VIAJEO PLUS

D4.3: Clean Vehicles Solutions for Mobility Weeks

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Abstract	This document aims to provide a list of clean vehicles solutions that can be used as 'champions' during the mobility weeks in Europe, China, Latin America and Singapore.
Keyword list	Best Practices; Mobility Weeks; Clean Vehicles
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1. Introduction

This document has been produced with the aim of providing guidance on the nature of the clean vehicles solutions to be exhibited during the Viajeo-Plus mobility weeks. These mobility weeks will take place in Europe (Summer 2014), China (Winter 2014), Latin America (Winter 2015) and Singapore (Spring 2016). Clean Vehicles solutions in each of these cities will be proposed during this document.

Clean vehicles will form the backbone of sustainable transport – the ability to continue to make trips without producing local emissions is vital in ensuring environmental sustainability, especially in urban areas. Urban rail is most commonly electrified, although zero/low-emissions road transport solutions are much less common. Clean Vehicles solutions include vehicles powered by Liquefied petroleum gas (LPG), Biofuels (e.g. ethanol, methane), Fuel Cells (e.g. Hydrogen) Hybrid propulsion (smaller motor and energy storage device) and Fully-Electric vehicles (using batteries, supercapacitors, or a combination thereof).

2. Methodology to select best practices for the City Showcase

A methodology for selecting best practices for different purposes within the Viajeo Plus project has been identified in the deliverable D2.1 "Best Solution Selection Methodology"[2]. A summary of the procedure for decisions on the different level of best solutions is given in Figure 1:

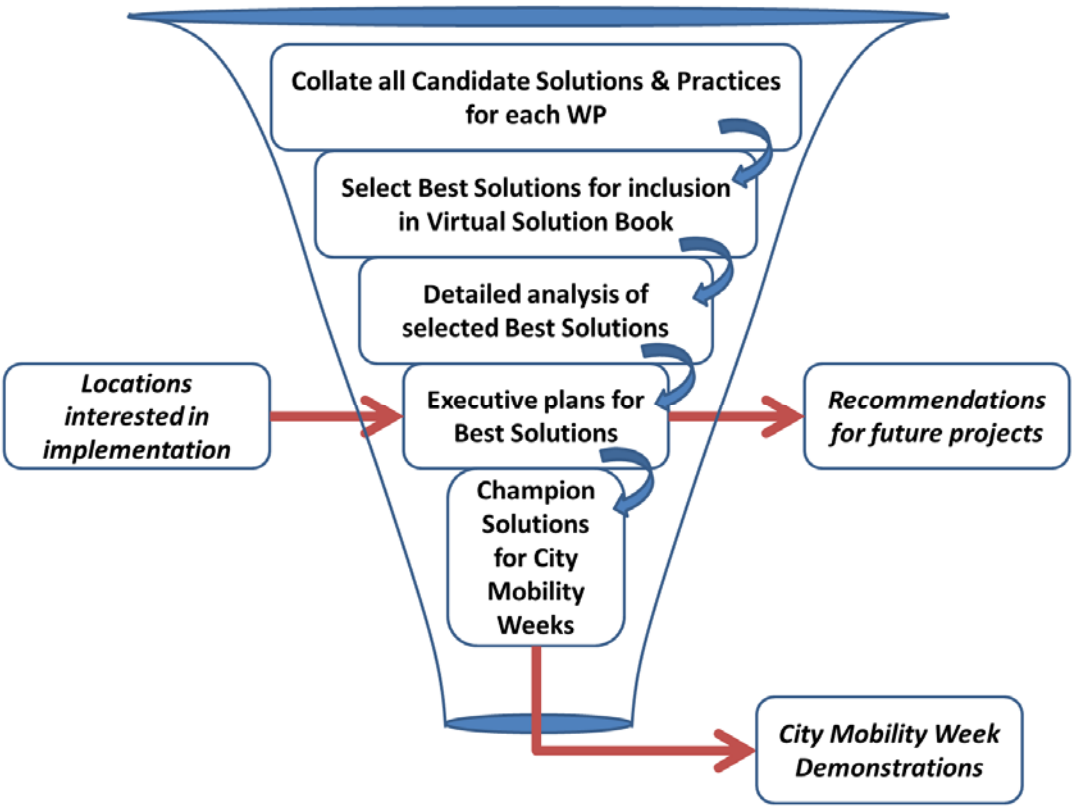

Figure 1 – Viajeo PLUS flow diagram for selecting the ultimate set of Best Practice/Solutions

