



LIFE Project Number

LIFE19 ENV/IT/000209

Final Report

Covering the project activities from 01/09/2020 to 29/02/2024

Reporting Date¹

28/05/2024

LIFE PROJECT NAME or Acronym

LIFE DUALNG

Data Project

Project location:	Montirone (BS), Italy
Project start date:	01/09/2020
Project end date:	29/02/2024
Total budget:	€ 1,316,891
EU contribution:	€ 724,290
(%) of eligible costs:	55.00 %

Data Beneficiary

Name Beneficiary:	BM Carrozzerie srl
Contact person:	Mr. Francesco Bandera
Postal address:	VIA DEL PALAZZO 2, 25010 MONTIRONE (BS), Italy
Telephone:	+39 030 2170249
E-mail:	engineering@bmcarrozzerie.it
Project Website:	https://www.carrozzeriebm.it/dualng/

¹ Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

This table comprises an essential part of the report and should be filled in before submission

Please note that the evaluation of your report may only commence if the package complies with all the elements in this receivability check. The evaluation will be stopped if any obligatory elements are missing.

Package completeness and correctness check	
Obligatory elements	✓ or N/A
Technical report	
The correct latest template for the type of project (e.g. traditional) has been followed and all sections have been filled in, in English <i>In electronic version only</i>	✓
Index of deliverables with short description annexed, in English <i>In electronic version only</i>	✓
<u>Mid-term report</u> : Deliverables due in the reporting period (from project start) annexed <u>Final report</u> : Deliverables not already submitted with the MTR annexed including the Layman's report and after-LIFE plan Deliverables in language(s) other than English include a summary in English <i>In electronic version only</i>	✓
Financial report	
The reporting period in the financial report (consolidated financial statement and financial statement of each Individual Beneficiary) is the same as in the technical report with the exception of any terminated beneficiary for which the end period should be the date of the termination.	✓
Consolidated Financial Statement with all 5 forms duly filled in and signed and dated <i>Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets + full Excel file)</i>	✓
Financial Statement(s) of the Coordinating Beneficiary, of each Associated Beneficiary and of each affiliate (if involved), with all forms duly filled in (signed and dated). The Financial Statement(s) of Beneficiaries with affiliate(s) include the total cost of each affiliate in 1 line per cost category. <i>In electronic version (pdfs of signed sheets + full Excel files) + in the case of the Final report the overall summary forms of each beneficiary electronically Q-signed or if paper submission signed and dated originals*</i>	✓
Amounts, names and other data (e.g. bank account) are correct and consistent with the Grant Agreement / across the different forms (e.g. figures from the individual statements are the same as those reported in the consolidated statement)	✓
Mid-term report (for all projects except IPs): the threshold for the second pre-financing payment has been reached	✓
Beneficiary's certificate for Durable Goods included (if required, i.e. beneficiaries claiming 100% cost for durable goods) <i>Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets)</i>	Not due
Certificate on financial statements (if required, i.e. for beneficiaries with EU contribution ≥750,000 € in the budget) <i>Electronically Q-signed or if paper submission signed original and in electronic version (pdf)</i>	Not due
Other checks	
Additional information / clarifications and supporting documents requested in previous EASME letters (unless already submitted or not yet due) <i>In electronic version only</i>	✓
This table, page 2 of the Mid-term / Final report, is completed - each tick box is filled in <i>In electronic version only</i>	✓

**signature by a legal or statutory representative of the beneficiary / affiliate concerned*

Instructions:

Please refer to the General Conditions annexed to your grant agreement for the contractual requirements concerning a Mid-term/Final Report.

Both Mid-term and Final Technical Reports shall report on progress from the project start-date. The Final Report must be submitted to the EASME no later than 3 months after the project end date.

Please follow the reporting instructions concerning your technical report, deliverables and financial report that are described in the document “Guidance on how to report on your LIFE 2014-2020 project”, available on the LIFE website at: <https://ec.europa.eu/easme/sites/easme-site/files/report-your-life-project.pdf>. Please check if you have the latest version of the guidance as it is regularly updated. Additional guidance concerning deliverables, including the layman’s report and after-LIFE plan, are given at the end of this reporting template.

Regarding the length of your report, try to adhere to the suggested number of pages while providing all the required information as described in the guidance per section within this template.

1. Table of contents

1. Table of contents.....	3
2. List of key-words and abbreviations.....	4
3. Executive Summary (maximum 2 pages).....	4
4. Introduction (maximum 2 pages).....	5
5. Administrative part (maximum 1 page).....	7
6. Technical part (maximum 25 pages).....	8
6.1. Technical progress, per Action	8
6.2. Main deviations, problems and corrective actions implemented.....	28
6.3. Evaluation of Project Implementation	29
6.4. Analysis of benefits.....	36
7. Key Project-level Indicators	40
8. Comments on the financial report.....	40
8.1. Summary of Costs Incurred	40
8.2. Accounting system.....	41
8.3. Partnership arrangements.....	44
8.4. Certificate on the financial statement	44
8.5. Estimation of person-days used per action	44
9. Envisaged progress until next report (this section should be included only for the Mid-term report)	45
Instructions / guidelines for the submission of deliverables / annexes.....	46

2. List of key-words and abbreviations

Acronym	Definition
GHG	Greenhouse Gas
EC	European commission
EU	European Union
HDV	Heavy-duty vehicles
DDF	Diesel Dual Fuel
CNG	Compressed Natural Gas
LNG	Liquid Natural Gas
BP	Business Plan
PM	Project Monitor
MT	Management Team
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
Covid-19	COronaVirus Disease 2019
EoL	End of Life

3. Executive Summary (maximum 2 pages)

The technology implementation activities were completed at the prototype level by the end of 2021, as planned in the timetable. The next phase of customer scouting and technology positioning in the HDV sector/market was provided during all project duration and completed as scheduled by February 2024. So far, the prototypes have been released, one running CNG (Daily) and the other LNG (Stralis). The related deliverable “D1. Release of the two prototypes vehicles” containing specific technical details has been produced as well.

The installation process of the Dual-Fuel conversion kit has been optimized and finalized and all the technical details are described in the related deliverables “D3. Report on the optimization of the DDF system” and “D1. Release of the two prototypes vehicles”.

The testbed, which was expected in the proposal, is not being purchased nor utilized as the end-users have demonstrated to have a strong preference for making road test instead of static tests.

At this purpose, the team purchased and installed useful tools for measuring power and road dynamic simulation in HDVs. This has permitted to verify the operation of the vehicles under normal operating conditions, dynamic diagnosis and tuning.

During project’s implementation, the following problems and risks encountered caused delays in the retrofitting activities, causing a project’s prolongation request:

- The quick rise of natural gas price experienced in the last months, which affect the scouting of new customers and installation of the retrofitting kit as well. This factor triggered also uncertainty in the market;
- The spread of the virus affected BM main target groups, which now are represented almost exclusively by public transport companies. These companies, which initially were really interested in DDF technology, have become more reluctant to install the retrofitting kit as they faced many problems related mainly to emerging new safety protocols.
- The outbreak of the conflict between Russia and Ukraine had causing indirectly major problems regarding the gas supply chain and related price volatility, once more discouraging the application of the DDF technology among final users.

Nevertheless, from Midterm report stage, thanks to project's prolongation, the Coordinator has reached 21 HDV's retrofitted by the end of February 2024.

The monitoring of impact's action was developed and evaluated in three different aspects:

1) the adopted LCA analysis is likely to be able to demonstrate reduced emissions for vehicles with DDF systems in each expected scenario.

The final results presented in study show a beneficial impact deriving from the installation of the DDF system, but this study must be considered as an initial exploration of the potential benefits and not a final statement.

2) connected to LCA study, at the final stage, it was produced also The Life Cycle Cost (LCC) of Dual-Fuel Technology. It refers to the assessment of the total costs associated with the entire lifespan of a dual fuel system. This includes the initial costs of purchasing, installing, and maintaining the system, as well as the operational and fuel costs throughout the entire lifespan of technology.

While LCC and LCA are two different methodologies, they are often linked together to provide a comprehensive analysis of the environmental and economic impacts of a product or system. By considering both LCC and LCA, companies can make more informed decisions about the design, production, and management of their products to minimize the environmental and financial costs.

3) a modeling approach is performed to assess the impact of DUALNG on air quality and GHGs emissions in a test case over Lombardy Region (IT).

The first step aims at identifying a set of scenarios characterized by different penetration levels of the DUALNG technology in the Heavy Duty Fleet in Northern Italy and in particular in Lombardy region, one of the most polluted area in Italy. The scenario design includes the use of natural gas and of biomethane.

In the second step, the results of the previous phase are evaluated through the Comprehensive Air quality Model with eXtension (CAMx) deterministic model. In the frame of the project, CAMx is applied in order to validate the results of the first step and in order to evaluate the differences in the percentage contribution of the heavy-duty vehicles to total pollutant concentrations in the base case scenario (actual scenario) and on the scenarios defined in the first step.

During the third step, the Multi-dimensional Air Quality model (MAQ) is applied. MAQ integrates the ability to evaluate energy efficiency and fuel switch abatement measures and it can evaluate also impacts on human health and greenhouse gases emissions.

Regarding dissemination activities, "Communication & Outreach Plan" has been finalized.

It has two principal objectives:

1. To define the positioning of communication depending on the specific target groups
2. To communicate efficiently this positioning through a mix of communication instruments, both during the project lifetime and after the project end.

Furthermore, both beneficiaries organized and participated to several events, webinar and specific round table to spread and disseminate the project and his objectives in order to reach as many clients as possible.

4. Introduction (maximum 2 pages)

State of art

The global transportation sector is one the major sources of health burden due to its contribution to elevated fine Particulate Matter (PM2.5), ozone precursors, nitrogen dioxide, as well as carcinogenic species (PAHs and POPs) and heavy metals [International Council on Clean Transportation, 2019]. Globally, over 30% of transport-related air pollutants and GHG emissions comes from road freight transport [International Energy Agency, The Future of Trucks, July 2017]. In Europe, around 70% of

freight is transported by road and there are around 7 million diesel trucks operating in the EU-28. Annual registrations of new trucks in the EU increased by 45 % from 2010 to 2016, to around 380 000. Diesel-powered Heavy-Duty Vehicles (HDVs) account for 27% of total on-road emissions [EEA, Analysis of key trends and drivers in GHG emissions in the EU between 1990 and 2014, 2016], more than double than passenger cars which stand at 12%, and this share is expected to increase to around 45% under a business-as-usual scenario.

Such a trend is incompatible with an EU goal of achieving a 60% reduction from 1990 in GHG emissions by 2050, and more specifically with the transport-specific goal for 2030 of reducing emissions by 30% from a 2005 baseline.

Fuel-efficiency standards for HDVs are critical to counteract the negative impacts on climate change and energy security from continuing increases in freight demand. Today, transport still relies on oil for 94% of its energy needs.

BM proposes a disruptive, clean, integrated and economically attractive diesel dual fuel (DDF) technology, exploiting a mixture of diesel fuel with Compressed Natural Gas (CNG) or Liquid Natural Gas (LNG) or biomethane, for retrofitting of HDVs i.e. buses, trucks, vans but also potentially applicable to ship engines. The DualLNG control unit determines the amount of diesel fuel injected and air/gas mixture dosage dynamically, modifying it in real time according to the feedback provided by the engine, to guarantee perfect operational conditions.

The technology equipped on circulating HDVs will allow a significant saving of 35% in the emissions of fine dust, 12% cut of ozone precursors (NO_x), 60% reduction for acidifying substances and a cut of 15% of CO₂. This will be achieved with particularly economical and minimally invasive installation of a "kit" having practically no rival technologies on the market, without modifying the engine.

The specific objectives of the DUALNG-LIFE proposal are then:

1. To implement a wider scale demonstration project by installing the kit, over two years, on 50 HDV vehicles (either buses and trucks), in order to validate the dual-fuel technology on real-scale road tests.
2. To analyse and prove the environmental benefits (through LCA, LCC, Integrated Assessment Modelling) and the social and economic advantages for HDV owners who retrofit their vehicle.
3. To communicate the project results to a wide target audience, in order to raise awareness of all interested end-users and policy makers.
4. To involve, by dedicated round-tables, all value chain stakeholders and especially policy makers who have the crucial role to set-up incentives schemes for HDVs retrofitting programmes to support the diffusion of dual-fuel technology in the EU.

The main result of the “close to market” project DUALNG will be to prove, through a wide real scale demonstration programme, the effectiveness and environmental advantage of LNG dual-fuel technology for existing HDV fleet retrofitting. Dual fuel diesel-LNG/biomethane vehicles today can offer a well-developed technology, with performances and cost equivalent to petrol or diesel units.

Technical benefits and impacts expected

The engine continues to work as a normal Diesel cycle and keeps its performance unchanged. The overall noise is lowered thanks to the effect of the gas combustion. Reduction by over 50% of carbon residues with improvement of durability and quality of the engine oil.

Significant reduction in fuel management costs.

