Dynamic charging boosts electric vehicles' potential

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as Dynamic EV charging on the way

With an increasing need to use electric vehicles in city centres to reduce pollution, David Crawford looks at various solutions to power delivery.

Volvo project manager Richard Sebestyen with the 'upside down' pantograph

The UN's September 2014 Climate Summit has added fresh momentum to the drive to increase urban electric vehicle (EV) takeup. It has launched the Urban Electric Mobility Initiative, which wants to see EVs accounting for 30% of all urban travel by 2030, and make cities worldwide more friendly to their use.

Encouragingly, the plan is being well supported by commercial companies. Joan Clos, executive director of UN-Habitat, the agency's better urban futures programme, says: "Mobilising support from the private sector is vital to enable us to implement technological breakthroughs in urban mobility."

Industry forecasts for EV sales by 2020 range between 5% and 10% of global production, which is expected to reach 100 million units a year by 2021. So anything up to 10 million EVs a year will be coming on to the world's roads and will require secure and convenient access to charging.

Static 'plug-in' EV charging continues to roll out across the world (although only Estonia currently has a national network); with service and parking areas and the driveways and garages of private homes finding roles as top-up locations. But range anxiety (drivers fearing that they will run out of power between charging points) continues to prove a major deterrent to wider EV take-up and has opened up the debate on alternative ways of sourcing power.

The most readily-available prospect is via the roadway that the vehicles are using, suitably modified to carry and transfer energy from national grids. To quote Stan Albrecht, president of the US' Utah State University (USU), which is playing a central role in dynamic EV charging research in North America: "Every prior attempt to electrify the car has assumed the vehicle would be the energy carrier. By comparison, the grid is much more efficient at moving energy."

Hence the growing interest in dynamic charging of vehicles on the move, using onboard inductive units to pick up a charge from power sources buried in the road or located above the surface. Dr Ralf Effenberger, executive director of German system developer Intis, stresses the importance of dynamic charging in "allowing EVs to become as flexible as their internal combustion engine counterparts".

The Asia/Pacific region has taken an early lead in deployment.

In 2013, the [South] Korea Advanced Institute of Science and Technology (**KAIST**) opened what it claims as the world's first dynamic charging route, using subsurface cabling. It is running two 'online electric' buses on a 24km-long regular service route plying between the main railway station and the central business district of the city of Gumi, a technology hub lying 200km south-east of the capital, Seoul. The batteries are a third the size of those being installed in conventional passenger EVs.

KAIST research identifies five main drivers behind the move. Two are technical: relating to batteries (weight, price, capacity) and charging (duration, frequency, efficiency). Three are socio-economic – continuing depletion of oil resources, growing environmental pollution, and the emergence of tougher emissions regulations. The first two need solutions to maximise EVs' contributions to meeting the other three.

The Continuous Electric Drive (CED) project under way

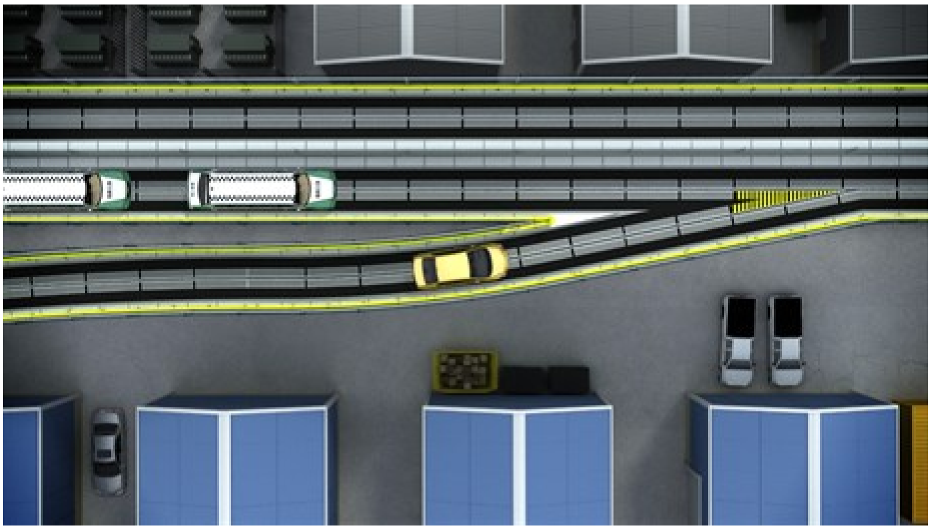
In New Zealand, the University of Auckland has been running research projects on wireless power transfer since 1989, when it developed the original application for use in industrial materials handling. It has worked with global consulting engineers **Arup** to develop the HALO ITP (inductive power transfer) technology, acquired in the following year by US wireless technology developer **Qualcomm**, which has branded it Wireless Electric Vehicle Charging. Currently, HALO is undergoing static car charging trials in Europe.

Meanwhile, the university's Faculty of Engineering continues to work on the challenge of what Professor Grant Covic calls "creating a low-cost, rugged, roadway-based primary system." It has built a laboratory-scale dynamic highway for technology testing.