After identifying the methodology for selecting best practices, a large number of solutions have been initially gathered and analysed, before the most appropriate of which have been selected for inclusion in the Virtual Solution Book and additional analysis and promotion. A list of criteria can be found in Annex I. However, the selection of best solutions for City Showcase also needs to take consideration of:

- **Relationship with potential host cities**: This is crucial; a City Showcase requires full cooperation with the host city and support from local policy makers and stakeholders to explain motivation, implementation issues, operations and benefits of such solutions to participants of City Showcase.

[2] D2.1 is a public deliverable and available at: http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/

- **Attractiveness of a solution for non-experts and external audience:** The City Showcase aim to give first hand experiences. Some solutions that may not provide interesting first-hand experiences to users can be simply presented in the Virtual Solution Book rather than selected for the City Showcase. Solutions that provide interesting first-hand experiences to attract users would be given priorities.

- **Transport and mobility services in potential host cities:** Since the City Showcase can only be hosted once in each of the four regions/countries, it is not feasible to let participants to go different cities in region/country. Therefore, the host cities should have more than just one innovative solution and ideally is advanced in transport and mobility services in general in order to make the host cities more attractive to participants.

- **Location of potential host cities**: A host city should be easy to reach by participants from all over the world.

3. Clean Vehicles Solutions for Mobility Weeks

3.1. Europe

3.1.1. Plug-in hybrid buses

Buses with a hybrid propulsion system that can be powered by both stored on-board electricity and a conventional internal combustion engine (ICE) have been developed by Volvo, which are now in trial operation in the city of Gothenburg. The parallel drivetrain allows for the bus to be driven either electrically or using the ICE.

The first plug-in charging station was installed at a bus stop at Redbergsplatsen, Gothenburg, in May 2013. The Ultra-fast charging station installed at each end of the #60 bus route supplies electricity to the new Volvo Plug-in Hybrid Bus to enable quiet, emission-free electric-only driving for the majority of the route. The Volvo Plug-In Hybrid is based on Volvo 7900 Hybrid bus, but with the addition of a larger, energy optimized battery and ultra-fast charging capability. Charging the on-board battery takes place automatically at the bus termini, which charges the bus for 5 – 8 minutes at the end of each trip. This extends the all-electric range of the Volvo hybrid bus to a predicted 60% or more of the route.

This allows for a significant reduction in the levels of noise and air pollution, contributing to better urban air quality, and hence quality of life. The introduction of these new buses has allowed for a reduction in fuel consumption of 81% (in comparison to the equivalent diesel bus consumption), with an overall total energy consumption reduction of 61%. The results of the field tests being conducted in Gothenburg show that Volvo Buses' plug-in hybrid more than meets expectations. The overall experience for both the drivers and the passengers has also been improved, with lower noise levels (in the range of 20 dBA), and faster accelerations.

The HyperBus project is funded partly by the EU Life+ Innovation program, as well as with contributions from Business Region Göteborg, Göteborg Energi, City of Göteborg Traffic & Public Transport Authority, Volvo Buses and the public transport company Västtrafik.

3.1.2. City Delivery Concept – "Stadsleveransen" Stadsleveransen

The City of Gothenburg has developed numerous sustainable urban logistics solutions, some of which involve the use of clean vehicles. For example, the Stadsleveransen involves the consolidation of numerous small deliveries by ICE-powered vehicles destined for the city centre in micro-terminals, which are then distributed using zero-emissions vehicles, thusly reducing congestion, noise levels and emissions. These terminals serve a limited geographic area, number of shippers and transport operators. As such, they can help make more efficient usage of transport resources, by reducing the mileages of Heavy Goods Vehicles (HGV) with low average loads.

