APPRAISAL REPORT

FOR PULA PORT AUTHORITY POPILOT ACTION

Project acronym	ADRIGREEN
Project Title	Green and intermodal solutions for Ports and Airports
Financed through	ERDF
Project duration	01/01/2019. – 31/12/2021.

Related activity:	4.1 –Testing phase
Deliverable name:	Appraisal report for Pula port Authority pilot action
Type of deliverable	Report
Language	English
Work Package Title	Testing and evaluating innovative intermodal and low-carbon solutions
WP number	4
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Project website	https://www.italy-croatia.eu/web/adrigreen

CONTENT

I. EXECUTIVE SUMMARY

The main objective of ADRIGREEN project is to improve the integration of Croatian and Italian ports and airports with other modes of transportation in order to enhance the processing of passengers during the summer seasons and to improve environmental performances of the Adriatic maritime and aviation systems.

According to project life cycle progress, international investigation has been performed in order to identify best existing solutions for lowering airports/ports environmental impact. Further, these identified solutions have been summarized in Joint Action Plan definition for each region / partner.

Pula port Authority pilot action objective included adoption of smart solutions to improve reduce CO2 and to establish standard in maintaining costal surfaces.

In order to reduce CO2 energy consumption Pula port Authority started using electric bikes, electric scooters for port operational process and use of cars like means of transportation to and from work. Electric machine for washing open spaces and electric bikes and scooters are very easy to operate and employees are satisfied wit the usage. Employees are used to use their own cars for job operations, so this “driving park” Pula port authority bought is first means on transport in port authority.

Within ADRIGREEN project PPA has purchased one electric machine for washing open costal spaces, three electric cars and two electric scooters.

After the pilot action implementation PPA has performed assessment of environmental impact and benefits of the pilot action implemented.

According to environmental analysis implemented pilot action has reduced CO2 emission within which not only PPA employees have benefited, but also passengers and local community.

Analysis performed within ADRIGREEN project gives to PPA and local authorities’ awareness and possibilities to change and improve of environmental management process in all different environment aspects.

II. BACKGROUND OF THE PROJECT IMPLEMENTATION

Green and intermodal solutions for Adriatic ports and airports - ADRIGREEN is a project approved under the INTERREG V-A Italy Croatia CBC Programme 2014-2020. The programme is funded by the European Regional Development Fund under the European Territorial Cooperation objective during the programming period 2014-2020.

Project description:

One of the main problems that characterize the Adriatic coastal area is the imbalance in the development of infrastructures and modes of transport, caused by low level of investments and insufficient approach to innovation. In Italy and Croatia there are many maritime cities, which have to deal with a very high number of passengers, especially during the peak season. Even though the road transportation is still predominant, the number of people that are reaching Adriatic cities by ferries and airplanes is significantly increasing year by year. However, most of Adriatic ports and airports are suffering from lack of integration with various modes of transportation, causing serious traffic congestion problems during the summer season.

The aim of the project is to improve the integration of Adriatic ports and airports with other modes of transportation by testing several intermodal operational and technological solutions. By identifying and analysing already existing procedures, the project partners will test a number of intermodal practices in order to evaluate their adaptability and transferability into the Programme area.

Also, it is very important to create more environmental-friendly and less polluting transport between ports (cities) and airports by reducing CO2 emissions. This can be achieved by purchasing electric vehicles for transport routes between ports and airports, or for use in port/airport premises.

(The project has started in January 2019 and it is expected to end by January 2022. The total budget approved for the project amounts to 2.104.217,00 EUR, 85% of which is co-financed through the ERDF fund (European Regional Development Fund). The project will be implemented by 10 project partners.)

Background of project implementation

ADRIGREEN project consists of several technical work packages as follows:

1. WP T1 – Identification of innovative solutions and Action plan definition
2. WP T2 – Testing phase
3. WP T3 – Networking and training on Green and intermodal solutions

WP T1 – identification of innovative solutions and Action plan definition

Within first technical work package (WP T1) several activities were performed:

A) Replicability research and analysis replicable operational and technological solutions
B) Environmental assessment
C) Joint Action plan definition

Activities have been started in June 2019 and finalised as of December 2020.

A) Replicability research and analysis replicable operational and technological solutions

Partnership has made a general overview of existing solutions for lowering airports/ports environmental impact and for intermodal connection of ports/airports with other means of transportation. Within this activity SWOT analysis of each project partner was performed to assess current situation and fields for improvement. Also, international investigation research was conducted in order to identify and analyse the best solutions already implemented worldwide that can be easily implemented in Adriatic region. One of the main focus areas of international investigation included on-going operational and technical initiatives for making ports/airports environmentally friendly with particular attention to maintenance activities.

