

# OSIRIS newsletter



Welcome to OSIRIS, a FP7 research project aimed at setting up a holistic approach for the reduction of energy consumption for urban rail systems embracing all the parts of the system from vehicles to infrastructure and operation.

Unlike other transport modes, urban rail systems are complex environments and their energy consumption is characterized by a wide range of inter-dependent factors which have to be taken into account.

OSIRIS aims to ensure a reduction of the overall energy consumption within Europe's urban rail systems of 10% compared to current levels by 2020 through a number of key actions described in this newsletter.

Started in January 2012, OSIRIS has entered into its second period and a number of crucial and consistent objectives have been achieved. This newsletter aims at informing the reader about the results and what comes next. Seventeen partners from all across Europe have worked hard together and are pleased to invite you to discover more about how to achieve an effective energy consumption reduction in the European rail systems.

For more info on OSIRIS and its partners, please visit our website [www.osirisrail.eu](http://www.osirisrail.eu) !

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# OPERATIONAL REQUIREMENTS AND NEEDS



Tram in Milan

Since many years PT operators are dealing with the energy management to find out, through innovation, the solutions to optimize the consumption and to have a lower impact on the environment. The sector has to contribute to the 20 20 20 strategy using alternative fuels, lowering the consumption, optimizing the operations. Osiris is the project where the achievement of these objectives can be tested and the improvement in energy management can be realized.

Duty Cycle - 2

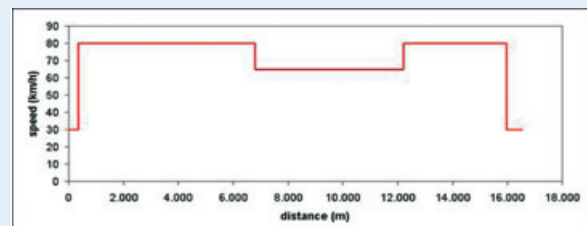
Station	Distance (m)	Height (m)	Speed limit (km/h)	peak			off-peak		
				Arrival	Stop	Departure	Arrival	Stop	Departure
				hh:mm:ss	hh:mm:ss	hh:mm:ss	hh:mm:ss	hh:mm:ss	hh:mm:ss
San Donato Bivignese (Lino)	0	87.78	30				00:00:00		00:00:00
SAN GIOVANNI	354	87.78	30				00:00:00		00:00:00
ROGGERO P. S.	1050	86.18	30	00:02:48	00:00:20	00:03:09	00:02:48	00:00:20	00:03:09
PORTO DI SILE	2011	87.40	30	00:04:23	00:00:20	00:04:43	00:04:23	00:00:20	00:04:43
CORVETTO	2411	86.75	30	00:06:03	00:00:20	00:06:23	00:06:03	00:00:20	00:06:23
BENEITA	2450	86.68	30	00:07:30	00:00:20	00:07:50	00:07:30	00:00:20	00:07:50
LOCATELLO B.	2229	86.12	30	00:09:20	00:00:20	00:09:40	00:09:20	00:00:20	00:09:33
P. TA. ROMANA	2711	102.28	30	00:11:10	00:00:20	00:11:30	00:11:01	00:00:20	00:11:21
CAPOCATA	3364	103.50	30	00:13:04	00:00:20	00:13:24	00:12:56	00:00:20	00:13:16
MASCOMI	3770	103.00	30	00:14:44	00:00:20	00:15:04	00:14:29	00:00:20	00:14:49
GIUGO	4143	103.20	30	00:16:40	00:00:20	00:17:00	00:16:10	00:00:20	00:16:30
MONTENAPOLEONE	4789	102.44	30	00:18:38	00:00:20	00:18:58	00:17:58	00:00:20	00:18:18
SEARTE	5199	102.00	30	00:20:15	00:00:20	00:20:35	00:19:34	00:00:20	00:19:54
REPUZZALE	6111	102.88	30	00:22:02	00:00:20	00:22:22	00:21:32	00:00:20	00:21:52
CENTRALE	714	116.80	30	00:24:00	00:00:20	00:24:20	00:23:00	00:00:20	00:23:20
SCHIRO	856	104.80	30	00:25:32	00:00:20	00:25:52	00:24:32	00:00:20	00:24:52
DARA	924	107.80	30	00:27:04	00:00:20	00:27:24	00:26:04	00:00:20	00:26:24
MILICCHIO	934	111.00	30	00:28:09	00:00:20	00:28:29	00:27:09	00:00:20	00:27:29
CORVANO	967	114.50	30	00:30:50	00:00:20	00:31:10	00:29:50	00:00:20	00:30:10
AFFORCIBITTO	1005	117.90	30	00:32:40	00:00:20	00:33:00	00:31:40	00:00:20	00:32:00
AFFORCITA	945	120.00	30	00:34:30	00:00:20	00:34:50	00:33:30	00:00:20	00:33:50
CORRIPARA	942	122.80	30	00:36:20	-	00:36:20	-	-	00:36:20
PIZZA (S. M. VINCENZO & LINO)	976	125.21	30						

