

The GHG emission avoidance calculation in practice

Energy intensive industries, including CCU, substitute products and biofuels

Aikaterini Konti, JRC.C.2, Joint Research Centre

Key points for energy intensive industries applications

- Include a complete diagram;
- Use the hierarchy of literature sources in appendix 1 of the methodology where requested;
- Justify the choice of values, if more than one value is available at the same level of the literature hierarchy, in particular if this could lead to an underestimation of project emissions or overestimation of reference emissions.

Overall principle changes in emissions of project compared to reference scenario over first 10 years

Overall principle: changes in emissions of project compared to reference scenario over first 10 years

“Processes”:

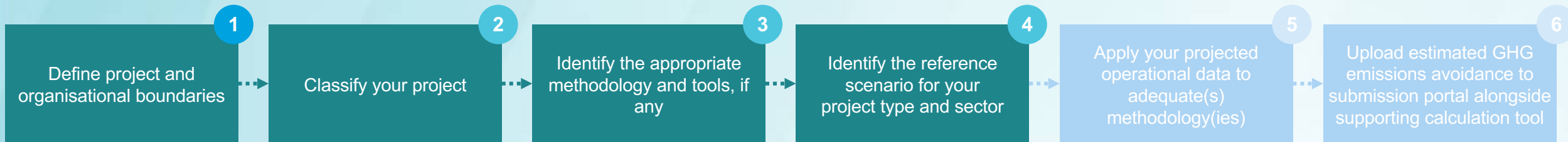
- Produce the “principal products”
- Are under the control of the applicant
- Use EU ETS calculation rules and MRV

$$\Delta \text{GHG}_{\text{abs}} = \sum_{y=1}^{10} \left(\text{Reference (Ref}_y) - \text{Project (Proj}_y) \right)$$

The diagram illustrates the calculation of absolute change in greenhouse gas emissions ($\Delta \text{GHG}_{\text{abs}}$) over a 10-year period. It is defined as the sum from year 1 to 10 of the difference between Reference (Ref_y) and Project (Proj_y) emissions. Each scenario is broken down into several components:

- Reference (Ref_y) components:** Inputs, Processes (incl. carbon capture), Combustion (principal products), End of life (principal products), and Non-principal products.
- Project (Proj_y) components:** Inputs, Processes (incl. carbon capture), Combustion (principal products), Change to in-use (principal products), End of life (principal products), and Non-principal products.

Plus signs (+) indicate that these components are summed within each scenario. A minus sign (-) between the Reference and Project boxes indicates that the Project emissions are subtracted from the Reference emissions.



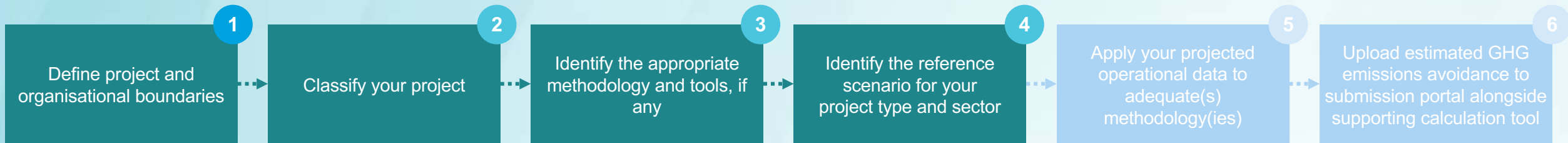
Nine basic cases:

1. An EU ETS product benchmark corresponding to production of the principal product exists => **benchmarks should be the basis for the reference scenario.**

Example: A project producing hot metal. Reference scenario: combination of the benchmarks for coke, sintered ore, and hot metal. The expected consumption per unit of output of the intermediate products that are used in the production of the final product (hot metal) **may be considered**, as the emissions from coke and sintered ore production are not included in the hot metal benchmark value.