Europe

At the same time, the university's commercialisation arm UniServices maintains an ongoing R&D relationship to support Wireless Electric Vehicle Charging in both applications. Qualcomm also has its own R&D centre in Auckland, from where it hopes that work on dynamic charging can feed into projects such as the European €9 million (US$12.5 million) FABRIC project.

Co-funded by the European Commission (EC), FeAsiBility analysis and development of on-Road charging solutions for future electric vehICles is carrying out trials at three test sites. A French ITS research centre at Satory, near Versailles, is focussing on the issue of vehicles moving into and overtaking out of charging lanes. An existing Italian wireless technology test track near Turin, developed to simulate urban driving conditions and currently configured for static EV charging, is being upgraded for dynamic tests. Both are focussing on system interoperability.



How lanes would merge on a TEV track

In Sweden, the **Volvo** automotive test track near Gothenburg is feeding in results from tests of a charging technology that it has developed jointly with French energy giant Alstom. This starts from the point that long-distance trucks and coaches will need a continuous external power source. The method being tested involves two power strips built into the road surface along its entire length, with a current collector in the form of an 'upside down' pantograph, or 'pick-up'.

The charging lanes are intended to be open to all traffic and the strips would be built in sections, with only one at a time being live as the vehicle passes, so ensuring safety for other road users. Its design incorporates leeway to allow for the truck not being driven precisely over the strips at all times.

A Volvo spokesman told ITS International: "There are methods of increasing the friction of the strip surface enough to make it safe to drive on, even by motorbikes. And the good thing is that all EVs can use the strips - this is not so easy with overhead wires because of the difference in height between a car and a truck."

Technical work began in 2011 and in summer 2012, Volvo built a 400m-long track at its testing facility in Hällered outside Gothenburg. "We are currently testing how best to connect the electricity from the road to the truck," says Richard Sebestyen, project manager at the Volvo Group Trucks Technology research and development division.

The project, which runs from January 2014 to December 2017, is engaging closely with the automotive industry, according to Denis Naberezhnykh, senior ITS consultant to project partner TRL. "Vehicle manufacturers are seriously considering the use of on-road charging solutions to overcome barriers to

electromobility," he told ITS International. His confidence is supported by the close involvement as partners, not only of Volvo, but also of Swedish truck and bus manufacturer Scania and Italy's Centro Richerche Fiat.

FABRIC's aim is to identify the costs and benefits calculations needed to source the investments required for widespread implementation.

Utah State University's test bus

In Belgium, the 2010-2013 Continuous Electric Drive project, run by the Flemish Drive automotive research centre, segregated a 500m stretch of a lane on the Belgian N769 national highway as a temporary test track with both asphalt and concrete surfaces.

It concluded that dynamic charging was highly feasible from the perspectives of both road construction and system design – the latter performing comparably with static charging.

Following the trials, the lane reopened to general traffic for assessment of any impacts on durability (such as deformation) with satisfactory results. A poll of 1,200 Flemish motorists showed higher levels of interest in dynamic charging than in wireless static or plug-in forms.

Intis is operating a test track at Lathen, Lower Saxony, on the site of a former maglev (magnetic levitation) R&D centre, where it has so far demonstrated wireless power transfer to a moving car, bus and van. The track is designed to accommodate a range of charging options.

Richard Gould from its business development department, told ITS International: "we are now examining our options for commercialisation going forward." The system won the energy and infrastructure category of the Bavarian state prize for e-mobility at the August 2014 at the eCarTec (electric car technology) trade fair in Munich, Germany.

On 15 October 2014, the **International Association of Public Transport** (UITP)-coordinated Zero Emission Urban Bus System (ZeEUS) project launched its first charging demonstration in Barcelona, Catalunya, Spain. Local operator Transports Metropolitans de Barcelona is trialling four fully electric vehicles. In June 2015 Polish company Solaris will deliver two buses that will charge opportunistically along the route, using a retractable roof-mounted pantograph to reach overhead cabling.

Among other participating cities, Cagliari (Italy), Glasgow (UK); London (UK), Münster (Germany), Plzen (Czech Republic) and Stockholm (Sweden) will all trial opportunity charging.

Co-funded by the EC Directorate-General for Mobility and Transport with a budget of €22.5 million (US$27.9 million), the project aims to demonstrate solutions for a range of urban bus networks.

The control room for the INTIS test road

In the UK, the **Highways Agency**, which runs the English national motorway and trunk road network, is upping the game by setting its sights on real-life, on-motorway trials within the next two years. It has recently appointed a consortium led by global engineering consultants **Halcrow** and transport consultancy **TRL** to investigate available technologies.

The chosen site is likely to be a motorway with a high night-time volume of commercial traffic. Criteria for system adoption include a life cycle comparable to that of asphalt (typically around 16 years); cost-effective maintenance; resistance to vibration and weather; and efficient charge collection at high speeds.

