SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

Sustainable Water Integrated Management and Horizon 2020 Support Mechanism

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The application of Life Cycle Assessment (LCA) in olive mills

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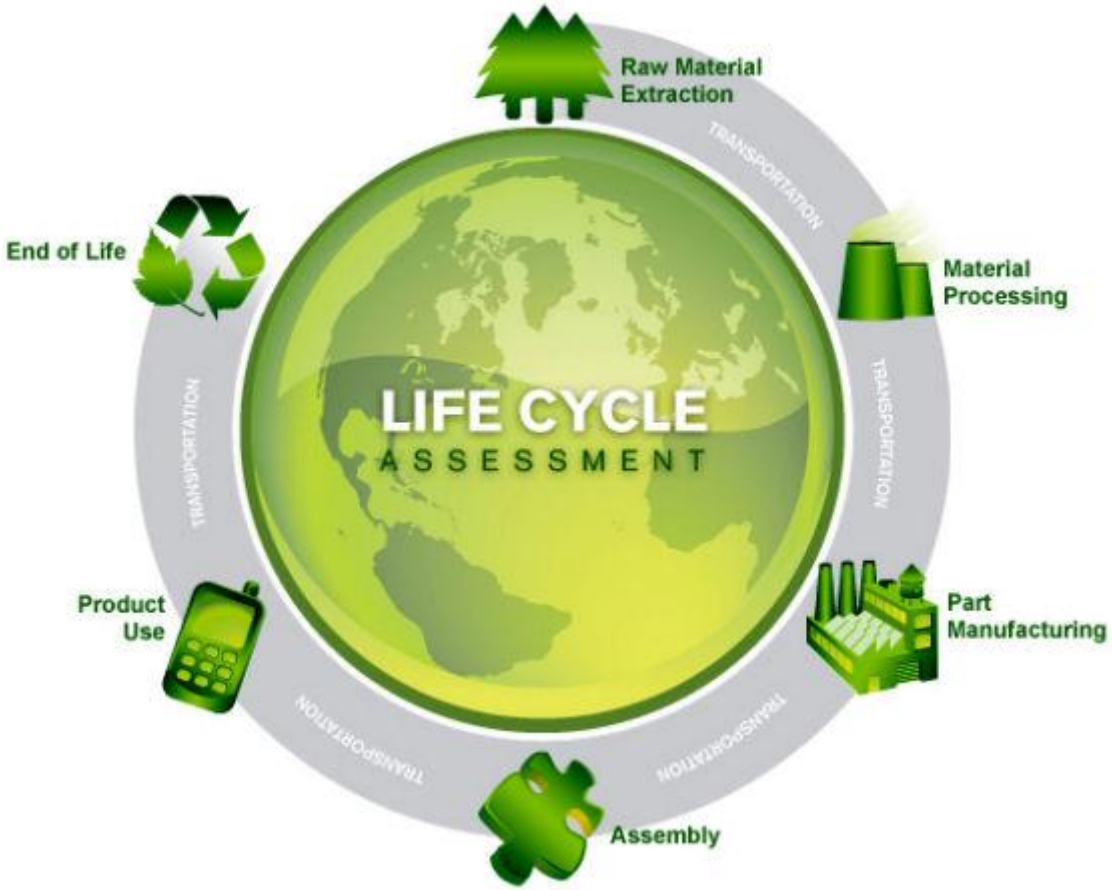
Presentation Outline

- Life Cycle Analysis (LCA)
- Key considerations of a LCA
- Product Carbon Footprint

What is Life Cycle Assessment (LCA)

- Life cycle assessment (LCA) involves the evaluation of some aspects - often the environmental aspects - of a product system through all stages of its life cycle. Sometimes also called “life cycle analysis”, “life cycle approach”, “cradle to grave analysis” or “Ecobalance”
- It represents a family of **tools and techniques** designed to help in environmental management and, longer term, in sustainable development

What is Life Cycle Analysis (LCA)



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A growing need

Sustainable development is on the national and international agendas. It requires many things, but above all it requires **rapid improvements in eco-efficiency**, or in the efficiency with which we **use energy and a wide range of materials taken from nature, and how we minimise waste**.

This builds on the long-running international interest in so called “cleaner technology”. Even more demanding, however, sustainable development calls for eco-efficient improvements throughout the **life cycle of a given product or system**.

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What is a product's life cycle?

Simply stated, the life cycle of a product embraces all of the activities that go into making, transporting, using and disposing of that product.

The typical life cycle consists of a series of stages running from extraction of raw materials, through design and formulation, processing, manufacturing, packaging, distribution, use, re-use, recycling and, ultimately, waste disposal.

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The producer's responsibility

Once, a manufacturer simply handed a product over to a distributor or customer, and that was the end of the story.

These days it is widely recognised that any producer works with "chains" of suppliers "upstream", and chains of customers "downstream". **The producer's responsibility no longer ends at the factory gate**. Increasingly, industry accepts that product stewardship is the way forward. Governments, too, are imposing "take back" requirements, to make producers take their wastes back and reprocess at least a proportion.

