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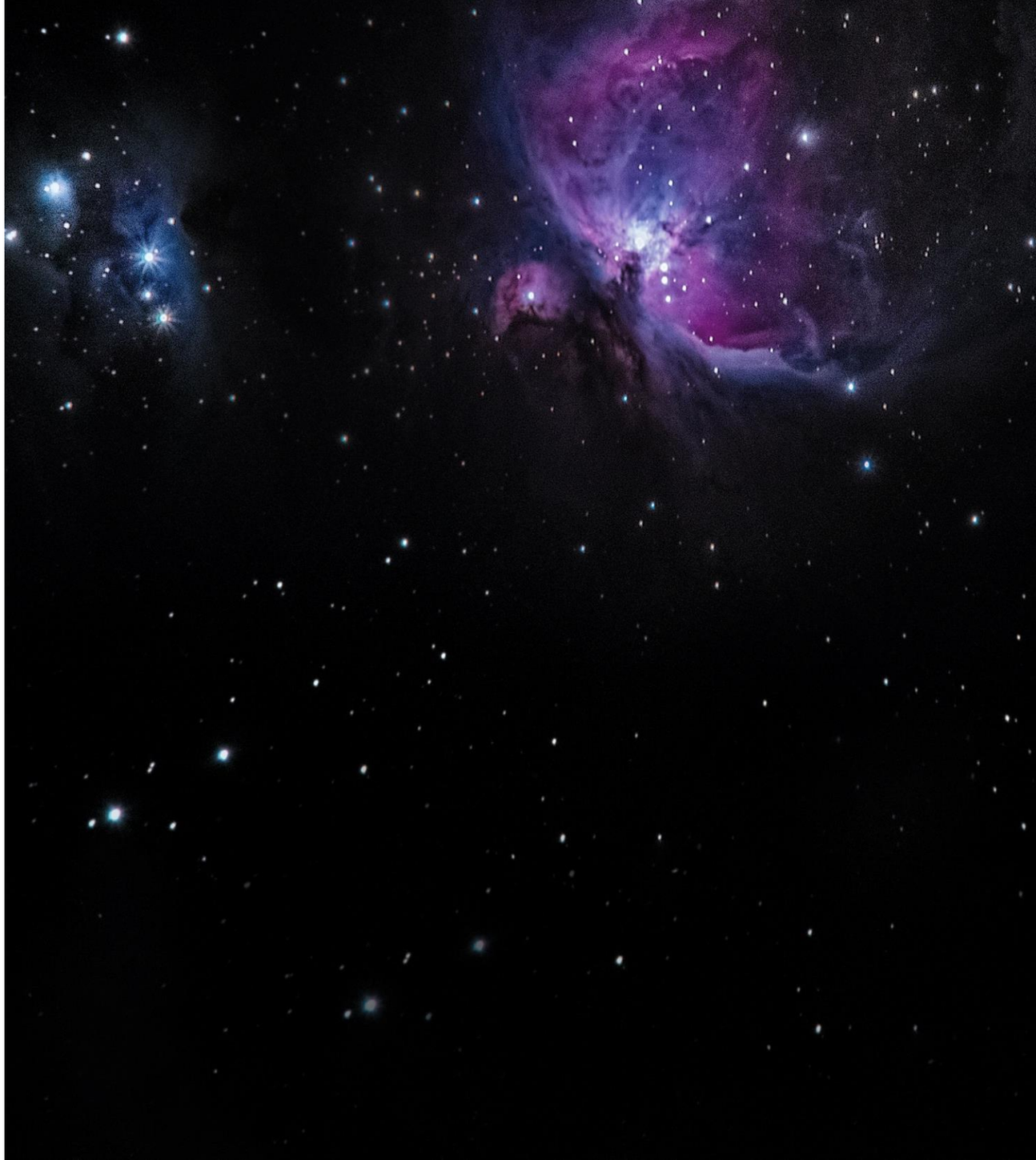
Benchmarking of environmental impacts

Clean Space Industrial Days – October 11, 2022

MAKING AN IMPACT THAT MATTERS since 1845

Agenda

Context and objectives of the project (5 mins)
Task 1: Benchmark of the environmental impacts of space activities against those of relevant activities **(8 mins)**
Task 2: Critical analysis of how companies/sectors communicate on both environmental impacts of their activities and on how they plan to reach “environmental neutrality” **(8 mins)**



Context of the project

Various space LCAs have been carried out by ESA

Since 2009 ESA has carried out environmental life-cycle assessments (LCA) of space missions (including dedicated LCAs of all segments – space and ground, the European family of launchers, and some technologies and manufacturing processes).