Environmental benefits expected

	NOx (g/kWh)	CO (g/kWh)	HC (g/kWh)	PM (g/kWh)	CO2 (g/kWh)
Euro V std.	2,00	1,500	0,460	0,020	700
DUALNG	1,76	0,512	0,495	0,013	590
Reduction	0,24	0,988	-0,035	0,007	110
% change	-12,0%	-65,9%	7,6%	-35,0%	-15,7%
HDV (*)	NOx (g/km)	CO (g/km)	HC (g/km)	PM (g/km)	CO2 (g/km)
Euro V std. (A)	4,600	3,4500	1,0580	0,0460	1610
DUALNG (B)	4,048	1,1776	1,1385	0,0299	1357
Reduction (A-B)	0,552	2,2724	-0,0805	0,0161	253
	NOx (kg)	CO (kg)	HC (kg)	PM (kg)	CO2 (ton) (\$)
Annual saving p.v.	55,2	227,24	-8,05	1,61	25,3
Tot. Saving (2023)	2760	11362	-402,5	80,5	1265
Tot. Saving (2027)	38640	159068	-5635	1127	17710

(*) Note that CO2 is expressed in metric tons

Environmental performance for the kit being applied to Euro III-IV-V-VI vehicles are expected to be very satisfactory. These were estimated on Euro V and calculated on III-IV-VI by assuming that the performance of the kit will be similar to that of a retrofitted Euro V vehicle and hence we will achieve a comparable relative (%) reduction of pollutants.

Economic benefits expected

Assuming a 50% diesel-NG mix, we estimate that potential savings for the end user are about 0.20 euro/km (without taxes). Thus, taking into account a mean consumption of 32 L/100km, a truck driver travelling on average for 120,000 km/year will save about 9,000 euros/year.

Given an average installation cost of the DDF kit of € 14,000, the pay back time of the transformation is about 1.5 years. BM intends to propose itself as the first player specialized in the installation of the dual-fuel system with LNG. Our BP shows that we will be able to retrofit about 700 vehicles in 5 years (2023-2027) for a cumulative revenue of 10 mln Euro. The initiative IRR is of 35%. This is realistic since BM currently works with 10 public/private bus transport companies and 4 truck companies who have already a potential fleet of more than 500 vehicles to be renewed.

5. Administrative part (maximum 1 page)

Project management process, the working method, the problems encountered

Given the strategic importance of the project for BM Carrozzerie's future business plans, Mr. Romano Bandera (CEO of BM), has been appointed as project manager. He will ensure that the communication between the parties involved will be tight, continuative and effective, and will perform the following tasks assigned in the Grant Agreement and in the Partnership Agreement. Since August 2022, Romano Bandera has retired, and has been replaced by Mr. Francesco Bandera as Project Manager who already knew the project's aims. A project manager assistant has been identified in CSMT, which has a long experience in managing European projects (Mr. Alberto Bonetti). The project manager and his assistant coordinate the team and monitor the project progress during all period of the project. The Executive Board was set up, including the project manager, the project manager assistant and key staff of BM and CSMT. Due to maternity leave and her subsequent resignation from CSMT Anna Frascarolo's employee has been definitely replaced in the organization chart by Greta Consoli. A tight, continuative and effective communication framework was set up between the management team and the partners. A shared folder on Microsoft Teams was created, where project official reports and working documents and a timeline reporting all the project deadlines are uploaded. The partnership agreement was prepared by CSMT, shared between partners and signed on December 17th 2020). After prolongation's request approved by CINEA, the partnership agreement was updated and signed on November 25th, 2022.

Communication with the EASME and Monitoring Team.

Proper communication with EASME has been established soon and keeps regular. An excellent support is provided by our Project Monitor (PM) Dr. Simone Pagni.

Monitoring visits:

1. On 9th December 2020, via web-conference, the first monitoring visit was held with the Project Monitor Mr Simone Pagni. During the visit the project was presented, with particular reference to the state of the work from a technical and managerial point of view. In the second part of the

meeting, financial issues were addressed, submitting a copy of the requested documents to the PM and discussing specific issues;

- 1) On 9th December 2021, the second monitoring visit took place via web-call; PM met key figures involved in the Project, also getting informed of its status and several progresses till that date. Technical, administrative and financial issues were discussed, and did not evidence particular problems. Regular exchanges and good support by the PM have continued since;
- 2) On 26th December 2022, the third monitoring visit took place at BM Carrozzerie plant; during the visit the team described the overall ongoing activities, the main objectives accomplished, and major problems encountered. At the end, an on-site visit has been organized in order to show the PM the working areas, where the kit are installed and the two prototypes, which currently are still operating;
- 3) On 23rd February 2024, the fourth and so the last monitoring took place at BM Carrozzerie plant: during the visit the team described all the final results, and objectives reached until the end of the project with a focus on monitoring impact evaluation and final financial statement foreseen.

Prolongation's request and others:

On 24th October 2022, the Coordinator has requested to CINEA a project's prolongation about 12 months. So the end date was postponed from February 2023 to February 2024.

The main problems that have led to this prolongation were:

- The quick rise of natural gas price experienced in the last months, which affect the scouting of new customers and installation of the retrofitting kit as well. This factor triggered also uncertainty in the market;
- The spread of the virus affected BM main target groups, which now are represented almost exclusively by public transport companies. These companies, which initially were really interested in DDF technology, have become more reluctant to install the retrofitting kit as they faced many problems related mainly to emerging new safety protocols.
- The outbreak of the conflict between Russia and Ukraine had causing indirectly major problems regarding the gas supply chain and related price volatility, once more discouraging the application of the DDF technology among final users.

On 24th November 2022, The Cinea's letter confirmed the receipt of the request and approved the amendment.

Furthermore, after the prolongation confirmation, it was introduced a Progress Report with due date on 30th June 2023. This because the gap between the Midterm Report and the Final Report has exceeded more than 18 months.

On 29th June 2023 the PR was sent to CINEA Agency and Project Adviser, Mario Lionetti's response, on 27th July 2023, was positive: the PR contains sufficient information for the Agency to evaluate the state of implementation of the project.

6. Technical part (maximum 25 pages)

6.1. Technical progress, per Action

ACTION B.1: DDF technology optimization

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
B1	09/2020	09/2020	09/2021	09/2021	BM	Accomplished

Activities undertaken and outputs achieved

Task B1.1 Creation and optimization of the retrofit processing area of vehicles

The prototypes have been released, one running CNG (Daily) and the other LNG (Stralis). The related deliverable “D1. Release of the two prototypes vehicles” containing specific technical details has been produced as well.

The team purchased and installed useful tools for measuring power and road dynamic simulation in HDVs. This has permitted to verify the operation of the vehicles under normal operating conditions, dynamic diagnosis and tuning.

The mapping on the road proved to be highly efficient as it allowed us to test the vehicle in different conditions of use and with different types of load, also going to make up for efficiencies or inefficiencies of the original engine that can only be achieved with different types of tests.

By keeping track of all the refuelling moments and the kilometers covered with the relative fuel recharge carried out, it was possible to calculate the average replacement of the Dual-Fuel system installed.

Moreover, unlike CNG, it was important that the LNG vehicle did not remain stationary for more than 5/6 days in a row. Prolonged downtime would result in the gradual loss of the methane contained in the tank to the atmosphere with consequent negative environmental externalities.

A further fundamental factor concerns the identification of the type of route the vehicle would have taken: for the LNG prototype, it was a rural route while for the CNG one it was a mixed urban/rural route.

Regarding the LNG vehicle, we registered a slight increase in methane replacement thanks to a re-mapping of the standard parameters. These tests allow improving the overall performance of the Stralis prototype reducing the average replacement from 41% to 48%.

For the Daily vehicle, a total mapping development starting from scratch has allowed to reach an excellent average replacement.

As in the case of the Stralis, we carried out various road tests simulating a type of route that the vehicle typically travels and the weight that is usually loaded, going to change the exchange map in favour of a better replacement without losing power in the range of engine use.

The results of these tests were satisfactory and very close to expectations, which assumed a replacement of 44-45% since this is an urban route than the previous one, reaching a final replacement of 45.3%.

Task B1.2 Optimization of the Dual-Fuel conversion kit installation process

The installation process of the Dual-Fuel conversion kit has been optimized and finalized. Although there are some slight differences between CNG and LNG installation processes and further specific details concerning the installation processes are described in the related deliverables “D3. Report on the optimization of the DDF system” and “D1. Release of the two prototypes vehicles”.

An analysis of pollution emissions through P.E.M.S. method has been realised on the LNG prototype as foreseen in the application form.

On one-hand, the collected data have confirmed the expectations regarding CO₂ and NO_x, which registered a decrease of 11, 4%, and 19, 8% respectively.

On the other side, the results on CO (- 4%) and PM₁₀ (- 32, 1%) emissions are not satisfactory. This fact brought to light issues like smokiness and injection problems related to obsoleted engines, which can cause a decrease in the overall performance of the kit.

Consequently, BM has planned a preliminary task that has the aim to check the diesel engine and validate whether the Dual fuel installation will be useful or not.

This sub-task will therefore execute for every new installation.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D1	B1	Release of the first 2 prototype vehicles (CNG e LNG)	BM	28/02/2021	Accomplished
D2	B1	Testbed for HDVs	BM	28/02/2021	Accomplished
D3	B1	Report on the optimization of the DDF system and results on savings achievable in ideal and real conditions on the two installed prototypes	BM	30/09/2021	Accomplished

N°	Action	Expected Milestone	Responsible	Date	Status
M1	B1	Kits for the 2 prototypes have been ordered and delivered by the supplier	BM	31/12/2020	Accomplished
M4	B1	TestBed has been selected, ordered, delivered by the supplier and installed at BM premises	BM	28/02/2021	Accomplished
M10	B1	Optimized performance of the prototype vehicles confirm the expected fuel consumption and emissions	BM	30/09/2021	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

The testbed, which was expected in the proposal, is not being purchased nor utilized as the end-users have demonstrated to have a strong preference for making road test instead of static tests. Supplementary human effort was necessary in order to run those tests, therefore the budget allocated to the testbed has been transferred in personnel cost.

ACTION B.2: Demonstration campaign on trial vehicles, data collection and preprocessing

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
B2	02/2021	02/2021	02/2023	02/2024	BM	Accomplished

Activities undertaken and outputs achieved

Task B2.1 Planning of the demo campaign and scouting of customers for HDV retrofitting

The scouting of customers has been carried on since the start of the project through networking actions and dissemination activities as shown in the related action D1.

At the end of 2021, additional 21 letters of commitment have been accomplished so far reaching a total of 34 letters.

Despite the strong collaboration with CLM and the customers commitments, the retrofitted vehicles are 21 at the end of the project.

Netherless the average price of methane is decreased during 2023, the continuous price fluctuations make the market unstable and more evident the uncertainty trend related to the economic convenience of dual fuel transformation. All of this has significantly influenced customers choices.

Task B2.2 Installation of the DDF retrofit kits on 50 vehicles

Although the action B1.1 has allowed optimizing the installation process of the diesel dual fuel kit, every type of vehicle need then specific tasks to complete the installation optimally. Therefore, some differences in the installation process arose (it is necessary to adapt the installation to each different vehicle model),

For this reason, the time necessary for the transformation was slightly higher (about 10-15%) than what was assumed at the beginning of the project for each installation.

	N1	N2	N3	M1	M2	M3	TOTALE
EURO 3						6	6
EURO 4							
EURO 5						11	11
EURO 6	4						4
TOTALE	4					17	21

Progress of vehicles transformed and final numbers:

- Vehicles completed retrofitted: 21

The 21 vehicles currently converted are all running on CNG. For the purchase of materials, we applied the procedures in accordance with ISO9001:2015, which BM Carrozzerie is certified.

Regarding the CNG approved tanks, we have carried out a tender with an internal procedure for the awarding of the contract to the supplier that would guarantee us the greatest availability of different types of cylinders (size and capacity) to adapt to the different vehicles that we have to transform.

As mentioned in the previous paragraph “*Task B2.1 Planning of the demo campaign and scouting of customers for HDV retrofitting*”, several problems emerged among the final users due to the initial pandemic situation and then the progressive mistrust in the natural gas market caused by the price increase, in the year 2022. Despite the positive trend of methane cost in 2023, an increasingly difficult scenario for dual-fuel technology, due to the PNRR, led to the attention and funds on the purchase of new vehicles with alternative traction and experiments on hydrogen vehicles.

When BM has decided to apply this system, in addition to the pollutants saving, the transformation had a real cost effectiveness because methane cost was less than diesel cost. As you can see in the table related to *Letter of commitment* APAM had decided to transform 10 vehicles into DUAL FUEL before this unfavourable situation showed up.

Task B2.3 Data collection and analysis

At the end of project, the final data show an average replacement rate of 45.3% related to the 21 retrofitted vehicles. This percentage was obtained considering the refueling data during the activity period of vehicles. More and detailed information are available and reported in the deliverable “D6_Final report on retrofitted HDVs”

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
----	--------	----------------------	-------------	------	--------

D4	B2	Progress Report on retrofitted pilot HDVs and realy results of demo tests	BM	30/06/2023	done
D5	B2	Database of results on complete HDVs set and report on data analysis	BM	28/02/2024	done
D6	B2	Final Report on retrofitted HDVs	BM	28/02/2024	done

N°	Action	Expected Milestone	Responsible	Date	Status
M7	B2	Verification of customers feedbacks and commitment (at least 50 end users to be committed to perform HDV retrofit)	BM	31/12/2022	Accomplished
M13	B2	Verification of installation progresses (at least 25 kits are installed)	BM	30/06/2023	Accomplished
M14	B2	Verification of installation progresses (50 kits are installed)	BM	31/12/2023	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

Both the activity of demo-campaign planning and the vehicle retrofitting activity, are recording quite significant delays. This situation is a consequence of the huge inconvenience suffered in the last two years by the transport sector due to the lockdowns and emergencies related to COVID-19.

