Evaluation of Carbon Footprint in Wastewater Treatment Plants

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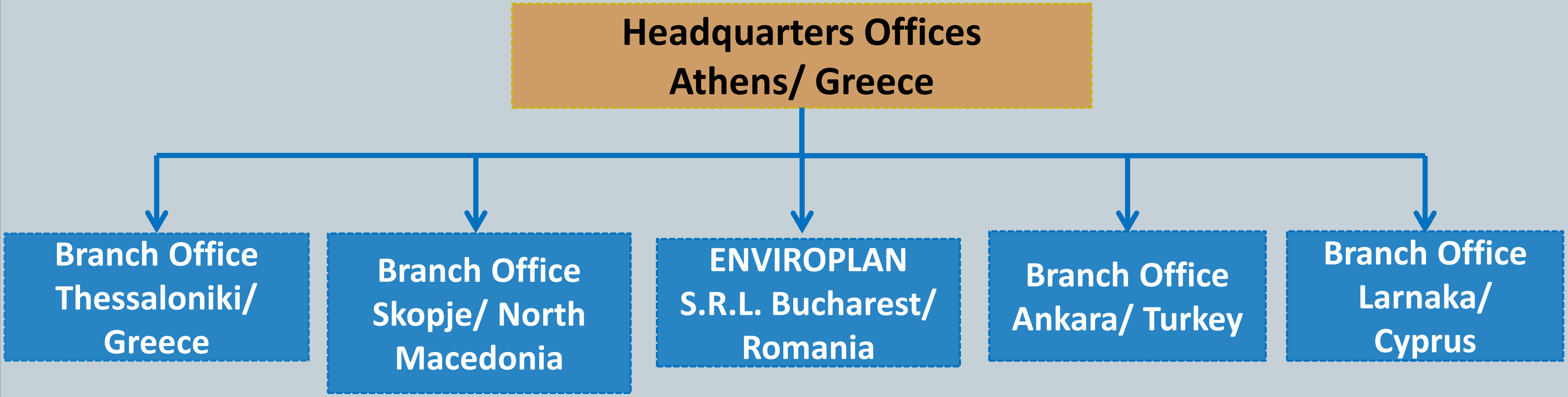

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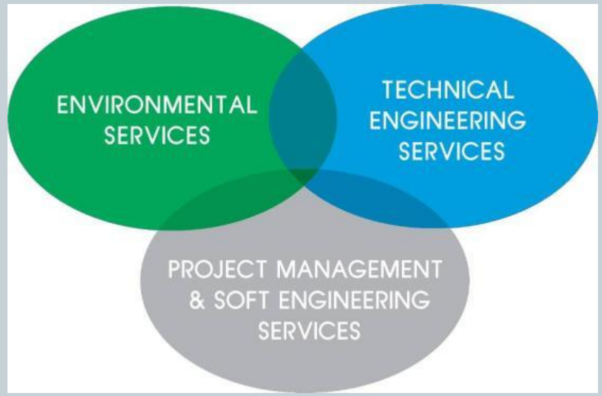

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  - ✓ Waste Management Organizations
  - ✓ Local Authorities
  - ✓ Private sector

Climate Change
Wastewater treatment plant

This presentation focus on climate change mitigation regarding the development of a Wastewater treatment plant.

Mitigation is dealing with the causes of climate change by reducing GHG emissions.

Methodology for the quantification of GHG emissions for different configuriations of Wastewater treatment plant will be presented followed by results from a case study related with the development of a Wastewater treatment plant in Saida-Lebanon in the Framework agreement to support EIB advisory services (EIBAS) activities inside and outside EU-28 – LOT 1: Environment.

Climate Change Mitigation
GHG emissions calculations Methodology

As part of the option analysis, the quantification of each examined alternative option regarding WWTP treatment scheme was performed according to The Carbon Footprint Methodology, that provides a series of emissions factors derived from internationally recognized sources, e.g. GHG Protocol and IPCC Guidelines for National GHG Inventories.