What Can LCA Do?

- Supporting decision-making, **highlighting efficiency opportunities** along a value chain.
- Understanding the industrial systems involved in manufacturing products and **delivering services to end-users**.
- **Optimizing** industrial systems by identifying operations within a market chain that have the greatest opportunity for improvement, often referred to as “hot spots.”
- Ensuring that changes made to improve one part of an industrial system do not “shift the burden,” by **moving a problem**, or creating a new issue in another part of the chain.
- Informing decision makers about the trade-offs that a decision will have on the **balance of impacts** across the environmental impact categories, such as, implementing a particular technology to reduce GHG emissions that may result in increased water usage.
- **Comparing** two systems that deliver the same service/product as defined by the **functional unit**.

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What Can LCA Do?

Here it is important to note that:

- Differences of less than approximately 10%, are within the typical error of **good quality LCAs**; meaningful differences must be much larger.
- LCAs can only meaningfully **compare products or services that deliver the same functional unit**; comparison of dissimilar products is meaningless.
- Indicating whether an improvement investment at one part of a market chain will have any **significant improvement effect** over the whole life cycle.
- **Benchmarking** one organization's processes against an industry average of similar processes to identify improvement possibilities.
- Providing **footprinting data**, such as carbon footprints.
- Environmental claims should be supported by LCA data

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What Doesn't LCA Do?

- An LCA doesn't measure the performance of a product or its constituents—it doesn't tell you if the product you are analyzing will perform any better or worse than another product. **It will tell you the life cycle inputs and outputs to make that product**.
- An LCA has **nothing to do with compliance with environmental laws**. Compliance is usually taken as the assumed baseline—there is no litter or excess solid waste, no violation of air pollution standards or water permits—and **LCA assumes** the product system you are measuring meets applicable local and regional environmental standards.

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What Doesn't LCA Do?

- An LCA typically does not include the "bricks and mortar" of capital equipment in the manufacturing facility where your product is made. **The energy and wastes associated with manufacture of capital equipment**, including equipment to manufacture buildings, motor vehicles, and industrial machinery, also are not usually included.
- LCA typically does not include an analysis of **support personnel requirements**, nor the energy and wastes associated with research and development, sales, and administrative personnel or related activities.
- LCAs also do not normally measure **building space conditioning**. The fuel and power use to heat, cool and light manufacturing facilities are omitted from the calculations in most cases. For manufacturing plants that carry out thermal processing or otherwise consume large amounts of energy, space conditioning energy is quite low compared to process energy.

What Doesn't LCA Do?

- An LCA generally does not include every single material, such as catalysts, pigments, or other additives that total less than 1% by weight of the net process inputs. These minor contributions are typically not included in the assessment, unless inventory data for their production are readily available or there is reason to believe the materials would make significant contributions to energy use or environmental impacts.
- An LCA typically does not provide information about **employee direct impacts**. Travel to and from work, travel for work and lunchroom waste, for example, are typically not included in the LCA study.

What Doesn't LCA Do?

- Another thing an LCA **does not do** is provide the same level of exposure calculations as a **risk assessment analysis**. For instance, an LCA on a particular foodservice package will provide some LCA impact data, possibly including human and environmental toxicity. But a risk assessment that looks at the exposure of a particular chemical in foodservice packaging, including a rigorous measure of migration and consumption factor calculations to measure dietary exposure and acceptable daily intake, is beyond the scope of an LCA.
- LCA **does not define what specific course of action to take**. LCA provides results that will **help stakeholders make better decisions**, based on evaluated trade offs.

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How to Decide if an LCA is the Right Tool

- If you are looking to examine more than one environmental or energy attribute of a product, and you need to examine **trade-offs** in making changes that can help identify places to **reduce the overall footprint** of a product system, it might make sense to consider the broader approach that an LCA presents.
- LCA takes a **holistic view of service provision** by measuring inputs to, and outputs from, all unit operations invoked by delivering a service to an end-user. Inputs include raw materials, facilitating substances, components and energy, while outputs include products, co-products and wastes. These material and energy flows are both upstream of the consumer and downstream (e.g., waste management) and are compiled in the analysis in terms of the functional unit. An LCA, by definition, **does not focus on one environmental parameter** but examines all relevant aspects.

