merlin

Deliverable 5.1 – Review of the impact indicators and extract of the project data from the LIFE KPI Webtool-M9

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Summary

The purpose of this deliverable is to provide a description of the Key Project Indicators (KPIs). It includes the value of every KPI at the beginning, at the end and 5 years after the project ends. The specific context and the description of every KPI of the project is also included in this deliverable

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List of Acronyms and Abbreviations

GA: Grant Agreement

GHG: Greenhouse gases

KPIs: Key Project Indicators

WWTP: Wastewater treatment plant

Executive summary

The purpose of this deliverable is to provide a description and the estimated values of the Key Project Indicators (KPIs) of the Project LIFE MERLIN. Every KPI includes different specific contexts, and for every specific context, there are three different values: the value at the beginning of the project (Start Value), the value at the end of the project (End Value) and the value 5 years after the end date of the project (Beyond End Value).

KPIs will provide the essential information of the critical indicators of the progress and performance of the project, indicating its status in the different stages of the project. These values provide the information required to create an analytical basis for decision making and help focus attention on what matters the most.

On this deliverable, the KPIs reported in the grant agreement (GA) are compared with the KPI values reported in the First Snapshot in the Life KPI 2.0 Webtool, which were validated by Dimas Ramos (KPI Expert). Any deviation between the KPIs reported in the Grant Agreement and the values included the KPI 2.0 Webtool are indicated in this deliverable in the corresponding section.

1. Introduction

LIFE MERLIN aims to demonstrate an innovative, cost-effective and synergistic combination of sludge pre-treatment technology with smart co-digestion to maximize biogas production, aligned with RePowerEU targets for EU energy independence and de-carbonization. This technology will be implemented in two municipal wastewater treatment plants (WWTPs): Monte Orgegia (Alicante, Spain) and Murcia-Este (Murcia, Spain).

Key Project Indicators (KPIs) are a project performance measurement that evaluate the success of some of the specific sections of the project, fixing different values of optimal progress for the different specific contexts of the different sections. The values of the different KPIs allow us to control the performance of the different stages of the project, considering the different aspects of every section of the project.

2. Key Project Indicators

2.1. KPIs extract

The KPI values included in LIFE KPI 2.0 Webtool after validation by Dimas Ramos (KPI expert) are shown in Table 1. Regarding compound context column, below the description of each of the categories:

- Alicante project area: KPI values related to implementation of LIFE MERLIN technology in WWTP Monte Orgegia (Region of Alicante).
- Murcia project area: KPI values related to implementation of LIFE MERLIN technology in WWTP Murcia-Este (Region of Murcia).
- Overall project area: KPI values related to implementation of LIFE MERLIN technology in both WWTPs, Monte Orgegia and Murcia-Este.
- Replication Scenario: KPI values related to the replication of the technology in 6 WWTPs located in different Spanish regions after the end of the project. The estimated size of the WWTPs is 3 WWTPs with a water treatment capacity for $2.2 \cdot 10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants.

Table 1. KPI values included in KPI Webtool. Start Value, End Value and Beyond End value correspond to the value at the beginning of the project, the value to be obtained at the end of the project and the value to be obtained 5 years after the end of the project, respectively. Compound Context refers to the territorial extent where LIFE MERLIN project technology is implemented.

Compound Context	Category	Indicator	Start Value	End Value	Beyond End Value	Unit
Alicante Project Area	Project Setting	Project Work Area	0	9,031	24,670	m^2
Murcia Project Area			0	23,125	44,684	
Replication Scenario			0	0	660,000	
Overall Project Area	Humans impacted by the project	Other persons impacted independently of project area	0	24,530	36,140	Number of persons
Alicante Project Area	Resource efficiency and waste & Circular Economy	Waste reduction due to digestion & Mass of product prepared for re-use	0	4,790	9,580	Tn/year
Murcia Project Area			0	7,165	24,640	

Replication Scenario	Resource efficiency and waste & Circular Economy	Waste reduction due to digestion & Mass of product prepared for re-use	0	0	252,178	Tn/year
Alicante Project Area		Renewable primary energy production	2.1	2.52	2.99	GWh/year
Murcia Project Area			8.13	9.09	11.08	
Replication Scenario			58.93	58.93	96.68	
Alicante Project Area	Climate Change Mitigation	Reduction of greenhouse gas emissions	1,336.4	1,253.2	1,183	Tons CO_2eq/year
Murcia Project Area			1,310.4	1,110.2	642.2	
Replication Scenario			27,244.6	27,244.6	18,618.6	

Alicante Project Area	Governance	Number of supervisory/enforcement bodies	0	1 (Regional Authority) 1 (Local Authority)	1 (Regional Authority) 1 (Local Authority)	Number of public bodies involved
Murcia Project Area			0	1 (Regional Authority) 1 (Local Authority)	1 (Regional Authority) 1 (Local Authority)	
Replication Scenario			0	0	6 (Regional authority) 6 (Local authority)	
Overall Project Area		Involvement of stakeholders	0	11 (Private for profit) 6 (Others)	11 (Private for profit) 6 (Others)	No. of stakeholder entities involved
Replication Scenario			0	0	25 (Private for profit) 6 (Others)	
Overall Project Area	Information and awareness	Website	0	3,500	5,600	Number of unique website visits
		Other tools for reaching/raising awareness	0	7 (Events/Exhibitions) 5 (Distinct media products)	7 (Events/Exhibitions) 5 (Distinct media products)	Number of outcomes

Overall Project Area	Information and awareness	Other tools for reaching/raising awareness	0	40 (Articles in print media) 2 (Displayed information) 13 (Journal or conference publications)	40 (Articles in print media) 2 (Displayed information) 13 (Journal or conference publications)	Number of outcomes
		Surveys carried out	0	10 (from Public bodies) 50 (from Private for profit entities)	10 (from Public bodies) 50 (from Private for profit entities)	No. of employees/ individuals surveyed
Overall Project Area	Networking and synergies	Networking and synergies with projects/initiatives	0	2 (HORIZON projects) 2 (LIFE Projects)	2 (HORIZON projects) 2 (LIFE Projects)	No. of projects/ initiatives
Overall Project Area	New jobs created	New jobs created within the project consortium	0	3.44	5.45	Number of FTEs
Replication Scenario			0	0	30	
Replication Scenario	Economic sustainability and catalytic effect	Catalytic effect - Spatial (SPAIN)	0	0	6	Number of replications

Overall Project Area	Economic sustainability and catalytic effect	Revenue from sales during or after the project	0	0	0	Euro
		Revenue from fees during or after the project	0	0	0	
		Catalytic effect - Financial	0	0	1,870,000 (Beneficiary own contribution)	
Replication Scenario			0	0	13,900,000 (Beneficiary own contribution)	

2.2. KPI explanation per each category

2.2.1. Section 1.5 Project Setting - Work Area

The KPI "Area of environmental/climate implementation actions (e.g. development, testing, demonstration, application of best practices/innovations)", indicates the area of the facilities where the demonstration plant will be installed.

The values (also available in Table 1) are:

Alicante Project Area:

- Start value = 0 m^2
- End value = 9,031 m^2 (The total surface of WWTP Monte Orgegia is 50,000 m2. (Source: Link Alicante Total Area). At the end of the project it is expected that, from all the sludge used in anaerobic digestion, 18.1% (82 m^3/d from 454 m^3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 9,031 m^2 (=18.1·50,000/100)
- Beyond End value = 24,670 m^2 (5 years after the end of the project. it is expected that. from all the sludge used in anaerobic digestion, 49% (224 m^3/d from 454 m^3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 24,670 m^2 (=49·50,000/100))

Murcia Project Area:

- Start value = 0 m^2
- End value = 23,125 m^2 (The total surface of WWTP Murcia-Este is 125,000 m2. (Source: Link Murcia-Este Total Area). At the end of the project it is expected that, from all the sludge used in anaerobic digestion, 18.5% (120 m3/d from 649 m3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 23,125 m2 (=18.5*125,000/100)
- Beyond End value = 44,684 m^2 (5 years after the end of the project, it is expected that, from all the sludge used in anaerobic digestion, 36% (232 m3/d from 649 m3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 44,684 m2 (=36*125,000/100))

Replication Scenario:

- Start value = 0 m^2
- End value = 0 m^2
- Beyond End value = 660,000 m^2

(6 WWTPs are considered in the replication plan, 3 WWTPs with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants. The WWTP of Baix Llobregat is used as model to perform the calculations for the 3 WWTPs with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants, and the WWTP of Sant Feliu de Llobregat is used as a model to perform the calculations for the 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants.