The project started in 2012 with a small scale pilot action for half a year. A small number of shops (8-10) were initially contacted and asked to redirect their goods through the consolidation centre. The consolidation centre was set up in a car park in the city centre, and a small electric vehicle was used to deliver the goods from the centre to the retailers. The retail trade association in the city centre was responsible for the consolidation centre and it was operated by a security company. The pilot was during this phase mainly financed by projects, the local authority and the trade association together with a property owner in the city centre.

As of November 2013, 200 receivers were using the consolidation centre and discussions were also being held with another hauler to be involved in the demonstration. To help with the final delivery of the growing quantity of goods handled, a transport company using electric cargo bikes have also been added to the operations. During this phase, additional funding of the demonstration was raised through selling advertising space on the vehicle, which formed an important part of the business model for Stadsleveransen. Local distribution at the Lindholmen Science Park has been fully operational since 2011 with, as of September 2014 14 companies connected to it. The terminal receives and distributes goods and mail and carries out clean waste management. Since then it has continued to develop with support from local authority, transport operators and trade associations.

There are many stakeholders involved in such a project, including local authorities, freight operators and local businesses. It is important to obtain an agreement with business and retailers to use the terminal and its delivery vehicles – choosing a location of a micro-terminal should take into consideration many aspects, necessitating that local authorities play an important role, together with trade associations and individual business owners.

3.2. China

3.2.1. Chengdu BRT

Clean vehicles in China will play an important role in lowering air quality problems within major cities, and as such, the Chinese government has issued a series of policies made to provide subsidies to green car buyers. For example, a new policy in force until 2017 exempts buyers from a 10% vehicle tax when they purchase certain fuel-efficient automobiles. However, consumers say they are still hesitant to invest in certain types of green vehicles (i.e. electric vehicles), due to the lack of supporting infrastructure (i.e. charging stations).

Furthermore, with regard to the public sector, various city departments in Chengdu have joined together to improve the environmental performance of transport within the city. In July 2014, Chengdu was approved to be one of the first six cities to be a National Ecological Environment Demonstration Area, allowing Chengdu to take the opportunity to improve many aspects of the city.

One recent important development in the transport system in Chengdu is the elevated BRT system with dedicated lanes and elevated stops. Two elevated BRT lines (K1 and K2) have a total route length of 29km, with 28 stations in total. The frequency of services during peak times is 90 seconds, with a daily ridership of over 270,000. The average operating speed of the BRT can reach 27km/h, in comparison to the 14km/h exhibited by conventional bus services in the city. However, the BRT system in Chengdu has an additional advantage, in that it is solely powered by Compressed Natural Gas (CNG) – a fuel which has numerous benefits over conventional fuels. For example, CNG exhibits a lower cost per unit, a higher fuel density and significantly fewer pollutants (e.g., carbon dioxide, carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter) than petrol[3].

[3] Zhiliang Yao, Xinyue Cao, Xianbao Shen, Yingzhi Zhang, Xintong Wang, Kebin He, On-road emission characteristics of CNG-fueled bi-fuel taxis, Atmospheric Environment, Volume 94, September 2014, Pages 198-204

3.2.2. Shanghai electric buses

Shanghai has experimented in electrically-powered buses since 2005, with the first notable implementation during the 2010 Shanghai EXPO, where 120 fully electric buses were put into operation. During the EXPO, the buses were used in the EXPO park and were charged at each bus stop, after which they were used throughout Shanghai. The power supply came in the form of on-board supercapacitors which were charged at every bus stop.