Little communication on LCA studies so far

Today ESA is viewed as the global leader in LCA and ecodesign for space missions. However, ESA does not communicate on the results of its studies, since uncertainties on the results are quite large, and because some of these studies contain confidential commercial data.

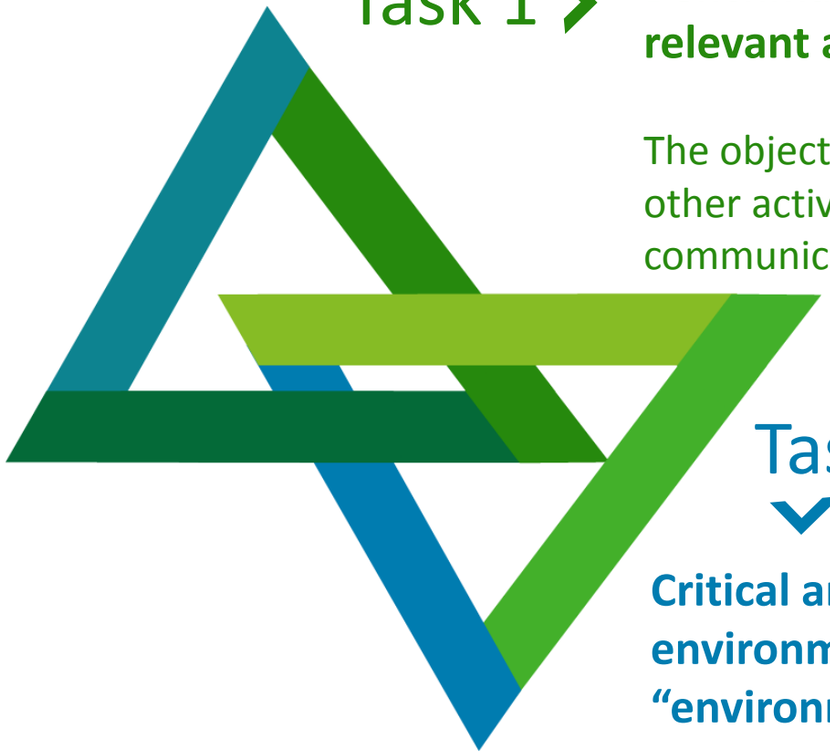
Questions on the relative impacts of space activities compared to other activities

The questions can be answered with the objective to inform ESA's stakeholders and possibly the general public on the magnitude of the impacts of space systems by comparing them to daily activities with environmental impacts which the target audience can relate to.

Global tendency to announce initiatives towards "environmental neutrality"

There is little clarity on what is meant by environmental neutrality, thus creating sometimes misinformed expectations. Should ESA envisage to announce an objective towards "environmental neutrality" of its space missions, the grounds must be properly prepared, with clear definitions of the terms and assumptions, to be agreed with industry.

Objectives of the project



Task 1

Benchmark of the environmental impacts of space activities against those of relevant activities

The objective is not to compare the environmental performance of space systems against other activities, but to make the communication of LCA results easier by providing communicable equivalents

Task 2

Critical analysis of how companies/sectors communicate on both environmental impacts of their activities and on how they plan to reach "environmental neutrality"

Since there are many different understandings of "environmental neutrality" and other similar "neutrality" concepts, the definitions used are clearly exposed. The communication of companies covering a wide range of activities, not limited to sectors akin to space but also such companies or sectors that the general public can relate to, are analysed.

Overview of the Task 1 methodological approach

Scoping and (partial) update of LCA results

- Selection of 4 space systems
- Selection of 6 environmental impact categories
- Partial update of LCA results

Benchmark of impacts

- Selection of 16 equivalents[1] for the benchmark
- Research and selection of normalisation factors for each equivalent

Analysis of the benchmark

- Conversion of space system LCA results using normalisation factors[2]
- "Scaling" of normalised LCA results

Results of the benchmark

including graphical representations for increased communicability

FICTIVE EXAMPLE: The climate change impact of a space mission is **10^6 kg CO_2 eq**.
After the benchmark, it was found that this is equivalent to around **1 return trip from Paris to New-York of an entire A380.**

[1] **Equivalent** = an activity selected to be benchmarked against a space activity for a given environmental impact category. *Example:* travel by a private ICE vehicle for climate change impact.