2. An appropriate reference scenario can be constructed from an EU ETS product and other benchmarks sub-installation (heat, fuel, others)

Example: a project manufacturing cold drawn steel bars may be able to construct a reference scenario in which the “processes” box is based on combination of the product benchmark for hot metal and a fuel benchmark sub-installation reflecting additional fuel consumption for the drawing process.



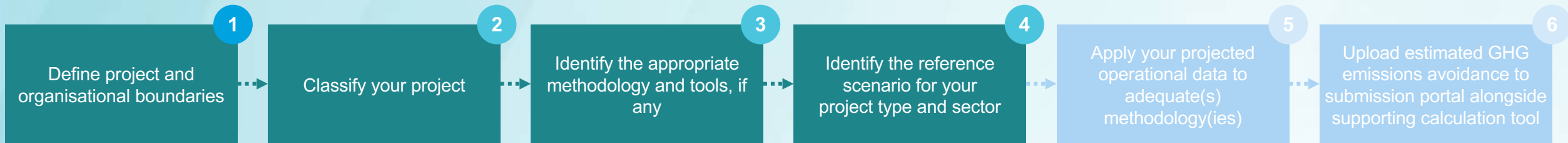
Nine basic cases:

3. The project is a modification to an existing production system the applicant may choose to use **the existing (i.e. unmodified) production system** as the reference scenario (subject to conditions).

Example: if a steam methane reformer at an oil refinery is replaced with an electrolyser and the principal product is identified as hydrogen, this could not be treated as a modification as the main element of the hydrogen production system is entirely replaced.

If, however, refined hydrocarbon fuels were treated as the principal product then the project could be treated as a modification in the context of this wider production system.

Possible SIW: modified plant not demonstrated to meet the relevant EU ETS benchmark



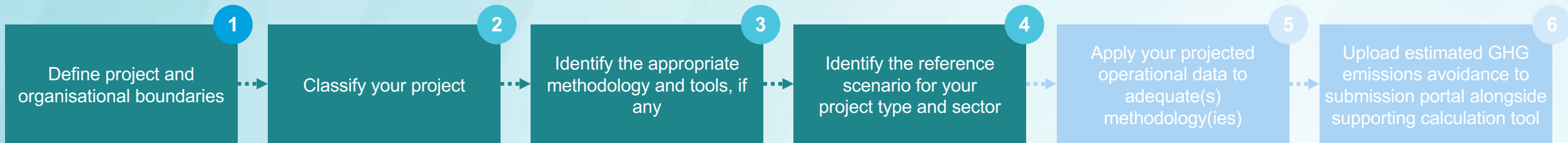
Nine basic cases:

4. Principal product is a transport fuel substitute =>reference scenario should be based on the **IF fossil fuel comparator values**.

Example: A project produces hydrogen. Hydrogen is supplied to fuel cell vehicles. It substitutes the transport function of conventional cars running on fossil fuel. The reference scenario for the **substituted function** is the consumption of the fossil fuel required (fossil fuel comparators Table 2.2) for a comparable conventional car to transport **the same load an equal distance**.

Otherwise, the correct reference scenario would be ‘generic’ hydrogen production, and the reference scenario emissions would be based on the EU ETS hydrogen product benchmark. (The appropriate sector for the principal product hydrogen would be hydrogen).

SIW: incorrect reference selected (FFC or benchmark)



Nine basic cases:

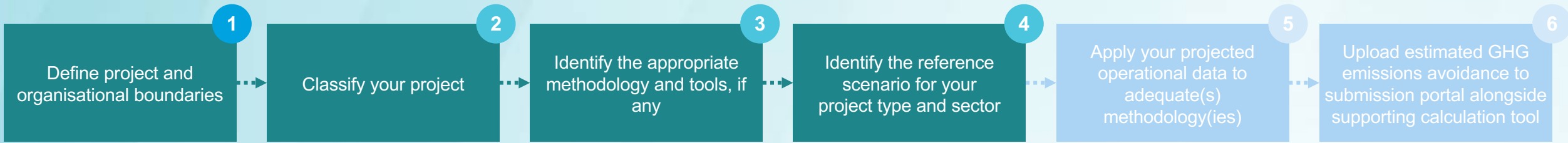
- Principal product is a natural gas substitute => reference scenario should be based on the **combustion emissions intensity of natural gas.**

Example: Production of renewable gas fed into natural gas grid. Reference scenario:

If there is no arrangement in place to supply to a specific market, then it has to be assumed that the reference for the natural gas fed into the gas grid would be the general combustion emissions intensity of 56.1 gCO₂e/MJ.