Life Cycle Stages

- Inputs and outputs in the main manufacturing/ processing sequence
- Distribution/transportation
- Production and use of fuels, electricity and heat
- Use and maintenance of products;
- Disposal of process wastes and products
- Recovery of used products (including reuse, recycling and energy recovery)
- Manufacture of ancillary materials
- Manufacture, maintenance and decommissioning of capital equipment
- Additional operations, such as lighting and heating
- Other considerations related to impact assessment (if any)

Strengths and limitations

Strengths:

- Analytical, data-based method
- Considers the full life cycle of a product or process
- Highlights trade-offs
- Variety of impact assessment methods available makes the tool robust by considering different perspectives
- Flexible
- Supports decision-making

Strengths and limitations

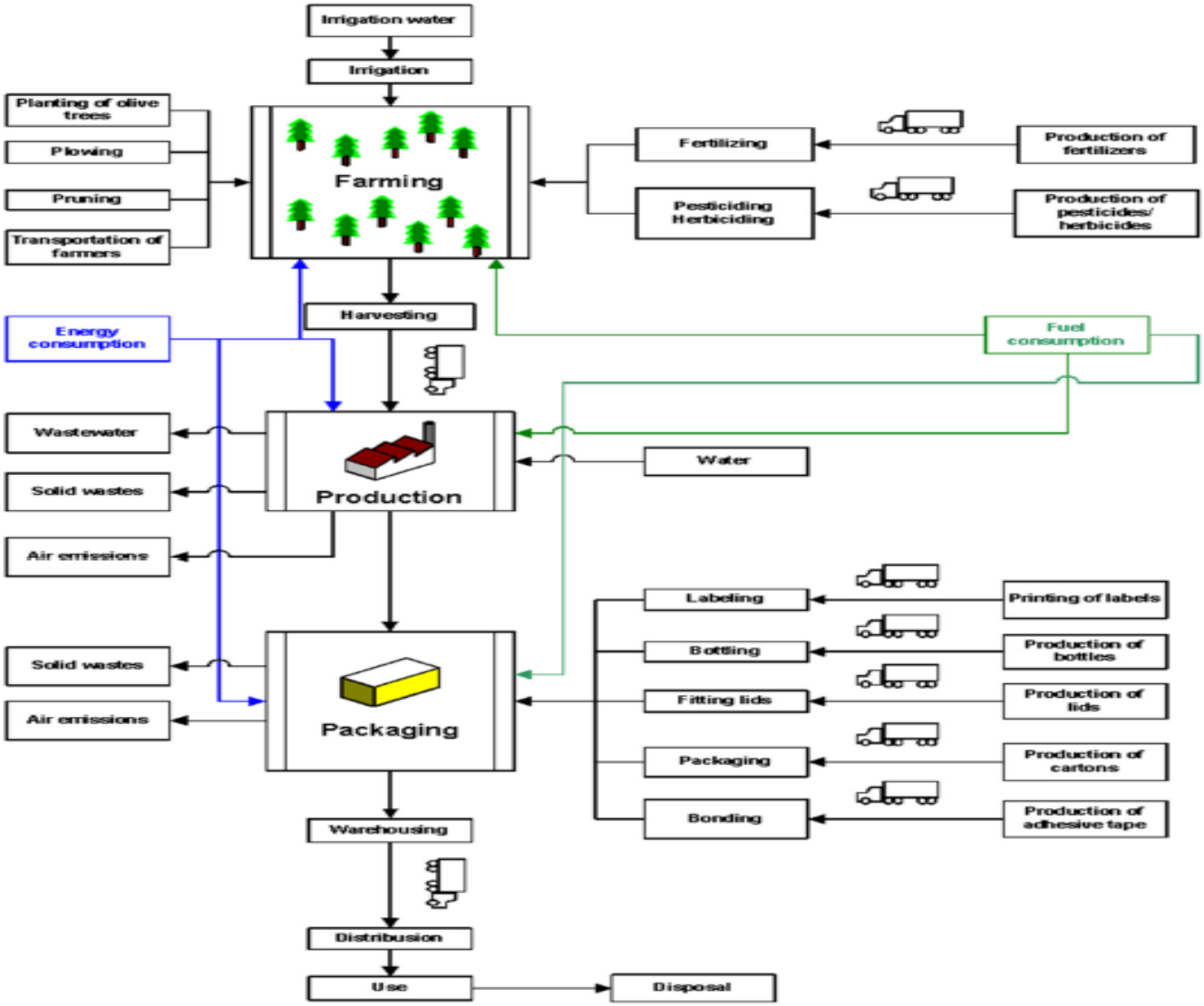
Limitations:

- Data intensive
- Snapshot view—doesn't account for changes over time
- Provides input for decision making but not the definitive answer (due to trade-offs)
- Cannot calculate impacts for topics for which numerical models do not exist
- There is no absolutely scientific basis for reducing LCA results to a single overall score or number. However, aggregation methods are available that can be used for normalizing and weighting environmental results