ATM – Azienda Trasporti Milanesi – is the leader of the work package 1, and is involved in analyzing the current context and to define a field of measurement able to identify meaningful parameters. ATM and the other operators involved in the project are also asked to test the implemented technology in order to measure the real effect on the field, defining and realizing some use cases.

In detail, the WP1 has the main objectives:

- 1 to assess and identify critical economic and regulatory factors impacting on energy efficiency;
- 2 to generate a baseline inventory of energy requirements;
- 3 to define clear measurable Key Performance Indicators and standardized duty cycles;
- 4 to define a operational testing framework. This will be used as input for the final testing under a set of operationally relevant test cases.

Duty Cycle - 1



In the middle of the progress of the project, the work performed since the beginning has brought the partners to share experiences and data :

- A** to create an inventory of the main external factors impacting on energy efficiency;
- B** to generate the energy inventory that uses existing data, know-how and available technology of operator/suppliers. These data have created the set of baseline statistics for measurement of savings;
- C** to agree on a set of Energy Key Performance Indicators that could provide a significant picture of energy features, create a basis for international comparison, be measurable and verifiable;
- D** to start the discussion about standard duty cycles and operational modes which will enable true comparison of energy saving technologies as well as overall energy consumption and costs and will reduce effort and costs for simulation and prediction at the same time.

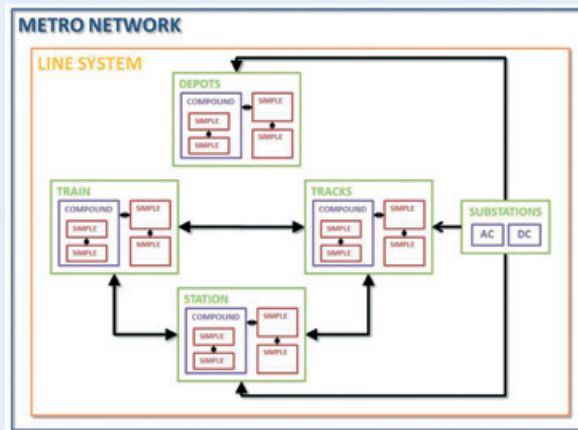
The effective partnership among operators, industry, universities has already brought good results: not only the partners are performing the tasks requested by the project but they are also realizing the existence of a field to play where a win win experience can be achieved.

There is a mutual interest in joining a better understanding of the system as a whole, of the challenges that the already existing and implemented technologies can help to reach, of the interdependence of each factor composing the system: this imposes a global thinking, is the drive of the project and the fuel of our work in the next months.

