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ANNEX: ACTIONS OF AWARENESS, INFORMATION AND DISSEMINATION AND TOOLS UTILISED BY THE PORT-PVEV PROJECT 107
Transport Malta, the Port Authority of Catania, the Ministry for Transport and Infrastructure of Malta, and the Province of Caltanissetta – the four entities responsible for the ports of Valetta, Ċirkewwa, Catania and Gela – came together in 2012 and applied for funds under the OP Italy-Malta 2007-2013 Programme and secured funding for the PORT-PVEV project.

The PORT-PVEV project focused on decoupling economic growth from its dependence on non-renewable sources of energy, thus contributing towards the reduction of carbon emissions within port areas and the improvement of air quality for the benefit of residents and visitors within the participating harbours and their hinterlands.

Activities included in this project were aimed at demonstrating the production of green energy from renewable sources through the installation of photovoltaic panels at port administration buildings and within public spaces surrounding the participating ports.

The deployment, testing and demonstration of the feasibility of electromobility in and around the proximity of the partner ports was also a main priority for the PORT-PVEV project and above all demonstrating carbon neutral transport.

Also central to the project was the compilation of local green plans for ports and port areas to be used as future green policy guidelines for actions that would further decarbonise port areas after the PORT-PVEV is completed.

The project commenced its implementation in September 2012 and was concluded in June 2015. At a co-financing rate of 85% from the European Union’s Operational Programme Italy-Malta 2007-2013, the total project cost amounted to €2,500,000 shared between the four partners within the cross border area.
The main objective of PORT-PVEV was to demonstrate how ports, port areas as well as their hinterlands, and the operations therein, can reduce carbon emissions generated from the respective operations with the final aim of contributing towards the decoupling of the dependence of economic growth on non-renewable sources of energy.

The PORT-PVEV Project is essentially a demonstration project. Through the deployment of pilot actions in Malta, Catania and Gela, the project aimed to test and demonstrate how carbon, air and noise emissions can be reduced from economic activities taking place within the port area.

This has been done through the:

1. Use of solar energy to partly provide electricity for port administration buildings and reduce their dependence on non-renewable sources of energy, thus reducing the building’s carbon footprint;

2. Installation and testing the operation of solar car charging stations in public car parks within port areas to test and demonstrate the extent to which carbon neutral transportation can be achieved;

3. Deployment of battery electric vehicles (BEVs) in Catania, Gela and Valletta harbour areas to partly substitute combustion engine vehicles used in port operations;

4. Study options for future policy implementation to further decarbonise port areas, including a study on the feasibility of on-shore energy supply technology for berthing vessels in ports which would enable them to access their power supply from the national grid rather than using on-board engines powered by heavy fuel oil.

Several factors contributed towards the design of this project including greenhouse gas emissions emanating from several port activities and their influence on climate change; localised air pollution emitted from these activities synonymous with port areas; noise emissions generated from both ships and vehicles; and the resulting effects of all the above on the population residing within and around the partner port areas.
1.3 THE PARTNERS

1.3.1 TRANSPORT MALTA

‘TRANSPORT MALTA’ is the Authority for Transport in Malta set up by Act XV of 2009 which brought together the Malta Land Transport Authority, the Malta Maritime Authority and the Civil Aviation Directorate. The Authority falls under the responsibility of the Ministry for Transport and Infrastructure.

Transport Malta (TM) regulates all modes of transport (road, sea and air) including regulation of all forms of public transport systems and operations.

Through Transport Malta the Government endeavours, to achieve the following main objectives and policies:

- develop integrated transport policies aimed at achieving modal shifts that favour public transport and non-polluting strategies;
- ensure the development of an efficient and socially sustainable transport system in Malta, both on land and on sea;
- promote the maritime and civil aviation facilities of Malta and the registration of ships and aircraft under the Maltese flag;
- promote policies that favour the development of Malta as a maritime hub in the Mediterranean and as an entry-port to the European Union;
- encourage measures for the development of civil aviation and ancillary services, and in particular of air transport services of both passengers and cargo;
- ensure that the administration, services and operations of ports and yachting centres in Malta are efficient and cost-effective;
- maritime pollution control.

1.3.2 PORT AUTHORITY OF CATANIA

The Port Authority of Catania is a public body established by the Italian Law n. 84/94 in order to plan, promote and monitor port operations and related commercial and industrial activities in the ports falling under its responsibility.

The Port Authority is also responsible for maintenance of common port areas and the provision of general services at ports. The Port Authority has also the institutional task of promoting national and international activities of the port, in order to facilitate its insertion in the enterprise and in international trades.
The Ministry’s mission is to promote and develop the transport sector in Malta by means of proper regulation and by the promotion and development of related services, businesses and other interests, both locally and internationally and to enable the effective implementation of programmes and capital infrastructural projects which fall within the Ministry’s responsibility.

1.3.4 PROVINCE OF CALTANISSETTA

The Regional Province of Caltanissetta is one of the nine provinces of the Sicilian Region. It is the local government in the territory and is formed by the union of 22 municipalities, including the Municipality of Gela. The Province population amounts to a combined total of 250,000 inhabitants, while the Province employs 400 employees.

Its main duties include:
1. building and maintaining of state secondary schools;
2. building and maintaining of provincial streets;
3. environmental protection;
4. promoting of the local development: agriculture, handicraft, tourism, industry, trade and professional training;
5. promoting of the politics for development, cohesion and regional, national and community agreement;
6. enhancing social and cultural politics.

Through delegation of administrative functions, the Province can ensure the management of interventions and services the responsibility of municipalities, in cooperation with municipal bodies, as well as functions delegated by the Region.
1.4 PARTICIPATING PORT AREAS

1.4.1 MALTA

Malta’s Capital City of Valletta is bordered by two main harbours; the Grand Harbour and Marsamxett Harbour.

The Grand Harbour is Malta’s main port, and one of the most spectacular natural deep water harbours in the Mediterranean, adorned by its majestic fortifications of massive proportions built by the Knights of St. John during their long stay in Malta.

These two ports on each side of Valletta, particularly the Grand Harbour, girdled by this uninterrupted line of fortifications, which is becoming an increasingly popular port of call for cruise passengers and related growth in the cruise industry as well as other leisure and sporting events and activities such as international yacht regattas.

Apart from acting as a safe and secure haven for seafaring vessels of all types and sizes, the Valletta Grand Harbour also offers a comprehensive service covering practically all maritime industries; including cruise liner and general cargo berths, petroleum installations, bunkering facilities as well as ship and yachting repair services. The Valletta Grand Harbour sees an annual total average of 510,808 passengers, which is more than the total population of Malta. The Grand Harbour also provides the link between Malta and Sicily through a service operated privately by Virtu Ferries that offers daily connections between the ports of Valletta and Pozzallo.

The Marsamxett Harbour, on the other hand is the northern of Valletta’s two natural harbours, separated from the southern one (Grand Harbour) by the Valletta peninsula. To the north it is surrounded by Gżira and Sliema as far as Dragut Point and extends inland to Pietà and Msida. It is generally more dedicated to leisure use than is the Grand Harbour. Marsamxett Harbour facilities include primarily a yachting port with marinas, a yacht yard, and berths for passenger commercial vessels for harbour and round-Malta cruises.

Of the seven islands that form the Maltese archipelago, Gozo is the second largest. The sister island can be reached by sea through a scheduled Ro-Ro ferry service operated by Gozo Channel Co. Ltd. The service operates from the Port of Cirkewwa (situated at the northern most tip of Malta) and from Marsamxett to the Gozitan Port of Mgarr. The Malta-Gozo channel sees a total annual average of 20,000 trips catering for both passengers and cargo transport between the two islands.

Beneficiaries within the Participating Port Areas

A total of 199,266 people reside within and adjacent to the project demonstration area; i.e. the Valletta Grand Harbour and its hinterland (Malta Census, 2011). 52,995 residents live directly adjacent to the Harbour in localities such as Valletta, Msida and Ta’Xbiex, while 146,271 people live in the Harbour hinterland also known (for national statistical purposes) as the Southern Harbour and Northern Harbour districts.

Beneficiaries directly affected: 52,995 residents
Beneficiaries indirectly affected: 146,271 residents

The total number of tourists who visited Malta in 2014 amounted to 1,689,809, 90% of which (1,520,828 tourists) visited Valletta which is the main PORT-PVEV project demonstration area in Malta (Market Profile Analysis, Ministry for Tourism, 2014).

Of these, 471,554 were cruise passengers who passed through the Valletta Grand Harbour between January and December 2014 (NSO Data). In the first quarter of 2015, a total of 20,653 cruise passengers passed through the Valletta Grand Harbour (NSO Quarterly Data). This makes a total of 492,207 of cruise passengers who landed in and passed through directly from the project demonstration area since the demonstration actions were launched within the harbour area.

Beneficiaries directly affected: 492,207 tourists
Beneficiaries indirectly affected: 1,520,828 tourists

Photo credit: Peter Paul Barbara
Apart from the above, one also needs to consider the number of workers commuting through and working in the project demonstration area, which is also the Central Business District for Malta; Transport Malta alone directly employs 554 employees. However, the data is unavailable to calculate the total number of employees working directly in the demonstration area. Therefore, as a minimum number of subjects, the employees working at Transport Malta is taken as the number of beneficiaries directly benefiting from the project as well as employees made aware of the project.

**BENEFICIARIES DIRECTLY AFFECTED:**

**554 EMPLOYEES**

According to the National Household Travel Survey, a survey which takes place every 10 years, 37,583 commuters travel through the project demonstration area and who, therefore, are made aware of the project through the various information and dissemination activities which have taken place during the lifetime of the project (NHTS, 2010).

**BENEFICIARIES DIRECTLY AFFECTED:**

**37,583 COMMUTERS**

Between October and December 2014 a total of 1,040,122 passengers made use of the ferry terminal at Ċirkewwa. Between January and March 2015, the number of passengers amounted to 842,193. Therefore, a total of 1,882,315 passengers were directly exposed to the PORT-PVEV project actions implemented at the Ċirkewwa Terminal.

**BENEFICIARIES DIRECTLY AFFECTED:**

**1,882,315 FERRY PASSENGERS**
1.4.2 SICILY
1.4.2.1 PORT OF CATANIA

Catania is the capital city of the Province of Catania situated on the east coast of Sicily along the Ionian Sea. A major section of Catania’s coastline is dominated by its port which, over the years, has become one of the most important “gates” to the island. The port affects a vast geographical area and includes six of the former provinces of the island, who use the port for the transport of goods to domestic and international markets, thanks to the maritime connections assured by major Italian shipping companies.

A total of 3,817 ships called at the Port of Catania in 2014 carrying a total of 5,847,707 tonnes in cargo.

Beneficiaries within the Participating Port Areas

A total of 1,115,704 people reside within and adjacent to the project demonstration area; i.e. the Province of Catania (ISTAT and Catania Province, 2013); 58,187 residents live in the Municipal District including adjacent to the port of Catania and the Historic Centre, while 323,409 people live in the entire Harbour hinterland constituted by the Catania Municipality (ISTAT and Catania Municipality, 2013).

Beneficiaries directly affected:

58,187 residents

Beneficiaries indirectly affected:

323,409 residents

Apart from the above, one also needs to consider the number of workers commuting through and working in the project demonstration area, which is also the competence area of Catania Port Authority; totally, public and private companies, port operators, agents and other enterprises operating inside the port of Catania amount to 2,229 employees (source: Catania Port Authority).

Beneficiaries directly affected:

2,229 employees

In 2014 a total of 141,967 passengers made use of the ferry terminals in Catania Port. Between January and February 2015, the number of passengers amounted to 12,803. Therefore, a total of 154,770 passengers were directly exposed the PORT-PVEV project actions implemented at the Catania Port Area.

Beneficiaries directly affected:

154,770 ferry passengers

The total number of tourists who visited the Province of Catania amounted to 734,697 tourists, 364,097 of which have visited the City of Catania (ISTAT and Province of Catania, 2013).

Of these, 232,632 were cruise passengers who passed through the Port of Catania between January and December 2014 (source: Catania Port Authority). Between 2013 and 2014 a total of 323,619 cruise passengers landed in and passed through directly from the project demonstration area.

Beneficiaries directly affected:

323,619 tourists

Beneficiaries indirectly affected:

364,097 tourists

In 2014 a total of 141,967 passengers made use of the ferry terminals in Catania Port. Between January and February 2015, the number of passengers amounted to 12,803. Therefore, a total of 154,770 passengers were directly exposed the PORT-PVEV project actions implemented at the Catania Port Area.

Beneficiaries directly affected:

154,770 ferry passengers

Apart from the above, one also needs to consider the number of workers commuting through and working in the project demonstration area, which is also the competence area of Catania Port Authority; totally, public and private companies, port operators, agents and other enterprises operating inside the port of Catania amount to 2,229 employees (source: Catania Port Authority).

Beneficiaries directly affected:

2,229 employees

In 2014 a total of 141,967 passengers made use of the ferry terminals in Catania Port. Between January and February 2015, the number of passengers amounted to 12,803. Therefore, a total of 154,770 passengers were directly exposed the PORT-PVEV project actions implemented at the Catania Port Area.

Beneficiaries directly affected:

154,770 ferry passengers
1.4.2.2 PORT OF GELA

Located on the South-West coastline of Sicily, the Port of Gela, finds itself in a strategic position in the Mediterranean due to its equidistance from the Suez Canal and the Strait of Gibraltar. It is a key actor in the maritime sector especially as part of traffic passing along the North-South and East-West Mediterranean routes.

Through the PORT PVEV Project, the city of Gela has been involved in a number of pilot actions in order to implement, test, evaluate and disseminate electromobility in and around its port areas and surroundings, according to the formal convention of 25.11.2013 signed by the Municipality of Gela and the Regional Province of Caltanissetta now Free Municipal Consortium of Caltanissetta.

The port area in Gela consists of three operational areas:

1. The industrial port area made up of the Isola Port, the adjoining breakwater and the retroport petrochemical site.
2. The port-urban area falling into the coastal area that includes Gela city centre, the so-called Rifugio Port, the old Sbarcatoio pier with the adjacent area of the disused Coast Customs;
3. The hinterland consisting of the retro-port areas that connect the aforementioned port sites and interact functionally and logistically with them.

Due to specific project objectives, Municipality of Gela decided to concentrate all the project actions within the port-urban and the urban areas of Gela.

Beneficiaries within the Participating Port Areas

In this regard, the demonstration area of the project is considered to be the Province of Caltanissetta and the Gela harbour area as well as its hinterland. Equipment and Infrastructure procured by the project has been deployed in Gela as established by the Agreement signed by the two Institutional bodies during project implementation. On the other hand, information and awareness has been disseminated in both Gela and the Province of Caltanissetta.

Keeping this in mind, beneficiaries made aware of the project, and beneficiaries benefitting from the project can be determined as follows:

A total of 76,826 people reside within and adjacent to the Gela harbour area, while a total of 63,034 people reside in Caltanissetta. Different project actions have been implemented in both demonstration areas, therefore residents benefitting from the positive effects of the project (improved air quality and lower carbon emissions) and residents made aware of the project actions through the various information and awareness activities amount to a total of 139,860.