If the disposition of the natural gas substitute is known (e.g., transport or industrial use) then the reference scenario should reflect emissions associated with providing that equivalent function.

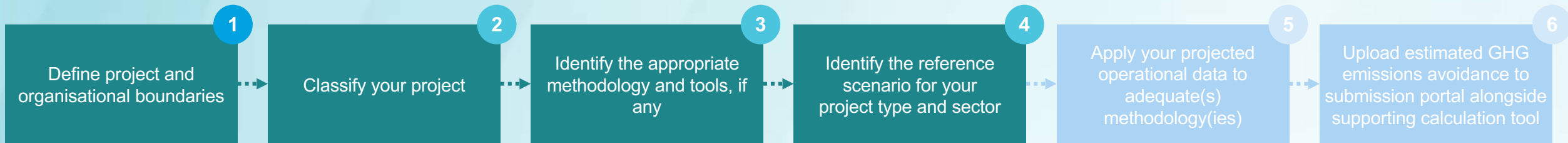
SIW: incorrect reference selected if the use is known



Nine basic cases:

6. In the reference scenario the principal product is synthesised from natural gas (e.g., methanol) and an emission value is available in the inputs data hierarchy (Appendix 1) for production of that principal product with natural gas as the primary feedstock => **this value should be the reference scenario emissions for the principal product (subtracting 15% for upstream emissions)**

Example: A project will produce propylene as the sole principal product. The EU ETS benchmark for “Steam cracking (high value chemicals)” may not be used as a reference (**SIW**). The applicant may look through sources in the data hierarchy to find a lifecycle emission value for propylene production from steam cracking of natural gas liquids and use that value (reduced by 15% if appropriate) as their reference scenario.



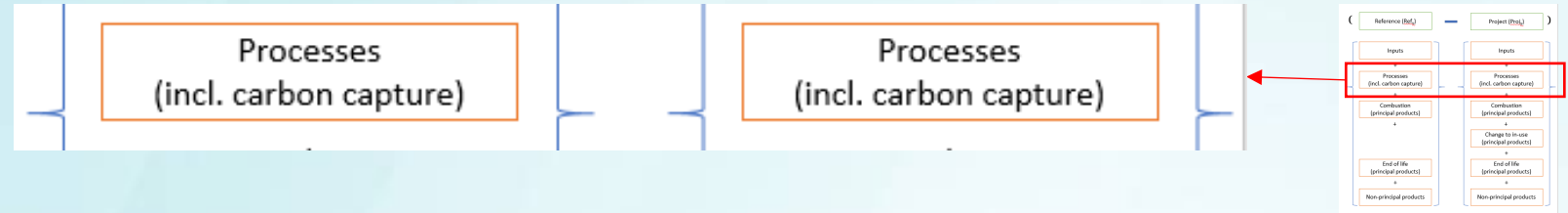
Nine basic cases:

7. If the project is for CCS from direct air capture, the reference scenario is zero emissions.
8. If the project is to transport or store CO₂ captured outside the system boundary, the reference emission is the quantity of CO₂ entering the system boundary.
9. Where it is not possible to construct a reference scenario for production of all the principal products from a project in the ways identified above, then the applicant must propose an appropriate reference production system with clear justification and provide a robust characterisation of the emissions associated with that system.

Possible SIW: It is possible to construct the reference scenario using one of the previous 8 cases.