[2] **Normalisation factor** = environmental impact value associated to each equivalent. *Example:* 0.095 kg CO2 eq/km travelled by an ICE car.

Four space systems and six environmental impact categories were analysed

Task 1

Space systems

Big Earth Observation mission

Small Earth Observation mission

Communication mission

One extra year of operations of each space mission

Environmental impact categories

Climate change

Ozone depletion

Air acidification

Freshwater eutrophication

Abiotic resource depletion of minerals

Primary energy consumption

The environmental impact categories were selected based on:

- their relevance for ESA,
- uncertainty,
- data quality,
- characterisation method robustness,
- inclusion in the PEF (Product Environmental Footprint), and
- communicability to the general public

Final selection of equivalents per environmental impact category

Climate change

- Use of a private ICE car
- Roundtrip from Paris to New York by plane
- Residential housing
- Impacts of an average European resident

Ozone depletion

- Use of a household refrigerator
- Use of a halon fire extinguisher

Air acidification

- Freight transport of goods by lorry
- Freight transport of goods by container ship

Freshwater eutrophication

- Use of a dishwasher
- Use of a washing machine

Abiotic resource depletion of minerals

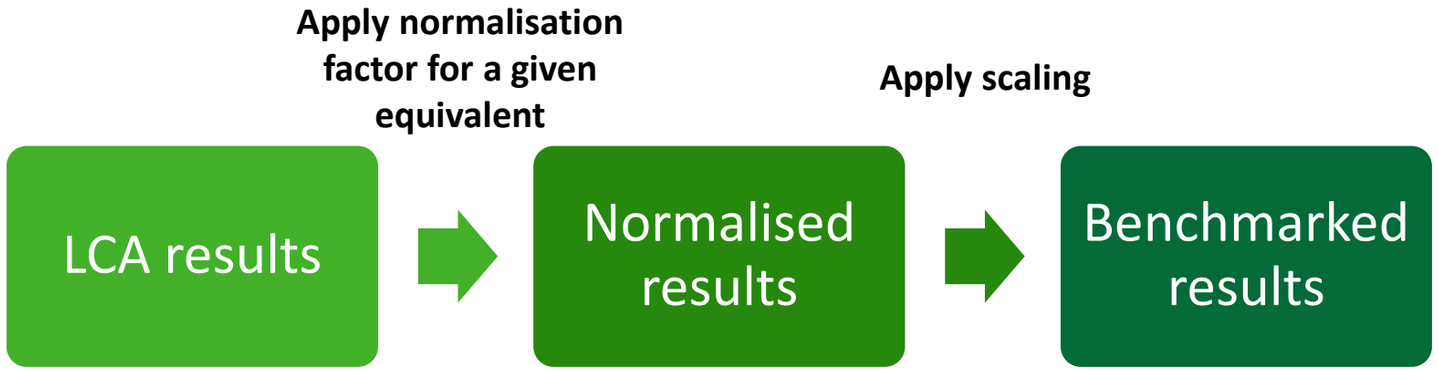
- Life cycle of a smartphone
- Life cycle of a photovoltaic module
- Production of a private electric vehicle
- Production of a 4-car metro

Primary energy consumption

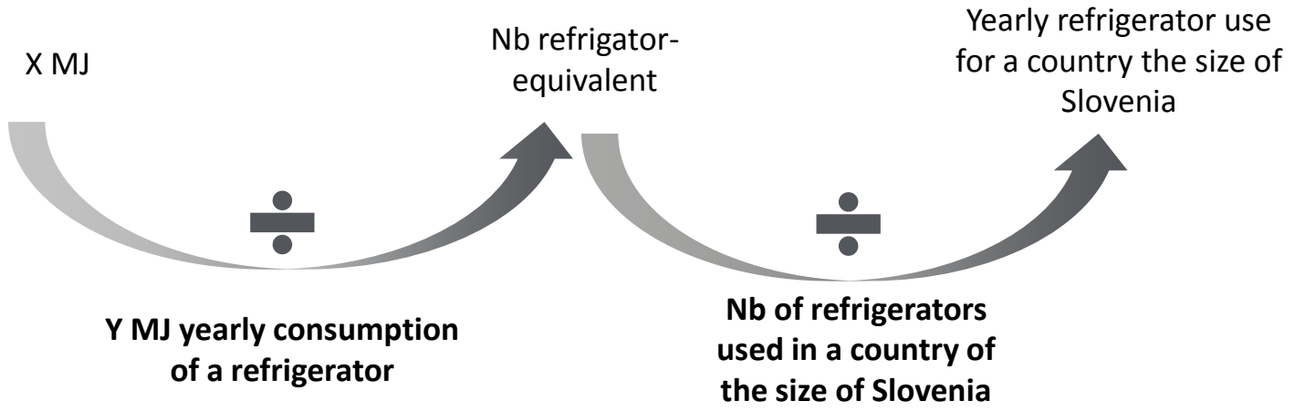
- Use of a household refrigerator
- Electricity consumption of an average European resident

