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Methodology for calculation of GHG emission avoidance

First call for proposals under the Innovation Fund

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Organisation of the methodology

Main principles | Basis of methodologies and cross-cutting assumptions

- Low-carbon projects in energy-intensive industries, including biorefineries, substitute products and carbon capture and utilisation (CCU);
- Carbon capture and geological storage (CCS);
- Renewable energy (RES) projects, including production facilities
- Energy storage projects, including production facilities

- Scope
- Boundaries
- **Absolute GHG emissions avoidance:** *first and second stage equations*
- Data and parameters: *default values to be used*
- Monitoring, reporting and verification of performance: *for disbursement and for knowledge-sharing purposes*

Application of the methodology

- To support applicants quantifying GHG emissions avoidance potential over the first 10 years of operation
- To form the basis of the scoring for the “GHG emission avoidance effectiveness” criterion and cost efficiency
- To serve as KPI for project monitoring and disbursements of grants
- To inform on requirements for knowledge-sharing purposes

Selection criteria

Projects will be selected based on:

1. Effectiveness of greenhouse gas emissions avoidance
2. Degree of innovation
3. Project viability and maturity
4. Scalability
5. Cost efficiency (cost per unit of performance)

Main principles

Absolute GHG emission avoidance

Absolute GHG emission avoidance will be the difference between:

- the **emissions that would occur in the absence of the project (*Ref*)**, and
- the **emissions from the project activity (*Proj*)**

Timescale: 10-years

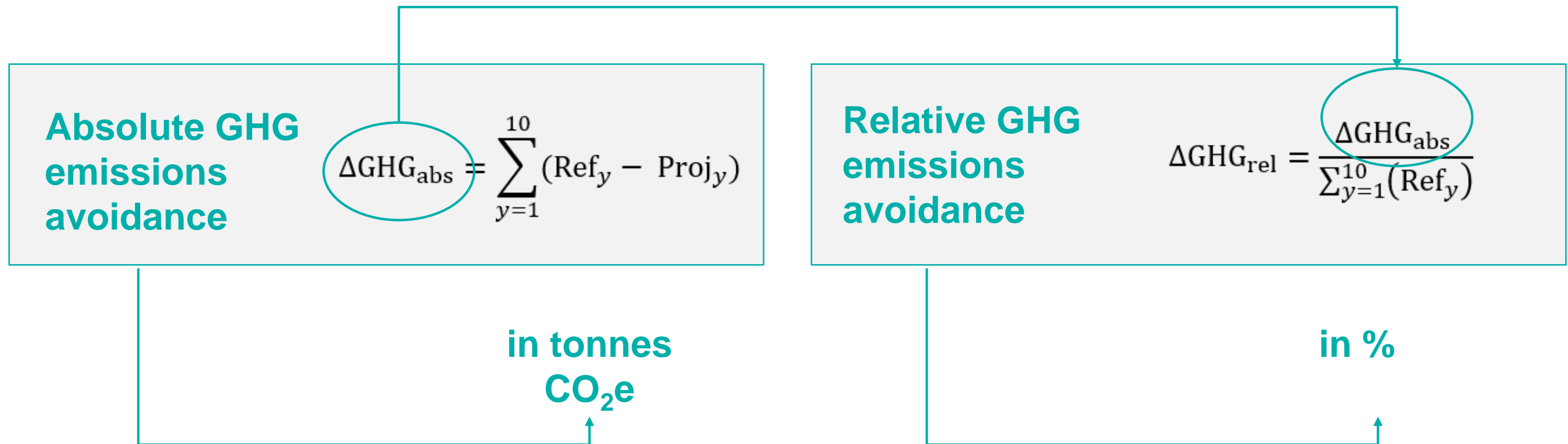
*unless project timeline shorter

Forecasting: emission factors are fixed for the 10 years of calculation

**Absolute GHG
emissions
avoidance**

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

Relative GHG emission avoidance



Classification

SECTOR

defined by grouping EU ETS activities (activity codes 20-47) where applicable

PRODUCTS

products of sector, derived from EU ETS activities and PRODCOM

Energy storage, and production facilities for components	Intra-day electricity storage	electricity
	Other energy storage	electricity
		heating/cooling
		e-fuels
Renewable energy, and production facilities for components	Wind energy	electricity
	Solar energy	electricity
	Hydro/Ocean energy	electricity
	Geothermal energy	electricity, CHP
	Bio-electricity	electricity, CHP
	Renewable Heating/Cooling	heating/cooling
Energy Intensive Industries, CCU and substitute products	Refineries	fuels (incl. e-fuels)
	Biofuels and bio-refineries	biofuel, bio-based products
	Iron & steel	coke
	Non-ferrous metals	aluminium
	Cement & lime	cement
	Glass, ceramics & construction material	flat glass
	Pulp & paper	chemical pulp
	Chemicals	organic basic chemicals
	Hydrogen	Hydrogen
CCS	CO2 transport and storage	CO2 Transport and Storage

Classification

- The applicant chooses the most appropriate sector when submitting the application
- The application may only be submitted for one sector
- If a project will earn revenues from the sale of several products, the applicant should define the 'principal product(s)'

Implications

- To derive the score: the **absolute** GHG emission avoidance of the project will be compared to the largest absolute GHG emission avoidance among submitted projects in the chosen sector
- To calculate the **relative** GHG emission avoidance, the project's absolute value of GHG emission avoidance will be compared to the GHG emissions in the reference scenario from the chosen sector