The calculation of the GHG emissions included:

- Both direct and indirect GHG emissions from the different configurations of the WWTP
- GHG emissions, Avoided GHG emissions and Net GHG emissions of an incremental approach (with-without project option)

Scope of GHG emissions produced by wastewater and sludge treatment activities

Activity	Net direct GHG emissions (scope 1)	Indirect GHG emissions (scope 2)	Avoided GHG emissions
Significant CH4 emissions from wastewater treatment (WWT) only arise from the anaerobic part of the process. Sludge disposal (e.g. landfill, use in agriculture, incineration) may be also responsible for CH4 emissions	CH_4 and N_2O	CO_2 from grid electricity consumption	CO2 avoided through energy recovery from PVs

- CH_4 from degradation of organic material in the wastewater under anaerobic conditions
- N_2O as an intermediate product from the degradation of nitrogen components in the wastewater
- CO2 from the consumption of electricity in the treatment process

Methodology

According ***European Investment Bank (EIB) carbon footprint methodologies, Methodologies for the Assessment of Project GHG Emissions and Emission Variations,*** in order to estimate the relative GHG emissions the following steps must be followed:

Define project Boundary
↓
Emission scopes to include
↓
Quantify absolute project emissions (Ab)
↓
Identify & quantify baseline emissions (Be)
↓
Calculate relative emissions Re=Ab-Be

Methodology

Define project Boundary

↓

Emission scope

↓

Quantify absolute proj

↓

Identify & quantify baseline emissions (Be)

↓

Calculate relative emissions
Re=Ab-Be

What to be included in the calculation of absolute, baseline, and relative emissions?

Definition of scope of GHG emissions.

Methodology

Define project Boundary

↓

Emission scopes to includ

↓

Quantify absolute project emissi

↓

Identify & quantify baseline emiss

↓

Calculate relative emissions
Re=Ab-Be

Scope 1: Direct GHG emissions. Occur physically from sources operated by the project within the project boundary.

Scope 2: Indirect GHG emissions. From electricity generation that is consumed by the project.

Methodology

Define project Boundary

↓

Emission scopes to include

↓

Quantify absolute project emissions

↓

Identify & quantify baseline emissions (Be)

↓

Calculate relative emissions
Re=Ab-Be

Absolute (Ab) GHG emissions: annual emissions estimated for an average year of operation for the project

Baseline (Be) GHG emissions: Provides the scenario without the implementation of the project

Basic Assumptions

For the total GHG emissions calculation, the following specific calculations have been implemented:

- CH_4 emissions from domestic wastewater:
  - *Calculation of total CH_4 emissions from domestic wastewater (TOW)*
  - *Estimation of the emission factor for each domestic wastewater treatment/discharge pathway or system*
  - *Estimate emissions, adjust for possible sludge removal and/or CH_4 recovery*
- N_2O emissions from domestic wastewater:
  - *Estimation of N_2O emissions from wastewater effluent*
- CO_2 emissions from electricity consumption
- Savings from PVs

Analytical equations are provided in Chapter 6: Wastewater treatment and discharge of 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Case Study

Framework agreement to support EIB advisory services (EIBAS) :

"***Feasibility Study for Upgrade and Expansion for Saida Wastewater Collection and Treatment Systems***"

Project Background

The four different configurations which were evaluated regarding WWTP technology were the following:

- Option 1: Conventional Activates Sludge treatment (CAS) including nitrogen removal, with primary sedimentation and Anaerobic Sludge digestion.
- Option 2: Biological Aerated Filter (BAF), including nitrogen removal, with primary sedimentation and Anaerobic Sludge digestion
- Option 3: Conventional Activates Sludge treatment (CAS) with no nitrogen removal, with primary sedimentation and Anaerobic Sludge digestion.
- Option 4: Biological Aerated Filter (BAF), with no nitrogen removal, with primary sedimentation and Anaerobic Sludge digestion

The WWTP alternative options refer mainly to ***secondary treatment***, with preliminary treatment, primary sedimentation, disinfection and sludge treatment to be almost identical for all the options.

Each WWTP alternative option includes:

- Inlet works – inlet pumping station
- Screening unit
- Grit and grease removal unit
- Primary sedimentation – primary sludge pumping station
- Biological treatment
- Disinfection unit
- Sludge treatment

Absolute Emissions-Year 2035

Year 2035

OPTION 1 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,224	t CH4/y	21	-46,710
Wastewater treatment N2O (WWTP)	6.84	t NO2/y	310	2,119
Sludge disposal	93.39	t CH4/y	21	1,961
Electricity Consumption	18,797,206	kWh/y	0.000792	14,887
Savings from PVs	-228,214	kWh/y	0.000792	-181
			Absolute emissions	**-27,923**

OPTION 2 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,353	t CH4/y	21	-49,417
Wastewater treatment N2O (WWTP)	6.84	t NO2/y	310	2,119
Sludge disposal	98.58	t CH4/y	21	2,070
Electricity Consumption	34,381,741	kWh/y	0.000792	27,230
Savings from PVs	-228,214	kWh/y	0.000792	-181
			Absolute emissions	**-18,178**

