Compilation of field notes and empirical insights from: UITP World Congress & Exhibition 2015

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Synopsis:

The UITP World Congress & Exhibition is the largest worldwide public transport event that is held every second year in different cities around the world. It involves wide range of participants from public transport authorities and politicians at the local, national and cross-national levels to the manufacturing companies, suppliers, operators, investors and solution providers to all segments of the public transport sector and its related mobility infrastructure. It includes rail, road, water-born and even alternative and new modes of public transport systems for short distance and urban mobility covering metropolitan areas and other specific territories.

This report summarizes background information on the UITP organization, its impact and related public transport projects as well as field notes and empirical insights collected from the research visit to UITP world congress and exhibition in Milan between 8 to 10th of June 2015. The focus of the research visit and the scope of this report mainly concern city-bus vehicles and related EU-funded projects or public-private partnerships for technological advancements of the alternative powertrain in this field i.e. hybridization and electrification of city buses.
1 Background

Early establishment
The origins of UITP goes back to a very old union of 63 tramway operators from 9 European countries who came together in August 1885 in Brussels to form the “Union Internationale de Tramways / Internationaler Permanenter Strassenbahn - Verein” or what is today known as L’Union internationale des transports publics (UITP) simply translated as the International Association of Public Transport.

Further expansion
Over the years, the structure and configuration of UITP has been changed to include more diverse range of actors to join and share their interests in the public transport sector. As a result, UITP is now considered as the most comprehensive arena for maintaining dialogue among industry actors, policy makers as well as a platform for knowledge sharing among experts in the public transport sector.

UITP still has its headquarters in Brussels and maintains close proximity to the EU institutions and policy makers at the European level. Although it was originally established as a European association, the scope of the actions of UITP is not limited to Europe anymore.

Towards global positioning
Over the last 15 years the organization has been expanded into different parts of the world and currently holds 12 liaisons and regional offices across Africa, Eurasia, Asia-Pacific, Australia/NewZealand, as well as Latin America and the Middle East. In addition, there are also two centers for transport excellence in Singapore and Dubai. In total, it has reached 16,000 contacts in 96 countries through 1,400 full members. To further reflect its aim for such a global reach, UITP has decided to change its main event’s name from UITP World Congress & Exhibition to Global Public Transport Summit from next round to be held in Montreal, Canada 15-17 May, 2017.
2 Congress and exhibition

Locale
The UITP’s 61st biannual congress and exhibition was held at Milano Congressi\(^i\) (MiCo), the largest congress center in Europe with more than 1,600 delegates from different parts of the world\(^ii\). Around 300 exhibitors including private and public organizations also held booth stands at two large exhibition halls located at two separate floors\(^iii\): one for OEMs and suppliers of road transport (Exhibition hall 3) and the other dedicated mainly to the rail and other means of transport (Exhibition hall 4). Plenary and parallel sessions were also held in a separate hall that also included a large auditorium for accommodating 1,400 audiences. In total, 15,700 visitors participated in 2015 UITP in Milan\(^iv\).

Occurrences
Events were organized in different formats including focus sessions, plenary sessions, lunch sessions, networking activities and some side events. Among different types of events, the most important were focus sessions and plenary sessions where experts have been invited to make presentations or to hold debate panels on different topics related to public transportation.

Focus sessions were held at the exhibition site and close to the OEMs or supplier companies’ booth stands. These events were mainly focused on technical and practical issues and sometimes experiments with latest technologies in public transport sector. Presenters were mainly from the exhibiting companies trying to highlight their state-of-the-art products and services with Q/As following at the end of each session. Every session had a specified theme and consisted of 4-5 presentations that lasted between 1 to 1.5 hours in total\(^v\).

\(^i\) MiCo: [www.micomilano.it/SpaziORG_en.html](http://www.micomilano.it/SpaziORG_en.html)
\(^ii\) Complete list of delegates: [http://www.uitpmlan2015.org/content/list-delegates-2015](http://www.uitpmlan2015.org/content/list-delegates-2015)
\(^iii\) Complete list of exhibitors: [http://www.uitpmlan2015.org/exhibitors](http://www.uitpmlan2015.org/exhibitors)
\(^v\) Full access to all presentation materials have been provided as part of UITP registration fee to the researcher and are available upon request.
The plenary sessions in contrast mostly focused on policies and planning issues at the macro level such as EU policies, international standards, long-term planning of public transportation and sustainable mobility in the future. Network activities were mainly intended for permanent members of UITP and delegates. Lunch sessions had a similar orientation, with the possibility of wider range of other actors to join the community and engage in discussions over the lunch tables or coffee breaks. In addition to that, there were side events mostly organized by the UITP itself or its affiliated organizations to demonstrate their achievements in previous or ongoing projects. There were also presentations about upcoming projects related to the bus systems such as EBSFII and ELIPTIC (see section 3 for more detailed information about these projects).

**City-bus vehicle manufacturers in the exhibition**

The complete exhibition hall 3 at the main entrance of MiCo was designated to accommodate stand booths as well as prototypes of vehicle manufacturers and in some cases engine and subsystems manufacturers for vehicle manufacturers. Some of the most important OEMs and bus manufacturers in the exhibition hall included: BYD, IRIZAR, PVI (Gépébus), BOZANKAYA, SOLARIS, OTOKAR, KARSAN, TEMSA, VOLVO, VANHOOL, VDL, SCANIA, MANA, IVECO, DAIMLER (EVOBUS), MCV, and EBUSCO.

With regards to suppliers of engines, powertrain or other subsystems for city buses some major companies included: Cummins, Allison Transmission, Medcom (batteries and hybrid systems), Voith, ZF, Ballard, Ventura, Opbrid and Schunk (supplier of inverted pantograph charging to Volvo buses in Göteborg), as well as operators such as KOELIS.

Companies often showed their most advances in electrification of powertrain or full electric buses, but there were also few established OEMs such as Mercedes, IVECO, and MAN who provided only conventional powertrain vehicles to the show (see section 4 for more details).
3 Economic and political impact

PTx2 goal set by UITP

At the 2009 UITP world congress and exhibition in Vienna, the public transport sector set the goal of doubling its market share by 2025. In Europe, public transportation currently makes up around 130 to 150 billion Euros corresponding to 1% to 1.2% of the total EU GDP. This number includes the value created along the public transport supply chain estimated by the EU-level economic and demographic figures provided by national public transport associations, transport ministries, national statistics institutes and individual public transport research collected by UITP\textsuperscript{vi}.

The grounds for such an ambitious goal to double the public transport share of market by 2025 mostly lie with the growing trend of urbanization worldwide and the problem of traffic congestion in big cities around the world. The estimated costs of road congestion traffic take as much as 1% of the total EU GDP each year. Another reason is the need for transitioning into more sustainable means of transport by replacing private mobility (i.e. passenger cars) in the cities with public transport.

Nevertheless, such an increase in the share of public transport has already started to take place during the recent years in line with the increasing need for urban mobility across the world. According to UITP statistics, there has been an increase of 11% in public transportation in Spain, the UK and even the United States between 2004 and 2008. During the same period, public transportation in London and Brussels has increased by 20%. In 2008 alone, there were 60 billion journeys made through the public transport within EU (including all means of public transport). This is translated into an average of 120 public transport journeys per EU citizen per year. Of the total public transport journeys in Europe, buses account for a major share of 56% or an average of 32 billion travels, followed by trams, metro and railways each accounting for around 8 to 9 billion travels per year (corresponding to about 14% to 16% market share each).

\textsuperscript{vi} All numbers in this section are from public data available on UITP website: \url{www.ceec.uiotp.org/pt-figures} and \url{http://www.uiotp.org/key-eu-statistics}
It should be noted that these are aggregated numbers and when it comes to local data, the shares are not equally distributed across all cities in Europe. Similarly, total number of public transport journeys is not equally distributed either due to the differences in the infrastructure settings as well as the urban population of cities. For instance, according to the Mobility in Cities Database (collected by UITP), the share of public transport can go up to 300 journeys per inhabitants in medium and large cities in Europe, while in some others it drops below the average number.

In terms of economic impact, the sheer number of employment is estimated around 2,000,000 jobs for those which are directly related to the public transport sector in Europe. This figure only covers direct employment by the operators, but can be expected to add up another 4 to 5 million jobs if indirect employment is also added to the calculations. This equals to 2-2.5 indirect jobs for each direct job in the public transport sector in Europe. The estimations however are difficult to be made across all European states due to discrepancies across national data. Nevertheless, existing data suggest an approximate number of 157,000 to 160,000 employments in Germany and France by jobs that are indirectly related to public transport services.