Hybrid projects

- **Absolute GHG emission avoidance:** calculate separately using respective methodologies and add them up. Remove double counting of avoidance and/or emissions, if any.
- **Relative GHG emission avoidance:** calculate based on the cumulated emission avoidance and the cumulated project emissions

Reference scenario

Sector	Reference GHG emissions are based on:
Energy intensive industry / CCS	EU ETS benchmark(s)
Renewable electricity	Expected 2030 electricity mix
Renewable heat	Natural gas boiler
Energy storage	Single-cycle NG turbine (peaking power)

Forecasting of grid electricity

For calculations of emissions due to generation and use

Sector	Grid electricity substituted by net electricity export or discharging, for energy storage	Net grid electricity consumed or charging, for energy storage
Energy intensive industry / CCS	Expected 2050 electricity mix	Expected 2050 electricity mix
Renewable electricity / heat	Expected 2030 electricity mix for net export	Expected 2050 electricity mix for net import (in heat projects)
Energy storage	Emissions for electricity produced with single-cycle NG turbine (used for peaking power)	Expected 2050 electricity mix

Simplifications for first stage

Energy intensive industry

- applicant may select a bigger share of inputs that are considered *minor* (30% instead of 15%) or *de minimis* (10% instead of 5%): they can be derived from literature or disregarded

Renewable electricity and heating

- Project emissions are disregarded, except for bio-electricity and bio-heating

Energy storage

- On-site project emissions are excluded in the first stage

Monitoring, reporting and verification

For disbursement

A monitoring plan consisting of a detailed, complete and transparent documentation of the parameters used in calculations and data sources shall be submitted at the second stage of application, and shall contain for each project-specific parameter used in GHG avoidance calculation:

- Source of data
- Measurement methods and procedures
- Monitoring frequency
- Quality assurance and control procedures
- Responsibility for collection and archiving

For knowledge-sharing

Additional parameters will be monitored, which will **allow estimating actual GHG emissions avoided** during operation and **exchange of lessons learned**