In particular, public transport companies, which in recent years have been paying particular attention to environmental issues, have in the last year completely revised their investment priorities, currently linked to guaranteeing the health safety of transport.

Furthermore the uncertainty related to raw materials price, specifically gas furniture and, as a consequence, progressive mistrust in the natural gas market caused by the price increase, has severely affected the attractiveness of the DDF technology.

ACTION B.3: Industrial value chain development

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
B3	09/2020	09/2020	09/2022	06/2023	BM	Accomplished

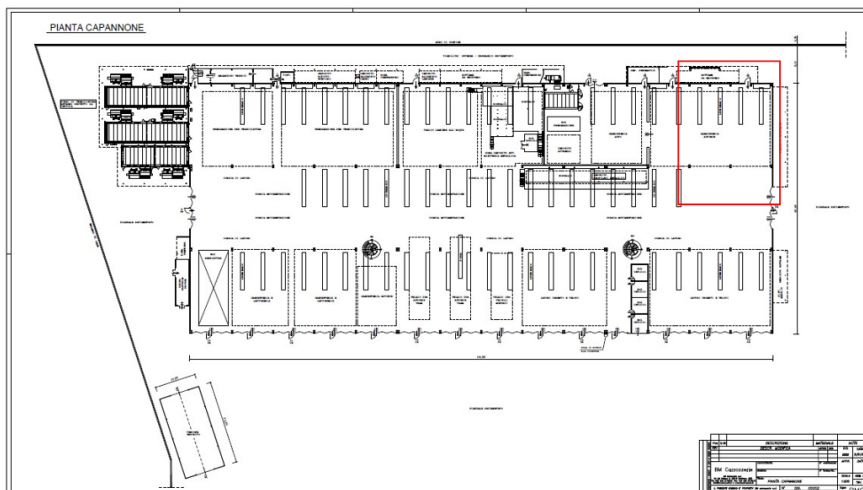
Activities undertaken and outputs achieved

Task B3.1 Activities related to the development of the industrial production capacity on the Dual Fuel Diesel transformation and on the treatment of natural gas

The retrofit processing area of vehicles is being created and all the related technical devices and systems developed as expected.

The work zone was identified in the shed area shown in the figure below, where bus bodywork is already carried out.

The transformation processes are carried out in the area marked in red without making any particular modifications as the installation takes place in the complete absence of methane and therefore does not require special systems for gas treatment.



In addition, considering the desire of expanding the area of industrial and railway carpentry in 2021 in order also to maintain the certification UNI EN ISO 15085 in class CL1 as officially requested by our certifying body, it was decided to undertake the development of a new shed.

This new activity was not actually foreseen in the application form. Nevertheless is considered to add value to the project as inside the new plant will be developed also a specific area for the installation of the retrofitting kit.

Task B3.2 Activities related to the training of qualified personnel for the installation, maintenance and sales of the Dual Fuel Diesel retrofit KIT

Staff training on mechanical and electrical installation of the retrofitting kit has been carried out. In particular, were involved three mechanical workers who are going to install the pneumatic part of the kit and one technician who is going to map and format the control units. Other staff training activities have planned to empower the BM's commercial network to promote the diesel dual –fuel technology:

- constant training of operators has allowed BM to develop a valid customer support network that offers an immediate help in resolving problems related to the new technology.
- implement staff-training course by the customer's companies to perform ordinary maintenance.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D7	B3	Installation of a specific work structure for methane and annex report describing projects and related safety compliance activities	BM	28/02/2021	Accomplished
D8	B3	Report on personnel training and empowerment of BM's commercial network	BM	30/06/2023	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

Although a specific working area for the installation of the DDF kit has been identified, the safety requirements for operating with methane were no longer necessary since the installation takes place in the complete absence of methane and therefore does not require special systems for gas treatment.

Furthermore, the new gas leak detection system implemented has requested an updated course for the staff involved in the installation of the retrofitting kit.

ACTION B.4: Replication and transfer

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
B4	08/2021	08/2021	02/2023	02/2024	BM	Accomplished

Activities undertaken and outputs achieved

Task B4.1 Business Plan of the DUALNG project

The structure of the Business Plan has been organised and it consists of this key points,:

- Company presentation, which contain information about mission, vision and main industry characteristics. Furthermore a SWOT analysis could highlights strengths, weaknesses, opportunities and threats for BM Carrozzerie;
- Business opportunity and Market, in which the market of CNG and LNG are deeply evaluated through PEST (Politic, Economy, Social, Technology) Analysis, market prospective and PORTER 5 FORCES framework in order to assess detailed impact of the main actors in the market (suppliers, clients, incumbers, potential entrants and potential substitutes);
- Position Strategy, which describes how the company attacks market shares through his specific value proposition. This section defines the price strategy and distribution and promotion strategy to promote retrofitting kit as well;
- Canvas Business Model, it illustrates key elements of BM Business Model;
- Financial Plan: starting from the financial plan provided in the application we update data in order to outline a more precise revenues and costs framework, financial income projections, cash flow analysis and key indicators of economic sustainability.

The business plan has been updated through all the duration of the project. Our last update in April 2023 has been checked by Close2Market. Their answer is positive, and they confirm that the deliverable D9 is fully sufficient.

Task B4.2 Plans for replication and transfer

Plans for replication and transfer is developed in 2 different aspects and levels:

- 1) Position Paper intends to explain the advantages of applying dual-fuel technology in terms of emissions and economic benefit compared to diesel engines, including regulations regarding emissions and HDV retrofit;
- 2) Replication Plan intends to discover and take into consideration different alternatives to fossil fuels (methane, biomethane, biogas and hydrogen) and identifying the key sectors to implement DualNG technology.

The associated beneficiary, CSMT, in collaboration with the CLM and the coordinator BM, have investigated both.

The objective of this action is not only a mere description of the potential (as an advantage in terms of emission and economic saving) and replicability of the technology, but also primarily the goal to increase community awareness and create good “market sensitivity” in terms of environmental improvement and in the need to address emissions from HDVs. It is crucial to spread the message that retrofitting an existing HDV, or any other means of transportation that have the potential to be replicated

with DDF technology, could be an affordable and environmentally friendly alternative to buy a new one.

For this reason, a relevant work of contamination and exchange of ideas has been provided by the CLM through the “quaderno dei carburanti rinnovabili”. An essay which comes from the fruit of the coordination and collaboration within the monthly thematic tables organized by the CLM itself, where entrepreneurs, researchers, and other stakeholders come together to discuss the topic and challenges of change and sustainability.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D9	B4	Business Model definition and draft business plan	BM	28/02/2022	done
D10	B4	Position paper on DualLNG technology	BM	30/06/2023	done
D11	B4	Replication plan including the results of the study at EU level and feedbacks from involved stakeholders and including cooperation	BM	29/02/2024	done

N°	Action	Expected Milestone	Responsible	Date	Status
M8	B4	Input data to feed the business model and the business plan	BM	30/09/2021	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

n/a

ACTION C.1: Monitoring of the impact of the project actions

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
C1	09/2020	09/2020	02/2023	02/02/2024	CSMT	Accomplished

Activities undertaken and outputs achieved

Task C1.1 Environmental performance assessment by LCA/LCC

Several assumptions that were made within the adopted LCA may lead to uncertainties in the results, but this is a rather common aspect to consider when implementing LCA studies. In any case, the adopted LCA is likely to be able to demonstrate reduced emissions for vehicles with DDF systems in each expected scenario. The primary cause of all impact categories is the amount of diesel used to travel. By

increasing the CNG/Diesel ratio, higher ecological and economic benefits could be achieved. A higher percentage of CNG is expected to reduce the overall emissions.

The deliverable “D15_Final report, including LCA and LCC of the project action” contains all the final data and evaluation about environmental and economic impacts of DualNG Technology.

While cost evaluation and LCA are two different methodologies, they are often linked together to provide a comprehensive analysis of the environmental and economic impacts of a product. By considering both analysis, companies can make more informed decisions about the design, production, and management of their products to minimize the environmental and financial costs.

The two studies were conducted analysing the vehicle categories M3 (bus), according to EU classification based on UNECE standards, because of their relevance in the project.

The LCA results showed that vehicles equipped with DDF systems has lower impact in comparison to vehicle without DDF system (diesel vehicle). Representatively, we show in the following figures the reduction of the tailpipe total GHG (CO₂e) emissions of euro 3 and euro 5 buses equipped with DDF system in comparison to their equivalent diesel vehicles;

The CO₂e reduction is about 23-28 % for Euro 3 buses, 23-25% for Euro 5 buses. Other categories, e.g. fine particulate matter formation, Ozone formation, were evaluated in the LCA assessment and also in that case it was confirmed the environmental benefits of DDF installation.

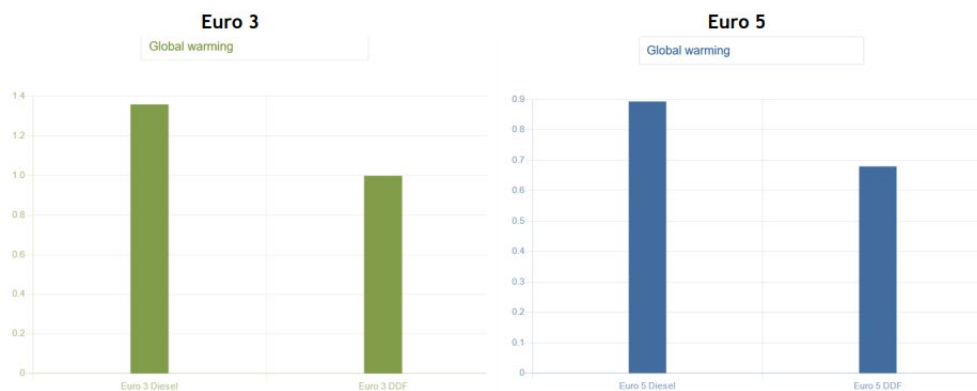


Figure 1: Impact on climate change (CO₂-eq emissions of buses per km). The installation of DDF system on dual fuel buses can further reduce of 26.5% and 23.9% the CO₂-eq associated to diesel for both euro 3 and euro 5, respectively.

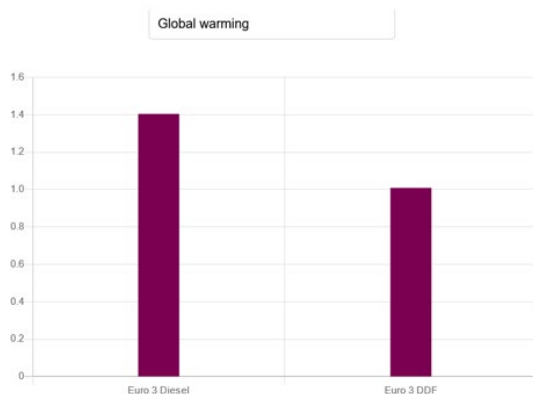


Figure 2 GWP. Bus Euro3-Diesel and Bus Euro3 equipped with the DDF system

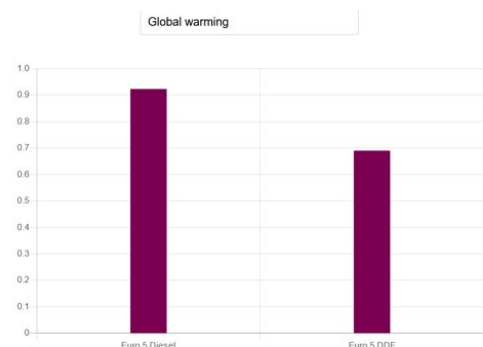


Figure 3. GWP. Bus Euro5-diesel and Bus Euro5 equipped with DDF system

The positive impact is also relevant in the economic aspect generating significant savings. The analysis aimed to assess the costs and consequently the annual economic savings resulting from the application of dual-fuel technology in the sector of M3 vehicles-12 meters in length (Euro 3 and Euro 5) compared to a new diesel vehicle Euro 6 with the same technical features (M3 – 12Meters length). So, finally, the primary objective is to understand, in case of Vehicle's EoL (end of life), if it's better to adopt a revamping solution with the DDF kit or to opt for the purchase of a new diesel vehicle - Euro 6.

For assessing the potential of economic impact, the following aspects can be considered over three years of scenario (2021,2022,2023) and they include:

- Traction costs;
- Purchase costs;
- Refueling costs (in terms of the driver's hourly cost during the refueling's phase);
- Maintenance and technical downtime costs for safety.

Compared to expected results in terms of economic benefits (paragraph 4), the cost evaluation has shown different trends in order to the type of vehicle considered.