OPTION 3 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,326	t CH4/y	21	-48,853
Wastewater treatment N2O (WWTP)	14.18	t NO2/y	310	4,395
Sludge disposal	97.50	t CH4/y	21	2,047
Electricity Consumption	15,161,995	kWh/y	0.000792	12,008
Savings from PVs	-228,214	kWh/y	0.000792	-181
			Absolute emissions	**-30,583**

OPTION 4 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,353	t CH4/y	21	-49,417
Wastewater treatment N2O (WWTP)	14.18	t NO2/y	310	4,395
Sludge disposal	98.58	t CH4/y	21	2,070
Electricity Consumption	20,117,002	kWh/y	0.000792	15,933
Savings from PVs	-228,214	kWh/y	0.000792	-181
			Absolute emissions	**-27,200**

Absolute Emissions-Year 2050

Year 2050

OPTION 1 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,582	t CH4/y	21	-54,229
Wastewater treatment N2O (WWTP)	7.94	t NO2/y	310	2,461
Sludge disposal	108.42	t CH4/y	21	2,277
Electricity Consumption	18,797,206	kWh/y	0.000792	14,887
Savings from PVs	-196,278	kWh/y	0.000792	-155
			Absolute emissions	**-34,760**

OPTION 2 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,732	t CH4/y	21	-57,372
Wastewater treatment N2O (WWTP)	7.94	t NO2/y	310	2,461
Sludge disposal	114.44	t CH4/y	21	2,403
Electricity Consumption	34,381,741	kWh/y	0.000792	27,230
Savings from PVs	-196,278		0.000792	-155
			Absolute emissions	**-25,433**

OPTION 3 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,701	t CH4/y	21	-56,717
Wastewater treatment N2O (WWTP)	16.46	t NO2/y	310	5,103
Sludge disposal	113.19	t CH4/y	21	2,377
Electricity Consumption	15,161,995	kWh/y	0.000792	12,008
Savings from PVs	-196,278	kWh/y	0.000792	-155
			Absolute emissions	**-37,384**

OPTION 4 **Description of source**	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	-2,732	t CH4/y	21	-57,372
Wastewater treatment N2O (WWTP)	16.46	t NO2/y	310	5,103
Sludge disposal	114.44	t CH4/y	21	2,403
Electricity Consumption	20,117,002	kWh/y	0.000792	15,933
Savings from PVs	-196,278	kWh/y	0.000792	-155
			Absolute emissions	**-34,089**

Baseline Emissions-Years 2035 & 2050

Year 2035 Baseline

Description of source	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	278	t CH4/y	21	5,828
Wastewater treatment N2O (WWTP)	16.68	t NO2/y	310	5,171
Sludge disposal	0.00	t CH4/y	21	0
Electricity Consumption	1,879,721	kWh/y	0.000792	1,489
			Absolute emissions	**12,487**

Year 2050 Baseline

Description of source	Activity data	Units/year	Emission Factor t CO2-eq/unit	Emissions t CO2-eq/yr
Wastewater treatment CH4 (WWTP)	322	t CH4/y	21	6,766
Wastewater treatment N2O (WWTP)	19.37	t NO2/y	310	6,003
Sludge disposal	0.00	t CH4/y	21	0
Electricity Consumption	1,879,721	kWh/y	0.000792	1,489
			Absolute emissions	**14,258**

Relative Emissions-Years 2035 & 2050

Year 2035 Relative emissions	
	Emissions t CO2-eq/yr
Option 1	-40,410
Option 2	-30,666
Option 3	**-43,070**
Option 4	-39,687

Year 2050 Relative emissions	
	Emissions t CO2-eq/yr
Option 1	-49,017
Option 2	-39,691
Option 3	**-51,642**
Option 4	-48,346

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Reduction of GHG emissions Project contribution

With Project Scenario Option 3	2024	2035	2050
Net GHG emissions, t CO_2-eq	-24,180	-30,583	-37,384

Without Project Scenario Baseline	2024	2035	2050
Net GHG emissions, t CO_2-eq	10,826	12,487	14,258

% reduction of GHG emissions	2024	2035	2050
	323%	345%	362%

- The percentage of reduction of GHG emissions in years 2024, 2035 and 2050 through the appliance of Option 3 will contribute positively in the climate change mitigation and adaptation as it will reduce the GHG emissions (in t CO2-eq).

Thank you for your attention

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