Summary of practical sustainable applications to achieve carbon reductions at airport and port infrastructures are as follows:

Solution	Brief description	Port reference case studies	Airport reference case studies
Solar panels	Solar panels installed in different areas of the port/airport (e.g., rooftops of buildings and warehouses) for generating renewable energy.	Rotterdam, Amsterdam, and Gothenburg	Copenhagen, and Helsinki Airport
Geothermal heat pump/ Aquifer thermal energy storage[1]	Renewable thermal energy for large heating and cooling loads. Cooling/heating system employs a water-based thermal energy storage system that stores heat/cold in ground- water reservoirs.	Marseille	Paris-Orly, Nashville, Calgary, Stockholm-Arlanda, and Copenhagen Airport
Energy monitoring system	Monitoring system of the energy consumption of airport/port equipment, buildings and other facilities for supporting decision-making and implementation of measures for improving energy efficiency.	Valencia, Koper, and Jade Weser Port	Copenhagen Airport
Smart grid	Electricity network based on digital technology that can cost-efficiently integrate the behaviour and actions of all generators and consumers that are connected to the grid.	Antwerp	-
Daylighting strategy	A daylighting strategy can reduce electricity for lighting and peak electrical demand, cooling energy and peak cooling loads, maintenance costs associated with lamp replacement, and electrical service to the building. Maximize south glazing and minimize east- and west-facing glass[2].	Yokohama	Denver, and San Francisco Airport

[1] Baxter et al. (2018). An assessment of airport sustainability, Part 2—Energy management at Copenhagen Airport. *Resources*, *7*(2), 32.

[2] https://www.lrc.rpi.edu/programs/daylighting/pdf/guidelines

Green roofs	Green roofs are covered with vegetation and a growing medium planted over a waterproofing membrane. When weight restrictions need to be considered, it is possible to utilize substrates that provide an adequate nutrient supply with relatively low specific weight. Main environmental goals: absorbing rainwater, providing insulation, and helping to mitigate the heat island effect in the built environment.	Värtahamnen, and Copenhagen	Frankfurt, Ibiza, Munich Airport, Paris Orly, and Bordeaux–Mérignac Airport
Concrete pavement instead of asphalt	Pavers are lower maintenance and generally have a longer lifespan compared to asphalt.	Värtahamnen	-
LED	Light emitting diode (LED) is a highly energy efficient lighting technology.	Venice, Hamburg, and Los Angeles	Stockholm Arlanda, Copenhagen, Schiphol, and Oslo Airport

Source: international investigation ADRIGREEN

For more details, please see related document International investigation ADRIGREEN.

B) Environmental assessment

Next step in project implementation comprised of producing Environmental Impact Assessment (EIA) for each project partner based on ad-hoc guidelines produced by technical expert in the project, Polytechnic University of Marche. In order to asses current situation in each partner, evaluation grid for EIA was produced to cover different environmental aspects; environmental impact of local air quality, waste and water management, energy consumption, carbon footprint and noise pollution.

There are different levels of implementation of efficient environmental management within ADRIGREEN ports in the document „Environmental performance assessment of Adrigreen ports“ realized by Marche Polytechnic University divided by area:

a) Water Consumption and Management at Adrigreen ports
b) Waste production and management at Adrigreen ports
c) Energy Consumption and Management at Adrigreen ports
d) Greenhouse gases emissions deriving from water consumption at Adrigreen ports
e) Greenhouse gases emissions due to the fractions of waste produced at Adrigreen ports
f) Greenhouse gases emissions deriving from electricity consumption at Adrigreen ports
g) Multimodality
h) Noise pollution

WATER

Between 2016 and 2018, mean water consumption ranged from 6.64 to 117.33 l/passenger and from 0.96 to 88.98 l/m2 at Adrigreen ports. According to Adrigreen partners, water consumption per passenger may be affected by the amount of water consumed:

- due to basic activities and the personnel working at the ports with a relatively smaller number of passengers per year;
- due the high number of ships in port that refill tanks or by pleasure and fishing vessels.

WASTE

Between 2016 and 2018, mean waste production ranged from 0.49 to 2.92 kg/passenger and from 0.08 to 0.57 kg/m2 at Adrigreen ports.

All the ports have a de-centralized waste management system with one or more concessionaires engaged for collection and recycling.

According to Adrigreen partners, in some cases it is not immediate to obtain data about the fractions of waste produced because these are collected by the concessionaires.

Waste produced per passenger may be affected by the amount of waste produced by cruise ship, pleasure ships and fishing vessels.

ELECTRICITY

Between 2016 and 2018, mean electricity consumption ranged from 1.19 to 12.97 kWh/passenger and 0.34 to 1.77 kWh/m2 at Adrigreen ports.

Electricity consumption is the major contributor to greenhouse gases emissions at the ports.

