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Support to preparation of the first call for proposals under the Innovation Fund - methodologies for calculation of relevant costs and effectiveness of GHG emissions avoidance

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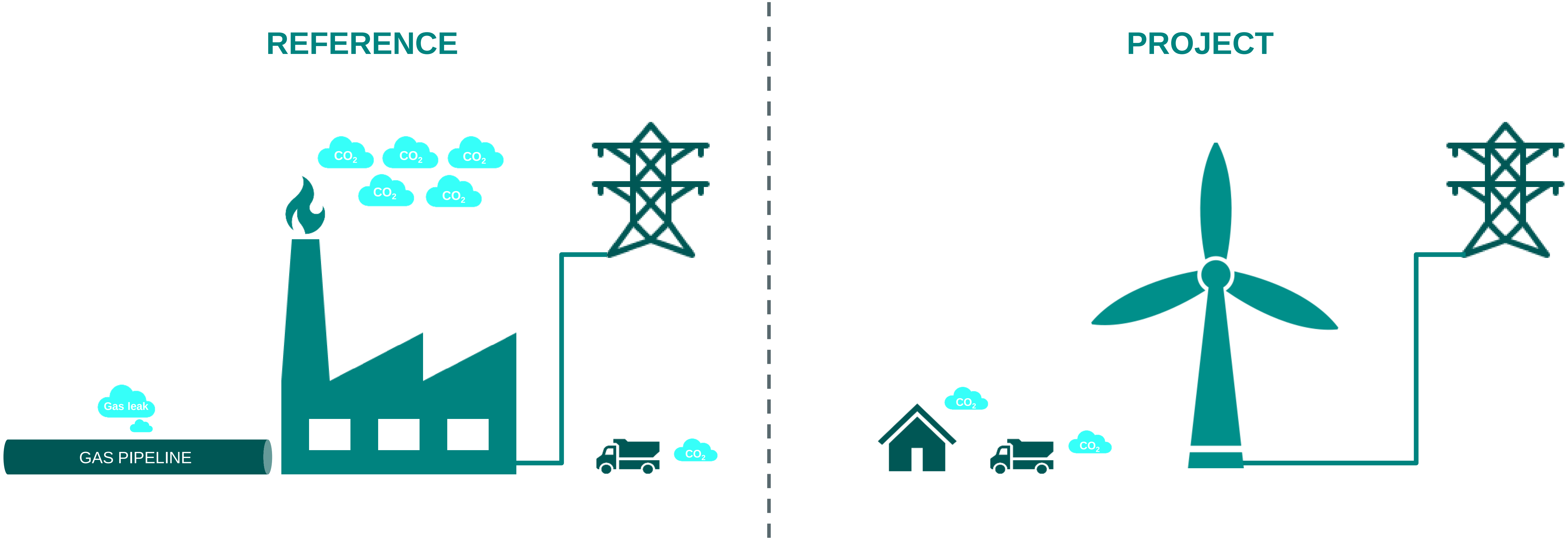
GHG savings due to renewable energy generation



GHG emission avoidance is estimated as the emissions created without the project reduced by the emissions created with the project

Renewable Energy | Potential approaches for quantification

Potential approaches for quantification	Pros	Cons
Comparison of **cradle-to-grave** (or to-gate) emissions for reference and project scenarios *[Approach 1: detailed]*	• Most accurate and fair way to compare the impacts of two different scenarios • Exposes potentially hidden impacts from allegedly clean technologies	• Time and resource consuming for both quantification and monitoring • Uncertainties related to activity data used to quantify indirect emission sources
Comparison of **production emissions** at the renewable plant and a pre-defined reference scenario *[Approach 2: simplified]*	• Low MRV requirements (i.e. only energy generated needs to be monitored)	• Does not reflect the GHG emission avoided by the project • Expected savings are masked, as most significant sources for the reference or project might end up being omitted, leading to unfair comparison of different RES projects.
Comparison of main emission sources within the project boundaries, with pre-defined reference scenario and factors *[Approach 3: sensible simplifications]*	• Emissions are sufficiently accurate, as most relevant emissions are quantified • Efforts for quantification might be reduced if assumptions and factors are pre-set and provided	• Broad variety of scenarios to be considered when developing the framework • Loss of accuracy with the use of default emission factors and actual baseline