Beneficiaries directly affected:

76,826 residents

Beneficiaries made aware of the project:

139,860 residents

The total number of tourists who visited Gela and Caltanissetta in 2014 amounted to 63,254. This makes a total of 63,254 tourists who stayed at and passed through directly from the project demonstration area; and therefore made aware of the project actions through the various information and awareness activities.

Beneficiaries made aware of the project:

63,254 tourists

Considering the number of workers commuting through and working in the project demonstration area, the Province of Caltanissetta directly employs 350 employees, while the Municipality of Gela employs 454 employees. Data regarding the number of other workers commuting to and working directly in the project demonstration area is unavailable. Therefore, as a minimum number of subjects, the employees working at the Municipality and at the Provincia is taken as the number of beneficiaries directly benefiting from the project as well as employees made aware of the project.

Beneficiaries directly affected:

454 employees

Beneficiaries made aware of the project:

804 employees
According to the National Statistics Office, over the last fifty years the mean temperature of the Maltese islands has increased by 0.23°C every ten years while Greenhouse Gas Emissions increased by 49% in Malta between 1990 and 2007. The National Statistics Office also reports that as at September 2013, the stock of licensed motor vehicles in Malta stood at 321,425; up by 0.8% over the previous quarter. Of these, 79.3% are passenger vehicles, 14.4% commercial vehicles and 5.2% are motorcycles. Buses and minibuses accounted for less than 1% of the total vehicle fleet. By 2014, the number of vehicles on the road increased by 1,535 amounting to a total of 322,960 – equivalent to 0.75 vehicles per capita. These vehicles were responsible for 500,000 tons of CO₂ emissions in 2014 which roughly amounts to 1.3 tonnes of CO₂ emissions per vehicle over a 12 month period (source: Malta Resources Authority).

Nitrous Oxide (NO₂) is one of the gases primarily emitted by combustion engine vehicles. Therefore by mapping NO₂ emissions it becomes clear where the areas of high traffic concentrations lie; ergo the localities most severely affected by transport emissions.

In this regard, the 2008 State of the Environment Report states that “although the annual average national NO₂ concentration remained well below the 40μg/m³ EU and the World Health Organisation (WHO) limit value, it continued to increase between 2006 and 2007, from 25.4μg/m³ to 28.9μg/m³ respectively. In 2007, annual average values exceeded annual EU standards in 6 localities namely, Floriana (50.6μg/m³), Fgura (49.9μg/m³), Sliema (45.4μg/m³), Mosta (42.0μg/m³), Gżira (41.7μg/m³) and San Gwann (40.8μg/m³).

“Furthermore, 27 individual sites registered NO₂ levels higher than the EU and WHO limit, with St. Anne’s Street” located in Floriana, “increasing by 6% to 98.4μg/m³ in 2007” making it one of the most polluted streets in Malta.

This is more clearly shown in the figure below which maps out NO₂ emissions across Malta through data gathered by the Malta Environment and Planning Agency (Mepa) in 2015 by means of diffusion tubes.
In Italy, the national emissions average per vehicle as recorded in 2014 amounts to 118 g CO₂/km, which is higher than the EU set average for 2020 at 95 g CO₂/km. Taking the project demonstration area into account a total of 180,000 tonnes of CO₂ emissions has been recorded in Gela in 2011, 50% of which are emitted solely from the transport sector.

These figures make it abundantly clear that the areas with the highest gas concentration are the harbours of Valletta themselves and their hinterlands which spread out over the Northern and Southern Harbour districts.

What is alarming is that 47.9% of the population live in these two districts. More specifically, 14.8% of the population reside right adjacent to the Grand Harbour and Marsamxett harbour in localities such as Sliema, Gzira, Ta Xbiex, Floriana, Marsa and Cottonera.

SICILY

In Italy, the national emissions average per vehicle as recorded in 2014 amounts to 118 g CO₂/km, which is higher than the EU set average for 2020 at 95 g CO₂/km.

Taking the project demonstration area into account a total of 180,000 tonnes of CO₂ emissions has been recorded in Gela in 2011, 50% of which are emitted solely from the transport sector.

The following tables show the emissions recorded in the Municipality of Gela in 2011.

Absolute values of total CO₂ emissions by sector in the municipality of Gela

Percentage values of total CO₂ emissions by sector in the municipality of Gela

Considering only the Municipal utilities, transport has been responsible for 99.52 tonnes of CO₂ emissions during the year in question.
2.2 TARGETED LEGISLATION

As things stand, the current European Climate Change and Energy targets which were approved by the European Council in 2008 in the form of the Climate Change and Energy Package are the following:

1. Cutting Greenhouse Gas Emissions by 20% when compared to 1990 levels
2. Having 20% of energy consumption through increased energy efficiency
3. 20% of EU energy needs must come from renewable energy sources
4. 10% of all transport fuel must come from renewable energy sources

As EU Member States, both Malta and Italy are bound by these climate change regulations and policies in order to contribute towards the overall European target to limit the increase of the mean surface temperature to 2°C less when compared to pre-industrial levels.

DECISION No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community’s greenhouse gas emission reduction commitments up to 2020

The Effort Sharing Decision (ESD) was derived out of the 2009 EU Climate and Energy Package which sets out the EU’s commitments as identified above. The ESD sets objectives for reducing emissions for each of the Member States and defines the means for checking whether they have been met.

The ESD covers the six greenhouse gases controlled by the Kyoto Protocol during its first commitment period (2008-2012): carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) which are emitted from road transport and domestic navigation, waste, agriculture, industrial processes, solvent and other product use, fuel combustion in industry and in the residential, institutional and commercial sectors, as well as fugitive emissions from fuels. Non-CO₂ emissions emanating from the energy production sector also falls under the remit of the ESD while CO₂ emissions from the energy production sector, along with emissions from the international aviation sector fall under the Emissions Trading Scheme, (another regulation falling under the Climate Change and Energy Package).

As a result of the Effort Sharing Decision:

- Malta must limit its emissions from the sectors listed above to no more than 5% increase in GHG Emissions compared to 2005 Levels.
- Italy must reduce its emissions from the same sectors by 13% GHG Emissions compared to 2005 Levels.

DIRECTIVE 2014/94/EU on the deployment of alternative fuels infrastructure

Transport in Europe is 94% dependent on oil, 84% of it being imported, with a bill up to EUR 1 billion per day, and increasing costs to the environment. With this in mind and with the presumption that alternative fuels are urgently needed to break the over-dependence of European transport on oil, the Clean Power for Transport package was issued with the aim to facilitate the development of a single market for alternative fuels for transport in Europe.

The final Directive 2014/94/EU, endorsed in September 2014:

- Requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure;
- Foresees the use of common technical specifications for charging and refuelling stations;
- Paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.

Among other things, the national policy frameworks are required to cover:

- Electricity for road transport in urban/suburban and densely populated areas
- Electricity to berthed vessels at shore-side

More specifically, the Directive states that “charging points should be established taking into account the number of electric vehicles estimated to be registered by the end of 2020 in each Member State. As an indication, the appropriate average number of recharging points should be equivalent to at least one recharging point per 10 cars.” Taking Malta as an example, the target set for the number of EVs to be on the road by 2020 is at 5000; therefore, as a result of this Directive, Malta is also required to install at least 500 charging points on the road network by the same year.

In terms of Shore-Side electricity facilities, the term refers to the provision of shore-side electrical power through a standardised interface to seagoing ships or inland waterway vessels at berth. This can serve maritime and inland waterway transport as clean power supply, in particular in maritime and inland navigation ports where air quality and noise levels are poor. Shore-side electricity can contribute to reducing the environmental impact of sea-going ships and inland waterway vessels.

In this regard, the Directive states that “Member States shall ensure that the need for shore-side electricity supply for inland waterway vessels and seagoing ships in maritime and inland ports is assessed in their national policy frameworks. Such shore-side electricity supply shall be installed as a priority in ports of the TEN-T Core Network; and in other ports, by 31 December 2025; unless there is no demand and the costs are disproportionate to the benefits, including environmental benefits.”
CONTRIBUTION TOWARDS: CUTTING GREENHOUSE GAS EMISSIONS BY 20%

As previously specified, much of Europe’s road transport depends heavily on oil. Combustion engine vehicles emit a cocktail of harmful emission gases, much of which are cancerous, including Nitrous Oxide, Carbon Dioxide and Carbon Monoxide.

The fact that Electric Vehicles do not emit any tail-pipe emissions offers a significant solution to the improvement of air quality, especially in urban centres.

To this effect, the project deployed a total of 44 electric vehicles aimed at replacing combustion engine vehicles previously in use by the Partner Entities. While cutting on emissions within urban centres throughout the demonstration period, as well as after the end of the project, the electric vehicles will also help to serve as a data source that will be eventually used for future policy development as well as a demonstration source; showing other entities of similar size and function, the practical feasibility of electric vehicles, with the aim of the further deployment of electric vehicles across the partner territories and across Europe.

CONTRIBUTION TOWARDS: 20% OF ENERGY CONSUMPTION THROUGH INCREASED ENERGY EFFICIENCY

The use of EVs may also help improve grid efficiency, especially during EV night charging. Energy storage in batteries of vehicles reduces adverse fluctuation effects on the grid and facilitates the continued expansion of solar energy in the whole system. Having a large national EV fleet and their integration in the national grid will also raise the efficiency of conventional power stations, when the demand for energy is low, for example during the night, which in turn will contribute towards the reduction in demand for fossil fuels.

2.3 HOW PORT-PVEV MEETS THE DEMAND

CONTRIBUTION TOWARDS: 20% OF EU ENERGY NEEDS FROM RENEWABLE ENERGY SOURCES

Through the installation of a Photovoltaic Plant at the Transport Malta Head Office and solar car ports in both Malta and Catania, solar energy is being produced as a result of this project and fed into the respective national grids, thus contributing to the overall share of electricity produced through renewable sources.

CONTRIBUTION TOWARDS: 10% OF ALL TRANSPORT FUEL FROM RENEWABLE ENERGY SOURCES

Energy produced from renewable sources can be used to offset the electricity required for the propulsion of electric vehicles. All renewable sources that feed into the grid contribute to reduce the Emissions Factor (EF) of the charging of all electric vehicles from the grid. It is therefore possible to reduce the electric vehicles’ EF by increasing the proportion of renewables feeding in the grid, no matter the location of the renewable source. Through the Malta-Italy electricity interconnector, the Natural Gas Hybrid Power Plant (NGHPP) of the Gela power station in Sicily and the Malta Electricity Grid, it has become easier to purchase electricity produced through cleaner methods and which electricity is available on the European grid. To this effect more distant renewable sources (e.g. North sea Wind) can also be used locally to further offset the electric vehicles’ EF. In this regard, however, the PORT-PVEV project went a step further by constructing solar charging stations which utilise converted solar energy to charge the electric vehicles directly. In this regard, therefore, the transport fuel is 100% renewably sourced making the use of electric vehicles at carbon zero.

CONTRIBUTION TOWARDS: TARGETS SET UNDER THE ALTERNATIVE FUELS DIRECTIVE

The Alternative Fuels Directive was published in 2014; two years after the PORT-PVEV project started its implementation in 2012. In spite of this, the project has inadvertently targeted the policies set in the Directive on two scores.

Electricity for road transport in urban/suburban and densely populated areas

Through the project a total of 45 charging points providing electricity for EVs have been deployed on the road networks of Malta, Catania and Gela thus greatly contributing towards the respective national targets of one point per ten EVs which each Member State is now bound to implement by 2020.

Electricity to berthed vessels at shore-side

The Directive states that each Member State is to develop national policy frameworks which incorporate demand and cost/benefit analysis for the provision of services including that of shore side energy supply to berthed vessels. In this regard, a full feasibility study into the matter, focusing on the Valletta Harbours, has already been compiled through the PORT-PVEV project; meeting the Directive’s requirements on the issue.

Photo credit: Peter Paul Barbara
CHAPTER 3

THE SCOPE OF THE PROJECT

THE PORT-PVEV OBJECTIVES WILL BE REACHED IN TWO WAYS:

- DEMONSTRATION
- STUDIES

3.1 DEMONSTRATION

Back in 2011, when the PORT-PVEV project was still at design phase, electromobility in both Malta and Sicily was still very unpopular and take-up of this new technology was very slow. Seeing the potential that electromobility has for both regions to improve their local air quality levels, mitigate climate change and at the same time contribute towards meeting the targets set in the 2020 Climate Change and Energy Package, the demonstration element for this project became an important element in the project’s design since by seeing the vehicles and green infrastructure in operation, the public can understand better the advantages that can be achieved from switching to electromobility, thus encouraging market uptake of electric vehicles. Apart from this, apart from the fact that electric vehicles are relatively cheaper to operate and maintain when compared to their conventional counterparts.

In the public mind, many prejudices against electric mobility were present at the time in terms of fears on the battery autonomy of electric vehicles; lack of information in the type and availability of EVs on the market; misconceptions on the costs involved, especially when comparing the operational costs of conventional vehicles as opposed to electric vehicles; negative impressions on the actual feasibility, efficiency and safety of EVs.

Through its actions, the PORT-PVEV project was designed to offer the true picture of electromobility by targeting both the public at large and, more specifically, private companies who own and operate large vehicle fleets.

At project design, it was believed that if electromobility is going to seriously contribute towards the mitigation of climate change, while every single vehicle replacement from combustion engine to clean electric will make a difference; the switch to electromobility has to come in very large numbers. Moreover, in terms of cost savings, owners of large vehicle fleets stand more to gain. The truth of this fact became amply clear during the project implementation. Results and analysis are described in detail in chapter 4.

To effectively address the relevant audiences, the choice of the partners was essential. Being road transport regulators, port authorities and provincial administrators, the four partners were well positioned to set the policy and lead by example when that policy is being enacted. Any action taking place by the Participating Partners can leave extensive impacts in that Partner’s respective sphere of influence. Therefore when the port authorities of Catania and Malta implement actions which contribute towards decarbonising the port they are regulating, those actions add in effect as the actions that are implemented can target the specific areas where the problems lie. Same goes when the Province Administrators implement actions within the Province itself.

Moreover, this project did not treat its four partners solely as Regulators and Public Administrators; it considered each partner as an employer, a fleet owner and operator dealing with the same corporate operating costs and daily operations as any other private company. Therefore, actions aimed at reducing own energy bills, maintenance
blocks spans over 1,704.22 square metres. As part of the pilot actions, the PORT-PVEV sought to answer the following questions:

- What is the maximum Solar Power in kWh which can be produced annually on site, when using the entire surface area available within a given building?

- Does the total kWh generated through the PV installation offset the energy needed by the same building? And can the Port Operations Building become carbon neutral solely through the offsetting of energy used compared with clean energy produced on site?

- How much savings in carbon emissions is the Malta Transport Centre building making as a result of the PV installation?