**UITP as a key interlocutor in EU projects**

As one of the most comprehensive arenas for public transport debates and policies, UITP is often considered an indispensable part of European projects on a wide range of public transport and urban mobility issues such as safety, energy efficiency, electrification, network management, ticketing, security, intermodal and seamless mobility. Moreover, through its members and affiliates across all EU member states, UITP brings more than 400 stakeholders from urban, suburban and regional public transport operators and authorities together and thus is considered as a key interlocutor for the European institutions and other policy bodies at the European level. UITP serves as a platform for sharing EU funding opportunities among its members and encourages them to take part in such projects. It also provides assistance such as data aggregation, user experiment platforms, as well as direct engagement in the form of collaborating partner in many EU projects. According to UITP statistics, 80% of the internal market legislations and policies related to public transportation in Europe are made in Brussels. This in return makes the UITP’s headquarter in Brussels as the pivotal node in the overall network of public transport actors within Europe.

EU projects related to the advancement of city-bus vehicle technologies in which UITP is also a collaborating partner are listed below. Please note that the most relevant projects are selected here (see next section for selection criteria and direct link to these projects).

- **Current projects:**
  ZeEUS, NODES, ITXPT, ERTRAC, CIVITAS, OPTICITIES, Viajeo PLUS

- **Recently finished projects** (as of May 2015):
  3iBS, EBSF

- **Upcoming projects:**
  EBSF2 and ELIPTIC

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vii For more information see: [http://www.uitp.org/eu-policy](http://www.uitp.org/eu-policy)
UITP projects for advancing city-bus vehicles, technologies and infrastructure
UITP has a vast number of collaborating projects in different segments within public transport sector. The criteria for selection of projects in this report are based on following aspects:
  o Direct relevance to city-bus vehicles or closely related technologies or infrastructure
  o EU-level funding and projects related to urban road transportation within Europe
  o Projects in which there might be possibilities to engage as an academic partner or make contributions from LiU/IEI/PIE or in collaboration with other universities/departments.

ZeEUS: Zero Emission Urban-bus Systems
Link: http://zeeus.eu

EBSF: European Bus-system of the Future (Phase I and II)
Second phase of the project starts from May 2015
Link: http://ebsf2.eu (phase I), http://ebsf2.eu (phase II)

3iBS: Intelligent, Innovative, Integral Bus Systems
Link: http://www.3ibs.eu

ELIPTIC: Electrification of Public Transport In Cities
Link: www.eliptic-project.eu

OPTICITIES:
Partners from Sweden: Volvo, Chalmers, Göteborgsstad, Västtraffik
Link: http://www.opticities.com

Viajeo PLUS
Göteborg as the showcase city for Europe
Link: http://viajeoplus.eu/

NODES: New tools for design & operation of urban transport interchanges
Link: www.nodes-interchanges.eu

ITXPT: Information Technology for Public Transport
Link: http://itxpt.org

ERTRAC: European Road Transport Research Advisory Council
Link: http://www.ertrac.org/

CIVITAS: Cleaner and better transport in cities
Link: http://www.civitas.eu/
Over 200 European cities towards greener transport under one dynamic and very active network consisting of: Demonstration cities, Forum Network cities
4  City-bus vehicles and show cases
The exhibition part of UITP provided the opportunity to explore latest advancements regarding city-bus vehicles and related technologies and infrastructure. This section provides empirical findings from observations as well as personal interviews with representatives of bus manufacturers at the exhibition site.

4.1 BYD (China)

Background
The company was established around 20 years ago (1995) as a rechargeable-battery producer in an attempt to reclaim the Chinese domestic market against Japanese imports and soon gained substantial market share due to more competitive price and greater access to the local market. An underlying reason however lies in the access to the inexpensive domestic raw materials, and in particular the rare earth materials needed for the production of rechargeable batteries that are found in abundance across China and in parts of Mongolia such as Bayanobo Kuang. It went on to be listed in the Hong Kong Stock Exchange in 2002 and from there started to expand even further towards international markets. Now the company’s official website claims that: “BYD is the largest supplier of rechargeable batteries in the globe, and has the largest market share for Nickel-cadmium batteries, handset Li-ion batteries, cell-phone chargers and keypads worldwide. It is the largest supplier of rechargeable batteries and it also has the second largest market share for cell-phone shells in the globe.”

The main business areas of the company are now consists of IT, automobile and new energy. In the IT segment, where it has its roots, BYD continues as one of the world’s largest suppliers of computer and mobile devices components. The auto segment was established in 2003 by the acquisition of Tsinchuan Automobile Company Ltd. It was through this acquisition that BYD gained access to the pool of knowledge in whole-car manufacturing and competence in the areas of mold R&D, and auto parts, as well as traditional engine and dual mode electric cars. Now in the auto segment the company offers passenger cars, buses, and the related charging systems. According to their official website, they are also cooperating with Daimler in the automotive segment. In the energy business BYD has its focus on solar technology, battery energy storage stations (based on Fe Battery technology), as well as solar farms and intelligent grid networks.

Full battery electric buses
Due to its advantageous position in the battery technology, BYD expanded its business in the electric vehicles segment and in 2010 launched its full electric bus (K9) in the domestic market. The K9 bus by BYD is a low-floor 12-meter body and can be produced in 2-doors or 3-doors variations. The electric traction is BYD's self-innovated in-wheel motor drive system which realizes the function of in-wheel motor drive and hub redactor (for regenerative breaking) at the same time. It weights around 18ton (excluding the battery weight) and can be equipped with either 2-pack or 3-pack batteries. Size of the battery pack would then have a great implication on the total weight and the distance range as a result as well as total price of the bus.

http://www.byd.com/aboutus/profile.html
http://www.byd.com/na/auto/about.html#sections
The batteries are iron-phosphate (LiFePO4) and currently the estimated price for a 2-doors body with a 2-pack battery is around double price of the similar bus with conventional diesel engine. However, according to the interviewee (Country Manager at BYD Europe) ‘more trust [with the electric technology] by customers, would result in less demand for battery capacity, [which in return] results in price reduction in the future. When asked if the current infrastructure would support such trust building process among the customers, the interviewee responded that ‘there is a need for change in the infrastructure, because the existing infrastructure was designed based on dirty diesel engines, but now it is time to be changed’.

According to the company representative, BYD has run its K9 bus not only in China but also tested it in 41 cities across Europe and other parts of the world. It has also sold buses in many different parts of the world outside its home market including Sweden, Denmark, USA, Holland, and Israel. There are currently 35 buses running in the Netherlands (Schiphol airport) with plans to deliver another 6 as well as 13 buses already running in the city of Nottingham and 3-5 new buses to be delivered to Sweden this year. There are also 51 buses to be delivered to the city of London next year. In 2013 BYD has also opened its bus series production line factory in Lancaster, Southern California\(^x\). According to the interviewee, BYD’s competitive advantage lies in its in-house battery technology and battery management system. In the domestic market, Yutong is considered as the biggest competitor (and biggest bus manufacturer in China) but their competence mainly lies in the conventional diesel technology. BYD has chosen to provide only inductive charging method with two options: normal charge (6hrs) and fast charge (3hrs). According to the interviewee, BYD guarantees a performance rate of above 75% during the first

\(^{x}\) [Link](http://www.byd.com/na/auto/ElectricBus.html)
5 to 7 years of operation. The average breakeven point (rough estimation) is about 6 to 7 years as demonstrated below.

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<table>
<thead>
<tr>
<th>Time</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-7 yrs</td>
<td>~400K$</td>
</tr>
<tr>
<td>~200K$</td>
<td>Electric bus</td>
</tr>
<tr>
<td>~200K$</td>
<td>Conventional bus</td>
</tr>
</tbody>
</table>
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The breakeven point for BYD electric buses (according to Country Manager at BYD Europe)

“Pure electric buses, the only way”

It was obvious from the interview as well as the company’s advertisements that BYD is aiming for an all-electric solution at least for the inner-city transport. It can be seen in the below picture as well.
The company’s plan is to introduce pure battery electric buses for inner-city applications, while for the outside rings using range extenders such as hydrogen fuel cells would be possible.