Renewable Energy Example | Approach 3

Geothermal to heat, dry plant

$$GHG_{savings,y} = (EG_y * EF_{NGas}) - PE_{dry\ or\ flash\ steam} + PE_{binary}$$

not applicable as not binary plant

Source: Mindanews. Mindanao Geothermal Plant

Parameter	Symbol	Unit	Value	Source
Net heat generation produced in year y	EG_y	MWh	500,000	Monitored by project developer

Parameter	Symbol	Unit	Value	Source
Emission for natural gas combustion	EF_{NGas}	$kgCO_2e$ / MWh	202.3	Based on IPCC 2006

Parameter	Symbol	Unit	Value	Source
Average mass fraction of carbon dioxide in the produced steam in year y	$w_{steam,CO2,y}$	tCO_2/t steam	0.7%	CDM Project 8532
Average mass fraction of methane in the produced steam in year y	$w_{steam,CH4,y}$	tCH_4/t steam	0.0001%	CDM Project 8532
GWP methane	GWP_{CH4}	tCO_2e/t CH_4	25	IPCC AR4
Quantity of steam produced in year y	$M_{steam,y}$	t steam	3,000,000	Based on CDM Project 8532 for a geothermal plant of 50MW capacity

Renewable Energy Example | Approach 3

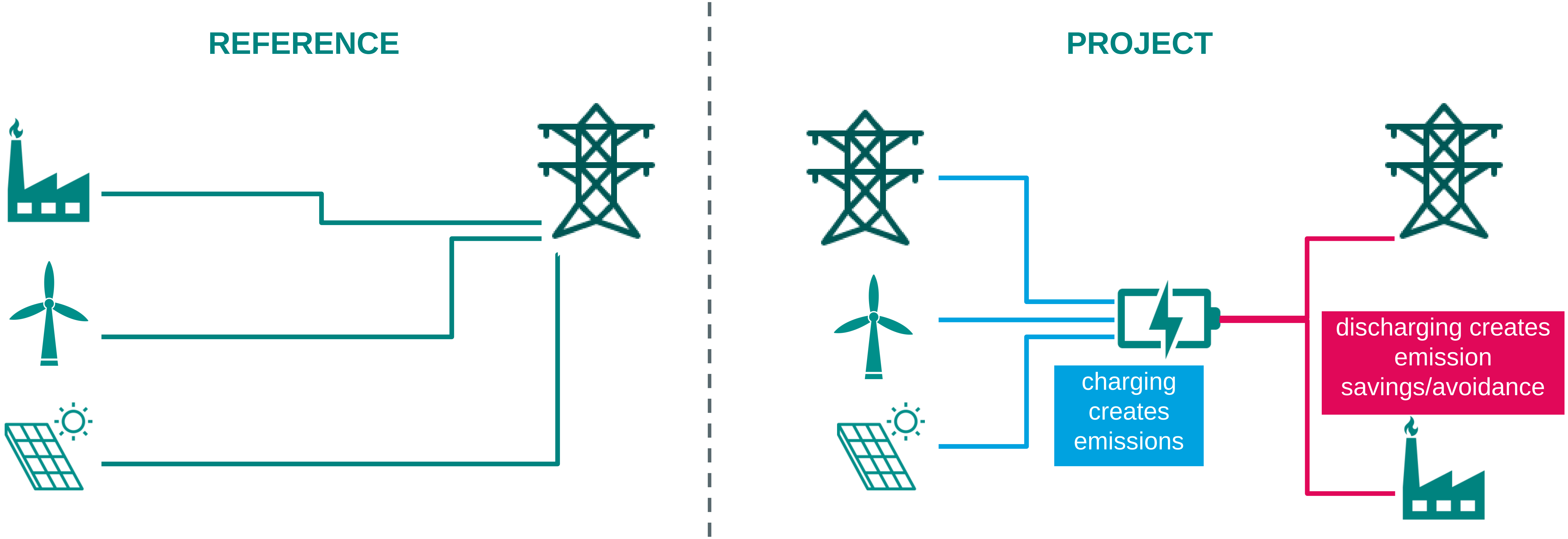
Geothermal to heat, dry plant

$$GHG_{savings,y} = (EG_y * EF_{NGas}) - PE_{dry\ or\ flash\ steam} = \mathbf{80,075\ tCO_2e}$$

$(500,000\ MWh * 202.3\ kgCO_2e / MWh) / 10^3 - (0.7\% * 0.0001\% * 25)\ tCO_2/t\ steam * 3,000,000\ t\ steam$

