

# sustainability

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December 2010

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Safety was, until very recently, the prime guiding criterion of road transport development. Environmental impacts enjoyed scant regard, being seen as a necessary evil if life and commerce were to go on. A few, more progressive regional and national governments implemented schemes and initiatives which showed what could be done with a little thought and application, while more green-minded individuals made lifestyle choices which reduced their effects on the world around them. In reality, though, their efforts yielded little in the face of continued profligacy and even outright denial elsewhere.

A decade ago, few could have predicted that emissions and energy policy would rank as an equal to safety in political terms. Whatever one's view of the success or otherwise of the Kyoto Protocol and its successors (the 16th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change was just starting as this foreword was being written), they have at their heart a common theme: that efficient energy use could yield significant cuts in emissions at (relatively) low cost.

Transport is not our biggest single polluter. But it is a major one. It is reasonable to expect that big efforts be made to curb its effects, therefore, and this first Sustainability for Road Infrastructure supplement is especially significant given its genealogy. Combining the strategic, constructional and operational foci of World Highways and ITS International magazines, it looks at the challenges and solutions of road transport all the way from the conceptual to the actual; a fact reflected in the order of the articles herein. As such it is a rare and precious resource, and one which will grow in importance in coming years.



*Transport is not our biggest single polluter. But it is a major one*  
Jason Barnes  
Editor, ITS International

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# Strength in numbers

ON BOTH SIDES OF THE ATLANTIC, APPROACHES TO DEVELOPING SUSTAINABLE TRANSPORTATION THROUGH A COLLABORATIVE APPROACH HAVE BEEN VERY SUCCESSFUL



Urban traffic congestion, accidents and pollution are serious, and growing, problems in cities throughout the world. In 2002, the European Commission, recognising the need to help cities achieve more sustainable, clean and energy-efficient urban transport systems, launched the Civitas initiative.

Civitas (City-VITAlity-Sustainability) helps cities by implementing, demonstrating and evaluating an ambitious integrated mix of technology and policy based measures. It has now grown to a community of 58 demonstration cities, while over 180 cities, members of the Civitas Forum Network, have committed to introduce wide-ranging urban transport policies and sharing the results. By uniting cities throughout Europe who share common goals, the programme is able to achieve its peer group education goal and to offer financial support

to cities for sustainable mobility initiatives. Through workshops and training events, cities have the opportunity to inspire and aid active exchange of knowhow, ideas and experience to facilitate change in the field of transport.

Eight categories of measures have been identified as the basic building blocks of an integrated strategy. Each Civitas city

chooses an appropriate set of measures from those building blocks and combines them to form integrated solutions for clean urban transport. In addition, it puts in place the appropriate planning framework, ensures political involvement and support, and establishes the necessary partnerships to ensure delivery of the plans.

Genova in Italy provides a good example of the kind of results being achieved by participating cities. In September, 2010, it won the Civitas City of the Year award, which recognises the Civitas network member which has been most active, responsible and progressive in developing sustainable mobility measures.

Among a number of bold initiatives introduced, the city authorities in Genova bought over 100 clean vehicles for public transport, introduced a car-sharing scheme, restricted vehicle access to the historic centre and piloted a goods distribution pricing scheme based on mobility credits.

## PRICING SCHEME BASED ON MOBILITY CREDITS

According to jury-member Anthony May, professor of transport engineering at Leeds University (UK) and President of the World Conference on Transport Research Society: "Genova has been particularly adventurous in its policy, and has covered freight (and demand management for both passenger and freight) more effectively than other cities. It identifies the challenges and how to overcome them well."

Brescia, also in Italy, was the runner-up in this category. By introducing a broad series of measures – car-sharing, bike-sharing, cleaner public transport vehicles, integrated fares system and other actions – the city authorities achieved striking results in modifying citizens' transport behaviour.

Visit the Civitas website ([www.civitas-initiative.org](http://www.civitas-initiative.org)) for full details of the initiative, including details of the current five major projects – Archimedes, Elan, Mimosa, Modern, and Renaissance – and participating cities.

More recently, on 6 December, 2010, at a special conference and workshop in Berlin, Germany, Civitas announced a new project, Catalyst, to ensure that the experiences of the Civitas initiative are exploited to the maximum level.

This new project aims to prepare publications, such as best practise manuals, topic-based guides and scientific articles, as well as establishing and facilitating interactive partnerships between cities, organising study tours and staff exchanges, thematic workshops and conferences, conducting international, national and local networking, undertaking impact studies and building a recognisable image for Civitas-like policies.



# Clean cities initiative

Clean Cities, the US Department of Energy's (DOE) flagship transportation deployment programme was formed in 1993 to reduce US petroleum consumption through the use of alternative fuels and vehicles, hybrid electric vehicles, fuel blends, increased fuel economy, and idle reduction measures. To achieve its objectives, the programme's foundation is built on forming partnerships with stakeholders in its nearly 90 Clean Cities coalitions throughout the United States. These partners include fuel suppliers and distributors, vehicle manufacturers and marketers, national laboratories, state and local governments, and other federal agencies.

Clean Cities is based on the concept that federal support can empower local citizens and organisations to become the leaders of a national movement for change. The resulting partnerships have inspired thousands of innovative, committed stakeholders to exceed all expectations in guiding their communities toward effective transportation solutions. And the programme continues to flourish and grow.

Clean Cities' primary goal is to reduce US petroleum use by 2.5 billion gallons

per year by 2020. To achieve this overall goal, the initiative identified three petroleum-reduction strategies:

- Replace petroleum with non-petroleum-based alternative fuels and blends
- Reduce petroleum consumption by promoting smarter driving practices, idle reduction, and the use of more fuel-efficient vehicles and advanced technologies
- Eliminate petroleum use by encouraging the use of mass transit, trip elimination measures, and other congestion mitigation approaches

Coalitions across the nation are pursuing these strategies through local efforts to build alternative fuel infrastructure, help school districts transition buses to run on biodiesel blends, work with truck stop owners to install idle reduction equipment, and implement citywide incentive programmes to encourage the use of subways and other public transportation.



In addition, Clean Cities is pursuing the following three initiatives designed to help US drivers adopt petroleum-reduction fuels and technologies.

- Building reliable alternative fuelling infrastructure in at least 15 major geographic areas
  - Partnering with at least 15 of the largest US vehicle fleets to help them reduce petroleum use
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## Stemming the tide

In cities worldwide, there are too many cars on too few roads. And the problem is getting worse: in 1950, just 29 per cent of the world's population lived in an urban environment. The UN predicts this number will reach 57 per cent by 2025. Indeed, Europe already is an essentially urban society, with four out of five Europeans living in towns and cities.

Five years ago, Stockholm had over half a million cars travelling into the city every weekday. By 2005, average commute times were up by 18 per cent from the year before.

Since 2007, when Stockholm introduced its congestion charging system, the scheme has reduced traffic by 18 per cent and cut emissions by between 14 and 18 per cent in the Swedish capital.

This bold initiative showed what can be done to reverse the trend and was a factor in Stockholm becoming the first winner of the European Green Capital for 2010, an EU initiative to make citizens aware of the need for sustainable urban living, and to show them how they too can become a part of the drive towards sustainable development and a more resource-efficient life.



The road technology underpinning Stockholm's successful congestion charging system was developed by Q-Free and is based on automatic number plate recognition (ANPR), applied in a multi-lane free-flow configuration.

The roadside infrastructure comprises an advanced detection and coordination system, together with Q-Free cameras equipped with the company's ALPR software engines on both the roadside and the backoffice. The processing capacity of the camera is higher than the road's capacity for handling vehicles, meaning that the cameras send out decoded number plate strings and corresponding photos of the number plate itself in real-time.

Q-Free's ANPR solution reads more than 96 per cent of all vehicle images automatically with an error rate of less than 0.001 per cent. Correct identification requires that both the registration number and state code are read correctly, which is a truly challenging task as neighbouring countries have plates with similar syntax and fonts.

# N<sup>o</sup>1

## On road Lighting Solutions :

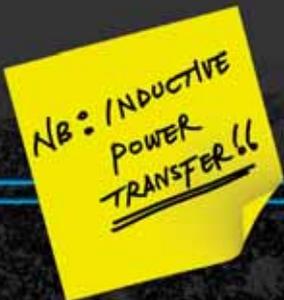
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- crosswalks
- highways
- schoolzones
- workzones
- airports



applications

iii level

iii vertical



Of course, Stockholm was not the first to introduce city centre congestion charging –Singapore was the first – and London introduced its scheme in 2003. The road technology system underpinning London’s scheme is also based on ANPR. Currently, over 500 PIPS Spike+ cameras and ANPR software supplied by PIPS Technology, a Federal Signal company, monitor every entrance and exit to the Congestion Charging zone along the boundary road, and monitor journeys made within the charging zone. Each Spike+ unit consists of one colour camera plus a monochrome camera for each lane of traffic being monitored. The cameras provide high quality digital images of the whole vehicle to ANPR software, which reads and records each number plate.

Five years after the introduction of its congestion charging zone, London went a stage further in trying to make the city cleaner and improve its air quality – the worst in the UK - by deterring the largest, most individually polluting diesel-engine vehicles from entering the city.

**A STAGE FURTHER**

The London Low Emission Zone (LEZ) was introduced in February 2008, with the first phase requiring heavy goods vehicles (HGVs) over 12 tonnes to meet the Euro III standard for particulate matter (PM) emissions, or pay a daily charge, to drive in the zone. The second phase, which commenced in July 2008, required all HGVs over 3.5 tonnes, buses and coaches to meet this standard to drive in the zone without charge. The fourth phase, which will commence in January 2012, will require these HGVs, buses, and coaches to meet the tighter Euro IV standard for PM emissions to drive within the zone without charge.