# ENERGY SIMULATION AND OPTIMISATION TOOL, AND ITS IMPACT ON THE THERMAL ANALYSIS

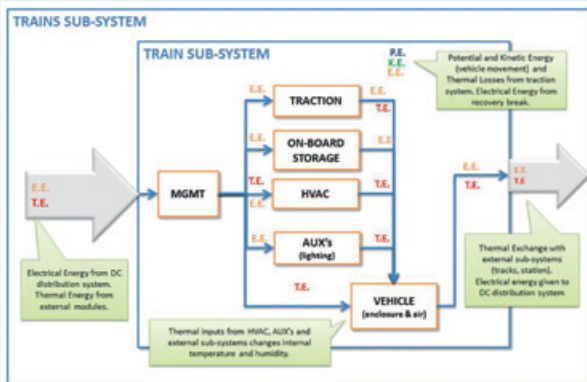
The objective of WP2 “Energy simulation and optimization tool, and its impact on the thermal analysis” is to develop a holistic model framework with clear characterization of interfaces to sub-systems and commercial multi-train simulation tools for the overall modeling of energy flow and consumption in a complete urban rail system.

OSIRIS Tool modules energy hierarchical structure



So far the main result was the elaboration of a holistic strategy for an integrated urban rail energy efficiency management based on the use of a model methodology which provides manufacturers and operators with uniform information on system level. New energy efficiency technologies and validated concepts/solutions

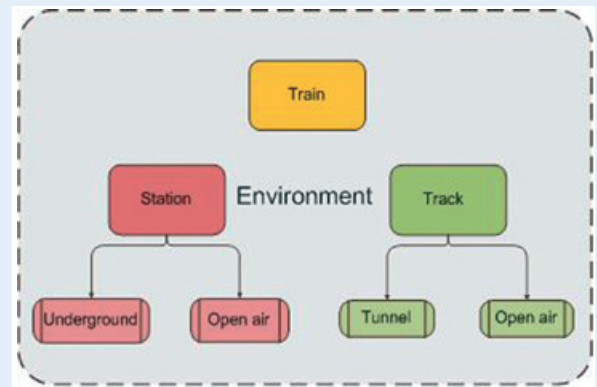
Trains sub-system components



for the whole urban rail system (trackside, on-board, control) should be developed in compliance with this new integrated approach. The developed strategy defines the characteristics of the system to be modeled and the main requirements of the solution. Specifically, this involves the development of definitions for the following: Components identification, characteristics and operation, Modeling approach, Modules interactions and Dependencies study with electrical and thermal interactions, Model architecture with definition of input / output parameters and interface specification.

The global thermal model is in an advanced stage. The following main subtasks have been already completed: OSIRIS model ready for a line simulation, Two-way dual track tunnels, Variable operational profiles (speed profiles and dwell times), Traction chain modeling, Radial heat conduction, Non-stationary energy flows between components of the vehicle, coach and environment (station, tunnel and outdoor sections), depending on operational parameters, Basic modeling of sensible and latent heat loads generated from the rail vehicle (traction, HVAC and auxiliary components) and auxiliary units to the tunnel, Concentrations of air pollutants in passenger carriages. The following main subtasks are in progress: Network simulation with coupled station interactions, Turbulent flow profiles, Basic passenger load estimation, Interaction between HVAC controls, energy consumption, and passenger comfort, Estimating the levels of passenger comfort associated with the ambient conditions.

Thermal subsystems



The OSIRIS tool development is ongoing. Line simulation for energy and thermal models are completed and the definition of Interfaces with other models is in progress. A preliminary simulation of use-case M2 Line Istanbul has been demonstrated. Further calculations show the importance of the topology used by the distribution system. Next steps are the development of user interfaces and the real-time optimization.

The definition of an optimization strategy has been started and use-case-relevant examples with the presentation of how to use the computer tool for optimizing have been demonstrated. The next steps are the collection of optimization parameters and the definition of Optimization algorithms, Multi-objective handling, Constrained optimization and the Integration of strategies.

