# D5.1

# Lyon: Demo Description and Implementation Plan

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Coordinator: UITP – International Association of Public Transport

# SUMMARY SHEET

| | |
|---|---|
| Programme | Horizon 2020 |
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| Project Title | European Bus Systems for the Future 2 |
| Acronym | EBSF_2 |
| Coordinator | UITP – International Association of Public Transport |
| Project Director | Michele Tozzi, michele.tozzi@uitp.org |
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| Abstract | The objective of the EBSF_2 Lyon demonstration is to validate in a city environment innovations on eco driving and energy management. Overall, the demonstration is committed to bring technology bricks, both on diesel and hybrid busses, by testing an improved eco-driving system able to provide real-time information to the drivers as well as complete analysis to the operator, and a better management of auxiliaries. All these new developments will be compliant with ITxPT architecture and related standards to allow interoperability.<br>Deliverable 5.1 describes the objectives of the technological innovations “Innovative eco-driving application”, “Extension of ZEV mode on hybrid buses” and “Improvement of management of auxiliaries” to be tested within the Lyon demo, coherently with the Validation Objectives defined together with the EBSF_2 Evaluation Team. Moreover it reports on technical specifications, responsibilities and planning of the demo activities along the project’s lifetime. |
| Keywords | Energy Management, Auxiliaries, Hybrid Technology, IT Standards |

# INTERNAL DISTRIBUTION

| Participant N° | Participant organisation name | Country |
|---|---|---|
| 1 Coordinator | Union Internationale des Transports Publics - UITP | Belgium |
| 2 | Régie Autonome des Transports Parisiens - RATP | France |
| 3 | Iveco France SA - IVECO | France |
| 4 | Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. - FRAUNHOFER | Germany |
| 5 | Hübner Gummi- und Kunststoff GMBH - HUEBNER | Germany |
| 6 | DigiMobee SAS - DIGIMOBEE | France |
| 7 | Centro de Estudios e Investigaciones Técnicas - CEIT | Spain |
| 8 | Chalmers Tekniska Hoegskola AB - CHALMERS | Sweden |
| 9 | Compañía del Tranvía de San Sebastián, SA (CTSS) – DBUS | Spain |
| 10 | IRIZAR S Coop - IRIZAR | Spain |
| 11 | D'Appolonia S.p.A. - DAPP | Italy |
| 12 | EvoBus GmbH - EVOBUS | Germany |
| 13 | Volvo Bus Corporation - VBC | Sweden |
| 14 | Pluservice srl - PLUSERVICE | Italy |
| 15 | Universidad Politécnica de Madrid - UPM | Spain |
| 16 | Actia S.A. - ACTIA | France |
| 17 | Teknologian Tutkimuskeskus - VTT | Finland |
| 18 | MEL-SYSTEM | Italy |
| 19 | Ineo Systrans – INEO | France |
| 20 | Stuttgarter Strassenbahnen AG - SSB | Germany |
| 21 | Associazione Trasporti - ASSTRA | Italy |
| 22 | Pilotfish Networks AB - PILOTFISH | Sweden |
| 23 | Start Romagna SpA - START ROMAGNA | Italy |
| 24 | FIT Consulting Srl - FIT | Italy |
| 25 | Hogia Public Transport Systems AB - HOGIA | Sweden |
| 26 | Trapeze ITS UK Limited - TRAPEZE | Switzerland |
| 27 | Digigroup Informatica srl - DIGIGROUP | Italy |
| 28 | Transports de Barcelona SA - TMB | Spain |
| 29 | TIS PT, Consultores em Transportes, Inovação e Sistemas, SA - TISPT | Portugal |
| 30 | Rupprecht Consult - Forschung & Beratung GmbH - RUPPRECHT | Germany |
| 31 | Keolis SA - KEOLIS | France |
| 32 | Syndicat Mixte des Transports pourle Rhone et l agglomeration Lyonnaise - SYTRAL | France |
| 33 | Transport for London – TFL | UK |
| 34 | Università degli Studi di Roma La Sapienza – UNIROMA1 | Italy |
| 35 | Verband Deutscher Verkehrsunternehmen - VDV | Germany |
| 36 | Promotion of Operational Links with Integrated Services, Association Internationale - POLIS | Belgium |
| 37 | Tekia Consultores Tecnologicos S.L - TEKIA | Spain |
| 38 | Innovative Informatikanwendungen in Transport-, Verkehrs- und Leitsystemen GmbH - INIT | Germany |
| 39 | Union des Transports Publics - UTP | France |
| 40 | Västtrafik AB - VTAB | Sweden |
| 41 | Commissariat à l'Energie Atomique et aux Energies Alternatives - CEA | France |
| 42 | Consorcio Regional de Transportes de Madrid - CRTM | Spain |

## EXTERNAL DISTRIBUTION

| Entity | Short name | Country | Contact person |
|---|---|---|---|
| European Commission - INEA | EC INEA | - | Mr. Walter Mauritsch |

## DOCUMENT CHANGE LOG

| Version | Date | Main area of changes | Organisation | Comments |
|---|---|---|---|---|
| 0.1 | 26/10/2015 | | IVECO | First draft |
| 0.2 | 23/02/2016 | All chapters | IVECO/SYTRAL/DIGIGROUP INFORMATICA | Alignment with UITP guidelines |
| 0.3 | 16/06/2016 | All chapters | UITP | Review and Quality Check |
| 0.4 | 11/07/2016 | All chapters | DIGIMOBEE | Review (IT standards) |
| 1.0 | 12/07/2016 | | IVECO | Final version |

## CONTRIBUTING PARTNERS

| Company | Names | Company Info |
|---|---|---|
| SYTRAL | Magalie Campmas | Lyon's Transit Authority |
| KEOLIS | Emmanuel Sorin | Lyon's operator |
| KEOLIS | Alberto Gonzalez-Pizarro | Lyon's operator |
| DIGIMOBEE | Emmanuel De Verdalle | IT expertise |
| IVECO | Lionel Blain | OEM |
| DIGIGROUP INFORMATICA | Vittorio Moreggia | Ecodriving software supplier |
| METATRONIX | Marco Rocco | Ecodriving supplier |

## ACRONYMS

AVMS – Advanced Vehicle Monitoring System

EBSF – Europena Bus system of the Future

HMI – Human Machin Interface

KPI – Key Performance Indicator

ITxPT – Information Technology for Public Transport

MADT – Multi-Application Driver Terminal

OEM - Original Equipment Manufacturer

PTA – Public Transit Authority

PTO – Public Transit Operator4

TI – Technological Innovation

VO – Validation Objective

ZEV – Zero Emission Vehicle

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# 1 Executive Summary

The key objective of the EBSF_2 Lyon demonstration is to validate in a city environment innovations on eco driving and energy management.