London’s Low Emissions Zone applies to all roads and some motorways across most of Greater London, and not just the central London Congestion Charging zone, so an additional 300 PIPS Spike ANPR cameras were deployed for the scheme. As vehicles drive within the LEZ, they are checked against a database of vehicles which meet the emissions standards, or are either exempt or registered for a 100 per cent discount, if the LEZ daily charge has been paid. The cameras check against a database which is compiled using data from the Driver and Vehicle Licensing Agency (DVLA), the Vehicle and Operator Services Agency (VOSA) and the Society of Motor Manufacturers and Traders (SMMT), together with information from vehicle operators who register their vehicle details with Transport for London (TfL).

[www.q-free.com](http://www.q-free.com)  
[www.pipstechnology.com](http://www.pipstechnology.com)

“London’s Low Emissions Zone applies to all roads and some motorways across most of Greater London, and not just the central London Congestion Charging zone, so an additional 300 PIPS Spike ANPR cameras were deployed for the scheme”



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*The road forward*

# French vision

A FRENCH APPROACH TO SUSTAINABLE ROADS, BY JEAN-LOUIS MARCHAND

Sustainable development is often presented as resting on three pillars; economics, social and environmental and these rules apply for the road industry. The market has reflected these requirements by delivering the Corporate Social Responsibility (CSR) deal, while local authorities have created what is titled Agenda 21. The Agenda 21 and CSR charters will form part of a new standard, ISO 26000, which is due to be published shortly. This follows years of consultation in over 90 countries, and some 100 organisations in France alone, headed by the Afnor body.

Compliance is at the heart of this new standard, which stipulates that it has not been designed for new certification, but to show that there can be no economic development without ethical practices. The standard will help each organisation to meet responsibility targets for the impact of its decisions and activities on society and on the environment. In addition the new standard will also ensure accountability.

For the road industry, CSR can be seen as the latest move in corporate management action. Companies are used to keeping a close eye on incomes and expenditures, and they set up quality systems just as rigorously. These have evolved into management systems, on which CSR is based. From a conventional customer-supplier relationship has developed an approach that makes for

a better fit with current day complexities, in which companies try to identify challenges to guarantee success. The most far thinking firms are now investigating all the companies they come into contact with or the factors that may affect their business. This extends far beyond the client because users, neighbouring residents, associations, politicians and non-governmental organisations can all impact on a company's operations. These factors must be taken into account when strategies are defined and when action plans are designed and implemented.

## FORWARD THINKING

On 25th March 2009, the French Road Industry's capacity to face up to changing trends was highlighted by the signature of a new agreement called the Convention d'Engagement Volontaire (CEV). This agreement was made between the state, local authorities, and professional trade federations concerned by the design, construction, maintenance and operation of road infrastructure. The agreement, drafted in the wake of the French Grenelle de l'Environnement roundtable talks, highlights the forward thinking of the road industry. It provides a new basis for governance, better able to respond to the issues raised by sustainable development in the infrastructure sector. This is of prime concern for roads, a sector that must more than ever prove its compatibility with the target of preserving natural resources and biodiversity, and reducing greenhouse gas, both during construction and during use.

Reducing the consumption of natural resources means focusing on recycling, in particular on the systematic use of reclaimed asphalt pavement, or RAP, and of the

Recycling asphalt surfaces removed with a milling machine provides a direct route to sustainability using proven technology



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*The industry should also increase the recycling of surplus materials and waste from public works sites and increase the re-use of bituminous material from road deconstruction, with a goal of 60% in 2012*

**Jean-Louis Marchand**, president of Union des Syndicats de l'Industrie Routière Française (USIRF), the confederation of French road industry unions

► bitumen it contains. Lowering greenhouse gas production is synonymous with reducing energy consumption, keeping in mind the energy needed to produce materials and supplies used on site. For many years now, the road industry has been trying to optimise its product offering and costs by developing techniques and products that use fewer materials and energy. The CEV will allow the sector to highlight existing know-how that has not been used to its full potential, encouraging innovation by inciting owners to open up their calls for bids to technical alternatives. However, decision-makers must also be in a position to compare technical alternatives, to find the best match for their criteria. To do so, they need a reference tool designed to compare techniques.

Road companies in the Usirf have worked together to develop a tool, combining their own software and databases on emission factors called Evaluation System for Environmental technical alternatives (Système d'Evaluation de Variantes Environnementales) or SEVE. It is currently in the final stages of testing, and should be ready for use at the beginning of next year.

#### **PROTECT BIO-DIVERSITY**

In the future, SEVE should be operated and developed by the Institute for Roads, Streets and Mobility Infrastructure (IDDRIM). This is a new governance body created in the framework of the CEV, whose members include owners, project managers, professional trade organisations, design engineers, research specialists, schools and training organisations, associations and technical committees in the field of infrastructure.

In addition to preserving natural resources and limiting greenhouse gas emissions, road builders must endeavour to protect bio-diversity. Companies often shoulder the blame when the client, due to a lack of means or a lack of knowledge, does not plan for appropriate measures to save a species endangered by a project. Industry managers have to be trained in order to prevent problems that have not been sufficiently anticipated by the client.

Lastly, it is also important to highlight the increasing amount

of attention paid to health issues. The industry recognises the need to be in a position where it can answer questions about employees, people who live near jobsites, or customers who use the infrastructure being built.

Mobility is a key factor for an economic and sustainable development. Roads can be built or rebuilt while respecting the environment. This process can be optimised by exchanging know-how between all the stakeholders in charge of the design, the construction, the operating, the use and the maintenance of the infrastructure.

#### **VOLUNTARY AGREEMENT**

The CEV is a voluntary agreement for sustainable development between the road industry companies and the French Ministry of ecology, energy and sustainable development. This states that the industry should conserve non-renewable resources through various means such as reusing or recovering 100% of the natural geological materials excavated on earthmoving sites, with a goal of delivering a 10% improvement from 2012 and 100% by 2020.

The industry should also increase the recycling of surplus materials and waste from public works sites and increase the re-use of bituminous material from road deconstruction, with a goal of 60% in 2012. At the same time the industry should preserve biodiversity and natural environments initially by disseminating recommendations and methodologies, particularly to earthmoving companies by 2012 at the latest. Reducing greenhouse gas emissions and energy consumption is another key target and can be achieved through progress in transport, asphalt mixing plants and road products, with a target of 10% and 6% reductions in CO<sub>2</sub> for road construction and earthmoving companies respectively by 2012 and 33% by 2020.

Meanwhile water consumption should be reduced on site with the aim of reducing water consumption by 50% and firms should increase the environmental performance of businesses and infrastructure. This last target should be achieved through encouraging the comparison of environmental solutions by developing a methodology for use by all businesses relating to energy consumption, greenhouse gas emissions and the conservation of natural resources. This methodology will be validated by ADEME and released in September 2009.

#### **IMPROVE SAFETY**

Companies also have to improve the safety of users, local residents and staff working on site, by signing a road safety charter that sets out the conditions for operating sites with traffic and covers the development of technical cooperation in the areas of road operation, traffic management and road telematics and work with all those involved to create the conditions for environmentally-aware competitiveness. Other factors include helping to develop research and innovation, creating the conditions for a new type of technical partnership and promoting the aims of this act of commitment.

The companies, members of the Confederation of French Road Builders Unions (USIRF), have committed to the CEV in order to be able to present environmental comparisons of technical solutions. This comparison structure features software called SEVE and is based on two main aspects. It involves establishing a set of guidelines that are auditable and validated by an external body such as the Environmental Agency Responsible for Energy (ADEME), using current standards and based on values and co-efficients established by recognised professional bodies. The programme includes development of a software tool implementing these guidelines and enabling them to be put to practical use. Initially, the guidelines will only relate to environmental impacts connected with highway construction and environmental indicators will be limited to greenhouse gas emissions.

## road construction

Envirodeck was used on the Vial de Borde bridge project in Spain



An environmental revolution is underway along the edges of roads and bridges throughout Europe: drainage systems made from fully recycled plastic. Apart from the environmental benefits of recycling materials, rather than using 100% virgin aggregates, their advantages in terms of safety, productivity, appearance, and performance are compelling.

Pipeline & Drainage Systems (PDS), a UK company, became a major player in Europe with its bridge, kerb, and channel drainage systems using traditional materials. However, the company recognised the huge advantages that lightweight products could bring in

helping reduce installation times and increase on-site safety, as well as the environmental benefits.

In 2003, PDS launched the industry's first lightweight, fully recycled kerb drainage unit, the Envirokerb. Made from fully recycled plastic, it weighs as little as 14.5kg - well within the limits for manual installation, as the picture illustrates.

In 2007, the company launched a lightweight composite bridge drainage solution, the Envirodeck, followed a year later with the launch of a fully-recycled one-piece drainage channel, the Envirochannel. All PDS products are manufactured to the European standards set down in the EN1433 (Combined Kerb and Linear

Drainage Systems).

According to contractor Johnny Edwards & Son, the advantages of Envirokerb over existing drainage systems are 400% more production per day and up to 60% saving on labour per linear metre over conventional two piece units, plus the considerable benefit of manual installation.

In terms of finish and durability, Birmingham City Council highways department has gone on record as saying: Of all the projects we have carried out so far we have not had a single breakage or chipping to kerbs either during installation or after we have left site, and the product has proven to be stronger in all aspects than the traditional concrete kerbs. [www.pds-plc.com](http://www.pds-plc.com)

# Tried and tested



Christophe Nicodème, director general of the ERF, kicked off the debate by laying down the road infrastructure industry's concerns over the financing of roads in the future in light of the budgetary consequences of the economic crisis.

while minimising their environmental impact.

Importantly, given recent economic developments unfolding across Europe, the ERF sees this initiative as very timely. The implications of the ongoing economic crisis on road financing have started to

become apparent. The ongoing sovereign debt crisis is forcing upon Europe's governments and policymakers a new reality, with public spending being reigned in substantially in the name of fiscal orthodoxy. And given that Europe's roads have been to date primarily financed by public funds, where money will come from in the future remains an open question.