## TECHNOLOGIES RELATED TO ENERGY EFFICIENT VEHICLE & INFRASTRUCTURE



Tram in Saragossa powered with onboard energy storage

In WP3 the existing energy saving technologies on board urban rail vehicles are analysed, in order to have a detailed approach of the overall possible energy consumption reduction. The technologies studied include regenerative braking, onboard energy storage systems (ESS), permanent magnet synchronous motors (PMSM) and innovative control of comfort auxiliaries. Furthermore, the definition of common functional and operational parameters and electrical and mechanical interfaces will allow operators and integrators to replace present devices with enhanced versions with little effort in the future. Focusing on the use of onboard energy storage systems (based on supercapacitors and/or batteries), a detailed safety risk assessment is being done.

WP3 is developing the electrical and thermal model of these innovations. At vehicle level, this will allow to make an intelligent design of thermal management of the vehicle. But the work done in WP3 will also be used for the optimisation of the energy efficiency of urban rail systems from a holistic point of view (in WP2). Finally, two different new efficient solutions are being explored in WP3: the use of Li-ion batteries in rail vehicles for onboard energy storage and the introduction of SiC technologies on auxiliary converters and transformers.

Concerning the evaluation of the aforementioned onboard energy saving technologies, measurements and/or simulations have been done in order to assess the energy savings that could potentially be realized if implemented, to further understand the benefits of each technology in different scenarios and to evaluate the most

influencing factors. The simulation of an existing metro system, that is not currently using regenerative braking, has led to the conclusion that energy savings between 16% and 24% could be obtained for off-peak and peak times respectively. In the case of study it was observed that 66% of regenerative braking energy may be returned back to the catenary and used by other trains during peak periods. However, only 45% may be transferred during off-peak hours. Additionally, by slightly increasing the regenerating voltage of the catenary the receptivity of the line can be significantly improved, resulting in potential energy savings of 9%. Regarding onboard Energy Storage Systems, the evaluation of existing supercapacitors based systems showed that traction energy savings of about 30% can be achieved. The track gradient and the driving style have an influence on the amount of energy saved. Descending gradients lead to storage of energy that otherwise would be lost.



Tram in Vitoria

Concerning the PMSM, its usage combined with new traction architectures, such as the direct-drive configuration, allows important energy savings, of around 18%.

To finalize, the following four solutions to reduce the energy consumption of HVAC have been analysed: the supply of fresh air based on real demand, the use of heat pumps, the use of free cooling and the introduction of variable frequency air conditioning compressors. Individually, each of these solutions could reduce between 17% and 20% the energy consumption of comfort auxiliaries. Taking into account that in urban services the impact of the HVAC consumption is relatively high compared to traction consumption, these technologies have a great potential if widely deployed.

# ENERGY EFFICIENT INFRASTRUCTURE RELATED TECHNOLOGIES

The aim of the WP4 is to study new electric and thermal solutions to reduce the energy consumption and CO2 emission in the urban railway infrastructure. The technical objectives will be addressed to both electric and thermal domain (Figure 1). The Task 4.1 objectives are related to evaluating innovative smart grid architecture to monitor/control the energy flows, to evaluate new energy storage systems. The Task 4.2 and 4.3 objectives are related to reducing the energy consumption of HVAC system in metro infrastructure and to define the related thermal management strategies. To improve the HVAC system energy consumption there are some aspects that could be considered:

- 1 to reduce thermal energy waste improving the equipments;
- 2 to use high efficiency HVAC systems like geothermal ones;
- 3 to recover the thermal energy for other useful applications.

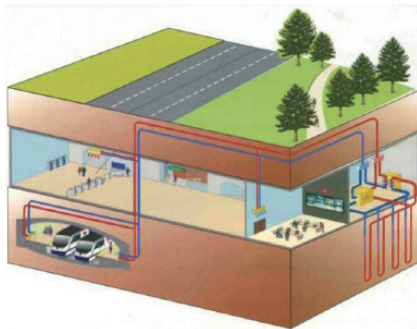


Fig. 3 Madrid Solution

Regarding the task 4.1, innovative smart grids (Figure 2) and future urban rail grid architectures have been described, analyzing new components for the intelligent monitoring of the electric system. Besides, regenerative braking energy has been evaluated and different technologies that contribute in saving braking energy and reducing energy consumption have been studied.