For the three ports, implementing a policy to reduce electricity consumption would be advantageous both in economic and environmental terms.

NOISE

Based on the data provided, noise pollution does not affect the development of Adrigreen ports and their activities. However, the three ports implemented measures to reduce or monitoring noise pollution or are going to do so in the future.

MULTIMODALITY

From Airport to Port:

- The three ports involved can be reached by bus and car. The frequency of the bus service is between 8 minutes and 30 minutes. Travel time by bus is between about 20 minutes (P1, P3) and 50 minutes (P2).

From Railways station to Port:

- In all the ports, the railway does not reach the port. However, from P1 and P3 ports it is possible to reach the nearby railway station either on foot or by bus in about 10 minutes. There are no railway stations near P3 port.

Data extracted from: ADRIGREEN WP3-D2 APT For more details, please see related document EIA ADRIGREEN (In the Attachment) .

C) Joint action plan definition

Joint action plan definition has been produced by Polytechnic University of Marche with recommendations for improvement for each type of environmental activity (*please see: Adrigreen_WP3_D3_200218_Final*):

Since Pula port Authority pilot action comprises of *"adoption of smart solutions to improve waste&water management and to reduce energy consumption in small-medium regional Ports"* below are presented reference case studies for actions aimed at decreasing energy consumption:

General measure	Specific action	Metrics	Port reference case studies
Decreasing energy consumption	Building management system	Total energy consumed (electricity consumption (kWh); fuel consumption (m3; l; kg)); GHG emissions (kg CO2eq/m3; kg CO2eq/passenger)	port (this study).
Decreasing energy consumption	Cogeneration plant	Total energy consumed (electricity consumption (kWh); fuel consumption (m3; l; kg)); GHG emissions (kg CO2eq/m3; kg CO2eq/passenger)	Website Port of Venice and Chioggia
GHG = Greenhouse Gases.			

Source: Adrigreen_WP3_D3_200218_Final

Also, according to survey reported by the European Environment Agency (2019), the purchase of electric vehicles is the most popular mitigation action to contain the environmental impact of the airports' vehicle fleet as can be seen from table below.

	Share of (51) EU28 European Free Trade Association airports [%]
Electric vehicles	86
Hybrid vehicles	47
Vehicles that run on sustainable alternative fuel	35
Provide incentives for taxis that use 'green' vehicle solutions	18

Source: Adrigreen_WP3_D3_200218_Final

ADRIGREEN project PPA pilot action comprises of purchasing of electric vehicles and scooters in order to replace usage of personal diesel cars with electrical bikes and scooters and cleaning machine to achieve reduction of fuel consumption , decreasing CO2 emission, PPA pilot action is in line with recommendations specified in Joint Action plan definition.

WP T2 – Testing phase

Testing phase is the core phase of the project where identified solutions and best practices are to be put in place and tested within each partner pilot action. First deliverable of this work package related to Feasibility study for each pilot action where initial financial and environmental analysis have been performed.

Initial financial and environmental assessment of Pula Port Authority pilot action demonstrated feasible and sustainable plan for reducing fuel consumption and CO2 emission by replacing old diesel car park with new electric assets.

This plan is to continue to build electric feet of the port authority in the future.

III. PULA PORT AUTHORITY ANALYSIS SUMMARY

Pula Port Authority is small port with a potential to grow that has introduced port to new environmental challenges, public enquiry and will to take an effort in green transition such as decrease of air pollutions and integration of environmental protective measures.

Pula Port Authority has begun to create awareness of transport integration, in which she found support in project partner Pula Airport.

In order to cope with new environmental challenges, Pula Port Authority has planned to realize constructional projects to open the possibility to involve in new projects and to open the new chapter in the self-development. With new building and representative spaces and control port center port authority will create new dimension on green transition. Now the internal communication and transport between those units is representing organizational and environmental challenges. Such needs should be met with environmental-friendly solutions taking into the account specifics of port technology and operations.

The ADRIGREEN Project represents a unique opportunity for Pula port Authority to continue its development toward an environmentally friendly port. In addition, thanks to the project, the Port will analyse and evaluate existing and future strategies, concepts and technology to improve intermodal solutions. Pula port Auhorirty is especially interested in improving and integrating communication and transport between units, and in opportunities to implement new innovative technologies according to the latest environmental and sustainable development principles.

Pilot action includes purchasing of electric washing machine and electric bikes and scooters covering:

- adoption of smart solutions to improve wastewater management and to reduce energy consumption in small-medium regional Ports

The new solutions tested at the Port will reduce air pollution and will better integrate operational systems.

Gained experience and benchmark information will provide inputs for future sustainable development of the whole region.