Considering that levels of investments in road infrastructure had been declining even before the crisis and taking into account the challenges faced by many governments to maintain the quality of the existing road network, the ERF used the event to stress that it is essential to work together to develop a coherent strategy that puts sustainable road infrastructure at the heart of transport policy and to ensure the existence of financing mechanisms for the maintenance and the development of a cleaner and more sustainable road infrastructure. In that latter respect, Elena de la Peña, chair of the ERF Sustainability Programme, outlined the many initiatives that the road infrastructure sector has undertaken to render its practices more sustainable.

[www.erf.be](http://www.erf.be)

## An uncertain future for Europe's roads

At the end of September, 2010, the European Road Federation (ERF) organised a crucial, first-of-its-kind, debate on Sustainable Roads and Optimal Mobility under the patronage of European Parliament member, Mathieu Grosch. The event brought together policymakers, including Jean-Eric Paquet, from the European Commission, and Marc Roman who addressed the meeting on behalf of the Belgian Presidency, and industry representatives to discuss how everyone can work together to ensure that roads continue to provide their expected socio-economic benefits,

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## Cost effective alternative to new lane construction

The concept of 'managed lanes' is rapidly gaining popularity with road agencies worldwide as an alternative to new lane construction. By borrowing lanes from the off-peak traffic direction, more lanes can be given to peak traffic without the costs and time constraints of new construction. One major concern when running traffic in a contraflow configuration is safety.

Moveable Concrete Barrier, from Barrier Systems International, is an innovative technology that combines the safety of a solid barrier with the ability to reconfigure the roadway in real time, thus cost-effectively increasing capacity, reducing congestion and pollution, by making more efficient use of existing roadways. The system uses one metre long steel-reinforced concrete barriers that are pinned together to form a continuous wall. A barrier transfer machine (BTM) lifts the barriers by a modified "T" top and moves the wall one or more lanes to reconfigure the roadway to respond to peak traffic needs. It can transfer a kilometre of high performance concrete barrier up to two lanes in four minutes, offering road agencies an innovative strategy to make congested roadway systems more efficient, safe and functional. These benefits can be realised in less than one year and at a fraction of the cost of building new highway lanes, especially lanes for bridges, tunnels and viaducts. Importantly, Moveable Concrete Barrier is supremely flexible, a 'reusable asset' that can be used during construction projects. And when it is no longer needed, it can be moved to other congested locations. It allows road



A kilometre of high performance concrete barrier up to two lanes can be positioned in just four minutes. The system is about to open on Victoria Road, in New South Wales, Australia for a 'bus only' contraflow lane during peak periods

agencies to preserve their corridor options (managed lanes, bus rapid transit (BRT), reversible lanes, contraflow, HOV and HOT Lanes), while at the same time providing a 'fast-build' solution to mitigate congestion.

[www.barriersystemsinc.com](http://www.barriersystemsinc.com)

## Rapid winter refurbishment cure

In general, summer months are the most favourable for road, and bridge, repairs for obvious reasons. However, when this involves a popular and busy leisure route, the resulting chaotic congestion and vehicle emissions can be unacceptable.

That was the problem faced by New Jersey Department of Transportation (NJDOT) in undertaking a bridge rehabilitation project on the Dorland J. Henderson Memorial Bridge, known as the Manahawkin Bay Bridge, a steel girder bridge that carries traffic along Route 72 between Long Beach Island and Manahawkin, New Jersey. However, by specifying Transpo's T-17 Methyl Methacrylate Polymer Concrete Patch and T-18 MMA Overlay for the 130,000 sq.ft. bridge rehabilitation, NJDOT was able to schedule the project to start after the end of the 2009 summer beach season for completion before the start of the 2010 season. The materials would be placed in cold weather and would be required to cure properly in the anticipated low temperatures. After the removal of the old deteriorated concrete, T-41s MMA Primer was applied to seal the concrete surface and increase the bond strength of the T-17 MMA Polymer Concrete patches to the existing surface. The T-17 materials were mixed using a small portable concrete mixer and

finished with standard hand tools. Contractor PKF-Mark III, also removed over 1,000 metres of the old curb to form and pour a new curb using T-17 materials.

After patching, 3/8" T-18 MMA Polymer Concrete Slurry Thin Overlay was installed. After the bridge deck was shot-blast cleaned, the surface was coated with T-18 MMA Primer. This sealed the existing concrete surface and increased the bond of the T-18 Overlay to the concrete and T-17 patches. Even though the existing bridge walkways exhibited deterioration, the contract only required the surface to be sealed. Because of the low viscosity and ability to penetrate deep into narrow cracks, Transpo's T-78 MMA Crack Sealer, which cures within an hour of application, was applied over the entire walkway surface.

Prepackaged T-18 materials, when mixed together form a self-levelling slurry that can be applied in a single application. The specially formulated slurry has almost

zero voids that make the finished overlay virtually waterproof. A high wear and skid resistant aggregate was broadcast onto the overlay surface. After the overlay cured, the entire surface was coated with T-18 MMA Topcoat to help lock the aggregate into the overlay. The rapid cure time of one hour, and the ability to apply the material at temperatures ranging from 14° to 90°F (-10 to 32°C) reduced application time and overall construction costs. T-18 MMA Polymer Concrete Slurry Overlay extends the life of existing bridge decks while adding minimal deadweight.

\* T-17 rapid-setting permanent polymer concrete for patching



JOHN BULLOUGH, SENIOR RESEARCH SCIENTIST AND ADJUNCT ASSISTANT PROFESSOR AT RENSSELAER POLYTECHNIC INSTITUTE'S LIGHTING RESEARCH CENTER, ON THE EVOLUTIONARY TRENDS THAT ARE TRANSFORMING ROADWAY LIGHTING

## Roadway lighting: evolution and evaluation

Roadway lighting technologies have been evolving rapidly in the past decade, in contrast to the more gradual changes witnessed in prior decades. Earlier years were characterised by widespread use of drop-lens, cobrahead fixtures containing mercury- and sodium-vapor lamps. The technological inertia (a body at rest tends to stay at rest) led to standards for roadway lighting that were largely unchanged from the 1960s through the 1990s. For the most part, roadway lighting is switched on at dusk through a timer or photocell and switched off at dawn. Indeed, operating roadway lighting is a large municipal expense.

Recently, developments in roadway lighting have occurred at a rate that could be considered bewildering. On several fronts — new light sources, new fixture designs, and new control strategies, fuelled by scientific knowledge of how light interacts with us and our environment — roadway lighting is experiencing a new kind of inertia (a body in motion tends to stay in motion), whereby rapid development begets more rapid development. In this article, several of these evolutionary trends transforming roadway lighting are explored, and there are plenty of resources that illustrate these points on the [www.lrc.rpi.edu](http://www.lrc.rpi.edu) website.

### YELLOW TO WHITE

After high pressure sodium lamps were introduced, their high efficacy (lumens/watt) and dependable operation made them the default choice over mercury lamps for roadway lighting in North America, although many mercury lamps still remain. Metal halide lamps, based on mercury lamps with improved color properties (but usually with shorter lives), have been the primary alternative until recently. Induction lamps are electrodeless fluorescent lamps which promise to last two to three times longer than sodium lamps with efficacies not much lower, and don't require the long, tubular shapes of conventional fluorescent lamps. Unlike mercury and sodium lamps, induction lamps can start and re-strike nearly instantly.

The introduction of light-emitting diodes (LEDs) that produce white light, through blue LEDs in combination with phosphors that convert some blue to yellow light, has garnered wide interest for lighting. Individual LEDs have lower output than other roadway sources, but their small size facilitates precise optical control of LED arrays. Some LED roadway systems produce very uniform illumination along the road surface. LEDs also have instant-on and re-strike properties. Dimming by adjusting current or via high-frequency pulse-width modulation is relatively simple. Initial LED costs are quite high, but LEDs are approaching the efficacy of sodium, with typical operating lives of 50,000 hours (more than double that of sodium), if they are designed with proper heat sinks. The Lighting Research Center (LRC) at Rensselaer Polytechnic Institute has evaluated many LED roadway lighting fixtures, individually



**John D. Bullough, Ph.D.** is a senior research scientist and adjunct assistant professor at Rensselaer Polytechnic Institute's Lighting Research Center, where he leads the centre's transportation lighting and safety research. He has written or co-written about 250 articles and technical publications about lighting. He is a member of the Society of Automotive Engineers and the Visibility Committee of the Transportation Research Board. In 2005 he was elected a Fellow of the Illuminating Engineering Society of North America.

[www.lrc.rpi.edu](http://www.lrc.rpi.edu)

and in real-world installations, available through the website.

What these newer alternatives share is a whiter color appearance compared to sodium lamps. Their color is more in-tune with the eye's sensitivity at nighttime (or mesopic) light levels, and laboratory studies and field installations in North America and Europe have confirmed that the perceived brightness and visual detection of roadway hazards are improved under whiter light than under relatively yellower sodium illumination, even when a light meter would say light levels under the two were equal. It may be possible to use less light, and less energy to create equivalent visual effectiveness, which could in turn make photovoltaic power more feasible. Standards for roadway lighting in the near future may take these findings into account.

**THE SKY TO THE ROAD**

Light pollution is a growing public concern. Light emitted into the sky rather than onto the road is not only wasteful, it reduces nighttime access to the stars by creating sky glow, which can disorient nesting sea turtles. When light distributions from roadway fixtures are not well-controlled, or when fixtures are near property boundaries where they can shine onto residential windows and other unwanted locations, light trespass and glare result. Many communities are beginning to devise regulations to limit light pollution. Calculation tools for comparing the potential for sky glow, light trespass and glare using lighting simulation software are available, based on placing a virtual 'box' over the right-of-way and its lighting system, and minimising the light exiting the box surfaces through careful fixture selection and placement.

Fixture design has evolved too, and drop-lens fixtures with visible refractors below the lamp are being superseded by flat lenses producing no upward light. Despite claims that fixtures with flat lenses require shorter pole spacing (and more fixtures/mile), analyses of modern flat-lens fixtures show that they can be spaced just as far apart as drop-lens fixtures and meet light level and uniformity criteria.