The Demo Consortium has developed a new approach to eco-driving, based on the use of a mathematical model which calculates in real-time a dynamic fuel consumption target taking into account the vehicle operating conditions and assess a fuel economy performance index. The system since 2012 has been installed on new generation buses within the SYTRAL fleet: more than 200 buses (both 12m and 18m) have been equipped with such a system. In the Lyon demo the current system will be improved with respect to several aspects, namely:

- Improved modelling of auxiliaries energy consumption
- Implementation of additional driving style indicators
- Enhancement of HMI (Human Machin Interface) to provide real-time and/or “off line” hints to the driver
- Tuning of parameters for optimal performance
- Application and adaption of the system to the demo hybrid buses
- Specification to comply with standard IT architecture (ITxPT based) for IT systems interface (AVMS - Advanced Vehicle Monitoring System - and ecodriving).
- Specification to share eco-driving HMI on MADT (Multi Application Driver Terminal)

Regarding energy management two different buses will be used for the Lyon demonstration: the diesel version of the IVECO Urbanway and the hybrid version of the same vehicle. The objective is, on one hand, to test the efficiency of new technologies/components for the auxiliaries (on board diesel buses for more comfort, as interfaces with the operating system or for safety reasons) and, on the other hand, to test the opportunities offered in this field by new technologies dealing with electro mobility.

Regarding eco-driving system, a specification will be delivered to define standard interface with the AVMS (Advanced Vehicle Monitoring System) based on IT architecture supported by ITxPT association. This on-board interface (based on European standard EN13149) will define standard IP messages to share data, such as like Line, Service, Bus station, etc., and offer a full interoperability between eco-driving system and AVMS.

In addition, MADT concept (developed during EBSF project) will be evaluated to share eco-driving HMI on a single driver terminal. In this way, a dedicated specification guideline will be delivered including some mock-up of the interface. The demo will also investigate on vehicle data needs to enrich Bus-Fleet Management System interface and report to the project’s partners in charge of defining functional requirements for IT evolution in this field.

# 2 Background and Context

SYTRAL is the 2nd Public Transport Authority in France that operates several networks (TCL, Libellule, Les Cars du Rhône, Rhônexpress, OPTIBUS), as detailed in the map show in Figure 1.

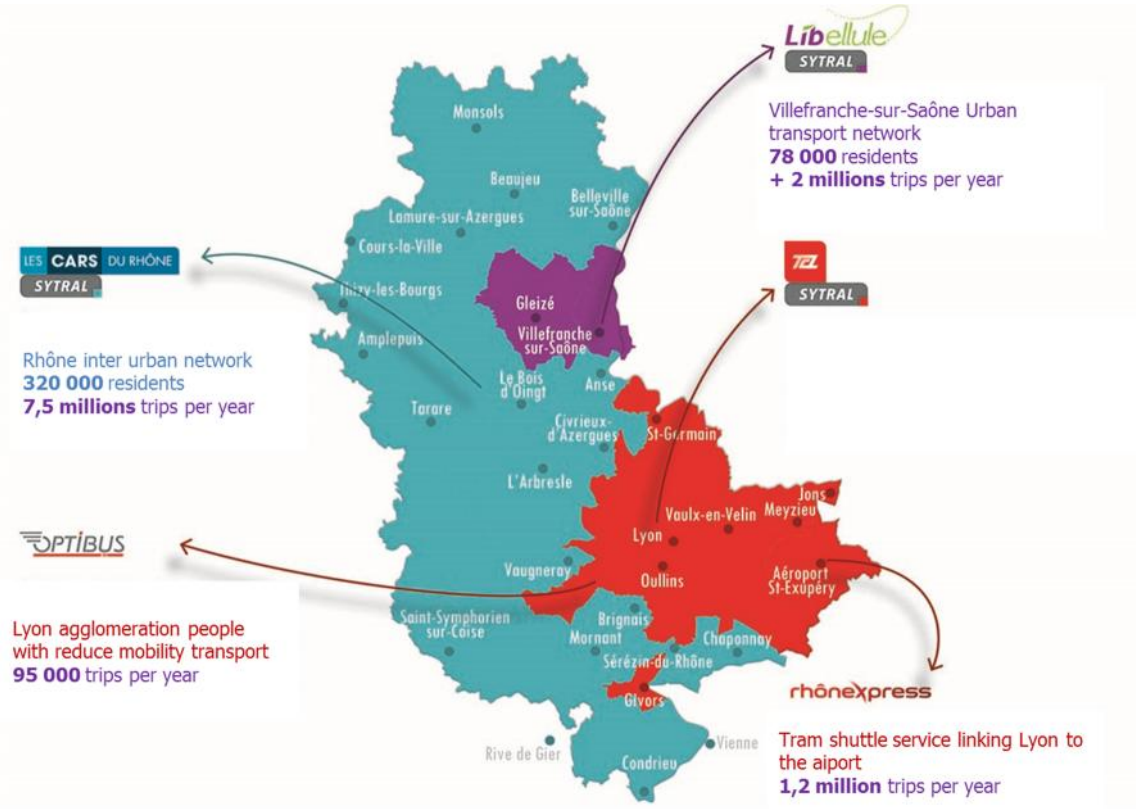


**Figure 1 – Public Transport networks operated by SYTRAL**

1 concession and 7 Public Service Delegations, including KEOLIS LYON, are contracted for the operation of the Lyon's network which includes 5 modes of transport totalizing 1,7 million passengers per day. This is a solid and efficient network linking the different modes of public transport and roadways with the park-and-ride facilities on the outskirts of town.

The 75% of the traffic is powered by electricity thanks to:

- 4 Metro lines: 178 carriages and 44 stations (35 km)
- 2 Cable car lines of: 6 carriages (1.2 km)
- 5 Tramways f: 85 trains and 88 stations (64 km)
- 9 Trolleybuses lines of: 131 buses (121 km)
- 121 Bus lines of: 950 buses

The SYTRAL 2015 budget accounts for 710 Million Euros of which 58% is the network operating cost, 21% the equipment cost, 20% the debt repayments and 1% the SYTRAL operating cost.