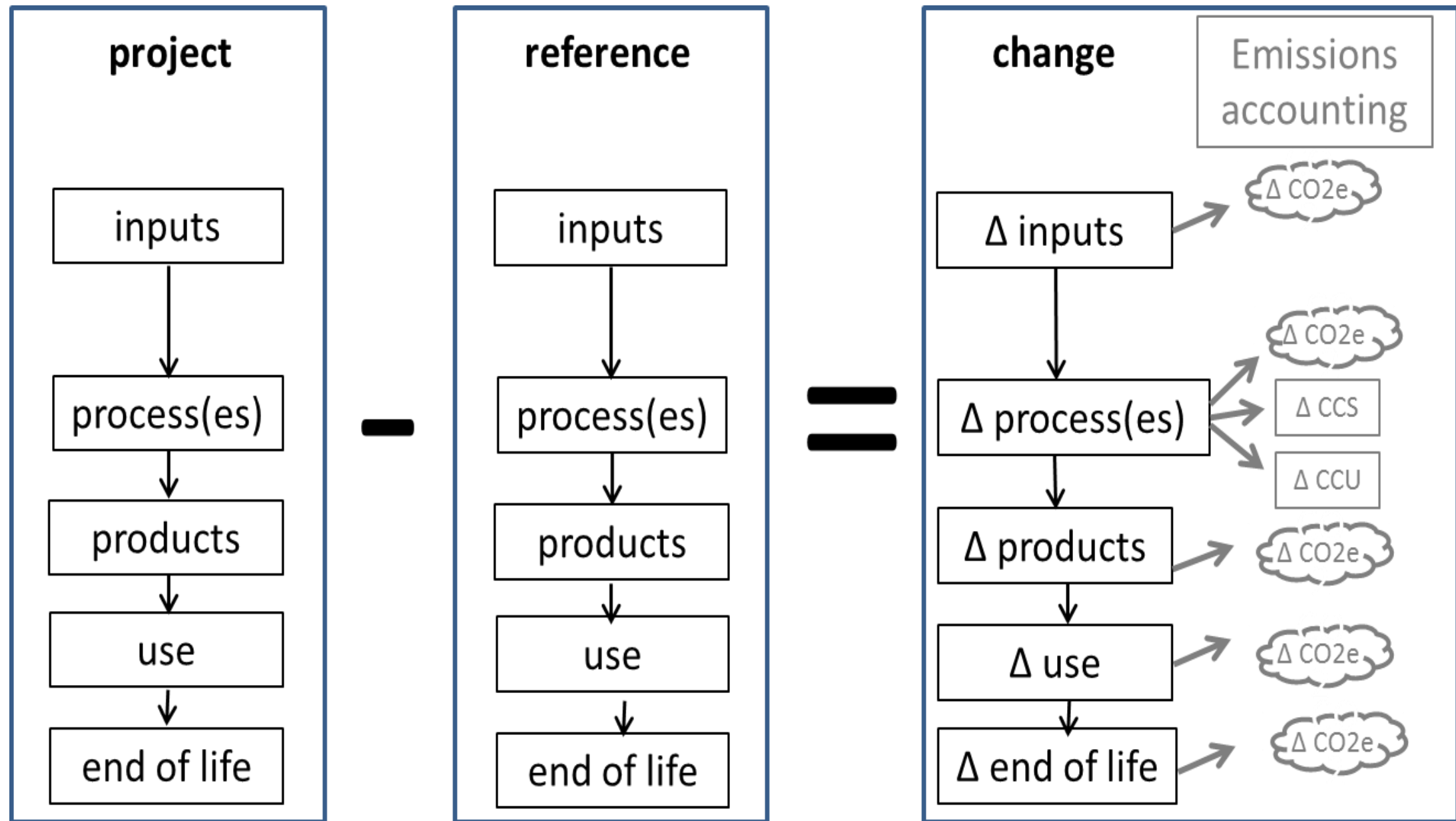
GHG emission avoidance calculation

Energy-intensive industries, incl. substitute products, bio-refineries and CCU

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

“Use” and “end-of-life” emissions can be ignored if they don't change





Energy-intensive industries

Reference scenario

- Reference for new processes uses EU ETS benchmarks (where possible)
- Reference for modifying existing plant may be existing plant, if EU ETS benchmarks are met overall
- Fuel products are judged against fossil fuel comparator derived from REDII

Simplification of emissions for **INPUTS** at different stages of the application

1st stage: inputs with joint emissions **<10%** of project emissions savings: ignore
inputs with joint emissions **< 30%:** take emissions from literature
other inputs: actual emissions calculation if possible

2nd stage: inputs with joint emissions **<5%** of project emissions savings: ignore
inputs with joint emissions **<15%:** take emissions from literature
other inputs: actual emissions calculation if possible



Energy-intensive industries

Inputs

- *rigid inputs*: if the supply of an input is fixed, its emissions are those avoided in its existing or alternative use (can be positive or negative) (so called *displacement emissions*)
- *elastic inputs*: emission factor equals the emissions involved in supplying the extra input

Bio-based inputs make use of REDII “defaults” or “actual values” (-15% as upstream emissions are not covered by the EU ETS)

Fossil-fuel inputs according to EU ETS rules

Attribution of emissions to “principal products” by a simplified ISO procedure (only needed to calculate relative emission avoidance)

Energy-intensive industries

Carbon capture and use (CCU)

- Both CO2 capture and use are part of the project boundary
- If CO2 use results in additional CO2 captured, then it is counted as emission reduction
- Link with EU ETS must be established: emissions coming from an EU ETS activity or EU ETS substitute products

Corrections for:

- **by-products** that are not balanced between “project” and “reference” scenarios
- any changes in the efficiency of the **product in use**, or in **end-of-life emissions**

Carbon Capture and Storage (CCS)

Scope (examples)

Plant of origin

- Energy intensive industries
- Fossil fuel power generation facilities
- Natural gas processing

Technologies

- Pre-combustion
- Post-combustion
- Oxyfuel combustion
- Chemical looping combustion

Storage sites

- Depleted (or nearly depleted) oil and gas reservoirs
- Unmineable coal beds
- Saline aquifers
- Basalts

Carbon Capture and Storage (CCS)

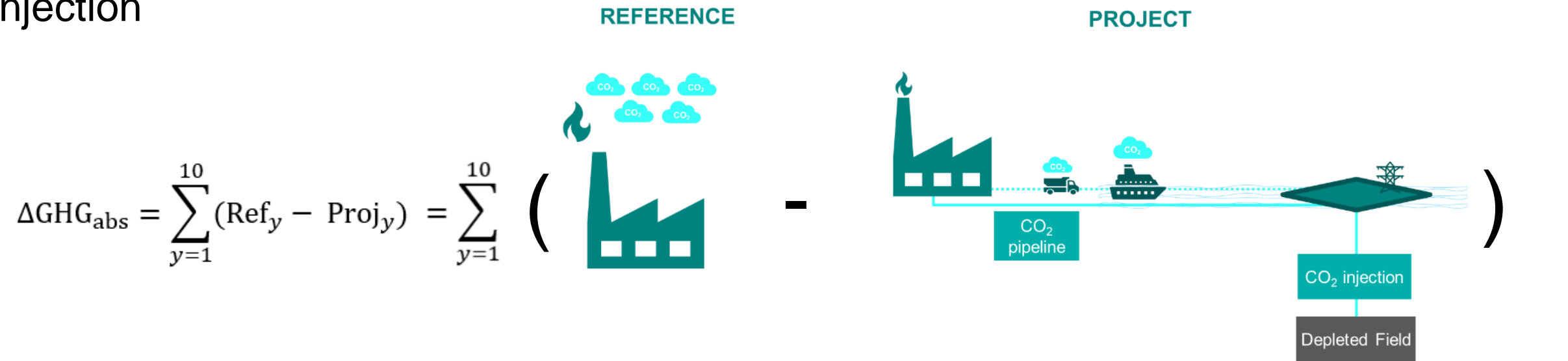
Boundaries

Scenario	Emission source	First stage	Second stage
Reference	CO ₂ releases that would be to atmosphere in the absence of the project activity	✓	✓
Project	CO ₂ capture activities, e.g. fuel combustion for compression and liquefaction of the CO ₂	✓	✓
	Transport of CO ₂ by pipeline, e.g. leakages	✓	✓
	Transport of CO ₂ by road, rail and maritime modal [not covered under EU ETS]	✓	✓
	Injection at the geological storage site, e.g. fuel combustion in booster stations	✓	✓