Reference emissions,y	-	Project emissions,y
101,150 tCO_2e	-	21,075 tCO_2e

GHG savings due to use of energy storage



GHG emission avoidance is estimated as the emissions avoidance during discharging reduced by the emissions caused by the charging process

Note: GHG emissions during the production of a storage unit are neglected

Energy Storage | Potential approaches for quantification

Potential approaches for quantification	Pros	Cons
Comparison of reference and project scenarios **based on an hourly charging and discharging profile** *[Approach 1: detailed]*	• Most accurate way to compare the impacts of two different scenarios • Exposes potentially hidden impacts from economic optimisation	• Complex MRV requirements (hourly load profiles and emission factors) • Highest uncertainties in ex-ante assessment
Comparison **based on annual amount of energy stored only** *[Approach 2: simplified]*	• Low MRV requirements (i.e. only the amount of energy stored needs to be monitored)	• Weak link to real GHG emission avoidance • Incentive to store energy also at times when not useful
Comparison **based on annual energy stored using emission factor of energy charged** *[Approach 3: sensible simplifications]*	• Stronger link to real GHG emission avoidance than simplified approach • Moderate MRV requirements (amounts of energy stored and times of usage for different purposes)	• Higher uncertainties in ex-ante assessment than simplified approach • No full accounting of hidden impacts of economic optimisation

Energy Storage Example | Approach 1

Power-to-H2

1. **Estimate based on an hourly charging and discharging profile**

$$\Delta GHG_y = \Delta GHG_{discharge,y} - \Delta GHG_{charge,y} = \sum_t (ED_{t,y}) / ec^{H2} * EF^{ETS\ H2} - \sum_t (EC_{t,region} * EF_{t,y})$$

Parameter	Symbol	Unit	Value	Source
Energy discharged per hour	$(\sum_t ED_{t,y})$	MWh	0 – 100	Project Developer / default profile
Benchmark emissions of H_2 production	$EF^{ETS\ H2}$	tCO_2 / t H_2	8.85	Benchmark of EU ETS
Energy content H_2	ec^{H2}	MWh / t	39.41	Based on official source

Parameter	Symbol	Unit	Value	Source
Energy Charged per hour	$EC_{t,y}$	MWh	0 – 100	Project Developer / default profile
Hourly emissions of electricity generation (marginal/mean, regional/EU)	$EF_{t,region}$	tCO_2e / MWh	0 – 1.084	Based on scenario projection

ΔGHG_y = *288,075 / 39.41 * 8.85 tCO2 – 384,100 * 0,076 tCO2*
= *64,691 tCO2 – 29,365 tCO2* = ***35,326 Tons of CO2***

Energy Storage Example | Approach 2

Power-to-H2

2. Estimate based on annual amount of energy stored only

$$\Delta GHG_y = \boldsymbol{ConvEff_y} * \boldsymbol{StorEff_y} * \left(\sum_t \mathbf{EC}_{t,y}\right) / ec^{H2} * EF^{ETS\ H2} - \left(\sum_t \boldsymbol{EC_{t,y}}\right) * \boldsymbol{EF_{region}}$$

Parameter	Symbol	Unit	Value	Source
Conversion Efficiency PtH_2	$ConvEff_y$	%	75	Project Developer
Storage Efficiency H_2	$StorEff_y$	%	99.9	Project Developer

Parameter	Symbol	Unit	Value	Source
Annual Energy Charged	EC_y	MWh	384,100	Project Developer
Annual emissions of electricity generation (marginal/mean, regional/EU)	EF_{region}	tCO_2e / MWh	0.196	Based on scenario projection

ΔGHG_y = *75% * 384,100 / 39.41 * 8.85 tCO2* – *384,100 * 0.196 tCO2*

= *64,691 tCO2* – *75,420 tCO2* = ***-10,730 Tons of CO2***

Energy Storage Example | Approach 3

Power-to-H2

3. Estimate based on annual energy stored using emission factor of energy charged

$$\Delta GHG_y = ConvEff_y * StorEff_y * \left(\sum_t EC_{t,y} \right) / ec^{H2} * EF^{ETS\ H2} - \sum_x \left(EC_{x,y} * EF_{x,region} \right)$$