IV. DESCRIPTION OF PILOT ACTION IMPLEMENTED

Pula port Authority pilot action implemented is in compliance to third main pilot action field identified within the project: *"adoption of smart solutions to improve waste&water management and to reduce energy consumption in small ports"*; and is divided into different types of vehicles purchased:

- electric cleaning machine
- electric scooters and bicycles to be used by port staff for faster and cleaner service offering

According to the need's analysis performed, Pula port Authority has identified following fields for improvement in landside and airside area:

- energy efficiency improvements within port processes,
- cost effective optimisation of business processes.

The purchase and application of an electric vehicle for cleaning the stone part of the coastal wall and pier, and the purchase of electric bicycles and scooters will reduce CO2 emissions and will reduce fuel consumption and regular maintenance costs that have been outsourced so far area. The cleaning machine, electric bicycles and scooters will be visible to stakeholders and the general public and will contribute to sustainable environmental policy, awareness and reduction of greenhouse gas emissions.

The daily operational activities carried out by the staff, sailors, of the Pula Port Authority, required more time and the usage of cars. The process was not only more polluting but also slower due to the use of local roads on which other vehicles also operate. Electric bicycles and scooters can be used on roads where there are no traffic jams, especially in the summer months. In the summer months, there is less rain and a higher flow of people, and therefore the need to clean the coast is greater. With the electric shore washing machine Pula port Authority became independent of the external company that maintained the waterfront, and the costs of maintaining it were reduced.

Prior to ADRIGREEN project, several personal vehicles on petrol or diesel performed these processes, and the local company for maintenance is using regular machine with regular cleaning agents.

Therefore, within ADRIGREEN project Pula port Authority has purchased three electric bicycles, two electric scooters, and one electric cleaning machine.

Therefore, within ADRIGREEN project Dubrovnik Airport has purchased 10 electric bicycles and 10 electric scooters for day-to-day airport staff activities, replacing remaining two diesel vehicles and with usage of these electric scooters and bicycles energy consumption and airborne pollutant emissions will be significantly reduced.

V. ENVIROMENTAL ANALYSIS

Financial analysis

Pula port Authority has performed financial analysis of equipment purchased and used. In conducting financial analysis following assumptions were taken into the consideration:

- purchase price of new cleaning machine and costs of maintenance,
- The current cost of maintaining and cleaning the coast

Other information:

- electric machine was purchased and put in use 16.07.2020.
- electric scooters and bicycles were purchased and put in use:
  E CITY APOLO - 1.04.2021.
  2 * MS ENERGY E-BIKE - 30.04.2021.
  2 * MS ENERGY E20 - 26.03.2021.

Financial analysis is presented in Feasibility study for Pula Port Authority pilot action, for more details please see related document.

Environmental analysis

Environmental analysis performed relates to basic calculation of CO2 emissions according to technical specifications of equipment purchased compared to the one replaced. In further steps of the pilot action testing, evaluation grid are developed in order to assess action performance and to show how the environment and transit of passengers benefited from pilot actions.

Also, it is important to specify that it is not yet fully investigated the impact of changing electric battery each five years on environment in respect of battery production and battery disposal

Initial environmental analysis of Pula port Authority pilot action

Within Feasibility study for Pula port Authority pilot action initial environmental analysis has been performed which related to basic calculation of CO2 emissions according to technical specifications of equipment purchased compared to the one replaced.

Accordingly, listed below are technical specifications of pilot actions:

- Cleaning machine rented vehicle –diesel vehicle CO2 emission is 162 g / km, on a yearly basis, 10.000 km, it is 1.620.00 g. Electric vehicles emission factor was 234,81 g CO2 eq/kWh in Croatia in 2017;
- Five old vehicles –CO2 emission is 162 g / km, on a yearly basis, 7.500 km, it is 1.215.00. Electric vehicles emission factor was 234,81 g CO2 eq/kWh in Croatia in 2017.

Environmental analysis based on evaluation grid for specific pilot action

Next step in conducting environmental analysis included development of evaluation grid based on specifics of each pilot action implemented and type of electric vehicles and equipment purchased.

Evaluation grid has been developed by Polytehnic University of Marche based on methodology provided by European environment agency (*1.A.4 Non road mobile machinery 2019*).

Main purpose of evaluation grid and appraisal report is to asses pilot action performance and to show how the environment and transit of passengers benefited from pilot actions.

Environmental analysis

Emissions of airborne pollutants (NOx and PM) and CO2 deriving from diesel vehicles

For diesel vehicles, the emissions of NOx, PM, and CO2 were evaluated following Tier 1 according to (Ntziachristos et al. 2019), as follows:

$$E_i = \sum_j EF_j \times FC_j \times U_l$$

where E_i is the emission value of NOx [g], PM [g], and CO2 [kg]; EF_j is the emission factor specific for diesel fuel and the i-vehicle category (i.e., passenger car, and light commercial vehicle Table 1), [g/kg fuel] for PM and NOx; [kg CO2/kg fuel] for CO2; FC_j is the average fuel consumption related to the vehicle category (Table 2)[g/km]; U_l is the usage per year for the l-vehicle (Table 3), [km/year].