!!! For projects with multiple principal products it is possible that reference scenarios fall under different sections

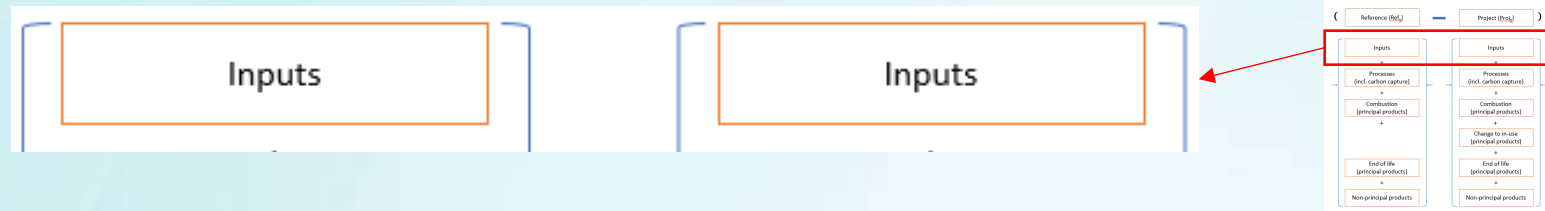
Processes



- Process emissions within the project boundaries in both scenarios to produce the **same quantity of the principal products or deliver an equivalent function**.
- Projects with CCS: The **CC credit** calculated according to the methodology in section 3 shall be included as a separate **negative emission term**.
- Projects with CCU: Need to demonstrate that the captured CO₂ will be used. The **full amount of CO₂ generated** by the project should be included as a **positive emission term or as zero (biogenic CO₂)**, even though some of this CO₂ is to be captured. All emissions associated with capture, transport and incorporation of the CO₂ (negative term) into a product should also be fully accounted as a separated term in this box.

Possible SIW: wrong treatment of non-principal products (i.e.: treating them as co-principal products creating a reference for them in the reference scenario).

Inputs



- Include the inputs that enter the system boundary associated with the processes boxes. Include both energy and material inputs.
- Use emission factors from **data hierarchy** (Appendix 1). Do not use EU ETS benchmarks for inputs emissions or own estimated EF which inflate the reference emissions (**SIW**).
- EU ETS benchmarks do not generally include inputs emissions → add them in inputs box of reference scenario.
- For the project scenario, and for reference scenario under ‘Case 3 (modifications to existing production systems) the applicant may choose to bring the production of any input into the “processes” box and assess the emissions directly. This requires that the applicant should be able to identify the source of that input and to cooperate with the producer of that input.

Elastic inputs: Simplification of emissions for INPUTS in the application

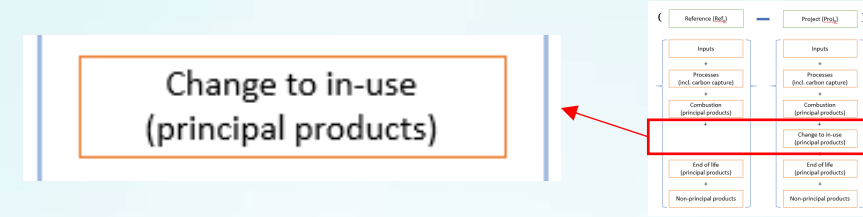
- **De minimis**: inputs with joint emissions <5% of the total emissions ascribed to the inputs may be neglected
- All other inputs must be considered and calculated based on the emissions factors from the data hierarchy.