When asked about the massive use of batteries for full electric buses, the interviewee believed that there are wide range of applications for the second-life of the batteries such as small passenger cars, short-distance travelling vehicles, in-house material handling lifts and trucks, or lawn mowers, telecom or office power backup systems or even residential electricity storage.

**Interviewee:** Patrick Oosterveld (Country Manager at BYD Europe, the Netherlands)

**Contact details:**

Public profile on LinkedIn: [https://www.linkedin.com/pub/patrick-oosterveld/19/3a6/7b3](https://www.linkedin.com/pub/patrick-oosterveld/19/3a6/7b3)
4.2 SOLARIS (Poland)

Background

Solaris was established as a family-owned business in Poland by Solange and Krzysztof Olszewski in 1996. Its history of progress can be traced back to Neoplan Polska, a licensed agency from Germany to produce buses, coaches, trollies and trams in Poland back in early 1990s. Despite its modest start, the company has grown to become one of the major European manufacturers of city, intercity and special-purpose buses as well as low-floor trams. It currently owns majority of its domestic Polish market and exports to 29 markets overseas. Since 2004 Solaris has been transformed from limited liability to a joint-stock company.

The close proximity of Solaris founders as well as its highest management team to Germany and its giant automotive producers such as MAN and Daimler throughout the years has positioned the company in a competitive edge. The current CEO of the company to replace Mrs. Olszewski is Dr Andreas Strecker who has previously worked for Daimler and its EvoBus subsidiary as the head of worldwide bus strategy as well as controlling bus manufacturing activities in Mexico, Latin America and Asia. As a remark on the importance of industry exhibitions for expanding firms’ networks exploring new areas of knowledge and competence, it is interesting to mention that Strecker met Olszewski family back in 1996 during an industry exhibition where both sides became interested in maintaining their cordial relationship until Solaris founders became confident in handling over the leadership of their company to the hands of Dr Andreas Strecker as the CEO of Solaris Bus & Coach that took effect by the 1st of April 2015xii. Strecker himself has a doctorate degree in Technical Business Administration from the University of Stuttgart in Germany.

Battery electric and hybrid buses

Solaris has a very diversified portfolio of buses and trolliesxiii in different sizes, capacities and with different powertrain and charging technologies. The size for city buses varies from 8.9m, to 12m, and 15m, to the articulated 18m, 18.75m and 24 m. In case of electric buses, different battery technologies including lithium ion phosphate (LiFePO 4) and lithium titanium are used.

xii Since 2003 there have been fully eclectic trolley buses running in Sweden (Landskrona and Malmö).
Charging technologies can also vary from inductive to conductive with different means including plugin, pantograph, as well as range extenders such as hydrogen or any possible combinations. According to the company representative (Vice Director Public Relations), when it comes to electric buses, Solaris has no pre-defined preference or limitation but instead offers a variety of technological solutions among which the most suitable options can be selected and adapted to the existing infrastructure and specific needs of each customer. The price of electric buses are estimated around double than that of conventional buses (~450,000€) with the lower operating costs (for fuel consumption, breaking pads, service and maintenance for ECR/EGR and engine, etc.) that can be reduced down 3 to 5 times less in comparison to conventional buses. The breakeven point can be estimated around 8 years, but of course it highly depends on the configuration settings such as the type of batteries, charging methods, infrastructure, usage, etc. According to the interviewee, the prices of batteries are also falling down which will further lower the overall price of electric buses and help to shorten the breakeven point.

Solaris official website lists a wide range of city buses from conventional to hybrid and fully electrics as well as hydrogen range extension. On the hybrid buses two models are offered (Urbino 12m and 18m hybrid) which are based on Allison power split technology combined with combustion diesel engine from Cummins. On the electric buses three models are available (Urbino electric LE 8.9m 12m and 18m). Traction motors are supplied from TSA (Austria) and ZDF (Germany) ranging from 120KW/h to 160 KW/h and 240 KW/h as well as hub-wheel drive axles 2x60 kW.

When asked about the difference between full electric buses provided by Solaris and that of BYD, the interviewee replied that: ‘even though BYD electric buses are cheaper in terms of price, they are inferior in terms of technology for three reasons:
1) Heavy battery packs
2) Very long charging time
3) Very heavy cabin weight’.

He further added that, these factors make BYD electric buses much less flexible and least responsive to the to customer requirements. On the other hand, ‘Solaris vehicles are adaptable to different infrastructure and have the least adverse effects on the existing infrastructure’.

Talking about the challenges for selling electric buses, the interviewee considered a number of factors that are still hindering the process including: economic barriers, psychological barriers, communication barriers and the strong lobbying power by the existing oil industry. With regards to the economic barriers, higher prices of alternative powertrain technologies and in particular the low return on investment (ROI) ratio still needs to be improved. Psychological barriers are due to lack of trust to the new technologies which go hand in hand with the need to highlight
environmental benefits as well improving communication channels towards both policy makers and decision makers at different levels as well as the citizens as the final beneficiaries. When it comes to the sustainable transitioning of the public sector, the interviewee believed that city-buses are the easiest segment within the automotive industry for such transitioning to take place.

**Interviewee:** Mateusz Figaszewski (Vice Director Public Relations, Solaris Bus & Coach S.A.)

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4.3 BOZANKAYA (Germany/Turkey)

Background
The company was originally established as a design and engineering office in 1989 in Wolfenbüttel (located on the Oker River about 13 kilometers south of Brunswick) by Murat Bozankaya of Turkish descent in Germany. Later in 1997 The Bozankaya Metall & Kunststoff GmbH was established and in 2000 the office was relocated to Salzgitter. Three years later Bozankaya Ltd. Sti., was established in Ankara. Since then a couple of other companies have been established, merged or extended until 2009 when the final relocation and extension of Bozankaya to a new place in Ankara was taken placexiii.

Nevertheless, there still strong linkages to Germany and the network of German automotive manufacturers such as Neoplan (MAN), EvoBus (Daimler) as well as Siemens and Stadler to the extent that the Sileo brand is being introduced as a German-Turkish co-production in the words of the CEO: “Sileo, derived from the Latin word Silentium, which means in German peace or tranquility. The Sileo is a German-Turkish co-production: The body comes from TCV from Turkey, but the entire drive and battery technology as well as the equipment it gets here in Germany”xiv. There is not much information available on the company’s website; however the representative at UITP said that Bozankaya provides different models of buses with a variety of powertrain technologies including: Diesel combustion, CNG, Trolley trams, as well as electric buses.

Battery electric buses
On the electric side, Bozankaya offers its renowned Sileo bus based on full electric technology. As mentioned earlier, the bus is rather branded as a product from Germany and for the purpose of branding in Europe the company has dedicated a completely different website where the information can be found in German and English languages (see: www.sileo-ebus.com).

Technical specifications on the official catalogue mentions an electrical range of >200KM on a single chargexv, but the company representative at UITP said that the range for electric buses can go up to 310 KM for new buses starting from 2016.

xiii http://www.bozankaya.de/new_site/en/page&id=2040&navid=52
When it comes to electric buses, Bozankaya has a completely different viewpoint on the technological solutions. The company representative, Mr. Stephan Rudolph a physicist by training who has worked for long time with batteries and physio-chemistry of battery packs, says: “we’re not talking about battery size or other technicalities, what our customers want from us is the [distance] range to be guaranteed!”. And to achieve that, Bozankaya has developed its in-house battery management system (BMS). It has also worked very closely with partner companies and suppliers from Germany to reduce the weight and optimize the battery packs (SCL battery system with active balancing, permanent monitoring at the single cell level and compatible charging for minimal losses) as well as the auxiliary and recuperation system. The battery management system also includes the charging infrastructure which has very specific characteristics: it is a high voltage DC charging (560V) and it uses a fleet-based charging infrastructure called Dynamic Charge Matrix that can charge up to 10 connections in 10 arrays of buses (up to 10x10=100 buses) simultaneously. Later on the same day, Mr. Rudolph held a focus session presentation to elaborate on the specific technological solution by Bozankaya (Sileo) for charging their electric buses as illustrated in the below figure.

As it can be seen in the picture (right) this type of charging is very specifically designed for Sileo bus systems (no universality). One important implication is that Sileo buses can only be charged using Sileo charging system and thus no other charging facilities or existing infrastructure can be leveraged. Another implication is that due to its specific characteristics, Sileo charging facilities might not be useful for charging other buses either! Nevertheless, the price estimation for Sileo electric buses is around 400,000€ which includes charging facilities together with 10 years of warranty for the batteries.