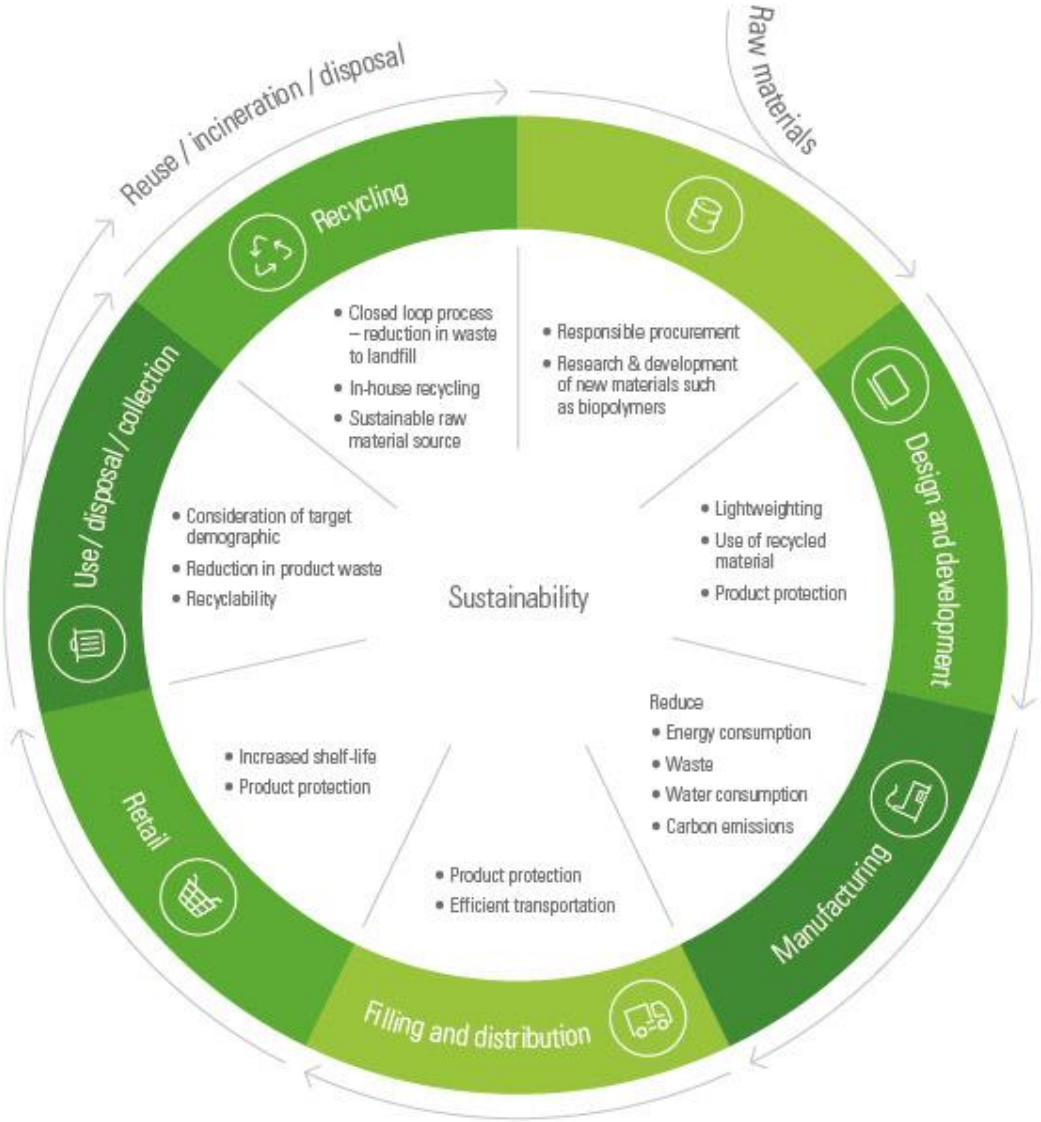
Key considerations

- **Accuracy**: Measure of the variability of the data values for each data category expressed (e.g., variance)
- **Completeness**: Percentage of locations reporting primary data from the potential number in existence for each data category in a unit process
- **Representativeness**: Qualitative assessment of degree to which the data set reflects the true population of interest (i.e., geographical coverage, time period and technology coverage)
- **Estimation of time in the data collection process**: The process for collecting primary data is usually the most time consuming part of an LCA. It's important to find the right balance between the amount of time and resources for the study accuracy in order to get the most appropriate information to help in your decision making process
- **Consistency**: Qualitative assessment of how uniformly the study methodology is applied to the various components of the analysis
- **Reproducibility**: Qualitative assessment of the extent to which information about the methodology and data values allows an independent practitioner to reproduce the results reported in the study

System investigated



LCA analysis



Carbon Footprint and LCA

The **difference between** an **LCA** and a **Carbon footprint** are related to the impact categories which are studied. A **Carbon Footprint** is focused on one environmental impact category: **greenhouse gas emissions** ($CO_{2\ eq}$). Meanwhile an **LCA** takes more impact categories into account, such as land use, water use and acidification.

Carbon Footprint

The term carbon footprint is commonly used to describe the total amount of **CO2 and other greenhouse gas (GHG) emissions** for which an individual or organisation is responsible. Footprints can also be calculated for events or products.

Defining the functional unit

Do you want to know the impact **per tonne** of product, **per unit** produced, or **per yearly** service period?

A functional unit (FU) is a measure of the function of the system to be analysed and provides a reference to which the inputs and outputs of the system can be related.