Inputs

Rigid inputs: They can only be supplied to a new IF project by diverting them from another use or disposition (e.g.: municipal waste, used plastics, used lubricating oil, waste heat etc.). Need to consider the impact of diverting it from its existing use:

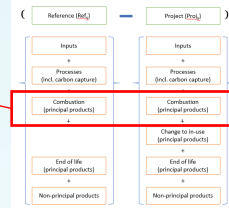
1. The diversion is expected to increase demand for one or more elastic inputs: The rigid input should be replaced in the “inputs” box with the relevant quantities of the elastic inputs.
2. The diversion is expected to increase demand for other rigid or semi-elastic inputs: Assess the diversion of inputs until they have been fully characterized as a combination of elastic inputs.
3. The diversion is expected to create no additional demand for other inputs (i.e.: it would otherwise have been disposed without productive use): changes in emissions due to changing the disposition of the input should be counted as the emissions intensity of the input. (e.g.: The emissions attributed to using municipal waste (currently being incinerated without energy recovery) as input are negative)
4. A combination of the three cases: assess each input as above and combined to give the overall emissions implication of use of the rigid input.

Change to in-use



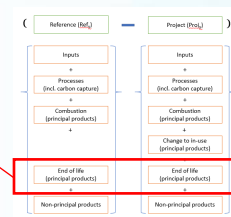
- Allows to claim credit when the characteristics of innovative products may save emissions in the use phase of the principal product (e.g.: innovative nitrogen compound to use as fertilizer that reduce N_2O emissions compared to conventional nitrogen fertilizers).
- Need to be **well justified** and based on a realistic use case.
- Savings must be **enabled directly by the properties of the produced product** (not used as input for a second product that will deliver the in-use savings)

Combustion



- If principal products are combusted for energy purposes (e.g.: novel transport fuels, fuel additives, solid fuels and natural gas substitutes), include combustion emissions in this box.
- Novel transport fuels: the IF fossil fuel comparator includes already combustion emissions for the reference scenario. In the project scenario, include the stoichiometric combustion emissions in the combustion box.

End of life



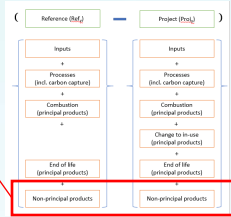
- Disposal or recycling of a principal product after the end of its useful life
- If carbon is incorporated in the material on a long-term basis (≥ 50 years), 50% of the CO₂ emissions from stoichiometric combustion may be included in this box.
- Combustion/end of life emissions for CCU products are not affected by the source of the captured CO₂. However, combustion and end of life emissions associated with carbon that enters the project boundaries in biogenic inputs other than captured CO₂ are counted as zero as normal.

Possible SIW: include for example a credit for the avoided primary polymer production due to increased recyclability

Non-principal products

Non-principal products

Non-principal products



- Co-products produced when producing the same quantity of principal products or deliver an equivalent function in the reference and project scenarios. Non-principal products are outside the project boundaries.
- Only claimed in the scenario, in which they are produced.
- Use emission factors from **data hierarchy**. Frequent error: use of combustion only EF
- A credit (negative emissions term) should be included in this box calculated as:

$$= (-1) * (\text{quantity of non-principal product}) * (\text{emission factor of that product})$$

Possible sources of SIW in energy intensive industries

- The principal product(s) and the reference products they substitute as well as their quantities incorrectly identified;
- Principal product(s) do not represent the main objective of the project;
- Principal product(s) are not all in the same sector;
- Reference emissions created in the reference scenario for a non-principal product that is produced only in the project scenario;
- For a new plant, reference scenario not sufficiently built from EU ETS benchmarks
- For a project to modify an existing plant, modified plant not demonstrated to meet the relevant EU ETS benchmark;
- Rigid inputs incorrectly identified and alternative use of that input incorrectly identified;
- Not all additional inputs and processing steps have been considered.