WWTPs with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants: The total surface of WWTP Baix Llobregat is 410,000 m^2. (Source: Link WWTP Baix Llobregat Total Area)

5 years after the end of the project, it is expected that, from all the sludge used in anaerobic digestion, 40% (753 m^3/d from 1,884 m^3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 164,000 m^2 (=40·410,000/100)

The total surface area for the 3 WWTPs with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants is 492,000 m^2

WWTP for 373,333 equivalent inhabitants: The total surface of WWTP Sant Feliu de Llobregat is 14 ha, 140,000 m^2. (Source: Link WWTP Sant Feliu de Llobregat Total Area). Five years after the end of the project, it is expected that, from all the sludge used in anaerobic digestion, 40% (168 m^3/d from 419 m^3/d) will be pretreated by LIFE MERLIN technology. It is used this same percentage to calculate the project work area within the WWTP and the resulting value is 56,000 m^2 (=40·140,000/100). The total surface area for the 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants is 168,000 m^2

Total Replication case: 492,000 + 168,000 = 660,000 m^2

2.2.2. Section 1.6 Humans impacted by the project

These KPIs indicate the number of people whose lives will be directly, positively impacted by the main environmental and communication actions of the project have been calculated considering the amount of people expected to be involved in the project as

well as the followers of the social media of the partners. Considering that most of the actions to have an impact on humans are performed together for both demos sites during the project and, after the project, also together with the replication sites, we include this impact indicator only as Overall project Area because it is not possible to calculate the impact for each site and only the overall impact.

The values (also available in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = 24,530 persons
- Beyond End value = 36,140 persons

Comments:

Persons who may have been influenced via dissemination or awareness raising project-actions (reaching).

End of the project

By the end of the project, LIFE MERLIN project will reach at least 24530 people through the following:

Project website: 3,500 visits (unique visits tracked through Matomo)

Kick-off event: 50 attendees

Stakeholder workshops: 60 attendees (includes a workshop by AMAEM, a workshop by EMUASA and a workshop by Cetaqua)

Transfer webinar: 50 people

Virtual tour: 100 views

Project videos: 500 views (includes promotional video and final video)

Posts on social media: 20,000 views

Leaflet: 100 downloads

Layman's report: 100 downloads (total of downloads in English and Spanish)

Exhibition at Museo de Aguas de Alicante: 70 visitors

5 years after the end of the project

5 years beyond the project and based on previous experience with other LIFE projects we assume that at least 36,140 people will be reached through the project:

Project website: 5,600 visits. Assuming that after the lifetime of the project. The visits will decrease to 35 visits/month on average, it gives 2,

100 visits (35 visits/month x 12 months x 5 years). Considering also the expected visits at the end of the project, a total of 5,600 visits (3,500 visits + 2,100 visits) are expected.

Virtual tour: 1,000 views. Assuming that after the lifetime of the project, there will be an average of 15 visits/month it gives 900 visits (15 visits/month x 12 months/year x 5 years). Considering also the expected views at the end of the project, 1,000 views are expected (100 visits + 900 visits).

Project videos: 1,000 views. It is assumed that during the next 5 years there will be at least 50 views/year per video, giving 500 views (50 views/year per video x 2 videos x 5 years). Considering also the expected views at the end of the project gives 1,000 views (500 views + 500 views).

Posts of social media: 27,000 views. 7 new posts after the project are expected, each reaching an average of 1,000 people giving 7,000 views (1,000 people/post x 7 post). Considering also the expected views at the end of the project gives 27,000 views (20,000 views + 7,000 views).

Leaflet: 280 downloads. After the project, we aim for an average of 3 downloads/ month, giving 180 downloads (3 downloads/ month x 12 months x 5 years). Considering also the expected downloads at the end of the project gives 280 downloads (100 downloads + 180 downloads).

Layman's report: 1,260 downloads. Considering that the Layman's report will be published towards the end of the project, we expect the numbers to grow during the upcoming months. Thus, we assume an average of 100 downloads/month during the next two months after the project and afterwards we expect this number to decrease to 20 downloads/month afterwards. Considering also the expected downloads at the end of the project, 1,260 downloads are expected (100 downloads + (100 downloads/month x 2 months) + (20 downloads/month x 58 months)).

2.2.3. Section 4 RESOURCE EFFICIENCY AND WASTE (INCLUDING ENERGY, CIRCULAR ECONOMY AND FORESTS)

2.2.3.1. Subsection 4.1.1. PRIMARY ENERGY CONSUMPTION REDUCTION

KPI values related to primary energy consumption reduction were included in the Grant Agreement for both WWTPs. However, no KPI values were included in the corresponding section of the KPI webtool after discussing this topic with Dimas Ramos (KPI Expert). The conclusion was that the implementation of the LIFE MERLIN technology will allow a higher production of biogas and so, a higher production of electricity from renewable sources, but the WWTP will not reduce its electricity consumption after the implementation of the technology, because it will only increase its electrical self-sufficiency with the corresponding decrease on greenhouse gases (GHG) emissions due to the replacement of electricity from grid mix produced from fossil fuels by renewable energy produced from biogas.

2.2.3.2. Subsection 4.1.2. RENEWABLE PRIMARY ENERGY PRODUCTION

This indicator monitors the contribution of LIFE MERLIN technology to the net increase in the amount of primary energy produced from renewable sources (i.e. biomass) in each WWTP.

The values (also available in Table 1) are:

Alicante Project Area:

- Start value = 2.1 GWh/year
- End value = 2.52 GWh/year
- Beyond End value = 2.99 GWh/year

Murcia Project Area:

- Start value = 8.13 GWh/year (This value has been updated to match the current primary energy produced in Murcia-Este. In GA, the start value for Murcia-Este was 5.98 GWh/year)
- End value = 9.09 GWh/year (This value has been updated because the current start value for Murcia-Este is higher than the value included in the GA. The difference between End value and Start Value is the same as the GA)
- Beyond End value = 11.08 GWh/year (This value has been updated because the

current start value for Murcia-Este is higher than the value included in the GA. The difference between Beyond End value and Start Value is the same as the GA)

Replication Scenario:

- Start value = 58.93 GWh/year
- End value = 58.93 GWh/year
- Beyond End value = 96.68 GWh/year

Comments

Due to the length of the calculations for the increase in the amount of primary energy from renewable sources obtained after implementation of LIFE MERLIN technology, they are included in Annex 1 at the end of the report.

2.2.3.3. Subsection 4.3 WASTE REDUCTION DUE TO DIGESTION & MASS OF PRODUCT PREPARED FOR RE-USE

This section includes the amount of biowaste that is processed in a more sustainable way due to the implementation of LIFE MERLIN technology and causing a reduction of the amount of residual waste and an improvement of waste disposal, especially reduction in landfilling.

The values (also available in Table 1) are:

Alicante Project Area:

- Start value = 0 Tn/year
- End value = 4,790 Tn/year
- Beyond End value = 9,580 Tn/year

Comments:

Monte Orgegia WWTP is currently not using co-substrate in the anaerobic digestors. At the end of the project, considering that the amount available of the cosubstrate residues identified (i.e. Creamy residue from Ice-cream production, fruits and vegetables and Sludge from ice-cream production) is above 10,000 Tn/year but that co-digestion starts from zero in the WWTP, it is expected that maximum 4,790 Tn/year of co-substrate waste

will be treated.

5 years after the end of the project, considering that co-digestion is already implemented in the WWTP and that co-substrate residue amount availability is above 10,000 Tn/year, it is expected that double of the amount treated at the end of the project can be achieved and 9,580 Tn/year co-substrate waste will be treated.

The yearly amount of waste to be treated by codigestion will be quantified by weighing every batch of waste that enters the WWTP to be treated. The sum of all the batches from a year will result in the Tn/year treated in anaerobic codigestion.

Murcia Project Area:

- Start value = 0 Tn/year
- End value = 7,165 Tn/year
- Beyond End value = 24,640 Tn/year

Comments:

Murcia-Este WWTP has already implemented co-digestion in the anaerobic digestion process and currently they are treating 12,775 Tn/year co-substrate waste. At the end of the project, considering that the amount available of the residue identified (i.e. Aqueous residue with high content of sugar) is above 20,000 Tn/year and that Murcia-Este has already high experience on the co-digestion process, it is expected that an increase of 7,165 Tn/year of co-substrate waste treated will be achieved, reaching a total value of 19,929 Tn/year.

5 years after the end of the project, considering that co-digestion is already implemented for long time in the WWTP, Aguas de Murcia wants to give an important boost on renewable energy production from biogas production in the mid-term future and that co-substrate amount availability of this type of residue (i.e. Aqueous residue with high content of sugar) is above 40,000 Tn/year, it is expected that the amount of co-substrate waste treated will be increased by 24,640 Tn/year compared with current treatment capacity, reaching a total value of 37,415 Tn/year. So currently, 24,640 Tn/year of waste are not properly managed, and at the end of the project, 17,475 Tn/year will not be properly managed (=24,640-17,475).

The yearly amount of waste to be treated by codigestion will be quantified by weighing every batch of waste that enters the WWTP to be treated. The sum of all the batches from a year will result on the Tn/year treated in anaerobic codigestion

Replication Scenario:

- Start value = 0 Tn/year
- End value = 0 Tn/year
- Beyond End value = 252,178 Tn/year

Comments:

The replication scenario is based in the implementation of LIFE MERLIN technology in 6 additional WWTPs (3 WWTP with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants).