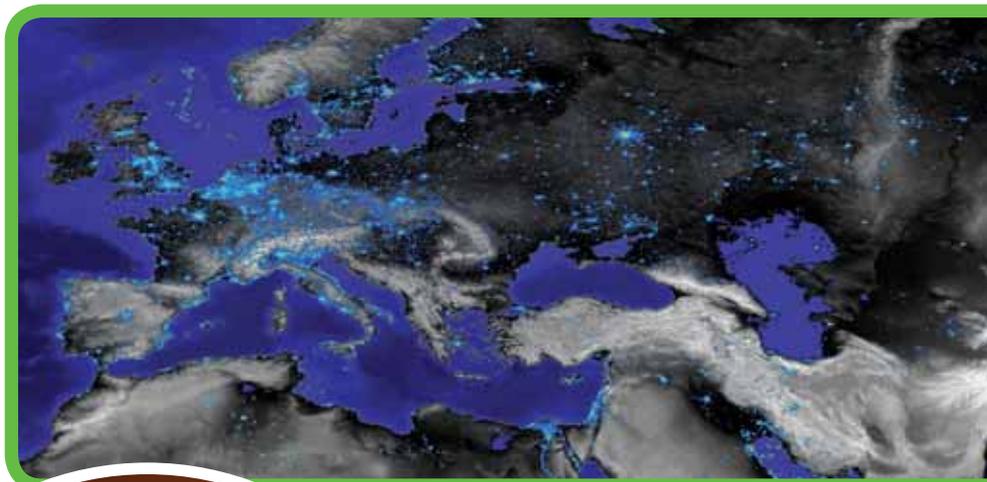
**ALL NIGHT TO AS NEEDED**

There aren't many locations with as much traffic at 3 a.m. as at 9 p.m., yet most roadway lighting systems shine just as brightly in the wee hours of the night as during much busier evenings. Given the large public expense of roadway lighting, this situation seems in need of correction. Yet few authorities are willing to turn roadway lighting systems off completely during periods of infrequent use, and even schemes to switch every other roadway fixture off are undesirable because they may result in 'patchy' distributions of light and dark along the road. Systems for dimming the overall output from roadway lighting, even with mercury and sodium vapor lamps have been available for years; in conjunction with motion sensors or timers, they can reduce roadway light levels by half during inactive periods, reducing energy costs and paying back initial cost increments within a few years. But awareness of these systems is relatively low.

The increased use of LED roadway lighting systems, which can be designed for dynamic output control quite easily, will likely spur wider use of dynamic lighting on roadways that could adjust light levels based on in-pavement traffic sensors, ambient light from adjacent commercial properties, and even increased light following snowfall. Through central control systems, LED roadway lighting could even be programmed to produce temporarily higher levels for short periods following accidents, special events, or for night repair work.

**STREETLIGHTS TO HEADLIGHTS**

Until now this discussion of roadway lighting has ignored the even more ubiquitous source of light on our roadway networks - vehicle headlights. Suffice it to say that the roadway lighting and vehicle lighting engineers don't talk to each other very much, but the roadway community should pay heed to developments in adaptive high beam systems. These are high beam patterns used with cameras or other sensors that can dim the forward beam pattern in the immediate vicinity of other vehicles to prevent excessive glare, allowing drivers to have the benefits of their high beams guilt-free, without the anxiety of blinding oncoming drivers. Could such systems, if they become more widespread, reduce a need for some roadway lighting? The possibility may not be completely far-fetched.



The world is wasting energy at an unsustainable level. For instance, Britain's 7.5 million street lamps cost an estimated US\$780 million a year to run. Solar-powered LED road studs are increasingly being used in streetlight switch off initiatives and on motorways and major routes where street lighting columns would incur significant cost in both installation and ongoing energy bills



## saving energy

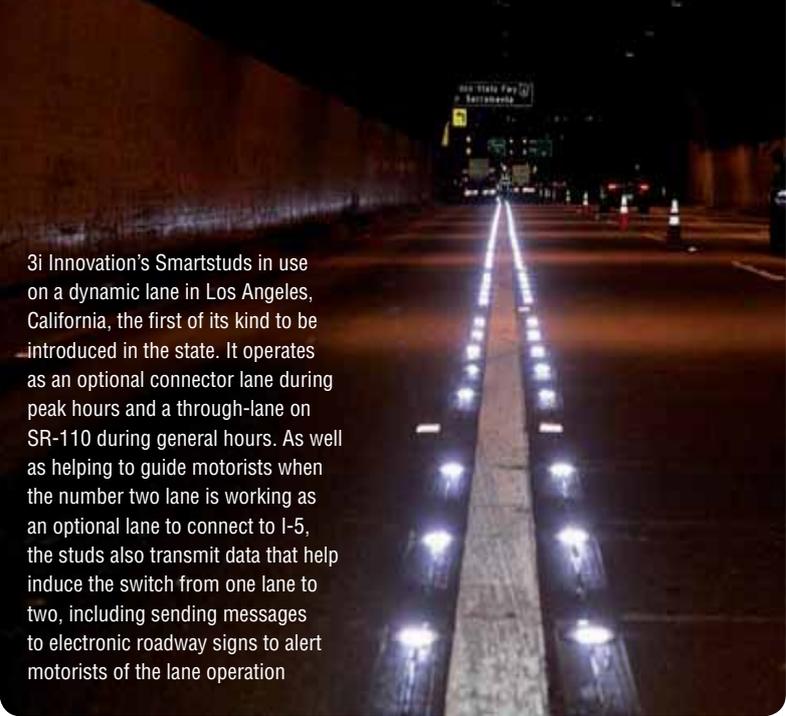
# Wireless lights

New Zealand company 3i Innovation is achieving significant success with its inductive power transfer (IPT) technology which is used to power a range of products, including the Smartstud and iiiLevel (eye-level) energy-efficient LED road markers.

IPT converts magnetic energy to electrical energy, which allows them to function independently from a fixed-cable system. Energy is delivered by a central cable that emits a magnetic field, but the studs do not need to be fixed by electrical wire to harness the electricity and are thus wireless.

The iiiLevel offers intelligence with patented two-way communications and diagnostic capabilities. Information can be sent wirelessly to control the output of each iiiLevel light (flashing, sequencing and degrees of brightness) as well as receive data from each unit (marker performance, road temperature and vehicle speed). The power supply itself can run up to two kilometres of 200 road markers from a single source, and can be powered by both mains and by a solar panel.

Significant deployments of 3i's studs include their use on a dynamic lane system in Los



3i Innovation's Smartstuds in use on a dynamic lane in Los Angeles, California, the first of its kind to be introduced in the state. It operates as an optional connector lane during peak hours and a through-lane on SR-110 during general hours. As well as helping to guide motorists when the number two lane is working as an optional lane to connect to I-5, the studs also transmit data that help induce the switch from one lane to two, including sending messages to electronic roadway signs to alert motorists of the lane operation

Angeles, in Santa Monica's McClure Tunnel where they illuminate the freeway's centre divider, and more recently

at Germany's 8km Rennsteig Tunnel, which required 32km of the lights in four lines.  
[www.3iinnovation.com](http://www.3iinnovation.com)

## Manage energy costs

Energy costs for street lighting are a major budget item for municipalities and authorities. LED lighting systems may be the ultimate answer in providing energy savings, but in the meantime better management of existing high pressure sodium (HPS) lamps can slash energy costs by up to 40%.

The Lumen IQ street light network management system, from Canadian company Streetlight Intelligence (SLQ), is a fully-integrated networked lamp control system

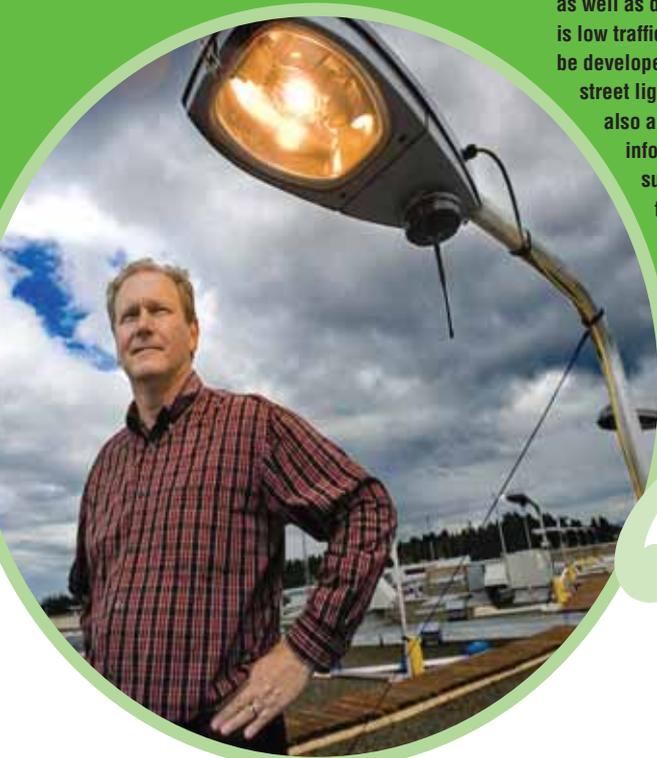
comprised of lamp controllers, communication hubs, a dedicated handheld PC for in-field setup and programming, as well as a robust, web-based software system for street light network management from a centralised location.

The system enables an authority to remotely programme the output of its entire street light network and/or any number of subgroups of lights, or even individual fixtures, from a single location (which could be anywhere in the world). Lamps can be turned on and off at specific times as well as dimmed during periods where there is low traffic. Adaptive lighting protocols can be developed to optimise the performance of a street lighting network. Moreover, the system also allows dispatch crews to collect information on maintenance needs, such as lamp failures, and to monitor the performance of individual street lights, which enables proactive maintenance and reduced response times.

Following a lengthy pilot project to evaluate the savings, the city of Castlegar, British Columbia, is currently deploying

the Lumen IQ adaptive street light management system for use in all of its street lights. The system is also currently being deployed on the Highway One expansion portion of the Gateway development project within the Trans Canada Highway corridor through greater Vancouver, while a pilot project is currently underway in Doha, Qatar.