Calculation example

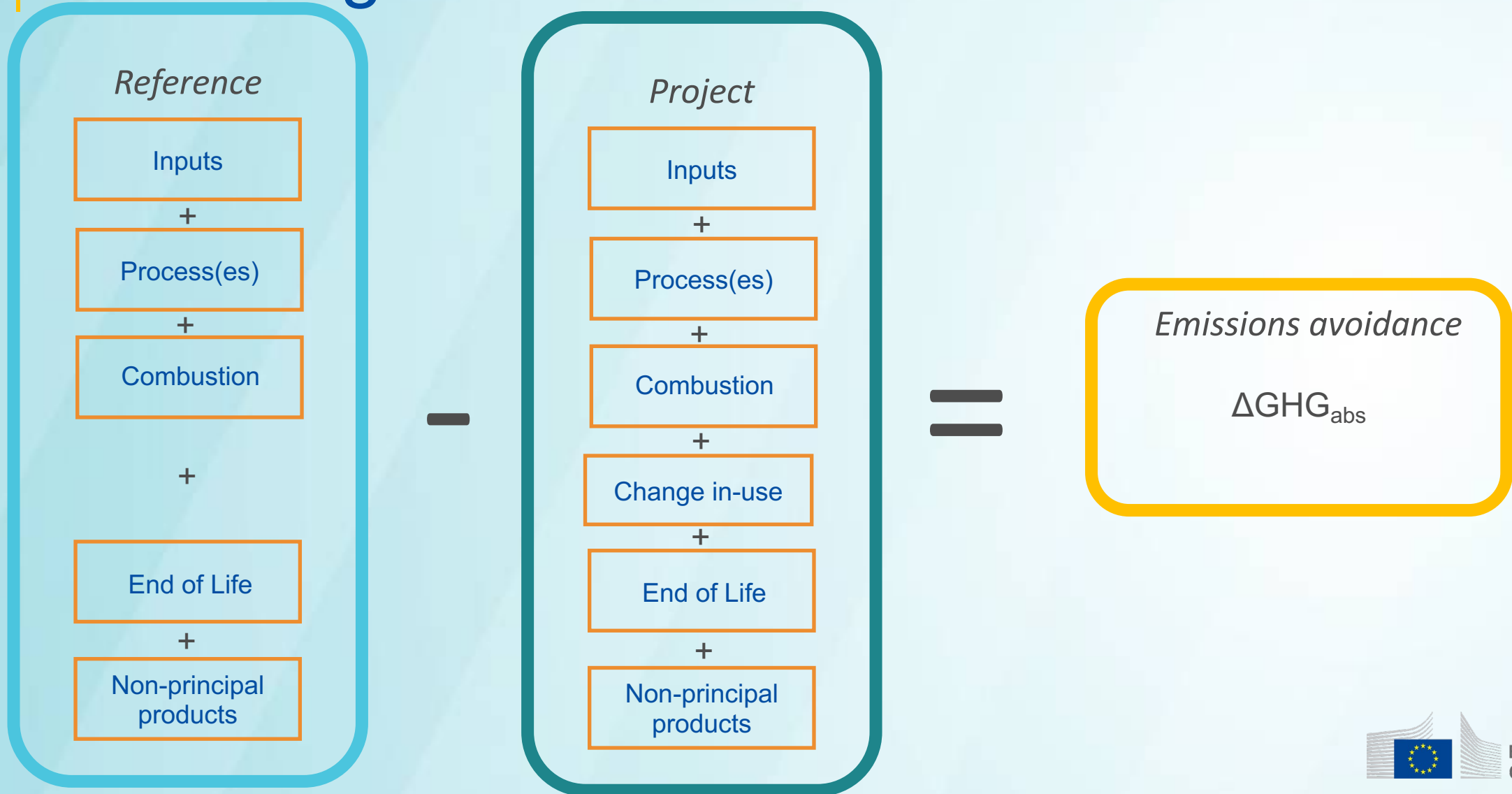
Example: Green Hydrogen

The following example is **intended to show important aspects of how the methodology works in practice** and where possible errors could occur. The slides are included purely for illustrative purposes

- Consider a project to produce **Green Hydrogen**. Note this example project;
 - Falls within Energy Intensive Industry
 - Hydrogen as the only (and therefore principal) product
 - The sector is hydrogen
 - Hydrogen is supplied for industrial use