However, whilst these buses helped to reduce local air pollution, they presented a number of problems, including maintenance problems and an insufficient operational distance. However, the maturation of such technologies continues, and in 2014, a fleet of 60 electric buses containing a pantograph and an on-board battery were implemented. These vehicles are able to operate using the pantograph, which can also be used to charge the battery in-service, whilst the battery can be used to propel the vehicle for 15km on one full charge. Such an implementation is an important step towards the broad implementation of clean road transport vehicles in urban areas. By the end of 2014 it is expected that there will be over 300 of these electric buses in operation.

3.3. Latin America

3.3.1. Ecofrota Program (São Paolo, Brazil)

The program Ecofrota was first considered as a response to new climate change laws in the City of São Paulo in June 2009, which recommended that the city's public transport system should operate with renewable fuel by 2018 and, from 2009, gradually reducing the use of fossil fuels by at least 10% each year.

The technologies to achieve this vision are varied, including: biodiesel, ethanol, diesel, cane sugar, hydrogen and electricity-powered engines, also using hybrid and battery technologies. The diversity of technologies is advantageous, providing a better distribution of the energy matrix, and better choice of technologies for different applications. Such a project requires cooperation between local government, public transport operators and bus manufacturers.

The program launched in February 2011, and by February 2012, the Ecofrota already had more than 1,600 buses, divided into 200 lines, which corresponded to 11% of the total fleet of the municipality. During this period there was a 6.3% reduction in emissions of pollutants. The changes thus far in energy usage bring benefits to the city's economy, the quality of life of its inhabitants and the preservation of its environment.

3.4. Singapore

3.4.1. Electric Vehicles

Electric vehicles are gaining greater prominence in Singapore, given the suitability of the environment to such a technology. For example, the city state of Singapore has a robust power grid to cope with the inevitable increase in power requirements due to vehicle charging. It also enjoys a continuously warm climate without cold winters, providing the optimal conditions to ensure the highest possible longevity of the battery life. Furthermore, Singapore is only 30 miles wide, eliminating the potential for concerns regarding the operational range of electric vehicles.

In 2014, programs to further encourage the uptake of electric vehicles within Singapore have been undertaken, in cooperation with the car manufacturer BMW and Greenlots – a global provider of open standards-based charging solutions. This is part of BMW's 360º ELECTRIC program, and will help to support Singapore's growing EV population. This has allowed for the development of a greater level of infrastructure to facilitate in the uptake of more electric vehicles, in addition to smartphone apps to aid daily usage of electric vehicles.

BMW have also developed the 'i Wallbox Pure' to aid home charging of electric vehicles for Singaporean citizens. Specialist advisors also appraise the home and workplace environment for potential electric vehicle owners, to ensure that it is suitable to accommodate a home charging units. The greater uptake of electric vehicles will aid the improvement of air quality in the Singaporean area, which often suffers from smogs, and in 2013 suffered its worst-ever air quality ratings.

3.4.2. Fuel Cell & Hybrid Propulsion buses

The latest incarnation of 'Green' buses have been in trial operation in Singapore, through SBS Transit (The Singapore Transport Company) since 2010. These consist of fuel cell buses and hybrid buses. The 'zero-emissions' fuel cell bus is a collaborative effort between the Nanyang Technological University (NTU), Beijing's Tsinghua University, China's second largest bus manufacturer Higer, and SBS Transit. It is powered by two energy sources: hydrogen and lithium-ion batteries. An on-board fuel cell simultaneously powers the bus and charges the batteries.

Additionally, the hybrid bus, which runs on both diesel and electricity, was brought in by ComfortDelGro Engineering in collaboration with Shanghai Sunlong Bus Company and Gemilang Coachworks of Malaysia. Fuel savings of up to 30% are derived by using regenerative braking energy stored in on-board lithium-ion batteries to power the bus and hence reduce fuel consumption. The bus uses a parallel hybrid system that is developed by Eaton Corporation of the United States.

4. Conclusions

This report has aimed to highlight some of the clean vehicles solutions available to be viewed during the mobility weeks in Europe, China, Latin America and Singapore, with a view to enabling other cities, both in Europe and in Topic One Countries (Latin America, China and Singapore) to learn from their successes and inspire them to develop clean vehicles solutions to aid the vision of achieving sustainable urban transport systems worldwide.

