LCA structure
- Uncertainty due to choices: for instance, choice of allocation rules, functional unit, system boundaries, characterisation method, weighting method
- Spatial variability: variability stems from inherent fluctuations in the real world
- Temporal variability: variations over time are relevant in both the inventory and impact assessment, or another aspect is the chosen time horizon to integrate potential effects, which, for instance, applies to global warming potentials (GWP)
- Variability between sources and objects
- Epistemological uncertainty: is due to the lack of knowledge on system behaviour, e.g. a certain type of epistemological uncertainty arises when future systems are modelled, because the future is inherently uncertain
- Mistakes: difficult to assess
- Estimation of uncertainty: in itself a source of uncertainty

BJÖRKLUND A.E (2002) Survey to improve reliability in LCA. International Journal of LCA 7(2), p: 64-72

LoRe-LCA: Low Resource consumption buildings and constructions by use of LCA in design and decision making: Methods and guidelines for sensitivity analysis,
including results for analysis on case studies

UNCERTAINTY:
SENSATIVITY ANALYSIS

- Significant tool for studying the robustness of results and their sensitivity to uncertainty factors
- Undertaken through varying the levels of various inputs, and comparing this to the overall results
- Shows the impacts of various input processes

UNCERTAINTY:
SENSITIVITY

- One-way sensitivity analysis: determines the amount of an individual input parameter value needs to change, all other parameters held constant, in order for output parameter values to change by a certain percentage.
- Scenario analysis: involves calculating different scenarios, to analyse the influence of discrete input parameters on either output parameter values or priorities.
- Factorial design and multivariate analysis (MVA): changes in the discrete input variables are represented by the high and low levels in factorial design.
- Ratio sensitivity analysis: in ratio sensitivity analysis, which is applicable only in comparative studies, a ratio is calculated to determine the percentage an input parameter value needs to change in order to reverse rankings between two alternatives.
- Critical error factor: is a measure of the sensitivity of a priority between two alternatives to an input parameter value x.
- Tornado diagrams: illustrate the change in output parameter values for equal levels of change in input parameters.

UNCERTAINTY:
PEDIGREE MATRICES

- Pedigree Matrices are an element of the NUSAP (Numeral, Unit, Spread, Assessment and Pedigree) approach to statistics, which is part of post-normal science
- The idea is to give an impression of the level of ignorance, in short, the unknown unknowns
- Marks are given against a weighted grid, to give an idea of the level of representativeness of the data, and how it differs from the area under study
- There are various mathematical operations which can be undertaken to convert this into a probability distribution, however, mixing of qualitative and quantitative data can lead to false impressions of accuracy within the uncertainty.

UNCERTAINTY:
PEDIGREE MATRICES

	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation
1	Verified data based on measurements	Representative data from all sites relevant for the market considered, over and adequate period to even out normal fluctuations	Less than 3 years of difference to the time period of the data set	Data from area under study	Data from enterprises, processes and materials under study
2	Verified data partly based on assumptions or non-verified data based on measurements	Representative data from > 50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Less than 6 years of difference to the time period of the data set	Average data from larger area in which the area under study is included	Data from processes and materials under study (i.e. identical technology) but from different enterprises
3	Non-verified data partly based on qualified estimates	Representative data from only some sites (<< 50%) relevant for the market considered or > 50% of sites but from shorter periods	Less than 10 years of difference to the time period of the data set	Data from area with similar production conditions	Data from processes and materials under study but from different technology
4	Qualified estimate (e.g. by industrial expert)	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Less than 15 years of difference to the time period of the data set	Data from area with slightly similar production conditions	Data on related processes or materials
5	Non-qualified estimates	Representativeness unknown or data from a small number of sites and from shorter periods	Age of data unknown or more than 15 years of difference to the time period of the data set	Data from unknown or distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)	Data on related processes on laboratory scale or from different technology

