EV CITY CASEBOOK

50 BIG IDEAS

SHAPING THE FUTURE OF ELECTRIC MOBILITY

TOYOTA i-DRIVE
Source: Toyota Global Pressroom

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October 2014

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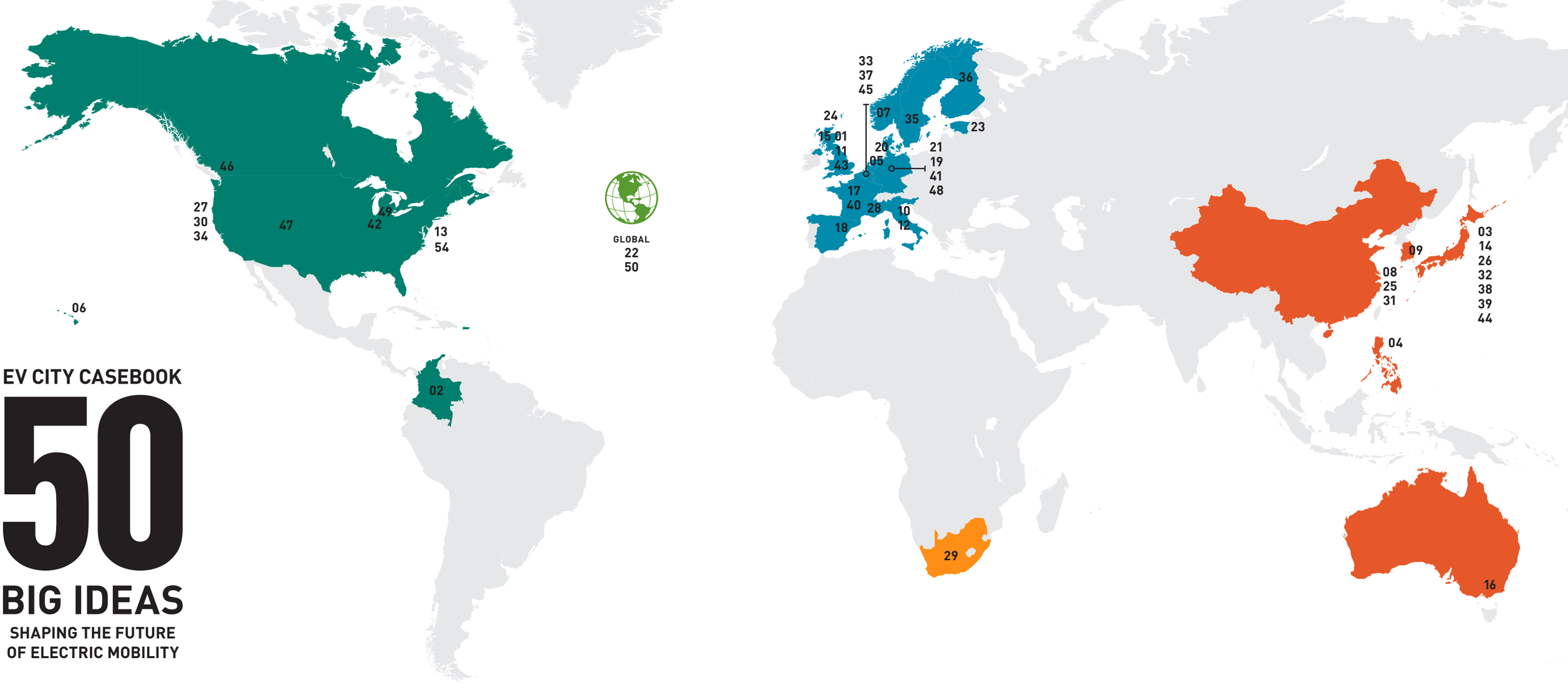