Carbon Capture and Storage (CCS)

Absolute GHG emissions avoidance: first and second stages of application

GHG avoided equals to the CO2 stored, minus emissions for CO2 capture, transport and injection



$$\Delta\text{GHG}_{\text{abs}} = \sum_{y=1}^{10} (\text{Ref}_y - \text{Proj}_y) = \sum_{y=1}^{10} \left(\text{Factory} - \left(\text{Factory} + \text{CO}_2 \text{ pipeline} + \text{CO}_2 \text{ injection} + \text{Depleted Field} \right) \right)$$

*Part chain projects also possible

$$= \sum_{y=1}^{10} \left(\text{Ref}_{\text{release},y} - \left(\text{CO}_2_{\text{transferred to the capture installation},y} + \left(\text{Proj}_{\text{capture},y} + \text{Proj}_{\text{transport pipeline},y} + \text{Proj}_{\text{injection},y} \right) + \text{Proj}_{\text{transport road},y} + \text{Proj}_{\text{transport maritime},y} \right) \right)$$

As defined in Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 (MRR)

Carbon Capture and Storage (CCS)

MRV for disbursement



Parameters to be monitored	Data unit
Amount of CO ₂ transferred to the capture installation	tonnes CO ₂
Distance travelled by road modals	km
Amount of CO ₂ transported to the storage site by road modals	tonnes CO ₂
Distance travelled by rail modals	km
Amount of CO ₂ transported to the storage site by train modals	tonnes CO ₂
Distance travelled by maritime modals	km
Amount of CO ₂ transported to the storage site by maritime modals	tonnes CO ₂

- Source of data
- Measurement methods and procedures
- Monitoring frequency
- QA/QC procedures
- Responsibility for collection and archiving

+ ETS MRV requirements

Carbon Capture and Storage (CCS)

Data and parameters

Parameters to be monitored only for knowledge-sharing (fixed ex-ante for calculations and disbursement)	Data unit
Emission factor for liquid CO ₂ transport by heavy truck	kg CO ₂ e / tonne.km
Emission factor for freight by rail modals	kg CO ₂ e / tonne.km
Emission factor for freight by maritime modals	kg CO ₂ e / tonne.km

Carbon Capture and Storage (CCS)

MRV for knowledge sharing

CCS: KS

- **Capture ratio**, in tonnes CO₂e emitted / tonne CO₂ fossil transferred to the capture installation
- **Transport by pipeline ratio**, in tonnes CO₂e / tonne CO₂ fossil transferred to the capture installation
- **Injection ratio**, in tonnes CO₂e emitted / tonne CO₂ fossil transferred to the capture installation
- **Type(s) of modal(s)** used in the transportation of the CO₂ from the site of origin to the storage site
- **Weight fraction of the truck, train wagon or ship occupied** by the compressed CO₂ and, separately, the empty tank (i.e. fully or partially loaded), per trip and modal
- High-level mapping of **environmental impacts** and mitigation measures
- High-level **risk screening** and mitigation measures
- **Lessons learned** and experiences

Renewable electricity and heating

Scope (examples)

Products

- Grid-connected electricity from wind, solar, hydro/ocean, geothermal energy and biomass
- Heating and cooling, including from bio-heat
- Combined heat and power generation
- Components for renewable energy installations (e.g. production of innovative heat pumps, PV modules and wind turbines)

Types of projects

- Construction of a power plant that will use renewable energy sources to generate electrical and thermal energy
- Retrofitting (or repowering), rehabilitation (or refurbishment), replacement or capacity addition of an existing renewable power plant
- Construction of a manufacturing plant of components of innovative renewable technologies

Renewable electricity and heating

Boundaries

Scenario	Emission source	First stage	Second stage
Reference	Generation of grid-connected electricity or heating in fossil fuel fired power plants, which will be displaced due to the project activity	✓	✓
Project	GHG emissions due to purchased electricity and fossil fuel consumption in stationary machinery and on-site vehicles at the project site		✓
	GHG emissions due to leakage during the operation of geothermal power plants		✓
	GHG emissions from the supply of consumed materials other than fuels [REDII]	✓	✓

Renewable electricity and heating

Absolute GHG emissions avoidance: First and second stages

$$\Delta\text{GHG}_{\text{abs}} = \sum_{y=1}^{10} (\text{Ref}_y - \text{Proj}_y) = \sum_{y=1}^{10} \left(\begin{array}{c} \text{REFERENCE} \\ \text{PROJECT} \end{array} \right)$$

Rationale

RE displaces the energy (and associated emissions) produced at the conventional plant:
2030 EU mix for electricity and NG boiler for heating

Project emissions are disregarded, except for bio-electricity/heating

Comparison of most significant emission sources within the project boundaries, with a pre-defined reference scenario and factors

Renewable electricity and heating

Absolute GHG emissions avoidance: First stage of application

$$\Delta\text{GHG}_{\text{abs}} = \sum_{y=1}^{10} (\text{Ref}_y - \text{Proj}_y) = \sum_{y=1}^{10} \left(\begin{array}{c} \text{REFERENCE} \\ \text{PROJECT} \end{array} \right)$$

$$= \sum_{y=1}^{10} \left(\text{Ref}_{\text{grid}} \text{ or } \text{Ref}_{\text{heat}} - 0 \right)$$