UNCERTAINTY:
PEDIGREE MATRICES

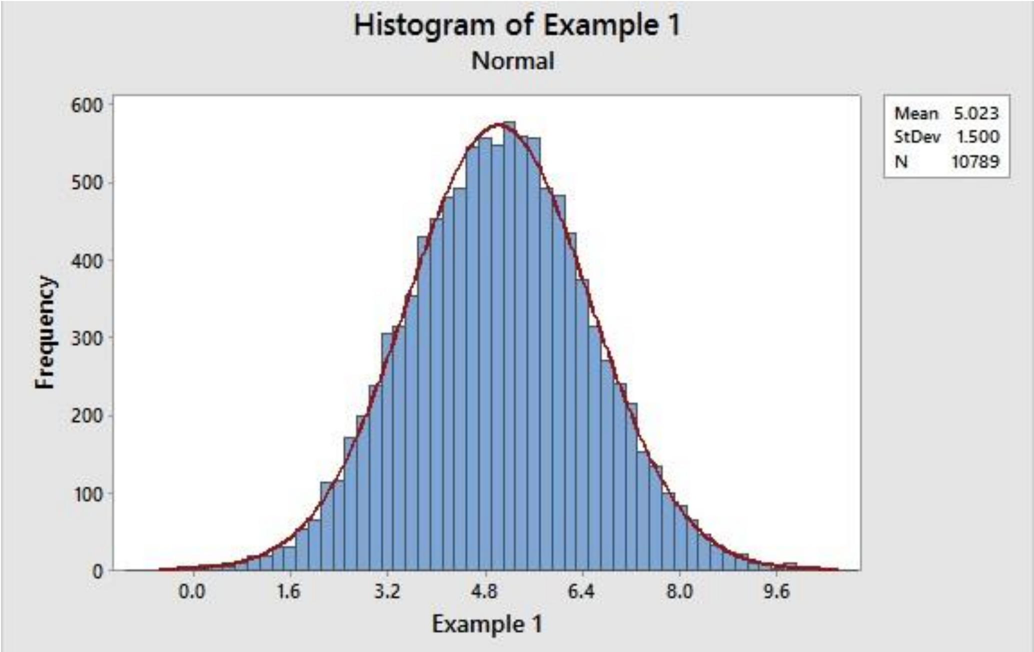
- Pedigree matrix is modified using additional uncertainties
- This creates a lognormal distribution, described by a geometric mean and a geometric standard deviation
- OpenLCA can calculate an uncertainty from the pedigree matrices
- The advantage of a geometric standard deviation is that it can be scaled easily

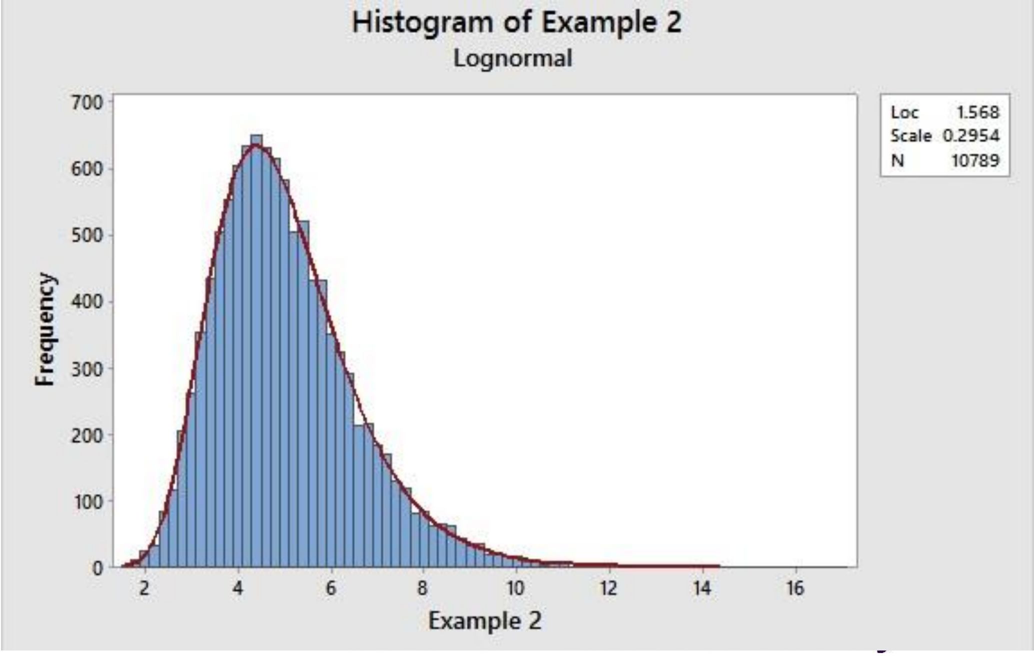
input / output group	c	p	a
demand of:			
thermal energy, electricity, semi-finished products, working material, waste treatment services	0.0006	0.0006	0.0006
transport services (tkm)	0.12	0.12	0.12
Infrastructure	0.3	0.3	0.3
resources:			
Primary energy carriers, metals, salts	0.0006	0.0006	0.0006
Land use, occupation	0.04	0.04	0.002
Land use, transformation	0.12	0.12	0.008
pollutants emitted to water:			
BOD, COD, DOC, TOC, inorganic compounds (NH_4, PO_4, NO_3, Cl, Na etc.)		0.04	
Individual hydrocarbons, PAH		0.3	
Heavy metals		0.65	0.09
Pesticides			0.04
NO_3, PO_4			0.04
pollutants emitted to soil:			
Oil, hydrocarbon total		0.04	
Heavy metals		0.04	0.04
Pesticides			0.033