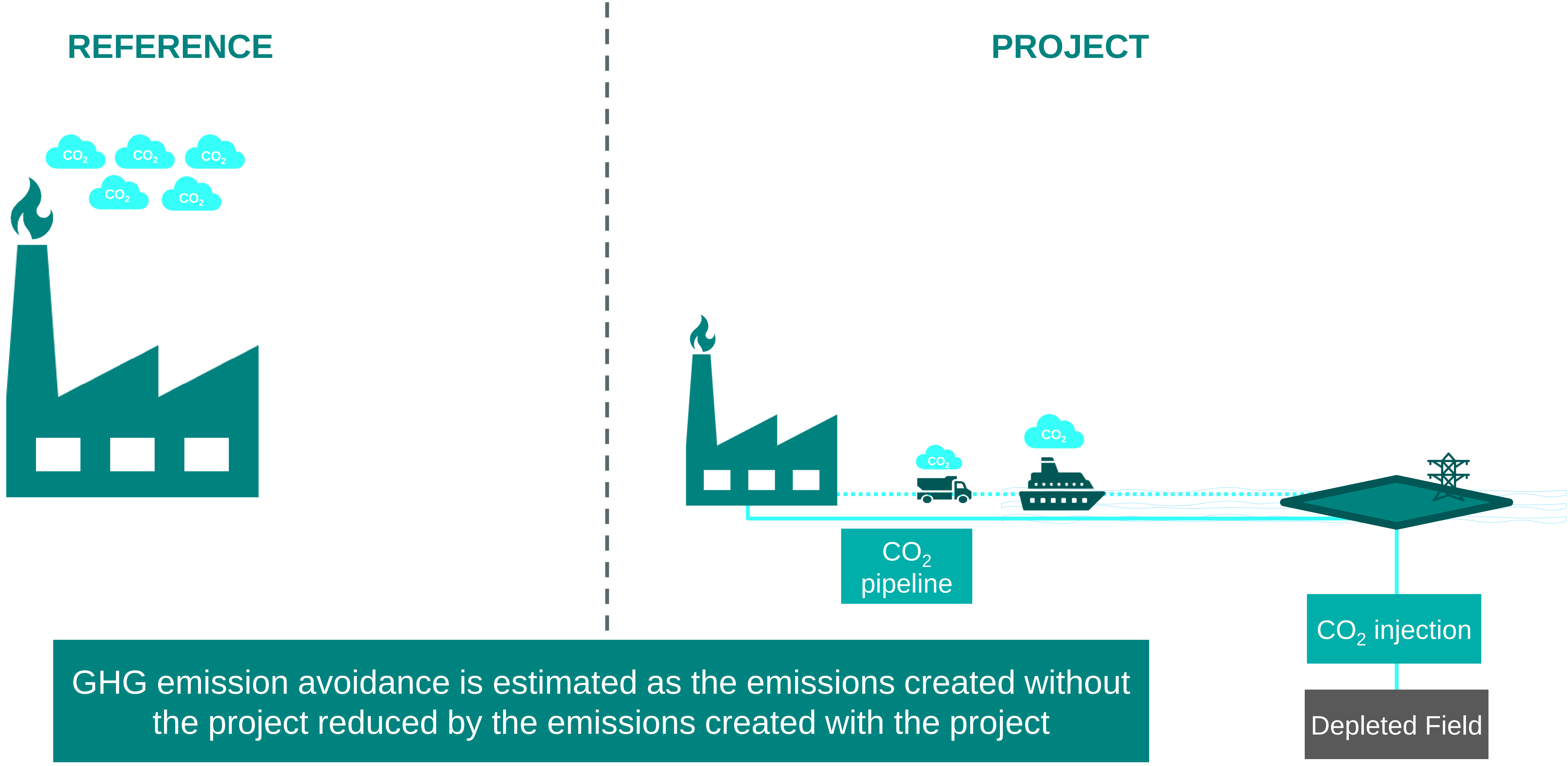
Parameter	Symbol	Unit	Value	Source
Conversion Efficiency PtH$_2$	$ConvEff_y$	%	75	Project Developer
Storage Efficiency H$_2$	$StorEff_y$	%	99.9	Project Developer

Parameter	Symbol	Unit	Value	Source
Energy Charged per type of usage (market, grid stability,...)	$EC_{x,y}$	MWh	129,000 - 254,200	Project Developer
Emission factor of electricity charged by type (marginal/mean, regional/EU)	$EF_{x,region}$	tCO_2e / MWh	0 – 0.196	Based on scenario projection