GHG emissions for the generation of grid-connected electricity or heating in fossil fuel fired power plants, which will be displaced due to the renewable technology

= Net energy generated * Emission Factor for the reference technology

Renewable electricity and heating

Absolute GHG emissions avoidance: Second stage

$$\Delta\text{GHG}_{\text{abs}} = \sum_{y=1}^{10} (\text{Ref}_y - \text{Proj}_y) = \sum_{y=1}^{10} \left(\begin{array}{c} \text{REFERENCE} \\ \text{PROJECT} \end{array} \right)$$

$$= \sum_{y=1}^{10} \left(\text{Ref}_{\text{grid}} \text{ or } \text{Ref}_{\text{heat}} - (\text{Proj}_{\text{on-site}} + \text{Proj}_{\text{geo}} + \text{Proj}_{\text{bio},y}) \right)$$

As defined in Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Recast)

Renewable electricity and heating

MRV for disbursement

Alternatively: installed capacity, load factor, operating hours

- Source of data
- Measurement methods and procedures
- Monitoring frequency
- QA/QC procedures
- Responsibility for collection and archiving



Parameters to be monitored	Data unit
Net amount of electricity to be generated by the renewable technology and fed into the grid	MWh
Net amount of thermal energy to be generated by the renewable technology	MWh
Quantity of fossil fuel type FF combusted in stationary sources at the project site	Litres or m ³
Quantity of fossil fuel type FF combusted in mobile sources at the project site	litres
Amount of electricity imported from the grid and consumed at the project site	MWh
Quantity of steam produced	tonnes steam
Quantity of steam entering the geothermal plant	tonnes steam
Quantity of steam leaving the geothermal plant	tonnes steam
Quantity of working fluid leaked/reinjected	tonnes working fluid
Global Warming Potential for the working fluid used in the binary geothermal power plant.	tonnes CO ₂ / tonnes working fluid
Amount of bio-based fuel 'f' consumed by the project	MJ
GHG emissions from the supply of bio-based fuel 'f'	tonnes CO ₂ e /MJ

Renewable electricity and heating

Data and parameters: fixed

Description	Data unit
Emission factor for combustion of natural gas	tonnes CO ₂ e / MWh, tonnes CO ₂ /TJ and in tonnes CO ₂ e / m ³
Emission factor for the combustion of gasoline	tonnes CO ₂ e / litre and in tonnes CO ₂ e /TJ
Emission factor for the combustion of diesel	tonnes CO ₂ e / litre and in tonnes CO ₂ e /TJ
Emissions of electricity production in 2030 (ref.)	tonnes CO ₂ e / MWh
Emissions of electricity production in 2050 (proj.)	tonnes CO ₂ e / MWh

Renewable electricity and heating

MRV for knowledge sharing

RES : KS

- [All RES] Energy generated by hour, based on the **actual** load factor, and technology efficiency per operating hour
- [All RES] **Key raw materials and feedstock** used at the power plant, and their origin
- [Geothermal] **Composition of steam** by month, in % of each element
- [Geothermal] **Average loss**, by month, i.e. Quantity of steam leaving the geothermal plant / Quantity of steam entering the plant, in %
- [Geothermal] Average amount working fluid leaked/reinjected by month, in t working fluid/t steam entering plant
- [Geothermal] Electricity and heat **production** by month, in kWh / t steam entering plant
- [Waste to energy] **Original use/treatment** of the feedstock
- [Bioelectricity and heat] **Type of bio-based fuel used**. Any pre-treatment(s) of biomass before processing
- [Bioelectricity and heat] **Type(s) of modal(s)** used in the transportation of solid biomass fuels from the site of origin to the biorefinery or power plant
- High-level mapping of **environmental impacts** and mitigation measures
- High-level **risk screening** and mitigation measures
- **Lessons learned** and experiences

Energy storage

Scope (examples)

Services and products

- Short-term electricity storage such as arbitrage
- Auxiliary services to electricity grids
- Avoidance of renewable energy curtailment
- Other energy storage
- Manufacture of components for energy storage, e.g. batteries

Technologies

- Electricity storage tech
- Heat & cold storage tech
- Hydrogen storage tech
- Gaseous fuel storage tech
- Liquid fuel storage tech
- Combinations of the above, including smart grid technologies

Energy sources/sinks

- Electricity grid
- Heat grid
- Gas grid
- Pipelines and trailers
- Renewable energy plants
- Waste heat recovery
- Fueling stations
- Industrial plants

Energy storage

Boundaries

Scenario	Emission source	First stage	Second stage
Reference	Emissions related to the provision of energy in the absence of the project activity	✓	✓
	Emissions related to the provision of auxiliary services to the grids in the absence of the project activity	✓	✓
Project	Emissions related to the provision of energy caused by the project activity	✓	✓
	On-site emissions of fugitive GHGs and from energy use other than energy storage		✓