Annex

No.	Criteria	Definition	Proposed Scoring Scale
01	Innovation Degree	Solution is comparatively new and has not experienced broad diffusion in practice	(No negative values) 0 = Solution is innovative for the host city/country only 1 = Solution is innovative within a global region 2 = Solution is innovative across different global regions
02	Policy Relevance	Solution addresses a range of key policy objectives (e.g. economic efficiency; modal shift; social inclusion; environmental sustainability; increased accessibility etc.)	(No negative values) 0 = Little or no relevance to any key policy objectives 1 = Relevant to one, specific key policy objective 2 = Relevant to more than one key policy objective
03	Civic delivery team	Resource capability to successfully deliver the solution	-2 = Requires a large team spread across multiple departments or stakeholders to successfully implement and operate the solution -1 = Requires a small team spread across multiple departments or stakeholders to successfully implement and operate the solution 0 = Solution can be successfully implemented with one key partner taking the lead but with support from other partners +1 = Solution can be successfully implemented and managed by a larger but dedicated team hosted within one organisation +2 = Solution can be successfully implemented and managed by a smaller but dedicated team hosted within one organisation
04	Maturity	Solution is ready for implementation, having passed pilot or experimental stages and can build on working examples in one or more cities	(No negative values) 0 = Solution maturity is equivalent to a TRL of <=5 1 = Solution maturity is equivalent to a TRL of 6-7 2 = Solution maturity is equivalent to a TRL of 8-9 (TRL = Technology Readiness Level)
05	Global Potential	Solution could become implemented broadly across countries/cultures/regions	-2 = Significant social, political, cultural, economic etc. barriers exist to a wider implementation -1 = Some social, political,

			cultural, economic etc. barriers exist to a wider implementation 0 = No social, political, cultural, economic etc. barriers exist to a wider implementation, but little benefit would be gained on a global scale +1 = Wider implementation would bring benefits on a global scale +2 = Wider implementation would bring significant benefits on a global scale
06	Localised applicability	Solution addresses a very particular issue with a limited take-up potential	-2 = Solution only addresses a specific issue, only relevant to existing location -1 = Solution only addresses a specific issue, which is found in multiple locations 0 = Solution addresses a small number of issues, primarily found in existing location +1 = Solution addresses a small number of issues, found in multiple locations +2 = Solution addresses a wide range of issues, which are found in multiple locations
07	Complementarity	Represents a promising complement for other (innovative) solutions	-2 = Very limited or no complementarity potential with other solutions -1 = Limited complementarity potential with other solutions 0 = Some complementarity potential with other solutions +1 = Good complementarity potential with other solutions +2 = Strong complementarity potential with other solutions
08	Expected Impacts	Previous implementation of solution has had social, economic and environmental impacts	For each of social, economic and environmental (where relevant): -2 = Strong negative impact -1 = Negative impact 0 = No impact/no change +1 = Positive impact +2 = Strong positive impact
09	Measurability	Progress of solution implementation can be measured sufficiently	(No negative values) 0 = Hard to measure progress due to a lack of data or suitable metrics 1 = Progress can be measured with

			some limitations (e.g. data may be incomplete) 2 = Progress can be easily measured regardless of location
10	Public Acceptance	Solution is likely to have a wide public acceptance	(No negative values) 0 = No impact/no change 1 = Some public acceptance 2 = Strong public acceptance
11	Expandability/ Scalability	Solution can be up-scaled to accommodate different contexts and situations	-2 = Solution cannot readily be up-scaled -1 = Solution would require significant effort/investment to up-scale in a new context 0 = Solution would require some effort/investment to up-scale in a new context +1 = Solution would require minimal effort/investment to up-scale in a new context +2 = Solution would require little or no effort/investment to up-scale in a new context
12			
13	WP specific indicators – to be defined in conjunction with WP leaders (if required)		
14			
15			