**Figure 2 –SYTRAL means of transport**

The bus fleet operated by SYTRAL includes both standard (12m) and articulated bus and more than half of them are compliance with EURO V and Euro VI emission standards. The fleet composition by size and emission standard is shown in Figure 3.

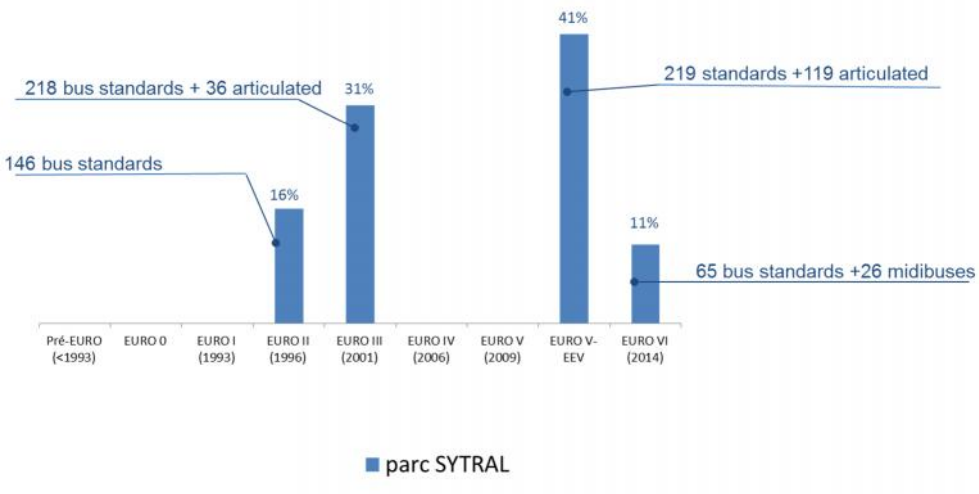


**Figure 3 – Bus fleet composition by size and emission standard**

Overall the 121 bus lines (Figure 4) allow investigating different physical and operational parameters because of their variety, namely:

- 3 topographic profiles: flat, medium slopes and heavy slopes (more than 6,5%);
- Downtown routes facing high traffic, urban classic traffic and suburban ones;
- Some routes are heavily loaded by passengers (more than 25 000travels/day)
- The commercial speed of vehicles on the routes varies from 10 km/h to more than 20km/h.
- The autonomy requested to the buses can reach 400 km/day and 18 hours a day;
- Buses operate with low temperature during the winter (under 0°c) and high temperature during the summer (more than 37°C);

- The variety of drivers including the trolleybus specificities brings different approach & habits of driving.

All of the above have already helped experimentations dealing with both hybrids (6 vehicles tested for 20 months) and 11 electric bus (on a route including a slope of 16%) to evaluate the influence of different operational conditions.

The database of the experimentations already done is precious to evaluate the EBSF2 tests.

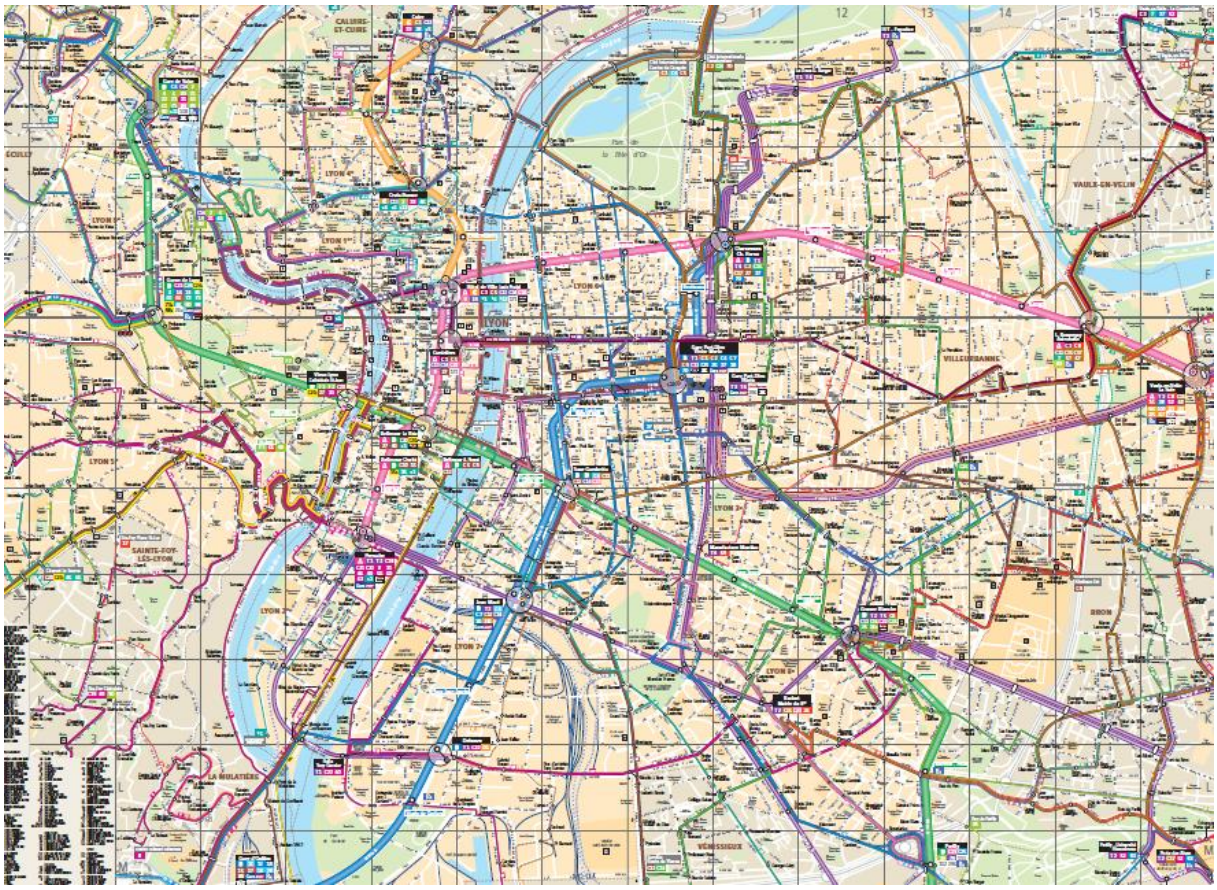

**Figure 4 – Extract of "downton" network map**

The bus fleet is also equipped with efficient models of ITS, mileage counting system, passenger counting system, INTELLIBUS (tele-diagnostic), TETRA radiocom (GPS localisation), etc. that enable recording of the tests , especially for the eco-driving evaluation.