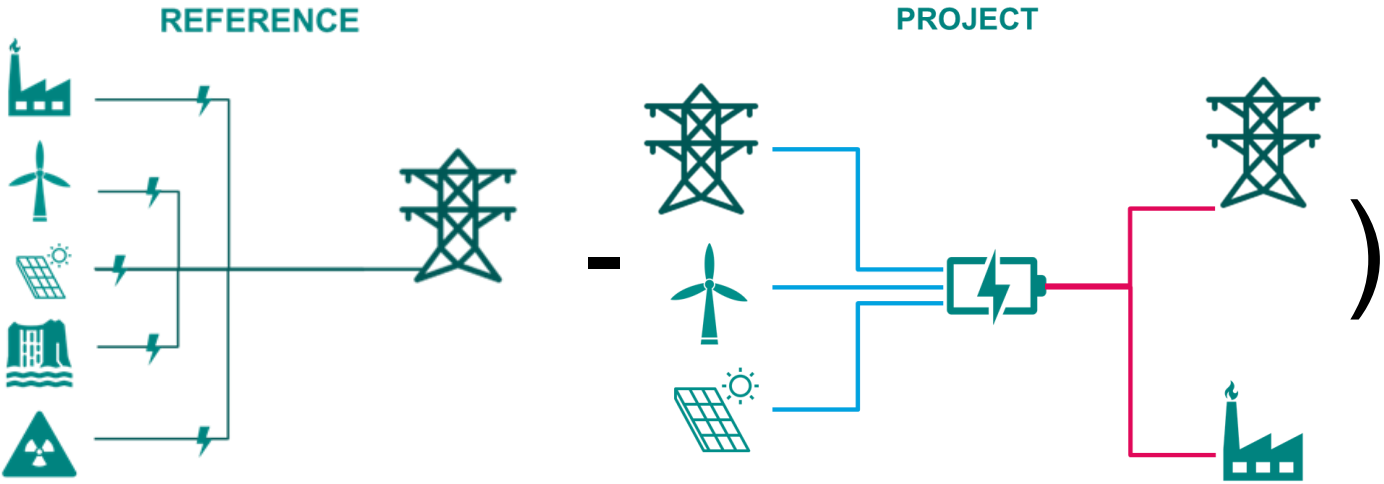
Energy storage

Absolute GHG emissions avoidance: First and second stages

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

energy supply by storage units avoids reference emissions

energy use of storage units may create emissions



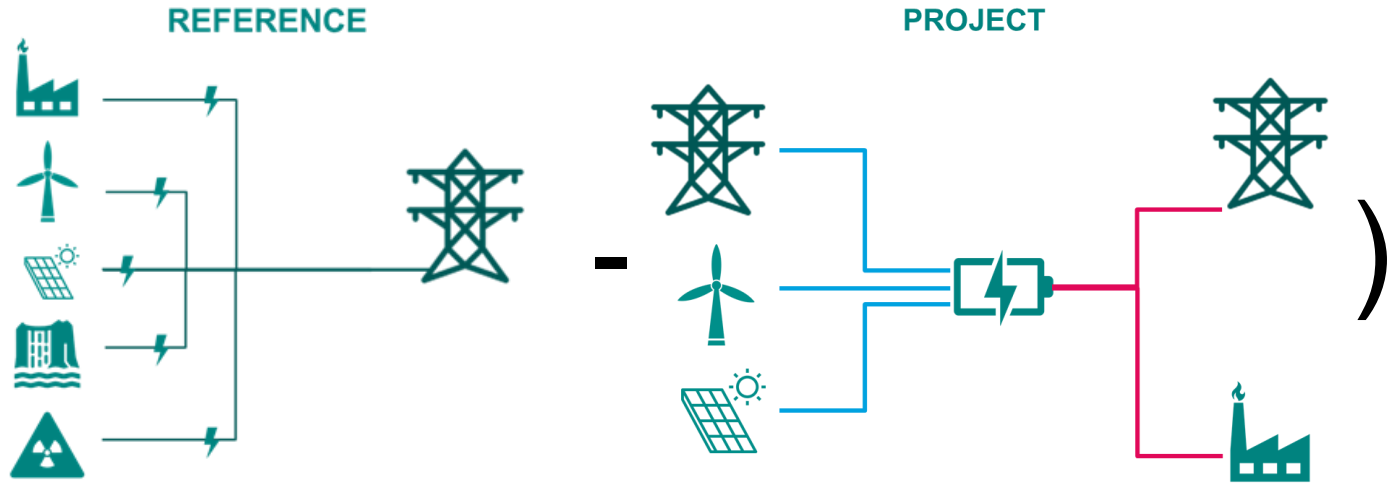
Rationale

Comparison based on annual energy stored using emission factors depending on type of usage

Energy storage

Absolute GHG emissions avoidance: First stage

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



$$= \sum_{y=1}^{10} (\text{Ref}_{\text{energy},y} + \text{Ref}_{\text{services},y} - \text{Proj}_{\text{energy},y})$$