Scaling of normalised results to obtain the final benchmark

As the orders of magnitude of some of the normalised results are not all easy to grasp in the case of the impacts of space missions, a final scaling step was suggested to gain a relative understanding of the results with regards to palpable orders of magnitude:



Example for primary energy consumption:



Results of the benchmark for a space mission

Task 1

The ranges below outline approximate environmental impacts of a space mission. While they are not the full range of environmental impacts of European space missions operated by ESA, they are considered representative as they were derived from the analysis of the LCAs of three different types of space missions, including one big and one small Earth Observation mission and one Communication mission.

Approximate equivalent environmental impacts of a space mission			Typical uncertainty of one space mission
The impacts on **climate change** are approximately equivalent to…	0.3 - 1	roundtrips from the Earth to the Sun	± 20%
	10 - 40	return trips from Paris to New York of an entire A380	
	10% - 50%	of the yearly energy use of residents of a city the size of Monaco	
	3% - 11%	of the average GHG emissions of a European city the size of Monaco	
The impacts on **ozone depletion** are approximately equivalent to…	10 - 50	buildings the size of ESOC using halon fire extinguishers	± 70%
	10% - 80%	of the refrigerator usage of Germany during one year, if CFC-containing refrigerators were placed back into circulation	
The impacts on **air acidification** are approximately equivalent to…	1 - 3	Eiffel towers transported by truck around the Earth at the equator	± 20%
	4 - 12	Atomiums transported by ship around the Earth at its equator	
The impacts on **freshwater eutrophication** are approximately equivalent to…	10% - 90%	of the yearly dishwasher use for a country the size of Luxembourg	± 80%
	10% - 80%	of the yearly washing machine use for a country the size of Montenegro	
The impacts on **abiotic resource depletion of minerals** are approximately equivalent to…	10% - 60%	of all smartphones in the EU	± 50%
The impacts on **primary energy consumption** are approximately equivalent to…	10% - 70%	of the yearly refrigerator use for a country the size of Slovenia	± 40%
	10% - 40%	of the electricity consumption of individuals in a city the size of Monaco	

ICE = Internal Combustion Engine

Conclusions and key learnings of Task 1

Task 1

There is difficulty in defining a “generic space mission” as each mission has its specificities.

Partially updating LCAs using a combination of different studies leads to **uncertainties associated with the obtained results**. Those uncertainties need to be kept in mind.

Multiple equivalents are possible for one given impact category, but caution must be used in using robust and relevant sources for the normalisation factors.

This project has enabled a **first step towards the communication of space mission LCA results to a broader public**.

Objectives & methodology for Task 2

Task 2

Benchmark of existing guidance documents on “environmental neutrality”

OBJECTIVE

Understand the different concepts of “environmental neutrality” and other similar “neutrality” concepts through a benchmark of key existing guidance documents on these concepts.