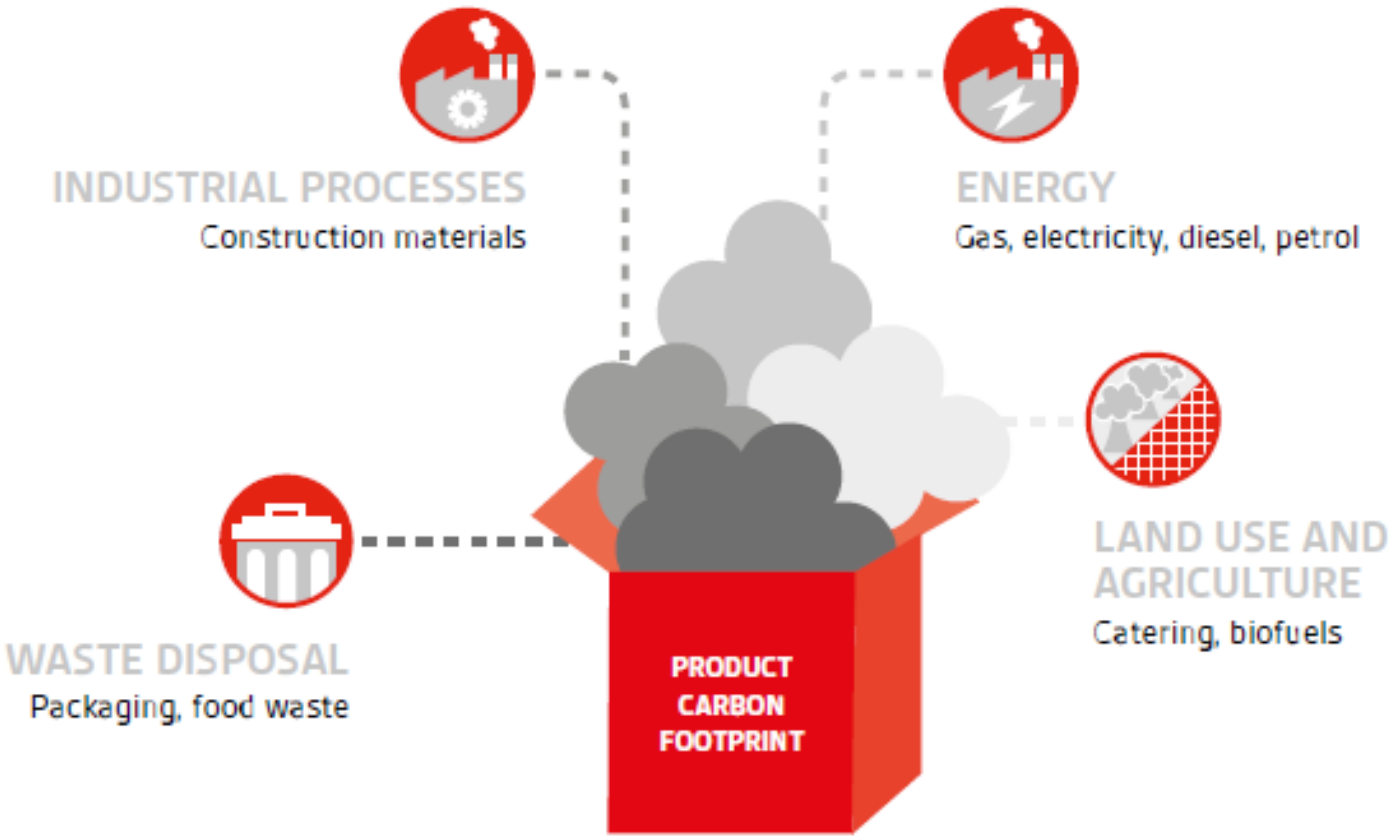
The FU will be informed by the system boundaries put in place and by the product system map drawn.

A functional unit is usually defined as a specific amount of product or service delivered to the customer, for example:

- **Mass (weight**) – 1 kg apples at home,
- **Units** – 1,000 disposable paper cups,
- **Service** – 1 year of car use,
- **System** – protecting 1m2 of wall for ten years

The FU allows comparing two different systems with the same function. There is the potential to use existing documentation to inform the choice and application of the functional unit; however this is often sector and category dependent.

The sources of GHG emissions from the manufacture of a product



Direct emissions that result from activities the organisation controls

Most commonly, direct emissions will result from combustion of fuels which produce CO2 emissions, for example the gas used to provide hot water for the workspace. In addition, some organisations will directly emit other greenhouse gases.

For example, the manufacture of some chemicals produces methane (CH4) and the use of fertiliser leads to nitrous oxide (N2O) emissions.