Regarding the task 4.2, the operator requirements about HVAC and the identification of the HVAC systems inside the metro infrastructure have been identified; with the operator collaboration (ATAC and RATP), heat gaps of specific technical metro rooms have been evaluated to identify the possibility to apply low enthalpy geothermal systems and geothermal solutions requirements to reduce the energy consumption have been defined.

The thermal load figures depend from the building rooms of the infrastructure; in fact, e.g. signaling & ATC equipment rooms present a cooling thermal load < 30 [kW] while traction power room < 70 [kW].

Starting from the typical thermal loads identification, the possible geothermal solutions to be used to improve the HVAC energy consumption has been analyzed.

Different geothermal solutions, with particular attentions to the existing solutions in Vienna, London and Madrid (Figures below), have been analyzed highlighting the advantages and disadvantages of each solutions.

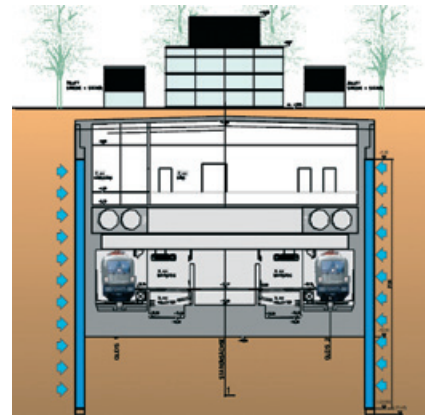


Fig. 4 Vienna Solution

Besides, the interfaces with the WP2 have been identified, to define the holistic model which will include also thermal aspects. Regarding the task 4.3, the Deliverable contents have been defined to identify the partner contributions to the task.

As far as Task 4.1 is concerned, the content of the D4.2: "Simulations report for the different transportation systems using braking energy recovery systems" will be defined with the partners.

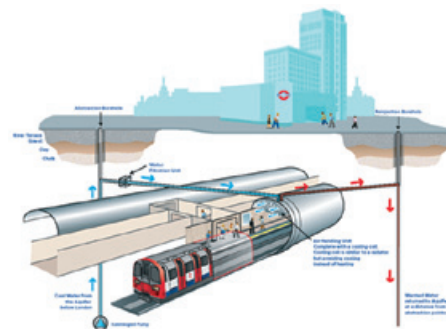


Fig. 5 London Solution

Regarding the tasks 4.2 and task 4.3, the results of D4.4 deliverable will allow to design geothermal heat pump solutions to be applied both in existing Metro system and new ones, also considering different boundary conditions arising from the data of real Metro systems. The idea is to realize a comparison among several solutions to define the most effective solution for the different use-cases: a warm city, a cold city and a temperate city plant.

A thermal specialist (SGM Consulting) has been activated to support Ansaldo STS in the simulation activities based on the specific tool "Design Builder".

# OPERATIONAL REQUIREMENTS AND NEEDS

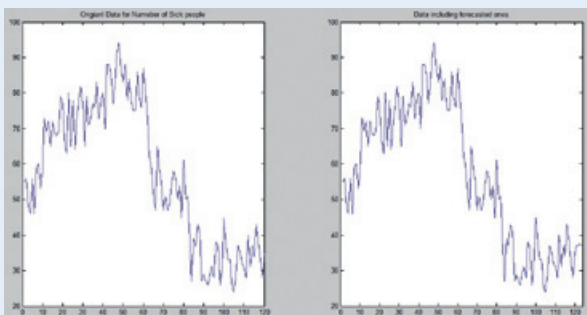


Tram in Istanbul

WP5 proposes to explore energy saving opportunities in improved operations of existing equipment, including through optimized train scheduling, efficient train pool management, and power demand management by having a cost relatively light in investment.