Further to reducing the building’s dependence on conventional electricity, the project also sought to study how the operations of the port authority can be decarbonised. The Port Authority of Catania, Transport Malta and the Municipality of Gela all engage in day-to-day activities which heavily depend on the use of road transport. Be it the performance of road-side checks, enforcement, maintenance; all are activities which necessitate the use of a car. In order to help decarbonise these activities, therefore, the PORT-PVEV partnership deployed a total of 44 full electric vehicles ranging from passenger cars, light goods panel vans, crew-vans, quadricycles, and electric bicycles. The variety of the fleet represents the various uses which these vehicles were then applied to.

The use of electric vehicles in day-to-day operations is in itself a very effective means of directly reducing emissions within the port area; be they carbon related, air emissions or noise. In fact, the project sought to understand precisely how much carbon emissions are being saved through the direct use of electric vehicles. To properly go about answering this, the questions were shaped as follows:

- What CO₂ in Kg is emitted over a distance in a kilometre driven by a conventional light goods van and a conventional M1 Passenger vehicle?

- Considering the fleet deployed as part of the project is in fact replacing the use of combustion engine vehicles, what is the annual savings in CO₂ kg being made through the direct use of the electric vehicles?

- Considering that electricity for re-charging is being off-set by the power generated through the PV Plant, what is the annual savings in CO₂ kg being made through the direct use of the electric vehicles?

- If the full potential fleet (the maximum number of EVs which can be deployed while still being supported solely by the power generated by the plant on location) is purchased, how much annual Kg CO₂ will be saved?

To support the fleet of electric vehicles deployed through the project, charging infrastructure was also purchased and installed at the different port administration premises and at public spaces within the participating port areas. As the fleet varies in the types of vehicles deployed, so too does the infrastructure installed to support it; from triple point fast charging pillars able to charge 80% of a vehicle battery in less than 30 minutes, to single-point mounted wall boxes.

The purpose for the installation of charging infrastructure is dual in this case. Apart from being necessary to re-charge the on board vehicle batteries, the charging points within the port administration premises were also crucial to help the project team understand the following issues:

- Does the total kWh generated from the PV plant on the building roof offset energy used by the current EV fleet?

- How many further vehicles (if any) can be deployed for the current installation to still support in full the energy required by the EVs?

- Does the total kWh generated from PVs offset energy used by the current EV fleet and the building?
Further to the above, does any kWh generated remain to cover the purchase of more EVs while still supporting the current fleet and the building, therefore allowing the deployment of further EVs and still remaining carbon neutral?

By considering the PV installations made through the project and the deployment of the electric vehicles in the three territories, further studies could be carried out, particularly to determine the costs being saved, if any, from operating the green infrastructure as opposed to depending only on conventional electricity and combustion engine vehicles. In this regard, the questions answered by the project were subdivided in two sections; the first dealing solely with the operational costs of the vehicle fleet, while the second dealt with the PV installation:

**ELECTRIC VEHICLES**

- What is the cost for petrol and diesel (separately) per kilometre travelled by a combustion engine vehicle?
- What is the cost for electricity per kilometre travelled by an electric vehicle?
- Considering the mileage travelled as average per car used by the Partner, what is the cost of the fuel purchased in a given year?
- Considering the same mileage as above, what are the electricity costs to support this mileage?
- Considering the fleet purchased through the project, what are the annual costs, if any, being saved on propulsion by substituting the fleet from combustion engine to electric?
- What will the annual savings be on fuel costs if the full potential fleet (the maximum number of EVs which can be deployed while still being supported solely by the power generated by the PV Plant on location) is deployed?

**Photo Voltaic PLANT**

- If it is concluded that the energy produced by the PV plant is sufficient to cover the electricity needed by the EVs; and considering maintenance costs; what is the total annual operation cost for an electric light goods van and an electric M1 vehicle?
- Considering the entire fleet deployed by the project, what is the total annual operational cost being saved on the vehicles when compared to the same number of combustion engine vehicles?

- What are the annual average costs spent on combustion engine vehicle maintenance?
- Considering the pilot year, what were the costs spent on electric vehicles maintenance?
- How much money in maintenance is being saved annually, if any, by using the EV fleet?
- How much money in maintenance would be saved annually if the full potential fleet is purchased?
- What is the total cost of insurance for a conventional light goods van and a conventional M1 passenger vehicle?
- Considering Fuel, Maintenance and Insurance costs: what is the total annual operational costs for a conventional light goods van and a conventional M1 passenger vehicle?
- If the PV Plant is being used solely to feed electricity into the grid, how much cost in energy bills is TM saving as a result of the PV Plant?
- After deducting the electricity utilised to power the electric fleet, how much cost in energy bills, if any, is still being saved annually by the organisation?

On the other hand, the deployment of charging infrastructure forming part of this project goes further than simply providing the re-charging needs...
of an electric car. Through the PORT-PVEV Project a main demonstration element was to test the extent to which carbon neutral transport can be achieved. To do this, three solar car charging stations in Malta and one in Catania were constructed in public car parking areas within the port area. From these stations, the project sought to test:

- The maximum kWh which can be produced on site from a parking structure of a size which fits the limitations of a public car park;
- The maximum kWh which can be stored in batteries on site, before the energy produced on location spills over and feeds into the grid;
- Whether the energy stored within the battery is sufficient to support a single EV charge in full;
- The number of EVs which can be charged using the site battery, before same battery is depleted and electricity is supplied from the grid.

By answering the above questions, the project could then determine the extent to which carbon neutrality can be achieved.

Here, it is pertinent to point out that carbon neutral transportation is to achieve a net zero carbon emissions during a vehicle's propulsion. Consequently, the production and use of a fuel that is not generated through a carbon free process cannot be considered as carbon neutral when applied to a vehicle's propulsion.

With regards to the solar car charging stations installed as part of the PORT-PVEV project, carbon neutral transport is deemed possible since the solar power generated on site (through the PV array installed on the car-port roof) is stored in batteries (also found on site) and fed into electric vehicles, which themselves do not emit any tailpipe emissions during propulsion. In this case, therefore, carbon emissions are neither being released during the production of the fuel nor are they being discharged during propulsion.

The demonstration element of this project was further extended to the charging and use of electric bicycles. Three stand-alone e-bike charging stations were installed in Catania. Like the solar car-ports, the e-bike stations are covered in a PV array, thus producing energy on site, with the difference that the e-bike stations operate completely off-grid. Therefore, the entire power needed to charge the electric bicycle motors is generated using solely the energy from the sun.

In sum, the demonstration element of this project was maximised as widely as possible: the wide range of vehicles and infrastructure deployed as part of this project was meant to serve as a demonstration in itself. The infrastructure has been installed at public and highly visible locations within the port areas to ensure better access to users. Moreover, as a direct consequence of this project, tourists visiting the port area of Catania will be able to make use of electric bikes to travel around the city; municipality officials working at the Gela port area will be making use of crew vans and passenger cars to carry out their duties; port administration officers in the Valletta Grand Harbour will be making use of full electric quadricycles and crew vans as well as passenger cars for their work-related travel needs.

Over a twelve month period, all these different types of vehicles have been demonstrated as part of the pilot project and will continue to be used after the end of the project lifetime; the feasibility of the cars tested and their efficiency promoted in view of a wider uptake of green energy solutions.

3.2 STUDIES

In 2011, the concept of electromobility was new to everyone, not only for the public to accept but also for policy makers to understand and mould the solutions the technology provides in the best possible manner to meet the demands of the respective territories and areas of remit.

The studies forming part of this project therefore were crucial in this regard. Through the data gathered and data analysis as part of the demonstration phase of this project, the Partners could use the results achieved to suggest future policy by elaborating on the actions that have yielded positive results and tweak those actions which were not as successful in a bid to propose the measures that would lead to the most beneficial results in the future.

Following this methodology, Local Green Plans have been compiled that propose future actions which can be implemented to further green port areas and the operations therein. The Local Green Plans are scheduled for implementation following the end of the PORT-PVEV project, therefore acting as a second phase to the project itself.

Much of the actions forming part of this project are aimed at greening road transport within given port areas. Considering the commercial activity which takes place in the area in question, road transport is a major factor in the pollution synonymous to the harbour. However, PORT-PVEV goes further and attempts to tackle ship emissions as well.

As part of the project a detailed study has been compiled into the feasibility of grid-connected infrastructure to power berthded vessels using electricity instead, supplied from on shore electricity grid rather than using the on-board high-polluting heavy fuel oil to power ships’ hotelling needs. If implemented in practice, the system, also known as Cold Ironing, will not only improve air quality within the port area but also vastly reduce noise emissions generated by ship engines to the particular benefit of residents living in and around the harbours.

3.3 METHOD OF IMPLEMENTATION

The PORT-PVEV project has been divided into three separate phases of implementation.

Phase 1

During the first phase of this project, the managing team compiled a Cross-Border Action Plan which provided dynamic operational guidelines to be followed by the four partners during the technical implementation of the operative work packages which were carried out during the second and third phases of implementation.

In parallel, the project team also compiled the Communication Guidelines which have helped to create a holistic corporate image of the project to be used in disseminating information in the three territories.

Phase 2

The second phase saw the procurement, construction, installation and deployment of the equipment and infrastructure which were necessary to bring about the objectives of the PORT-PVEV project, namely the greening of the partner port areas. This phase therefore included the purchase of the 44 full electric vehicles, the setting up of supporting charging infrastructure, the installation of solar-power generating infrastructure on buildings and solar charging stations in the port areas.

Phase 3

During the third phase, also known as the pilot phase, the equipment and infrastructure were tested and evaluated. Through the data gathered and analysed the partners could then develop strategic local plans to guide policy makers on the possible future implementation of proposed actions to further decarbonise port areas.

This phase also included the publication of the results and data analysis reports. Such reports have been disseminated with stakeholders and the general public in order to maximize the results achieved by this project.
3.4 PROJECT ACTIVITIES AND OUTPUT
3.4.1 ACTIVITIES AND OUTPUTS IN MALTA

Transport Malta

In the design and deployment of the project activities, Transport Malta focused on the production of green energy and its use to reduce the carbon footprint of the main administration building by also using same energy to power electric vehicles. Apart from reducing the organisation’s carbon footprint, Transport Malta’s scope also extended to reduce the overall emissions – be they air and noise – within the port area.

The actions undertaken by Transport Malta as part of this project could therefore be summarised as follows:

1. Deployment of 13 full electric vehicles including 2 light goods vans, 4 crew vans, 3 passenger cars, and 4 quadricycles (specifications for each vehicle can be found below);
2. The installation of a Photovoltaic Plant on the roof of Malta Transport Centre, which is situated along the Deep Water Quay in the Valletta Grand Harbour;
3. The installation of three charging pillars at the Malta Transport Centre, offering a total of six three-phase charging points, to charge the vehicles deployed as part of the project (specifications for each charging pillar can be found below);
4. Installation of the first fast electric car charger in Malta;
5. Compilation of a study into the feasibility of deploying infrastructure offering shore side energy supply to berthed vessels visiting the ports of Valletta.

Ministry for Transport and Infrastructure

The focus of the Ministry’s actions was the testing and demonstration of carbon neutral transport and the extent to which it can be made available to the public.

To achieve this, three solar charging stations have been installed in key and prominent car parks in Maltese port areas, namely at the:

1. Deep Water Quay car park in Marsa:
   Marsa Deepwater Quay is located at the Grand Harbour, close to Valletta and adjacent to the Malta Transport Centre. The area, which is currently being refurbished and upgraded, is used for the handling of cargo, cruise and petroleum vessels, and other operations such as passenger handling, cargo storage and container stacking.
2. Ta’ Xbiex Marina car park:
   Ta’Xbiex Yacht Marina together with the Msida Marina is the largest marina in Malta, together providing mooring facilities for more than 700 boats on 15 serviced pontoons. The marina is located at the Marsamxett Harbour.

Each carport structure is made of galvanised steel and is designed to accommodate four EVs and one equipment room. Three sources of power supply the structure to charge EVs:
- a PV array mounted on top of the carport structure;
- a lithium-ion storage battery;
- the utility grid.

Each carport houses two dual-point charging pillars. One of the charging-pillars is connected directly to the grid, as per conventional practice. The second charging pillar draws electrical power directly from the PV array, backed up by the lithium-ion battery, and by the utility grid if the electrical power from the PV array and from the battery is not sufficient to sustain full EV charging requirements in terms of capacity and/or throughput.

i. Ċirkewwa Ferry Terminal:
   The Ċirkewwa Gozo Ferry Terminal is located at the northernmost part of Malta, opposite to the sister islands of Gozo and Comino. The terminal handles 20,000 trips every between Malta and Gozo, and ferries approximately 4.1 million passengers and 1.2 million vehicles annually between the two islands.

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   The Ċirkewwa Gozo Ferry Terminal is located at the northernmost part of Malta, opposite to the sister islands of Gozo and Comino. The terminal handles 20,000 trips every between Malta and Gozo, and ferries approximately 4.1 million passengers and 1.2 million vehicles annually between the two islands.
   2. Deep Water Quay car park in Marsa:
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   3. Ta’ Xbiex Marina car park:
      Ta’Xbiex Yacht Marina together with the Msida Marina is the largest marina in Malta, together providing mooring facilities for more than 700 boats on 15 serviced pontoons. The marina is located at the Marsamxett Harbour.
Main components of the solar carports include:

1. Galvanised steel carport structure
2. Carport structure foundations
3. 11.25kWp PV array
4. PV array inverter
5. 24kWh lithium-ion storage battery
6. Battery inverters
7. 44kW EV charging-stations
8. Surveillance system
9. Carport equipment room
10. Ancillaries

Photo credit: Peter Paul Barbara
SOLAR CARPORTS: TECHNICAL SPECIFICATIONS:

The carport structure area is 16.0m by 5.0m, so that each carport accommodates 45 PV modules mounted on top of the structure roof. The structure height at the front is approximately 3.0m. Each carport accommodates five parking bays, four bays for parking EVs, and one bay hosting the carport equipment room. The galvanised steel structure is guaranteed to withstand a category C5M marine environment and Force 12 winds.

The PV array mounted at the top of the carport structure consists of 45 PV modules. The nominal power rating per module is 250Wp, so that the array total nominal power is 11.25kWp. Rated module efficiency is 15%. Each carport shall generate 17,437kWh per annum, decreasing at a linear rate of 1% per annum over the first ten years. Therefore, on average, the carport PV array is capable of sustaining 1,585 - 50% EV battery top-ups per annum, or 30 - 50% EV battery top-ups per week. This figure is higher in summer and lower in winter.

DC power generated by the PV array is transformed into AC power by the PV array inverter. This AC power is delivered to the EV charging pillar when an EV is connected to the charging point and to the lithium-ion storage battery when an EV is not connected to the charging pillar. When the storage battery is fully charged, the AC power is delivered to the utility grid.

The lithium-ion storage battery has a bank of 3 inverters which transform AC power from the PV array inverter to DC power to charge the battery, and DC power from the battery to AC power to charge an EV connected to the charging pillar. The battery inverters control the system power flow from the PV array, lithium-ion storage battery, and utility grid.

The carport equipment room houses all carport electronic and power equipment as a safeguard against mechanical impact, adverse weather conditions, vandalism, and theft. The equipment room area is 1.95m x 3.00m, and the brick walls are covered with white composite panel cladding.