input / output group	c	p	a
pollutants emitted to air:			
CO_2	0.0006	0.0006	
SO_2	0.0006		
NMVOC total	0.04		
NO_X, N_2O	0.04		0.03
CH_4, NH_3	0.04		0.008
Individual hydrocarbons	0.04	0.12	
PM>10	0.04	0.04	
PM10	0.12	0.12	
PM2.5	0.3	0.3	
Polycyclic aromatic hydrocarbons (PAH)	0.3		
CO, heavy metals	0.65		
Inorganic emissions, others		0.04	
Radionuclides (e.g., Radon-222)		0.3	

UNCERTAINTY:
PROBABILITY DISTRIBUTION

- Normal distribution for uncertainty, whilst mathematically easy to deal with, is rare in nature
- Usually, things follow a log normal distribution. This ensures there are no negative values
- To combine a log normal distribution, the easiest way is through a Monte Carlo analysis





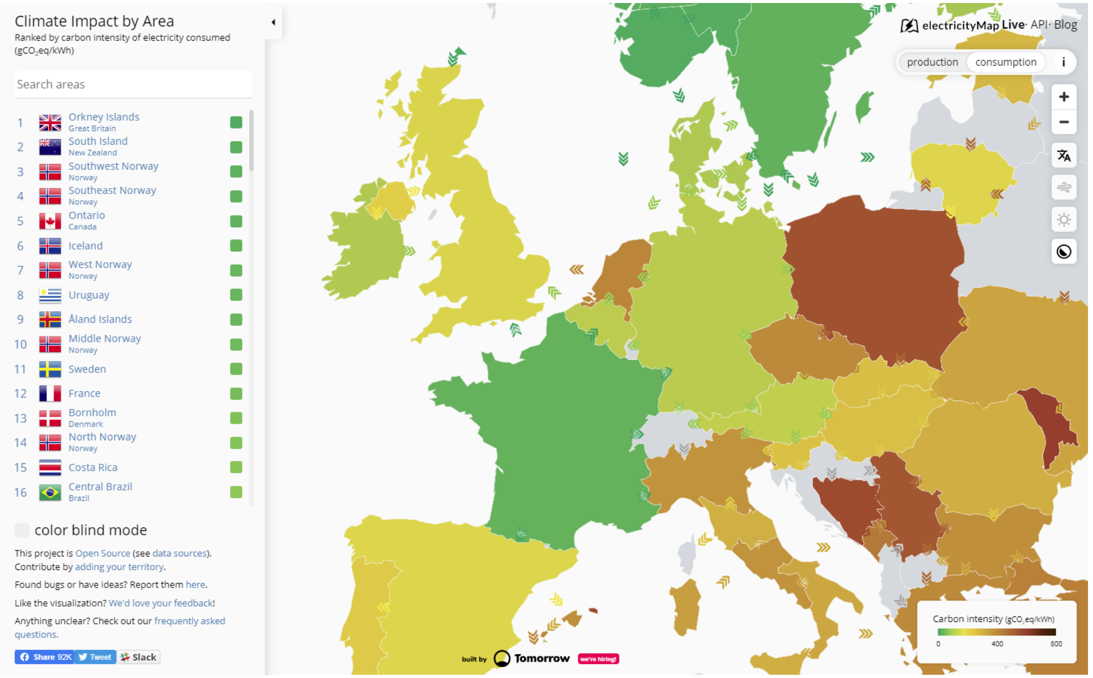
DECERNA

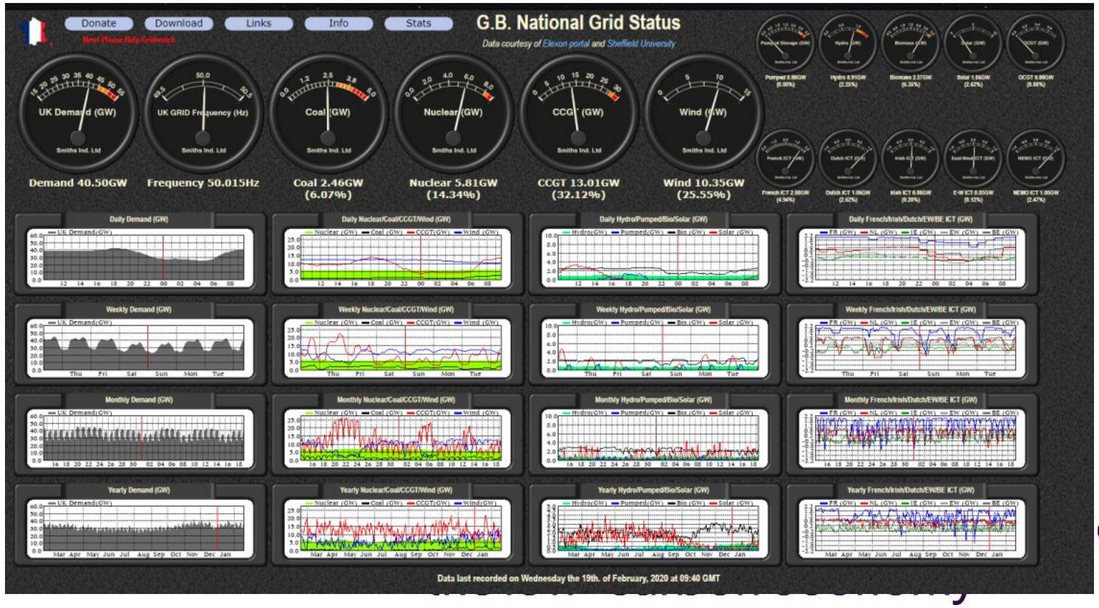
LIFE CYCLE INVENTORY: ELECTRICITY

- Energy impacts are usually the major source of environmental impacts.
- It is very important to have the most accurate electricity data within a model
- Models within GaBi, Ecoinvent and DEFRA for the UK electricity grid vary, due to the boundary conditions
- Also, if undertaking an energy saving on an existing building, the saving should not be considered as against the average grid mix, as the most likely energy system to lower output would be CCGT, not renewables (although in the UK wind is 2% curtailed for example)
- Future scenarios are useful, but there is very little data on future energy storage, which will impact models

LIFE CYCLE INVENTORY: ELECTRICITY

- You can find electricity data for the UK and other countries through a range of sources;
- Electricity Map
  - https://www.electricitymap.org
  - API available for real time CO_2eq impacts of grid
  - Subscription for historic data
- Gridwatch
  - https://www.gridwatch.templar.co.uk/
  - Free historic data
  - We strongly recommend a donation to support the individual who makes it
- When creating your own electricity models, account for losses within the grid (7% for the UK is reasonable) and energy storage losses