Forecasting passenger traffic can also enable energy demand-side and energy supply-side management options for future smart grid applications.

Fig. 1 Plot of original data and plot of original data added forecasting data for Bahçelievler



## Main results

**1 Short-term.** For short term passenger traffic forecasting, ULASIM and KOC University have developed a model and tested it in two passenger stations, in Line M1. For power load demand estimation studies, some test measurements have been realized in Line M1, in several escalators to get their power versus load characteristics. ULASIM has also installed energy metering devices in some stations on some pieces of equipment to obtain their daily power load curves. These stations include the Bahçelievler, Merter stations on Line M1 and Taksim, Osmanbey, on Line M2. In these same stations, passenger counting systems have also been installed to help better correlate these results.

**2 Medium term.** For medium term passenger traffic forecasting, AREVA and RATP have developed a model focused on daily forecasts over a whole metro network using historical data going back as far as 5 years. The objective was to build a general robust model which is not influenced by the characteristics of the data used to elaborate it. Therefore, it is assumed that it can be useful for other transport operators and other scopes as well (one line instead of a whole network). Similarly to short term forecasting although not directly dedicated to fine tune a network’s operation, medium term is more energy orientated and how the relation towards it can be improved. The figure below is a graphic representation of the passenger traffic in the metro network in Paris from 2007 to beginning of 2013. Overall, there is a certain form that is reproduced annually. Each year some lows occur nearly in the same period, a drop in the demand is seen in July – August. The other lowering may be caused by school holidays or other events that happen during the year.

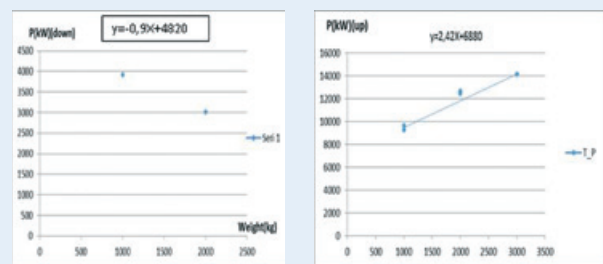


Fig. 2 & 3 Some examples of measurement results for equipment power-load curves

For modeling purposes, this graphs obtained using the provided data are decomposed into the three components introduced above.

**3 Passenger Traffic Modeling.** ULASIM and Koc University (subcontractor) have been developed a model for passenger traffic forecasting. Using Box-Jenkins Methodology has been used to develop the model and this method is considered to provide significant improvements on the accuracy in for the short-term forecasting. (Fig. 1)

**4 Power Load Modeling.** Some mathematical formulas found in mentioned articles to compare our site measurements. What we observed that unfortunately there is no tight matching between the results, as there are many type of equipment with different design and construction, meaning that, as there are many type of equipment in around the world, also their power and load characteristics are individual and only site experiments and measuring can be valid for precise results. In the other hand some statistical methodologies can be proceed that we aim to do this. (Fig. 2)

Next steps:

- Equipment base power – load characteristics are to be validated;
- Relation between power demand and passenger traffic will be investigated an reported;
- Any energy saving potential will be investigated from the point of operational modes.

# OPTIMAL STRATEGY TO INNOVATE AND REDUCE ENERGY CONSUMPTION IN URBAN RAIL SYSTEMS

The objective of WP6 “Validation and Assessment” is to create and maintain the frame for benchmarking and evaluating gains in energy consumption of urban rail systems, before and after implementing energy saving technologies and operational solutions.