**Interviewee:** Stephan Rudolph (Dipl. Physiker) Development Manager at Bozankaya Bus & Bahnsysteme Entwicklung Konstruktion  
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4.4 **SCANIA**\textsuperscript{xvi} (Sweden/Germany)

At UITP 2015, Scania showcased its newly designed hybrid-biofuel city bus vehicle called: \textit{Citywide LE Hybrid}. It is a parallel hybrid powertrain that can run a wide range of alternative biofuels (i.e. biogas, bioethanol, biodiesel, HVO). The bus is a low-floor design based on the new cabin configuration (Citywide) combining with the existing K-series chassis to replace the previous \textit{OmniCity} and \textit{OmniLink} designs. As shown in the following pictures (bottom-left), there have been some changes inside the cabin to make more room for standing and talking by removing the chairs in the entrance areas. According to the company representatives, the idea was to create a social atmosphere inside the city bus. Chairs were also tilted towards the windows so that sitting passengers could better see outside perspectives through the glasses.

\textsuperscript{xvi} Due to prior acquaintance, background information was deemed unnecessary for this company.
Biofuel-hybrid-electric city buses

As shown in the previous picture, the bus display in the top photo (marked with yellow oval dash line) reads: ‘Citywide LE Biofuel Hybrid’ however the engine demonstration right outside the bus was indeed an ordinary biogas engine, but not a hybrid powertrain! It is reflected in the below figure and the text beside the engine that reads: 280hp Euro6 Biogas Engine.

Asking about the most recent developments with hybrid electric powertrain from the company representatives during the exhibition, not much information was gained but the company has already announced since late October last year (2014) that the new line of Scania city buses can be equipped with parallel hybrid electric powertrain as well xvii. It is also available in the product portfolio on the company’s website xviii. Below figure is a schematic illustration of the Scania Citywide bus with biofuel hybrid electric powertrain, yet the type of hybrid configuration (series or hybrid) is not clear for CNG/Biogas engines.

Scania’s 280 hp Euro6 Biogas engine on display at UITP 2015, Milan

Photo by: Benny Borghei

Scania Citywide biofuel hybrid electric bus

Source: Scania corporate website


The body length ranges from 12m up to 18.1m and the Euro6 powertrain may vary between 7-liter and 9-liter diesel or biofuels (i.e. CNG, biodiesel, bioethanol, or biomethane). The parallel hybrid powertrain is apparently delivered with 9 liter diesel/biodiesel (i.e. liquid fuels), but not with CNG or biogas.

Above slide is an exempt from public presentation by Jonas Strömberg Director of Sustainable Solutions at UITP 2015 in Milan, where Scania slogans biofuled hybrid as the best hybrid case for suburban transportation. Thus it may take a while until Scania provide hybrid powertrain for all of its biofuel engine categories including gas fuels (i.e. CNG and biogas). Perhaps this is something that needs to be closely followed up.

Interviewee: Christian Persson (Project Sales Manager, Bus Systems by Scania)
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4.5 **MAN**\(^{\text{ix}}\) (Germany)

Next to Scania in the exhibition was located MAN as the two companies are also placed under the same roof when it comes to the ownership by Volkswagen. MAN showcased its Lions City GL bus an 18.75-metre long articulated bus with five double-width doors designed for large passenger volumes (up to 142 persons) in the urban areas. The powertrain options on Lion City models (Euro 6 standard) ranges from diesel to natural gas, biogas or e-gas (extracted gas from coal). There were no electric or hybrid powertrain demonstrations from MAN. Searching at the company’s website, there seems to be hybrid electric powertrains also available for the Lions City models. It is a series hybrid that was showcased at UITP 2009 in Vienna for the first time, but did not appear again this year.

The online corporate archive shows that serial production of hybrid city buses (based on series-hybrid technology) has been started since June 2009\(^{\text{xx}}\). Below figure is an illustration of the hybrid technology development at MAN since mid-1970s till date.

\(^{\text{ix}}\) Due to prior acquaintance, background information was deemed unnecessary for this company.

MAN Lions City bus has also won the prize for the ‘Bus of the Year 2015’ due to its unique design for the inner cabin area and doors concepts to facilitate rapid passenger flows and short stopping times during peak traffic periods. Information are available on the corporate website regarding Lion’s City Hybrid but there are not much technical specifications of the vehicle available\textsuperscript{xxi}.  

No more information was found regarding electrification or further investments in expanding hybrid technologies (other than series hybrid technology) on the corporate website or from the UITP 2015 exhibition in Milan.

\textsuperscript{xxi} www.bus.man.eu/man/media/en/content_medien/doc/business_website_bus_master_1/Lions_City_Hybrid.pdf
4.6 IVECO\textsuperscript{xxii} (Italy)

Next to MAN in the exhibition hall was IVECO with its natural gas powered city bus as shown in the photos below. Again, like most incumbent commercial vehicle manufacturers, no electrification or hybridization of the bus powertrain was exhibited at IVECO during UITP 2015 exhibition.

However, investigating corporate website and other online material revealed that IVECO had earlier exhibited its hybrid electric bus called Urbanway during the previous UITP exhibition in Geneva in 2013\textsuperscript{xxiii}. Below photos are demonstrations by IVECO for its hybrid technology during the previous exhibitions.

Under E3 strategy for sustainability (Energy Efficiency Ecology) on IVECO corporate website, it is stated that the company can offer three different categories of vehicles based on both series and parallel hybrid technology. The parallel hybrid technology to be used in light and medium sized cargo transport (ECODaily Hybrid and Eurocargo Hybrid), while the series hybrid technology to drive the urban transport buses (i.e. Urbanway). However, looking at the product and sales figures no more information could be found in terms of actual sold products in the market except some development projects in collaboration with IVECO-France and as part of an EU funded program called ElliSup\textsuperscript{xxiv}.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{IVECO-Bus-running-on-natural-gas-demonstrated-at-UITP-2015-Milan}
\caption{IVECO Bus running on natural gas demonstrated at UITP 2015, Milan}
\textit{Photo by: Benny Borghei}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{IVECO-Urbanway-hybrid-electric-bus-prototype-demonstration-at-UITP-2013-Geneva}
\caption{IVECO Urbanway hybrid electric bus (prototype) demonstration at UITP 2013, Geneva}
\textit{Source: IVECO corporate website}
\end{figure}

\textsuperscript{xxii} Due to prior acquaintance, background information was deemed unnecessary for this company.


On the website of Carnot institute where this project was hosted in collaboration with other partners in France, the initial goal was to develop rechargeable hybrid electric buses branded as Citelis by Iveco-Iribus in France (see the photo on the right side). In later stages, it has been taken forward with plugin hybrid and all electric buses since 2009. The Ellisup has so far become a concept bus for electric buses of the future (see the photo below).xxv Again, on the product highlights of IVECO, there could not be found sellable hybrid or electric buses actually on the market.

4.7 DAIMLER\textsuperscript{xxvi} (Germany)

Next to IVECO was Daimler with its new extra-long \textit{CapaCity L} articulated bus that stretched 21m long, weighted 32tonns and could accommodate up to 191 passengers at once. Most of the components for this new bus concept are based on the existing Citaro buses which have been already proven their high functionality. The standard powertrain was based on a 7.7-litre diesel engine with the possibility of CNG as an option. Beside the bus, Daimler showcased the diesel engine for the bus which can be seen in the left photo below. The engine is a Euro VI low emission family of Mercedes and the company argues that it could reach the lowest CO2 efficiency per passenger with a diesel engine that consumes 0.5 liter per passenger per 100 km\textsuperscript{xxvii}.

![Mercedes CapaCity L model demonstration (right) and the diesel engine powertrain (left) at UITP 2015, Milan](image)

\textit{Photo by: Benny Borghei}

Again, like other traditional heavy vehicle manufacturers, an important aspect was that there was no electric or hybrid technology demonstration for Mercedes buses at the UITP exhibition. Asking from one representatives of the company about possible hybridization or electrification of buses in the future did not result in so much information either. There was only one senior representative who expressed that hybridization is not part of Mercedes strategy, but in the long term full electrification is on the agenda. He further expressed that hydrogen fuel cells would be then the option for full electric transportation towards the next decade (after 2020). Therefore, either full electric or series hybrid with possibilities for range extension such as using hydrogen fuel-cells are the only electric options that are being considered by Mercedes at the moment. Series hybrid and fuel-cell hybrid electric versions of Citaro can be found on Daimler’s website\textsuperscript{xxviii}.