It is estimated that a WWTP with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants will process 188.4 Tn/d (=68,766 Tn/year) of co-substrate in anaerobic digestion, which equals approximately 10% of the total daily sludge to be treated in anaerobic digestion. On the other hand, It is estimated that a WWTP with a water treatment capacity for 373,333 equivalent inhabitants will process 41.9 Tn/d (=15,293 Tn/year) of co-substrate in anaerobic digestion, which also equals approximately to 10% of the total daily sludge to be treated in anaerobic digestion.

Then, the total co-substrate processing for the 6 WWTPs will be 252,178 Tn/year.

(3x41.9 + 3x188.4 = 690.9 Tn/d = 252,178 Tn/year).

2.2.4. Section 8 CLIMATE CHANGE MITIGATION

2.2.4.1. Subsection 8.1. REDUCTION OF GREENHOUSE GAS EMISSIONS

This section includes the quantification of LIFE MERLIN technology's net mitigation impact, which is the reduction in the carbon footprint of the project's demonstration actions, in terms of total net amount of CO_2eq reduced per year.

The values (also available in Table 1) are:

Alicante Project Area:

- Start value = 1,336.4 Tons CO_2eq/year (This value is different from the start value included in the GA. A correction has been made because the initial GHG emissions included in the GA (1,876 Tons CO_2eq/year) did not consider the primary energy that is already produced in the WWTP so the GHG emissions

were overestimated. The updated value has been calculated considering the current primary energy produced in the WWTP)

- End value = 1,253.2 Tons CO_2eq/year (This value has been updated compared with the value included in the GA (1,797.5 Tons CO_2eq/year) because start value has been recalculated. The difference between End value and Start Value is the same as the GA)
- Beyond End value = 1,183 Tons CO_2eq/year (This value has been updated compared with the value included in the GA (1,683 Tons CO_2eq/year) because start value has been recalculated. The difference between Beyond End value and Start Value is the same as the GA)

Comments:

The renewable primary energy production is 2.10 GWh/year (Start Value), 2.52 GWh/year (end of the project) and 2.99 GWh/year (5 years after end of the project). See Annex 1 for detailed calculation.

The current total energy consumption of the WWTP is 7.24 GWh/year.

At the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 0.1 Gwh/year, resulting in 7.34 GWh/year energy consumption.

5 years after the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 0.3 Gwh/year, resulting in 7.54 GWh/year energy consumption.

The electrical consumption of the pretreatment unit has been obtained from values provided by the equipment supplier:

End of the project: Installation of 1 unit ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 1 sludge pump (1 kWh/unit electrical consumption). Total electrical consumption of 11.5 kWh, which corresponds to 0.1 Gwh/year.

5 years after the end of the project: Installation of 3 units ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 2 sludge pumps (1 kWh/unit electrical consumption). Total electrical consumption of 33.5 kWh, which corresponds to 0.3 GWh/year.

Using the latest emission factor available for the residual Spanish energy mix (=260 gCO_2/kWh, Reference: Link Spanish energy mix emission factor), the CO_2eq emissions linked to the electricity consumption that has been produced from fossil fuels is the following :

- (7.24-2.10 [Gwh/year])·260 [tnCO_2/Gwh] = 1,336.4 Tn CO_2eq/year (Start Value),
- (7.34-2.52 [Gwh/year])·260 [tnCO_2/Gwh] = 1,253.2 Tn CO_2eq/year (End of the project)
- (7.54 - 2.99 [Gwh/year])·260 [tnCO_2/Gwh] = 1,183 Tn CO_2eq/year (5 years after the end of the project).

Murcia Project Area:

- Start value = 1,310.4 **Tons CO_2eq/year** (This value has been updated compared with GA (1,970 **Tons CO_2eq/year**) because current primary energy produced in Murcia-Este is higher than the start value included in GA (See section 2.2.3.2)).
- End value = 1,110.2 **Tons CO_2eq/year** (This value has been updated compared with GA (1,799.1 **Tons CO_2eq/year**) because current primary energy produced in Murcia-Este is higher than the start value included in GA (See section 2.2.3.2)).
- Beyond End value = 642.2 **Tons CO_2eq/year** (This value has been updated compared with GA (1,334.5 **Tons CO_2eq/year**) because current primary energy produced in Murcia-Este is higher than the start value included in GA (See section 2.2.3.2)).

Comments:

The renewable primary energy production is 8.13 GWh/year (Start Value), 9.09 GWh/year (end of the project) and 11.08 GWh/year (5 years after end of the project. See Annex1 for detailed calculation.

The current total energy consumption of the WWTP is 13.17 GWh/year.

At the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 0.19 Gwh/year, resulting in 13.36 GWh/year energy consumption.

5 years after the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 0.38 Gwh/year, resulting in 13.55 GWh/year energy consumption.

The electrical consumption of the pretreatment unit has been obtained from values provided by the equipment supplier:

End of the project: Installation of 2 units ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 1 sludge pump (1 kWh/unit electrical consumption). Total electrical consumption of 22 kWh, which corresponds to 0.19 Gwh/year.

5 years after the end of the project: Installation of 4 units ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 2 sludge pumps (1 kWh/unit electrical consumption). Total electrical consumption of 44 kWh, which corresponds to 0.38 GWh/year.

Using the latest emission factor available for the residual Spanish energy mix (=260 gCO_2/kWh, Reference: Link Spanish energy mix emission factor), the CO_2eq emissions linked to the electricity consumption that has been produced from fossil fuels is the following :

- (13.17-8.13 [Gwh/year])·260 [$tnCO_2/Gwh$] = 1,310.4 Tn CO_2eq/year (Start Value)
- (13.36-9.09 [Gwh/year])·260 [$tnCO_2/Gwh$] = 1,110.2 Tn CO_2eq/year (End of the project)
- (13.55 - 11.08 [Gwh/year])·260 [$tnCO_2/Gwh$] = 642.2 Tn CO_2eq/year (5 years after the end of the project)

Replication Scenario:

- Start value = 27,244.6 Tons CO_2eq/year
- End value = 27,244.6 Tons CO_2eq/year
- Beyond End value = 18,618.6 Tons CO_2eq/year

Comments:

6 WWTPs are considered in the replication plan, 3 WWTPs with a water treatment capacity for $2.2{\cdot}10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373333 equivalent inhabitants. Then, renewable energy production for both types of WWTP is calculated:

WWTP for $2.2{\cdot}10^6$ equivalent inhabitants:

The Start Value for this WWTP is obtained from real data from WWTP Baix Llobregat (Barcelona Province, Spain), which has the same treatment capacity.

The renewable primary energy production is 15.73 GWh/year (Start Value) and 26.0 GWh/year (5 years after the end of the project). See Annex 1 for detailed calculation.

The total energy consumption of the WWTP, which we assume remains constant until the end of the project, is 46.7 GWh/year.

5 years after the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 1.15 Gwh/year, resulting in 47.85 GWh/year energy consumption.

The electrical consumption of the pretreatment unit has been obtained from values provided by the equipment supplier:

5 years after the end of the project: Installation of 12 units ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 6 sludge pumps (1 kWh/unit electrical consumption). Total electrical consumption of 132 kWh, which corresponds to 1.15 GWh/year.

Using the latest emission factor available for the residual Spanish energy mix (=260 gCO_2/kWh, Reference: Link Spanish energy mix emission factor), the CO_2eq emissions linked to the electricity consumption that has been produced from fossil fuels is the following :

- (46.7-15.73 [Gwh/year])·260 [$tnCO_2/Gwh$] = 8,052.2 Tn CO_2eq/year (Start Value)

  Total value for 3 WWTPs: 8052.2·3 = 24156.6 $TnCO_2eq$/year
- (47.85 - 26.0 [Gwh/year])·260 [$tnCO_2/Gwh$] = 5,681 Tn CO_2eq/year (5 years after the end of the project),

  Total value for 3 WWTPs: 5,681·3 = 17,043 $TnCO_2eq$/year

WWTP for 373,333 equivalent inhabitants:

The Start Value for this WWTP is obtained from real data from WWTP Sant Feliu de llobregat (Barcelona province, Spain). which has the same treatment capacity.

The renewable primary energy production is 3.91 GWh/year (Start Value) and 6.23 GWh/year (5 years after end of the project). See Annex 1 for detailed calculation.

The total energy consumption of the WWTP, which we assume remains constant until the end of the project, is 7.87 GWh/year

5 years after the end of the project, it is estimated that the sludge pretreatment unit electrical consumption will be 0.38 Gwh/year, resulting in 8.25 GWh/year energy consumption.

The electrical consumption of the pretreatment unit has been obtained from values provided by the equipment supplier:

5 years after the end of the project: Installation of 4 units ultrasound reactor+agitator (10.5 kWh/unit electrical consumption) + 2 sludge pumps (1 kWh/unit electrical consumption). Total electrical consumption of 44 kWh, which corresponds to 0.38 GWh/year.