EV CITY CASEBOOK

50 BIG IDEAS

SHAPING THE FUTURE OF ELECTRIC MOBILITY

NISSAN SMART HOUSE, CEATEC 2012 – CHIBA CITY, JAPAN
Source: autoblog.gr

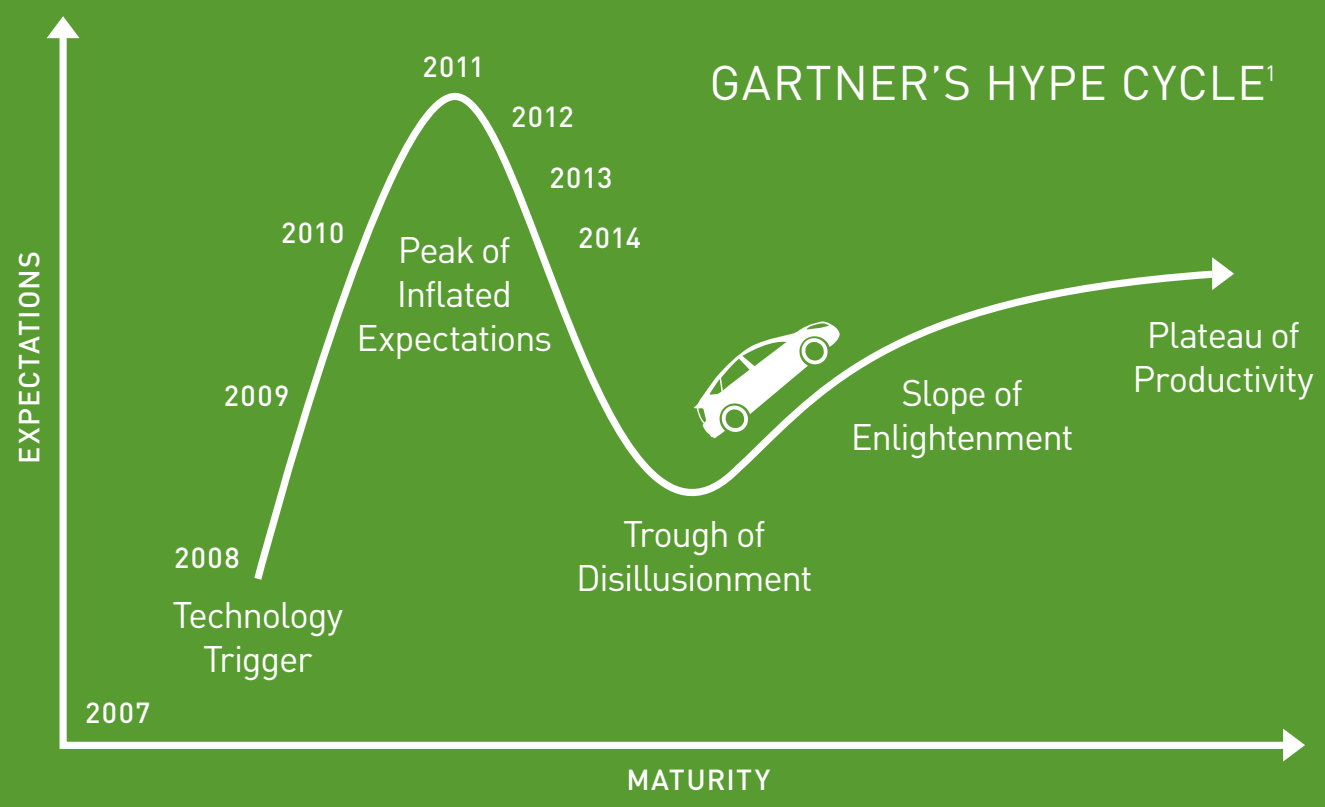
SHAPING THE FUTURE OF ELECTRIC MOBILITY

Cities, businesses, and governments around the world have recognised electric vehicles (EVs) as an essential part of a smarter and more sustainable future. The multiple environmental, economic, and energy system benefits offered by EVs and plug-in hybrid EVs have shaped a broad consensus on why this transformation is essential. This has changed the narrative on future mainstream market adoption of EVs from questions of if to when. However, what will drive this transformation and how this will create new opportunities for electric mobility remain less clear.