Table 1. Tier 1 emission factors for diesel passenger cars and light commercial vehicles adapted from Ntziachristos et al. (2019).

Category	Fuel	Airborne pollutants and CO2	Unit of emisison factor	Emission factors
PC	Diesel	NOx	[g/kg fuel]	12.96
PC	Diesel	PM	[g/kg fuel]	1.10
PC	Diesel	CO2	[kg CO2/kg fuel]	3.169
LCV	Diesel	NOx	[g/kg fuel]	14.91
LCV	Diesel	PM	[g/kg fuel]	1.52
LCV	Diesel	CO2	[kg CO2/kg fuel]	3.169

PC – Passenger car; LCV – Light commercial vehicle

Table 2. Typical fuel consumption per km, by category of vehicle (Tier 1) adapted from Ntziachristos et al. (2019).

Vehicle category	Typical fuel consumption [g/km]
Passenger car	60
Light commercial vehicle	80

Table 3. Usage per year of the diesel vehicles that are going to be partially replaced at Pula Port

Manufacturer and vehicle type	Vehicle category	*Usage [km/year]
Volkswagen Passat 1.6 TDI	PC	*789.5
Peugeot 206	PC	*789.5
Peugeot 308	PC	**1973.7
Nisan Quashqai	PC	**1973.7
Peugeot partner 1,6 HDI 2011	PC	**1973.7
Road sweeper (Johnston)	LCV	***140

PC – passenger car; LCV – light commercial vehicle.

*Usage is calculated based on 6 km/day (source: Pula Port), assuming 300 days/year and about 44% of the mileage replaced by e-bicylces and scooters;

**Usage is calculated based on 15 km/day (source: Pula Port), assuming 300 days/year and about 44% of the mileage replaced by e-bicylces and scooters;

*** Usage is calculated based on cleaning 4,500 m2, with a cleaning path of about 1 m, and about 10 km back and forth route between the port area and the company providing the cleaning service, 10 times/year.

Emissions of greeenhouse gases deriving from electric vehicles

For each electric vehicle, the CO2 equivalent emission (E_i) was evaluated as follows:

$$E_i = \sum_j FC_j \times EF_j \times T_i$$

where FC_j is electricity consumption related to the battery capacity of electric vehicles [kWh]; EF_j is the emission factor of 205 g CO2 eq/kWh that was determined for Croatia (Koffi et al. 2017).); T_i is the number of recharge per year for the i-vehicle, [-].

For the i-vehicle, the number of recharge per year (T_i) was obtained as follows:

$$T_i = \frac{U_i}{R_i}$$

Where U_i is the usage per year for the i-vehicle (Table 4), [km/year or h/year]; R_i is the range of the i-type of battery reported by the manufacturer, [km or h].

Table 4. Usage per year of the electric vehicles purchased to be used in place of some diesel passenger vehicles and a rented ride-on scrubber-dryer at Pula Port.

	Type of vehicle	**Manufacturer**	**Number of units**	**Utilization each unit [unit]**	**Range [unit]**	**Battery capacity [Wh]**
Electrical scooter	e20	MS Energy	2	1500 [km/year]	60 [km]	840
Electrical bicycle	e-bike i10	MS Energy	2	*1500 [km/year]	45 [km]	280.8

Electrical bicycle	e-bike Apollo	Torpado	1	*1500 [km/year]	70 [km]	468
Electrical ride-On Scrubber-Dryer	T17 Heavy-Duty Battery Ride-On Scrubber-Dryer	Tennant	1	**68.2 [h/year]	7.5 [h]	38800

*Usage is calculated based on 5 km/day (source: Pula Port), assuming 300 days/year

**Usage is calculated based on cleaning 10 times a surface of about 9000 m2 (source: Pula Port), assuming 1.3 km/h average speed, and given a cleaning path of 1.015 m. Note that the cleaning surface has doubled from 4500 to 9000 m2 following renovation of Pula port. (https://www.tennantco.com/content/dam/tennant/tennantco/products/machines/scrubber%20riders/T17/t17-specifications-en.pdf)

Results

Each year, the diesel vehicles (passenger cars, and street sweeper) emit about 16.8 times the greenhouse gases deriving from the electricity utilised by the electric vehicles (e-street sweeper,e-bicycles and e-scooters) (Figure 1).

End of waste and the life cycle assement of diesel and electric vehicles were not assessed.