The initiative forms part of a new focus on road users as customers by the Agency which is due by April 2015 to mutate from its present status as an executive agency of a government department to becoming a Government-owned company. It regards providing dynamic charging as a business service to a new generation of drivers.

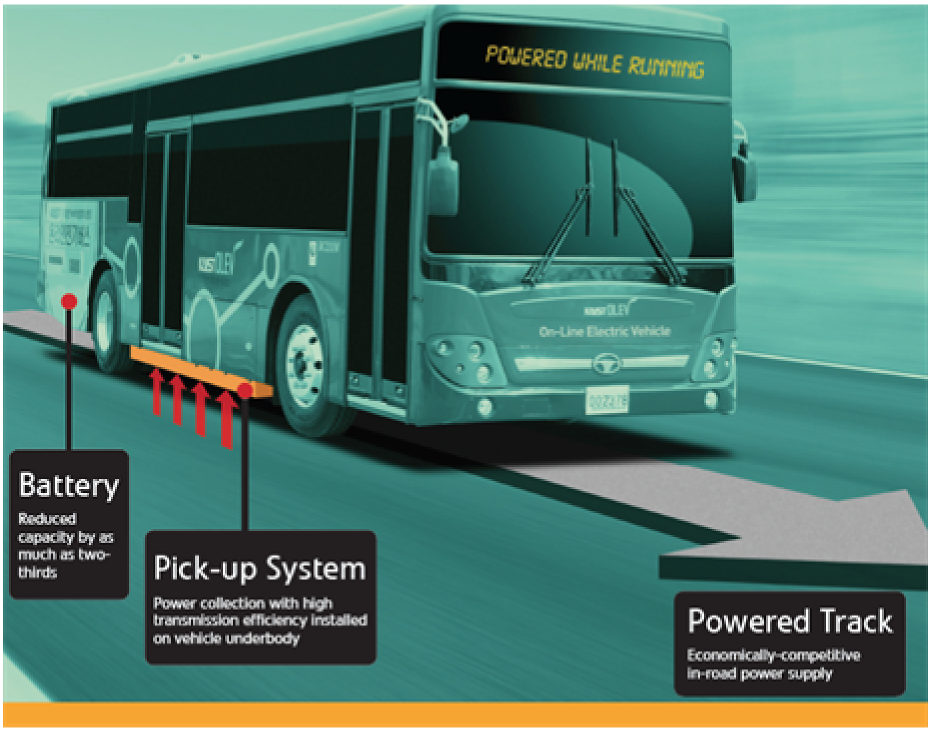
America

This December the US Department of Transportation (USDOT) will hear a presentation from the highly-ambitious US/European Tracked Electric Vehicle (TEV) project. This is working towards a new type of infrastructure, based on a dedicated electrically-powered track on which it claims both standard electric and hybrid cars will be able to travel at high speeds, using contact strips in the road surface to access power.

The presentation will contribute to a USDOT Federal Highways Administration (FHWA) workshop forming part of its Exploratory Advanced Research Program, which is researching longer-term - and higher-risk - breakthrough initiatives with the potential for "transformational improvements". Programme manager David Kuehn lists "new propulsion technology, fuelling sources and infrastructure" as key elements.

Comments **TEV project** co-ordinator Caroline Jones Carrick: "TEV can be implemented using existing technologies. No technical breakthroughs – like special batteries or fuel cells – are needed". She is the daughter of Will Jones, founder of US industrial battery innovator Philadelphia Scientific, which is backing the venture.

The prefabricated track would use modular components which, says Jones Carrick, would cost less to build than a three-lane US interstate highway or its equivalent "and yet have three or four times more carrying capacity". It could use existing motorway lanes or sections of disused railways and be financed by automatically



A KAIST bus in service

collected tolls.

The trial of **Siemens**' eHighway for heavy commercial vehicles travelling between the ports of Long Beach and Los Angeles in California, will start in July 2015.

Meanwhile, Utah State University is building what Professor Regan Zane, of its Department of Electrical and Computer Engineering, claims will be the country's first orthodox dynamic charging test track. The new oval roadway will follow on from a successful 2013 project, which initially developed a static system, and test ways of making EVs cost-effective. Conceived in collaboration with USU spinoff WAVE (Wireless Advance Vehicle Electrification), the track is designed to handle EVs ranging in size from a passenger car up to a full-size bus.

Zane sees the project, if successful, having major impacts on pollution, emissions and vehicle operation costs. "If we wrap this up at the interest levels we are anticipating, we think the concepts could be pretty well proven within 10 years," he says.

At the same time, the US Department of Energy's Oak Ridge National Laboratory is involved in a 2012-2015 research programme on the scope for integrating high-power wireless charging into production EVs currently on sale. The third year is earmarked for demonstrating the capability for dynamic charging.

A central issue for road operators across the world is the extent of the road surface affected, approximately 10% according to modelling by North Carolina State University or between 5% and 15% in KAIST's experience.

Opportunistic charging, of course, reduces or (with overhead pantograph contact) eliminates the issue altogether.

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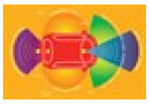

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