ΔGHG_y = 0,75 * 384,100 / 39,41 * 8,85 tCO2 – (129,900 * 0.196 + 254,200 * 0) tCO2

= 64,691 tCO2 – 25,507 tCO2 = **39,184 Tons of CO2**

GHG savings due to carbon capture and storage



GHG emission avoidance is estimated as the emissions created without the project reduced by the emissions created with the project

CCS | Potential approaches for quantification

Potential approaches for quantification	Pros	Cons
Comparison of **cradle-to-grave** (or to-gate) emissions for reference and project scenarios *[Approach 1: detailed*]	• Most accurate and fair way to compare the impacts of two different scenarios • Exposes potentially hidden impacts from leakage or ocean acidification	• Time and resource consuming for both quantification and monitoring • Uncertainties related to activity data used to quantify indirect emission sources
Project emissions assumed to be zero. GHG savings equals to the CO_2 stored *[Approach 2: simplified*]	• Low MRV requirements (i.e. only tonnes of CO_2 stored over 10 years needs to be monitored) • Aligned to NER300 approach	• Does not reflect the GHG emission avoided by the project • Expected savings are masked, as most significant sources for the reference or project might end up being omitted, leading to unfair comparison with CCU projects
Inclusion of emissions from capture, transportation and injection (pumps) within the project boundaries *[Approach 3: sensible simplifications]*	• Emissions are sufficiently accurate, as most relevant emissions are quantified • Efforts for quantification might be reduced if assumptions and factors are pre-set and provided	• More resource consuming for both quantification and monitoring, in particular for transportation (e.g. vessels) • Loss of accuracy with the use of default emission factors and actual baseline

Key points for discussion across various project types

Energy Storage

- Should the emission factors be based on **regional or EU-wide electricity generation**? Or **marginal or mean electricity generation**? Or, even be allowed to replace emission factors based on **specifics of the project**?
- If so, which **evidence** should be provided at the application stage (PPAs, empirical data on curtailment, ...)?
- If a project has **co-benefits** (e.g. delivers hydrogen and heat), should the cumulative GHG avoidance be assessed?

Carbon Capture and Storage

- Shall emissions from **capture**, **transportation** and **injection** be excluded for simplification or included to have a more consistent comparison with incentivise use?

Renewable Energy

- **Energy generated** should be only the amount fed into the grid should be accounted for, i.e. any energy generated for internal use shall be deducted, and only the surplus should be claimed in retrofit/capacity added projects
- If **emission factors** are to be provided, should we assume the most conservative, a blend or most likely? Shall these vary to match regional context? Or allow project proponents to use actuals, where available?
- For **biomass to energy** projects, reference scenario for waste treatment, shall be composting, landfill, incineration or treated using the most likely treatment in the Member State? Similarly, if biogas to energy, should we assume that CH_4 would be directly released in the reference scenario or flared?
- **Combustion of fossil fuel** at project plant and off-site transportation (bioenergy projects) shall be included or should we assumed that these emissions would also occur in the reference plant (e.g. leakage from gas pipeline if natural gas)?

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Proposed structure for guidance document

1. **Scope**, e.g. *"This methodology applies to projects that involve generation of grid-connected electricity, heat or steam using one or a combination of the below technologies…"*
2. **Applicability**
3. **Boundaries** (i.e. emissions sources in/out).
4. Formula for the **GHG savings / avoidance calculation**
5. Formula for the **Reference emissions calculation**
6. Formula for the **Project emissions calculation**, e.g. *"For most renewable energy power generation project activities, PEy = 0. However, some project activities may involve project emissions that can be significant. For instance, for geothermal, biofuels, biomass, emissions could include fuel combustion in the power plant, imported electricity consumed in the plant, fugitive losses in steam (geothermal), and other direct emission sources. These emissions shall be accounted for as project emissions by using the following equation*:"

$$GHG_{project,y} = PE_{FF,y} + PE_{GP,y}$$

Where:

$GHG_{project,y}$	=	Project emissions in year y (t CO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year y (t CO_2/yr)
$PE_{GP,y}$	=	Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO_2e/yr)

7. Tables with **data and parameters not monitored** (i.e. national or default emissions factors that will be provided),
8. Tables with **data and parameters to be monitored** (i.e. this to inform monitoring plan), example below:

Data / Parameter:	EG_y
Data unit:	MWh/year
Description:	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year y
Source of data:	Project activity site
Measurement procedures (if any):	Electricity meters
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	-

Thank you