Using the latest emission factor available for the residual Spanish energy mix (= 260 gCO_2/kWh. Reference: Spanish energy mix emission factor), the CO_2eq emissions linked to the electricity consumption that has been produced from fossil fuels is the following :

- (7.87-3.91 [Gwh/year])·260 [$tnCO_2/Gwh$] = 1,029 Tn CO_2eq/year (Start Value)

  Total value for 3 WWTPs: 1029·3 = 3,088 $TnCO_2eq$/year

- (8.25-6.23 [Gwh/year])·260 [$tnCO_2/Gwh$] = 525.2 Tn CO_2eq/year (5 years after the end of the project)

  Total value for 3 WWTPs: 525.2·3 =1,575.6 $TnCO_2eq$/year

- **Total Start Value for 6 WWTPs: 24,156.6 + 3,088 =27,244.6 $TnCO_2eq$/year**
- **Total Value 5 years after the end of the project for 6 WWTPs: 17,043 + 1,575.6 = 18,618.6 Tn $CO2_2eq$/year.**

2.2.5. Section 10 GOVERNANCE

2.2.5.1. Subsection 10.1.2 NUMBER OF SUPERVISORY/ENFORCEMENT BODIES ENGAGED BY THE PROJECT

This section includes the number of supervisory/enforcement bodies (i.e. Local and Regional public authorities) engaged in project activities.

Alicante Project Area:

- Start value = 0
- End value = 1 Regional Authority and 1 Local Authority
- Beyond End value = 1 Regional Authority and 1 Local Authority

Comments:

During the project, we aim to engage at least 1 local authority (Alicante City Council) and 1 regional authority (Mancomunitat l'Alacantí, which is a commonwealth of municipalities of the region of the same name and it has powers on wastewater treatment of the region.). Both public entities signed a support letter to the project when the proposal was submitted. The engagement of these two public bodies aims to promote the collaboration between the project partners and the public sector, and involve them in the development of the project and the future replication of the technology. For this purpose, we offered José Andrés Lluch, Technical Director of Mancomunitat l'Alacantí, to join the

advisory board of the project and he has accepted. We expect that his presence in the advisory board will ensure the fluent collaboration and exchange of information on the project, which will benefit both the partners and the project itself, and also Mancomunitat l'Alacantí.

We also aim that, once the project has finished, the collaboration between the public bodies and the project partners will continue, and, 5 years after the end of the project, they will be also involved in the full implementation of the technology in the WWTP.

Murcia Project Area:

- Start value = 0
- End value = 1 Regional Authority and 1 Local Authority
- Beyond End value = 1 Regional Authority and 1 Local Authority

Comments:

During the project, we aim to engage at least 1 local authority (Murcia City Council) and 1 regional authority (ESAMUR, which is the water sanitation and wastewater treatment entity in the region of Murcia). ESAMUR signed a support letter to the project when the proposal was submitted. The engagement of these two public bodies aims to promote the collaboration between the project partners and the public sector, and involve them in the development of the project and the future replication of the technology. For this purpose, we offered Carlos Lardín, member of ESAMUR, to join the advisory board of the project and he has accepted. We expect that his presence in the advisory board will ensure the fluent collaboration and exchange of information on the project, which will benefit both the partners and the project itself, and also ESAMUR.

We also aim that, once the project has finished, the collaboration between the public bodies and the project partners will continue, and, 5 years after the end of the project, they will be also involved in the full implementation of the technology in the WWTP.

Replication Scenario:

- Start value = 0
- End value = 0
- Beyond End value = 6 Regional Authority and 6 Local Authority

Comments:

Using the scenarios of Alicante and Murcia as a basis, where 1 local authority and 1 regional authority are aimed to be engaged in the project, the target is that at least, for each WWTP where the technology will be replicated, the corresponding local authority and regional authority will be involved. Considering that the technology will be replicated in 6 WWTPs, it is expected to involve at least 6 local authorities and 6 regional authorities. The engagement of public bodies aims to promote the collaboration between the future private end-users of the LIFE MERLIN technology and the corresponding public authorities, and also involve them in the replication of the technology in each territory.

2.2.5.2. Subsection 10.2 INVOLVEMENT OF OTHER STAKEHOLDERS (NOT DUTY HOLDERS OR ENFORCEMENT/SUPERVISORY BODIES) IN PROJECT ACTIVITIES

This section includes the quantification of stakeholders other than duty holders and supervisory/enforcement bodies. Stakeholders included in this section belong to businesses (Private for profit organizations) and others, such as sector associations that have or will participate in activities organized by the project.

Considering that most of the actions to promote the involvement of stakeholders in the project activities are performed for both demosites together, we include this impact indicator in the section of Overall project Area because it is not possible to calculate the impact for each site separately and only the overall impact.

The values (also included in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = 11 Private for profit and 6 other stakeholders entities involved
- Beyond End value = 11 Private for profit and 6 other stakeholders entities involved

Comments:

Water operators are the main potential end-users of the LIFE MERLIN solution. Thus, we aim to engage at least these water operators, which belong to Veolia or are already collaborating with Veolia in other projects:

- AQUONA, which signed a support letter to the project when the proposal was submitted;
-Aigües de Barcelona, which signed a support letter to the project when the proposal was submitted;
-ViAQUA, which signed a support letter to the project when the proposal was submitted
-VEOLIA Spain, which signed a support letter to the project when the proposal was submitted;
-Emasagra;
-HIDRAQUA and
-Aigües de Sabadell.

Additionally, we aim to include as stakeholders the industrial partners that can be involved in the project as cosubstrate suppliers. We aim to, at least, engage the following companies:

-Helados Alacant, which signed a support letter to the project when the proposal was submitted;
-Mercalicante, which signed a support letter to the project when the proposal was submitted;
-Solamplas, which signed a support letter to the project when the proposal was submitted and
-Aquambiente.

We expect that, 5 years after the end of the project, the private entities involved will be the same as the ones already involved during the project.

In addition, we aim to engage Spanish and international platforms in the field of wastewater treatment and biogas production to involve them in the dissemination and awareness raising project-actions:

-Water Europe, which signed a support letter to the project when the proposal was submitted;
-AVEBIOM, which signed a support letter to the project when the proposal was submitted
Catalan Water Partnership (CWP);
-Asociación Española de Biogás;
-European Biogas Association and
-World Biogas Association.

We expect that, 5 years after the end of the project, the international and Spanish platforms involved will be the same as the ones already involved during the project.

Replication Scenario:

- Start value = 0
- End value = 0
- Beyond End value = 25 Private for profit and 6 other stakeholders entities involved

Comments:

We expect that the Spanish and international platforms in the field of wastewater treatment and biogas production to be involved in the dissemination and awareness of the LIFE MERLIN technology will be the same than the ones involved during the project:

-Water Europe,
-AVEBIOM,
-Catalan Water Partnership (CWP),
-Asociación Española de Biogás,
-European Biogas Association and
-World Biogas Association.

We aim that, at least, the water operators already engaged as stakeholders during the project will remain involved in the replication of the LIFE MERLIN technology and in fact they will be actively as WWTP operators responsible for implementing the technology in a number of their WWTPs:

- AQUONA,
-Aigües de Barcelona,
-ViAQUA,
-VEOLIA Spain,
-Emasagra,
-HIDRAQUA and
- Aigües de Sabadell.

We aim to engage, at least, three industrial partners with potential to provide co-substrate per each WWTP where the LIFE MERLIN will be replicated. So, at least, 18 industrial partners will be engaged as stakeholders.

2.2.6. Section 11 INFORMATION AND AWARENESS

2.2.6.1. Subsection 11.1 WEBSITE

This section includes the number of visits to the website created by the project. Considering that one single website is used for dissemination of the project in both demosites and in the replication scenario, we include this impact indicator only as Overall project Area, because it is not possible to calculate the impact for each site and only the overall impact.

Overall Project Area:

- Start value = 0
- End value = 3,500 unique visits to the website
- Beyond End value = 5,600 unique visits to the website

Comments:

During the project, we expect a total of 3,500 unique visits to the webpage (unique visits tracked through Matomo).

5 years after the end of the project 5,600 visits to the website are estimated. Assuming that after the lifetime of the project. The visits will decrease to 35 visits/month on average, it gives 2,100 visits (35 visits/month x 12 months x 5 years). Considering also the expected visits at the end of the project, a total of 5600 visits (3,500 visits + 2,100 visits) are expected.

2.2.6.2. Subsection 11.2 OTHER TOOLS FOR REACHING/RAISING AWARENESS

Considering that all the tools for reaching/raising awareness on the project involve both demosites, we include this impact indicator only as Overall project Area, because it is not possible to calculate the impact for each site and only the overall impact. No tools related to this section are expected to be used in the replication scenario.

The tools used to reach or raise awareness on the project (also included in Table 1) are the following:

Overall Project Area:

- Start value = 0

- End value = 7 (Events/Exhibitions); 5 (Distinct media products); 40 (Articles in print media); 2 (Displayed information).
- Beyond End value = 7 (Events/Exhibitions); 5 (Distinct media products); 40 (Articles in print media); 2 (Displayed information).