# 3 Demo Objectives

The Lyon demo partners are committed to contribute to 3 project research areas (i. Energy Strategy and auxiliaries, ii. Green Driver Assistance System, iii. IT Standards introduction in existing fleets with ITxPT architecture and related IT standards deployment) by testing and evaluating the following technological innovations (TI):

- TI-1: Innovative eco-driving application for both diesel and hybrid buses, with the aim to improve the existing version of software,
- TI-2: Extension of ZEV mode on hybrid buses for restricted areas in the center of cities,
- TI-3: Improvement of management of auxiliaries which represents an important part of fuel consumption.

Coherently with the EBSF_2 evaluation methodology which applies to all the project demonstrations, a set of validation objectives have been identified for the Lyon test site. The applicable validation objectives relate mainly to operational, environmental and cost-efficiency domains.

The validation objectives related to the Technological Innovation to be tested in Lyon are reported below according to the name and coding agreed with the project evaluation team:

**VO 1 Improving the overall energy efficiency of fleets**

Applicable on all Technical Innovations. The aim of the consortium is really to decrease the Total Cost of Ownership of the vehicles, and thus of the fleet.

**VO 4 Reducing the consumption of conventional fuels**

The target is to help the driver in a better driving style and to improve the efficiency of the auxiliaries.

**VO 5 Increasing the uptake of fully electric and hybrid options**

The implementation of eco-driving on hybrid buses will make these kinds of vehicles much more efficient. Providing an extended ZEV mode on hybrid will make them compete with full electric vehicle as an alternative in restricted city areas.

**VO 9 Making driving practice more environmentally conscious**

A specific training and the eco-driving system will help the driver to know the right driving behavior to save fuel.

**VO 12 Improving on board travel comfort**

Both training for a smoother driving style and HMI eco-driving will provide lower accelerations and thus increase the passenger comfort on-board.

**VO 17 Improving interoperability for IT systems**

The development of eco-driving and its HMI will be conducted in respect of ITxPT architecture and related IT standards.

### VO 20 Minimizing operating and maintenance costs

The aim of the project is to check if having a smoother driving style can extend the maintenance intervals.

### VO 27 Reducing noise and air emissions

Eco-driving and auxiliaries management will save fuel consumption, and therefore pollutants and CO2 emissions.

Extended ZEV, by definition, is zero emissions and noise. The target of this project is to compare on a complete day of operation, the fuel consumption level and the emissions versus a regular hybrid bus.

Validation objectives can indeed be related to one or several TIs, as shown in Table 1.

| | | Energy strategy and auxiliaries | Driver assistance | IT standard introduction in existing fleets |
|---|---|---|---|---|
| **VO1** | Improving the overall energy efficiency of fleets | TI-1.TI-2 TI-3 | | |
| **VO4** | Reducing the consumption of conventional fuels | TI-1.TI-3 | | |
| **VO5** | Increasing the uptake of fully electric and hybrid options | TI-1.TI-2 | | |
| **VO9** | Making driving practice more environmentally conscious | | TI-1 | |
| **VO12** | Improving on board travel comfort | | TI-1 | |
| **VO17** | Improving interoperability for IT systems | | TI-1 | TI-1 |
| **VO20** | Minimizing operating and maintenance costs | TI-1 | | |
| **VO27** | Reducing noise and air emissions | TI 1.TI 2 TI 3 | | |

**Table 1 –Validation Objectives and Technological Innovations**

# 4 Demo Description

## 4.1 Innovative eco-driving application (TI-1)

A new approach to eco-driving will be tested in Lyon thanks to a mathematical model which calculates in real-time a dynamic fuel consumption target by taking into account the vehicle operating conditions and assesses a fuel economy performance index (Figure 6).

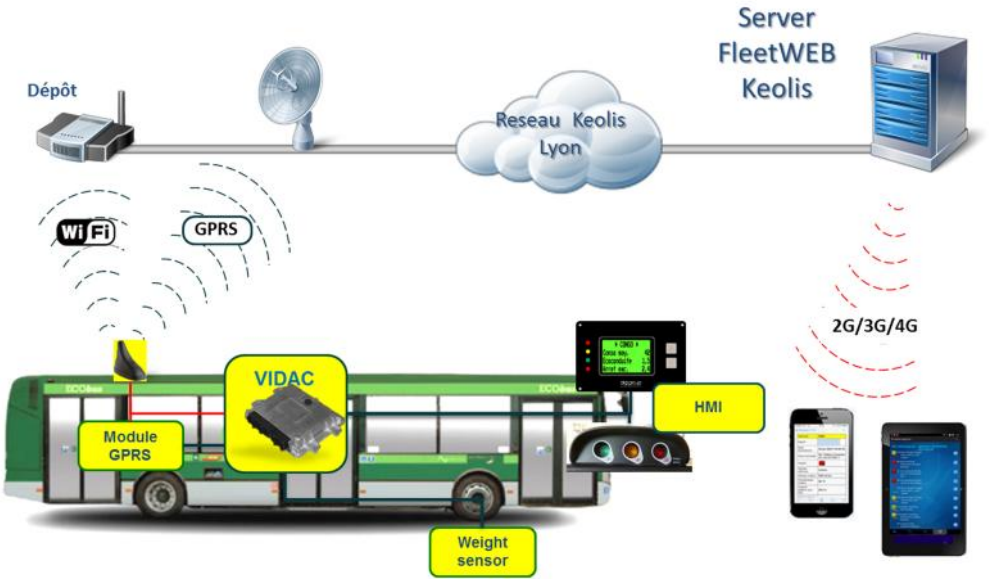


**Figure 5 – TI-1: Architecture**

The SYTRAL buses are already equipped with a first version of the eco-driving system iDRIVE. Within EBSF_2 an improved software will be developed to give the driver more accurate information via an enhanced HMI. The main innovations, summarized in Figure 7, are dealing with:

- Improved algorithms for computing fuel consumption target;
- Implementation of “user-friendly” HMI;
- Optimization of thresholds for passengers’ comfort and safety;
- Optimization of model parameters for EURO VI vehicles.

Even if the current electronic architecture is not fully compliant with ITxPT architecture and related IT standards, the consortium will provide specification, recommendations and new design (HMI shared on MADT) for its future implementation.