Emissions from the use of electricity

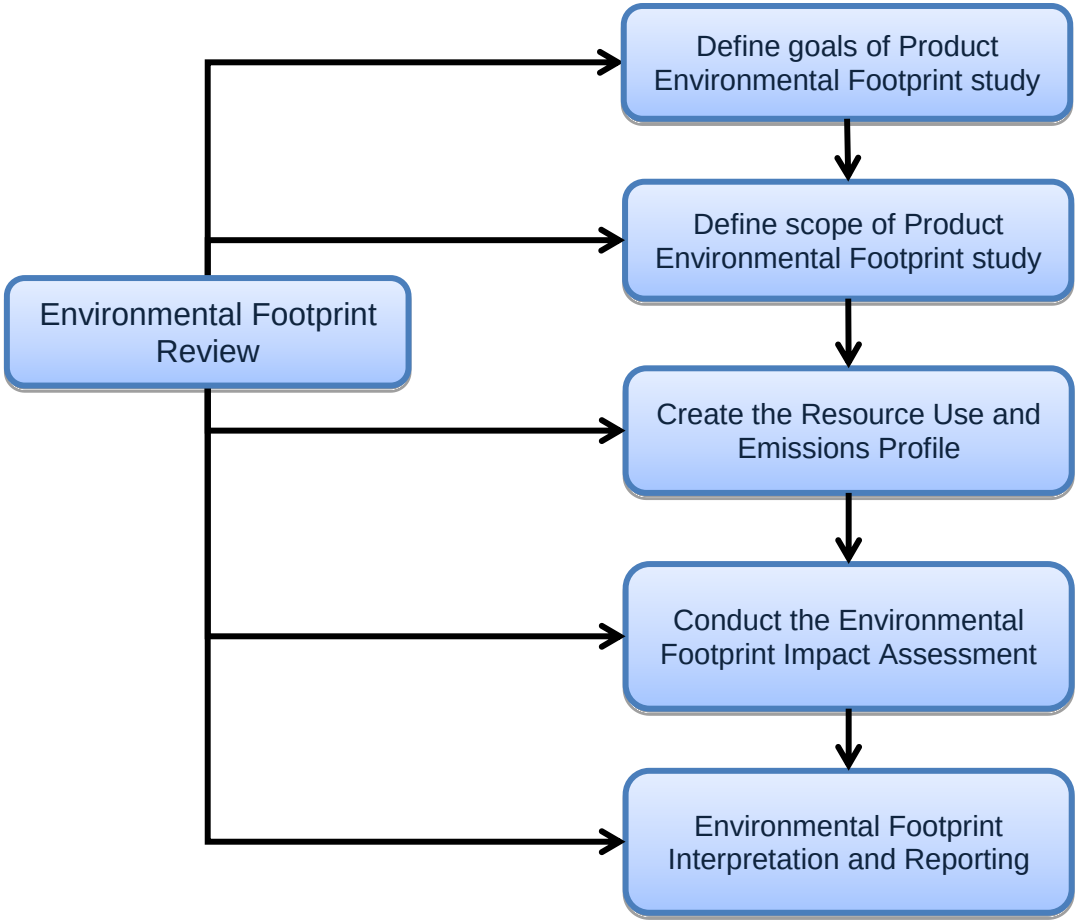
Workplaces generally use electricity for lighting and equipment. Electricity generation comes from a range of sources, including nuclear and renewables. However, in the UK around 75% is produced through the combustion of fossil fuels. Although the organisation is not directly in control of the emissions, by purchasing the electricity it is indirectly responsible for the release of CO2.

Indirect emissions from products and services

Each product or service that is purchased by an organisation is responsible for emissions. So the way the organisation uses products and services affects its carbon footprint.