Comments:

Number of different publications made (Journal/conference): A total of 4 papers in peer-reviewed journals and 9 publications in conference proceedings are expected. Further publications are not expected after the end of the project.

Number of different displayed information created (information board): during the execution of the project 2 notice boards will be installed, one in Monte Orgegia WWTP and another one in Murcia Este. Further displayed information is not expected after the end of the project.

Number of events/exhibitions organised: A total of 7 organised events are expected to be performed during the project. 1 at the beginning of the project (already performed in April 2025), 3 workshops with stakeholders, 1 webinar, 1 exhibition at Museo de Aguas de Alicante and 1 final event. Further events are not expected after the end of the project.

Other distinct media products created (e.g. different videos/broadcast/leaflets): A total of 5 other distinct media products are planned during the project; 2 videos, 1 leaflet, 1 Layman's report in English and 1 Layman's report in Spanish. Further media products are not expected after the end of the project.

Number of articles in print media (e.g. newspaper and magazine articles): A total of 40 impacts are expected (both in print and in digital general and technical media). Further articles in print media are not expected after the end of the project.

2.2.6.3. Subsection 11.3 SURVEYS CARRIED OUT TO ASSESS AWARENESS AND BEHAVIOUR CHANGE REGARDING THE ENVIRONMENTAL/CLIMATE PROBLEM ADDRESSED

This includes the size of the surveyed sample achieved by the project in terms of the number of individuals and/or entities surveyed. Considering that all the surveys to be filled in involve both demosites from the project, we include this impact indicator only as Overall project Area, because it is not possible to calculate the impact for each site and

only the overall impact. No tools surveys are expected to be filled in relation to the replication scenario.

The values (also included in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = 10 (from Public bodies) and 50 (from Private for profit entities) individuals surveyed
- Beyond End value = 10 (from Public bodies) and 50 (from Private for profit entities) individuals surveyed

Comments:

Interview-based survey(s) carried out linked to task 5.3: semi-structured interview is a qualitative research method that uses a combination of predetermined and open-ended questions. Up to 15 Stakeholders to be interviewed.

Interview-based survey(s) carried out during the project linked to task 5.3: A semi-structured interview will be used as a qualitative research method. This interview uses a combination of predetermined and open-ended questions. Number persons from private stakeholders to be interviewed: 11 Stakeholders.

Questionnaire-based survey(s) carried out during the project linked to task 5.3: 3 workshops to be performed during the project (1 in Barcelona, 1 in Alicante and 1 in Murcia). In each of these workshops, a questionnaire will be handed to each attendee to be filled in. It is expected that 13 persons from private entities will assist each workshop. Then a total of 39 questionnaires are expected to be answered by persons from private entities during the project.

A total of 50 surveys to be answered by persons from private entities during the project. It is not expected to perform any survey after the end of the project.

Interview-based survey(s) carried out during the project linked to task 5.3. A semi-structured interview will be used as a qualitative research method. This interview uses a combination of predetermined and open-ended questions. Number of persons from public bodies to be interviewed: 4.

Questionnaire-based survey(s) carried out during the project linked to Task 5.3: 3 workshops to be performed during the project (1 in Barcelona, 1 in Alicante and 1 in

Murcia). In each of these workshops, a questionnaire will be handed to each attendee to be filled in. It is expected that 2 persons from public bodies will assist each workshop. Then a total of 6 questionnaires are expected to be answered by persons from public bodies during the project.

A total of 10 surveys will be answered by persons from public bodies.

It is not expected to perform any survey after the end of the project.

2.2.7. Section 12 NETWORKING AND SINERGIES

2.2.7.1. Subsection 12.1 NETWORKING AND SYNERGIES WITH PROJECTS/INITIATIVES

This section includes the networking interactions with other EU funded projects or initiatives (i.e. number and type of projects/initiatives (not individuals) with which their project has interacted or will interact). Considering that the networking actions will involve both demosites from the project, we include this impact indicator only as Overall project Area, because it is not possible to calculate the impact for each site and only the overall impact. No networking interactions are expected to be performed in relation to the replication scenario.

The values (also included in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = Networking with 2 HORIZON projects and 2 LIFE Projects
- Beyond End value = Networking with 2 HORIZON projects and 2 LIFE Projects

Comments:

LIFE MERLIN aims to establish sustained and meaningful relations with similar projects to discuss and share experiences and avoid overlapping research efforts. In this sense, LIFE MERLIN will organise frequent meetings and joint promotional materials to create a critical mass of exchanged knowledge, intelligence, and experiences with the purpose of disseminating and exploiting the project outcomes and results for different or combined purposes. Some similar HORIZON EU-funded projects that have already been identified are:

-SEMPRE-BIO (EU H2020),

-PRODIGIO (EU H2020) and
-BIOMETHAVERSE (EU H2020).

In this sense, we expect to attend 2 networking meetings and events and interact with at least 2 similar projects for networking activities.

It is not expected to perform networking and synergies activities with other projects after the end of the project.

LIFE MERLIN aims to establish sustained and meaningful relations with similar projects to discuss and share experiences and avoid overlapping research efforts. In this sense, LIFE MERLIN will organise frequent meetings and joint promotional materials to create a critical mass of exchanged knowledge, intelligence, and experiences with the purpose of disseminating and exploiting the project outcomes and results for different or combined purposes. Some similar LIFE EU-funded projects that have already been identified are:

-LIFE NIMBUS (LIFE19),
-LIFE CHANDELIER (LIFE23) and
-LIFE CYCLOPS (LIFE21).

In this sense, we expect to attend 2 networking meetings and events and interact with at least 2 similar projects for networking activities.

It is not expected to perform networking and synergies activities with other projects after the end of the project.

2.2.8. Section 13 NEW JOBS CREATED WITHIN THE PROJECT CONSORTIUM

This section describes the values of the new jobs created by the project, including the link of each new job created to the corresponding partner. The values are reported as Full Time Equivalent (FTE) jobs for the Overall Project Area and the Replication Scenario.

The values (also included in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = 3.44 FTEs
- Beyond End value = 5.45 FTEs

Comments:

End of the project : The total number of new jobs created in the project is 3.44 FTEs. Below the details of the new jobs created.

Aguas de Alicante (AMA):

Guillermo Mas was hired in February 2025 and he will work on the project for 42 months (65% time dedication) = 0.57 FTEs. He will be involved in the technical work from tasks from AMA related to WP2 and WP3.

Cristina Ramos was hired in October 2024 and she will work for 47 months in the project. 21 months with a time dedication of 18% (Oct 24 until June 26) and 26 months with a time dedication of 40% (July 26 until end of the project). She will work as project manager of the tasks linked to AMA, perform technical work for WPs from 1 to 5, with a focus on WP2 and WP3, and communication tasks related to WP6. Number of FTEs = 0.295

A person will be hired on Sept 26 and he/she will be employed until the end of the project. He/she will work in the project for 20 months during 2 years with a time dedication of 50%. He/She will work in tasks related to the daily operation of the demo plant and corresponding lab analysis (WP3). Number of FTEs = 0.208

Total Number of FTEs linked to AMA = 1.07

Aguas de Murcia:

A person will be hired on Jan 26 and will be employed until the end of the project. He/She will work for 9 months (from jan26 until Aug26) on tasks related to the construction of the demo plant (WP1) with a time dedication of 25%, and he/she will work for 24 months (Sept 26 until Aug 28) on tasks related to the daily operation of the demo plant (WP3) with a time dedication of 100%. Number of FTEs = 0.55

Cetaqua:

Marcel Vilaplana was hired in July 2025 and he will work 48 months in the project with a time dedication of 95%. He will work as project coordinator, he will perform the management of tasks linked to CET in WP1 to 6 and he will also perform technical work on the tasks linked to CET in WP1 to 5. Number of FTEs = 0.95

Gabriela Anriquez was hired in April 2025 and she will be employed until the end of the project. She will work for 41 months in the project as a support technician in the tasks linked to CET mainly in WP2 and WP3 with a time dedication of 50%. Number of FTEs = 0.43

Total Number of FTEs = 1.4

Createch:

Pilar Rodriguez has been hired after the start of the project and she will work 39 months in the project (from Jun25 until Aug28) with a time dedication of 15% (=0.12 FTEs). She will be involved in the tasks included in WP2 and WP3 with a focus on the development of the digital tool and its implementation in each demo plant.

Lluis Godó has been hired after the start of the project and he will work 39 months in the project (from Jun25 until Aug28) with a time dedication of 15% (=0.12 FTEs). He will be involved in the tasks included in WP2 and WP3 with a focus on the development of the digital tool and its implementation in each demo plant.

Francesc Batlle has been hired after the start of the project and he will work 39 months in the project (from Jun25 until Aug28) with a time dedication of 25% (=0.2 FTEs). He will be involved in the tasks included in WP2 and WP3 with a focus on developing the control programming and use of Artificial Intelligence of the digital tools.