This second edition of the EV City Casebook explores these future-facing questions. It profiles 50 examples of transformative policies, projects, technologies, and business models that have been implemented in 23 countries across six continents. This work draws on the global networks of the partners that have produced the Casebook: the Clean Energy Ministerial's Electric Vehicles Initiative (EVI), the International Energy Agency's Hybrid & Electric Vehicle Implementing Agreement (IA-HEV), and future city think tank Urban Foresight.

A call for submissions was launched in early 2014, generating over 150 nominations from around the world, spanning the full spectrum of applications related to electric mobility. A panel of electric mobility experts from national governments and international NGOs met in Copenhagen in May 2014 to identify the measures that offered the greatest potential to advance global adoption of EVs. This provided a basis to shortlist 50 Big Ideas and linked case studies to showcase inspiring and innovative developments from around the world.

The goal of this Casebook is twofold: to demonstrate the significance of what has been achieved to date and to show how innovative solutions can create new opportunities for electric mobility in the future. Experience suggests that it is unlikely that a single breakthrough or policy intervention will bring about this transformation, but rather a combination of different measures. The 50 Big Ideas presented in this Casebook are by no means an exhaustive list of factors that will contribute to this change. However, they do highlight areas of considerable promise for the future of electric mobility.



YEAR	YEAR OF	OUTLOOK[2]
2007	HIBERNATION	EVs were only a minority activity for governments, and vehicle manufacturers. Technologies such as biofuels and hydrogen arguably enjoyed greater prominence and attention.
2008	IGNITION	The economic downturn hit vehicle manufacturers hard and encouraged the acceleration of electrification R&D as the closest-to-market technology to reinvent the fortunes of an ailing sector.
2009	PARTNERSHIPS	As the complexity of preparing for the introduction of EVs became clear, collaborative EV programmes were initiated to combine the expertise of governments, OEMs, utilities, cities, regions, and technology suppliers.
2010	PILOTS	Data and findings from pilots emerged from major cities and pioneering regions around the world, informing both the development of vehicles and charging infrastructure systems.
2011	EXPECTATION	The eagerly anticipated arrival of electric cars culminated in global demand appearing to outstrip supply.
2012	QUESTIONS	The first full year when anyone could buy an EV encouraged questions about the prospects for electrification and the barriers to switching to this new technology.
2013	AMBIVALENCE	Notable early market successes such as Norway and California were tempered by persistent concerns over perceived barriers and a belief that market uptake should be more rapid in many important automotive markets.
2014	CHASM	Industry and governments wrestled with identifying the future policies, technologies, and business models that would facilitate the transition from early niche markets to widespread adoption of EVs.

[1] Source: Adapted from Gartner Hype Cycle, gartner.com/technology/research/methodologies/hype-cycle.jsp
[2] Source: Urban Foresight Limited

THE PAST, PRESENT, AND FUTURE

After over a century of fossil-fuelled motoring, the electrification of road transport represents one of the most significant global transformations of modern times.

RIDING THE HYPE CYCLE

As recently as **2007**, EVs were a minority item on the agenda of most governments and vehicle manufacturers. This changed in 2008 when, in the midst of a global economic downturn, a number of vehicle manufacturers announced bold commitments to accelerate their electrification programmes as a strategy for recovery and reinvention. However, these vehicle manufacturers realised that they could not achieve this ambition alone.

Over the course of **2009**, partnerships were forged with cities, regions, governments, and key industry actors to create the infrastructure and marketplace for this new technology. This led to the development of multiple collaborative projects, and by **2010** most major cities around the world were hosting infrastructure pilots and vehicle trials in support of government policies to reduce harmful pollution and petroleum dependence.