Local emissions of airborne pollutants such as NOx and particulate matter (PM) is assumed to be null for the electic vehicles. However, the emission of airborne pollutants should be considered depending on the location of production and the technology utlised for producing electicity.

On the contrary, utilising the diesel vehicles would result in local emissions of NOx and PM (Figure 2).

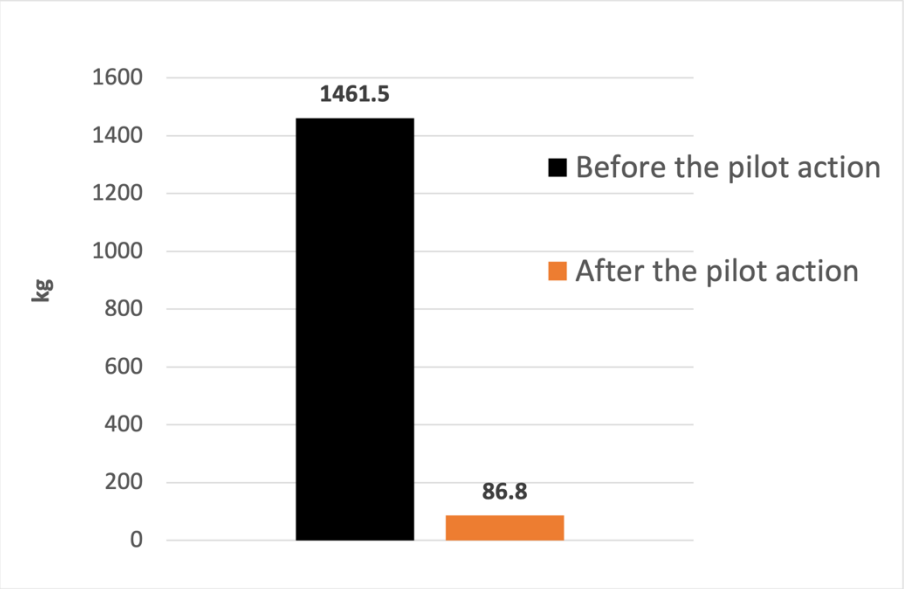


Figure 1 Comparison between greenhouse gases emissions deriving from the usage of diesel vehicles (i.e., cars and street sweeper) (CO2) and electric vehicles (e-street sweeper,e-bicycles and e-scooters) (CO2 eq) per year.

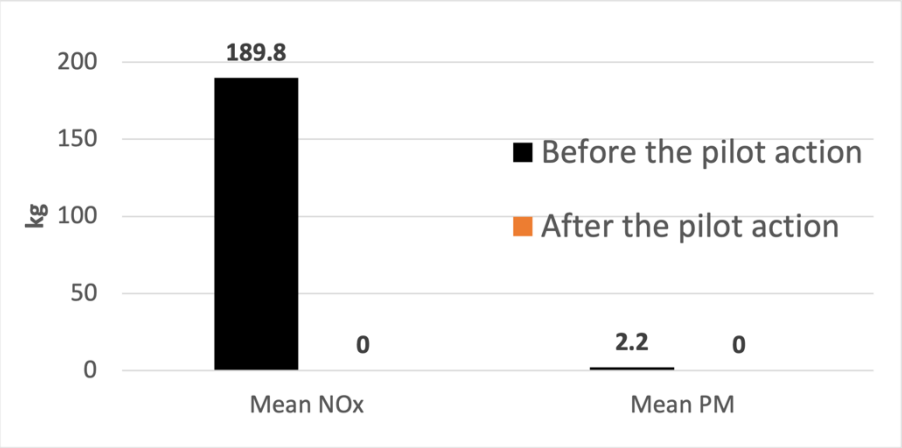


Figure 2 Comparison between local emissions of airborne pollutants (i.e., NOx and PM) deriving from the usage of diesel vehicles (i.e., cars, and street sweeper) and electric vehicles (e-street sweeper,e-bicycles and e-scooters) per year.

References

Ntziachristos, L.; Samaras, Z., et al. 2019. EMEP/EEA air pollutant emission inventory guidebook 2019. Available at https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view

Koffi, B.; Cerutti, A.; Duerr, M.; Iancu, A.; Kona, A.; Janssens-Maenhout, G. 2017. CoM Default Emission Factors for the Member States of the European Union - Version 2017, European Commission, Joint Research Centre (JRC) [Dataset]. Available at http://data.europa.eu/89h/jrc-com-ef-comw-ef-2017

VI. ANNEX I – TECHNICAL SPECIFICATIONS

T17 Heavy-Duty Battery Ride-On Scrubber-Dryer

An innovative, high-performance battery scrubber-dryer focused on delivering customized solutions to meet customer needs. The T17 cleans effectively in just one pass, enhances indoor air quality, and improves operator and supervisor experience, all in one machine.