Total number of FTEs from Createch = 0.45

Total number of FTEs from all partners at the end of the project = 3.44

5 years after the end of the project: 5.45 FTEs will be created

- 0.45 FTEs by Createch, who are the same persons hired during the project and keeping the same dedication that during the project with the objective of developing and implementing the digital tool in the full-scale plant in Monte Orgegia and Murcia-Este and in the WWTPs from the replication scenario.
- 2 FTES by Aguas de Alicante in Monte Orgegia. Their work will be mainly linked to the tasks related to the continuation of operation of the project demo plant, design and construction of the LIFE MERLIN plant at full scale in the WWTP, operation of the full scale plant and corresponding lab analysis and co-substrate supply.
- 3 FTEs by Aguas de Murcia in Murcia-Este, including the person hired during the project that will continue working with a time dedication of 100%. Their work will be mainly linked to the tasks related to the continuation of operation of the project demo plant, design and construction of the LIFE MERLIN plant at full scale in the WWTP, operation of the full scale plant and corresponding lab analysis and co-substrate supply.

Replication Scenario:

- Start value = 0
- End value = 0
- Beyond End value = 30 FTEs

Comments:

5 years after the end of the project:

6 WWTPs are considered in the replication plan, 3 WWTPs with a water treatment capacity for $2.2 \cdot 10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants.

30 FTEs will be created (6 FTES per each WWTP with a water treatment capacity for $2.2 \cdot 10^6$ equivalent inhabitants and 4 FTEs for each WWTP with a water treatment capacity for 373333 equivalent inhabitants) to perform the full implementation of LIFE Merlin technology in each WWTP in the following 5 years after the end of the project. Their work will be mainly linked to the tasks related to design and construction of the LIFE MERLIN plant at full scale in the WWTP, operation of the full scale plant and corresponding lab analysis and co-substrate supply.

2.2.9. Section 14 ECONOMIC SUSTAINABILITY AND CATALYTIC EFFECT

2.2.9.1. Subsection 14.1 REVENUE DURING OR AFTER THE PROJECT END DUE TO PROJECT OUTCOMES

No revenues from fees or sales are expected in the project for any of the partners from the consortium. The outputs from LIFE MERLIN technology are biogas and waste in the form of digestate. Biogas is entirely used to be converted into electricity only for self-consumption of WWTP and the digestate is managed by each WWTP to be reused or recycled but it does not provide any revenue to the WWTP operator. The situation will be the same for the scenario of 5 years after the end of the project, so also no revenues from fees or sale will be obtained by any of the partners from the consortium. So the corresponding values for the Overall Project Area are the following:

Overall Project Area:

- Start value = 0 Euro obtained from fees or sales
- End value = 0 Euro obtained from fees or sales
- Beyond End value = 0 Euro obtained from fees or sales

2.2.9.2. Subsection 14.2 CATALYTIC EFFECT – FINANCIAL – CUMULATIVE INVESTMENT TRIGGERED OR FINANCE ACCESSED

The values corresponding to investment during and after the project (also included in Table 1) are:

Overall Project Area:

- Start value = 0
- End value = 0
- Beyond End value = 1.87 M€ (from beneficiary own contribution)

Comments:

End of the project: During the project, the source of financing will be the own contribution of each partner as co-financing and already included in the budget. Then, no additional financing is expected.

5 years after the end of the project: After 5 years, the future investments by Aguas de Alicante and Aguas de Murcia will depend on the CAPEX corresponding to the full scale implementation in each site. Thus, we estimated a total extra investment of 1.87M€ (0.9M€ for Aguas de Alicante and 0.97M€ for Aguas de Murcia).

Replication Scenario:

- Start value = 0
- End value = 0
- Beyond End value = 13.9 M€ (from beneficiary own contribution)

Comments:

5 years after the end of the project, 13.9 M€ are expected to be invested in total by other WWTPs sites to replicate the LIFE MERLIN solution estimating 6 replication sites (3 WWTPs with a water treatment capacity for $2.2 \cdot 10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants).

2.2.9.3. Subsection 14.3.1.CONTINUATION IN THE SAME PREMISES/AREA(S) AS THOSE USED DURING THE PROJECT

LIFE MERLIN technology will have a continuation at higher scale in the same premises in both WWTPs. 5 years after the end of the project, the full scale implementation of the technology is expected to be achieved and it is estimated that 35.8% and 48.9% of the total sludge produced will be treated in Murcia Este and Monte Orgegia, respectively, in comparison with the 18.5% and 18% of the total sludge that is expected to be treated at the end of the project in Murcia-Este and Monte Orgegia , respectively.

Regarding the co-substrate waste treatment, 5 years after the end of the project, 37,415 Tn/year and 9,580 Tn/year are expected to be treated in Murcia-Este and Monte Orgegia, respectively, in comparison to the 19,929 Tn/year and 4,790 Tn/year that are expected to be treated at the end of the project in Murcia-Este and Monte Orgegia, respectively.

2.2.9.4. Subsection 14.3.3 CATALYTIC EFFECT – SPATIAL – REPLICATION OF THE SAME TECHNICAL APPROACH INTO NEW GEOGRAPHICAL AREAS

The values of replication of the technology (also available in Table 1) are the following:

Replication Scenario:

- Start value = 0
- End value = 0
- Beyond End value = Technology replication in 6 WWTPs

Comments:

LIFE MERLIN has considered a replication plan of its technology in 6 additional WWTP sites: 1 in Alicante, Rincón de León WWTP (Alicante, Spain), 2 in Barcelona (Spain), 1 in Galicia (Spain), 1 in Palencia (Spain) and 1 in León (Spain). The replication is expected to be completed 5 years after the end of the project.

Annex

CALCULATIONS FOR SECTION 2.2.3.2 (4.1.2.B. RENEWABLE PRIMARY ENERGY PRODUCTION)

The yearly renewable energy production (Start Value, end of the project and 5 years after end of the project) is based on the amount of biogas produced by anaerobic digestion and it is calculated the following way:

1. Energy Production = Biogas Production (Nm^3/year) · Net calorific Value Methane · Methane fraction in biogas · Efficiency CHP engine · Conversion Factor (MJ-kWh) = Biogas production · 35.8 · 0.65 · 0.36 · 0.278

    a. Methane net calorific value = 35.8 MJ/m^3 (Source: Link methane net calorific value)

    b. Methane fraction in biogas = 65% (=0.65) (Estimated as standard methane content in biogas produced in anaerobic digestion)

    c. Efficiency CHP Engine = 36% (=0.36) (Estimated as standard efficiency CHP engine)

    d. Conversion Factor: 1MJ = 0.278 kWh

Start Value

The Start Value for the amount of biogas produced was provided by Aguas de Alicante (Monte Orgegia) and Aguas de Murcia (Murcia-Este). An average from monthly real data from each WWTP from period February 2024 <-> February 2025 has been used:

Murcia Este:

Biogas production = 3,497,430 Nm^3/year

Energy production = 3,497,430 · 35.8 · 0.65 · 0.36 = 8,138,520 kWh/year = 8.13 GWh/year

Monte Orgegia:

Biogas production = 902,645 Nm^3/year

Energy production = 902,645 · 35.8 · 0.65 · 0.36 = 2,100,455 kWh/year = 2.10 GWh/year

Replication 6 WWTPs:

6 WWTPs are considered in the replication plan, 3 WWTPs with a water treatment capacity for $2.2 \cdot 10^6$ equivalent inhabitants and 3 WWTPs with a water treatment capacity for 373,333 equivalent inhabitants. Then, renewable energy production for both types of WWTP is calculated:

WWTP for $2.2 \cdot 10^6$ equivalent inhabitants:

The biogas production Start Value for this WWTP is obtained from real data from WWTP Baix Llobregat (Barcelona Province, Spain), which has the same treatment capacity, with a value of 6,761,754 Nm^3/year of biogas production. This biogas production is obtained from sludge anaerobic digestion without use of co-digestion. Using this value, the renewable primary energy production before implementation of LIFE MERLIN technology is 15.73 GWh/year. See calculation below:

$$6{,}761{,}754\ Nm^3/year \cdot 35.8\ MJ/Nm^3 \cdot 0.65 \cdot 0.36 \cdot 0.278 = 15{,}734{,}602\ kWh/year = 15.73\ GWh/year\ per\ WWTP$$

$$15.73\ GWh/year \cdot 3 = 47.19\ GWh/year\ per\ 3\ WWTPs$$

WWTP for 373,333 equivalent inhabitants:

The biogas production Start Value for this WWTP is obtained from real data from WWTP Sant Feliu de llobregat (Barcelona province, Spain). which has the same treatment capacity, with a value of 1,680,361 Nm^3/year of biogas production. This biogas production is obtained from sludge anaerobic digestion without use of co-digestion. Using this value, the renewable primary energy production before implementation of LIFE MERLIN technology is 3.91 GWh/year. See calculation below:

$$1{,}680{,}460\ Nm^3/year \cdot 23.3\ MJ/Nm^3 \cdot 0.36 \cdot 0.278 = 3{,}913{,}559\ kWh/year = 3.91\ GWh/year\ per\ WWTP$$

$$3.91\ GWh/year \cdot 3 = 11.74\ GWh/year\ per\ 3\ WWTPs$$

Total for 6 WWTPs:

$$11.74 + 47.19 = 58.93\ GWh/year$$

End of the project

The production of energy at the end of the project and 5 years after the end of the project is calculated considering the Start Value plus the additional energy obtained from the increased amount of biogas obtained by pretreating by ultrasound technology a fraction of secondary sludge before anaerobic digestion plus the use of co-substrate in anaerobic digestion (=co-digestion).