Each solar carport has a 24kWh lithium-ion battery to store solar power generated by the PV array. Lithium-ion battery technology provides high storage capacity, and very fast charging and discharging rates. The battery is capable of fully charging a flat EV battery within 40 minutes.

Each solar carport has two 44kW charging pillars, and each charging pillar has two three-phase 22kW charging points. One charging pillar is connected directly to the utility grid, while the second charging station draws power from the PV array, the lithium-ion storage battery, and the utility grid in that order. The system is capable of charging 4 flat EV batteries to full capacity in 1 hour.

Each carport has a surveillance system comprising of two high-definition Internet Protocol (IP) cameras and Network Video Recorder (NVR) to monitor carport area against acts of vandalism and theft.
THREE-POINT FAST CHARGER:
QUANTITY DEPLOYED THROUGH THE PROJECT: 1
LOCATION: MALTA, TRANSPORT CENTRE
PROJECT PARTNER RESPONSIBLE: TRANSPORT MALTA

GENERAL SPECIFICATIONS
Model: CIRCONTROL - CirCarLife - Quick Charge Combo CCL-QPC-CH-CCS-AC63
Number of Charging Points: 3
Electrical Supply: ≥ 86 kVA 125 A, 400 V AC, 3P + N + E
Earthing Resistance: < 150Ω
Residual Current Protection: Type B RCD 30mA
Short Circuit / Overload Protection: Type C MCB
Operating Temperature: -35°C to +45°C
Ingress Protection: IP 54

DC CHARGING SPECIFICATIONS
Output Performance: 50 kW 120 A, 50 – 500 V DC
Integrated Charging Cables: 2
Cable Length: 5m
DC Charging Outlet A: CCS, Combo-2, EN 61851-23 / DIN 70121
DC Charging Outlet B: CHAdeMOTM, CHAdeMO / JEVS G105, CHAdeMO 1.0
Charging Time: 80% of 20kWh EV battery charged within a 30 minutes

AC CHARGING SPECIFICATIONS
Output Performance: 43 kW 63 A ± 10%, 400 V AC, three phase
Integrated Charging Cable: 1
Cable Length: 5m
AC Charging Outlet C: Fast AC cable, IEC62196 Mode-3 Type-2, EN61851-1:2010
Residual Current Protection: Type B RCD 30mA
Short Circuit / Overload Protection: Type C MCB

COMMUNICATION
Authentication / Activation: RFID card (graphic display may be offered as an ancillary means of authentication/activation)
RFID System: ISO/IEC14443A/B
Network Communication: 3G modem and Ethernet
3.4.2 ACTIVITIES AND OUTPUTS IN SICILY

The Port Authority of Catania

In Catania, the Port Authority’s project actions focused on the greening of road transport in the port area by using green mobility to offer solutions which enhance accessibility in the city. In this regard, the Port Authority of Catania deployed the following actions:

1. Introduction of electric bicycle sharing by making available 20 electric bicycles for public use;
2. Encouraging modal shift and inter-modality through the installation four facilities to store and charge the above-mentioned electric bikes and positioning them close to public transport stations;
3. Enhancement of carbon neutral transport through the installation of one two-car solar fast charging station, moreover, three of the four bike-sharing stations mentioned above are off-grid solar bike stations;
4. Deployment of one full electric passenger car to be used by the Port Authority in its day-to-day duties;
5. Installation of 1 two-point fast charging pillar;
6. Production of green energy through the installation of a solar covered parking shelter for 2 cars;
7. Compilation of a Local Green Plan for future implementation of green transport policies.

Province of Caltanissetta

The Province of Caltanissetta, in cooperation with the Municipality of Gela, focused the project actions within the Gela port area. Actions implemented in Gela aimed at increasing commuters’ accessibility through the use of green mobility and decarbonising of the Municipality’s operations by greening the day-to-day transport duties through the deployment of electromobility. Actions implemented were:

1. Purchase of five electric vehicles including 3 crew vans and 2 passenger cars to be used by the Municipality;
2. Installation of three double-point car charging pillars in accessible public places which are also used for the charging of electric bicycles;
3. Deployment of five electric bicycles for public use;

CHARGING PILLARS INSTALLED IN SICILY: TECHNICAL DATA

All the e-infrastructures installed in Gela are public direct-current quick charging stations with three-phase electric power of 22 kw, 32 A and 380 V AC, designed to charge 80% of an electric car battery in approximately 1 hour and to detect automatically the electric vehicle connected and the related voltage needed by the battery.

In compliance with IEC 62196-1, quick charging stations use:

- Charging “mode 3”
  - type 2 connectors (“Mennekes”)
    - VDE-AR-E 2623-2-2, single and three-phase vehicle coupler with current intensity of up to 32A and automatic socket locking (IEC 62196-2). The Mennekes connector contains 7 contacts; 5 for power supply pins L1-L3 (live wires) N (neutral) PE (protective earth) and 2 for communication pins. This currently represents the standard for charging electric vehicles in Europe. It can be used in single-phase or three-phase alternating current (AC), or direct current (DC) charging;
  - “Schuko” sockets for e-bikes with a charging power of 230V 16A, and placed in special electro-locked compartments on the side of the charging pillar; or horizontally in the cycle-station charging bar

- slow or fast charging using a specific EV socket-outlet with a communication system between the pillar and the vehicle in PWM and electrical control and safety functions. It is the only method for accelerated charging (up to 63 A, 400 V) in public environments. The vehicle is fully charged between 30 minutes to 1 hour with a maximum power of 43W charging.
1 interactive electric pillar equipped with 2 Mennekes outlets at 400 V 32 A (22kW each) three-phase power supply with PWM for Type 2 plugs, Mode 3; RFID Card access with contactless technology; Sharware software; touch-screen display and modem for remote maintenance, control and data transmission.

1 cycle-station with a charging bar for 2 e-bikes, 2 electro-locked compartments housing user battery charger and Schuko socket 230V 16 A; protection from bad weather and theft; 2 automatic bike handlebars with burglar proof locking systems.

CHARGING STATION HOUSING 2 EVS AND 2 E-BIKES
QUANTITY DEPLOYED THROUGH THE PROJECT: 2
LOCATION: GELA
PROJECT PARTNER RESPONSIBLE: PROVINCE OF CALTANISSETTA

Both Charging Stations are made up of charging points connectable to 2 electric cars and 2 e-bikes. These have been installed in:
• Via Dalmazia
• Viale Mediterraneo

The Charging Pillar has been installed in Via Ossidiana at the Local Police Station.
CAR CHARGING PILLARS

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 2  
**LOCATION:** CATANIA  
**PROJECT PARTNER RESPONSIBLE:** PORT AUTHORITY OF CATANIA

**GENERAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Ecospazio Network Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Type</td>
<td>Free-standing on concrete plinth or on load-bearing concrete floor, bolted down onto an assembly frame</td>
</tr>
<tr>
<td>Number of Charging Points</td>
<td>2 (22kW AC + 10%) - can charge two vehicles at a time</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-25°C to +40°C</td>
</tr>
<tr>
<td>Ingress Protection</td>
<td>IP 44</td>
</tr>
<tr>
<td>Charging time</td>
<td>approx. 60 minutes (Referring to the maximum output, an expected average battery capacity of 20 kWh in 2012 and a charging device in the vehicle offering the maximum charging capacity.)</td>
</tr>
</tbody>
</table>

**CHARGING SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Output Performance</th>
<th>22kW ±10%, 32A, 400 V AC, three phase (possibility to charge also with single phase and with minor intensity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug Connection</td>
<td>IEC Type 2 plug connection in accordance with VDE-AR-E 2523-2-2 with automatic connector interlocks</td>
</tr>
<tr>
<td>Charging mode</td>
<td>Mode 3 as per IEC 61851</td>
</tr>
</tbody>
</table>

**ELECTRIC VEHICLES TECHNICAL DATA**

All 44 vehicles purchased by the project partners were selected through official public procurement procedures which took place separately in each of the demonstration territories. This section gives a technical rendition of the vehicles purchased.

**Mitsubishi iMiEV**

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 1  
**LOCATION:** CATANIA  
**PROJECT PARTNER RESPONSIBLE:** PORT AUTHORITY OF CATANIA

<table>
<thead>
<tr>
<th>Dimensions - length x width x height (mm)</th>
<th>3475 x 1475 x 1610</th>
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<tbody>
<tr>
<td>Doors</td>
<td>5</td>
</tr>
<tr>
<td>Seating Capacity</td>
<td>4</td>
</tr>
<tr>
<td>Gross vehicle Weight in kg</td>
<td>1450</td>
</tr>
<tr>
<td>Engine Type</td>
<td>YS1 Electric Motor</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Electric</td>
</tr>
<tr>
<td>Max Output kW (bhp) at rpm</td>
<td>49 (66) / 4000-8000</td>
</tr>
<tr>
<td>Max Torque Nm</td>
<td>196 (145) / 0-3000</td>
</tr>
<tr>
<td>Maximum speed in km/h</td>
<td>130</td>
</tr>
<tr>
<td>0 – 60 m/h (s)</td>
<td>13.5</td>
</tr>
<tr>
<td>Battery type</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery energy in kWh</td>
<td>16</td>
</tr>
</tbody>
</table>

**CHARGING SPECIFICATIONS**

| standard 120V household outlet 8 A      | 22 hours |
| standard 120V household outlet 12 A feature | 14 hours |
| AeroEnvironment/Eaton home charging docks | 6 hours |
| standard public quick-charger port that connects to CHAdeMO Level 3 | 80% in 30 min |
| Electric range in Km                    | 160                  |
### Renault Kangoo Z.E.

- **QUANTITY DEPLOYED THROUGH THE PROJECT:** 4
- **LOCATION:** MALTA, GELA
- **PROJECT PARTNER RESPONSIBLE:** TRANSPORT MALTA, PROVINCE OF CALTANISSETTA

<table>
<thead>
<tr>
<th>Dimensions - length x width x height (mm)</th>
<th>4084 x 1945 x 1562</th>
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<tbody>
<tr>
<td>Doors</td>
<td>5</td>
</tr>
<tr>
<td>Seating Capacity</td>
<td>5</td>
</tr>
<tr>
<td>Gross vehicle Weight in kg</td>
<td>1943</td>
</tr>
<tr>
<td>Max Payload in kg</td>
<td>140</td>
</tr>
<tr>
<td>Engine Type</td>
<td>SAgem2</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Electric</td>
</tr>
<tr>
<td>Max Power at rpm</td>
<td>3 000 - 11 3000</td>
</tr>
<tr>
<td>Max Torque Nm CEE</td>
<td>220</td>
</tr>
<tr>
<td>Maximum speed in km/h</td>
<td>135</td>
</tr>
<tr>
<td>0 - 50 km/h (s)</td>
<td>4</td>
</tr>
<tr>
<td>0 - 100 km/h (s)</td>
<td>13.5</td>
</tr>
<tr>
<td>Battery type</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery Capacity kWh</td>
<td>22</td>
</tr>
<tr>
<td><strong>CHARGING</strong></td>
<td></td>
</tr>
<tr>
<td>3 kW Wall box single-phased 16 A</td>
<td>6 to 9 hours</td>
</tr>
<tr>
<td>22 kW borne three-phased 32 A</td>
<td>80% in 1 hour</td>
</tr>
<tr>
<td>43 kW borne three-phased 63 A</td>
<td>80% in 30 min</td>
</tr>
<tr>
<td>Electric range in Kms</td>
<td>210</td>
</tr>
</tbody>
</table>

### Renault ZOE

- **QUANTITY DEPLOYED THROUGH THE PROJECT:** 3
- **LOCATION:** MALTA, GELA
- **PROJECT PARTNER RESPONSIBLE:** PROVINCE OF CALTANISSETTA

<table>
<thead>
<tr>
<th>Dimensions - length x width x height (mm)</th>
<th>4213 x 2133 x 1805</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating Capacity</td>
<td>2</td>
</tr>
<tr>
<td>Gross vehicle Weight in kg</td>
<td>2146</td>
</tr>
<tr>
<td>Max Payload in kg</td>
<td>650</td>
</tr>
<tr>
<td>Engine Type</td>
<td>Electric Motor - Synchronous AC motor</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Electric</td>
</tr>
<tr>
<td>Max engine power kW</td>
<td>44 (60hp)</td>
</tr>
<tr>
<td>Max Engine Torque Nm</td>
<td>226</td>
</tr>
<tr>
<td>Maximum speed in km/h</td>
<td>130</td>
</tr>
<tr>
<td>0 - 50 km/h (s)</td>
<td>0</td>
</tr>
<tr>
<td>0 - 100 km/h (s)</td>
<td>20.3</td>
</tr>
<tr>
<td>Battery type</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery Capacity kWh</td>
<td>22</td>
</tr>
<tr>
<td><strong>CHARGING</strong></td>
<td></td>
</tr>
<tr>
<td>standard 3 kW</td>
<td>6 to 9 h</td>
</tr>
<tr>
<td>Electric range in Kms</td>
<td>170</td>
</tr>
</tbody>
</table>
### Renault Kangoo Maxi Z.E.