According to Vince Krynski, CEO, Streetlight Intelligence, streetlight owners today have a number of energy efficiency options available to them. "The most common are updating the source technology – most often LED - and/or adding networked adaptive lighting controls that provide dimming functionality. These options are not mutually exclusive and in fact there is a growing sentiment in the industry that the preferred long term solution is LED lights with networked adaptive lighting controls. However, given the budget challenges faced by many municipalities the option of adding controls to existing HPS (high pressure sodium) lights which results in significant energy savings and a much better ROI than LED technology currently provides is the better choice."  
[www.streetlightiq.com](http://www.streetlightiq.com)



LED replacement programmes are 'sexy' and highly visible which is attractive to political decision makers but the adoption of adaptive lighting controls for many cities may well be the best near term solution

**Vince Krynski, CEO, Streetlight Intelligence**

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## LPT Variable Messaging Sign

Grupo Postigo's LPT (Low Power Technology) Variable Message Signs (VMS) enhance road safety while addressing global ambitions towards saving energy and sustainability.

The technology exhibits a power consumption under 350 watts on a 64 x 64 VMS displaying a message using the greatest number of LEDs.

- Reduces power consumption by over 85%.
- Reduces CO<sub>2</sub> emissions.
- Option of using independent renewable energy supply.
- Requires simple connections and minimal cabling.
- Cost saving in installation, operation and maintenance.
- Provides high efficiency and prolongs the life of LEDs (100,000 hrs = 11 years).
- CE certification to European Standard EN12966 including recommendations for the selection of VMS meeting energy efficiency criteria.

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## UK traffic signals on green

Consuming an average of just 9W across a typical dim/bright cycle, and offering power and carbon savings in excess of 75 per cent over conventional traffic signal installations, it's little wonder that most UK local authorities now specify Extra-Low Voltage (ELV) solutions for all on-street signals and related equipment for new installations.

Siemens ELV innovation began in 2008 with the introduction of the ST900 ELV intersection controller, followed in 2009 with the new ST750P pedestrian controller family, and in November, 2010 by a new design of 'low inrush' electrical transformer specifically designed to significantly reduce the overall power requirements of ELV traffic signal installations.

Although Siemens's ELV systems are now the de facto standard for new signal sites in the UK, large-scale retrofitting programmes are being undertaken to convert legacy systems to ELV. In August, 2010, the city of Manchester began a major refurbishment of traffic technology to significantly reduce energy use. The programme involves upgrading pedestrian controllers to enable replacement of incandescent lamps in around 600 signal heads at 120 pedestrian crossings throughout all 10 districts of Greater Manchester.

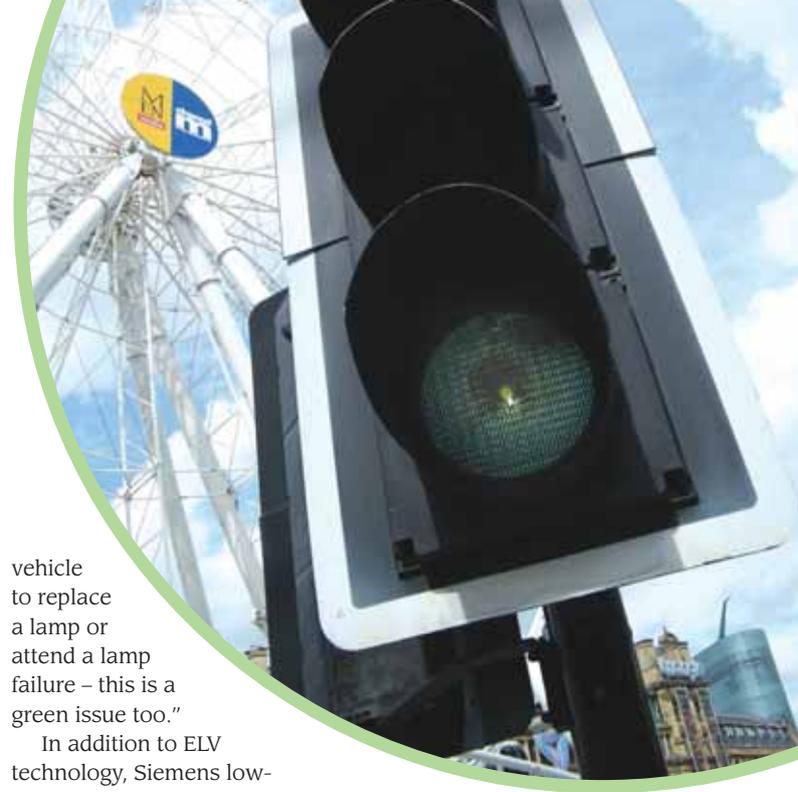
A similar refurbishment project, also involving 600 signal heads, is currently in progress across Medway, part of the Thames Gateway area, and is due for completion in March 2011.

According to Alan Hawker, Medway's traffic signal engineer, "ELV from Siemens will make a significant contribution not just in reduced power consumption but also ongoing maintenance. We have even looked at how much time is taken up travelling with a

vehicle to replace a lamp or attend a lamp failure – this is a green issue too."

In addition to ELV technology, Siemens low-power Helios retrofit enables both existing Siemens Helios and Peek Elite signal equipment throughout Medway to be upgraded to the latest CLS LED technology, whilst maximising the re-use of existing roadside infrastructure. With a total of 210 junctions including crossings, the project also involves the installation of new ELV controllers at over 50 sites, upgrading existing controllers to drive LED signals, Telscan CCTV cameras from Siemens at almost 40 locations, and the conversion of more than 100 sites to LED.

[www.siemens.co.uk](http://www.siemens.co.uk)



## The case for LED street lights

That LED street lighting could slash an authority's energy bill over High-Pressure Sodium lamps (HPS), is generally accepted. The problem in these cash-strapped times is the perceived hefty capital investment for LED systems – a perception that Telegra challenges with the statement that when deploying LED systems, which consume up to 50 per cent less energy than HPS lamps, Return On Investment (ROI) is less than five years because of additional built-in savings.

For instance, LED-based lighting has an operating life of around 20 years in real-life conditions without scheduled periodic (regular) maintenance needed. That provides a saving when compared to HPS lamps which require

bulb changes, typically at five-year intervals.

They are safer too, Telegra says. LEDs emit white light (as opposed to the yellow light emitted by HPS lamps) which can double drivers' peripheral vision and increase braking reaction time by some 25 per cent. The company says that using LED white lighting enables decreased intensity (energy use) while maintaining the same level of visibility feeling for a driver. Indeed, the company says that even high-power HPS lamps up to 400W can be replaced with its Lightway IQ high-power LED lamps that offer twice the power available with standard LED lamp products.

In ROI terms, Telegra claims that in comparing its LED technology with HPS, after the first HPS lamp bulb has been replaced (approximately five years of operation) the initial

investment in its LED lamp has been returned and after the second replacement (10 years) the user has not only returned the investment, but earned an extra US\$500 per each lamp.

Energy costs can be further reduced by using advanced flexible dimming algorithms fully integrated in advanced traffic management systems through topXview, the company's complete ITS software platform. This enables light intensity based on traffic and environmental data, switching to lower intensity in the small hours when traffic is light or selecting higher intensity when bad weather or accidents occur. In addition, wireless communication can be used as an advanced and precise alternative to classic control over power line. The wireless-enabled control device is installed in a field cabinet and can control a group of lamps within a range of up to 1000m.

[www.telegra-europe.com](http://www.telegra-europe.com)



“LEDs emit white light which can double drivers' peripheral vision and increase braking reaction time by some 25 per cent”

# Imaging for congestion charging or other sustainability projects?

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always one step ahead

Carmanah's EverGen 1720



## Two solar LED industry firsts

Canadian company has launched what it claims are two industry-first advancements in off-grid solar LED lighting technology – advanced occupancy sensing capabilities and the company's highest output self-contained light to-date, the EverGen 1720.

The advanced occupancy sensing capability allows a network of EverGen 1710 or 1720 solar LED lights to provide synchronised low-high activation when one of the lights within the network senses motion. Utilising mesh networking and occupancy sensors, the network of lights communicates wirelessly, providing illumination that is responsive to motion in areas such as parking lots, pathways, secure facilities and other

areas where lighting performs an integral role in maintaining safety and security.

Advanced occupancy sensing can be configured for either full or set distance activation. Full activation provides synchronised activation of all the lights within the system. Set distance activation provides for activation of lights within a set distance of the detected motion, effectively providing a bubble of illumination that follows motion throughout the facility.

Carmanah says that in ideal solar conditions with tailored operating profiles, its new EverGen 1720 solar LED light can provide output of up to 10,000 lumens. In more typical conditions, output of 5,000 lumens is common for these free-energy lights that are ideal for parking lots, residential roadways, sign, perimeters and other site lighting applications.

[www.carmanah.com](http://www.carmanah.com)



## Really mean VMS technology

Since their development in 2007, the latest versions of Grupo Postigo's motorway LPT VMS use new components with increased energy efficiency to keep power consumption under 350 Watts

Spanish company Grupo Postigo, which has 40 years of experience in road safety, both in integral road equipment and in managing traffic, recognised the need for motorway variable message signs to consume less power. Its researchers took up the challenge and, in 2007, the company claimed a major industry advance with the development of its Low-Power Technology (LPT) for VMS which consume a measly amount of power.

Since then, over 180 have been deployed, mainly in Spain and Portugal, and Grupo

Postigo has since applied its LPT technology to several other product ranges. For instance, the company is currently supplying 160 new LPT LED displays for the urban bus network in Valencia, Spain.

Although these LPT VMS products give the highest luminosity, and fully comply with the European Standard EN12966, their power consumption is miserly - 500 watts, even for the largest VMS for traffic control and regulation, and less than 20 watts for VMS used in public transport sites. This results

in an energy saving of over 80% in comparison to current energy consumption levels of VMS panels.