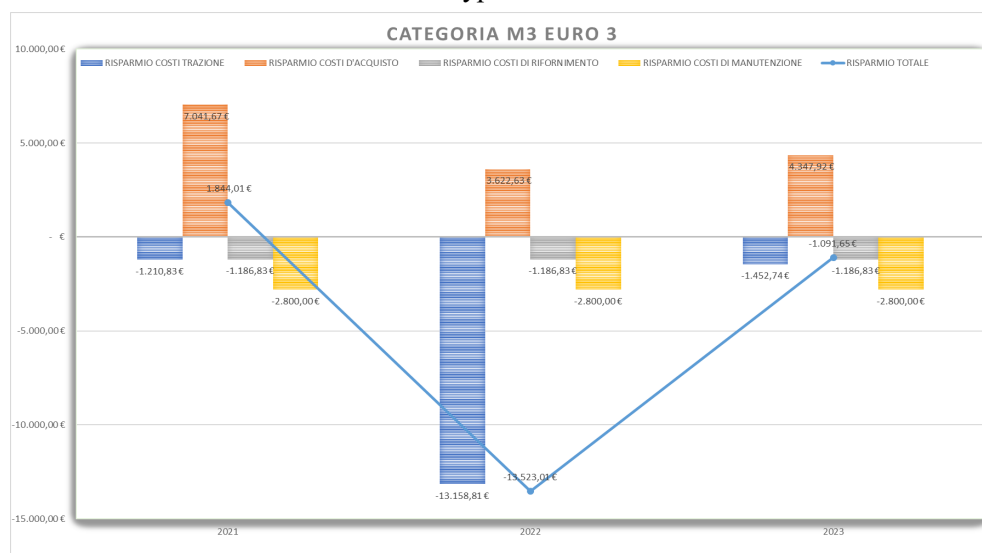


Figure 4: savings over three years of scenario. The economic values reported in the chart above are represented from the point of view of DDF solution installed on vehicle M3 euro 3

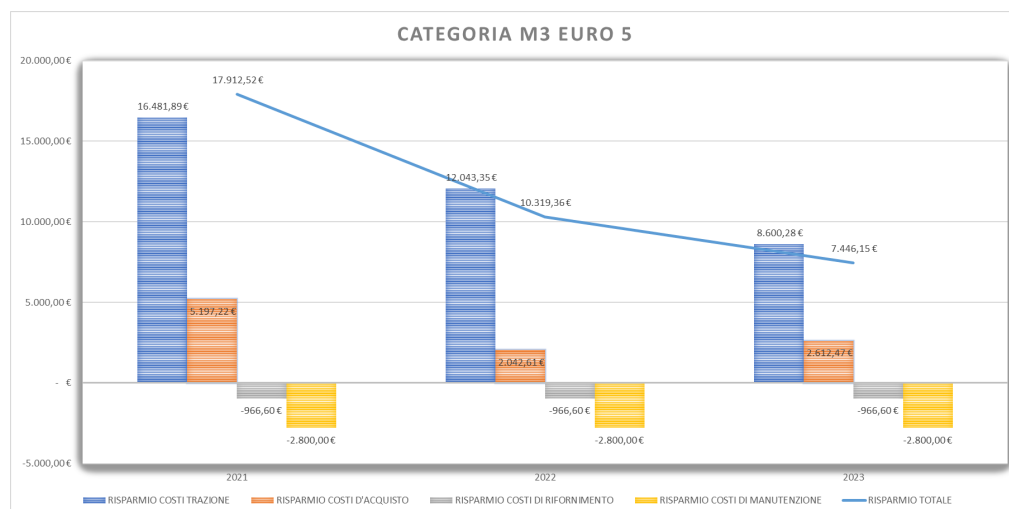


Figure 5: savings over three years of scenario. The economic values reported in the chart above are represented from the point of view of DDF solution installed on vehicle M3 euro 5.

For M3 Euro 3 vehicles, in ordinary market conditions where the price of methane is lower than diesel's price (so it make sense to consider in our final evaluation the most significantly correct, and not altered,

result of year 2021), the only advantage of adopting a dual-fuel kit solution comes from the possibility of extending the old vehicle's EoL, through a small initial investment compared to purchasing a new vehicle, which instead requires a larger financial commitment.

The trend is different for M3 Euro 5 vehicle because the economic benefit, compared to a new vehicle diesel euro VI, is not only related to the limited initial investment in terms of euros paid for the installation of DDF solution, but it also related to the lower fuel consumption and, as a consequence, that means a lower traction costs (the overall economic advantage over three years of scenario, has an average value around 11,000 euros as expected from initial data).

Better and deeper explanation about calculation and results are available in deliverable D15.

Task C1.2 Air quality integrated assessment of the DUALNG technologies in an European region

During the first phase of the project, MAQ system and the CAMx model have been set up for the base case, collecting and processing the input data and assessing the base case scenario.

In particular, the following steps have been performed:

1. Configuration of the modelling system used to perform air quality simulation over the domain under study (Lombardy region);
2. Simulation of the air quality and evaluation of the performances for nitrogen oxides and particulate matter.

Different kinds of outputs (simulation scenarios DUALNG2020 and DUALNG2030) are available in order to visualize and describe the different abatement policies and their impacts.

To both reference scenarios, all heavy vehicles in the Lombardy region are assumed equipped with DUALNG technology.

The introduction of DUALNG equipment leads to an increase of methane consumption and, consequently a reduction of diesel consumption. The simulation of the DUALNG2020 and DUALNG2030 scenarios shows that, as expected, the adoption of DUALNG technology has a significant impact on the annual mean concentrations of PM and NO₂ in the most polluted areas of the Lombardy region.

This is why DUALNG project can be considered a significant player in transition process, covering the time span still necessary for solutions to become technologically and economically mature.

Task C1.3 Socio-economic indicators assessment

The MAQ modelling system above mentioned allows, for each scenario, to estimate the health impacts and external costs associated with PM₁₀ exposure. For instance, the Extern approach (Bickel and Friedrich, (2005)) is applied to compute YLL (years of life lost) through concentration-response functions as:

$$YLL = \sum_{d=1, \dots, D} (S_{CRF} * P_d^c * x_d)$$

Where:

- S_{CRF} is the concentration-response function coefficient for long-term all-cause mortality due to PM₁₀ exposure;
- P_d^c is the population of class c exposed to PM₁₀ concentrations in cell d;
- x_d is the yearly average PM₁₀ concentrations in cell d.

External costs (HC) due to premature deaths are then computed as:

$$HC = YLL * ev$$

Where ev is the economic value associated with YLL in a given area (WHO, 2015).

The simulation of the DUALNG2020 and DUALNG2030 scenarios shows that, as expected the adoption of DUALNG technology is not a decisive factor in improving air quality or reducing premature deaths in Lombardy, but it's a key element (one of the possible options) to achieve climate neutrality and reduce atmospheric pollution.

Task C1.4 Evaluation and compilation of LIFE project performance indicators

We have finalized the inclusion of data into the KPI dataset webtool.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D12	C1	LCA goal, scope, inventory	CSMT	28/02/2021	Accomplished
D13	C1	Update of project performance indicators database (with progress report)	CSMT	31/12/2021	Accomplished
D14	C1	Air quality integrated assessment with scenario elaboration by MAQ tool and health impacts evaluation in the Lombardy Region	CSMT	31/12/2023	Accomplished
D15	C1	Final report, including LCA and LCC and socioeconomic impact of the project actions	CSMT	29/02/2024	Accomplished

N°	Action	Expected Milestone	Responsible	Date	Status
M5	C1	Defined procedures and protocols for LCA data gathering. Definition of baselines for comparison	CSMT	28/02/2021	Accomplished
M9	C1	Availability of LCA results, evaluation of indicators, updating data	CSMT	30/09/2021	Accomplished
M15	C1	Policy report on DUALNG impact on air quality in the Lombardy Region	CSMT	29/02/2024	Not due

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

The results from similar LCA studies should be carefully interpreted as there are many factors that may influence the environmental impacts of road vehicles, such as vehicle characteristics, vehicle age, vehicle maintenance, driving conditions, driver's behaviour, number of starts and stops, speed, total weight (net weight + payload), climate and weather conditions, roads conditions, distance between refuelling stations, and so on.

Due to the lack of reference and harmonised data on the performance and emissions, a further implementation of this study and a deeper analysis (e.g., from PEMS analysis over a higher range of vehicles) are necessary for creating a solid and realistic inventory for the vehicles considered in this study.

Regarding cost evaluation, it should be noted, that the consumption data and, as a consequence, the traction costs for retrofitted vehicles has not been recorded in an ideal scenario: many customer companies have suspended the use of the DDF kit in the last months of 2022, continuing to use the vehicles with original fuel (just diesel) and waiting for a decrease in the price of methane. That means the consumption data collected by the Coordinator and applied for calculations are altered by the terms of use of the vehicles.

ACTION D.1: Dissemination and networking

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
D1	09/2020	09/2020	02/2023	02/2024	CSMT	Accomplished

Activities undertaken and outputs achieved

Task D1.1 Development of the Dissemination and Outreach plan

The Communication & Outreach Plan has been finalized and approved by the Executive Board (already provided Deliverable D19 in the Midterm report).

The Plan has two principal objectives:

1. To define the positioning of communication depending on the specific target groups
2. To communicate efficiently this positioning through a mix of communication instruments, both during the project lifetime and after the project end.

Both BM and CSMT, in synergy also with some relevant actors, were involved in the definition of the Plan which consists of:

- the objectives,
- the definition of detailed actions which are necessary to reach the objectives,
- the channels/instruments to be used in order to reach with efficacy the different target groups,
- and the resources to be dedicated.

A communication strategy has been set up and communication material have been created:

- Logotype
- Leaflet (see task D1.4)
- Letterhead
- Deliverable Template
- Presentation template

Task D1.2 Project website

A specific web page dedicated to LIFE DUALNG project has been implemented within the BM Carrozzerie official website, in order to increase the visibility of the site, making it easy to access for all customers and potential customers of BM Carrozzerie.

The project website (available at <http://www.carrozzeriebm.it/dualng/>) is designed for awareness and dissemination purposes. It represents an important persistent and continuing resource for the interested parties (stakeholders, simple users, developers) in the European Community and abroad.

The site is currently being modified and updated to provide project overviews and highlights; up-to-date information on on-going project results, and the initial dissemination material such as the project factsheet.

It is worth noting that the project's web site, as our main communication channel, describe the goals of the project in a simple language. The administrative structure of the project (deliverables, work packages, etc.) will not be the first impression of the project itself.

Project members have been asked to promote the project website via banners or links on other related websites (project and company websites, etc.).

Some important stakeholders (e.g. Lombardy Mobility Cluster) will promote the project website via link on its website and newsletters.

CSMT and BM have also updated their websites with the DUALNG final event held on February, 2024. The objective was to attract as many participants as possible trough website, social network, newsletters, direct promotion by the president of CLM (Gaboardi) and also the support from “Ordine degli Ingegneri di Brescia”.

Task D1.3 Notice boards and roll-up poster

The notice board has been realized and is visible in the reception of BM Carrozzerie and the affiliated beneficiary CSMT.

All the prototype and new installations came along with LIFE stickers as the pictures below show.



Task D1.4 Project brochure

The project brochure was produced in electronic version and is available for download on the project website.

Task D1.5 Layman's report,

The Layman's report was produced in electronic version. When it will be confirmed from CINEA, after the final stage, we will make it available for download on the project website and We will send it via newsletters of CSMT and CLM to reach the greatest number of contacts and to increase their awareness on DDF technology.

D1.6 Project video

Projected during the final event.

Task D1.8 Dissemination at sector events

- In order to highlight the DUALNG project and its operative area, a specific working group named "Methan and Biomethan" within the "Environmental Sustainability" thematic table has been established by the Lombardy Mobility Cluster. It started on November 11th 2021 and on this date CSMT discussed along with CLM, about the main objectives of DUALNG and the next steps to involve as many stakeholders as possible.
- Further events and working group organized by the CLM in which CSMT and/or BM presented the DUALNG project are the following:
 - 08/09/2021: "Innovation, Environment and sustainable development: the new opportunities of the LIFE programme";
 - 23/09/2021: "Innovation in the materials for the vehicles of the future";
 - 01/10/2021: "Competences for the ecological and technological transition" working group;
 - 14/10/2021: "Connected vehicles and on-board sensors"
 - 28/10/2021: "Electric mobility" working group;
 - 10/02/2022: working group of CLM "environmental sustainable – dualfuel Methane & Biomethane"
- CSMT also attended four events within the Angelo Europeo Master programme in European projects where it has presented several successful LIFE projects including DUALNG as a case study. The dates were 20/09/2021, 29/09/2021, 27/10/2021 and 05/11/2021.
- On October 14th, 2021, CSMT organized a kick-off press conference of the LIFE CROMOZERO project. In the same event DUALNG has been brought to attention.
- An event regarding the LIFE programme organized by Oscar Lancini, member of the European Parliament, took place on September 24th 2021. CSMT has participated to the event and has presented DUALNG project.
- An event regarding the LIFE programme organized by CSMT in collaboration with "Confindustria Brescia", took place on May 20th, 2022: CSMT and BM, have participated both to the event and presented together DUALNG project.
- CSMT organized two webinars on July 22nd 2021 and on September 7th 2021 in which it has presented the structure and the evaluation in LIFE'S projects, and it has presented DUALNG as a successfully case study.
- Finally, during 2021 and 2022 BM participated to several sector events/fairs as:
 - International Bus Expo, Rimini 2021
 - Innotrans, Berlin 2022
 - Futura Expo, Brescia 2022

Task D1.9 Kick-off and Final event

The kick-off event was held on October 23rd. Initially planned on site, it was reorganized a few days earlier as a webinar, following the limitations set for the containment of the COVID-19 emergency. Information and promotional materials were produced (brochures, agendas, templates).