\textbf{Interviewee:} Frank Mandel (EvoBus Marketing Information department)

\textsuperscript{xxvi} Due to prior acquaintance, background information was deemed unnecessary for this company.

\textsuperscript{xxvii} \url{http://media.daimler.com/dcmedia/0-921-656660-1-1769354-1-0-0-0-0-0-0-0-0-1-0-0-0-0-0.html}

\textsuperscript{xxviii} \url{http://www.daimler.com/dccom/0-5-1228969-1-1401155-1-0-0-1401206-0-0-135-0-0-0-0-0-0-0-0.html}
4.8 Van Hool (Belgium)

Background
The company was established by Mr. Bernard Van Hool in 1947 as a family business right after Second World War where transport was critically needed in Belgium. As an entrepreneur with genuine interest in mechanics, Mr. Van Hool was active in establishing his own family business even before the world war, which nevertheless was destroyed during the war. However, postwar era marked the re-establishment of Van Hool family business as a bus builder which has still remained 100% family owned and is active in the design and construction of the body and chassis. The company has also enjoyed the export market through the colonized country of Congo and later on in other African markets such as Nigeria, Angola, Tunisia and Algeria.xxix

As for the powertrain, the company has been working with established manufacturers such as DAF, Detroit and Cummins for the supply of the diesel engine, transmission and other driveline equipment. As of today, the company employs 4,800 workforces in three production sites across Koningshooikt and Bree in Belgium. Since 2014, the company has also opened a new factory in Skopje (Macedonia) to deliver the 500 coach order it had earlier received in 2012 from the American market. Now it has already delivered more than 600 coaches to the United States. Though not being part of the European Union, Macedonia is still considered as an appropriate European oriented economy with lower labor and overhead costs that in the long run is considered as an advantage for Van Hool for further expansion of its export markets both in Europe and in the United States.xxx

Electric and hybrid city buses and bus-trams
The company demonstrated its full electric concept bus called ExquiCity. The idea behind the design of this concept was to provide a multi-propulsion platform where a wide range of alternative powertrain options could be chosen based on the requirements of the customers and the operational characteristics.

xxix http://www.vanhool.be/ENG/bedrijfsinfo/historiek
With the multi-propulsion platform\textsuperscript{xxxi}, Van Hoon sets itself free from the challenges of developing new capabilities for alternative powertrain and instead chosen to focus on its core capabilities, which is the design and production of chassis and body. As shown in the figure, the platform can accommodate a wide range of powertrain choices from diesel-hybrid or biogas-hybrid to fully electric or even hydrogen fuel cell in the future. The platform also allows for the operation of the vehicle as an ordinary bus or trolley bus either in 18 or 24 meters long. The trolley bus option can be powered either through inductive or conductive charging. The vehicle is propelled by wheel-hub traction motors.

Though being introduced as a concept platform at UITP, the company has already managed to sell a number of vehicles to the market as well as securing a number of orders to be delivered in the near future. In Sweden, the company has collaborated with Scania for the development of a biofuel vehicle called Van Hool Scania ExquiCity\textsuperscript{xxxii}. The company had earlier signed a contract back in 2012 with Nobina (formerly Swebus) for the delivery of 15 double-articulated (24m) biogas-hybrid vehicles which are in operation in Malmö and Skåne regions as of June 2014.

There was no mentioning of the type of hybrid configuration. However, the company website indicates that the Euro VI combustion engine running on biofuel is used to generate electricity, which in turn runs the electric motor, and thus most likely makes it a series-hybrid configuration\textsuperscript{xxxiii}. Similar vehicles have been also delivered to the city of Martinique in France as well as Bergen in Norway. A full electric version is also due to delivery by the early 2016 to Hamburg in collaboration with VHH and Hochbahn. The Hamburg project consists of two tram-buses using inductive pantograph charging at both ends of the route M3 with an estimated charging time of 40 minutes. The company has also come into an EU funded consortium from 2015 to 2019 which orders the delivery of 21 hydrogen powered buses as part of the 3Emotions (CHIC) project\textsuperscript{xxxiv}.

\textbf{Interviewee:} Communicating manager at Van Hool

\textsuperscript{xxxi} http://www.exquicity.be/en/
\textsuperscript{xxxii} http://www.scania.com/Images/P14X01EN_Scania_at_Persontrafik_2014_tcm40-448567.pdf
\textsuperscript{xxxiii} http://www.vanhool.be/ENG/actua/vanhooldeliversf.html
\textsuperscript{xxxiv} http://chic-project.eu/newsevents/news/21-more-fuel-cell-buses-on-the-road-soon-start-of-the-3emotion-project
4.9 EBUSCO (Holland)

Background
Founded in 2012 at the High Tech Automotive Campus in Helmond, the Netherlands, EBUSCO is considered a very small new entrant to a very old and established heavy industry. However, the location advantages of the automotive campus which hosts a high concentration of expertise, and a cluster of knowledge and open innovation in the automotive industry as well as strong linkages with suppliers of components and subsystems enabled the company to quickly emerge and boost its presence in the city-bus segment with full electric propulsion as the alternative powertrain to the conventional combustion engine. Proximity to the pool of science and access to relatively low-cost and yet highly educated labor force from TU/e (Technical University of Eindhoven) could be considered another positive factor.

Yet there might be other factors in explaining the rapid emergence of such new entrant. According to BusWorld magazine\(^{xxv}\), the company has signed an exclusive agency agreement for the sales and distribution of electric power storage, drive systems and related auxiliary equipment from leading Chinese manufacturer Yinlong\(^{xxvi}\). The body is supplied by Huanghai\(^{xxvii}\) (subsidiary of SG automotive in China) which is redesigned by Dutch engineers to get European certificates. The company has already managed to sell 300 buses in China and get feedback and verification of the functioning and safety of its vehicles. According to BusWorld, EBUSCO has run its first fully electric buses in its neighbor city of Eindhoven back in 2012 and now heads for the European markets. Apart from integrating body and components from different suppliers, the company also sells electric bus components, charging facilities and other equipment for the maintenance of electric buses or full electrification of the existing combustion engine buses to fully electric.

\(^{xxv}\) Link to the article on BusWorld magazine [http://www.busworld.org/articles/detail/1777](http://www.busworld.org/articles/detail/1777)

\(^{xxvi}\) Yinlong, the Chinese supplier of electric power systems [http://en.zhyle.com/show-56-32-1.html](http://en.zhyle.com/show-56-32-1.html)

\(^{xxvii}\) Huanghai, Chinese bus manufacturer [http://guangtongauto.zhyle.com/list-18-1.html](http://guangtongauto.zhyle.com/list-18-1.html)
Battery electric city buses

The company offers two variations of full electric buses: YTP-1 which was first launched in the Chinese market and sold 300; and the new fully aluminum body called EBUSCO 2.0. According to online sources, the new body was jointly made by EBUSCO and another Chinese manufacturer called Golden Dragon.xxxviii The aluminum body reduces the weight up to 500 Kg and thus increases the range and battery performance of the vehicle. The design includes a single electric motor for propulsion with the power of 150KW and charging facilities that are provided by EBUSCO that takes between 1.6 to 2.5 hrs (most likely DC charging) for a range of 250KM to 311KM full electric drive.

With such distance range, there is no need for opportunity charging during the day and in most cases the endpoint (night) charging at the depot would suffice. According to the company website, the energy density of battery cells has reached as high as 0.16kWh per Kg or 160Wh/Kg in compare to the other producers who compete around 90Wh/Kg. The company has run tests across many cities in Northern and Western Europe including Finland (Helsinki and Espoo), Sweden (Lerum, Båros, Jönköping, Kalmar, Karlskorna and in collaboration with Flygbussarna between Stockholm and Arlanda) as well as Norway (Stavanger), Germany (München & Bonn), Denmark (Copenhagen) and its home country Netherlands (Maastricht & Eindhoven). However, there are no available data on the sales figures or confirmed orders for EBUSCO in Europe. Even when asked from the CCO of the company at UITP, there was no clear answer. The only thing he was so clear about was that: “The hybrid buses can be [soon] surpassed by electric buses”. The reason he explained was the higher total cost of ownership (TCO) and the long term perspective of sustainability in the public transport sector.

Interviewee: Jean-Luc Deflandre (CCO at EBUSCO B.V.)