The early success of these projects contributed to **2011** becoming the year of peak expectation. Cities and fleets competed for the limited numbers of EVs available and demand appeared to greatly exceed supply. However, by 2012 these inflated expectations began to recede. This was the first year in which anyone could choose to buy an electric vehicle, which led people to focus on the limitations and barriers of switching to this new technology.

2013 was a year of contrasting outlooks. There was a swell of enthusiasm buoyed by the increasing choice of EVs and impressive early market sales in places such as Norway and California. However, this was tempered by the perception of slow sales of EVs in many important automotive markets.

2014 AND BEYOND

2014 is characterised by questions of how to make the transition from the early niche market to mainstream consumers. The author Geoffrey Moore[1] refers to this as 'crossing the chasm,' identifying that many new technologies can be pulled into the market by enthusiasts, but later fail to achieve wider adoption. This is because mainstream consumers have different needs and motivations to early adopters. Hence the challenge in the years to come is to identify the EV products, technologies, and business models that will connect with mainstream needs and motivations. These 'Big Ideas' will play a pivotal role in shaping the future of electric mobility.

[1] Moore, G.A. (1995) Inside the tornado: Marketing strategies from Silicon Valley's cutting edge, Harper Business, New York.

MANILA, PHILLIPINES
Source: iStock by Getty Images (Editorial)

WHAT THE ICONS MEAN

The impact of each of the Big Ideas has been evaluated against six dimensions to explain its expected contribution to advancing EV adoption and realising the associated benefits that this will bring.

RELATIVE ADVANTAGE

Does it give EVs a distinct advantage over internal combustion engine (ICE) vehicles?

EASE OF USE

Does it make EVs more convenient and enjoyable to use?

VEHICLE PERFORMANCE

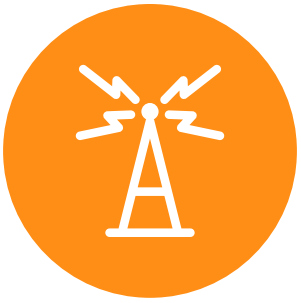
Does it enhance the design, construction, and performance of electric vehicles?

AWARENESS

Does it help people to better understand EVs?

ENVIRONMENTAL

Does it provide direct environmental benefits?



ENERGY SYSTEM

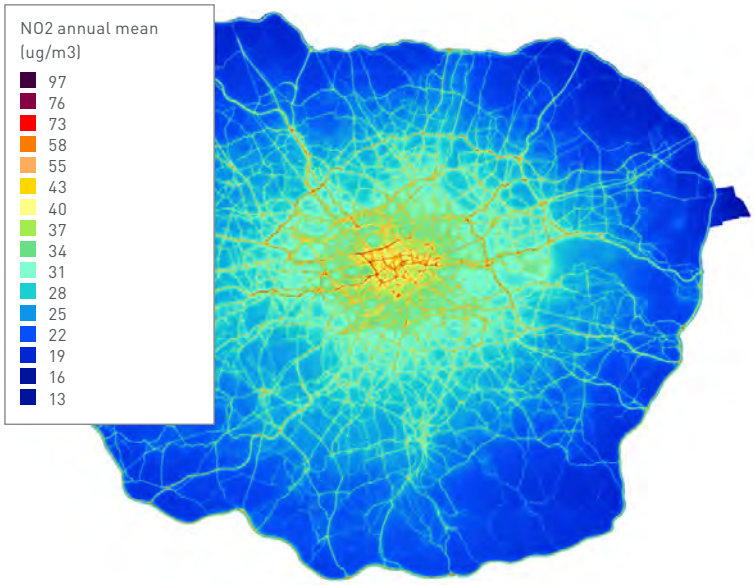
Does it enhance the management and operation of energy systems?

IMPACT RATING

The degree to which a Big Idea will have a direct impact on each of the six dimensions. NOTE: It is the Big Idea that is evaluated and not the illustrative case studies.