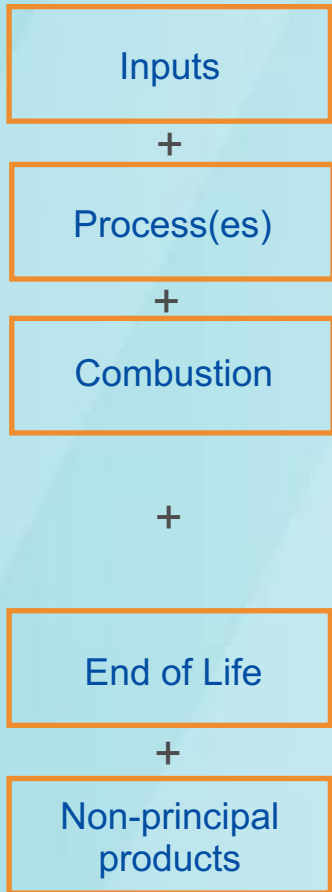
From: http://www.hydrogen.energy.gov/h2a_production.html

GHG diagrams



Identify Processes and Inputs

Reference



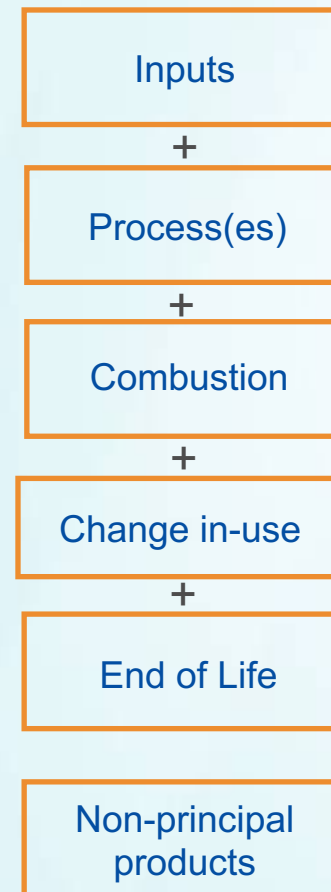
Process(es)

ETS benchmark
for hydrogen

Inputs

None

Project



Process(es)

electrolysis

Power
generation?

Renewable power production could be placed within the project boundary as a process, or outside the boundary as an input

Emission factor for electricity consumed is zero either way (assumed 2050 grid electricity GHG intensity)