NOTE: previously CCO and advisor of the board at BYD

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4.10 VDL (Holland)

**Background**

Originally founded as a family owned business by *Arthur Berkhof* and his son in 1970s, the company was later merged by Jonckheere Bus & Coach and changed its name to *Berkhof Jonckheere Groep*. Both companies were then purchased by VDL Groep in 1998, but kept their full autonomy within the VDL conglomerate. The company is specialized in the design and manufacturing of body and chassis for buses, coaches, mini & midi buses as well as some special products such as the mini-cooper body manufacturing. It is headquartered in Valkenswaard only 11 Km south of Eindhoven. The Citea low floor model of VDL is a renowned brand winning the bus of the year prize in 2011. Engines are often supplied by Cummins or FPT (Fiat) or the Dutch heavy vehicle manufacturer, DAF.

**Full electric city buses**

The company has already got an order of production for 8 fully electric articulated (18m) buses from Cologne transport KVB (Kölner Verkehrs-Betriebe). Buses are designed for opportunity charging using both inductive and conductive, but in Cologne they will be charged only at the end stations. Testing is set to take place during summer and autumn 2015. Earlier in 2015 the company has also delivered another 5 electric solo buses to Stadtwerke Münster, out of which 4 were sponsored through ZeEUS project coordinated by UITP. Another 1 was subsidized by the German Federal Ministry of Education and Research (BMBF). According to the commercial project manager, in total 7 cities in Germany have placed orders for VDL electric buses with varying funding schemes from EU, Germany, Netherlands.
Furthermore, 2 electric buses are going to be delivered in Copenhagen and Oslo in the near future as well as 10 (12m) buses to Finland. According to the company representative, battery performance, charging and price are still the main challenges for full electrification. Similar to other manufacturers, the estimated price difference between a full electric and a conventional diesel bus is about twice. To overcome the problem of costs, what is most important, according to him, is modularization!

Inauguration of Münster electric bus, April 2015
from left to right: Eckhard Schläfke (Stadtwerke Münster), Werner Rohlf (RWTH Aachen), Alex de Jong (VDL Bus & Coach bv), Umberto Guida (UITP) and Dr. Dirk Wernicke (Stadtwerke Münster).
Source: VDL

Looking at the company’s website, there is also a series hybrid version of the Citea SLF 12 meter bus available.

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4.11 IRIZAR (Spain)

**Background**

Established in 1889 by the Irizar family, the company is as old as the UITP organization itself. The company started with carriage production and today is specialized in body and chassis design and manufacturing as well as the integration of equipment. It is well known for making luxury coaches of the highest quality in Spain and for the international markets. The company has also supplied Volvo, Mercedes, IVECO, Scania and other heavy duty manufacturers with custom designed bodies. The company has been expanding since its inception in the late 19th century but since early 1990s it has become more international oriented and focused on growth and expansion. In now holds factories in not only in Spain, but also in Morocco, Brazil, Mexico, India and South Africa. Apart from horizontal expansion, it has also vertically integrated a number of suppliers specialized in different parts of coach systems and components. As a result it has become a large conglomeration that also includes an innovation center called Creatio. With the increasing trends of urbanization, Irizar also started to expand its business into the city bus segment. The result was introduction of i3 model in 2012 which is a low-entry solo range into the portfolio of Irizar.

**Full electric city buses**

In 2014, Irizar introduced its fully electric bus i2e. It based on the previous low entry model i3 with some modifications to make it more suitable for the urban transport conditions, such as adding another set of doors making it available in 1 to 3 double-sliding doors options. It can accommodate 76 passengers in total (both sitting and standing). The body is partly made by aluminum to reduce curb weight for electrification. The estimated range is between 200-250KM depending on the roads and driving conditions, but the company guarantees 180KM or 16hrs of continuous operation with a single full charge that will take 6 to 7 hours. The power is supplied through a battery pack of 376kWh made of Sodium Nickel (SoNick) combined with 125V supercapacitors. Charging is done through 125V standard combo plug and is only available for in-house (end station) charging. Irizar i2e electric bus has been developed in collaboration with ZeEUS project in which UITP was the coordinating body. Two of these buses were delivered to the public transport company TMB in the city of Barcelona for testing since 2014 and later to Madrid and San Sebastian as well.
Two more buses are delivered to the UK for tests in London from summer 2015, followed by 6 more buses to the city of Marseilles in France. One of the interesting features of Irizar electric bus is the in-house technology for the climate system capable of both warming up and cooling down the passengers and the driver areas. According to the company representative who explained the development process of the first electric bus at Irizar, the main reason for the development of such system into an electric bus in the first place was that in the hot summers of Barcelona it is basically impossible to a vehicle without air conditioning: “[…] of course the development and integration of a climate system that works purely on electric power was a challenge, but we managed to do that in house and we are very proud of it. It provides more pleasant environment for the passengers who are going to use our buses”. The bus is equipped with a smart climate system that adjusts the inside temperature while charging the vehicles so there would be less need for extra battery consumption when the bus goes off the road. That may partly explain why the company has chosen to have only depot or overnight charging.

Many other companies collaborated in the development of this electric car many of them already part of Irizar group such as Hispacold, manufacturer of the heating and air conditioning systems; Jema, specialized in electronics; Datik, a technology company that develops smart solutions for the transport sector; Masats, which manufactures accessibility systems; and CREATIO, the Group’s R&D centerxl.

4.12 Gépé bus (France)

Background
Gépé bus is a brand name from Power Vehicle Innovation (PVI) the producer of electric buses, vans, minibuses and small trucks in France. The company is specialized in alternative powertrains, in particular electric systems and charging equipment as well as CNG and some related infrastructure for electric charging. It has 25 years of experience in working with the development of electric vehicles. Gépé bus is the brand name for its electric buses. WATT systems (Wireless Alternative Trolley Technology Systems) is another brand which is providing specific charging solutions to PVI’s electric vehicles. The company has been very active in the electrification of public infrastructure in France including rail and road services. Since early 1990s the company has been developing full electric trucks for urban usage, such as household waste pickup and other municipal services. And since 2003 more than half of electric (mini/midi) buses in Paris have been supplied by PVI. Nevertheless, it is still quite a small company with around 150 employees.

Full electric city buses
Though focused only on mini and midi size vehicles, PVI is perhaps one of the earliest producers of full electric buses in the world. Their midi-bus model Oréos 55E (photo) has been running in Paris for around a decade. They have mostly collaborated with RATP (Régie Autonome des Transports Parisiens) the public transport authorities in France to bring in electric buses into the market since early 2000s.

The other full electric models are Oréos 2X minibus (7m) with 22 passengers capacity and Oréos 4X midibus (9m) with 49 passengers capacity (photos). Both are running on Lit/Ion batteries and supercapacitors with 170 kW/h capacity which is enough for driving 150KM on a single charge. The electric motor is located in the center of the vehicle close to the rear part of the chassis. The company has currently no plans to expand its business into producing larger size buses.

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4.13 OTOKAR (Turkey)

**Background**

The company was established in 1963 in Istanbul as the license manufacturer of Magirus Deutz from Germany to produce buses for the Turkish domestic market. In the early 1980s the company was acquired by Koç Holding and became part of the large conglomerate enterprise in Turkey. In the mid-1980s it gained license from Land Rover to produce off road and military cars in Turkey. From that point, the company gradually expanded its product portfolio to include light military and armored vehicles as well. Later on, Otokar introduced in-house designed and built to order tanks for the Turkish Armed Forces.

In the minibus segment, it is one of the largest producers of small size M-series known as Dolmuş in the Turkish market. In the city bus segment, the company produces solo bodies from 9m to 13.26m with engines sourced mainly from Deutz and Cummins. The company has also started to expand its export market to Europe since 2012 both in the city and coach bus segments.

The new low floors 10.6m Kent City together with two other models of the famous Kent series were all presented at the UITP exhibition. The company has recently introduced CNG and electric as alternative fuel powertrains for its city bus segment. The company has also provided body for the full electric Oréos 4X of Gépébus.

**Electric and hybrid city buses**

In 2012 Otokar launched its full electric bus called Vectio Electra (known as Doruk Electra in Turkish) in the Busworld exhibition in Turkey. The bus is a 9m full electric with 170 kWh lithium-iron magnesium phosphate batteries. The company has also introduced a series hybrid-electric bus (prototype) called Vectio (Doruk) Hybra. However, the CNG powered bus known as Doruk CNG has been also mentioned as the company’s hybrid bus, which should not be mistaken by the electric hybrid Doruk Hybra. According to the company representative, the future technology standards for both batteries and charging infrastructure are still uncertain. Moreover, prices are still too high for electric buses to gain dominant market shares.