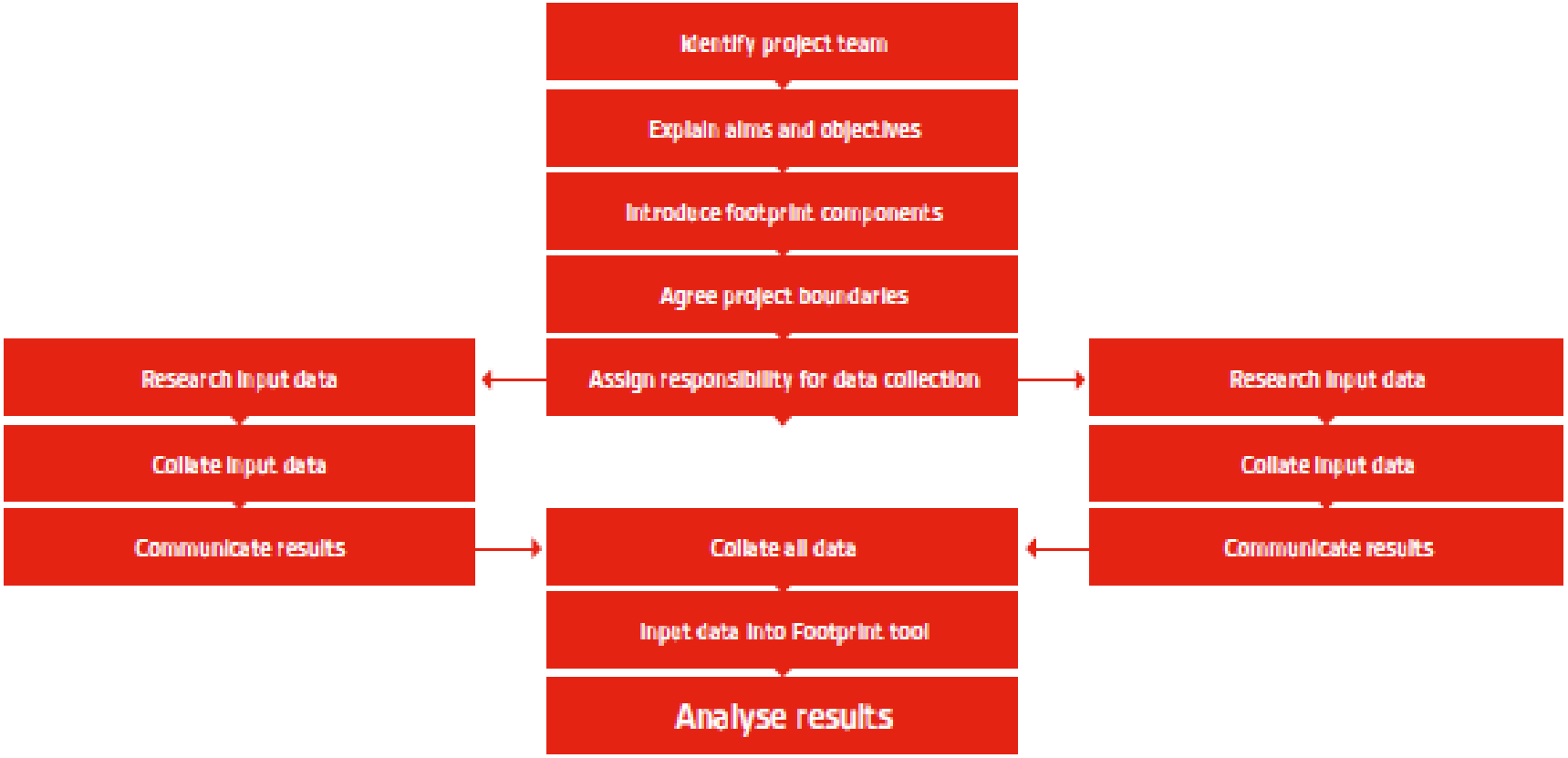
For example, a company that manufactures a product is indirectly responsible for the carbon that is emitted in the preparation and transport of the raw materials. Downstream emissions from the use and disposal of products can also be indirectly attributed to the organisation.

Phases of a Carbon Footprint



Decision tree to determine scope and boundary

Project process



Barriers from initiating a Carbon Footprint project

INSUFFICIENT FINANCIAL RESOURCES

- Source enough finance for an initial scoping study that will highlight potential cost savings as well as environmental benefits.
- This will also help to make a strong case for further research that could work out to be cost efficient in the long term.

LACK OF STAFF ENGAGEMENT

- Talk to staff – why are they reluctant to participate? E.g. extra work, or disillusion with green initiatives.
- How can you ensure they have the necessary support, training and capacity?

FUTURE COMMITMENT

- Staff, customers and other stakeholders may expect you to follow through and tackle your environmental impacts.
- This is positive; there are many potential benefits to taking further action, from efficiency savings to brand enhancement.

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Why calculate the Carbon Footrpint

- To manage the footprint and reduce emissions over time
- To report the footprint accurately to a third party.

Why calculate Carbon Footprint

Footprinting for management of emissions

Calculating an organisation's carbon footprint can be an effective tool for ongoing energy and environmental management. If this is the main reason that an organisation requires a carbon footprint, it is generally enough to understand and quantify the key emissions sources through a basic process, typically including gas, electricity and transport.

This approach is relatively quick and straightforward. Having quantified the emissions, opportunities for reduction can be identified and prioritised, focusing on the areas of greatest savings potential.

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Why calculate Carbon Footrpint

Footprinting for accurate reporting

Organisations increasingly want to calculate their carbon footprint in detail for public disclosure in a variety of contexts:

- For CSR or marketing purposes
- To fulfill requests from business or retail customers, or from investors
- To ascertain what level of emissions they need to offset in order to become 'carbon neutral'.

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Calculating a Carbon Footrpint

1. Define the methodology
2. Specify the boundary and scope of coverage
3. Collect emissions data and calculate the footprint
4. Verify results (optional for credibility)
5. Disclose the footprint (optional for advertising or CSR).

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Footprint calculation

Consumption data	X	Emission factor	=	Footprint
1,000 kWh (electricity)	X	0.537 $kgCO_2$/kWh (emission factor)	=	537 $kgCO_2$

Carbon footprint of olive oil production

- the production of fertilizers and pesticides, their transportation to the field and their use
- the extraction and use of water for irrigation
- the production, transportation and use of diesel fuel for all field activities
- the collection of olives with various mechanical means
- the transportation of olives to the olive-oil mills
- the production of olive-oil at the olive-oil mills
- the transportation of olive oil to bottling facilities of with various vehicles
- the storage, bottling and packaging of olive oil.