The event was widely publicized (press, local news, newsletters). The Lombard Cluster of Mobility collaborated in the organization and visibility of the event, through its own newsletter and space on the open innovation website of the Lombardy Region.

The event was attended by representatives of institutions:

Brescia Chamber of Commerce, Brescia Confindustria, Brescia Province, Brescia Municipality, Brescia University.

Representatives of freight transport companies association (F.A.I) and public transport companies were present as well; they expressed an interest in involving the demonstration phase of the project.

n. participants: 39

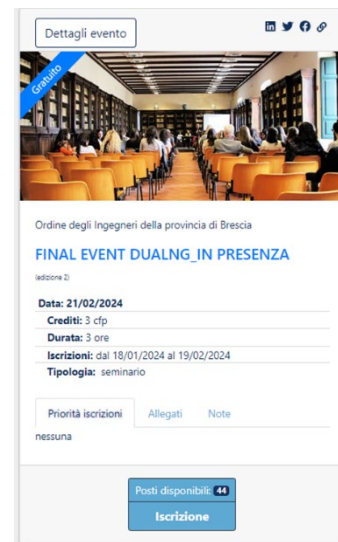
n. gadgets produced: 100 masks / 100 pens / 100 bags / 100 notebooks

n. brochure: 100

During January and February 2024, CMST has organized the Final Event of the project. The Event held on 21st of February 2024, in CSMT Hub.



CSMT and BM have also updated their websites with the DUALNG final event held on February 2024. The objective was to attract as many participants as possible through website, social network, newsletters, direct promotion by the president of CLM (Gaboardi) and also the support from “Ordine degli Ingegneri di Brescia”.



The Event was held both in person and online with a high level of participation especially remotely. About 25 people in person and more than 120 people online.



Task D.2.0 Networking with other projects or initiatives

At the beginning of the project, during the preparatory phase (within 6 months from the start of the project), we have contacted the Coordinators of relevant projects, here below mentioned, and we have organized ad-hoc conference calls (this will minimize travel costs)

LIFE CAT4HEAVY

A first web call with LIFE CAT4HEAVY project was held on February 2nd, 2021, in order to identify common interests and objectives. It was agreed to deepen the discussion as soon as the data of the experiments carried out in the two projects are available. Furthermore, the aim was to organize a shared event.

BIOMASS HUB

BIOMASS HUB is one of the 33 projects with a very high rate of innovation winners of the Lombardy Region call for "Call Hub Research and Innovation". The project proposes innovative systems, materials, technologies for the waste-management chain through the synergy between renewable energy and green chemistry or the creation of a biorefinery for the integrated production of biofuels, biomethane, energy, fertilizers and biomaterials.

Among the objectives of the project is the experimentation of new technologies and materials for the efficient production of energy from biogas and biomethane.

In addition, in order to highlight the DUALNG project and its operative area, a specific working group named "Methane and Bio-methane" within the "Environmental Sustainability" thematic table has been established by the Lombardy Mobility Cluster (LMC). It started on 11/11/2021. Further events and working groups arranged by the LMC in which CSMT presented the DUALNG project are the following:

- 08/09/2021: "Innovation, Environment and sustainable development: the new opportunities of the LIFE programme";
- 23/09/2021: "Innovation in the materials for the vehicles of the future";
- 01/10/2021: "Competences for the ecological and technological transition" working group;
- 14/10/2021: "Connected vehicles and on-board sensors"
- 28/10/2021: "Electric mobility" working group;
- 10/02/2022: "Environmental sustainability - WG dual fuel - methane and biomethane".

Further technical meetings (at least 3) with experts and representatives of local/regional public bodies involved in the LMC - Lombardy Mobility Cluster - have been also arranged/scheduled by mid 2023.

During years 2022 and 2023, after COVID shadow, we have intensified, all the dissemination and networking activities. In particular, in the second quarter of 2023, we had meetings with the coordinators of other relevant projects, organizing a specific video call for each project.

We have planned to resumed contacts with project's coordinators that we have been already get in touch in the past. But we have also planned to establish new connections with other projects (for example: LIFE GYSTRA, LIFE STEAM, LIFE OPERA, LIFE SAVE).

Networking with other life projects: resumed contacts here below

Project name	Undertaken action	Follow-up
LIFE CUT4HEAVY	We just reconnected with sakkasdin@yahoo.gr to request availability for an exchange of information about the status of the respective projects. We set up a second video call on the 9th of March 2023.	try to merge the technology of the 2 projects with one APAM vehicle

LIFE REPAIR	We reconnected, at the beginning of March 2023, with the contact person of the project (Katia.Raffaelli@regione.emilia-romagna.it) to request availability for an exchange of information about the status of the respective projects.	n/a – no reply
LIFE ECOTRAVID	We reconnected, at the beginning of March 2023, with the contact person of the project (pcuny@groupcls.com) to request availability for an exchange of information about the status of the respective projects.	n/a – no reply
LIFE NEW HYTS	We resumed contact, at the beginning of March 2023, with the contact person of the project (Daniel.Bakker@kwrwater.nl) to request availability for an exchange of information about the status of the respective projects. We have planned a video call on April 4th, 2023.	We made a video call with Slaats Nellie and Bakker Daniel to get to know the projects and we talk possible and/or meeting and sharing data of the project results. Shared publication to compare the technology dual-fuel (natural gas-diesel and hydrogen-diesel) or compare the business cases.
LIFE IP North-HU-Trans	We resumed contact, at the beginning of March 2023, with the contact person of the project (eszter.kiss@tim.gov.hu) to request availability for an exchange of information about the status of the respective projects.	n/a – no reply
LIFE NINBUS	We resumed contact, at the beginning of March 2023, with the contact person of the project Oriol Casal Valls (oriol.casal@cetaqua.com) to request availability for an exchange of information about the status of the respective projects.	n/a – no reply
LIFE LANDFILL BIOFUEL	We have reconnected with the contact person of the project (sunil.arjandas@fcc.es) to request availability for an exchange of information about the status of the respective projects. We have planned a video call on April 28th, 2023.	We made a video call with Arjandas Arjandas Sunil and Simorte Gancedo Maria Teresa to get to know the projects. We try to activate the connection with the consorzio of biomethane in Brescia in order to have a synergy.

Networking with other life projects: the establishment of new connections.

Project name	Undertaken action	Follow-up
LIFE GYSTRA	We contacted Dr. M. Dolores Hidalgo (dolhid@cartif.es), the contact person for the project, to set up a meeting to deepen the knowledge of our respective	n/a – no reply

	projects and understand if there is any further cooperation chance.	
LIFE STEAM	We contacted Dr. Davide Nascetti (davide.nascetti@gruppohera.it), the contact person for the project, to set up a meeting to deepen the knowledge of our respective projects and understand if there is any further cooperation chance. We planned a video call on March 27 th 2023.	We made a video call with Davide Nascetti and Stefano Longo to get to know the projects and we talk in the future for possible collaborations and/or meeting.
LIFE OPERA	We contacted Dr. Eriberto De Munari (edemunari@arpa.emr.it), the contact person for the project, to set up a meeting to deepen the knowledge of our respective projects and understand if there is any further cooperation chance.	They replied (2023, March 17 th) by mail while considering the technologies for abatement of pollutants within it, it has no intention of applying or verifying new technologies because it is concerned exclusively with finding the optimum between costs and expected results based on currently regulated technologies.
LIFE SAVE	We contacted on March 2023 Dr. Enrico Bianconi (enrico.bianconi@it.mecaprom.com), to set up a meeting to deepen the knowledge of our respective projects and understand if there is any further cooperation chance. We planned a video call on March 23 rd 2023 with Gregorio Iuzzolino (gregorio.iuzzolino@advanced-techno-solutions.com).	We made a video call with Gregorio Iuzzolino, Gianfranco Rizzo and Serena Pizzi to get to know the projects and we talk in the future for possible collaborations given the common interests (possible collaboration with Cluster Lombardo della Mobilità). The Prof. Gianfranco Rizzo shared articles of his work on LCA analysis.

As already reported in Action B2, the CB has expanded its commercial network also thanks to the opening of a new branch in Abruzzo region (southern Italy) in order to serve the local market, interested in the dual-fuel technology.

The new branch is located in Abruzzo's region, because the main customers (TUA Abruzzo & ATM Molise), involved in the project to support and increase the dual-fuel commercial network, are based in the South of Italy. This new opening was used to get geographically closer to all the stakeholders who had shown interest in dual-fuel kit, through letters of support and commercial agreement.

The 50% (11/21) of retrofitted vehicles, is purchased from TUA Abruzzo & ATM Molise.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D18	D1	Website	BM	31/12/2020	Accomplished

D17	D1	Kick-off workshop event	BM	31/12/2020	Accomplished
D19	D1	Dissemination and Outreach Plan	CSMT	28/02/2021	Accomplished
D20	D1	Final report on dissemination and outreach activities	CSMT	29/02/2024	Accomplished
D21	D1	Final Final workshop	BM	29/02/2024	Accomplished
D22	D1	Layman's report	CSMT	29/02/2024	Accomplished
D23	D1	Project video	BM	29/02/2024	Accomplished

N°	Action	Expected Milestone	Responsible	Date	Status
M2	D1	Project website is operating	BM	31/12/2020	Accomplished
M6	D1	Networking with relevant stakeholders and other projects	BM	31/03/2021	Accomplished
M11	D1	Verification of stakeholders involvement (participation to events, feedbacks of networking activities)	BM	31/12/2020	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

The main problems are related to the organization and participation in events, fairs, seminars, which have all been cancelled due to the COVID emergency (at the beginning)

ACTION E.1: Project management

Action N.	Scheduled start date	Actual start date	Scheduled end date	Actual end date	Responsible	Status
E1	09/2020	09/2020	02/2023	02/2024	BM	Accomplished

Activities undertaken and outputs achieved

Task E1.1 - Administrative and financial management

Administrative and financial management is in charge to Mrs Elvira Bandera (BM Carrozzerie), who coordinates the activities together with all the people involved in the project. Anna Frascarolo is the appointed financial manager in CSMT. Due to maternity leave and her subsequent resignation from CSMT Anna Frascarolo's employee has been definitely replaced in the organization chart by Greta Consoli.

A dedicated accounting system has been implemented by identifying the project costs in the analytical accounting system used by BM and CSMT.

Costs approval follow the general procedures used in the companies. For the time recording of working hours we use both electronic system. The hours are registered regularly on daily basis, then submitted and approved monthly by the direct Supervisor of employee involved in the project .

We ensure that all invoices (both electronic or paper) contain a clear reference to the LIFE project when requesting the quotation to the supplier. When this does not happen the invoices are stamped in order to show the link to the LIFE project, furthermore the invoice can be uniquely tracked in our accounting system and it is linked to the order.

Task E1.2 – Project monitoring and Milestone review

The project Management Team has been defined and described in the deliverable D24 “Management procedures”.

An internal KO meeting to start and plan works was organized on 05/08/2020 in which all the key figures involved in the project took part: technical, financial, commercial and administrative. The Project Manager and the Project Manager Assistant constantly monitor the progress of the project with respect to the work plan presented.

Anna Frascarolo and Francesco Bandera participated in the Welcome meeting organized by EASME on 7th and 8th October 2020.

Expected results, deliverables and milestones of the action

N°	Action	Expected Deliverable	Responsible	Date	Status
D24	E1	Management procedures	BM	31/12/2020	Accomplished
D25	E1	Partnership agreement	BM	31/12/2020	Accomplished
D26	D1	After-LIFE plan	BM	29/02/2024	Accomplished

Major problems / drawbacks encountered and deviations of the action plan, including consequences for other actions

No relevant problems have been encountered.

6.2. Main deviations, problems and corrective actions implemented

The main problems encountered during the projects were technical, financial, related to the market gas price and finally related do the unexpected pandemic situation.

The risk with the highest impact on the project is represented by the quick rise of natural gas price experienced in the last months, which affect the scouting of new customers and installation of the retrofitting kit as well.

Another relevant problem is related to BM main target groups, which now are represented almost exclusively by public transport companies. Following the spread of the virus, these companies, which initially were really interested in DDF technology, have become more reluctant to install the retrofitting kit as they faced many problems related mainly to emerging new safety protocols.

Here below a schematic table explaining the main deviations, they related impacts and the corrective actions taken when necessary.

Deviation/Risk Description	Action involved	Impact	Corrective action implemented
Significant increase in gas price, which is causing, along with the pandemic, an important uncertainty in the market and therefore among our clients which would install the DDF kit.	Whole project	High	Better focus on our main target groups which represent mostly by public transport company. More widespread dissemination campaign and lobby action in order to reach more clients.
The testbed, which was expected in the proposal, is not being purchased nor utilized as the end-users have demonstrated to have a strong preference for making road test instead of static tests	B1	minimum	The team purchased and installed useful tools for measuring power and road dynamic simulation in HDVs. This has permitted to verify the operation of the vehicles under normal operating conditions, dynamic diagnosis and tuning. Supplementary human effort was necessary in order to run those tests.
All the safety requirements for the specific working area for the installation of the DDF were no longer necessary since the installation takes place in the complete absence of methane and therefore does not require special systems for gas treatment.	B3	none	no corrective action necessary
A further implementation of LCA study based on more specific data (e.g., from PEMS analysis) is necessary due to the lack of reference and harmonised data on the performance and emissions for creating a solid and realistic inventory for the vehicles considered in this study (M3 and N3 category).	C1	medium	Necessary collect and process all the data monitored during the project.