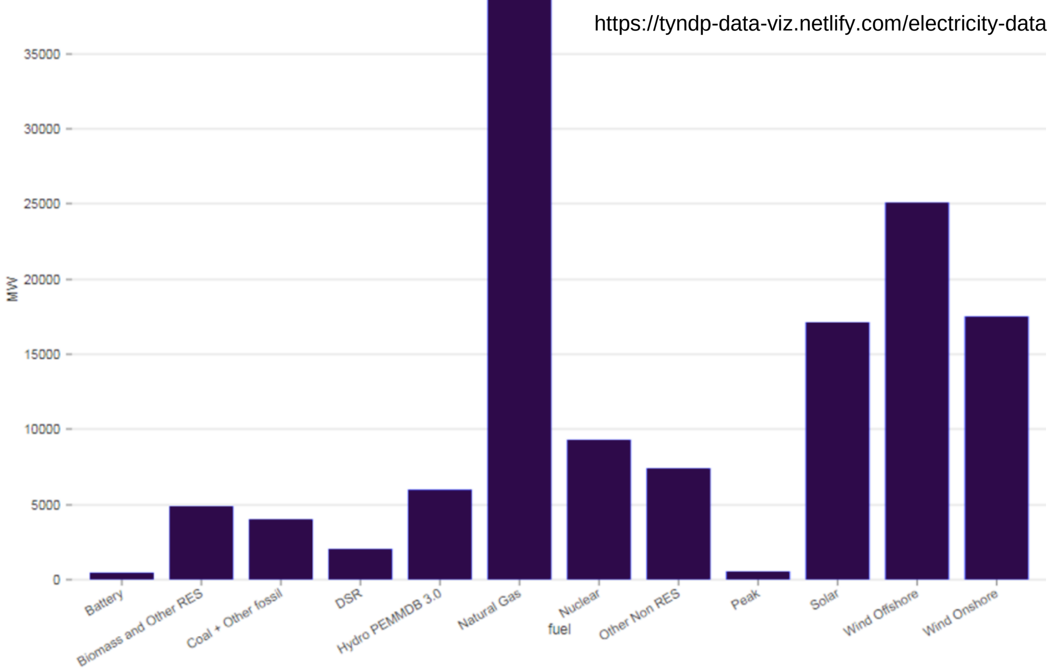


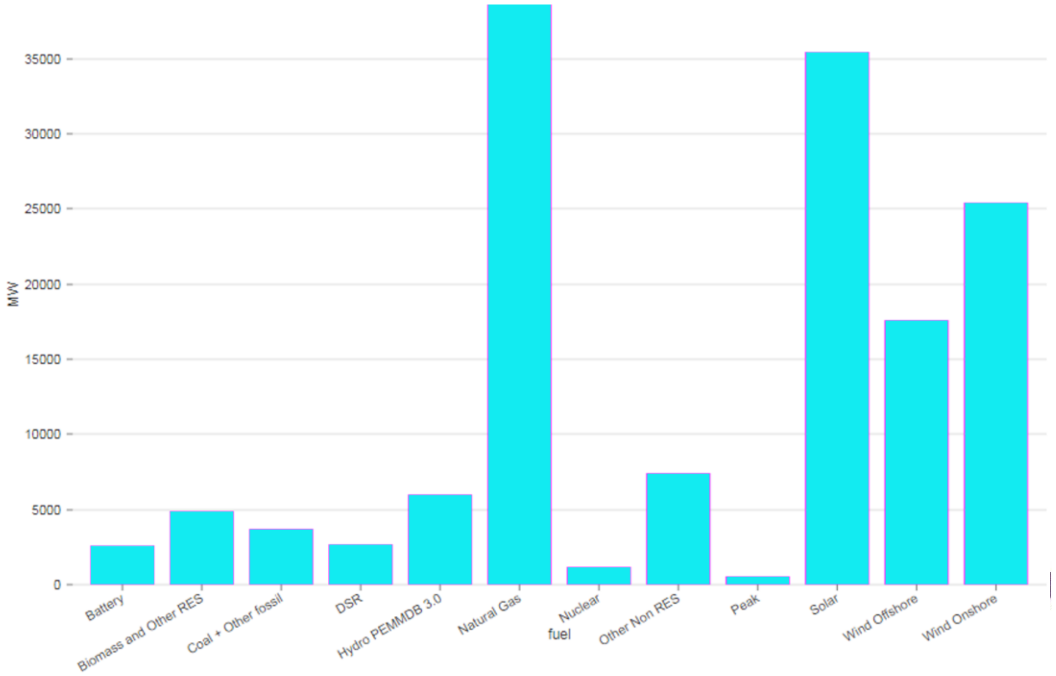
DECERNA

LIFE CYCLE INVENTORY: ELECTRICITY

- Future scenarios can be based on;
  - Nationally Declared Contributions under the Paris Agreement
  - European Network of Transmission System Operators for Electricity (ENTSO-E) Ten Year Network Development Plan (TYNDP)
  - National Energy and Climate Plans (NECPs) for the EU27+UK