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Carbon footprint of olive oil production

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Carbon footprint of olive oil production

Carbon Footprint of 1 kg of Olive Oil 1 L Bottle		
	Carbon Footprint	
	(Kg CO_2.eq)	(%)
Agriculture	**1.6**	**67.8**
Production and Use of Fertilizers	1.07	45.3%
Production and Use of Insecticides	0.23	9.8%
Use of Machinery for Ploughing	0.16	6.8%
Water Extraction and Use	0.12	5.1%
Rest	0.02	1%
Olive Oil Extraction	**0.29**	**12.1%**
Bottling and Packaging	**0.45**	**18.2%**
Glass Production	0.38	16%
Glass Transportation	0.05	2%
Al. Screw Cap Production	0.01	1%
Plastic Production	0.01	1%
Collection, Storage and Rest	**0.02**	**1.1%**
TOTAL	**2.36**	**100%**

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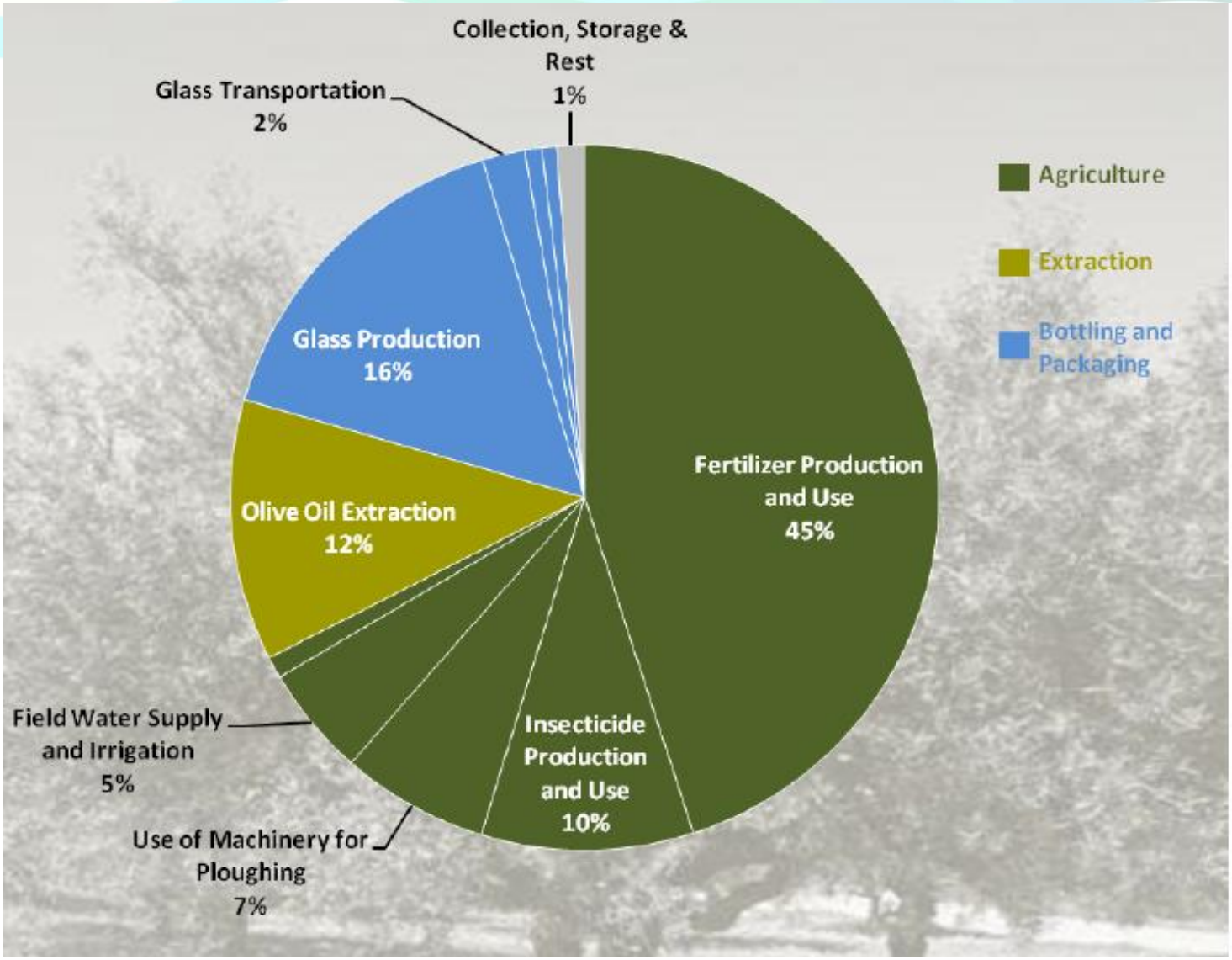
Carbon footprint of olive oil production



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Thank you for your attention.

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