Focus on Heat

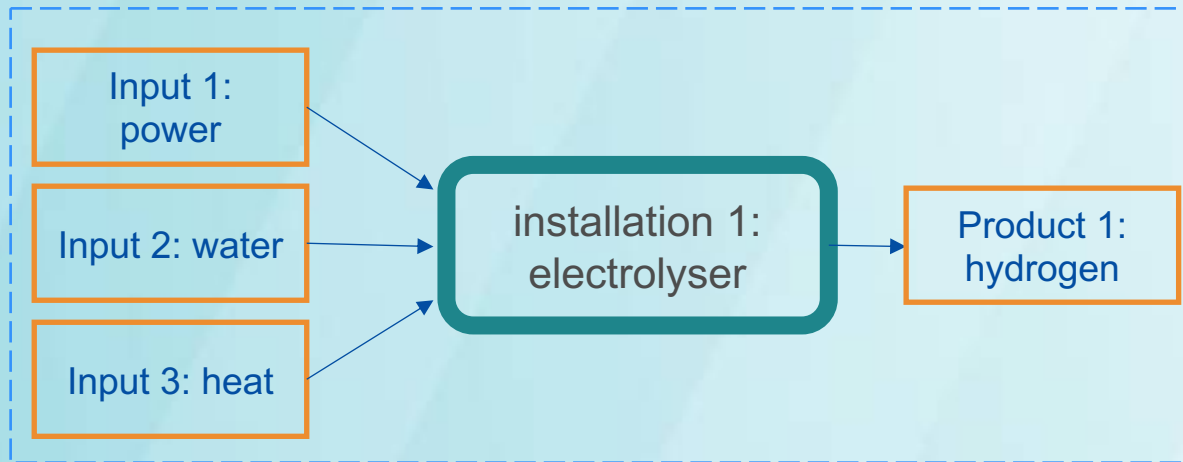
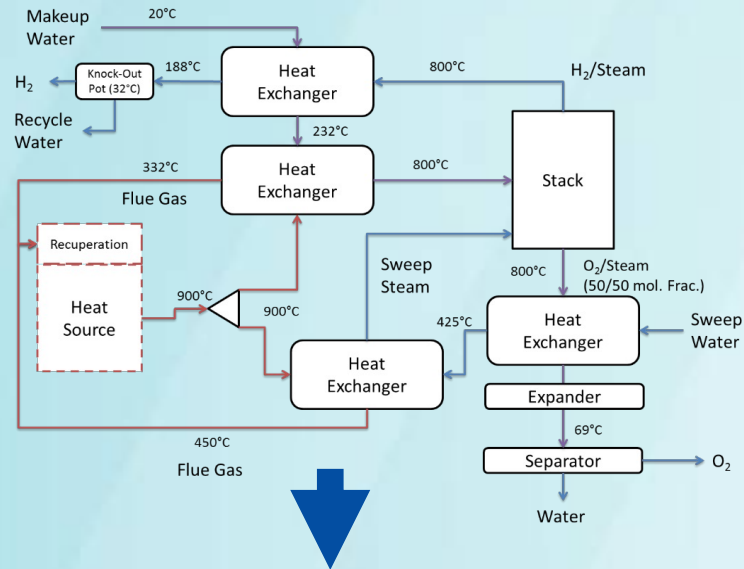
Non-identification of rigid inputs or incorrect identification of the alternative use of that input could lead to a SIW

Heat is required for high temperature electrolysis. Options:

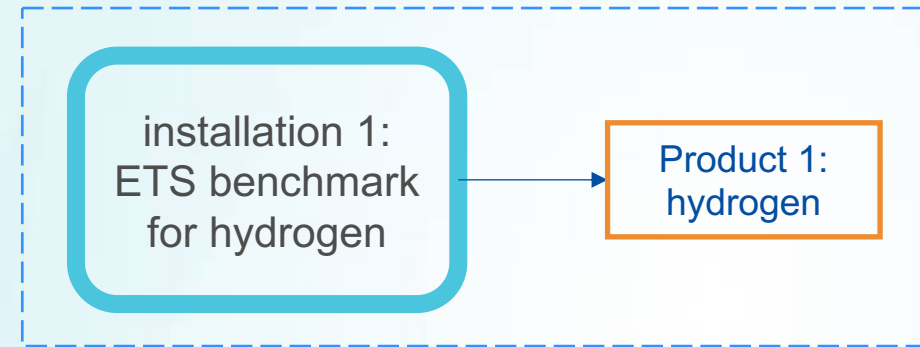
- Heat generated by direct fossil fuel combustion -> include those combustion emissions as part of electrolysis process -> **no heat as an 'input'**
- Heat supplied from outside the project unit -> **identify source and assess as an input**
 - Heat as by-product from other process -> treat as rigid input, **identify any emissions due to diversion**
 - Otherwise, treat heat as elastic input, assess actual GHG emissions of heat generation

Process(es) Boxes

Project



Reference



Emissions avoidance

$$\Delta\text{GHG} = \text{GHG}_{\text{ETS H}_2} - \text{GHG}_{\text{electrolyser}}$$

Emissions for Processes and Inputs

- **Reference**

- Process 1, ETS benchmark for hydrogen: 6.84 tCO₂e/tH₂

- **Project**

- Input 1, **power: 0 tCO₂e/tH₂**
- Input 2, water: “emissions for water provision may be neglected”
- Input 3, heat: 59.1 tCO₂e/TJ × 0.0032 TJ/tH₂ = 0.189 tCO₂e/tH₂

Possible SIW (e.g.: considering the emission factor of the local grid)

Overall Change in Emissions