https://tyndp-data-viz.netlify.com/electricity-data





DECERNA

LIFE CYCLE INVENTORY: ELECTRICITY

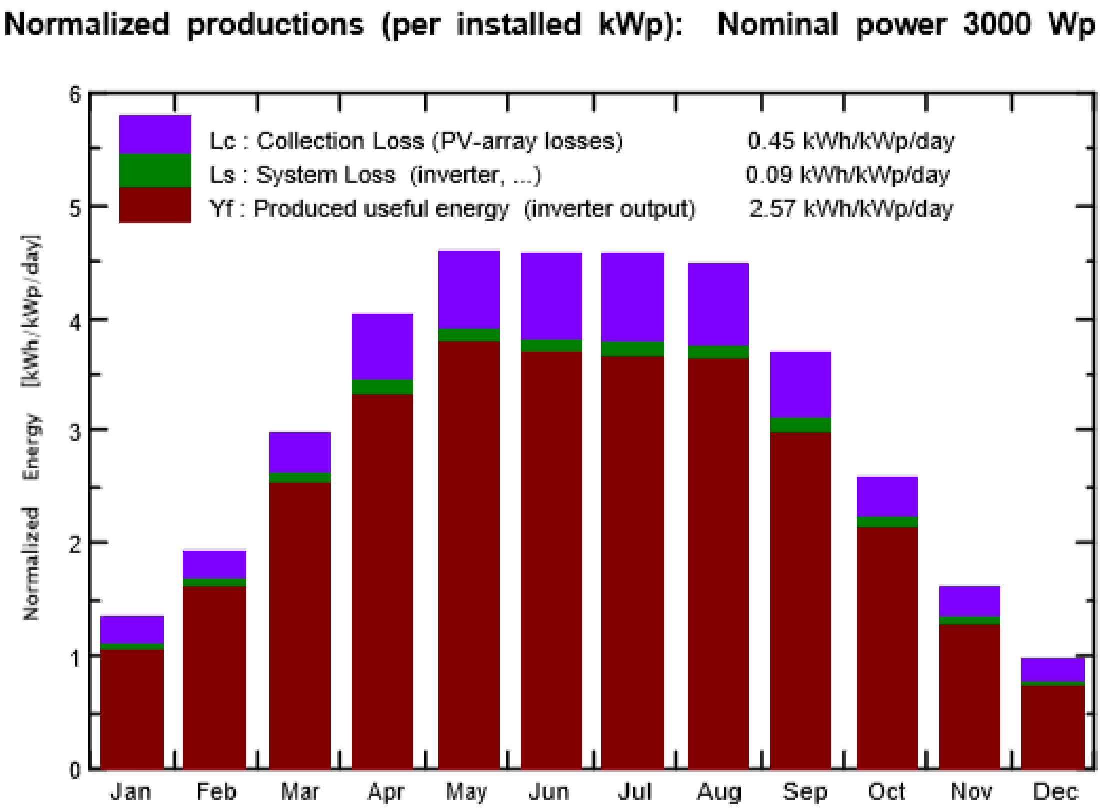
- Renewable energy models are generic within databases, not site specific
- However, renewable energy outputs is extremely site specific
- In order to create an accurate model, the LCA model must be modified
- With photovoltaics, this includes location, orientation, system sizing, curtailment, pitch….
- For wind, this includes wind speeds, curtailment, local grid issues…

LIFE CYCLE INVENTORY: ELECTRICITY

Used PVSyst (commercial solar design software) to create a model of a 3kWp system in London.

PV Array Characteristics

- PV modules: Jinkosolar JKM 300PP-72
  - Number of PV modules: 10
  - In series 10 modules
  - In parallel 1 strings
  - Nom. Power 300 Wp
- Inverter Model: Canadian Solar Inc. CSI-2.5KTL1P-GI-FL
  - Operating Voltage 80-500 V
  - Unit Nom. Power 2.50 kWac
  - Inverter pack Nb. of inverters 1 units
- Total Power 2.5 kWac



DECERNA

Delivering, unlocking, advancing the low-carbon economy

LIFE CYCLE INVENTORY: ELECTRICITY

- PVSyst
  - Year 1 output: 2,818 kWh
  - Over 25 years: 64,532 kWh
  - Output of 860 kWh/kWp/year
- EcoInvent 3.5
  - Model "electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted | electricity, low voltage | Cutoff, U"
  - Assumes 30 year lifetime
  - Output of 960 kWh/kWp/year
- Therefore, scale results by (960*30)/(860*25) = 1.34