6.3. Evaluation of Project Implementation

Methodology

The workplan was affected by a slowdown in retrofitting activities: the covid-19 pandemic, the outbreak of the conflict between Russia-Ukraine, the increase of gas price, and lastly the state incentives/funds to the purchase of new vehicles with alternative traction (electric traction and hydrogen experimentation), had caused delays in dissemination activities (public events) and in the advancement of vehicle conversions, The initial purpose was to achieve the objective of 50 retrofitted vehicles until the end of the project and so, after the midterm report, a 12-month extension was requested to overcome that difficulties.

The realization of prototypes and inherent technical issues in B1 encountered technical problems, which have been successfully overcome. In order to prompt all the other correlated activities, BM' staff was deeply engaged in all areas: technical office, quality insurance, quality control, marketing and management areas.

We have exploited in the project the internal procedures and protocols used in our company. We own several international certifications (SQS ISO 9001, UNI EN ISO 3834-2:2006, OICQ, CODICE ETICO 231) which bounds us to follow either in production and development standard methods and regulated procedures. The general approach and the methodology set-up by our Technical Director and Project Leader was robust and it was followed with success since the very beginning. Besides, we worked very well together and intensively with our external consultants which were selected according with standard company selection procedures. The same procurement procedures, which take into account green principles and "best value for money" rule, were applied for selection of expensive items and services. Globally, the consolidate cost reporting is in line with the budget even if costs linked to the coordinator are lower than foreseen values. Actually, despite the number of installations achieved by the end of the project are 21 instead of 50, the low standardization of installation processes and the elevated number of hours required to train personnel for the kit's installation and maintenance, led to a nearly full compensation of personnel costs.

Results achieved

Action	Foreseen in the revised proposal	Achieved	Evaluation
B.1	<p>Objectives: Optimization of the DDF conversion kit with functions that allow for on-line real-time monitoring of fuel consumption and emissions and optimize the installation method and system to get ready for demo campaign to be performed in B2.</p> <p>Expected results: Optimization of the DDF installation system. Acquisition of data on savings achievable in ideal and real conditions on the two installed prototypes.</p>	Completed	<p>Very satisfactory The Action B1 has been implemented as in the workplan. with no major deviations until now. The expected prototypes have been designed, developed and tested.</p> <p>Deliverables D1 (Release of the first 2 prototype vehicles CNG e LNG) and D3 (Report on the optimization of the DDF system and results on savings achievable in ideal and real conditions on the two installed prototypes) have been released on time; detailed results about the prototypes and the tests are reported therein.</p> <p>Shortcomings The testbed, which was expected in the proposal, is not being purchased nor utilized as the end-users have demonstrated to have a strong preference for making road test instead of static tests.</p>

B.2	<p>Objectives: Implement the demonstration project on a statistically significant and representative number of vehicles, by installing the kit on 50 HDV vehicles (either buses, trucks or vans) and perform a data collection campaign over 24+12 of duration's extension months in order to validate the dual-fuel technology on real-scale road tests.</p> <p>Expected results: Installation of the DDF retrofit kits on 50 vehicles and analysis of Diesel fuel savings with data obtained by road tests in different conditions of use (urban road, extra urban road, city roads, mixed routes, etc.).</p>	Completed	<p>Quite satisfactory 21 vehicles have been retrofitted by the end of the project. Although the heavy vehicle fleet available for the monitoring impact activity was lower than the initial objectives foreseen in the project, it is confirmed that the evaluation of the results obtained is methodologically established and appropriate to this DUALNG study case</p> <p>Shortcomings due principle to: -the COVID pandemic; -the increase of gas price; -the PNRR which brought attention and funds to the purchase of new vehicles with alternative traction, retrofitting with electric traction and experimentation on hydrogen vehicles.</p>
B.3	<p>Objectives: Development of industrial capacity. This mainly include two different tasks, the first is related to tangible asset management (i.e. industrial infrastructures and equipment) the second one is related to intangible assets such as: specialized technical staff training, empowerment of our customer support service to meet the needs of our final clients, empowerment of BM commercial network for boosting the sale of dual-fuel technology.</p> <p>Expected results: development of an adequate infrastructure for the installation of the retrofit kit and training of personnel adequate to comply with the safety regulations on natural gas. Training of qualified personnel, development of customer service and business acceleration.</p>	Completed	<p>Very satisfactory The retrofit processing area of vehicles is being created and all the related technical devices and systems developed as expected.</p> <p>Regarding the training, BM have carried out a course for installation and maintenance of the system. To each Customers, BM gives a user and maintenance manual prepared for installation with a maintenance course for the retrofit system.</p> <p>Shortcomings It was decided to undertake the development of a new shed. This new activity was not actually foreseen in the application form. Nevertheless, it was considered to add value to the project.</p>
B.4	<p>Objectives: - Prepare the Business Plan of the "close-to-market" project.</p>	Completed	<p>Very satisfactory The activities were completed.</p>

	<ul style="list-style-type: none"> - Take contacts and/or sign cooperation agreement with commercial partners to scale-up the market and replicate the installations in other geographic areas (e.g. neighbour regions of Lombardy) - Draft a position paper on DualLNG technology, to serve for briefing policy makers and authorities in charge to review regulations - Perform lobby actions, in cooperation with the Lombardy Mobility Cluster, towards the Regional authorities, to promote possible Regional incentives programmes for HDV retrofitting by dual-fuel technologies. <p>Expected results:</p> <ul style="list-style-type: none"> - 2 or 3 cooperation agreements to be signed with commercial partners to scale up the market; - About 10 agreements/contracts with new clients for the retrofit of their heavy duty vehicles (beyond the 50 retrofit as in Action B.2). 		<p>In May 2021, the birth of a new branch in the Abruzzo region has allowed BM carrozzerie to give a further boost to the sale of dual fuel retrofitted kits.</p> <p>The new branch is located in Abruzzo's region, because the main customers (TUA Abruzzo & ATM Molise), involved in the project to support and increase the dual-fuel commercial network, are based in the South Italy. This new opening was used to get geographically closer to all partners who had shown interest in dual-fuel kit, through letters of support and commercial agreement.</p>
C.1	<p>Objectives: Monitor and evaluate direct and indirect impacts of the DUALNG project in an environmental and socio-economic perspective.</p> <p>Expected results: The Life Cycle Assessment (LCA) will deliver a detailed environmental profile of the dual-fuel technology for vehicle retrofitting compared to competing scenarios (eg, vehicle dismantling). A report on air quality integrated assessment and socio-economic impacts assessment is also expected to be produced. In this respect, the expected final deliverable will hence analyse the socio-economic impact indicators such as: i) economic benefits, ii) employment, iii) ecological impact, iv) social benefits deriving from reduced air pollutant emissions, v) degree of social awareness and acceptance of the new dual-fuel solution.</p>	Completed	<p>Quite satisfactory All main steps to monitoring the environmental and economic impacts have been carried out</p> <p>Shortcomings Due to the lack of reference and harmonised data on the performance and emissions, a further implementation of this study and a deeper analysis (e.g., from PEMS analysis over a higher range of vehicles) are necessary for creating a solid and realistic inventory for the vehicles considered in this study.</p> <p>Regarding cost evaluation, it should be noted, that the consumption data and, as a consequence, the traction costs for retrofitted vehicles has not been recorded in an ideal scenario: many customer companies have suspended the use of the DDF kit in</p>

			the last months of 2022, continuing to use the vehicles with original fuel (just diesel) and waiting for a decrease in the price of methane. That means the consumption data collected by the Coordinator and applied for calculations are altered by the terms of use of the vehicles.
D.1	<p>Objectives: This action aims at widespread dissemination, communication and promotion of the DUALNG project and its results. Proactive activities will be performed for stakeholders engagement, networking and links with relevant initiatives.</p> <p>Expected results: Project website, Dissemination materials (boards, leaflets, technical brochures, etc). Presentation of the project at international exhibitions with demos, showcases and workshops. Communication and media activities on all possible physical/digital channels. Networking with other projects or initiatives, and involvement of stakeholders. Briefing to policy makers and relevant stakeholders.</p>	Completed	<p>Very satisfactory Dissemination material, media activities and networking activities were well organized according to the work planned.</p> <p>Minor Shortcomings The kick-off event, initially organized in a prestigious location and with the expected display of a prototype, was suddenly changed into a webinar due to limitations imposed for the COVID emergency just a few days before the event.</p>
E.1	<p>Objectives: Coordinating and managing properly this LIFE project from the technical, economic, administrative point of view.</p> <p>Expected results: Good technical, administrative and financial management and periodic monitoring of milestones and progresses.</p>	Completed	<p>Very satisfactory Management has worked well according with our expectations. The Team was strong and collaborative. Regular meetings helped in detecting promptly the emerging difficulties and there was a good cooperation with our consultants.</p>

Visible and projected results

BM Carrozzerie puts lot of emphasis on the visibility of the projects results. Public results and progresses of the project are visible on the DUALNG website.

Technical results of road tests of the two prototypes and of retrofitted vehicles will be available, in the form of graphs and summary tables, on the DUALNG website.

Another result which is visible is the preliminary LCA study which was performed in preparation of the full assessment that will be done by the end of the project. After the final stage, after the validation of CINEA, we will upload the final results of LCA study.

Project amendments

After the Mid-term report, it was requested a project's prolongation to meet the projected results. The end date was postponed from 02/2023 to 02/2024.

Results of the replication efforts

Replication and transfer actions (B4) were completed.

The results of the replication efforts have investigated strategies for promoting sustainability in mobility, underscoring the importance of maintaining "technological neutrality" to safeguard a century's worth of automotive knowledge. The exploration covered a spectrum of alternatives, with a specific focus on biofuels.

Methane and Biomethane emerge as pivotal contributors to decarbonizing the road transport sector, enabling an affordable transition and contributing to a circular economy. Their utilization not only makes existing and new infrastructure economically viable but also aligns with immediate priorities such as environmental sustainability, cost-effectiveness, reliability, and operational adaptability. Consequently, promoting the advancement of methane/biomethane in road transportation is crucial.

This comprehensive approach includes encouraging the use of fossil-free bio-fuels, through incentives and favourable excise duties, incentivizing the acquisition of methane-powered vehicles across various types, supporting retrofit solutions for Dual Fuel conversions and addressing gaps in the national CNG/LNG station network.

This encompasses promoting investments in new facilities through subsidized financing and incentives, especially along highways, key intersections, and in regions where infrastructure is currently insufficient.

Effectiveness of the dissemination activities

BM and CSMT made all possible efforts to promote the project and present the results to the target audience, despite obstacles incurred during project development.

The media dissemination, communication and networking activities were organized according to the work planned.

The kick-off event was successful in terms of participation and media coverage; several articles have been published on local paper and on-line technical journals. The local television channel has broadcast a report dedicated to the event and the DUALNG project.

The DUALNG projects, objectives and first results have been presented in several webinars and seminars, as listed in the activity D1.

Final results, as well, were presented in the final event where 120 people have participated online and in presence.

Policy impacts

The DUALNG project has several policy implications:

- Briefing the **Regional Authorities** (and subsequently the Italian Ministry and the EC-DG ENV) about the positive effect of DDF retrofit on the reduction of HDV engine emissions (opportunity to grant both exceptions to traffic restrictions to DDF retrofitted vehicles and also to set up opportune incentive programs).
- Strategic relevance in terms of European clean transport initiatives. Today, transport still relies on oil for 94% of its needs.
- Improving the knowledge base for the development, implementation, assessment, monitoring and evaluation of Union environmental policy actions that will improve how current legislation on HDVs is applied;
- Integrating the transport policies and regulations (Reg. (EC) 692/2008) with industrial emissions policy (Directive 2010/75/EU) and air pollutant regulations (AQD 2008/50, NECD 2016/2284).
- Projects like DUALNG can also contribute to boost the development of blue infrastructures through the Union. In fact, the retrofit market is clearly one of the most important issues ongoing regarding development of the transition from diesel to gas as a fuel for trucks.

CSMT is responsible for elaborating a position paper on the DualLNG technology, to serve for briefing policy makers and authorities in charge to review the regulations. It was produced in electronic version. When it will be confirmed from CINEA, after the final stage, we will make it available for download on the project website, in addition to Leyman's report and thanks to CLM we are going to make it available to several authorities.

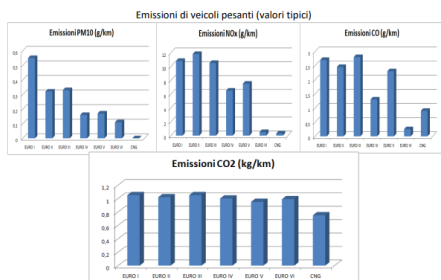
Below you will find an extract from the position paper on methane and biomethane, signed in 2021 by the Cluster and various national associations.