LOW EMISSION ZONE – LONDON, ENGLAND, UK
Source: commercialmotor.com

NITROGEN OXIDE CONCENTRATIONS LONDON, ENGLAND, UK



[1] Source: Transport for London

01_ULTRA LOW EMISSION ZONES

London, England, UK → Tackling Local Pollution in the Core

Creating a situation where the autonomy of fossil-fuelled vehicles is restricted can completely transform the relative advantage of electric vehicles. The question of range shifts from being about 'how far can you go' to 'where can you go?' Charges or bans for polluting vehicles not only further enhance the operational savings enjoyed by EV drivers, but also encourage people to buy a car for the journeys that they make most often, rather for the exceptional trips when a fossil fuel engine may be more convenient. Importantly, such restrictions also provide a targeted way to combat the pollution problems that are choking the urban core of cities around the world.

LONDON'S ULTRA LOW EMISSION ZONE

In London, half of all emitted pollution is from transport. This is why in 2013, the Mayor of London announced a plan for the "world's first big city ultra low emission zone" (ULEZ) to be operational by 2020. Mayor Johnson described this as a "game changing" vision that would deliver incredible benefits in air quality and stimulate the delivery and mass use of low-emission technology. This vision has been further set out by the city's transport authority, Transport for London (TfL) in a roadmap which outlines plans of how London could reduce air pollution and CO2.[1]

London currently has two road user charging schemes, the Low Emission Zone (LEZ) and the Congestion Charge. LEZ covers most of Greater London, operates 365 days a year, 24 hours a day, and applies to larger vehicles. Non-compliant vehicles are required to pay a daily charge of £100 ($160) or £200 ($320), depending on the vehicle type. The Congestion Charge Zone covers 21 square kilometres in the centre of London, operates on weekdays between 07:00 and 18:00. It applies to all vehicle types, with some discounts and exemptions with a daily charge of £11.50 ($18.40) or £10.50 ($16.80) with an AutoPay account.

TfL has been consulting stakeholders on options for the new ULEZ since early 2013. It is expected that the key entry requirement will be linked to new Euro 6 standards for mono-nitrogen oxides (NOx), with a CO2 emissions requirement for some vehicles in the region of 35-75g/km being considered. While a list of the vehicles affected has yet to be compiled, TfL has confirmed that it could include buses, coaches, taxis, heavy goods vehicles, motorcycles, cars and vans. A public consultation on plans for the new ULEZ was launched in October 2014, with TfL initially proposing to set a low charge for light vehicles and a high charge for heavy vehicles.

OUTLOOK

More than 200 cities and towns in 10 countries around Europe have established a Low Emission Zone or are preparing to implement one.[2] This includes a range of different restrictions, with some cities banning heavy goods vehicles and some restricting or charging according to the emission standard of every vehicle that enters the zone. Various other regulations can also be implemented to restrict ownership and utilisation of private vehicles. For example, many Asian cities use auctions to limit car ownership and number plate restrictions to reduce traffic volume. Car free days, car free roads or peak-hour driving restrictions are further alternatives to mitigate congestion and the environmental consequences of urban transport.

This combination of measures to manage traffic volumes and promote the use of lower emission vehicles are likely to feature prominently in strategies to combat the significant health and environmental impacts of road transport emissions. This will require more cities around the world to implement such measures. It will also demand stricter emissions controls and greater ambition from the cities that have already begun to implement these important restrictions.

[1] tfl.gov.uk/cdn/static/cms/documents/transport-emissions-roadmap.pdf
[2] theaa.com/motoring_advice/fuels-and-environment/european-low-emission-zones.html

02_ELECTRIC TAXIS

Bogotá, Colombia → High Mileage Taxis Save Money through Electrification

Although taxis represent a relatively small percentage of urban vehicles, their high mileage makes them disproportionately large contributors to problems of climate change and air quality in cities across the globe. High mileage also means high maintenance and fuel expenditures, making it possible for taxi operators and drivers to enjoy considerable savings through electrification. As a result, electric taxis are becoming a feature in cities around the world.