But very low energy consumption is not the only benefit, or saving, as Grupo Postigo points out. Reduced power and minimal heat generation extend the product life cycle, the level of performance, and the efficiency of LPT panels, and at the same time allows a simple connection with small sections of cable. They are therefore very easy to install, and can be integrated into an independent

supply using renewable energy, such as solar or wind, for total energy savings.

The advantages provided by VMS LPT technology also include a reduced investment in installation, and the operation and maintenance of the installations. Moreover, low consumption of the VMS LPT results not only in huge financial savings, but also serves to reduce CO<sub>2</sub> emissions in the Earth's atmosphere, in line with sustainable development policies promoted by governments around the world. [www.grupo-postigo.es](http://www.grupo-postigo.es)

# Going local

WEATHER MANAGEMENT SYSTEMS ARE GOING LOCAL, AS JON TARLETON, VAISALA ROADS GLOBAL MARKETING MANAGER EXPLAINS

Every highway, motorway, street, county and local road, and carriage way is impacted by the weather. Which begs the question, why isn't the management of weather handled in the same way across all roads? Why are the large ministry roads, department of transportation highways, tollways, and federal highways covered with road monitoring equipment, but our local roads are not? Are local roads less important or do they not require the same level of service?

The answer of course is 'no.' The city streets carry our children on school buses, or our families on the way to the market, all of which is pretty important to us if those are our families. Sure we hear of huge crashes on our major highways caused by weather, but most crashes and delays occur on our local streets and avenues. The major reason for such a discrepancy in the handling of weather management has nothing to do with the importance, and everything to do with funding and ownership of the local roadways.

Up to now, most cities and towns could not afford, or more than likely, just could not justify the cost of installing large weather stations, managing the gathering of the data, and service and maintain the equipment. Plus, due to the high investment, they would likely only be able to install a single weather station. If you could select the location for a weather station in your community where would that be? And remember, it has to be a location that is representative of your entire city. Not so easy, which is why cities and towns have avoided road weather monitoring solutions.

## MAJOR CHALLENGE

The major challenge with these communities is they are still responsible for managing weather's impact on their roads. Road weather information has been proven over the last several decades to be the key to a successful road maintenance plan. Having this information has been proven to save money and save lives by making the decision makers more effective and more accurate at making their decisions. In addition, by becoming more efficient the agency uses fewer road chemicals and less fuel, all of which has a huge impact on the local environment. It is, and can be done, without this technology, but it means

the decisions involve a lot of guessing because of the lack of true measurements. Most importantly, road weather solutions are most effective during times when nothing was projected to occur. The system alerts the decision maker or drivers immediately when a problem is detected, and not when the first incident has already occurred.

The good news is that all is not lost. What is changing is the landscape of road weather information and the availability of new technology that offers similar effectiveness at a much lower cost. Similar to what has occurred with traffic sensors, weather sensors are now available that can monitor surface conditions from the side of the road. This creates a significant cost savings because there is no cutting the pavement to install sensors and all the costs associated with direct pavement installations.

## LOWER COST

A second change is the improvement in lower cost weather station packages, allowing for the use of existing infrastructure to off-set costs. This trend to improve roadside equipment costs will only continue as new technology and simpler communications methods are used to collect the data.

The final way the landscape is changing is now road weather ITS companies can easily host the data for the agency, completely eliminating internal data management, and allowing users to access the information from any device that can access the internet.

The future for smaller agencies to enter the road weather community has begun. Cities and towns can now begin to realise the same benefits the large agencies have seen for years. By deploying multiple small-scale monitoring equipment throughout the city, they can begin to ensure that traffic flow continues through their streets and people reach their destinations safely. They can also lessen the environmental impact by using fewer road chemicals and less fuel to apply them.

[www.vaisala.com](http://www.vaisala.com)



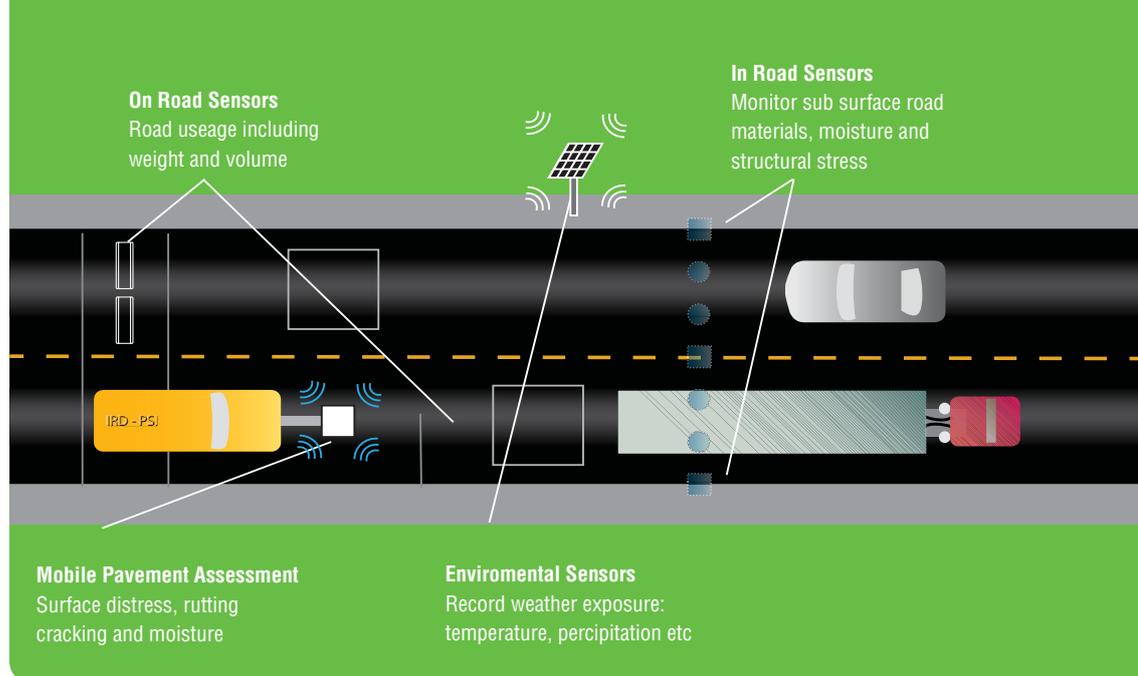
## road systems

An innovative technology package is now available that will boost road maintenance efficiency. This sophisticated road management system has been developed under a joint agreement between Canadian firms International Road Dynamics (IRD) and PSI Technologies. The Know Your Road system combines several technologies to allow highway authorities a comprehensive flow of information on roadway condition, traffic volumes, axle loads and environmental factors such as weather.

Know Your Road uses IRD's traffic monitoring, data processing and analysis systems, and PSI's mechanistic highway materials and structural analysis models and sensor technologies.

Looking at the broader picture this package will allow highway authorities to better manage their assets, according to Terry Bergan, president and CEO of IRD. The system allows the user to predict a highway's life cycle costs as well as maintenance needs. It can reveal how seasonal capacity fluctuates and when congestion is most likely to be a problem. Knowing how traffic volumes can vary will in some instances allow a highway authority to schedule any necessary maintenance at times when it will cause the least disruption to road users. The system can also be used to show the mechanical loads exerted by a particular vehicle. In the case of exceptional loads or overweight vehicles, the system can be used to identify these. As the package estimates specific damage costs it can help set user charges or fines respectively that are directly proportional to the damage they cause to the roadway.

The package provides an accurate assessment of current conditions and wear, and predicts future maintenance needs. It uses sensors installed below the road surface, on the road surface and around the road to provide accurate data in real-time on pavement temperature, climactic conditions, vehicle numbers



## Efficient road management

and demographic information on vehicle types including size and weight.

A combination of weigh-in-motion, traffic volume monitoring sensors, substructure strain sensors and temperature and rainfall monitors can be used to recover data continuously from each stretch of highway. Mobile ground penetrating radar equipment or other mobile pavement assessment tools such as laser scanners fitted to ordinary vehicles travelling at highway speeds can be used to analyse road structure over a wide array of a network. This data can be combined with GPS location to provide an accurate picture of road condition. These are analysed with the highway design parameters, real-time traffic data, and surface and sub-surface conditions collected by permanent sensors and mobile sensors to provide a mechanistic structural analysis of current highway and substructure conditions. Recovered data from the highway can be then combined with laboratory-derived information on the performance of the specific road materials to deliver a sophisticated damage prediction model for the highway.

[www.irdinc.com](http://www.irdinc.com)

[www.psitechnologies.ca](http://www.psitechnologies.ca)

## The software key to sustainable road

The International Road Federation (IRF) has released **Changer**, a user-friendly greenhouse gas (GHG) calculator specifically tailored to road infrastructure projects. Since its launch a year ago, this pioneering software is being successfully applied on major projects in a number of countries and regions throughout the world, including Australia, New Zealand, Europe and India.

As the IRF points out, governments will be increasingly required to submit regular GHG emission accounts as part of their commitments under the UN Climate Change Convention. **Changer** offers an easy and reliable emissions assessment and accounting tool for both the public and private sectors. An additional advantage is that proactive and accountable steps to reduce emissions enables countries to gain support from leading international financial institutions, which are progressively including compulsory GHG assessments of road

construction projects in their tendering procedures.

Meanwhile, **Changer** is, in its own right, attracting keen interest from some of the same donor agencies, including The World Bank, the Asian Development Bank and the International Energy Agency – all of whom instinctively recognise the lead taken by the project in terms of defining the elusive 'common methodology' that is an essential prerequisite for measurable and credible progress that transcends mere 'greenwash'.

The involvement of IRF has enabled **Changer** to be developed with the direct technical support, sector-wide expertise and cooperation of leading industry participants drawn from the Federation's membership throughout the world.

[www.irfghg.org](http://www.irfghg.org)





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# Polluter pays

CHARGING HEAVY GOODS VEHICLES IN EUROPE TO FINANCE THE COST OF THE DAMAGE AND DETERIORATION THEY CAUSE TO ROAD INFRASTRUCTURE IS NOT NEW. WHAT IS NEW IS EMISSIONS-BASED CHARGING TARIFFS

Until 2003, tolling for Heavy Goods Vehicles (HGVs) on Europe's motorways varied widely between EUROPEAN Union (EU) Member States, both in the charges and the systems used to calculate tolls. A harmonised system to address these variations was proposed by the EU, but it would go further than previous Directives.