Available Technologies

ec-H2OTM technology
Pro-PanelTM LCD Touch Screen or Touch-n-GoTM control module
IRIS® Fleet Management
ES® Extended Scrubbing

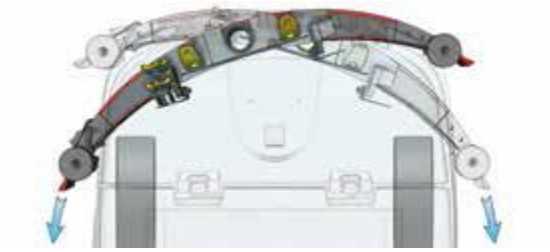
Engineered for Productivity

1. Touch-n-GoTM control module with 1-Step™start button allows operators quick access to settings without removing hands from the steering wheel. Also available with optional Pro-PanelTM technology.

2. Car-like propel and brake pedals allow for easy operation.

3. Recovery tank access step allows easy access to inspect and clean the recovery tank.

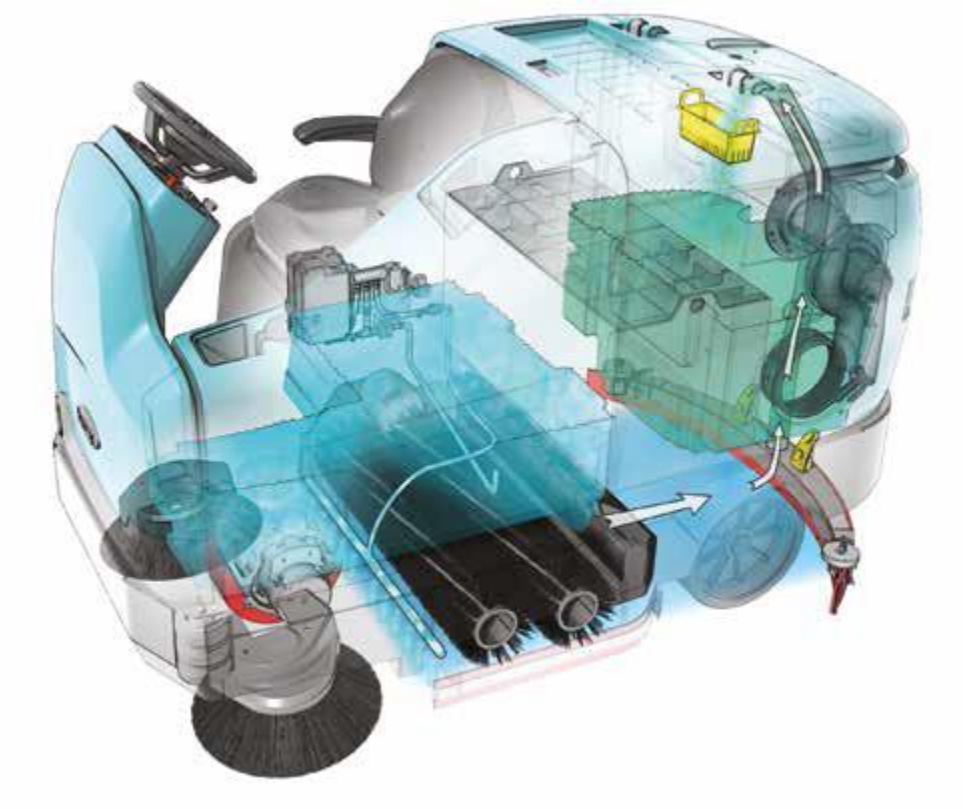
4. Revolutionary patent-pending water trap helps reduce spills and dripping by providing unrestricted airflow and captures moisture left int he recovery hose on shutdown.



5. Swinging squeegee provides excellent water recovery to help reduce the risk of slips and falls.

6. Large battery capacity options extend runtime for increased productivity

Inside the T17



1. Forward operating position improves operator safety and visibility.

2. Full front shroud ensures operator leg and foot protection.

3. Wraparound steel bumper helps protect your investment.

4. Yellow touch points save time and ensure proper maintenance.

5. Dual vacuum fans with corrosion-resistant impeller designed for long life.

6. Debris basket keeps material out of the recovery tank and prevents clogging.

7. Solution tank surroundings are engineered to provide maximum visibility, expanding sightlines to the left-hand sweeping side brush.