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4.14 TEMSA (Turkey)

**Background**

Termomekanik Sanayi ve Ticaret (TEMSA) was established in 1968 as an industrial trading company and later as a dealer of coaches, buses and trucks from Germany in Turkey. It was then acquired by Sabancı Group, the large conglomerates active in the steel and industrial business in Turkey.

The company has been producing coaches under license from Mitsubishi Fuso since 1970s and later expanded collaboration and sourcing from other established manufacturers including MAN, DAF, Cummins and Caterpillar. Since early 2000s the company has expanded its sales towards Europe with coaches. It also has midi coaches and city buses both for domestic and the export markets including Europe, US, and Asia/Middle East. In 2006 TEMSA established a European office in the Netherlands to specifically address the European markets and in 2008 opened another one in Germany to further strengthen its presence in the Western European markets. Germany is the largest European market for TEMSA followed by Italy, France, Sweden and Norway. According to the company representatives, there are currently 10,000 buses by TEMSA that are in operation all over Europe. To date it has also sold 600 buses to the US market, including the most advanced environmental engines complying with the EPA13 regulation. In terms of the powertrain, most focus is on Diesel and CNG powered engines with some new trials for electric propulsion.

**Electric city buses**

In the electric bus segment, TEMSA showcased a full electric version of its 9.5m low entry midi bus called ElectriCITY. Unlike other manufacturers, TEMSA had placed the battery pack on the floor to facilitate inductive charging option. The company claimed 150KM of full electric drive with this 14tons weighted body, 160KW battery pack and electric powertrain supplied from TM4 the Canadian producer of electrodynamic systems. However, the company representative stated that there are no solid plans for hybrid electric buses on the agenda; neither are plans to completely switch to electric buses market in the near future. Nevertheless, the company has some prototype electric buses which are up to start development from 2017.

The interviewee stressed that the most challenging issues are the presence of different charging types, lack of standards, differences in the local and national regulations as well as ambiguities with range distance requirements for electric buses.
Interviewee 1: Umut Kamay (MD: German Market and sales in Italy and Spain)
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4.15 Karsan (Turkey)

**Background**

The company was established in 1966 with the help of 269 investors to manufacture Mercedes Benz minibuses in Turkey. Majority of ownership was then acquired by Koç Holding in 1979 alongside Otokar. During 80s and 90s the company received licenses from Peugeot, Renault and Fiat to produce minivans, light commercial vehicles and ambulances in Turkey. During 2000s it received licenses from Hyundai and Renault Trucks to produce trucks, vans and buses.

The company was later on acquired by Kıraça Group that took over majority of shareholding with an investment of 70 million USD increasing the production capacity to 40,000 vehicles per year. Today, the company has a wide range of vehicles from minivans and mini trucks to minibuses, buses, and heavy trucks. The company is also active in the international exports market. The new taxi concept (V1) is a complete Turkish design aiming to enter the US market through the NY taxi fleet.

**City buses**

At the UITP exhibition, Karsan showcased a 6m minibus (*Jest* model) with an FPT engine from IVECO Group as well as an 8m low entry city bus called *Atak*. The engine complies with EEV/EuroV standard and can be also ordered with EuroVI engine according to the company website\(^{xliv}\). Apart from CNG, the company does not provide any other alternative powertrain option for its heavy vehicles. Considering FPT/FIAT supplying most of the powertrain technologies for Karsan, there seems to be no near or midterm plans for electrification or hybridization of the existing vehicle designs.

**Interviewee:** Guido Ucci (Sales Manager at Karsan Italy)

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4.16 Volvo\textsuperscript{xlv} (Sweden)

Volvo’s presence at UITP was highly influenced by the new concepts of public transportation based on alternative powertrain technologies and the socioeconomic impacts as a result.

The exhibition area for Volvo was rather spacious and quite central to the entrance of Hall 3. Therefore the decoration and design was quite visible to the visitors, where the company showcased only one bus which was based on the newly developed plugin hybrid (ElectriCity) bus. However, the focus was not only on the technological aspects, but also on the social impacts on the society. For instance, there was a dedicated section within their booth where the silent feature of the bus and its advantages were reconstructed based on computerized simulations of public transport noises in a city environment. The purpose was to highlight the advantages of quite electric buses in a built up city environment using audio visual effects.

Another interesting demonstration was the interactive interface for comparative analysis of consumption, costs and environmental pollutions related to the deployment of various powertrain technologies for city buses based on online GPS and repository of Volvo data bases on spot. This interface was particularly helpful for PTAs or city planners in their decisions on what technologies are more suitable for city buses based on the geographic and demographic characteristics as well as the demands of traffic and congestion in their supervised urban areas. There were senior staff on spot from Volvo, among them Edward Jobson, Håkan Karlsson and Håkan Agnevall to support decision makers in their choice of city bus powertrain technologies.

\textsuperscript{xlv} Due to prior acquaintance, background information was deemed unnecessary for this company.
Later, Edward Jobson held a presentation at Focus Session 8 on *Global experience of hybrid buses* in Hall 3. The impression from that presentation and the exhibition of various technological solutions for electric and hybrid powertrain was that, unlike other electric bus manufacturers, Volvo does not seek an all-electric solution for each and every application of city buses. Rather, a pluralistic perspective is pronounced by Volvo where full electric buses are suitable options for built up inner-city areas or zero emission districts with short distances and low speed travels (*the most inner circle in the picture*). And then plugin hybrids could be used in more distance travels (commuter hybrid) in the outer layers as well as hybrids and diesel engines for regional distance travelling i.e. in the most exterior districts of the metropolitan areas.

In the presentation, there were also revealing plans from Volvo to expand further into the electrification with both plugin hybrids as well as full electric buses that will kick off from the year 2017. There were also announcements of plans to expand further into the non-European markets such as Latin America (*as shown in the picture*).
5 Conclusions

The purpose with this report was to provide an overall grasp to one of the most important summits in the public transport sector involving major actors from the policy world to the industry and the intermediaries in between. In particular, the focus of this empirical investigation was on electrification of city buses in various forms i.e. hybridization, battery electric, or range extension using hydrogen fuel cells or any other means of electric transportation. In addition to background information about the UITP conference and exhibition, empirical data from 16 manufacturers of city bus vehicles have been collected and summarized. The table in the next page recapitulates findings from electrification of city buses from different manufacturers distinguishing between size and dimensions, powertrain characteristics, battery types and charging technologies.

Observations show a number of important developments in this field including battery performance improvements in terms of size and weight as well as price per units of energy. Batteries are still taking up a considerable share of costs for electric buses and are considered as a major bottleneck to justify costs of full electric transport in this segment. Current battery electric city buses (full electric) are priced around twice as ordinary city buses based on conventional diesel combustion engine. However the ultimate costs of battery packs differ based on variations in type and physio-chemistry of batteries as well as attached equipment such as battery management, heating and cooling systems, packaging and other related equipment required for securing proper functioning of the battery packs. A city bus requires at least 50kWh to 100 kWh battery pack to run on electric mode of transport whether it be a pure battery electric or hybrid-electric powertrain (mild hybrids are exempted since they don’t function on electric kinetic mode). Nevertheless, recent studies have shown decreasing trends in battery prices, which could facilitate further diffusion and scaling up of electric vehicles into the market. Yet, even if such positive trends come true and the final price for battery packs fall dramatically, it is going to have major implications on charging infrastructure due to the increased demand for electric power.

With respect to full electrification, the weight of the battery packs itself also becomes a bottleneck since carrying around tons of battery packs on electric vehicles regardless of the state of charge is not energy efficient. Thus, not only price/performance but also energy density of current batteries needs to be improved by multifold in order for the full electric drive to become economically justifiable. Current battery performance is about 0.16kWh/KG or 160Wh per KG as an average, which may still greatly vary attributable to the type and characteristics of the batteries.