To estimate the increase of biogas due to sludge pretreatment, it is calculated the corresponding Start Value value of biogas produced by the fraction of sludge that is preteated and a %increase in biogas production for the corresponding Start Value value is applied. The calculation is the following:

1. Extra biogas produced by sludge pretreatment = Start Value biogas production associated to pretreated sludge · % biogas production increase linked to pretreated sludge.

2. Start Value biogas production associated to pretreated sludge = Start Value total biogas production · Fraction of sludge pretreated (In the case of Murcia Este, the Start Value is the total biogas produced only from sludge digestion, excluding biogas obtained from digestion of co-substrate).

3. %biogas production increase linked to pretreated sludge = 20% =0.2 (This value was provided by the supplier of the ultrasound technology to be implemented in both WWTP as the most probable increase of biogas production to be obtained if the ultrasound pretreatment is implemented. The same value has been used for all WWTPs).

Murcia-Este:

Fraction of sludge pretreated = 18.5% = 0.185

The pretreatment is applied to 120 m^3/d of secondary sludge, which corresponds to 31% of the secondary sludge (=387 m^3/d) and 18.5% of the total sludge digested (=649 m^3/d), respectively. The fraction of sludge to be pretreated is linked to the available budget to purchase the ultrasound technology device. For Murcia-Este, according to the supplier, optimal pretreatment efficiency will be obtained if a maximum secondary sludge flow of 120 m3/d is treated.

As mentioned early, for Murcia-Este, the amount of biogas obtained from co-substrate digestion needs to be discounted from total biogas production start value to know the biogas production start value associated to pretreated sludge. Below the calculation of biogas obtained from co-digestion:

Residue to co-digest: Aqueous residue with high content of sugar

- Biochemical methane potential (BMP) = 27.24 L methane / kg waste
- Co-substrate waste to treat = 35 Tn/d = 35,000 kg/d
- Methane content in biogas = 65% (=0.65)
- Density food residue = 1 kg/L
- Biogas Production = 35,000 · 1 · 27.24 / (1,000·0.65) = 1,467 Nm^3 biogas/d = 535.436 Nm^3 biogas/year
- Start Value biogas production associated to pretreated sludge = (3,497,430 Nm3/year - 535,436 Nm^3/year) · 0.185 = 547,672 Nm^3/year
- Extra biogas produced from pretreated sludge = 547,632 Nm^3/year · 0.2 = 109,534 Nm^3/year

On the other hand, the estimated biogas production linked to the increased treatment capacity of the co-digestion process is 299,844 Nm^3 biogas/year. This value is calculated as following:

Residue to co-digest: Aqueous residue with high content of sugar

- Biochemical methane potential (BMP) = 27.24 L methane / kg waste,
- Increase of co-substrate to treat compared with Start Value (=35 Tn/d) = 19.6 Tn/d = 19,600 kg,
- Methane content in biogas = 65% (=0.65),
- Density food residue = 1 kg/L and
- Extra biogas production co-digestion = 19,600 · 1 · 27.24 / (1,000·0.65) = 821.5 Nm^3 biogas/d = 299,844 Nm^3 biogas/year
- Total biogas production at the end of the project = Start Value + Extra biogas produced from pretreated sludge + Extra biogas production co-digestion = 3,497,430 + 109,534 + 299,844 = 3,906,809 Nm^3/year
- Energy production end of the project = 3,906,809 · 35.8 · 0.65 · 0.36 · 0.278 = 9,091,144 kWh/year = 9.09 GWh/year

Monte Orgegia

Fraction of sludge pretreated = 18% = 0.18.
The pretreatment is applied to 82 m3m^3/d of secondary sludge, which corresponds to 22% of the secondary sludge (=366m^3/d) and 18% of the total sludge digested (=454 m^3/d), respectively. The fraction of sludge to be pretreated is linked to the available budget to purchase the ultrasound technology device. For Monte Orgegia, according to the supplier, optimal pretreatment efficiency will be obtained if a maximum secondary sludge flow of 82m^3/d is treated.

- Start Value biogas production associated to pretreated sludge = 902,645 x 0.18 = 163,033 Nm^3/year
- Extra biogas produced from pretreated sludge = 163,033 · 0.2 = 32,607 Nm^3/year

On the other hand, the estimated biogas production linked to the implementation of the co-digestion process is 146,267 Nm^3 biogas/year. This value is calculated performing the average as following:

Residue to co-digest: Creamy residue from Ice-cream production

- Biochemical methane potential (BMP) = 0.338 m^3 methane / kg COD removed
- Co-substrate amount treated = 1 Tn/day = 1,000 kg/day
- COD concentration in residue = 0.239 kg COD/L = 0.239 kg COD/kg (Assumed residue density = 1 kg/L)
- Estimation COD consumption in anaerobic digestion = 60% = 0.6
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 1,000 kg/d · 0.239 kg COD/kg · 0.6 · 0.338 m^3 methane/kgCOD removed / 0.65 = 75 Nm^3/d biogas = 27,217 Nm^3/year

Residue to co-digest: Fruits and vegetables

- Biochemical methane potential (BMP) = 0.578 m^3 methane / kg Volatile Solids (VS)
- VS concentration = 0.063 kg VS/L
- Co-substrate amount treated = 2 Tn/day = 2,000 kg/day = 2,000 L/d (Assumed residue density = 1 kg/L)
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 2,000 L/d · 0.063 kg VS/L · 0.578 m^3 methane /kg VS / 0.65 = 112 Nm^3/d biogas = 40,996 Nm^3/year

Residue to co-digest: Sludge from Ice-cream factory WWTP

- Biochemical methane potential (BMP) = 0.270 m^3 methane / kg Volatile Solids (VS)
- VS concentration = 0.051 kg VS/L
- Co-substrate amount treated = 10.1 Tn/day = 10,100 kg/day = 10,100 L/d (Assumed residue density = 1 kg/L)
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 10,100 L/d · 0.051 kg VS/L · 0.270 m^3 methane /kg VS / 0.65 = 213 Nm^3/d biogas = 78,054 Nm^3/year

Total Extra biogas production co-digestion = 27,217+40,996+78,054 = 146,267 Nm^3/year

Total biogas production at the end of the project = Start Value + Extra biogas produced from pretreated sludge + Extra biogas production co-digestion = 902,645 + 32,607 + 146,627 = 1,081,252 Nm^3/year
Energy production end of the project = 1,081,252 · 35.8 · 0.65 · 0.36 · 0.278 = 2,518,086 kWh/year = 2.52 GWh/year

5 years after the end of the project

The production of energy 5 years after the end of the project is calculated considering the Start Value plus the additional energy obtained from the increased amount of biogas obtained by pretreating by ultrasound technology a fraction of secondary sludge produced before anaerobic digestion plus the use of co-substrate in anaerobic digestion (=co-digestion).

To estimate the increase of biogas due to sludge pretreatment it is calculated the corresponding Start value of biogas produced by the fraction of sludge that is preteated and a % increase in biogas production for the corresponding Start Value is applied. The calculation is the following:

- Extra biogas produced by sludge pretreatment = Start Value biogas production associated to pretreated sludge · %biogas production increase linked to pretreated sludge
- Start Value biogas production associated to pretreated sludge = Start Value total biogas production · Fraction of sludge pretreated (In the case of Murcia

Este, the Start Value is the total biogas produced only from sludge digestion, excluding biogas obtained from digestion of co-substrate).

- %biogas production increase linked to pretreated sludge = 20% =0.2 (This value was by the supplier of the ultrasound technology to be implemented in both WWTP as the most probable increase of biogas production to be obtained if the ultrasound pretreatment is implemented. The same value has been used for all WWTPs).

Murcia-Este

Fraction of sludge pretreated = 35.8% = 0.358

The pretreatment is applied to 232 m^3/d of secondary sludge, which corresponds to 60% of the secondary sludge (=387 m^3/d) and 35.8% of the total sludge digested (=649 m^3/d). respectively. The fraction of sludge to be pretreated is estimated considering the inputs from ultrasound technology supplier. who does not recommend treating a fraction higher than 60% total secondary sludge because above this percentage, the extra amount of biogas obtained does not compensate the increase of investment needed to increase treatment capacity and the increase of expenses due to energy consumption of pretreatment operation.