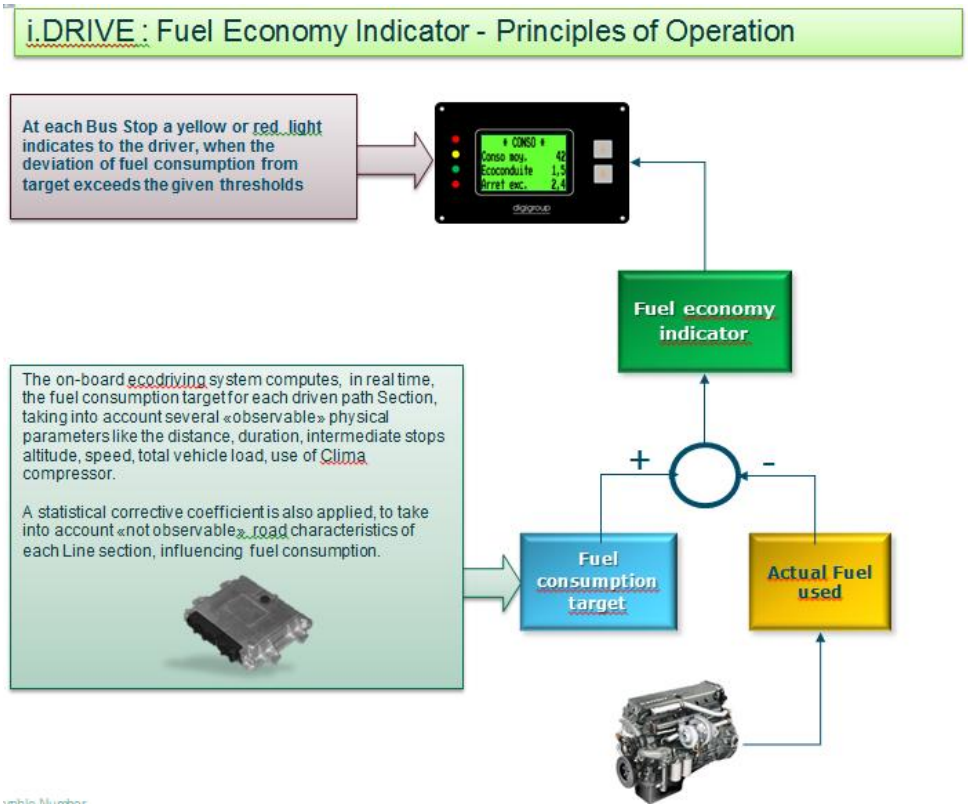


**Figure 6 –IDRIVE Fuel Economy Indicator; principles of operation**

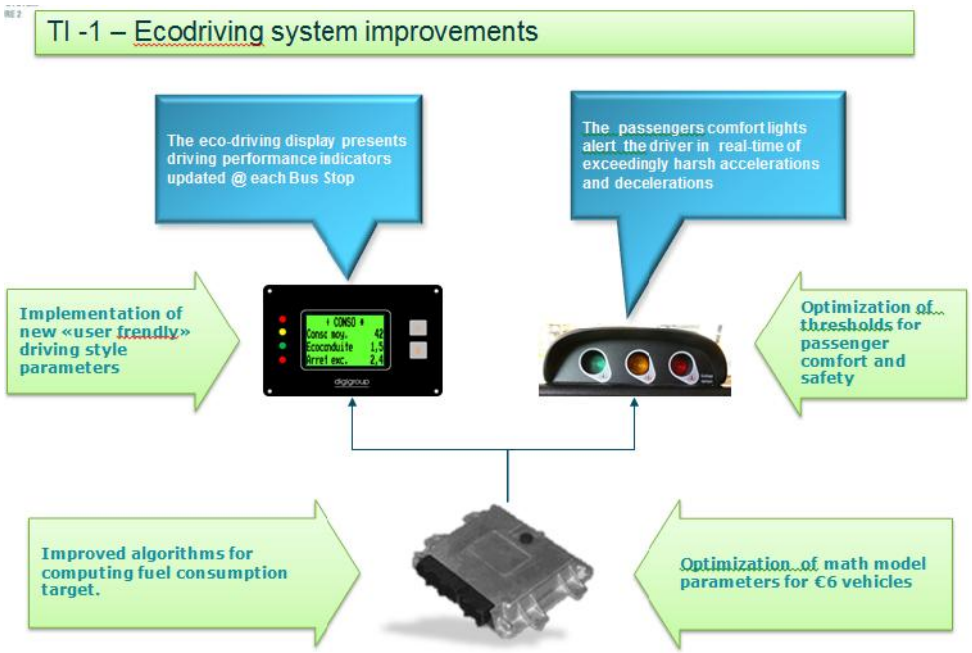


**Figure 7 – Ecodriving system imprvements**

## 4.2 ZEV mode extension on hybrid buses (TI-2)

TI-2 is based on a test to exploit a 2 km ZEV (Zero Emission Vehicle) mode which corresponds to the bus ride across the Croix Rousse tunnel in the city centre of Lyon. Tunnel de la Croix-Rousse is a pair of two tunnels located in the 1st and 4th arrondissements of Lyon, a road tunnel opened to traffic on 19 April 1952 and a sustainable transport tunnel opened in 2013 for buses, pedestrians and cyclists (see Figure 8). The tunnel length is about 1,800 meters.

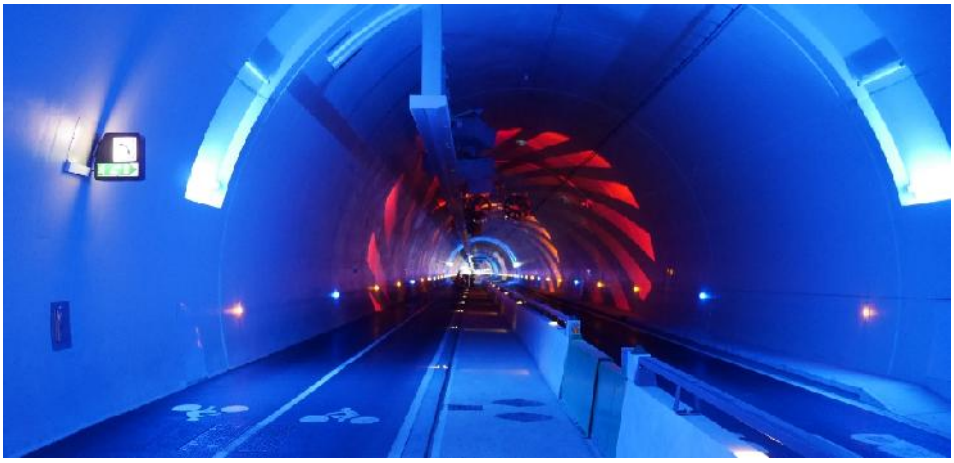

**Figure 8 - Tunnel de la Croix-Rousse : Second tube dedicated to sustainable mode of transport.**

The EBSF_2 test will be performed in the sustainable tunnel with an hybrid vehicle (IVECO Euro 6 Urbanway Hybrid) currently operating in “Arrive & Go” mode, which allows travelling for 50 meter in ZEV mode. The test relies on the efficient management of the batteries state of charge as well as the impact on the durability of the batteries.