Another observation is that established heavy vehicle manufacturers such as MAN, Daimler, and IVECO did not express an interest for electrification in this exhibition. This can be partly explained by the fact that expectations of further improvements in battery performance measures and electric powertrain technologies may in turn keep the established manufacturers away from taking substantial risks in entering such a turbulent market. In some cases such as Mercedes, electrification is seen as the future technology after 2020 and in the form of hydrogen fuel cell as the range extender for (series) hybrid electric vehicles in the mid to long term future. The message from other heavy vehicle manufacturers was not any better either, though all of them may have been occasionally involved in one or two testing or demonstration projects. Another reason is that the synergies of sharing common powertrain technologies across bus and trucks segments would be undermined due to the fact that electric mode of transport is still far from
reality in the trucks segment. The other reason is the competence destroying nature of electric powertrain that goes against core capabilities of established heavy vehicle manufacturers.

Such reluctance from established HDV manufacturers has in turn left plenty of space for bus makers such as Solaris, VDL, VanHoo and Irizar to play more an active role in the niche market for green buses. Solaris for instance has opened up all the possibilities of powertrain alternatives from fully electric with opportunity and end station charging or even hydrogen range extender to partial electrification such as hybrid electric to the conventional diesel engine powertrain. The insight from interview with Solaris representatives was that the company wants to be flexible with all the available technologies based on customer needs. Similarly, VanHool has come up with a platform concept that can make use of any available powertrain technologies from battery electric using inductive or conductive charging, hydrogen fuel cell, or diesel/CNG hybrid powertrain in their multi-propulsion platform concept.

There are also new entrants such as BYD, EBUSCO and others xlvi who are trying to fill the gap in the absence of established heavy vehicle manufacturers in the electric bus market. BYD for instance, entered European market in 2013 and has delivered full electric buses in rather large numbers in the Netherlands (35 to Schiphol), UK (13 to Nottingham and 51 to London in near future), and some fewer numbers to Sweden (3-5) as well as in Denmark, and Finland, Belgium and Spain (between 2 to 5 vehicles in each market).

Meanwhile, some established companies have created their own niche in this market by bridging the gap between the old and new technological paradigms. Hybrid electric powertrains are the technologies that both Volvo and Scania have decided to go along. In case of Volvo, diesel-hybrid and plugin-hybrid electric in parallel configuration have already been consolidated. The strong message from Volvo during UITP was that the company is decisive to continue on this path, and has already launched the 12m diesel hybrid bus as a full-fledged product available on all of its global markets. According to the formal announcement in the focus session presentation, next stage down the road for Volvo is to make the plugin hybrid and full battery electric versions of their buses available for all European markets in 2016 and 2017 respectively. Scania has also entered the hybrid electric field with its parallel technology which is still

Scania still has appetite for biofuels and CNG as part of its heritage even when it comes to hybrid electric vehicles. However, the strategy of the company does not seem quite clear as to which hybrid technology configuration is finally going to take the lead (i.e. parallel, series, or both?). The reason is that for diesel hybrid they have ultimately chosen the parallel configuration (i.e. Scania Citywide LE), but there are still ambiguities as to whether the same technology is suitable to be implemented with CNG/Biogas engines.

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xlvi Other niche entrants in the electric bus market include Hybricon (SE), Linkker (FI), Bolloré Bluebus (FR), tbus (UK), ASTONBUS (USA), Designline Bus Pacific (NZ), Ebus (USA), Proterra (USA), SmithElectric (USA), TECNOBUS (IT), Winston Energy (HK), Zondabus (CH) CoMan (SE). Due to the limited scope of the report which is designated to cover participating companies in UITP conference and exhibition, the profile of the abovementioned companies have not been covered here.
<table>
<thead>
<tr>
<th>Size &amp; Dimensions</th>
<th>Powertrain characteristics</th>
<th>Battery characteristics</th>
<th>Charging technology &amp; Charging supplier</th>
<th>Range &amp; Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BYD</strong></td>
<td>12m 18t 31+1 seats</td>
<td>Battery electric / Wheel hub</td>
<td>LiFePO4 260kW</td>
<td>Only Inductive Normal: 6hrs Fast: 3hrs</td>
</tr>
<tr>
<td><strong>SOLARIS</strong></td>
<td>8,5 to 24m All ranges</td>
<td>Power split hybrid (Allison)</td>
<td>LiFePO4 LiIonTit NiMH?</td>
<td>Inductive Conductive HFC</td>
</tr>
<tr>
<td><strong>Bozanka (Sileo)</strong></td>
<td>12m 2 or 3 doors</td>
<td>Battery electric (Siemens?)</td>
<td>200kW LiFePO 4</td>
<td>Sileo specific (DCM): From 4kW/50h to 100kW/2h independent of connection power</td>
</tr>
<tr>
<td><strong>Scania</strong></td>
<td>All range + Tram-bus: (with VanHool)</td>
<td>Parallel hybrid (diesel/biodiesel) Series hybrid (CNG)</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>MAN</strong></td>
<td>Solo (Lion City)</td>
<td>Series hybrid (diesel)</td>
<td>Ultracap high-performance energy storage system,</td>
<td>?</td>
</tr>
<tr>
<td><strong>IVECO</strong></td>
<td>Tram-bus</td>
<td>Full electric end station charging</td>
<td>The vehicle is not available for mass market</td>
<td>Pantograph: ELLISUP program</td>
</tr>
<tr>
<td><strong>Daimler VanHool</strong></td>
<td>Solo / Articulate? (Citaro)</td>
<td>Series hybrid (diesel) Fuel-cell hybrid</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>VDL</strong></td>
<td>Solo, 12m, 2-3 doors aluminum</td>
<td>Full battery electric 150kWh traction motor</td>
<td>High energy density batteries</td>
<td>1min charge=3KM (conductive)</td>
</tr>
<tr>
<td>Company</td>
<td>Size &amp; Dimensions</td>
<td>Powertrain characteristics</td>
<td>Battery characteristics</td>
<td>Charging technology &amp; Charging supplier</td>
</tr>
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<tr>
<td>IRIZAR</td>
<td>12m, 2-3 doors, 76 passengers Aluminum body</td>
<td>Battery electric</td>
<td>SoNick (376kW) + Supercapacitor (125V)</td>
<td>125V standard combo Overnight charging 6-7hrs</td>
</tr>
<tr>
<td>PVI (Gepe)</td>
<td>Solo 7-9m Mini/Midi</td>
<td>Battery electric</td>
<td>Lit/Ion + Supercapacitors 170kW</td>
<td>Plugin &amp; WATT (Wireless Alternative Trolley Technology Systems)</td>
</tr>
<tr>
<td>TEMSA</td>
<td>9.5m low entry, 14tonn body (ElectriCITY)</td>
<td>Battery electric supplied by TM4 of Canada</td>
<td>160kW battery on the bus floor</td>
<td>Inductive/Conductive</td>
</tr>
<tr>
<td>OTOKAR</td>
<td>9m Vectio (Doruk)</td>
<td>Full electric Series hybrid (hybra) prototype</td>
<td>LiFeMnPO4 170kW</td>
<td>?</td>
</tr>
<tr>
<td>KARSAN</td>
<td>No electric or hybrid buses</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>VOLVO</td>
<td>Solo/Articulated</td>
<td>Parallel diesel hybrid Plugin parallel</td>
<td>120kW Lithium-Ion</td>
<td>Inverted pantograph</td>
</tr>
</tbody>
</table>
6 Further information and useful links:

Rapportage from Bus & Coach Buyer:

UITP wrap up

UITP Photos
https://www.flickr.com/photos/uitp/sets/72157655320650765

UITP Photos by Mr. Ibou on Flicker
https://www.flickr.com/photos/mr_ibou/sets/72157654228932972

Hybrid-electric configurations
http://ecocar3.org/think-you-know-hybrids-mcmaster-says-think-again/

Related suppliers at UITP:
- ABB
- SCHUNK
- MEDCOM
- Siemens (no interview)
- Bombardier (no interview)
- Cummins (no interview)
- Voith (no interview)
- ZF (no interview)

Focus session attended: electric buses
- VDL
- IRIZAR
- SOLARIS
- BOZANKAYA

Plenary session 5 attended: Technological innovations for buses
- ZeEUS
- RATP
- VÄSTTRAFIK
- Q/As (question regarding hybrid/electric buses prices)

Plenary session 10 attended: EU policy properties on cities and public transportation
Focus session 8 attended: Sustainable buses and hybrid experience

UITP Presentations

Other events and contacts
Pauline Bruge (UITP Project Manager, Brussels)
Yannick Bousse (UITP Project Manager, Brussels)
Thematic workshops including local events in Sweden) Email to: stephanie.leonard@uitp.org "ZeEUS Electric Bus Forum" in Brussels.