**Quantity Deployed Through the Project:** 2  
**Location:** MALTA  
**Project Partner Responsible:** TRANSPORT MALTA

<table>
<thead>
<tr>
<th>Dimension (length x width x height) (mm)</th>
<th>4597 x 2133 x 1810</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating Capacity</td>
<td>2</td>
</tr>
<tr>
<td>Gross vehicle Weight in kg</td>
<td>2177</td>
</tr>
<tr>
<td>Max Payload in kg</td>
<td>650</td>
</tr>
<tr>
<td>Engine Type</td>
<td>Electric Motor - Synchronous AC motor</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Electric</td>
</tr>
<tr>
<td>Max engine power kW</td>
<td>44 (60hp)</td>
</tr>
<tr>
<td>Max Engine Torque Nm</td>
<td>226</td>
</tr>
<tr>
<td>Maximum speed in km/h</td>
<td>130</td>
</tr>
<tr>
<td>0 – 50 km/h (s)</td>
<td>0</td>
</tr>
<tr>
<td>0 – 100 km/h (s)</td>
<td>22.4</td>
</tr>
<tr>
<td>Battery type</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery Capacity kWh</td>
<td>22</td>
</tr>
</tbody>
</table>

**CHARGING**

- Standard 3 kW: 6 to 9 h
- Electric range in Km: 170

### Renault Kangoo Maxi Crew Van

**Quantity Deployed Through the Project:** 4  
**Location:** MALTA  
**Project Partner Responsible:** TRANSPORT MALTA

<table>
<thead>
<tr>
<th>Dimension (length x width x height) (mm)</th>
<th>4597 x 2133 x 1802</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating Capacity</td>
<td>5</td>
</tr>
<tr>
<td>Gross vehicle Weight in kg</td>
<td>2286</td>
</tr>
<tr>
<td>Max Payload in kg</td>
<td>650</td>
</tr>
<tr>
<td>Engine Type</td>
<td>Electric Motor - Synchronous AC motor</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Electric</td>
</tr>
<tr>
<td>Max engine power kW</td>
<td>44 (60hp)</td>
</tr>
<tr>
<td>Max Engine Torque Nm</td>
<td>226</td>
</tr>
<tr>
<td>Maximum speed in km/h</td>
<td>130</td>
</tr>
<tr>
<td>0 – 50 km/h (s)</td>
<td>0</td>
</tr>
<tr>
<td>0 – 100 km/h (s)</td>
<td>22.4</td>
</tr>
<tr>
<td>Battery type</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery Capacity kWh</td>
<td>22</td>
</tr>
</tbody>
</table>

**CHARGING**

- Standard 3 kW: 6 to 9 h
- Electric range in Km: 170
BMW i3

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 1
**LOCATION:** MALTA
**PROJECT PARTNER RESPONSIBLE:** TRANSPORT MALTA

- **Dimensions - length x width x height (mm):** 3999 x 1775 x 1578
- **Doors:** 5
- **Seating Capacity:** 4
- **Gross vehicle Weight in kg:** 1270
- **Max Payload in kg:** 425
- **Fuel Type:** Electric
- **Electric motor Output kW:** 125
- **Max Torque NM:** 250
- **Maximum speed in km/h:** 150
- **0 - 100 km/h (s):** 7.2
- **Battery type:** Lithium-ion
- **Battery Capacity kWh:** 18.8

**CHARGING**
- **Fast Charging:** DC 125 A - 80% in 30 min
- **BMW i Wallbox:** 16 A - 6-8 hours
- **Electric range in Km:** 190

---

Renault Twizy

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 4
**LOCATION:** MALTA
**PROJECT PARTNER RESPONSIBLE:** TRANSPORT MALTA

- **Dimensions - length x width x height (mm):** 2338 x 1381 x 1454
- **Seating Capacity:** 2
- **Gross vehicle Weight in kg:** 690
- **Max Payload in kg:** 115
- **Engine Type:** MB L7e
- **Fuel Type:** Electric
- **Max Power:** 13 kW - 17hp
- **Max Torque Nm:** 57
- **Maximum speed in km/h:** 80
- **Battery type:** Lithium-ion
- **Battery Capacity kWh:** 6.1

**CHARGING**
- **Slow charge:** 10 A from 0 to 100% - 3.5 hours
- **Standard Charge plug type:** 3 pin plug
- **Electric Range in Km:** 99
PEDELECS:

Electric bicycles, also known as EPACs (Electric Power Assisted Cycles) or pedelecs, are equipped with pedals and a low-powered electric motor including an electronic controller which stops the motor producing power when the rider is not pedalling or when a 25 km/h speed is reached.

The definition of what constitutes a pedelec, and the regulations that govern this mode of transport, is stated in Directive 2002/24/EC. More powerful machines are regulated more strictly under the motor vehicle EU Type Approval, and bicycles (including pedelecs) are regulated outside the Type Approval as lighter machines. Certifications for EPACs are done according to the European standard EN 15194 which specifies safety requirements for electric power assisted cycles.

RESET Candy Round Rondine 28"

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 5
**LOCATION:** GELA
**PROJECT PARTNER RESPONSIBLE:** PROVINCE OF CATANISSETTA,

<table>
<thead>
<tr>
<th>Motor: 250W 36V Brushless</th>
<th>EEC max power: 65 kW (88 hp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery: Lithium Ion - 10 Ah - 360 W</td>
<td></td>
</tr>
<tr>
<td>Gear: shimano 6 speed</td>
<td></td>
</tr>
<tr>
<td>Cyclometer: Yes</td>
<td></td>
</tr>
<tr>
<td>Charger: Single or three-phasepower from 3 - 43 kW</td>
<td></td>
</tr>
<tr>
<td>Display: LED with 6 levels of assistance and display power</td>
<td></td>
</tr>
<tr>
<td>Driving Range: 40-60 km</td>
<td></td>
</tr>
<tr>
<td>Full Charging Time: 5-6 hrs</td>
<td></td>
</tr>
<tr>
<td>Weight: 24.4 Kg</td>
<td></td>
</tr>
<tr>
<td>Restart button 6 Km/h: N/A</td>
<td></td>
</tr>
</tbody>
</table>

RESET Candy Round Rondine 26"

**QUANTITY DEPLOYED THROUGH THE PROJECT:** 20
**LOCATION:** CATANIA
**PROJECT PARTNER RESPONSIBLE:** CATANIA PORT AUTHORITY

<table>
<thead>
<tr>
<th>Motor: 250W 36V Brushless 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery: 65 kW (88 hp)</td>
</tr>
<tr>
<td>Gear: Lithium Ion - 10 Ah - 360 W</td>
</tr>
<tr>
<td>Cyclometer: shimano 6 speed</td>
</tr>
<tr>
<td>Charger: Single or three-phasepower from 3 - 43 kW</td>
</tr>
<tr>
<td>Display: speed controller control lights charging indicator GPS tracker</td>
</tr>
<tr>
<td>Driving Range: 40-60 km</td>
</tr>
<tr>
<td>Full Charging Time: 5-6 hrs</td>
</tr>
<tr>
<td>Weight: 24.4 Kg</td>
</tr>
<tr>
<td>Restart button 6 Km/h: N/A</td>
</tr>
</tbody>
</table>
As described in Chapter 3, the main areas of study for this project rest on four pillars:

1. The extent to which production of renewable energy on site can offset electricity consumption by the same building; thus understanding the extent to which the building’s carbon footprint can be reduced;

2. The feasibility of using electromobility in day-to-day organisations’ operational activities;

3. The extent to which carbon neutral transport can be achieved;

4. Studies to feed into future policy design and implementation.

This chapter will state what results have been achieved during the implementation of the pilot period under each pillar listed above and also subdivide the results achieved per project partner. The chapter will also explain the assumptions and variables considered when calculating each result, with the aim of enabling such results to be replicated by other entities also willing to take the step to green their daily operations in the fields being dealt with by this project.

It is important to note that 2013 is being taken in this report as the baseline year; this is the year before any of the equipment and infrastructure started to be deployed.
4.1 REDUCTION IN THE PORT AUTHORITY’S CARBON FOOTPRINT
4.1.1 CARBON SAVINGS ON THE PORT AUTHORITY’S ELECTRICITY CONSUMPTION

A Photovoltaic Plant was installed at the Malta Transport Centre – the Head Quarters for Port Operations in Malta and Transport Malta’s Head Office. The building is adjacent to the Deep Water Quay within the Grand Harbour. One of the key questions that was asked at the beginning of this project was:

- What is the maximum Solar Power in kWh which can be produced annually on site, when using the entire surface area available within a given building?

The Malta Transport Centre was selected at project design stage as the test site to answer this matter. The site was selected for two main reasons:

I. The location of the building: the Malta Transport Centre is located on one of the main quays of the Grand Harbour. It’s location therefore presented an ideal test bed within the project demonstration area since any reduction in the building’s carbon footprint would leave a direct positive impact on the area being targeted;

II. The Building’s energy consumption: the building is a three-block, five-storey corporate building housing hundreds of employees, hence its energy consumption is monumental; standing at 1,845,317 kWh in 2013. With this being the case, drastic measures had to be taken to reduce the building’s energy consumption and in turn its dependence on fossil fuels. Installing a PV plant on the building’s roof is only the first step in this regard.

To start with, the total surface area of the building’s roof spanned at 1,704.22 square metres.

However, when installing the PV plant, the space could not be used in its entirety. A one-metre border had to be left clear around the whole perimeter for safety purposes and to allow maintenance and cleaning of the panels. Moreover, due to building regulations, screening had to be installed on the land side of the roof area to render the structure invisible from the view seen from on top of the historical fortifications. The screening would have created shading on the panels installed adjacent to the screen; therefore further space had to be left clear to avoid installing panels which would yield no power as a result of the shade. Furthermore, a total of 151.19 square metres could not be used since the roof in question is inclined and not facing towards the south which is the ideal position for maximum power yield. These reductions in the surface area available have left a total of 1,290 square metres on which to install the photovoltaic panels.

TOTAL AREA COVERED IN PHOTOVOLTAIC PANELS: 1,290 M²

After consultation with both the site engineer and the suppliers, it was concluded that the PV panels would be installed at a 15 degree angle rather than the customary 30°; this has allowed the instalment of further panels, to a total of 456 modules, giving a total estimated peak of 114 kW, which amounts to a total annual yield of 189,240 kWh. This therefore, answers the first question; taking the Malta Transport Centre as a test case, the maximum solar power produced on site amounts to 189 MWh per year.
NUMBER OF PV PANELS INSTALLED: 456 MODULES

TOTAL ESTIMATED KILOWATT PEAK: 114KWP

TOTAL ESTIMATED SOLAR POWER PRODUCED ON SITE: 189,240 kWh/ANNUM

• Can the Port Operations Building become carbon neutral solely through the offsetting of energy used compared with clean energy produced on site?

Considering the excessive energy being consumed by the building, using solar power as a stand-alone measure to render the building carbon neutral is not sufficient. However, the PV Plant has contributed towards the reduction of the building’s carbon footprint. The PV installation in fact yields 10.08% of the building’s electricity consumption over twelve months. In other words, 10.08% of the building energy consumption is being offset through solar power generated on site.

SHARE OF SOLAR POWER GENERATED COMPARED TO THE BUILDING’S CONSUMPTION: 10.08%

• How much savings in Carbon emissions is the Malta Transport Centre building making as a result of the PV installation?

In 2013, the Greenhouse Gas emissions factor for the national power grid was estimated at 0.875 CO₂/kg/kWh (Source: MRA data, 2015). Therefore, every unit consumed by the Malta Transport Centre building in 2013, emitted a total of 0.875 kgCO₂. With a total consumption of 1,845,317 units in 2013, the total emissions for the building’s electricity for the same year amounted to 1,614 tonnes of CO₂.

Further to the above, considering that the PV Plant generates a total equivalent to 10.08% of the building’s electricity consumption, then the total CO₂ savings amount to 165 tonnes if the total generation of the PV plant is considered as a direct offset against the building’s consumption.

TOTAL ESTIMATED SAVINGS IN CO₂ EMISSIONS ON THE ELECTRICITY CONSUMED BY THE MALTA TRANSPORT CENTRE BUILDING: 165 T CO₂/ANNUM
PORT-PVEV
PROJECT OVERVIEW AND RESULTS
FINAL REPORT JULY 2015

4.1.1.1 RENEWABLE ENERGY PRODUCED THROUGH THE PORT-PVEV PROJECT

THROUGH INTERVENTIONS DONE AS PART OF THE PROJECT, AN ANNUAL AVERAGE TOTAL OF 260,735kWh IS BEING GENERATED THROUGH RENEWABLE ENERGY PRODUCED BY PHOTOVOLTAIC INSTALLATIONS DEPLOYED IN MALTA AND SICILY.

More specifically, these can be broken down as follows:

**TM PV Plant:**
The area covered by the PVs is 1,290m²
and the estimated kWh/annum is equal to 1,660kWh/kWp * 114kWp = 189,240kWh/year.

**Malta Solar Car Ports:**
The total area of PV modules for the 3 carports is 216 m² (3 X 72 m²).
Each carport produces 11.25kWp * 1,460kWh/kWp = 16,425kWh/year * 3 car ports = 49,275 kWh/year.

**Solar Car Ports in Catania:**
The total area of PV modules for the 2 carports is 39.96 m² (3 X 6.06 m²). All carport produces 6.00kWp * 1,550kWh/kWp = 9,290kWh/year.

**Solar Bike Port n.1 in Catania:**
The total area of PV modules for 1 bikeport is 19.998 m² (3.3 X 6.06 m²).
Bikeport n. 1 produces 3.00kWp * 1,540kWh/kWp = 4,610kWh/year.

**Solar Bike Port n.2 in Catania:**
The total area of PV modules for 1 bikeport is 19.998 m² (3.3 X 6.06 m²). Bikeport n. 2 produces 3.00kWp * 1,310kWh/kWp = 3,940kWh/year.

**Solar Bike Port n.2 in Catania:**
The total area of PV modules for 1 bikeport is 19.998 m² (3.3 X 6.06 m²). Bikeport n. 2 produces 3.00kWp * 1,450kWh/kWp = 4,340kWh/year.

Photo credit: Peter Paul Barbara
4.1.2 CARBON SAVINGS RESULTING FROM DAY-TO-DAY TRANSPORT OPERATIONS

Carbon emissions resulting from an organisation’s operations are not emitted solely from the consumption of electricity. The use of vehicles to conduct day-to-day duties is another main source of pollution.

In this regard, and as explained extensively as part of Chapter 3, three of the four PORT-PVEV partners have taken steps to reduce their carbon footprint by introducing electric vehicles as part of their fleets. This section will elaborate on how much savings in CO₂ have actually resulted from the 44 vehicles deployed as part of the project. To do this more comprehensively, the section has been divided into a series of questions which the studies compiled as part of the pilot period have sought to answer. Moreover, the results have been sectioned per partner since different emission factors apply for the two different countries.

- How much CO₂ is emitted in a kilometre driven by a conventional light goods van; a conventional M1 Passenger vehicle?

For Sicily, the national average of 118gCO₂/km is being taken as the baseline emissions factor for pump-to-wheel emissions for which combustion engine vehicles are responsible.

For Malta, the following emissions per vehicle are being considered (Source, MRA Data):

<table>
<thead>
<tr>
<th>CO₂ (KG/emitted by conventional N1 van per kilometre)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ (KG/emitted by conventional M1 car per kilometre)</td>
<td>Value</td>
</tr>
<tr>
<td>CO₂ (KG/emitted by conventional L7E per kilometre)</td>
<td>Value</td>
</tr>
</tbody>
</table>
• Considering the fleet deployed as part of the project is in fact replacing the use of combustion engine vehicles, what is the annual savings in CO₂ kg being made through the direct use of the electric vehicles?

**SICILY**

**Gela**

In Gela, a total of 10 conventional vehicles (5 internal combustion cars and 5 motorcycles) were selected to be replaced by EVs out of the current municipal fleet. Vehicles selected for replacement were chosen based on their usage, performance, technical specifications and obsolescence status.

In the selection, petrol fuelled vehicles were preferred to other diesel or methane fuelled vehicles because of the higher impact in terms of the carbon footprint and economic costs so as to maximize the environmental, economic and energy savings.

In order to assess CO₂ emission levels before the deployment of electromobility in the port-urban areas of Gela and to demonstrate the environmental, economic and energy advantages in using electric vehicles instead of conventional vehicles, the 10 conventional vehicles selected were compared to the 10 EVs deployed.

Since all EVs emit no CO₂, NOₓ, carbon monoxide or small particles during use, direct emissions for EVs are considered to be equal to zero g CO₂/Km. However, in order to properly compare emission levels between the newly deployed electric vehicles and the combustion engine vehicles they have replaced, CO₂ levels for EVs were evaluated by also comparing the energy consumption of electric vehicles during the charging process to emissions produced by conventional vehicles in terms of g CO₂/Km, thus enabling the assessment of pump-to-wheel emissions for both types of vehicles. In this regard, the local energy emission factor of 0.352 t CO₂/MWh was taken into consideration as the emissions generated during charge (source: PAES of Municipality of Gela and inventory of municipal emissions - guidelines IPCC 2006).