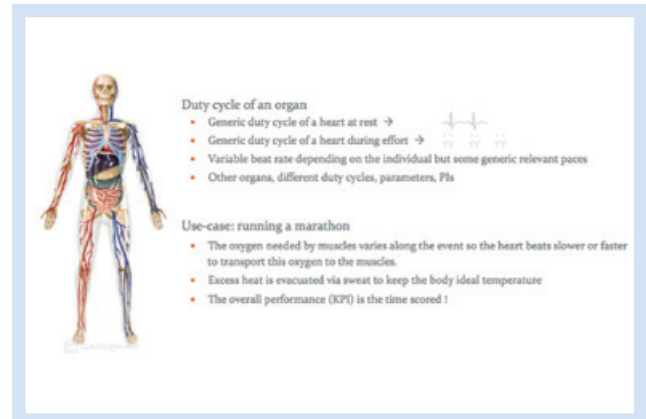
In direct relation with nearly all other WPs, this work has proven to be especially challenging in several dimensions:

- to ensure that key performance indicators are both meaningful for “all” urban rail operators and actually measurable;
- to structure the definition of conditions for measurements – whether “duty cycle” or “use cases” – to ensure that measurements before/after implementation are made under comparable–stable conditions;
- to provide a frame of validation for the extrapolation of measurements – necessarily made at a limited scale whether in number (trains , stations...), or time – to an entire line or urban rail system, with several types of improvement simultaneously implemented, and over long periods;
- to maintain a relevant data base – with a capability to compare across properties – despite the rather disperse and different natures of urban rail systems;
- and finally to define a manageable interface between field data and simulation tools , as the two will necessarily be linked and compare both to provide the necessary validation and extension of scale mentioned above.

So far, in all above fields, significant progresses have been achieved most often in a iterative process.

Regarding Performance Indicators and their measurability, it has been found necessary to distinguish:

- Key Performance Indicators KPI – essentially at system or large sub system levels (e.g. a network, an entire line ...) and limited in number ( 10 so far);
- Performance Indicators – more dedicated to a given element (e.g. energy performance of a given train, a station ...);
- Parameters – which are mainly elements contributing to the above ( e.g. voltage of electrical traction supply ...).



Duty cycle VS use cases

Additional measurements points have also be introduced/ implemented to gather data which was deemed to be relevant yet not considered in the past (especially when relating to stations and thermal elements)

Regarding the conditions for measurements, the fact that OSIRIS deals with overall rail system rather than merely certain elements (e.g. train) has required a drastically new and enlarged approach to the issue:

- duty cycles –applicable not only to train duties but also to passenger stations, power substations...– are under definition to reflect a limited number of generic use of a given element of the system ( eg the way a train typically runs between two stations) ; as such they enable to compare the energy performance of givens elements (e.g. train ) across design/origin;
- use cases are aimed at defining in a stable way specific conditions of use/operation of a dedicated urban rail line; as such they enable to compare the energy performance of that line across time as new/improved technologies and operational solutions are implemented.

Regarding the database, a structured frame has been developed and existing data from the four participating operators has been inputted into this frame: this database provides the benchmarking situation and keeps on being populated with additional data as it becomes available.

The important coming steps of WP6 work are on one side to operationally link real data with the simulation tool, as it becomes more mature; and on the other to consolidate data relating to new technologies/improved operations, comparing it with benchmarking measurements.

For the above purpose, duty cycles and use cases definitions will be completed.

# The OSIRIS Users Group

OSIRIS set up a Support and Users Group (SUG) consisting of urban transport operators and suppliers outside the consortium which is a targeted outlet for the dissemination and exploitation of results. Its purpose is:

- to express the needs and input from operators and suppliers who are not part of the consortium;
- to guarantee the delivery of high-quality results and technical solutions.

UITP set up this SUG by publishing a “call for expert” which was sent to all concerned UITP committees / commissions and 11 organizations signed the contract:

- 1 Light Mobility (Portugal)
- 2 Bombardier Transportation GmbH (Germany)
- 3 Stadtwerke München GmbH (Germany)
- 4 Nexus House (United Kingdom)
- 5 Tramvia Metropolitana (Spain)
- 6 Oradea Transport Local SA (Romania)
- 7 STIB (Belgium)
- 8 Metropolitano de Lisboa (Portugal)
- 9 Keolis (France)
- 10 Rheinbahn AG (Germany)
- 11) Ferrocarril Metropolitana de Barcelona SA (Spain).