= Net energy supplied * emission factor for reference technology

= Hours of service delivery * emission factor for reference service

= Fossil-based energy stored * fossil fuel emission factor

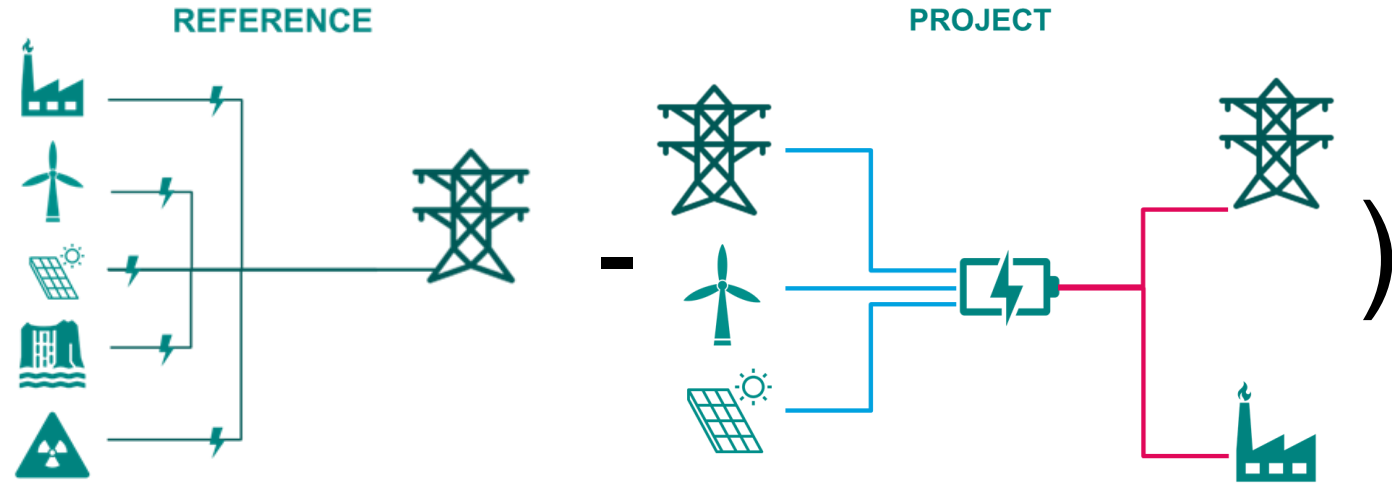


Ref EF el (discharging): single-cycle NG turbine used for peaking power
 Proj EF el (charging): expected EU 2050 electricity mix

Energy storage

Absolute GHG emissions avoidance: Second stage

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



$$= \sum_{y=1}^{10} \left(\text{Ref}_{\text{energy},y} + \text{Ref}_{\text{services},y} - \text{Proj}_{\text{energy},y} - \text{Proj}_{\text{on-site},y} \right)$$

= Fossil-based energy used on-site * fossil fuel emission factor

Energy storage

MRV for disbursement



Parameters to be monitored	Data unit
Input power rating	MW
Output power rating	MW
Maximum storage capacity including degradation	TJ
Generator rating	MW
Reactive power rating	Mvar
Inertia capability rating	GVA
Input-output efficiency including storage losses	%
Energy use by type	TJ
Energy supplied by type	TJ
Renewable energy used with proven additionality by type	TJ
Duration of delivery of service	h
Energy use in stationary sources (except in energy storage units) at project site by type	TJ
Energy use in mobile sources at the project site by type	TJ
Renewable energy with proven additionality used in stationary sources at project site by type	TJ
Renewable energy with proven additionality used in mobile sources at project site by type	TJ
Amount of fugitive emissions by type of greenhouse gas at the project site	tonnes

- Source of data
- Measurement methods and procedures
- Monitoring frequency
- QA/QC procedures
- Responsibility for collection and archiving

Energy storage

Data and parameters

Parameters not to be monitored (fixed ex-ante)	Data unit
Emission benchmark for generating hydrogen under the ETS in year y	tCO ₂ e / TJ (tCO ₂ e / tonne H ₂)
Emission benchmark for generating heat under the ETS in year y	t CO ₂ -eq / TJ
Combustion emissions of natural gas	t CO ₂ -eq / TJ
Combustion emissions of diesel fuel or gasoil	t CO ₂ -eq / TJ
Combustion emissions of heavy fuel oil (residual fuel oil)	t CO ₂ -eq / TJ
Combustion emissions many fossil fuels	t CO ₂ -eq / TJ
Emissions for electricity and steam production in 2050	t CO ₂ -eq / TJ
Emissions for with single-cycle NG turbine (used for peaking power)	t CO ₂ -eq / TJ
Mean losses due to transport of electricity to consumers via the grid in the EU in 2018	%
Mean losses due to transport of heat to consumers via heat networks in the EU in 2018	%
Mean losses due to transport of gaseous fuels to consumers via the grid in the EU in 2018	%
Mean increase of the emission intensity of grid electricity due the need for the auxiliary service	t CO ₂ -eq per unit depending on service (MW/GVAs/Mvar)