POSITION PAPER SU METANO - BIOMETANO

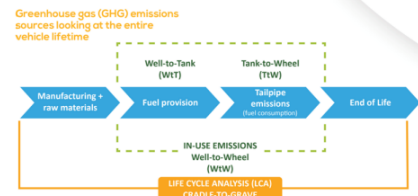
1 Una soluzione consolidata e in continua evoluzione

- 1.1 Il settore della mobilità sostenibile riserverà una pluralità di trazioni, ciascuna per una missione elettiva, con vantaggi e svantaggi nel ciclo di vita relativamente a **Prestazioni – Impatto Ambientale – TCO (Total Cost of Ownership)** che include anche il recupero/smaltimento).
- 1.2 I carburanti tradizionali "fossili" hanno oggi circa l'89% del mercato (fonte UE/EFTA) ed una diffusione universale per logistica di produzione, rifornimento e assistenza tecnica ai veicoli. Secondo tutti gli esperti internazionali non è pensabile che, a livello globale, questi carburanti tradizionali possano venire sostituiti "in toto". **Motori diesel e benzina dureranno ancora per anni, sia nel trasporto passeggeri che merci**, anche per le note caratteristiche di economicità e affidabilità dei veicoli, oltre che per la rete di rifornimento e manutenzione.



livello locale) e la decarbonizzazione, come ad esempio il biometano, l'energia elettrica da fonti rinnovabili o l'idrogeno verde.

- b. La produzione industriale di veicoli, componenti importanti (ad esempio le batterie) ed impianti deve essere affrontata con una logica allargata del tipo **Life Cycle Analysis** (vedi figura sotto riportata), che tiene conto di tutte le fasi che vanno dall'estrazione delle materie prime fino al recupero e smaltimento finale (dalla culla alla tomba): ad esempio, le prime analisi effettuate dal Politecnico di Milano hanno evidenziato che i veicoli elettrici, con gli impatti a monte legati alla raccolta, trattamento e trasporto di litio e terre rare e a valle per lo smaltimento di batterie e motori, presentano vantaggi e svantaggi economici, ambientali e sociali che richiedono ulteriori approfondimenti.



- c. Gli investimenti, soprattutto pubblici, per la realizzazione di reti/stazioni di rifornimento, devono essere coerenti con le capacità di diffusione delle tecnologie e portati avanti con coerenza rispetto alle politiche avviate, come nel caso delle reti di rifornimento LNG/CNG.
- 4.3 In questo contesto, per la capacità di dare risultati immediati rispetto ai temi di sostenibilità ambientale, costi di investimento ed esercizio, affidabilità e flessibilità d'uso, è importante favorire lo sviluppo del metano nei trasporti stradali in Italia:
 - a. nelle sue varie versioni (CNG per le automobili e i veicoli urbani e LNG per veicoli merci e autobus extraurbani), favorendo soprattutto:
 - L'uso del bio-metano (privo di emissioni di CO2 fossile) attraverso incentivi alla sua produzione e acisce favorevoli al consumo;
 - L'acquisto di veicoli a metano (automobili, furgoni, camion e autobus) attraverso incentivi;
 - Lo sviluppo dei retrofit per le auto e per i veicoli pesanti trasformati a Dual Fuel attraverso incentivi e altre forme di sostegno*.

The evolution of the position paper led to the creation of the Notebook on renewable fuels which is now a part of the Manifesto of the Lombardy Region.

* Ad esempio il progetto europeo DualNG sostenuto dal Cluster Lombardo Mobilità e finanziato con i fondi LIFE.

Describe how the project delivered the results foreseen in the Grant Agreement form B3 "EU ADDED VALUE OF THE PROJECT AND ITS ACTIONS". In addition, if in the Grant Agreement Form B1, the project has been labelled as significantly climate related and/or biodiversity related, cover these elements as well.

As reported, in the Grant Agreement in form B3, the DUALNG project aims to bring to the market a disruptive technology for HDV retrofitting based on the use, at least in part, of alternative fuels i.e. natural gas. These are two main objectives in the “air quality” priority area of the LIFE Sub-programme for Environment, which aims at sustainable road transport mobility for reduction of air pollutant emissions.

The achievement of the objectives reported above, has been carried out thanks to two levels of in-depth studies:

1) *the LCA (Life Cycle Assessment):*

this study’s results showed that vehicles equipped with DDF systems has lower impact in comparison to vehicle without DDF system (diesel vehicle). Representatively, the study shows the reduction of the tailpipe total GHG (CO₂e) emissions of euro 3 and euro 5 buses equipped with DDF system in comparison to their equivalent diesel vehicles; The CO₂e reduction is about 23-28 % for Euro 3 buses, 23-25% for Euro 5 buses;

2) *Air quality integrated assessment of the DUALNG technologies in an European region:*

through MAQ system and the CAMx model, different kinds of outputs (simulation scenarios DUALNG2020 and DUALNG2030) are available in order to visualize and describe the different abatement policies and their impacts.

To both reference scenarios, all heavy vehicles in the Lombardy region are assumed equipped with DUALNG technology.

The introduction of DUALNG equipment leads to an increase of methane consumption and, consequently a reduction of diesel consumption. The simulation of the DUALNG2020 and DUALNG2030 scenarios shows that, as expected, the adoption of DUALNG technology has a significant impact on the annual mean concentrations of PM and NO₂ in the most polluted areas of the Lombardy region.

6.4. Analysis of benefits

1. Environmental benefits

Euro 3

The analysis shows a lower GWP of the vehicle equipped with the DDF system (reduction of about 28.2%), lower fine particulate matter formation (reduction of 74%) and ozone formation (about 79.5% for Ozone formation, Human health and 79.2% Ozone formation, Terrestrial ecosystems). The lower impacts of the vehicle equipped with the DDF system are mainly because of the lower CO₂, CO, NO_x and PM 10 emissions during vehicle operation.

Euro 5

The analysis shows a lower GWP of the vehicle equipped with the DDF system (reduction of about 25.3%), lower fine particulate matter formation (reduction of 66.4%) and ozone formation (about 68.4% for ozone formation, Human health and Ozone formation, Terrestrial ecosystems). The lower impacts of the vehicle equipped with the DDF system are mainly because of the lower CO₂, CO, NO_x and PM 10 emissions during vehicle operation. This shows that Dual fuel buses equipped with the DDF system have a positive impact and contribute to the to the reduction of the climate change and other environmental and health issues.

The installation of the DDF system on dual fuel buses can reduce of 26.5% and about 23.9% the CO₂-eq associated to diesel for both Euro 3 and Euro 5, respectively. This shows that Dual fuel buses equipped with the DDF system have a positive impact and contribute to the to the reduction of the climate change.

2. Economic benefits

Benefits for the end-users

Main buyers of the DualLNG system will be owners of HDVs (trucks and buses), either public or private entities, for which we can show the convenience of the installation of the DDF kit to extend the useful life of the vehicle and – importantly – save fuel costs to pay-back the investment.

A bus driver that travels 105,000 km/year, can benefit a significant average annual savings, over three years of scenario.

The savings' trend is particular meaningful for M3 Euro 5 vehicle because the economic benefit, compared to a new vehicle diesel euro VI, is not only related to the limited initial investment in terms of euros paid for the installation of DDF solution, but it also related to the lower fuel consumption and, as a consequence, that means a lower traction costs (the overall economic advantage over three years of scenario, has an average value around 11,000 euros, as expected from initial data).

Here below, we have summarized benefits and drawbacks of the different solutions proposed and analysed through cost evaluation.

Solution proposed	Benefits	drawbacks
new diesel euro VI	<ul style="list-style-type: none"> • mature and consolidated technology; • reduced maintenance costs due to the already known technology. 	<ul style="list-style-type: none"> • technological adaptations to comply with EuroVII regulations; • despite the state incentives, a large economic investment is required, at the Eol, after 10/12 years, for the purchase of the new vehicle which replaces the old one; • declining social acceptability due to high sensitivity to environmental sustainability and energy efficiency issues.
euro 3 and euro 5 with DDF kit	<ul style="list-style-type: none"> • lower traction costs due to use/mix alternative fuels less expensive and less polluting (in and ideal scenario); • increasing in social acceptability that comes from issues raised during the actual energy transition period; • DDF technology requires a few structural investments (just the kit and its installation) 	<ul style="list-style-type: none"> • Low increasing in maintenance costs due to DDF kit installation ; • state incentives are addressed to the new alternative fuel, as hydrogen, electricity etc., to reach the goal of 45% emission's reduction by 2030 and net zero decarbonization until 2050; • lack or reduction of market share potentially interested in DDF technology due to high technological turnover.

	<ul style="list-style-type: none"> • adaptability: the DDF kit can be dismantled from one vehicle and reassembled on another one. 	
--	--	--

Benefits for BM Carrozzerie

Action B4 includes a specific task to better define a detailed Business Plan, on the basis of project outcomes and their validation at suitable scale.

We have analysed the BP economics: revenue streams, the cost structure analysis, forecasted investments including a depreciation plan and its timeframe, the projected evolution of production capacity. Costs have been carefully analysed by taking into account all fixed and variable costs, e.g.: raw materials and consumables, logistics & transportation costs; DDF kit installation direct costs, maintenance extra costs, direct and indirect personnel including more specifically sales and after-sales. Working capital analysis and financial analysis (i.e. analysis of required financial mix and sources) were done. The projection of revenues, margin and return of investment (ROI) were analysed for the 5 years after the end of the project.

Thanks to the support of C2M, we have finalized the Business Plan (deliverable D9) and we received their approval in April 2023.

3. Social benefits

The reduction in PM2.5 and NO2 concentrations leads to a reduction on attributable deaths due to long exposure on pollutant concentrations. Attributable deaths per province per 100000 population are summarized in the tables below. The uncertainty interval, represented by estimated values in brackets, is calculated by considering both the uncertainty on Relative Risk and Artificial Neural Networks.

PM2.5 Attributable Deaths per 100k inhabitants				
NUT3	CLE2020	DUALNG2020	PREAC2030	DUALNG2030
Varese	75 (61-88)	74 (61-87)	66 (54-77)	65 (53-76)
Como	85 (69-100)	83 (69-98)	74 (61-87)	72 (59-85)
Sondrio	29 (23-34)	28 (23-33)	23 (19-27)	22 (18-26)
Milano	106 (87-124)	106 (89-125)	99 (82-116)	97 (80-114)
Bergamo	66 (54-77)	65 (54-77)	53 (44-63)	53 (44-63)
Brescia	94 (77-111)	94 (78-110)	79 (65-93)	78 (64-92)
Pavia	137 (113-161)	137 (114-160)	132 (110-155)	132 (108-154)
Cremona	112 (92-131)	112 (93-131)	94 (77-110)	93 (76-109)
Mantova	126 (103-148)	125 (104-146)	114 (94-134)	113 (93-132)
Lecco	70 (57-83)	69 (58-82)	61 (50-71)	60 (49-70)
Lodi	116 (96-136)	116 (97-135)	102 (85-120)	101 (83-118)

Table 1 Annual number of attributable deaths per provinces and per 100k inhabitants due to PM2.5 exposure

NO2 Attributable Deaths per 100k inhabitants				
NUT3	CLE2020	DUALNG2020	PREAC2030	DUALNG2030
Varese	37 (10-64)	35 (7-60)	29 (6-51)	28 (6-49)
Como	37 (10-64)	36 (7-61)	31 (7-54)	30 (6-52)
Sondrio	7 (2-12)	6 (1-10)	4 (1-6)	3 (1-5)
Milano	37 (10-63)	35 (7-60)	31 (7-53)	29 (6-52)
Bergamo	33 (9-57)	31 (6-53)	26 (6-45)	24 (5-42)
Brescia	45 (12-77)	42 (8-72)	35 (8-60)	32 (7-57)
Pavia	24 (6-42)	23 (5-39)	20 (4-35)	19 (4-34)
Cremona	46 (13-80)	44 (9-74)	36 (8-62)	33 (7-58)
Mantova	35 (9-60)	34 (7-58)	31 (7-53)	30 (6-53)
Lecco	30 (8-52)	29 (6-49)	24 (5-42)	23 (5-41)
Lodi	44 (12-76)	42 (8-70)	34 (8-59)	32 (7-56)

Table 2 Annual number of attributable deaths per provinces and per 100k inhabitants due to NO2 exposure

4. Replicability and transfer, dissemination. C2M initiative

We confirmed that the DDF technology proposed in the DUALNG project has a high potential of replication and transferability across the EU, as described in the deliverable D11. Replication regards mainly the HDV sector while the transferability potential of DDF systems may concern other transport areas such as rail (i.e. vectors on non-electrified railway lines) and naval sectors (small fishing boats for instance). In the future, the feasibility of the conversion of railway engines, one of the areas in which

BM is specialised, can be verified. As regards marine applications, DDF engines already exist for large ships, but there is no market for DDF retrofitting for ships yet.

The dissemination and networking activities, carried out during the project, have increased the awareness of the relative supply chain of transport fuels and engine technologies, and create a “market sensitivity”. Indeed, the retrofitting of an existing HDV could be an affordable and environmentally friendly alternative to buying a new one, especially for those users (public or private) who do not have the economic possibility, in a short time, to renew their vehicle fleet. Thus, after project end, the beneficiaries will invest time and resources to promote the results, continuing dissemination and networking actions at national and at European level.

Furthermore, the interaction with private and public representatives is continuous, consolidated and extended to other initiatives in place. The project stakeholders, which are being involved in the dissemination activities of DUALNG, have encouraged the diffusion of the project results and have helped to spread the information about the new DDF system. Indeed, results are being shared with these as the project progresses.