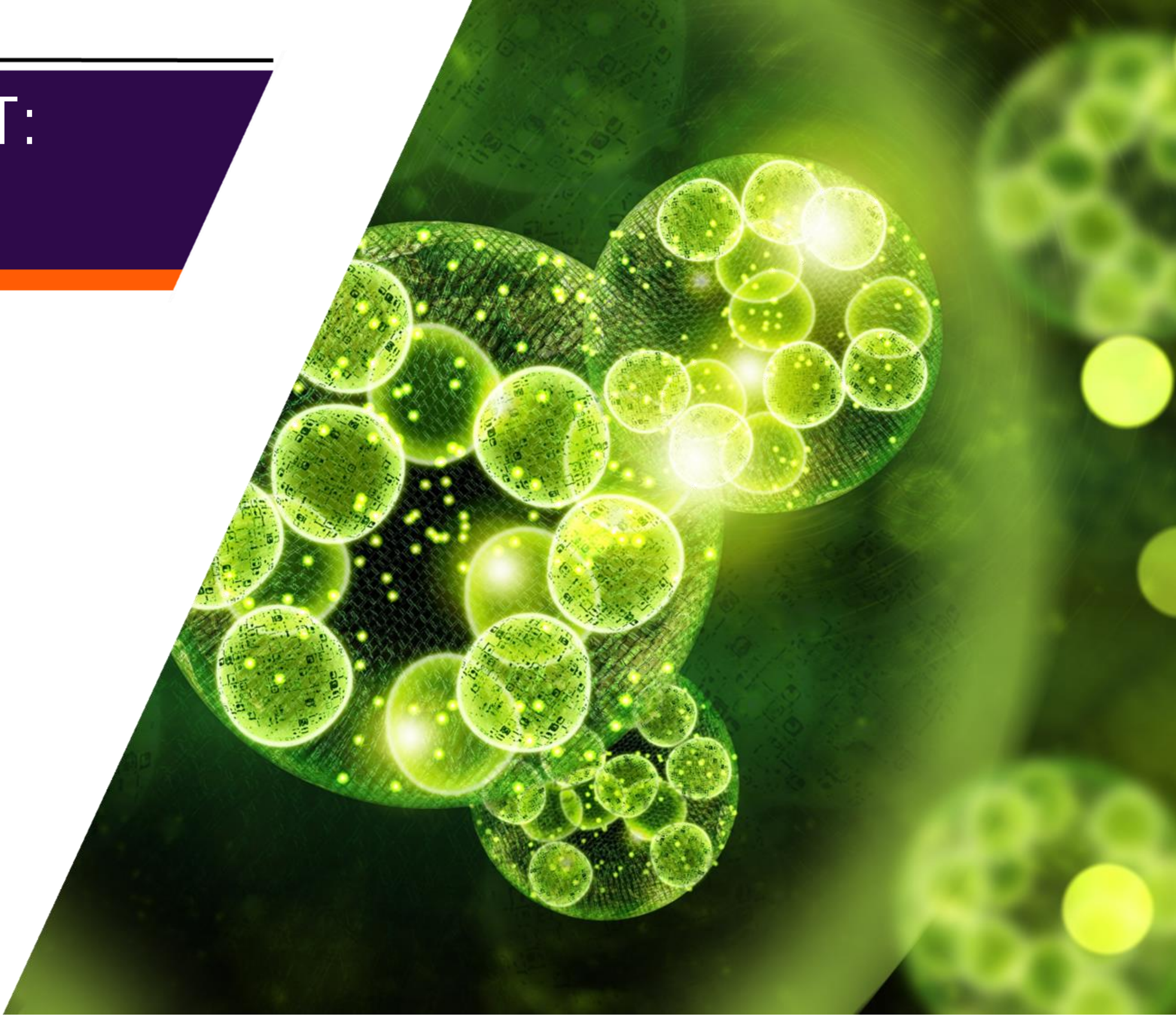
openLCA

EXAMPLE PROJECT: REALM

- Horizon Europe funded project under Grant agreement ID: 101060991
- Circular economy approach to food production
- Utilises microalagae as a vector for chemical reuse
- Running from 2022 to 2026
- Microalagae facilities based within Portugal

Co-funded by the European Union

UKRI Innovate UK



EXAMPLE PROJECT: REALM

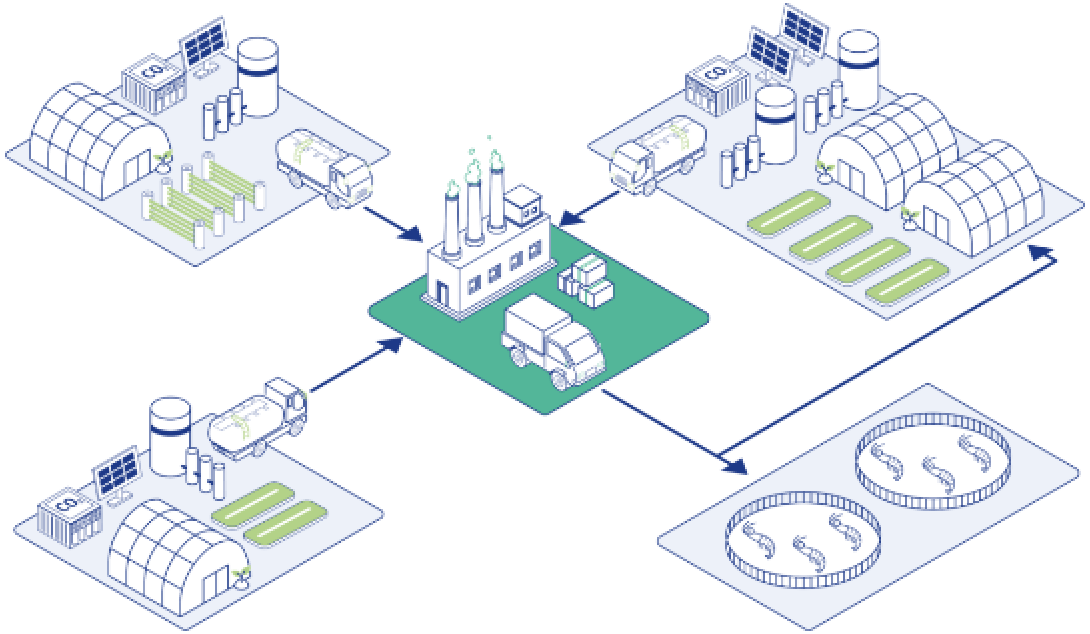
The process

In a decentralised operation, cultivation and processing of microalgae happens at different facilities, using raceway ponds or photobioreactors.