Energy storage

MRV for knowledge sharing

Energy storage: KS

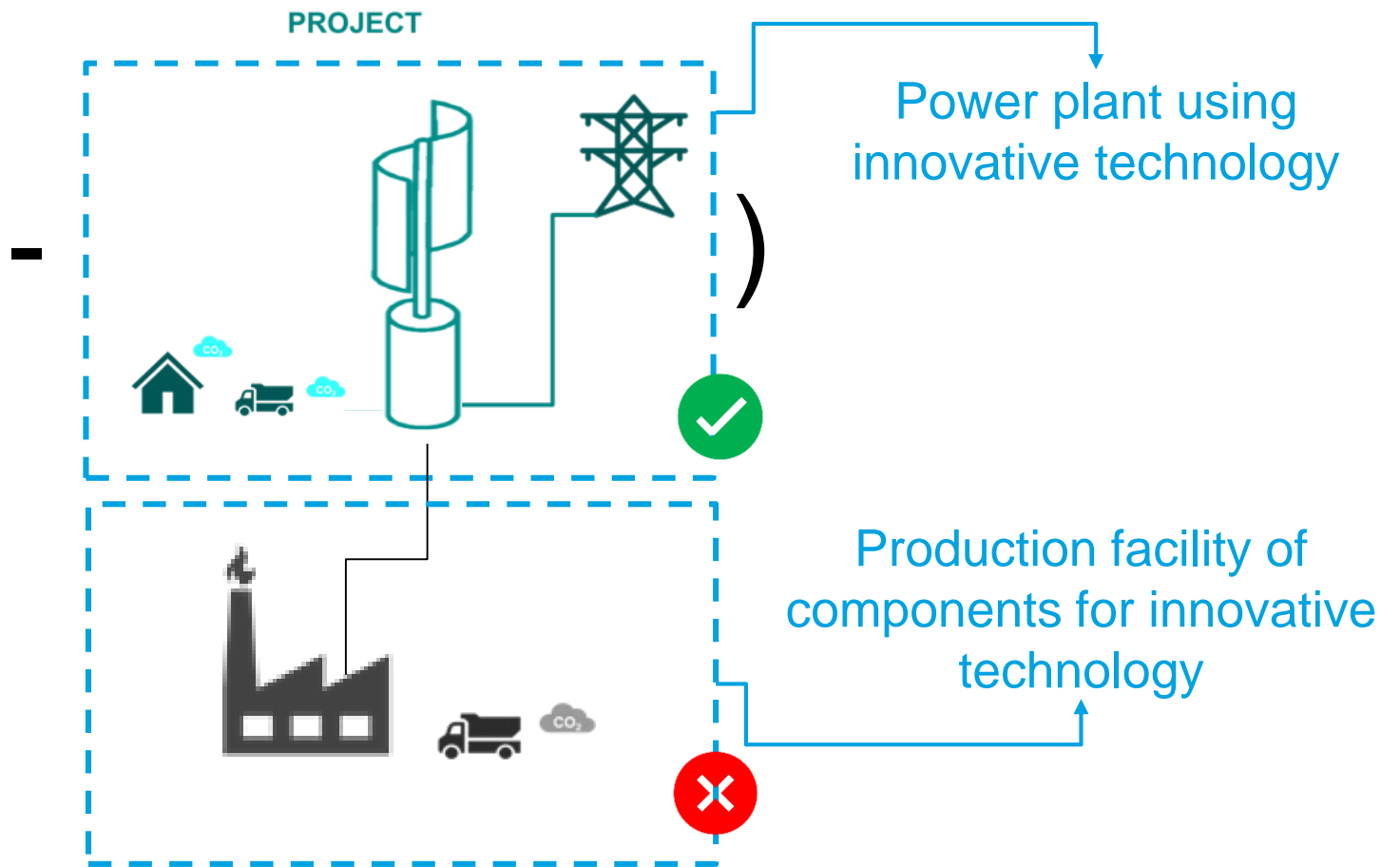
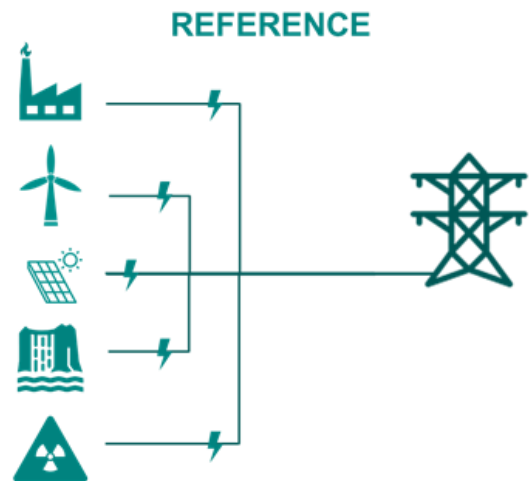
- **Energy supplied by each individual energy storage unit** (per annum)
- **Hourly profiles for use & feed-in of grid electricity** and **provided system services** (if applicable)
- **Hourly profiles for generation of electricity delivered to the project from PPAs** (if applicable)
- **Hourly profiles for avoided curtailment** based on final physical notifications of co-located RES plants or grid operator instructions (if applicable)
- **Reliability expressed according to reliability indicators** such as Energy Not Supplied,
- **Improvement in voltage variation in the grid and length of voltage variation** (if applicable)
- **Total Loss of Power, Restoration Time, Equivalent Time of Interruption** (if applicable)
- High-level mapping of **environmental impacts** and mitigation measures
- High-level **risk screening** and mitigation measures
- **Lessons learned** and experiences

Production of components

1&2

Absolute GHG emissions avoidance: First and second stages of application

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



GHG avoidance will be equal to the emissions saved by the innovative technology when operating depending on the number of units sold

Emissions due to the manufacturing are out of the scope of GHG avoidance calculations

Production of components

Additional rules

- Applicants shall demonstrate the existence of a buyer (i.e. a company that will run the innovative technology) to ensure:
 - Accountability over the promised GHG emission avoidance
 - Use takes place in the territory of the EU/Norway/Iceland
- Provisional contract agreements will have to be presented to evidence the statements made
- The rationale for the assumptions adopted to forecast the performance of the component produced as well as of other components that will be needed at the power plant but are not necessarily covered by the production facility shall be presented

Thank you