- Start Value biogas production associated to preatreated sludge = (3,497,430 Nm^3/year - 535,436 Nm^3/year) · 0.358 = 1,059,746 Nm^3/year.

- Extra biogas produced from pretreated sludge= 1,059,746 Nm^3/year · 0.2 = 211,949 Nm^3/year

On the other hand, the estimated biogas production linked to the implementation of the co-digestion process is 1,587,951 Nm^3 biogas/year. This value is calculated as following:

Residue to co-digest: Aqueous residue with high content of sugar

- Biochemical methane potential (BMP) = 27.24 L methane / kg waste
- Increase of co-substrate to treat compared with Start Value (=35 Tn/d) = 68.8 Tn/d = 68,800 kg
- Methane content in biogas = 65% (=0.65)
- Density food residue = 1 kg/L
- Extra biogas production co-digestion = 68,800 · 1 · 27.24 / (1,000·0.65) = 2,883 Nm^3 biogas/d = 1,052,386 Nm^3 biogas/year

- Total biogas production 5 years after the end of the project = Start Value + Extra biogas produced by sludge pretreatment + Extra biogas production co-digestion = 3,497,430 + 211,949 + 1,052,386 = 4,761,765 Nm^3/year

- Energy production 5 years after the end of the project = 4,761,765 · 35,8 · 0,65 · 0,36 · 0,278 = 11,080,927 kWh/year = 11.08 GWh/year

Monte Orgegia

Fraction of sludge preatreated = 48.9% = 0.489
The pretreatment is applied to 223.8 m^3/d of secondary sludge, which corresponds to 60% of the secondary sludge (=366 m^3/d) and 48.9% of the total sludge digested (=454 m^3/d), respectively. The fraction of sludge to be pretreated is estimated considering the inputs from ultrasound technology supplier, who does not recommend treating a fraction higher than 60% total secondary sludge because above this percentage, the extra amount of biogas obtained does not compensate the increase of investment needed to increase treatment capacity and the increase of expenses due to energy consumption of pretreatment operation.

- Start Value biogas production associated to preatreated sludge = 902,645 · 0.489 = 441,074 Nm^3/year.
- Extra biogas produced from pretreated sludge = 441,074 · 0.2 = 88,214 Nm^3/year

On the other hand, the estimated biogas production linked to the implementation of the co-digestion process is 292,534 Nm^3 biogas/year. This value is calculated performing the average as following:

Residue to co-digest: Creamy residue from Ice-cream production

- Biochemical methane potential (BMP) = 0.338 m^3 methane / kg COD removed
- Co-substrate amount treated = 2 Tn/day = 2,000 kg/day
- COD concentration in residue = 0.239 kg COD/L = 0.239 kg COD/kg (Assumed residue density = 1 kg/L)
- Estimation COD consumption in anaerobic digestion = 60% = 0.6
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 2,000 kg/d · 0.239 kg COD/kg · 0.6 · 0.338 m^3 methane/kgCOD removed / 0.65 = 75 Nm^3/d biogas = 54,434 Nm^3/year

Residue to co-digest: Fruits and vegetables

- Biochemical methane potential (BMP) = 0.578 m^3 methane / kg Volatile Solids (VS)
- VS concentration = 0.063 kg VS/L
- Co-substrate amount treated = 4 Tn/day = 4,000 kg/day = 4,000 L/d (Assumed residue density = 1 kg/L)
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 4,000 L/d · 0.063 kg VS/L · 0.578 m^3 methane /kg VS / 0.65 = 112 Nm^3/d biogas = 81992 Nm^3/year

Residue to co-digest: Sludge from Ice-cream factory WWTP

- Biochemical methane potential (BMP) = 0.270 m^3 methane / kg Volatile Solids (VS)
- VS concentration = 0.051 kg VS/L
- Co-substrate amount treated = 20.2 Tn/day = 20,200 kg/day = 20,200 L/d (Assumed residue density = 1 kg/L)
- Methane content in biogas = 65% (=0.65)
- Extra biogas production co-digestion = 20,200 L/d · 0.051 kg VS/L · 0.270 m^3 methane /kg VS / 0.65 = 213 Nm^3/d biogas = 156,108 Nm^3/year

Total extra biogas production co-digestion = 54,434 + 81,992 + 156108 = 292,534 Nm^3/year.

Total biogas production 5 years after the end of the project = Start Value + Extra biogas produced by sludge pretreatment + Extra biogas production co-digestion = 902,645 + 88,214 + 292,534 = 1,283,394 Nm^3/year.

Energy production 5 years after the end of the project = 1,283,394 · 35.8 · 0.65 · 0.36 · 0.278 = 2,986,459 kWh/year = 2.99 GWh/year.

Replication 6 WWTPs

WWTP for $2.2 \cdot 10^6$ equivalent inhabitants:

Fraction of sludge pretreated = 40% = 0.4

The pretreatment is applied to 753.4 m^3/d of secondary sludge, which corresponds to 60% of the secondary sludge (=1,213 m^3/d) and 40% of the total sludge digested (=1,884 m^3/d), respectively. The fraction of sludge to be pretreated is estimated considering the inputs from ultrasound technology supplier, who does not recommend treating a fraction higher than 60% total secondary sludge because above this percentage, the extra amount of biogas obtained does not compensate the increase of investment needed to increase treatment capacity and the increase of expenses due to energy consumption of pretreatment operation.

- Start Value biogas production associated to pretreated sludge = 6,761,754 · 0.4 = 2,697,240 Nm^3/year
- Extra biogas produced from pretreated sludge = 2,697,240 · 0.2 = 540930 Nm^3/year

On the other hand, the estimated biogas production linked to the implementation of the co-digestion process is 3,861,010 Nm^3 biogas/year. This value is calculated as following:

Residue to co-digest: food residue

- Volatile Solids (VS) concentration in food residue = 0.0631 kg VS/L
- Biochemical methane potential (BMP) food residue = 578.5 L methane / kg VS
- Co-substrate flow to treat = 188.4 Tn/d (Aprox. 10% of daily total sludge treated in anaerobic digestors) = 188,400 kg
- Methane content in biogas = 65% (=0.65)
- Density food residue = 1 kg/L
- Biogas Production = 188,400 · 1 · 0.0631 · 578.5 -/ (1000·0.65) = 10,578 Nm^3 biogas/d = 3,861,010 Nm^3 biogas/year

Total biogas production 5 years after the end of the project = Start Value + Extra biogas produced from pretreated sludge + Extra biogas production co-digestion = 6761754 + 540,930 + 3,861,010 = 11,163,694 Nm^3/year

Energy production end of the project = 11,163,694 · 35.8 · 0.65 · 0.36 · 0.278 = 25,998,698 kWh/year = 26.0 GWh/year per WWTP
26.0 GWh/year · 3 = 78 GWh/year per 3 WWTPs

WWTP for 373.333 equivalent inhabitants:

- Fraction of sludge pretreated = 40% = 0.4

- The pretreatment is applied to 167.7 m^3/d of secondary sludge, which corresponds to 60% of the secondary sludge (=251.5 m^3/d) and 40% of the total sludge digested (=419.2 m^3/d), respectively. The fraction of sludge to be pretreated is estimated considering the inputs from ultrasound technology supplier, who does not recommend treating a fraction higher than 60% total secondary sludge because above this percentage, the extra amount of biogas obtained does not compensate the increase of investment needed to increase treatment capacity and the increase of expenses due to energy consumption of pretreatment operation.
- Start Value biogas production associated to pretreated sludge = 1,680,460 · 0.4 = 672,184 Nm^3/year
- Extra biogas produced from pretreated sludge = 672,184 · 0.2 = 134,437 Nm^3/year

On the other hand, the estimated biogas production linked to the implementation of the co-digestion process is 859,278 Nm^3 biogas/year. This value is calculated as following:

Residue to co-digest: food residue

- Volatile Solids (VS) concentration in food residue = 0.0631 kg VS/L
- Biochemical methane potential (BMP) food residue = 578.5 L methane / kg VS
- Co-substrate flow to treat = 41.9 Tn/d (Aprox. 10% of daily total sludge treated in anaerobic digestors) = 41.900 kg
- Methane content in biogas = 65% (=0.65)
- Density food residue = 1 kg/L
- Biogas Production = 41900 · 1 · 0.0631 · 578.5 / (1,000*0.65) = 2354.2 Nm^3 biogas/d = 859.278 Nm^3/year

Total biogas production 5 years after the end of the project = Start Value + Extra biogas produced from pretreated sludge + Extra biogas production co-digestion = 1,680,460 + 134,437 + 859,278 = 2,674,175 Nm^3/year
Energy production end of the project = 2674175 · 35.8 · 0.65 · 0.36 · 0.278 = 6,227,783 kWh/year = 6.23 GWh/year
6.23 GWh/year · 3 = 18.68 GWh/year per 3 WWTPs

Total Renewable primary energy production per 6 WWTPs = 78 + 18.68 = 96.68 GWh/year

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