Since the beginning of 2010, all Member States are now bound by the European Directive 1999/62/EC encompassing infrastructure charging for HGVs.

One of the stated objectives of that Directive was that charging HGVs according to the 'polluter pays' principle is one of the main policy options in an effort to reduce the negative impacts of transport on the environment.

## USER PAYS

In parallel, the need to optimise the use of infrastructure, reduce congestion and increase the efficiency of the transport system could be met by the 'user pays' principle. The Directive sought the application of charges on HGVs that are proportional to the damage they generate in terms of pollution, noise and congestion, and established the methodology to be followed for the estimation of external cost charges as well as the areas of their application.

As a result of Directive 1999/62/EC, countries which already apply tolls or user charges are obliged to vary their prices according to vehicle pollution standards (Euro standards series) in order to favour the cleanest vehicles.

The principle of charging vehicles based on their emissions to encourage the use of cleaner vehicles was not a new approach in Europe. In 1992, Austria implemented the Ecopoint System with the aim of reducing the overall NOx emissions of vehicles

## The new tariff structure in Austria's truck tolling scheme

### EURO emission category toll rate system

Tolls for vehicles over 3.5t maximum gross weight - valid from 1.1.2010



| Rates                                   | Category 2<br>2 axles | Category 3<br>3 axles | Category 4+<br>4 and more axles |
|---|-----------------------|-----------------------|---------------------------------|
| A; EURO emission category EURO EEV & VI | 0,1440                | 0,2016                | 0,3024                          |
| B; EURO emission category EURO IV & V   | 0,1540                | 0,2156                | 0,3234                          |
| C; EURO emission category EURO 0 to III | 0,1760                | 0,2464                | 0,3696                          |

Emissions-based tariffs explicitly ensure that vehicles pay for their road use proportional to the amount of damage they cause and help improve air quality by encouraging the use of cleaner vehicles

transiting through the country. Initially the scheme was operated using physical paper stamps, graduating to a fully automatic system six years later.

That system lasted until 1 January, 2004, when ASFINAG, the national road authority wholly owned by the Federal Republic of Austria, went live with a nationwide toll collection system for HGVs above a maximum permissible laden weight of 3.5 tonnes. Kapsch TrafficCom provided the turnkey system, which is based on a Dedicated Short Range Communication 5.8GHz microwave solution that uses a simple, easily installable Onboard Unit (OBU) and communication points located throughout Austria's interurban highway network.

## UNIMPEDED

The system, the first Electronic Toll Collection (ETC) system deployed by an EU Member State, is a multi-lane, free-flow configuration which allows tolling to occur while vehicles are travelling highway speeds, creating unimpeded driving conditions. Gantries placed above highway lanes communicate with OBUs installed on the windscreen of passing lorries. Every working day, the system collects and processes over two million transactions in real time.

Since its inception in 2004, the Kapsch tolling system has been based on axle count. However, in January 2010 ASFINAG implemented emissions-based charging tariffs for its HGV charging scheme. This subdivided the previous three-category tariff structure (two, three and four or more axles) into three sub-classes (A, B and C) based on the Euro emissions category.

Under the new scheme, HGVs with Euro emission categories EEV and EURO VI (Tariff Group A) pay a 10 per cent lower toll than they did with the previously applied basic tariff. HGVs with Euro emission category IV and V (Tariff Group B) pay 4 per cent less, while HGVs with Euro emission categories 0 to III (Tariff Group C) – the ones with the highest pollutant emissions – pay 10 per cent more than they did previously.

From a technical point of view, charging based on emissions class is relatively straightforward. The flexibility of the Kapsch system means the tariff table in the back office can have as many parameters as desired and where OBUs are used the vehicle class can be programmed in and read automatically by the charging infrastructure.

[www.kapsch.net](http://www.kapsch.net)

# Balancing technology and planning

A balance between technology and collaborative system development planning is the best way to implement a sustainable transportation system that will serve the evolving needs of the driving public well into the future. That's the view of Econolite which has become an active participant in the sustainability process by providing the tools for implementing state-of-the-art ITS solutions, as well as providing the services and systems expertise that help DOTs maximise the capabilities of their ITS investments. For example, by developing traffic signal coordination strategies to traffic management operations, and using Centrac, the company's Advanced Transportation Management System (ATMS), it has been demonstrated that DOTs can significantly reduce driving delays, vehicle emissions, and save millions of dollars

(2009, Texas Transportation Institute).

Practical applications of an ATMS can easily enhance roadway efficiencies. The Centrac (Signal Timing) Scheduler is designed to programme one signal timing plan that focuses on moving traffic through a major arterial during the heavy morning commute, then switching to a more relaxed timing plan to accommodate the lighter local traffic. This type of signal coordination strategy reduces congestion by smoothing out traffic flow and lessens stop-and-go traffic, especially during critical peak-hour traffic.

An example of an effective public/private partnership to enhance transportation management system effectiveness and efficiencies is the recently developed ACS Lite programme, an arterial-based adaptive traffic control application that was developed

under contract to the FHWA Research, Development, and Technology Traffic Operations programme and a group of traffic management companies.

Econolite now offers the ACS Lite software as an optional module for its Centrac ATMS. While ACS Lite was originally designed to adapt the splits and offsets of signal control patterns/plans in a closed-loop system using arterial master traffic controllers, Centrac has implemented that adaptive functionality in the central system, eliminating the need for an arterial master. This

approach also eliminates the need for additional roadside infrastructure and operations support resources, helping to increase ITS capabilities while reducing capital expense for DOTs.

In field deployments, ACS Lite has demonstrated as high as a 35 per cent reduction in delay, a 29 per cent reduction in vehicle stops, and a seven per cent reduction in fuel consumption, and overall improvements in arterial travel times (2007, Shelby, Bullock, Gettman, Ghaman, Sabra, and Soyke).

[www.econolite.com](http://www.econolite.com)



## Patent-pending 3D detection

Smoothly flowing traffic saves time, keeps fuel costs down, and reduces greenhouse gas emissions and pollution, so optimising traffic flow with existing infrastructure is a key objective for achieving sustainable mobility and minimising the ecological footprint of communities.

LeddarTech has just launched a patent-pending, industry-first, 3D optical detection and ranging product it claims provides unique advantages and benefits in optimising traffic management.

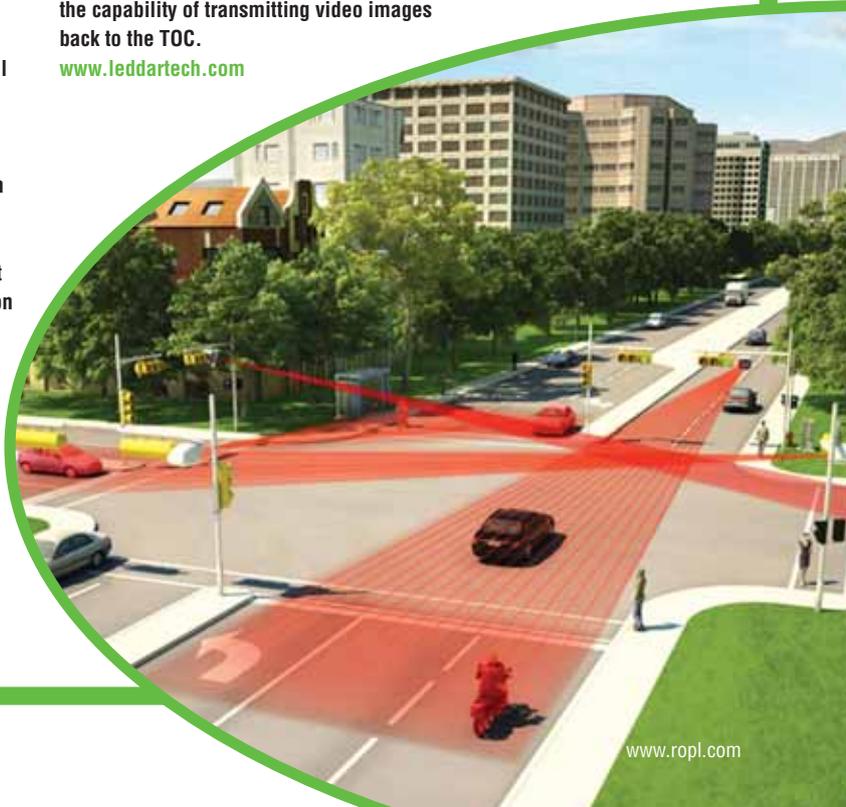
The Leddar d-tec (Light Emitting Diode Detection And Range) detector emits non-visible light into the area of interest and measures the time taken for the light to reflect back. Thanks in part to the speed of light, it provides very accurate 3D information as well as excellent lateral positioning of detected objects in the field of view, enabling the system to precisely detect objects of variable dimensions. In addition, since the acquisition information is compiled thousands of times per second, Leddar d-tec is able to provide robust detection in adverse weather and lighting conditions.

As LeddarTech points out, its innovative solution consistently and accurately detects vehicles of all types, including motorcycles and bicycles in all weather conditions, any time of the day. The system also uses direction of travel of vehicles, thereby preventing false calls to traffic signal controllers.

Leddar d-tec was designed to ensure fast and user-friendly installation. This non-intrusive solution can be mounted directly to current traffic infrastructure without the requirement of installing additional mounting poles since the device is not influenced by the horizon. Moreover, the company's engineering team integrated an onboard image processor

to assist engineers and technicians by making it possible to remotely align Leddar d-tec. A value-added feature of the onboard image processor is the capability of transmitting video images back to the TOC.