Sources of data taken into consideration for these comparisons were the following:

• annual mileage (km)
• annual fuel consumption
• CO₂ emissions
• car models data
• car fuel expenses sheet
• PAES petrol expenses sheet (Action Plan for sustainable energy - transport sector)
• ministerial guidelines on fuel economy and CO₂ emissions
• driving style, road conditions, itinerary travelled
• total/partial and min/max energy consumption for electric vehicles charging cycle
The average emissions per electric vehicle deployed in Gela were calculated first. This can be seen in the table below.

### Range and performance monitoring table - Renault Kangoo Z.E.

**ITINERARY**

<table>
<thead>
<tr>
<th>N°.</th>
<th>DATE</th>
<th>FROM</th>
<th>TO</th>
<th>Type of journey</th>
<th>Starting time</th>
<th>Stopping time</th>
<th>Vehicle range at starting (Km)</th>
<th>Vehicle range at finish (Km)</th>
<th>Km travelled</th>
<th>Max speed (Km/h)</th>
<th>Average speed (Km/h)</th>
<th>Driving style indicator</th>
<th>Road conditions</th>
<th>Average road gradient (%)</th>
<th>External temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30/03/15</td>
<td>Via Ossidiana</td>
<td>Viale Mediterraneo</td>
<td>urban</td>
<td>10:50 A.M.</td>
<td>11:20 A.M.</td>
<td>74</td>
<td>63</td>
<td>11</td>
<td>40</td>
<td>22</td>
<td>dynamic</td>
<td>paved</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>30/03/15</td>
<td>Viale Mediterraneo</td>
<td>Via Dalmazia</td>
<td>urban</td>
<td>11:20 A.M.</td>
<td>11:30 A.M.</td>
<td>63</td>
<td>63</td>
<td>2</td>
<td>25</td>
<td>12.5</td>
<td>eco-driving</td>
<td>paved</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>30/03/15</td>
<td>Via Dalmazia</td>
<td>Lung. - Rifugio Port</td>
<td>urban</td>
<td>11:30 A.M.</td>
<td>11:45 A.M.</td>
<td>63</td>
<td>55</td>
<td>8</td>
<td>35</td>
<td>20</td>
<td>dynamic</td>
<td>paved</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>30/03/15</td>
<td>Rifugio Port</td>
<td>Via Ossidiana</td>
<td>urban</td>
<td>11:45 A.M.</td>
<td>12:00 A.M.</td>
<td>55</td>
<td>52</td>
<td>3</td>
<td>30</td>
<td>17.5</td>
<td>neutral</td>
<td>paved</td>
<td>2</td>
<td>18</td>
</tr>
</tbody>
</table>

### Range and performance monitoring table - Renault ZOE LIFE Z.E.

<table>
<thead>
<tr>
<th>N°.</th>
<th>DATE</th>
<th>FROM</th>
<th>TO</th>
<th>Type of journey</th>
<th>Starting time</th>
<th>Stopping time</th>
<th>Vehicle range at starting (Km)</th>
<th>Vehicle range at finish (Km)</th>
<th>Km travelled</th>
<th>Max speed (Km/h)</th>
<th>Average speed (Km/h)</th>
<th>Driving style indicator</th>
<th>Road conditions</th>
<th>Average road gradient (%)</th>
<th>External temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13/05/15</td>
<td>Via Ossidiana</td>
<td>Viale Mediterraneo</td>
<td>urban</td>
<td>11:20 A.M.</td>
<td>11:30:00 A.M.</td>
<td>62</td>
<td>58</td>
<td>4</td>
<td>30</td>
<td>25</td>
<td>eco-driving</td>
<td>paved</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>13/05/15</td>
<td>Viale Mediterraneo</td>
<td>Via Dalmazia</td>
<td>urban</td>
<td>11:30:00 A.M.</td>
<td>12:40 A.M.</td>
<td>58</td>
<td>58</td>
<td>2</td>
<td>25</td>
<td>17.5</td>
<td>eco-driving</td>
<td>paved</td>
<td>4</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>13/05/15</td>
<td>Via Dalmazia</td>
<td>Lung. - Rifugio Port</td>
<td>urban</td>
<td>12:40 A.M.</td>
<td>12:55 A.M.</td>
<td>58</td>
<td>52</td>
<td>6</td>
<td>40</td>
<td>24</td>
<td>dynamic</td>
<td>paved</td>
<td>2</td>
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</tr>
<tr>
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<td>Via Ossidiana</td>
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<td>paved</td>
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These figures were then compared to the consumption of similar/equivalent combustion engine vehicles.

### Environmental Evaluation Table for FEV's Usage

<table>
<thead>
<tr>
<th>N°.</th>
<th>AUTHORITY</th>
<th>USER</th>
<th>FULL ELECTRIC VEHICLE</th>
<th>Internal combustion vehicle to be replaced</th>
<th>Current energy carrier</th>
<th>Annual distance covered (Km)</th>
<th>Average fuel consumption (litres/Km)</th>
<th>Calorific fuel power (MWh/litres)</th>
<th>Energy fuel consumption (MWh)</th>
<th>Emission factor Fuel (tCO2/MWh)</th>
<th>Vehicle Emissions (tCO2)</th>
<th>Average energy consumption (MWh)</th>
<th>Electric energy emission factor (tCO2/MWh)</th>
<th>Indirect emissions (tCO2)</th>
<th>Environmental impact (tCO2)</th>
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<tbody>
<tr>
<td>1</td>
<td>Municip. of Gela</td>
<td>Municipal personnel</td>
<td>Renault Zoe Life Z.E.</td>
<td>Fiat Panda 1108</td>
<td>petrol</td>
<td>20000</td>
<td>0.066</td>
<td>0.0088</td>
<td>11.616</td>
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<td>Fiat Panda 1368</td>
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<td>Municipal personnel</td>
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<td>0.279</td>
<td>1.444</td>
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<td>0.352</td>
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<tr>
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<td>Vespa 50 ET2</td>
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<td>6000</td>
<td>0.077</td>
<td>0.0112</td>
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<td>0.279</td>
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<td>8</td>
<td>Municip. of Gela</td>
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<td>Bike Reset Candy Round</td>
<td>Vespa 50 ET2</td>
<td>petrol - oil</td>
<td>6000</td>
<td>0.077</td>
<td>0.0112</td>
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<td>0.279</td>
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<tr>
<td>9</td>
<td>Municip. of Gela</td>
<td>Municipal personnel</td>
<td>Bike Reset Candy Round</td>
<td>Vespa 50 ET2</td>
<td>petrol - oil</td>
<td>6000</td>
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<td>0.0112</td>
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<tr>
<td>10</td>
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<td>0.060</td>
<td>0.352</td>
<td>0.021</td>
<td>1.423</td>
</tr>
</tbody>
</table>

Total: 87.859 22.653 17.018 5.990 16.663
Results show that emissions/km per vehicle for the Zoes and the Kangoo ZEs are lower than both the latest Italian national averages (118 g CO₂/km - 2014) and the European 2020 target of 95 g CO₂/km (currently under review).

For Kangoo ZE, the average pump-to-wheel emission factor is 64.240 g CO₂/km. This is 45% and 33% lower than the Italian national average and European 2020 target, respectively.

For Zoe Life ZE, the average pump-to-wheel emission factor is 60.63 g CO₂/km, which is 48% and 33% lower than the national average and European 2020 target, respectively.

Pump-to-wheel emissions estimated for the purchased EVs (5,990 t CO₂/year) is 73% lower compared to that of petrol-fuel combustion engine vehicles (22,653 t CO₂/year).

In terms of energy use, the annual consumption of the 10 EVs, standing at 17 MWh/year, amounts to 80% less in consumption when compared to the 87 MWh consumed by traditional vehicles.

In conclusion, with the use of electric vehicles, the Municipality of Gela has seen savings totalling to 17 tonnes CO₂/year as a direct results of electric vehicles.

GELA TOTAL CO₂ EMISSIONS SAVINGS FROM EVS
17 TONNES CO₂/ YEAR
Catania

For Catania, in order to calculate CO₂ emissions resulting from the 21 vehicles deployed (10 e-bikes and 1 M1 vehicle), the national average of 118 g CO₂/km was taken as the average emissions for conventional vehicles.

For every kilometre travelled by the iMiev, the 118 g CO₂ is being considered to be saved in full due to the fact that solar charging stations installed in Catania produce enough electricity to offset the energy consumed during the vehicle’s charging; therefore zero emissions are considered for the iMiev’s pump-to-wheel emissions.

No data is present on the usage of the e-bikes during the pilot period. Therefore, these have not been considered in the total emissions saved. When it comes to the iMiev however, the total CO₂ emissions saved as a direct result of the use of the vehicle is equal to 0.236 t CO₂/year.

**CATANIA TOTAL CO₂ EMISSIONS SAVINGS FROM EVS**

0.236 T CO₂/YEAR
MALTA

The 13-vehicle fleet was deployed as part of Transport Malta’s fleet in June 2014. Twelve months of data monitoring took place during which TM vehicle drivers were asked to fill in logs which recorded both the vehicle performance and the charging pillars’ output. In order to facilitate the data-gathering process, sub-metres were installed at each charging pillar, thus ensuring that the metre readings refer specifically to electricity used by the vehicles.

Baseline data on which total emission savings were calculated has been sourced by the Malta Resources Authority as listed above. For ease of reference, the figures have been provided again below:

**CO₂ KG EMITTED BY CONVENTIONAL N1 VAN PER KILOMETRE**
250.83 CO₂ g/km

**CO₂ KG EMITTED BY CONVENTIONAL M1 CAR PER KILOMETRE**
189.69 CO₂ g/km

Indirectly, this answers another two questions posed at the beginning of the pilot period:

- Does the total kWh generated from the PV plant on the building roof offset the total energy consumed by the charging pillars; i.e. by the total electricity needed to charge all the EVs over a one-year period?

  **THE ANSWER IS YES; WITH MUCH TO SPARE.**

  **TOTAL SOLAR POWER GENERATED ON SITE**
  189,240 kWh/YEAR

  **TOTAL ELECTRICITY CONSUMED BY EV FLEET**
  97,206 kWh

  **% OF ELECTRICITY BEING CONSUMED BY CURRENT EV FLEET**
  51.37%

- How many further vehicles (if any) can be deployed for the current installation to still support in full the energy required by the EVs?

  **AVERAGE ELECTRICITY CONSUMED PER EV**
  7,477 kWh/YEAR

  **MAXIMUM NUMBER OF EVS WHICH CAN BE DEPLOYED WHILE STILL BEING SUPPORTED SOLELY BY THE POWER GENERATED BY THE PLANT ON SITE**
  11 EXTRA VEHICLES FOR A TOTAL OF 24 ELECTRIC VEHICLES
Therefore, like in Catania, pump-to-wheel emissions for the Transport Malta EV fleet is considered to be zero g CO2/km since the energy used for vehicle charging is being totally offset by the power generated by the PV plant. With this in mind, the following table represents the total carbon emission savings per vehicle and in total for the TM EV fleet based on the kilometres travelled during the pilot period.

### Electric Vehicle Total Km travelled over 12 months | Emissions savings in tonnes over 12 months
---|---
BMW i3 | 14,330.18 | 3.138915
Kangoo ZE | 6,480 | 1.625992
Kangoo ZE | 2,727 | 0.684019
Kangoo ZE | 10,540.50 | 2.643896
Kangoo ZE | 10,146 | 2.544943
Kangoo ZE | 5,319 | 1.334176
Kangoo ZE | 2,626.5 | 0.658811
Zoe | 9,471 | 2.375631
Zoe | 5,103 | 1.279996
Twizy | 8,847.43 | 2.219219
Twizy | 4,172 | 1.046472
Twizy | 3,606 | 0.904501
Twizy | 2,138 | 0.536279
**Total** | **85,506.61** | **20.99225**

Total potential emission savings if the full potential EV fleet is deployed: **34 t CO2/year**

**TOTAL: 38.23 T CO2/ANNUM**

With the on-side PV plant annual yield used to offset energy consumption required by EVs, Transport Malta can deploy another 11 EVs and remain carbon neutral, saving another 14 tonnes of CO2, per annum.

**GELA:**
**17 T CO2/ANNUM**

**CATANIA:**
**0.236 T CO2/ANNUM**

**MALTA:**
**20.99 T CO2/ANNUM**
It is imperative to note that conventional vehicles’ tailpipe emissions do not consist solely of CO₂. Combustion engine vehicles are the source of other emissions such as NOx and Particular Matter (PM) which are both hazardous to the air quality and in turn to human health, severely affecting the respiratory system and cause lung disease.

To this effect it has been thought pertinent to also quantify savings incurred in air quality emissions through the deployment of electric vehicles.

To calculate these savings, two scenarios have been considered:

**100% OF THE FLEET USING DIESEL AS THE PROPULSION FUEL;**

**100% OF THE FLEET USING PETROL AS THE PROPULSION FUEL;**

The table below gives the total emissions saved in each case taking the equivalent break-horsepower per vehicle as the relevant baseline; the table therefore shows emission which would have been produced had the same mileage been conducted by a combustion engine vehicle using petrol/diesel.

One important point is that an assumption has been made that for Particulate Matter one has to assume that:

**PARTICULATE MATTER: PM₁₀ = PM₂·₅**

One also has to keep in mind that NOx and PM₁₀ is emitted by the power plant in the production of electricity. It is estimated that for 2014 the emission factors for the grid stood at 1.37 tonnes NOx/kWh and 0.42 x 10⁻⁷ tonnes PM₁₀/kWh.

While it is being considered that the on-site PV plant has offset all the electricity consumed by the electric vehicles, these savings are being calculated to understand the scenario had RES not been used to power vehicle re-charging, showing that even in such a case, electric vehicles still have much to offer in terms of air quality.

### 4.1.3 OTHER EMISSIONS SAVINGS

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<th>vehicles</th>
<th>Typical Consumption</th>
<th>Equivalent Fuel Use</th>
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<th>PM emissions saved per vehicle</th>
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<tr>
<td></td>
<td>kilometers</td>
<td>Petrol (g/km)</td>
<td>Diesel (g/km)</td>
<td>Petrol (g)</td>
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<td>Twizy</td>
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<td>656,705</td>
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<tr>
<td>Sum</td>
<td></td>
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</tr>
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</table>
COST PER KILOMETRE TRAVELLED BY A COMBUSTION ENGINE VEHICLE

Based on data provided by the Malta Resources Authority, it has been estimated that on average, 100 km travelled using unleaded petrol consume 7 litres of fuel. This means that one kilometre uses up approximately 0.07 litres of fuel.