We will focus on the concepts and their level of maturity and applicability at organisation level

Critical analysis of communications of “environmental neutrality” claims by companies

OBJECTIVE

Perform the **critical analysis of how companies/sectors communicate on environmental neutrality** and identify good practices for this kind of communication

Applicability of “environmental neutrality” concepts to ESA

OBJECTIVE

Understand the applicability of the different definitions of neutrality to ESA

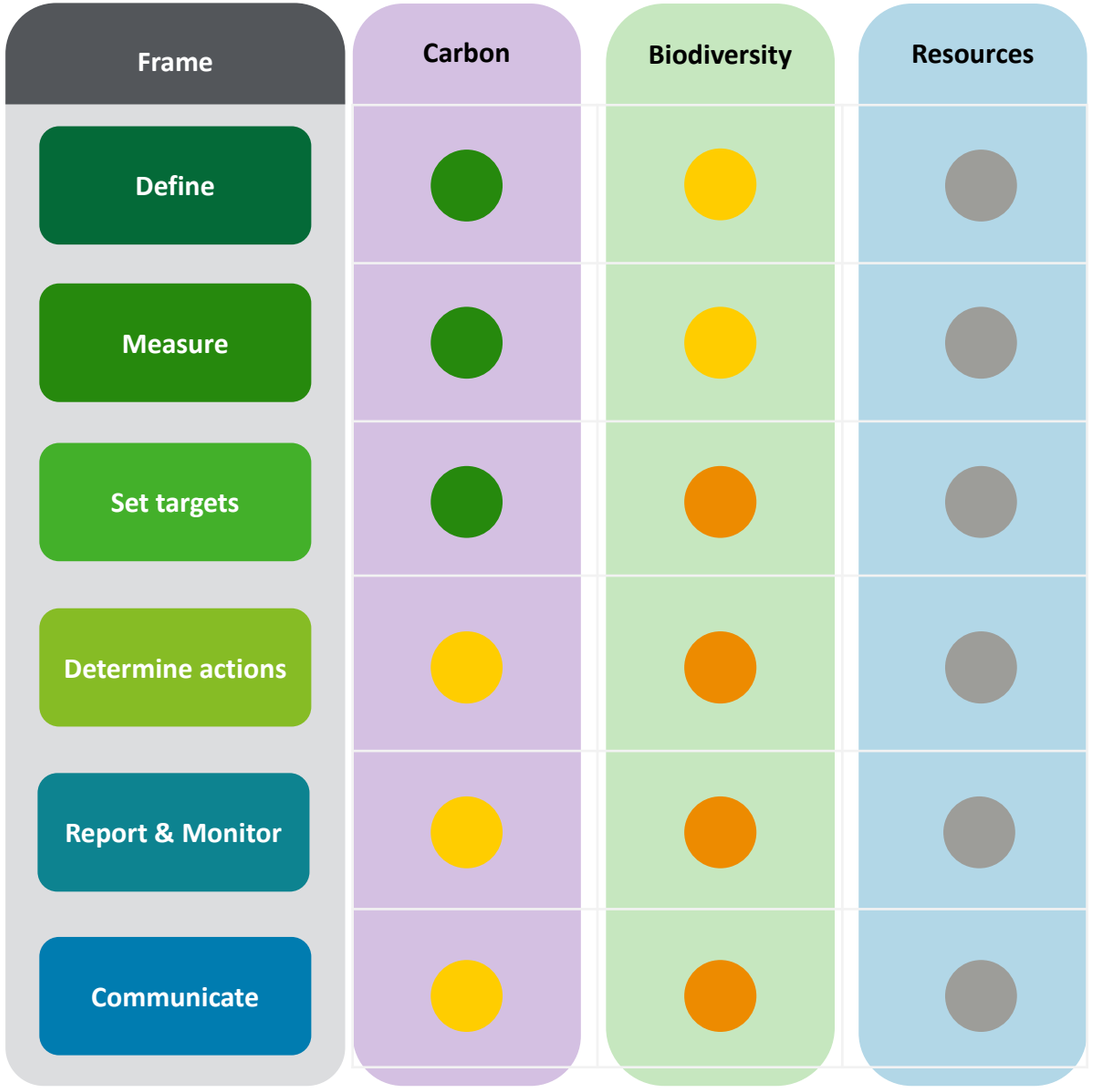
Areas selected for review in guidance documents

Selected areas and related concepts:

Area	Short description of the impact on the area	Concept	Justification for selection
Climate	Climate change is the increase in the average temperature of the Earth's surface, due to an increase in the greenhouse effect, caused by anthropogenic emissions of greenhouse gases (carbon dioxide, methane, nitrous oxide, fluorocarbons – e.g. CFCs and HCFCs – and others)	Carbon neutrality	High relevance for ESA
Biodiversity	Biodiversity losses of ecosystems, species and nature's contribution due to various pressures: land use change, resource exploitation, climate change, pollution, invasive species.	Biodiversity neutrality	Importance at local level for ESA
Resources	Refer to resource consumption of material and non-material resources.	Resources Circularity	Of interest for ESA