5. Best Practice lessons

- Proper training and education: One of the best practices for implementing a dual-fuel solution is to ensure that staff members are properly trained and educated on how to operate and maintain the system effectively.
- Regular maintenance and monitoring: Regular maintenance and monitoring of the dual-fuel system is essential to ensure that it operates efficiently and effectively. This includes checking for any potential issues, such as fuel leaks or malfunctions, and addressing them quickly to prevent any downtime or disruptions.
- Conducting regular performance reviews: Conducting regular performance reviews of the dual-fuel system can help identify any areas for improvement or optimization. This can include analyzing fuel consumption data, efficiency metrics, and any maintenance issues that may arise, allowing for continuous improvement and optimization of the system.

6. Innovation and demonstration value

Globally, the DUALNG project stay well aligned with its starting demonstration scope, although the number of retrofitted vehicles is lower than number foreseen at the beginning.

7. Policy implications:

In action B4 (Replication and transfer) a position paper on the DualLNG technology is completed, to serve for briefing policy makers and authorities in charge of reviewing regulations.

Dedicated round-tables were organized involving all value chain stakeholders and especially policy makers who have the crucial role to set-up incentives schemes to support the diffusion of dual-fuel technology in the EU. Regional and national authorities, as well as relevant stakeholder and customers, were involved through the cooperation of the Lombardy clusters for mobility (CLM) and Energy (LE2C), from which we have received an endorsement.

The project is directly relevant to:

- EC Transport White Paper 2011;
- Clean Vehicles Directive (2009/33/EC);
- Alternative Fuels Infrastructure Directive 2014/94/EU;
- National and regional legislation and in particular: Regional Council resolutions of Lombardy Region n. 2089 of 31/07/2019, n. 2090 of 31/07/2019 and n. 2157 of 23/09/2019), related to the defence of air quality and the health of citizens, by encouraging the disposal of the most polluting vehicles.

In addition, the project is indirectly relevant to:

- Directive 2016/2284/EU NECD (reduction of certain air pollutants) and Clean Air Policy Package for EU;
- Urban Agenda for the EU;
- European Smart City initiatives;
- Air quality legislation (Directive 2008/50/EC, NEC Directive).

7. Key Project-level Indicators

The inclusion of data into the KPI database webtool (<https://webgate.ec.europa.eu/eproposalWeb/kpi/module>) has been finalized.

8. Comments on the financial report

Globally, the consolidated cost reporting is in line with the budget even if costs linked to the coordinator are lower than foreseen values. Actually, despite the number of installations achieved by the end of the project are 21 instead of 50, the low standardization of installation processes and the elevated number of hours required to train personnel for the kit's installation and maintenance, led to a nearly full compensation of personnel costs.

8.1. Summary of Costs Incurred

PROJECT COSTS INCURRED			
Cost category	Budget according to the grant agreement in €*	Costs incurred within the reporting period in €	%**
1. Personnel	556,050.00	532,549.87	96%
2. Travel and subsistence	15,000.00	107.73	0,7%
3. External assistance	64,000.00	30,663.91	48 %
4. Durables goods: total <u>non-depreciated</u> cost			
- <i>Infrastructure sub-tot.</i>	5,000.00	0,00	0 %
- <i>Equipment sub-tot.</i>	59,000.00	0,00	0 %
- <i>Prototype sub-tot.</i>	28,000.00	22,072.70	79 %
5. Consumables	474,440.00	125,764.78	27 %

6.	Other costs	29,250.00	16,250.83	55 %
7.	Overheads	86,151.00	50,917.00	59 %
	TOTAL	1,316,891.00	778,326.82	59 %

*) If the EASME has officially approved a budget modification through an amendment, indicate the breakdown of the revised budget. Otherwise this should be the budget in the original grant agreement.

***) Calculate the percentages by budget lines: e.g. the % of the budgeted personnel costs that were actually incurred

8.2. Accounting system

Brief presentation of the accounting system

BM Carrozzerie

The company uses a digital business management system. In general accounting, the dedicated account was created in the separate statement:

10.01.00730 SPESE PROGETTO DUALNG LIFE19

The cost of direct personnel being divided into innumerable items, (tax authorities, inps, inail, etc) is reported in the respective general ledger accounts from which, at the end of the year, the annual cost per employee and the hourly cost is obtained which is consequently used to determine on the basis of timesheets, the cost to be charged to the project for employees.

Ditta: BM CARROZZERIE S.R.L.
Via Del Palazzo 2 25010 - Montrone (Bs)

Schede Contabili

10.01.00730 SPESE PROGETTO DUALNG LIFE19					Ripresa Saldo Iniz.	Ripresa Progr. Dare	Ripresa Progr. Avere	Ripresa SALDO
IVA: Cod. Fisc.: Situazione al: 31/12/2019					0,00	0,00	0,00	0,00
Data Comp	Data Reg Data Rif.	N.Oper. N.Rif.	N.Prot	Causale Registrazione	SALDO INIZIALE	DARE	AVERE	SALDO
29/10/2020	29/10/2020	6936	1648	Fattura Nr.000759 del 23/10/2020 HVM		11.168,00		11.168,00
29/10/2020	29/10/2020	6940	1652	Fattura Nr.000141 del 28/10/2020 ECOMOTIVE SOLUTIONS SRL		4.027,30		15.195,30
31/10/2020	31/10/2020	7145	1711	Fattura Nr.235 del 27/10/2020 CREATIVORI s.r.l.		1.700,00		16.895,30
31/10/2020	31/10/2020	7236	1756	Fattura Nr.000796 del 30/10/2020 HVM		1.075,00		17.970,30
31/10/2020	31/10/2020	7249	1765	Fattura Nr.1931 D del 31/10/2020 PICCINI IMPIANTI S.R.L.		2.460,00		20.430,30
Situazione al 31/12/2020					Saldo Iniziale 0,00	Progr. DARE 20.430,30	Progr. AVERE 0,00	Saldo FINALE 20.430,30

Page 1 of 1 Realizzato da: Digi Colebeato (BS) Tel. 030 2510305

The cost of direct personnel being divided into innumerable items, (taxes, social security contributions, etc) is reported in the respective general ledger accounts from which, at the end of the year, the annual cost per employee and the hourly cost is obtained which is consequently used to determine on the basis of timesheets, the cost to be charged to the project for employees.

CSMT Gestione scarl

The company uses a jobs management platform where a specific job number has been assigned to DUALNG (n. 2020-0100).

The screenshot shows a web browser window with the URL <http://gestionale/Commessa/Commessa.aspx?ID=2ab>. The page title is "COMMESSA" and the user is logged in as "webmail CSMT". The interface has a navigation menu with "Home Page", "Inserimento", "Gestione", "Archivi", and "Analisi dei dati". Below the menu, there are several tabs: "Mostra elenco", "Nuova RDP", "Salva", "Esporta", "Fogli di Lavorazione", "Profatture", "Rapporti di Prova", "Invia Comunicazione", and "Portafoglio".

The main content area displays the following information:

- COMMESSA COLLEGATA A 1 RDP: RDP00218 del 16/09/2015
- COMMESSA COLLEGATA A 1 OFFERTE: 2015-191 del 16/09/2015
- Numero: RDP00218 (highlighted in purple), 2015-0121
- Data Apertura: 16/09/2015
- Presunta Cons. 1: 16/09/2018
- Presunta Cons. 2: (empty)
- Urgente:
- Revisione: 0
- Stato Commessa: Aperta
- Data effettiva inizio lavori: 16/09/2015
- Data ricezione materiale da officina: (empty)
- Soggetto Ordinarie: EUROPEAN COMMISSION
- RCO: P. Colombi
- Agente in essere: Nessun agente assegnato.
- BU9-3/15
- B-1049 BRUXELLES BR BE
- Tel. (32-2) 299234918 Fax: (32-2) 299234918
- Sezione: PROJECT FUNDING
- Funzione: GESTIONE PROGETTI
- Consulenti/Laboratori di subappalto: (empty)
- Acquisti alla lista: [Acquisti alla lista](#)

Below this information, there are four main sections:

- Documenti e riferimenti cliente:** Ordine: LIFE13-ENV/IT/000559; Documenti cliente: Grant Agreement LIFE13 ENV/IT/000559; Riferimento cliente: (empty)
- Documenti CSMT:** ACCREDIA LAB: 0; ACCREDIA LAT: 0; N. Rapporto Subappalto: (empty)
- Materiale:** Il materiale è da rendere? ; Dove si trova il materiale da rendere? In laboratorio, In segreteria, Officina meccanica
- Rapporti di Prova:** Modalità di spedizione: (empty); Data consegna/spedizione: (empty)

Brief presentation of the procedure of approving costs

BM Carrozzerie

BM Carrozzerie is qualified ISO9001:2015, to select a supplier the purchasing office makes a market research and asks to more suppliers different offers that are verified. In the case of skills not strongly impacting from a technical point of view, the choice falls only on the most economically advantageous offer, instead for technical choices an internal decision-making body meets to evaluate the best technical-economic offer (example: tender for CNG).

CSMT Gestione scarl until 31/12/2022

All procurement requests go through the Project manager.

If the purchase concerns commonly used materials and the company has already made a choice of the supplier also through the ISO9001 Quality System procedures, the operational contact asks for a quote, verifies the congruence of the price with the previous purchases, sends an order signed by the the project manager.

In the case of purchases of particular equipment or services or worth more than 10,000 euros, the order confirmation is signed by the project manager and the company administrator.

CSMT Gestione scarl from 01/01/2023

The procurement procedure is still the same as the previous years. From 01/01/2023 in CSMT the management platform has been changed with a new software showed below:

Type of time recording system used, i.e. electronic or manually completed timesheets

Both beneficiaries are equipped with an electronic system to record the working time of employees (personnel directly employed by the company).

Brief presentation of the registration, submission and approval procedure/routines of the time registration system

At the beginning of the month, all staff working on the DUALNG project are given a Timesheet where the worker marks the hours dedicated to the project daily. At the end of the month, this form is delivered to the project manager who inserts the hours per worker in a database, dividing them by competence, department, and action so that they can be checked and evaluated. The cards are then delivered to the administration where they are checked with electronic records and validated with the signature of the Administrator.

Brief explanation on how it is ensured that invoices contain a clear reference to the LIFE project showing how invoices are marked in order to show the link to the LIFE project

The purchasing officers, starting from the order and therefore on the order confirmation, clearly indicates to the supplier that the invoice must clearly specify that the material refers to the project LIFE19 ENV/IT/000209.

From 2019 invoices in Italy are sent directly to the central Tax Agency and sent by them in electronic format to the company.

The purchasing officer that receives the electronic invoice transforms it into paper and verifies that the correct writing is reported.

If the reference is not clear on the invoice, the purchasing department affixes an explanation note on the invoice and then affixes the validation stamp that reports LIFE19 ENV/IT/000209 on it.

8.3. Partnership arrangements

Procedures for financial transactions between the coordinating beneficiary and the associated beneficiary and for financial reporting implemented have been set up in the partnership agreement, signed on December 17th 2020.

The coordinator will ensure that all the appropriate payments are made to the associated beneficiary within 30 days of the receipt of the funds paid by the Agency/Commission unless there is a justified delay.

Regarding the final statement of expenditure and income, the associated beneficiary shall provide the coordinating beneficiary with a dated and signed "participant cost statement summary" at least 20 days before the deadline for submission to the Agency/Commission of the final report.

The deadline for the associated beneficiary to provide the coordinating beneficiary with the mid-term financial statement is 20 days before the deadline for submission to the Agency/Commission of the mid-term report.

The associated beneficiaries will regularly update the financial statement situation on quarterly basis and provide them to the coordinating beneficiary.

Following the changes introduced after the request for a 12-month extension, approved by CINEA on 11/24/2022, this first partnership agreement before mentioned, it has been updated and replaced with a new one dated and signed the 25th of November, 2022.

8.4. Certificate on the financial statement

n/a

8.5. Estimation of person-days used per action

In order to have an overview of the use of budgeted person-days by group of actions, it is **recommended to fill in the following additional table**. Please provide estimates of % of person-days spent compared to the budgeted numbers². This table will allow you and the EASME to monitor the actual absorption of budgeted time and will highlight any major deviations that should then be explained. When compiling the information you may refer to the number of days referred to into Form R2 of the proposal:

Action type	Budgeted person-days	Estimated % of person-days spent
Action B: Implementation actions	1750	87 %
Action C: Monitoring of the impact of the project action	260	97 %
Action D: Public awareness/communication and dissemination of results	135	124 %
Action E: Project management	240	55 %
TOTAL	2385	88%

² As we are only requesting estimations, those figures are not meant to be used for the financial reporting.

9. Envisaged progress until next report (this section should be included only for the Mid-term report)
n/a

Instructions / guidelines for the submission of deliverables / annexes

- Please make a reference to the deliverables in the report text. In case the deliverables are presented in a national language other than English, please include a summary in English, in the deliverable, outlining the purpose, outcomes, results and conclusions.
- All the deliverables due in the reporting period shall be provided unless already submitted with previous report(s). Deliverables should only be resubmitted if a revised version has been requested by EASME.
- Please date deliverables with the actual date of completion (and the date of revision if applicable).
- You may annex any other document **only if** particularly useful to assess the success of the project but which is not part of the planned deliverables.