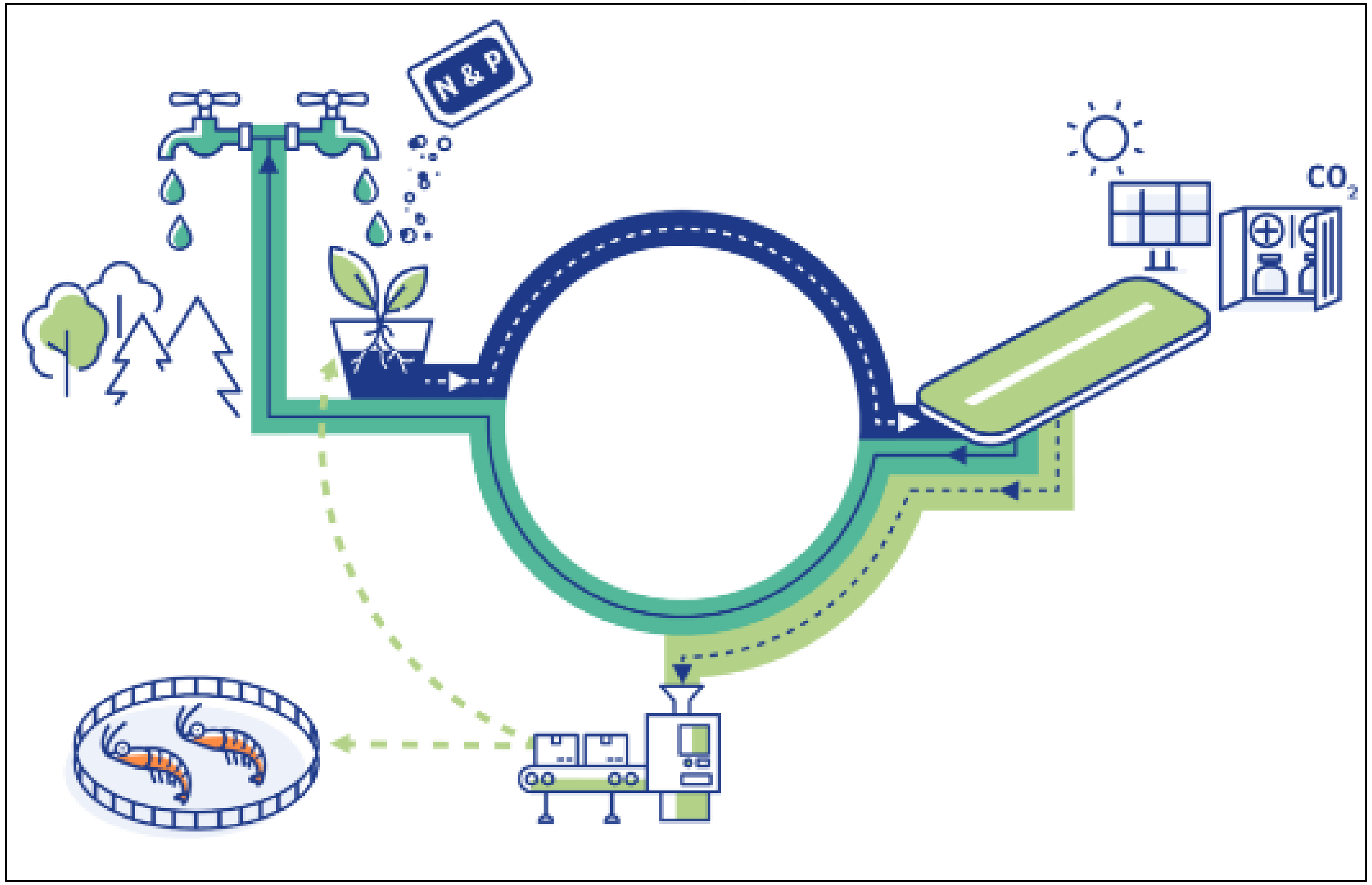
Just like in the dairy industry, microalgae producers grow this valuable resource and deliver it to a central production facility.

There, biofertilisers, biostimulants and aquaculture feed are produced.

Greenhouse farmers and aqua culturists can purchase the produced goods as sustainable alternatives to commercially available products.



EXAMPLE PROJECT: REALM



EXAMPLE PROJECT: DATA SOURCE

https://nexus.openlca.org/databases