**Figure 9 – The EBSF_2 IVECO demo bus.**

## 4.3 Improvement of auxiliaries management (TI-3)

Today the energy consumed by the auxiliaries on-board a diesel bus accounts for about 30% of the total energy budget (Figure 10), with HVAC representing the 13% of the budget, followed by alternators (7%), air compressor, direction pump and hydraulic pump (3% each).

Overall, improving the auxiliaries' energy management is key for the operators since it allows energy savings and therefore can positively impact the batteries efficiency and lifetime as well as driving range.

This technological innovation will encompass the possibility to reduce fuel consumption, check the weight and the behaviour of each auxiliary, test new auxiliaries and improve their management. Smart alternators with an improved electricity supply management system and enhanced auxiliaries driving will be then installed on the vehicle.

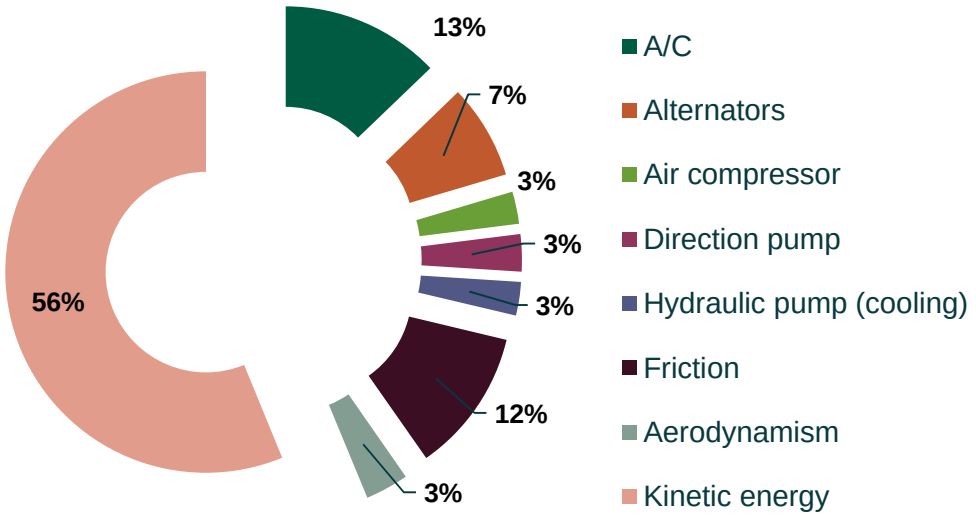


**Figure 10 – Energy consumption breakdown for a diesel bus (source : SORT CYCLE)**

Two buses will be used for this demonstration: the diesel version of the IVECO Urbanway and the hybrid version of the same vehicle.

The tests performed on both buses will allow to quantify the consumption of each auxiliary in different operational conditions, test the efficiency of new technologies/components for the auxiliaries (for more comfort, as interfaces with the operating system or for safety reasons) as well as test the opportunities offered in this field by the new technologies dealing with electro mobility.

## 4.4 Test scenarios

In terms of vehicles to be used to perform the tests, the Lyon demonstration relies on the following fleet:

- 40 Urbanway Euro 6 diesel buses for the test about ecodriving (TI-1)which will be operated on 3 different lines, with and without the updated ecodriving system;
- One Urbanway Euro 6 hybrid bus for the ZEV extension mode (TI-2) which will be operated on one line, including the tunnel de la Croix Rousse. The aim is to go through the tunnel in ZEV mode and to share this way only with soft modes.
- One Urbanway Euro 6 with Diesel Tector 7 which will be operated on at least 4 lines according to an experience plan built in the project. In 2016, tests will be performed with the standard version. In 2017, the vehicle will be equipped with new auxiliaries to be tested on the same lines and same operational conditions.

The following tables provide details about the test scenarios by technological innovation. The category of test to be performed is reported together with the vehicles, lines, routes and staff involved, as well as the preliminary timing of testing activities and data collection.

| **TILyo1** | | **Option** | |
|---|---|---|---|
| **Test category** | b) tests in controlled environment* | Hybrid version Control | Test |
| | c) Tests under real operational conditions** | Before | During |
| | d) technological concepts | Without Tecnological Concept | With Tecnological Concept |
| **Features** | | | |
| **Vehicles involved (units)** | | One Demo Hybrid w/o ecodriving* | Same Demo Hybrid with ecodriving* |
| | | 40 diesel w/o TILyo1** | + 40 diesel w/ TILyo1** |
| **Lines involved (units)** | | 3 | 3 |
| **Routes involved (units)** | | 20 | 20 |
| **Time span (data collection)** | | Fourth quarter of 2016 - First quarter of 2017*<br>Second quarter of 2016 - Second quarter of 2017** | Fourth quarter of 2016 - First quarter of 2017*<br>Second quarter of 2016 - Second quarter of 2017** |
| **Time span (testing activities)** | | Fourth quarter of 2016 - First quarter of 2017*<br>Second quarter of 2016 - Second quarter of 2017** | Fourth quarter of 2016 - First quarter of 2017*<br>Second quarter of 2016 - Second quarter of 2017** |
| **Staff involved (units)** | | 1*, 2** | 1*, 2** |

**Table 2 – Test Scenario TI-1**

| TILyo2 | | Option | |
|---|---|---|---|
| **Test category** | b) Tests in controlled environment | Control | Test |
| **Features** | | | |
| **Vehicles involved (units)** | | 1 | 1 |
| **Lines involved (units)** | | 1 | 1 |
| **Routes involved (units)** | | 10 | 10 |
| **Time span (data collection)** | | Second quarter of 2016 | Second quarter of 2016 |
| **Time span (testing activities)** | | Second quarter of 2016 | Second quarter of 2016 |
| **Staff involved (units)** | | 1 | 1 |