So far, two SUG Meetings have been organized by OSIRIS.

→ **1st SUG meeting.** The meeting was held in Brussels in December 2012 and addressed a number of topics which were presented to the Users Group: energy simulation and optimisation tool, energy efficient vehicle and infrastructure related technologies and the plan to submit a TecRec on onboard energy storage systems.

→ **2nd SUG meeting.** The second meeting took place in Brussels again on May 2013 and it was the opportunity for WP Leaders to present the first important results. ATM introduced the two first deliverables that had recently been adopted within the framework of the OSIRIS Operational Requirements and Needs (D1.1 A common set of environmental, societal and political requirements for energy saving and D1.2 Database to set categories for energy saving technologies) and AREVA presented the “OSIRIS Duty Cycles and Use case concepts”. Areva explained the difference between both concepts and explained what the approach within the project is and the presentation was followed by a discussion with the User Group members. Then, thanks to STIB, the participants had the opportunity to visit 3 braking energy recovery prototypes in a Brussels metro station.

Users Group at work



## Past and Upcoming Events



OSIRIS has been guaranteed proper diffusion of knowledge and project results through the participation of the consortium partners in a number of European and worldwide events linked to the transport sector:

### Past Events

**Transport Research Arena (TRA) 2012** that took place in Athens from 23 to 26 April 2012. TRA is a transport research event which enables the exchange of knowledge among all key stakeholders of the transport sector and promotes best practices already implemented worldwide. TRA2012 is supported and promoted by the European Commission, the Conference of European Directors of Roads (CEDR), the European Road Transport Research Advisory Council (ERTRAC), the European Rail Research Advisory Council (ERRAC) and the European Technology Platform Waterborne (WATERBORNE). The project has also been presented at the local stand of ERRAC/UNIFE/UIC.

**InnoTrans 2012** is the biggest rail infrastructure event in Europe which took place from 18 to 21 September 2012. The project was presented after eight months since its launch. The event was attended by the supply industries and European (and International) Urban Operators and Railways and is therefore an ideal forum to link end users with technologies and results.

**EU–Russia Workshop on Rail Research** was co-organized by the European Commission (DG MOVE and DG RTD) and took place on 16 – 18 of October in Moscow, Russia. The objective of the workshop was to exchange experience on the railway standardisation and research activities carried out in European and in Russia. Amongst other FP6 and FP7 projects, a general presentation of OSIRIS was given, explaining the main objectives and expected results.

**Annual Polis Conference 2012**, held in Perugia on 29 and 30 November 2012. The conference provides an opportunity for regions and cities to show their transport achievements and to exchange innovative transport solutions. OSIRIS was presented on 30 April 2012 during a parallel session focused on energy efficiency in public transport.

**UITP World congress 2013**. Three presentations of OSIRIS were given during the annual UITP World Congress, which was held from the 26th to the 30th May 2013 in Geneva. The presentations on OSIRIS goals and results succeeded in gathering a large audience at the ATM (presentation given by J. Sandor, Unife) and UITP (presentation given by C. Hoogendoorn, UITP) stands as well as during the UITP High Level Industry Committee (HLIC).

**UITP Seminar: Energy Efficiency in LRT** (4 December 2013, Brussels Belgium). This seminar has covered the latest developments in LRT energy savings, including the basis of OSIRIS results.

### Upcoming Events

**TRA2014**. UNIFE submitted an abstract to present OSIRIS during the next TRA event which will take place between November 14th and 17th in Paris.

**INNOTRANS 2014**. OSIRIS will take part in the next International Trade Fair for Transport Technology with its own stand between 23rd and 26th September 2014 in Berlin.

OSIRIS at the UITP World Congress 2013 in Geneva





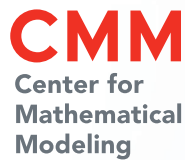


# Partners

**Project Coordinator**



**Technical Leader**



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