Level of maturity of the concepts in guidance documents and corporate communication

Task 2



Caption:

- The concept is mature at this step for both existing guidance documents and companies under review.
- The concept is mature at this step either for existing guidance documents or companies under review.
- The concept is mature at this step neither for existing guidance documents nor for companies under review.
- Multiple definitions of the concept – need to define a company-specific approach*

**For resources, analysing the maturity of the concept in the same way as carbon or biodiversity is not applicable because the concept of circularity is wide covering different sustainability dimensions. A circular economy strategy can therefore have different objectives, definitions and scopes depending on the organisation.*

Key Learnings on the concepts – Carbon Neutrality (1/2)

It is very important to distinguish between the reduced, avoided and removed emissions

Task 2

TARGETS & ACTIONS, HOW TO CONTRIBUTE TO A GLOBAL CARBON NEUTRALITY ? (based on the Net Zero Initiative)

Global decrease in emissions

Global increase of carbon removals

Pillar A – Reduce the company's emissions	Pillar B – Reduce others' emissions	Pillar C – Remove CO_2 from the atmosphere
Reduced emissions	**Avoided emissions**	**Removed emissions**
Reduction of GHG emissions in scope 1, 2 & 3 of the organisation through different actions. For instance: reduction of energy consumption, change to a low-carbon energy, use of eco-design to reduce the carbon footprint of products.	Emissions reductions that occur outside of a product's life cycle or value chain and evaluated against a reference scenario (ADEME, 2020).	Removing carbon from the atmosphere in a permanent way, which leads to gross negative emissions. For instance: direct absorption through restoration of forests, soil conversation practices; absorption through financing of carbon sequestration projects.

Key Learnings on the concepts – Carbon Neutrality (2/2)

Organisations have the necessary tools to define and implement a carbon reduction strategy

Task 2

Definition of carbon neutrality

- Divergence of definitions on the level of application (global, organisation, product).
- **Recommendation for an organisation to contribute to a global objective of carbon neutrality but not to have an objective of being carbon neutral.**
- Regulations under development on carbon neutrality > ISO14068 + “Climat & Résilience” law in France

Measuring carbon emissions

- GHG protocol mostly used by companies for emissions accounting. Other standards exist.
- Assessment frameworks for avoided emissions and removals are still under development.

Setting targets

- **SBTi** is mostly used by companies for setting reduction targets.
- **There are no targets for avoided emissions and removals.**

Determining actions

- **1. Reduce emissions** 2. Avoid 3. Remove

Key Learnings on the concepts – Biodiversity Neutrality

Task 2

Biodiversity impact assessment tools are being developed but no clear guidance on how to define biodiversity neutrality objectives is available for organisations yet

Definition of biodiversity neutrality

- “Biodiversity neutrality” does not exist as such, instead existing related concepts are: no net loss and net positive impact.
- No consensus currently on the level of application of this concept: it can be at a project level or at a corporate level. At this stage SBTN does not encourage net zero loss of biodiversity claims at a corporate level given the level of maturity of the method for corporates.

Measuring biodiversity impact

- A variety of tools and metrics (indicators) exist: the Global Biodiversity Score is one of them. The SBTN is further developing guidance on the different pressures.

Setting targets

- No global or national objectives (as it exists for carbon neutrality) exist for corporates to follow.

Determining actions

- Mitigation hierarchy is the approach set first at a project level; it is also used by SBTN. Concrete applications are lacking.

Key Learnings on the concepts – Resources Circularity

Task 2

There are multiple definitions of circular economy and resources circularity – Organisations have to elaborate their own definition and strategy

Definition of resources circularity

- More than 100 definitions of circular economy, or resource circularity, exist, and there is no consensus to define it at this stage.
- Different levels of definitions can exist: more restrictive focusing on resources or broader consider other environmental impacts than resources such as economic or social aspects.
- Need for companies to find their own definition of circularity

Measuring resources circularity

- Variety of tools exist to measure CE performance but with different definitions, objectives, different indicators at different stage of the definition of a circular economy strategy.

Setting targets

- Need for companies to find their own definition of circularity

Determining actions

- Need for companies to find their own definition of circularity

Thank you for your attention!

Any questions?

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