BOGOTÁ LAUNCHES BIOTAXIS PROJECT

In 2013, the City of Bogotá launched an initiative to create the largest fleet of electric taxis in the Americas. This ambitious initiative is the result of a joint project with the C40 Cities Climate Leadership Group, a global network of megacities committed to addressing climate change.The partnership culminated in the launch of a pilot of 50 electric taxis. As part of Colombia's countrywide Biotaxis project—an initiative to replace taxis with more environmentally friendly models—the electric taxi fleet is a highly visible symbol of Bogotá's commitment to tackling vehicle-based emissions.

Compared to all other forms of transportation in Bogotá, taxis are responsible for the most CO_2 emissions per passenger in the city.[1] Because of their high utilisation, taxis experience high wear-and-tear, costly maintenance, and significant fuel costs. However, in Bogotá, electric Biotaxis are reaping significant benefits. Having driven over 1 million kilometres, the EVs are averaging 57% less maintenance costs than other gasoline or compressed natural gas (CNG) taxis. Moreover, the BioTaxis are producing 60% less greenhouse gas emissions than the gasoline taxis and 49% less than the CNG taxis.[2] Thanks to these good results, the city is preparing an EV policy and working with C40 Cities to significantly expand the program.

BIOTAXIS – BOGOTÁ, COLOMBIA
Source: City of Bogotá

OUTLOOK

As every major city in the world hosts fleets of fossil-fueled taxis, concerted efforts to promote electrification provides a way to greatly reduce emissions, while exposing the general public to EVs and the financial benefits that they can offer. Analysis by Research & Markets forecasts the global electric taxi market will have a compound annual growth rate of 33% over the period 2013-2018. It cites that one of the key factors contributing to this growth is the cost effectiveness of EVs, especially for short journeys. Furthermore the analysis points to a high demand for low-cost electric taxis, particularly in countries such as China, the Philippines, and India.

[1] siemens.com/press/pool/de/events/2014/infrastructure-cities/2014-06-CCLA/bogota-climate-close-up.pdf
[2] City of Bogotá

03_INTEGRATED URBAN INTELLIGENCE

Toyota City, Japan → Placing EVs at the Heart of an Integrated Urban System

Digital and communications technologies are connecting electric vehicles with energy grids and wider transport systems to facilitate more efficient and effective operation of urban infrastructure and services.

Cities traditionally operate in silos, with limited integration between the infrastructure for transport, energy, and other essential public services. There are also silos within silos, especially in the case of transport, with different modes, service providers, monitoring, and control systems operating in inefficient isolation.

HARMONIOUS MOBILITY

A project in Toyota City, Japan, is piloting a system that places electric vehicles at the heart of an integrated urban system. The Ha:mo project is a multi-modal navigation system with the capability to incorporate different forms of transport into one route. This includes cars, trains, buses, taxis, power-assisted bicycles, and a network of over 100 shared ultracompact electric vehicles intended for short journeys within the city.

Hiroshi Miura, Director of Transport Policy at Toyota City Hall, explains that "Ha:mo" stands for "harmonious mobility" and provides intelligence to citizens through a smartphone app. "Ha:mo will notify you of traffic congestion before you set out on a journey and will recommend a route to avoid traffic jams. It also lets you plan journeys with information on the availability of parking spaces, traffic forecasts and provides a reservation platform for the carsharing network."

The system also provides intelligence to public transport operators: "By collecting real time information we can give warnings of increases in passenger numbers," explains Hiroshi. "The operators can use this information to increase their capacity by scheduling additional services to maintain smooth operation throughout the day."