**Table 3 – Test Scenario TI-2**

| TILyo3 | b) Tests in controlled environment | Control | Test |
|---|---|---|---|
| **Vehicles involved (units)** | | 1 | 1 |
| **Lines involved (units)** | | 3 | 3 |
| **Routes involved (units)** | | >5 | >5 |
| **Time span (data collection)** | | Second quarter of 2016 | Second quarter of 2016 - Second quarter of 2017 |
| **Time span (testing activities)** | | Second quarter of 2016 | Second quarter of 2016 - Second quarter of 2017 |
| **Staff involved (units)** | | 12 | 12 |

**Table 4 – Test Scenario TI-3**

Additional information on the bus lines involved in the tests are provide in Table 5.

| LINE | Depot | Nb Bus | Average speed | Nb passengers | Topography | SORT cycle |
|---|---|---|---|---|---|---|
| **C6 (Urbanway)** | Vaise | 8 | 17,64km/h | 11502 | 1 | 1 |
| **21** | Vaise | 9 | 24,46km/h | 4018 | 2 | 3 |
| **C22 (Urbanway)** | Audibert | 12 | 14,04km/h | 13474 | 0 | 1 |
| **93 or C7** | Audibert | 13 | 14,34km/h | 10733 | 1 | 1 |

**Table 5 – Bus lines involved in the tests**

## 4.5 Risks which may affect the test quality and mitigation actions

Potential risks have been mitigated by putting in place tests on a long period of time for TI-1 (ecodriving), in order to reduce the impact of external conditions, such as driving styles and climate and traffic conditions, on the outcomes of the test.

For TI-2, expected data and outputs are much easier to be obtained by tests, and all parameters concerning the batteries could be then extrapolated by calculation.

For TI -3, the consortium will build a very important experience plan to cross all the data in order to get the expected outputs with the best accuracy.

## 4.6 Implementation plan and main responsibilities by partner

### 4.6.1 Innovative Ecodriving application

The main demo activities can be split in 2 temporal scenarios. In 2016 the following tasks will be carried out:

- The test in operation of the fleet with the existing eco driving system,
- The preparation of technical specifications to improve the current software for diesel,
- The adaptation of the software for hybrid versions of buses,
- The modification of the software at the end of the year.
- In 2017 the test will be finalized by implementing the following tasks: Application of the software on the fleet and on one hybrid bus,
- Test of the fleet in the same period of time than in 2016, same conditions,
- Test of the hybrid bus with/without the ecodriving system,
- Data collection
- KPI analysis and report.

**Figure 11** shows the Gantt Chart for TI-1.

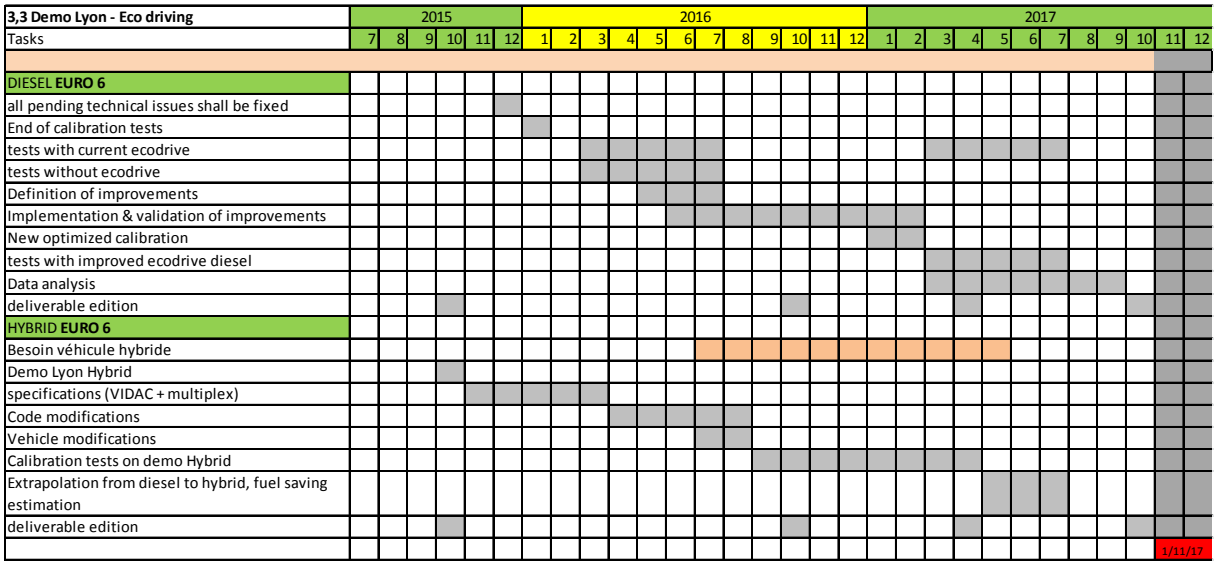


**Figure 11 – TI-1 : Gantt Chart**

The main responsibilities for the test of the TI-1 are summarized by partner in Table 6.

| Company | Partner's main activities |
|---|---|
| **DIGIGROUP INFORMATICA** | Digigroup Informatica will actively participate to eco-driving (TI1) tests, providing support for definition of advanced eco-driving indicators, vehicles and drivers performan - ce analysis, improvement of back-office software for data collection, data processing and HMI. |
| **DIGIMOBEE** | DIGIMOBEE will support the technical specifications to define a standard IT architecture to interface EcoDriving module and AVMS using EN13149 standard and ITxPT specifications. In addition a dedicated technical specification with screen's mockup will be delivered to apply MADT (Multi-Application Driver Terminal) implementation to display EcoDriving information to the driver. |
| **IVECO** | OEM, bus constructor. In charge of :<br>- providing buses for the demo in Lyon<br>- tests on buses; installation of sensors, analyzers, collecting data and writing test reports<br>- Design of HMI and electronic architecture. |
| **KEOLIS** | Operator of the network, in charge of :<br>- Operating the buses in accordance with the plan<br>- Providing driver's and operator's feedbacks on the ecodrive evolutions. |
| **METATRONIX** | Metatronix will provide required modification to onboard Intellibus firmware for providing support to improved eco-driving application |
| **SYTRAL** | PTA in charge of outputs analysis |

**Table 6 – TI-1 : Demo team responsibilities**

### 4.6.2 ZEV mode extension

All the tasks will be performed within 2016. On the basis of a regular Urbanway Hybrid Euro 6, Iveco Bus will modify the energy management software in order to perform at least 2 km in zero emission mode. Modifications will permit the bus to force the charge of batteries before the ZEV mode, and then, to force the bus to run in ZEV mode for 2 kms.