T17 Specifications

CLEANING SYSTEM

Scrubbing Path (main scrub deck) | With scrubbing side brush	1.015 mm | 1.320 mm
Sweeping Path (with Pre-sweep)	1.254 mm
Cylindrical brush speed	500 rpm
Cylindrical brush down force (up to)	250 kg
Debris hopper (on cylindrical machines)	20 L
Disk brush speed	315 rpm
Disk brush down force (up to)	250 kg
Solution tank	285 L
Solution capacity (ES®)	435 L
Recovery tank	346 L
Vacuum fan (Dual force)	2 x 0,8hp / 2 x 0,6 kW
Vacuum speed	14.500 rpm
Vacuum water lift	1.650 mm

PROPELLING SYSTEM

Propel speed forward (transport variable to) | Propel speed forward (scrubbing variable to) / h	9 km / h | 6,5 km
Gradeability Scrubbing | With optional ramp climb kit | Transport (empty)	8,7% | 10,5% | 21%

BATTERY SELECTIONS (EST. CONTINUOUS RUNTIME: ECONOMY MODE)

Battery optional packages	Wet 625 Ah C5
(Battery chargers available for all optional batteries)	Wet 775 Ah C5
Opportunity charging available on the 775 Ah C5	

MACHINE SPECIFICATIONS

Length basic machine	2.245 mm
Width, body	1.168 mm
Height (top of steering wheel)	1.480 mm
With overhead guard	2.096 mm
Weight empty (no battery)	875 kg
Minimum aisle turn	2.370 m

Electric scooters

MS Energy e10 and e20 (2 peaces)

The new e series is ideal for all those who will use the scooter every day. The powerful battery, a powerful three-speed engine and a larger silicone tread, provides ideal driving with a higher speed and range of up to 70km. Large 10″ air wheels, front and rear shock absorber and front and rear disc brakes make driving comfortable without the need for frequent stops on bumps and obstacles common on urban roads. When braking, the electric rear brake returns energy to the battery, thus charging it, while providing a solid and folding mechanism with mobility and easy use. When the ride is not needed, fold the scooter and take it with you.

Specifications

Wheel size	10″
Top speed	40 km/h
Aluminum	Frame Type
Color	Gray , White
Engine	500W
Max Power (peak)	1000W
Battery	48V/17.5Ah

Charging time	7-8h
Range	60-70 km
Brake Type	Front and Rear Disc Brake & EABS
Maximum load	120 kg
Suspension front	and rear
Additional options	Folding option
Weight	20 kg
Display	Yes, LCD
Bright	Yes, front and rear LED + reflective tape
Dimensions (D,V,S)	1275 x 1175 x 580 mm
Max. Climb	20°

MS Energy e10 and e20 scooters **use the MS Energy e** app, which you can download on the iOS Store or Google Play Store and connect it to your mobile device via Bluetooth. With the MS Energy e app, you can easily track your current speed, have an insight into the total kilometres traveled, and after driving, the app allows you to lock your scooter. In addition, the MS Energy e app offers other useful functions such as turning the lights on or off, changing gear modes, and provides a simple insight into the battery status as well as the temperature of the power controller.

Electric bike

E – city apolo (1 peace)

BIKE SPECIFICATIONS

FRAME	*Aluminium 6061 Hydroforming*
FORK	*Torpado CH-141 28" Aluminium*
HANDLEBAR STEM	*Multiset MTS-297 Aluminium*
GEAR	*Shimano TY300 7V*
SHIFTING	*Shimano REVO RS36 7V*
BRAKES	*Shimano M-200 Hydraulic disc brake*
WHEELS	*Torpado 700C*
SIZE	*50 - 54*

ENGINE SPECIFICATIONS

BATTERY	*Litio 36V/13Ah integrata*
DISPLAY	*HANDLEBARAnalogico*
HANDLEBAR	*MODE5*
MAXIMUM SPEED ASSIST	*25KM/H*
MOTOR	*REAR ENGINE 36V/250W*
BATTERY WEIGHT	*4.15 Kg*
CHARGING TIME	*6-8H*

MS Energy e-bike i10 20 inch 250W disc brakes (2 peaces)

The folding electric bike is a new member of the MS Energy family whose large 20″ wheels make riding comfortable without stopping at bumps and obstacles common on city roads. The i10 e-bike saves time and money in the city and is an ideal travel companion that you simply fold and put in the trunk.
Its battery can pass up to 50km, has three electric speeds, depending on how much acceleration you want. In addition to the electric motor e-bike i10 has 6 Shimano speeds, so you do not have to start the engine if you just want to pedal. But if you want electric motors to help you drive, just turn the pedals lightly.

Specifications

Wheel Size	20″
Maximum speed	25 km/h
Frame Type	Magnesium alloy
Color	Black
Engine	250W
Max Power (peak)	
Battery	36V, 7.8 Ah
Charging time	4-5 h
Range	45-50 km

Brake Type	front and rear disc brakes
Maximum load	120 kg
Suspension	–
More options	Possibility of concluding
Weight	
Display (show)	Yes, LCD
Light	yes, front and rear led light, stop light
Dimensions	
Max. Climb	

VII. ANNEX II – PICTURES