To translate this into Euros; at the time of writing, the unleaded petrol tariff stood at €1.42/ltr. In view of this, the following baseline costs could be determined:

**AVERAGE FUEL CONSUMPTION FOR UNLEADED PETROL VEHICLES**

| 7 LITRES/100 Km |

**COST OF FUEL PER KM TRAVELLED (BASED ON €1.42/ltr – UNLEADED PETROL TARIFFS)**

€0.09 / Km

*Costs are as per tariffs at the time of the writing of this report.*

**AVERAGE FUEL CONSUMPTION FOR DIESEL VEHICLES**

5.1 LITRES/100km

**COST OF FUEL PER KM TRAVELLED (BASED ON €1.36/ltr – DIESEL TARIFFS)**

€0.07 / Km

In order to determine whether it is feasible for an organisation to introduce electric vehicles as part of its general fleet, one of the main questions that need to be answered is the annual operational cost that will be saved, if any, as a result of the investment.

It is a known fact that electric vehicles’ purchase price is extensively higher when compared to similarly sized combustion engine vehicles. This has in fact been one of the main stumbling blocks for EVs’ market entry. What individuals/companies do not realise however is that over the medium/long term the costs saved from the operation of the EVs when compared to their conventional counterparts more than make up for the initial investment.

This section of the report shall analyse financial and administrative data gathered by the Municipality of Gela and Transport Malta and conclude definitively the annual financial savings incurred by each entity as a direct result of the use of the EVs introduced as part of their respective fleets.

Transport Malta

Before establishing the total savings made, a baseline needs to be determined to understand what costs are being spent on the operation of combustion engine vehicles by the same organisation.
The following list of questions have been grouped together for the sake of a more comprehensive set of data:

- Considering the mileage travelled on average per car used by the Project Partner, what is the cost of the fuel purchased in a given year?
- Considering the same mileage as above, what are the electricity costs to support this mileage?
- Considering the fleet purchased through the project, what are the annual costs, if any, being saved on propulsion by substituting the fleet from combustion engine to electric?

Based on the total mileage travelled by the EVs during the pilot year, the annual financial costs that would have been incurred by Transport Malta on the purchase of fuel to cover the same mileage can be summarised as follows:

Total mileage travelled during the 12 month pilot period: 85,506 km
Cost of mileage using petrol: €7,695.94
Cost of mileage using diesel: €5,985.42
Cost of mileage using electricity: €3,420.24

Savings
Compared to petrol: €4,275.30/year
Compared to diesel: €2,565.18/year

The above is only a mathematical calculation made to compare identical variables: cost of fuel compared with cost of electricity for the same mileage travelled. To calculate actual savings, Transport Malta 2013 financial data has been taken as a baseline. Of the 26 general fleet vehicles which were in use by the Authority in 2013, 13 have been selected at random in order to measure the actual cost spent on fuel during the baseline year. The vehicles chosen range from M1 to N1 vehicles, similar to the EV fleet deployed. The fleet also varies between petrol and diesel engine vehicles.

On these 13 combustion engine vehicles, Transport Malta has spent a total of €17,034.12 in fuel in 2013. Comparing this with electricity costs incurred by Transport Malta on vehicle charging in 2014/2015, as indicated above, the actual savings would be larger at €13,613.88.

There is a €9,338.58 difference between the mathematical calculation for the cost of petrol and the actual cost on fuel spent by TM on the 13 selected vehicles. No data exits as to the mileage clocked by the combustion engine vehicles in 2013, hence it cannot be definitively concluded whether there were more kilometres travelled in 2013 than the 85,506 km clocked on the EVs during the pilot year and thus providing a better understanding of the difference in cost.

One factor that might have affected this difference is driver behaviour. Range anxiety has been observed among TM drivers making use of the EVs. This fear factor has been evident when observing the driver logs, with EVs being connected to the charging pillars when the battery is still 70% full. This might therefore have also affected the number of kilometres travelled on the EV when compared to, say, if the same driver was making use of a conventional car.

Fearing that the battery charge might be depleted mid-trip, drivers might have been more prone to eco-drive while using the EV. It is also imperative to note that the electric car facilitates eco-driving, all cars display the level of battery energy being consumed while driving. Certain cars going even further and offer options that allow the car to drive in eco-mode thus extending the battery range. These factors might have influenced the energy consumed by the EVs as opposed to the combustion engine vehicles in 2013.

The use of regenerative braking must also be considered. Regenerative braking is an energy recovery mechanism which slows the EV by converting its kinetic energy into a form which can be either used immediately or stored until needed. This contrasts with conventional braking systems, where the excess kinetic energy is converted to heat by friction in the brakes and therefore wasted. In addition to improving the overall efficiency of the vehicle, regeneration can also greatly extend the life of the braking system as its parts do not wear as quickly. Moreover, regenerative braking on an electric car, which is also being driven economically and ecologically, will also extend the life of the battery charge; thus requiring less charging sessions over a given period; thus also reflecting in the amount of kWh used by the EV in battery charging.

Despite the range anxiety affecting many of the TM EV drivers, battery autonomy has proved extremely reliable in all EVs tested. Since the pilot spanned over one year, the seasonality factor could also be studied and its effects on the autonomy analysed. A difference has in fact been recorded between summer and winter which mainly attributes to the use of the air conditioning system in the car. However, it has also been recorded that all electronic applications leave their effect on the battery range including the radio and the headlights.

Having said that, for cars with a battery capacity of 22 kWh, the range for summer has averaged at 111 km per charge in summer and 131 km per charge in winter.
Moreover, a test has been conducted whereby the BMW i3 was driven from Malta to Catania. The journey is approximately one hour thirty minutes long covering 122 km. The battery was charged in full at the Transport Malta premises prior to embarking on the ferry. The EV battery not only covered the distance flawlessly but also arrived at the destination with forty kilometres to spare on the charge.

During the pilot period an average of 6,577 Km has been driven by each car. This figure has been forecasted over the full 24-vehicle fleet at a total of 157,848 Km. If the full fleet is deployed, approximate financial savings by Transport Malta on vehicle fuel is estimated to be as follows:

- What are the annual average costs spent on combustion engine vehicle maintenance?

One of the electric vehicles’ main selling points is that due to the fact that the vehicle has a single moving part, it requires much less maintenance and replacements when compared to a combustion engine vehicle, thus drastically saving on operational and maintenance costs. Since the feasibility of such an investment is being assessed, it is imperative to know conclusively whether these savings can actually be achieved.

Transport Malta’s financial data from 2013 is again taken as a baseline.

Before entering into the details as to cost savings, it is necessary to note that while the EVs deployed as part of the project are brand new, only 3 of the 13 combustion engine vehicles being used as a baseline comparison were new in 2013; this may affect the frequency by which the combustion engine vehicles needed repair during the base year.

In 2013, on the 13 combustion engine general use vehicles, Transport Malta has spent a total of €13,117.46 in maintenance. Cost of the annual compulsory service kit, faults in the starter, oil leaks and other periodic breakdowns were all common repairs needed by all the 13 vehicles.

It is also important to note that TM general vehicles, like with any organisational fleet, are heavily used, thus making the vehicles much more prone to wear and tear than had the vehicles been used by a private individual.

Having said this, when compiling maintenance costs of either type of vehicles, any costs related to third-party damages and accidents were left out of the equation.

### Total Actual Maintenance Costs 2013

- €13,117.46

### Average Maintenance Cost per Combustion Engine Vehicle

- €1,009.03

- Considering the pilot year, what were the costs spent on electric vehicles’ maintenance?

The total cost spent on maintenance of the 13 EVs between June 2014 and June 2015 amounted to €898.96. The bulk of the costs relate to annual service charges, which is a compulsory cost for every vehicle.

### Total Actual Maintenance Costs Incurred during the Pilot Year

- €898.96

### Average Maintenance Cost per Electric Vehicle

- €69.15

- How much money in maintenance is being saved, if any, annually if using the EV fleet?

#### Costs Saved per Vehicle Based on Average Costs

- €939.88/vehicle

#### Total Costs Being Saved: Actual

- €12,216.50/year

- How much money in maintenance would be saved annually if the full potential fleet is purchased?

#### Estimated Maintenance Costs for 24 Electric Vehicles

- €1,659.60

#### Estimated Savings on Full Potential Fleet

- €22,657.12

- What is the total cost of insurance for a conventionally light goods van and a conventional M1 passenger vehicle?

It can be conclusively determined that when it comes to insurance costs, the same rates apply for both type of vehicles. Insurance brokers make no differentiation between whether the car is conventionally or electrically propelled. In this regard, insurance costs have not been considered as part of actual and potential savings being made.

Annual licence costs however are another matter. Annual licence fees for vehicles are calculated based on the type and size of the engine; thus they vary between vehicles.
For electric cars, an annual standard licence of €10 is charged to reflect the congestion charge. It is important to note that while electric vehicles leave little to no effect on the environment, they still leave an impact on the road infrastructure and contribute to journey delays caused by road traffic.

In 2013, on the 13 combustion engine vehicles selected, Transport Malta spent a total of €2,821.41 in annual road licence. On the electric vehicles, based on the standard €10 fee, Transport Malta has spent €130 in road licence fees.

**ANNUAL ROAD LICENCE ON 13 COMBUSTION ENGINE VEHICLE**

€ 2,821.41

**SAVINGS**

€ 2,691.41

- Considering Fuel, Annual Road Licence fees and Maintenance costs: what is the total annual operational cost difference between a conventional vehicle and an EV?

To calculate this figure, the average cost per vehicle as stated above has to be used:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average mileage being considered/ year</td>
<td>6,577 Km</td>
</tr>
<tr>
<td>Annual average fuel costs/ car/ petrol</td>
<td>€ 591.93</td>
</tr>
<tr>
<td>Annual average maintenance costs/conventional car/ year</td>
<td>€ 1,009.03</td>
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<tr>
<td>Annual average licence fees/ conventional car/ year</td>
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<tr>
<td><strong>Total cost of operation per combustion engine vehicle/ year</strong></td>
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<td>Average mileage being considered/ year</td>
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<td>Annual average fuel costs/ EV</td>
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<tr>
<td>Annual average maintenance costs/ EV / year</td>
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<tr>
<td>Annual average licence fees/ EV/ year</td>
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<td><strong>Total cost of operation per EV/ year</strong></td>
<td><strong>€ 342.23</strong></td>
</tr>
</tbody>
</table>

**CONSIDERING THE ENTIRE FLEET DEPLOYED BY THE PROJECT, WHAT IS THE TOTAL ANNUAL OPERATIONAL COST BEING SAVED ON THE VEHICLES?**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings on Fuel/ petrol</td>
<td>€ 7,892.40/year</td>
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<tr>
<td>Savings on Maintenance</td>
<td>€ 12,218.50/ year</td>
</tr>
<tr>
<td>Savings on Annual Road Licence</td>
<td>€ 2,691.41</td>
</tr>
<tr>
<td><strong>Total annual savings 13-vehicle fleet</strong></td>
<td><strong>€ 22,802.31</strong></td>
</tr>
</tbody>
</table>

**IF THE PLANT IS BEING USED SOLELY TO FEED ELECTRICITY INTO THE GRID, HOW MUCH COST IN ENERGY BILLS WOULD TM BE SAVING AS A RESULT OF THE INSTALLATION?**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Units being produced</td>
<td>189,240 kWh/year</td>
</tr>
<tr>
<td>Savings based on most expensive commercial rare (€ 0.16)</td>
<td>€ 30,278.40</td>
</tr>
</tbody>
</table>

**AFTER DEDUCTING THE ELECTRICITY UTILISED TO POWER THE ELECTRIC FLEET, HOW MUCH COST IN ENERGY BILLS, IF ANY, IS STILL BEING SAVED ANNUALLY BY THE ORGANISATION?**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Units being produced</td>
<td>189,240 kWh/year</td>
</tr>
<tr>
<td>Savings based on commercial rare (€ 0.16)</td>
<td>€ 30,278.40</td>
</tr>
<tr>
<td>No. of units used by EVs</td>
<td>97,206 kWh (€ 15,552.96)</td>
</tr>
<tr>
<td><strong>Total Actual savings on Electricity Bills</strong></td>
<td><strong>€ 14,725.04/ year</strong></td>
</tr>
</tbody>
</table>

**Total Savings recorded: €37,527.35/year**

**Municipality of Gela**

Similar calculations have been made by the Municipality of Gela, focussing on the cost of fuel saved based on the mileage travelled by the EVs in the pilot period. The figure below shows the results that have been achieved by the Municipality.

<table>
<thead>
<tr>
<th>ID</th>
<th>Cost savings (Euro)</th>
<th>Cost savings (euros)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Renault Zoe Life Z.E.</td>
<td>941.48</td>
</tr>
<tr>
<td>2</td>
<td>Renault Zoe Life Z.E.</td>
<td>1819.36</td>
</tr>
<tr>
<td>3</td>
<td>Renault Kangoo Z.E.</td>
<td>1780.36</td>
</tr>
<tr>
<td>4</td>
<td>Renault Kangoo Z.E.</td>
<td>692.11</td>
</tr>
<tr>
<td>5</td>
<td>Renault Kangoo Z.E.</td>
<td>692.11</td>
</tr>
<tr>
<td>6</td>
<td>Bike Reset Candy Round</td>
<td>1036.13</td>
</tr>
<tr>
<td>7</td>
<td>Bike Reset Candy Round</td>
<td>1036.13</td>
</tr>
<tr>
<td>8</td>
<td>Bike Reset Candy Round</td>
<td>1036.13</td>
</tr>
<tr>
<td>9</td>
<td>Bike Reset Candy Round</td>
<td>1036.13</td>
</tr>
<tr>
<td>10</td>
<td>Bike Reset Candy Round</td>
<td>1036.13</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>11000/year</strong></td>
</tr>
</tbody>
</table>

| No. of units used by EVs | 97,206 kWh (€ 15,552.96) |
| **Total Actual savings on Electricity Bills** | **€ 14,725.04/ year** |
To test and deploy carbon neutral transport on a wider scale, the Ministry for Transport and Infrastructure deployed three solar car charging stations located in Deep Water Quay along the Grand Harbour, at Ta’ Xbiex Marina along Marsamxett Harbour and at the Ċirkewwa Terminal.

By using the stations to charge the on-board batteries, electric cars become completely emissions free, noise-less and completely carbon neutral, leaving absolutely no negative impacts on the environment.

Through the installation of these three carports, the Ministry for Transport and Infrastructure has added another 216 metres squared of surface area covered in PV Panels, generating an additional 49,275 kWh/year. The data generated by solar charging pillars installed as part of the demonstrative part of the project provided some insights on the feasibility of such infrastructure in the local scenario.

In general the following points were observed and discussion relevant to each point is included.

4.3 SOLAR CHARGING PILLARS

Grid Connected, Battery Mediated Charging Point Pros and Cons Compared to Direct Grid Connected Systems Without Battery Mediation

In practice a standard PV system cannot, and does not, directly charge an electric vehicle; issues with high impedance and internal resistance of the vehicle makes it technically and economically unpractical to have systems with such facility.

In reality most PV systems are grid connected and not stand alone systems. In this regard, it is more logical to assume that electricity generated by the system is all fed to the grid and then energy used for charging is reabsorbed from the grid. In such case the emission factor (EF) for charging is equivalent to the net EF of the grid where charging occurs. This implies that:

- All renewable sources attached to the grid contribute at reducing the EF of the charging of all EVs on the grid.
- It is possible to reduce the EF by increasing the proportion of renewables feeding in the grid, no matter the location of the renewable source (possibly even offshore e.g. Solar farms or wind farms)

Through electrical interconnection to the European grid more distant renewable sources (e.g. North Sea wind) can also be used locally.