[www.leddartech.com](http://www.leddartech.com)



# Induced demand

ITS AMERICA'S SUSTAINABLE TRANSPORTATION WORKING GROUP HAS UNDERTAKEN A COMPREHENSIVE STUDY: INDUCED DEMAND FROM ITS-BASED OPERATIONAL IMPROVEMENTS: ISSUES AND SOME THOUGHTS. THIS SUMMARY OF THE WHITE PAPER, AUTHORED BY LOUIS G. NEUDORFF, P.E., CO-CHAIR OF THE WORKING GROUP, BRIEFLY OUTLINES THE RANGE OF FACTORS EXAMINED

For decades, Transportation Systems Management and Operations (TSMO) strategies and the supporting ITS technologies have been deployed to improve the efficiency and reliability of the nation's surface transportation system (thereby promoting economic sustainability) and to enhance its safety and security (thereby promoting social sustainability). More recently, these same technologies and strategies have been promoted as part of the solution to promote environmental sustainability by reducing Greenhouse Gas (GHG) emissions, such as carbon dioxide (CO<sub>2</sub>), a major cause of global warming.

A small body of research does exist on the potential reduction in GHG emissions resulting from TSMO and ITS. These studies, consisting of both field evaluations and simulations, strongly indicate that TSMO strategies and the supporting ITS technologies have an important role to play in reducing GHG emissions from the surface transportation network.

Strategies such as ramp metering, incident management, variable speed limits, automated enforcement, and traffic signal coordination can potentially (and individually) lower CO<sub>2</sub> emissions by 5-15 per cent, with the synergistic effect of the strategies combined adding up to 20 per cent or greater.

## DIFFERENT CONCLUSIONS

Other studies, however, have led to different conclusions – the most notable being the Moving Cooler Report that concludes 'ITS / Operations' results in only a '0.3 to 0.6 per cent cumulative reduction' in CO<sub>2</sub> over a 40-year period. The primary reason for the disparity in results between Moving Cooler and other studies is the inclusion of the impacts from induced demand in the Moving

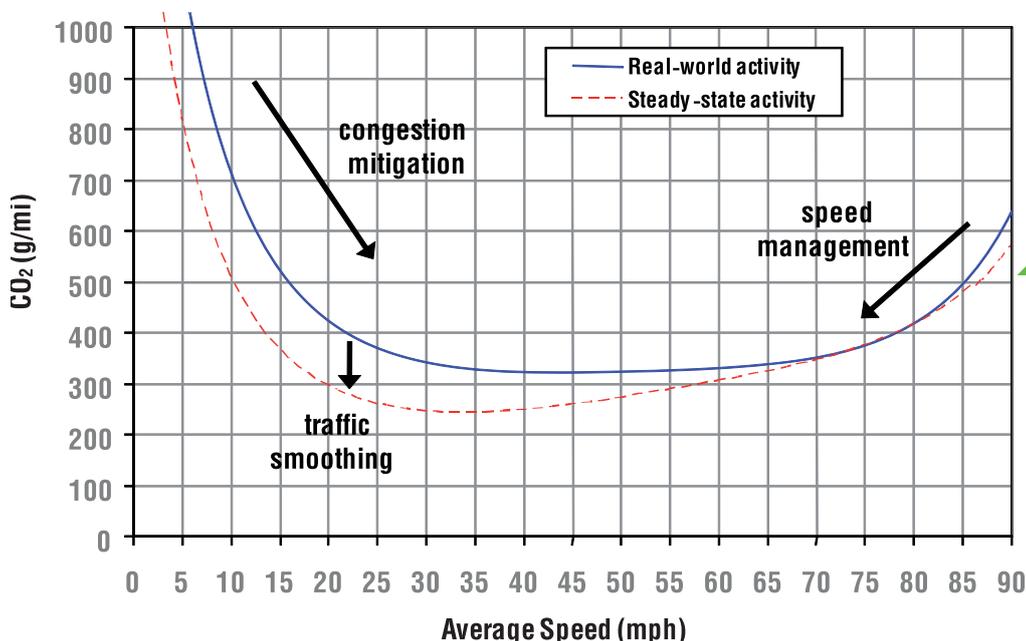


Cooler analyses. Specifically, the impact of induced demand for operations strategies (as calculated by Moving Cooler) is an average offset of 63 to 74 per cent of the cumulative GHG reductions from the reduced delay.

Induced demand may be defined as the additional travel that occurs as a result of lowering the generalised cost of travel (excluding the independent increases due to population and income growth). In economic

terms, when the generalised price of travel goes down because travel is made easier or faster or more convenient (e.g., an increase in supply), the additional quantity of travel that occurs through drivers taking advantage of it, is induced demand. The increased accessibility also results in new land use and development patterns, subsequently generating new or extended trips. Another term that is used is the 'rebound effect', which refers to increased consumption resulting from actions to increase efficiency and reduce consumer costs.

A common indicator of the magnitude of induced demand is 'demand elasticity', an economic measure of how much demand changes when the price changes. A significant amount of research has been conducted on induced demand, involving many variables ▶



An illustration of how TSMO strategies can reduce GHG emissions is the speed-based CO<sub>2</sub> emissions curve for a typical vehicle traveling on a highway section (solid blue line). The dashed red line represents the approximate lower bound of CO<sub>2</sub> emissions for vehicles traveling at constant steady-state speeds. Congestion mitigation increases average traffic speeds from slower, heavily-congested speeds; speed management reduces excessively high speeds to safer speeds; traffic smoothing reduces the number and intensity of accelerations and decelerations.

## road systems

- ▶ and producing a wide range of results with respect to demand elasticities. Nevertheless, nearly all of these numerous studies do have one thing in common – they have been based on the demand inducing effects of capacity expansions (i.e., increased supply from constructing new facilities or expanding existing roads).

### MORE EFFICIENT USE

TSMO strategies and additional capacity are NOT the same thing. In general, operational strategies do not add capacity; rather, they promote a more efficient use of the existing capacity, maximizing the potential throughput of the infrastructure, as defined by the facility's capacity. In light of this difference between TSMO and capacity expansions, might it be that the induced demand resulting from operations / ITS is also different from the induced demand from added roadway capacity?

Four hypotheses regarding induced demand and TSMO strategies are presented in the white paper and discussed, with numerous references cited both in favour and against the hypotheses:

- Savings in travel time and costs are the same from the perspective of the user, regardless of whether these cost savings come from increased supply or from TSMO strategies that improve the operational efficiency of the existing supply.
- The induced demand resulting from capacity expansion or operational improvements are essentially the same, but only for the short term. TSMO strategies do not directly impact accessibility in the manner that a new or expanded roadway does. (Has a developer ever built a condominium complex or a shopping center simply because the DOT re-timed the traffic signals?) Accordingly, ITS / operations do not affect long-term land use nor induce additional development (and the resulting additional trips). In other words, the long-term demand elasticities for TSMO are essentially



*Most research implies that the demand elasticities for TSMO strategies are much less than those for additional capacity*

**Lou Neudorff, co-chair of the working group**

the same as the short-term elasticities.

- The increase in throughput provided by a new road or a significant widening of an existing roadway (or, for that matter, new transit facilities) represents the 'quantum leap' in potential changes to the transportation infrastructure relative to the additional throughput supported by TSMO strategies. Because of this different context (and possibly user perception) between adding roadway capacity and making the existing capacity more efficient, the associated elasticities for operational improvements – both short-term and long-term – are significantly different from those for added capacity. Most research implies that the demand elasticities for TSMO strategies are much less than those for additional capacity. However, at the same time, given that 'in-vehicle' time is valued less than 'waiting time' – at least for mode choice studies – perhaps travel time reductions in congested

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traffic – as provided by TSMO – are more highly valued than overall travel time reductions, resulting (potentially) in a larger demand elasticity.

- TSMO strategies and ITS create negligible, if any, induced demand.

#### WIDE RANGE OF POSSIBILITIES

And the answer – we really don't know! Based on the available research, coupled with a fair amount of conjecture and surmise, a strong argument can be made for rejecting both the first and the fourth hypotheses. But that still leaves a wide range of possibilities (and potential demand elasticities) with respect to the second and third hypotheses.

Additional research is needed to better understand the induced demand / rebound effect resulting from the implementation of TSMO strategies and the supporting ITS technologies. Moreover, it is important to know if any differences exist in demand elasticities between different TSMO strategies. For example, several TSMO strategies, such as incident management, variable speed limits, road weather management, and work zone management, become operational only when needed. It is not known if travel time improvements that occur for a few days and hours a week affect travel behaviour in the same way as for every day improvements.

The induced demand resulting from improved reliability is another issue. Answers to these question is very important so that potential polices and projects can be accurately evaluated with due consideration given to all three attributes of sustainability – economic, social, and environmental. The role ITS technologies can play in other GHG reduction strategies – with minimal if any induced demand – are also worth noting, such as congestion pricing and mileage-based user fees, transit improvements (e.g., transit signal priority), and eco driving.

## Sustainable Transportation Working Group

ITS America's Sustainable Transportation Working Group collects and evaluates data and information to better understand the relationships between transportation systems, traveller behaviour and climate change. Nearly 150 ITS America members participate in one or more of the Working Group's six committees.

Besides tracking the latest legislation on climate change and sustainable transportation, this group brings together a diverse collection of professionals that work together to inform the public, policymakers and lawmakers about the capability of transportation technologies and operational strategies. Members of the new working group have interacted regularly with key decision makers on Capitol Hill on possible climate legislation and have published multiple white papers, including a response to the popular report *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*. Other areas of interest include: systems efficiency, performance measures, regional and local sustainable transportation policy, and more.

"ITS America and the Sustainable Transportation Working Group is leading the way in advancing the agenda on sustainability, and promoting ITS solutions as a key component of an efficient, sustainable transportation system," said Scott Belcher, President and CEO of ITS America.

#### Leadership

Co-Chairs: Lou Neudorff, Iteris, and Larry Yermack, Telvent

Vice Chair: Josh Peterman, Fehr & Peers

To access the full study, visit: [www.itsa.org/kc\\_sustainability/c128/Knowledge\\_Center/Sustainability.html](http://www.itsa.org/kc_sustainability/c128/Knowledge_Center/Sustainability.html)

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