First tests for fine tuning will be performed in Quarter 2, 2016 with the target to have demonstrations in Lyon and Paris in June to September 2016.

The target is to complete the task in Quarter 3, 2016.

Figure 12**Figure 11** shows the Gantt Chart for TI-1.

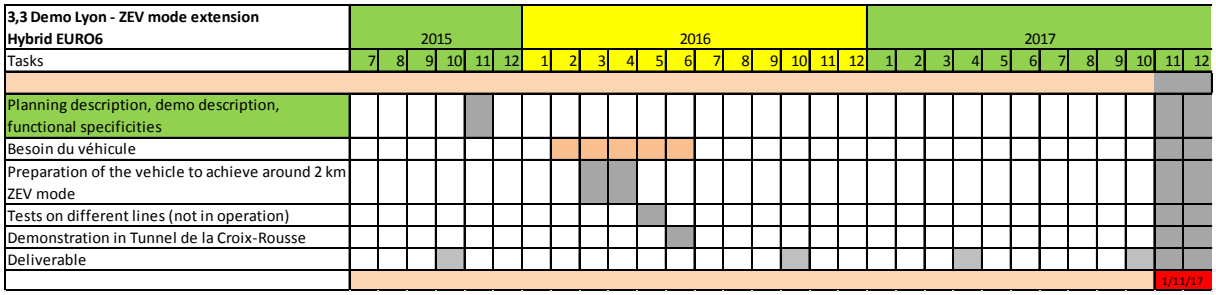


**Figure 12 – TI-2 : Gantt chart**

The main responsibilities for the test of the TI-2 are summarized by partner in Table 7.

| Company | Partner's main activities |
|---|---|
| **IVECO** | OEM, bus constructor. In charge of :<br>- Providing a hybrid demo<br>- Modification of BAE software<br>tests on buses. Installation of sensors, analyzers. Collecting data and writing test reports |
| **KEOLIS** | Keolis will provide driver's and operator's feedbacks |
| **SYTRAL** | In charge for organization of the demonstration through the "tunnel de la Croix Rousse" |

**Table 7 – TI-2 : Demo team responsibilities**

### 4.6.3 Improvement of auxiliaries management

The first task is to establish an experience plan in order to reduce the number of tests needed. Then, tests with current solutions will be performed in mid 2016 to obtain a complete status of each auxiliary consumption.

In the meantime, studies to install physically new auxiliaries in the engine compartment will be initiated. Modifications of the prototype will be done end of 2016 and beginning of 2017. Tests performed with the bus equipped with new solutions will be performed in mid 2017.

Figure 13**Figure 11** shows the Gantt Chart for TI-1.

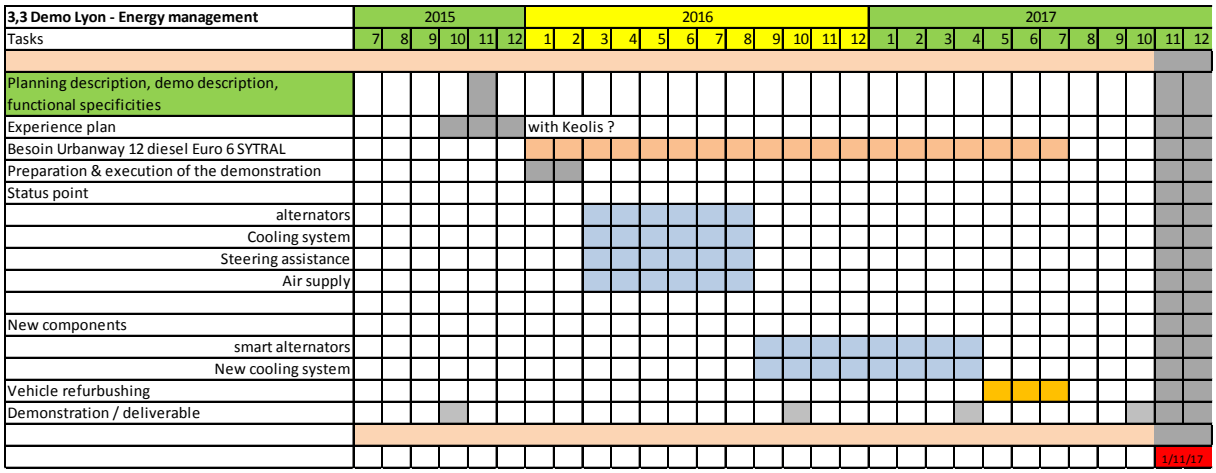


**Figure 13 – TI-3 : Gantt chart**

The main responsibilities for the test of the TI-3 are summarized by partner in Table 8.

| Company | Partner's main activities |
|---|---|
| **IVECO** | OEM, bus constructor. In charge of :<br>- tests on buses. Installation of sensors, analyzers. Collecting data and writing test reports<br>- installing new auxiliaries, |
| **KEOLIS** | PTO, in charge of tests authorization |
| **SYTRAL** | PTA, in charge of providing a Euro 6 bus for tests |

**Table 8 - TI-3 : Demo team responsibilities**

# 5 Partner Contribution

| Company | Sections | Description of the partner contribution |
|---|---|---|
| DIGIGROUP INFORMATICA | All | review of the document |
| DIGIMOBEE | All | review of the document |
| KEOLIS | All | review of the document |
| IVECO | All | Drafting all section except chapters by SYTRAL. |
| METATRONIX | | review of the document |
| SYTRAL | Section 3 | Drafting/review of the document |
| UITP | All | Review and quality check |

# Conclusions

The Lyon Demo team capitalizes on the opportunity to gather a Public Transit Authority like SYTRAL (Lyon), a Public Transit Operator like Keolis, suppliers with Digigroup Informatica, Digimobee and Metatronix, and a major bus constructor with IvecoBus. All these actors will pool their competences to develop buses more efficient in terms of fuel saving, emissions and noise reduction.

Being able to offer a full electric mode up to 2 kilometres on hybrid busses is a key target for cities that want to run public transport vehicles in ZEV mode in congested centres, without having to invest in full electric vehicles and related infrastructures. Additionally, the Lyon Demo will bring technology bricks on diesel and hybrid busses, by testing and validating an improved eco-driving system, able to provide real-time information to the drivers and complete analysis to the operator, and a better management of current and new auxiliary systems. To allow interoperability between different and multi-suppliers IT systems, all new developments will be compliant with ITxPT architecture and related IT standards.