The data collected during the pilot period shows that most electricity generated by the PV system installed on the solar charging stations was actually exported to the grid (i.e. not directly consumed because of absence of demand). This indicates that the demand in times of peak electricity production was far below the supply originating from the PV system. This issue is considered as a point in favour of having battery mediation within the system, since electricity generated can be stored and then redistributed to the users even when the demand is higher than the direct supply. This reasoning is fully valid in cases of isolated systems.

In grid connected systems the role of the battery is more questionable. The battery itself utilised two thirds of the energy fed to it either as self-consumption or as losses within the system. This very high percentage may be attributed to the low usage rate of the pillars in question, but still raises questions on the feasibility of the battery mediation. Other concerns with regards to battery mediation in grid connected systems are the following:

- The current electricity tariff structure in Malta does not envisage differential tariffs at different times of day; this implies the battery cannot be used as a tool to exploit such tariff advantages.
- From an engineering perspective the Grid can be seen as basically a huge battery from which to extract the energy needs, and in situations where security of supply is not a major issue, the need to supplement the grid with an additional source of energy and security of supply becomes low priority.

Overall, considering the current situation of supply and demand it becomes more economically and technically feasible to monetize all electricity generated which is not directly utilised for charging of EVs other than maintain a battery in operation in parallel.

The above highlights the interrelation between users/producers within the grid and the roles each play in reducing emissions from energy use and as a consequence from electromobility. Each producer (being a small domestic installation or a large power plant) contributes to the net emission of the system, thus all contribute in addressing emissions. Solar charging pillars can be an exception to the above when battery and battery management systems are installed.
4.3.2
LOW USE AT CURRENT STAGE HINDERS
FEASIBILITY ANALYSIS

The overall low usage of capacity from charging stations has been identified as part of a feasibility issue of stations. The positive aspect of utilising solar power to charge EVs would be better emphasised if more cars used the charging pillars on a regular basis during the pilot period.

Having said this, based on data recorded during the pilot period for the solar charging pillars, the following can be determined:

<table>
<thead>
<tr>
<th>Solar Electric Power Generated by PV Arrays</th>
<th>Electric Power Used by the Charging-Stations to Charge Electric Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar electric power delivered directly to charging-stations: 9%</td>
<td>Solar electric power delivered directly by PV arrays: 56%</td>
</tr>
<tr>
<td>Solar electric power delivered to carport Li-ion storage batteries: 14%</td>
<td>Solar electric power delivered by carport Li-ion storage batteries: 32%</td>
</tr>
<tr>
<td>Solar electric power delivered to charge electric vehicles: 23%</td>
<td>Solar electric power used by the charging stations: 88%</td>
</tr>
<tr>
<td>Solar electric power delivered to utility grid: 77%</td>
<td>Electric power drawn from utility grid: 12%</td>
</tr>
</tbody>
</table>

Photo credit: Peter Paul Barbara
In general terms, each carport has two dual-point charging-pillars, each charging-point rated at 22kW three-phase. One of the charging-stations is connected directly to the grid, as per conventional practice. The second charging-pillar draws electrical power directly from a PV array mounted on top of the carport structure backed up by a lithium-ion storage battery, and by the utility grid if the electrical power from the PV array and from the battery is not sufficient to sustain full electric vehicle charging requirements in terms of capacity and/or throughput.

During the day, assuming a level of sunlight sufficient for the 11.25kWp PV array to generate solar electric power, when the carport 28.8kWh lithium-ion storage battery is sufficiently charged with solar power from the PV array, electric vehicles connected to the charging-station are charged directly with solar electrical power generated by the PV array backed by solar electrical power stored in the lithium-ion battery. If electrical power flow charging the connected electric vehicle is insufficient, the solar electric power is further backed by conventional electrical power from the grid.
SOLAR CAR PORT DAY TIME OPERATION

Also during the day, when the carport lithium-ion battery is depleted, electric vehicles connected to the charging-pillar are charged directly with solar electrical power generated by the PV array backed by conventional electrical power from the grid. When the carport lithium-ion battery is not fully charged, and no electric vehicles are connected to the charging-station, the solar electrical power generated by the PV array charges the battery. When the carport lithium-ion battery is fully charged, and no electric vehicles are connected to the charging-station, the solar electrical power generated by the PV array is fed into the utility grid.

The screenshot depicts the power flows of an actual daytime electric vehicle charging event. Out of the 13.3 kW drawn by the electric vehicle, 3.8kW is solar electric power delivered directly by the PV array, and 9.5 kW is solar electric power stored in and delivered by the carport lithium-ion battery. The balance of electric power from the utility grid is negligible.

At night the PV array does not generate solar electric power, so that electric vehicles connected to the charging pillar draw solar electric power stored in the carport lithium-ion battery. If this is insufficient, electric power from the battery is backed by electric power from the grid.
SOLAR CAR PORT NIGHT OPERATION

The screenshot below depicts an actual night time electric vehicle charging event, starting just before 9pm. The stored solar electric power delivered by the carport lithium-ion battery, depicted by the yellow area of the graph, increases to approximately 3.8kW. The carport battery delivers a total of 11.9kW over a period of 3 hours 10 minutes. When battery solar power is depleted, electrical power supply charging the electric vehicle switches seamlessly to the grid. The electric power delivered to the electric vehicle from the grid is depicted by the red area of the graph. After a further 30 minutes, the charging event is terminated.

In order to understand the feasibility of the structures installed, and to understand the extent to which carbon neutrality can be achieved through the solar car charging stations, the results, like previously in this chapter, have been subdivided as answers to a series of questions.

ARE CARS CHARGED FROM THE STATIONS ACTUALLY CARBON NEUTRAL?

In the current set up where the PV array on top of the station produces an 11.25 kWp, the solar power produced on site is in fact sufficient to offset the demand being created by the electric vehicles being charged at the station. Net offsetting is feasible in the current set up. Therefore, yes, vehicles charged at the station during the pilot period did achieve carbon neutrality.

AND TO WHAT EXTENT?

In the current situation of low demand for EV charging, it can be assumed that 100% of emissions from charging has been offset by PVs.

HOW MANY CARS A DAY CAN THE STATION CHARGE USING ONLY SOLAR POWER?

In answering this question, one must naturally consider the car battery size and different charge necessities by the different cars.

However, considering the current set up, averaged out over all 6 charging pillars housed in the solar car charging stations installed in Malta, would result into 1.5 charges per day per charging pillar, assuming 20kWh/charge.

This means that in one year, the 3 solar car charging stations would support a total of 3,285 EV charges at full carbon neutrality giving rise to a potential of 95 tonnes in CO₂ emission savings in twelve months.
4.4 STUDIES

Through the PORT-PVEV Project, Transport Malta has also studied a solution for ships to pollute less while berthed at the quay.

Ships use Heavy Fuel Oil to operate and thus are responsible for an array of GHG emissions and a concoction of very harmful pollutants. In fact, the Global shipping industry accounts for 3% of the world’s total GHG emissions.

Whilst at berth, ship emissions do not cease. In order to supply electricity to the on board equipment, and supply power to the cabins, docked ships continue to use the on-board auxiliary engines. The electrical power needed to power a berthed ship is staggering; a single cruise liner uses as much power as a town of 10,000 inhabitants. Pollutants and much noise therefore continue to be emitted while the ship is stationary within the harbour.

These emissions are especially harmful to the residents living adjacent to the port which, in the case of Malta, amount to 14.8% of the island’s total population.

Cold Ironing is a process whereby electrical power is supplied to ships from the quay-side while the main and auxiliary engines of the ships are shut down. Using this infrastructure, ships can turn off their engines for the entire time they are docked at the harbour and use the electrical power supplied from the national electricity grid to power the floating city. Therefore, by using this technology the ship engines can be switched off rendering a cleaner air quality and a noiseless environment within the port area where residents are so abundant.

Through the PORT-PVEV project, Transport Malta studied this option and its feasibility for the Port of Valletta considering the port’s various quays, the space available for the infrastructure and the cost needed to provide this service at the Grand Harbour.

The demand analysis for the study was derived from:

- the type and number of vessels that berth in Valletta
- which type of vessels historically berth at the different terminals
- power consumption of each vessel
- power supply needed by the national grid

The study developed 5 Technical options for On-shore Power Supply provision taking into account technical constraints and potential demand. The study tested investment options under different assumptions regarding On-shore Power Supply availability and vessel retrofitting.

In line with findings of similar studies, the principal conclusions were:

- potential for economic benefits from On-Shore Power Supply could be significant
- economic and financial viability of On-Shore Power Supply infrastructure is highly dependent on the presence of On-Shore Power Supply facilities in other ports which are visited by vessels calling at the Valletta Port. For this to take place, however, it is likely to require mandatory regulation or industry-set standards at EU level.

A separate detailed report has been produced by the project. The report is entitled: “Feasibility study into the possibility of shore-side electrical supply for berthing vessels within Maltese Harbours” and is accessible on the Transport Malta website.
The PORT-PVEV project has achieved an overall 122.99 tonnes in Carbon Dioxide Emissions savings, and which will continue to be saved annually through the use of the L7e (quadricycles), M1 (passenger cars) and N1 (light goods vehicles) deployed through the project. These emission savings also result from the energy production by the PV installations and using said energy to offset electricity consumption by the electric vehicles. Furthermore, 95 tonnes in Carbon Dioxide Emissions can potentially be saved on an annual basis through the use of the solar charging stations which offer the possibility of 3,265 electric vehicle charging events at full carbon neutrality.

Moreover, considering Air Quality in Malta, a total of 45 tonnes of NOx and 1.6 tonnes of Particulate Matter emissions have been saved as a result of this project and will continue to be saved as a result of this project from the use of the 13 vehicles deployed by Transport Malta.

Through the testing and demonstration of the electric vehicles as part of this project it has been concluded that cost savings per electric vehicle when compared to combustion engine vehicles amount €1,474.86 per annum. Battery range autonomy has been recorded at an average of 131 km per charge for winter (considering AC being off the whole time) and 111 km for summer (considering that AC is on most of the time) per full charge. Moreover, an electric car is estimated to consume €0.04 in electricity per kilometre travelled.

Through photovoltaic installations deployed as part of the project, an annual average total of 260,735kWh is being generated through renewable energy produced by solar power in both Malta and Sicily.

It has been estimated that approximately 4 million people have benefitted from the results gained by this project, particularly the improved air quality. Beneficiaries range from residents, workers, commuters and tourists present in the three territories in which the PORT-PVEV project has been implemented.
A. COMMUNICATIONS STRATEGY

The Communication Plan was compiled in the first phase of project implementation and presented a systematic strategy for the communication and dissemination planned for the entire duration of the project, illustrating tools, objectives and specific activities to be followed by all partners in the execution of their duties within the project.

A logo was also created within the first phase of implementation to serve as the corporate image of the project and used in all information dissemination and communication material produced and used during project events.

B. PROJECT WEBSITE

A project website has been created for this project:

www.portpvev.eu

The website was created by the Province of Caltanissetta with the support of all partners and has constantly been updated during the implementation of the project. The website has been the main online information point for the project. During the project the PORT-PVEV website hosted a total of 2,706 visitors.

The project has also been made visible online through Partners’ own websites, Government websites, news articles as well as part of motoring magazines.

ANNEX

ACTIONS OF AWARENESS, INFORMATION AND DISSEMINATION AND TOOLS UTILISED BY THE PORT-PVEV PROJECT

C. PRESS RELEASES AND MEDIA VISIBILITY

Several Press Releases have been published throughout the project lifetime, including 3 in Malta and 10 in Sicily.

D. PROJECT AND FUNDING PROGRAMME VISIBILITY

Equipment and infrastructure procured and deployed as part of this project have been labelled with logos that show the funding element supporting the procurement of said equipment.
E. BILLBOARDS

A total of 19 billboards have been deployed within partner port areas in order to publicise the project and the efforts made to decarbonise the respective port areas.

3 billboards have been set up in the Valletta Grand Harbour and its hinterland between November and December 2013 in conjunction with the Mid-term event, while another 5 Billboards have been set up in the Valletta Grand Harbour and at the Ċirkewwa Ferry Terminal between November 2014 and January 2015 in conjunction with the full deployment of the project outputs within the respective harbours.

9 billboards have been set up in Caltanissetta and Gela during the months of April and May 2015.
F. MID-TERM EVENT

As part of the PORT-PVEV project, a Mid-Term Event Project Conference titled ‘Electromobility Islands’ was held on 29th November 2013 in Malta. The conference hosted an exhibition showcasing different types of Battery Electric Vehicles (BEVs) and related charging infrastructure. The exhibition was open for the general public on Saturday 30th November and Sunday 1st December 2013.

The Conference was opened by the Minister for Transport and Infrastructure. The PORT-PVEV partners conducted presentations on their respective project activities and the progress to date. Other speakers included representatives from international companies such as Renault ZE, BMW, Mitsubishi and Siemens and a representative on the LUTZ Project, a project in the UK on electric pods (in collaboration with the Milton Keynes Council). Maltese speakers were also invited, namely representatives from MEPA, University of Malta, Autosales LTD and the Ministry for Transport and Infrastructure. The latter gave a presentation on Demo-EV Project; implemented between 2011 and 2014 the Demo-EV introduced electric vehicles and public charging infrastructure on the national road network.

A total of 110 participants were present at the conference.
G. PROJECT LEAFLETS

A Project leaflet has been produced in English for the use of the entire partnership to promote and explain the project. The leaflet was first disseminated during the Mid-term event.

Another two leaflets have been created in both English and Italian for the use of the entire partnership aimed at dissemination with the general public, in order to promote and explain the project and disseminate the project results once all the activities were put in place. These leaflets have been created in view of the Final event which was held in Gela in June 2015.

H. VIDEO

In order to depict and describe the activities carried out within each demonstration area, and disseminate the information as widely as possible, a video has been created and launched in the PORT-PVEV final event. The video will continue to be available on the Project Partners’ respective websites and Facebook pages as well as on YouTube.

I. PROJECT FEATURED IN PUBLISHED ARTICLES

During the lifetime of the project, the partnership was invited to give several interviews that explain the innovation and demonstration element of the activities being implemented. The interviews featured in published articles in International magazines including Thinking Highways (Vol.9, No.2), Thinking Cities (Polis Annual Conference, Special Edition) and the Traffic Technology International (Feb/March 2014).

J. FINAL EVENT

The Final Event was held in Gela in July 2015 bringing together all project partners and relevant Sicilian stakeholders. At the event the partners presented their outputs deployed during the project as well as the results achieved. Both the project video and leaflets were officially launched during the event.
Italy-Malta Operational Programme – Cohesion Policy 2007-2013
A sea of opportunities for the future

This project is part-financed by the European Union Regional Development Fund (ERDF) Co-financing rate: 85% EU funds; 15% National funds

Investing in your future