Hiroshi sees this integrated intelligence having benefits beyond his core focus of transport: "The more people that use the Ha:mo network, the more data we can collect and analyse to create a complete view of the city." This, he explains, is particularly relevant for cities with increasing numbers of EVs: "Ha:mo gives us the potential to combine real time intelligence on battery status with calculations on the routes they will take, the traffic situation and their likely time of arrival. This means we can forecast changes in power demand."

HA:MO – TOYOTA CITY, JAPAN
Source: Toyota Global Pressroom

OUTLOOK

Increasingly connected citizens and the ubiquity of data are transformming the way that we live, work, and communicate in cities. The holistic integration of electric vehicles into these intelligent networks naturally brings connections to wider systems for power, transport, and smart communities. This has the potential to make services more efficient and responsive to individual needs. It could also be the start of a radical change in how we move around cities, consume energy, and access public services.

04_TRANSPORT POVERTY

Manila, Philippines → Driving Affordable Mobility

The lower fuel and maintenance costs of EVs provide an opportunity to offer more affordable transport to some of the poorest in society. Rising oil prices not only increase the cost of car ownership, but can also make public transport less affordable. For car dependent communities, or those with insufficient spare income to afford to travel, such restrictions on mobility can mean being cut off from employment, healthcare, and essential public services.

THREE WHEELING IN MANILA

The Asian Development Bank, working with the Philippine Department of Energy, has developed a project to help tackle this problem. 100,000 electric three wheelers will be deployed in Manila by 2017 to boost the income of low paid drivers and reduce the 10 million tonnes of CO2 emissions produced annually by the 3.5 million tricycles in the country.

E-TRIKE
Source: Asian Development Bank

"By using an innovative financing model, a Philippine driver with a daily income of about $15 can own a new $6,000 e-trike fitted with a quality lithium ion battery with a 5-year warranty," explains Sohail Hasnie of the Asian Development Bank.

"Our initial pilot found that drivers could expect to pay this back over 5 years in which time they will also save about $2,000 dollars in fuel and maintenance costs and potentially increase their income by up to $5,000. This represents an increase in take home pay of up to 15%."

E-TRIKE PROJECT AT-A-GLANCE	
100,000 e-trikes TO BE DEPLOYED	**$500** million COST OF PROJECT
400,000 tonnes AVOIDED CO_2 EMISSIONS	**$185** million SAVINGS PER YEAR

OUTLOOK

With an estimated 40 million three wheelers in operation around the world, it would appear that there is significant potential for future growth in this sector. However, the opportunities for considerable cost and emissions savings is not just restricted to three wheelers, with buses, taxis, and bicycle projects also delivering similar benefits.

The significance of these savings is also not restricted to developing nations. For example, recent reports identified that 800,000 car-owning households in the UK spent at least 31% of their disposable incomes on buying and running a vehicle.[1]

With volatile oil prices and transport expenditures increasing as a percentage of household budgets, electric mobility appears to be important means to provide affordable personal and public transport in many communities around the world.

[1] racfoundation.org/media-centre/transport-poverty-2014-press-release-ONS-data

05_BATTERY RIGHT SIZING

Amsterdam, The Netherlands → Custom Mileage Sweet Spots

One of the ways to optimise the cost and performance of an EV is to match the size of the battery to the specific needs of an individual or fleet. Variable specifications are commonplace in consumer electronics with pricing set according to the size of memory, processing speed, and indeed battery capacity desired.

Nissan LEAF's 24kWh (100 mile/160km) battery is reported to constitute around 30% of the total manufactured cost of the vehicle. Considerable savings could therefore be provided by offering smaller batteries for lower mileage applications or where journeys can be reliably extended by recharging. Similarly, users with higher mileage requirements could invest in larger battery capacities, opening up new market segments to electrification.

SCHIPHOL AIRPORT – AMSTERDAM, THE NETHERLANDS
Source: iStock by Getty Images (Editorial)

SCHIPHOL AIRPORT INVESTS IN EVs

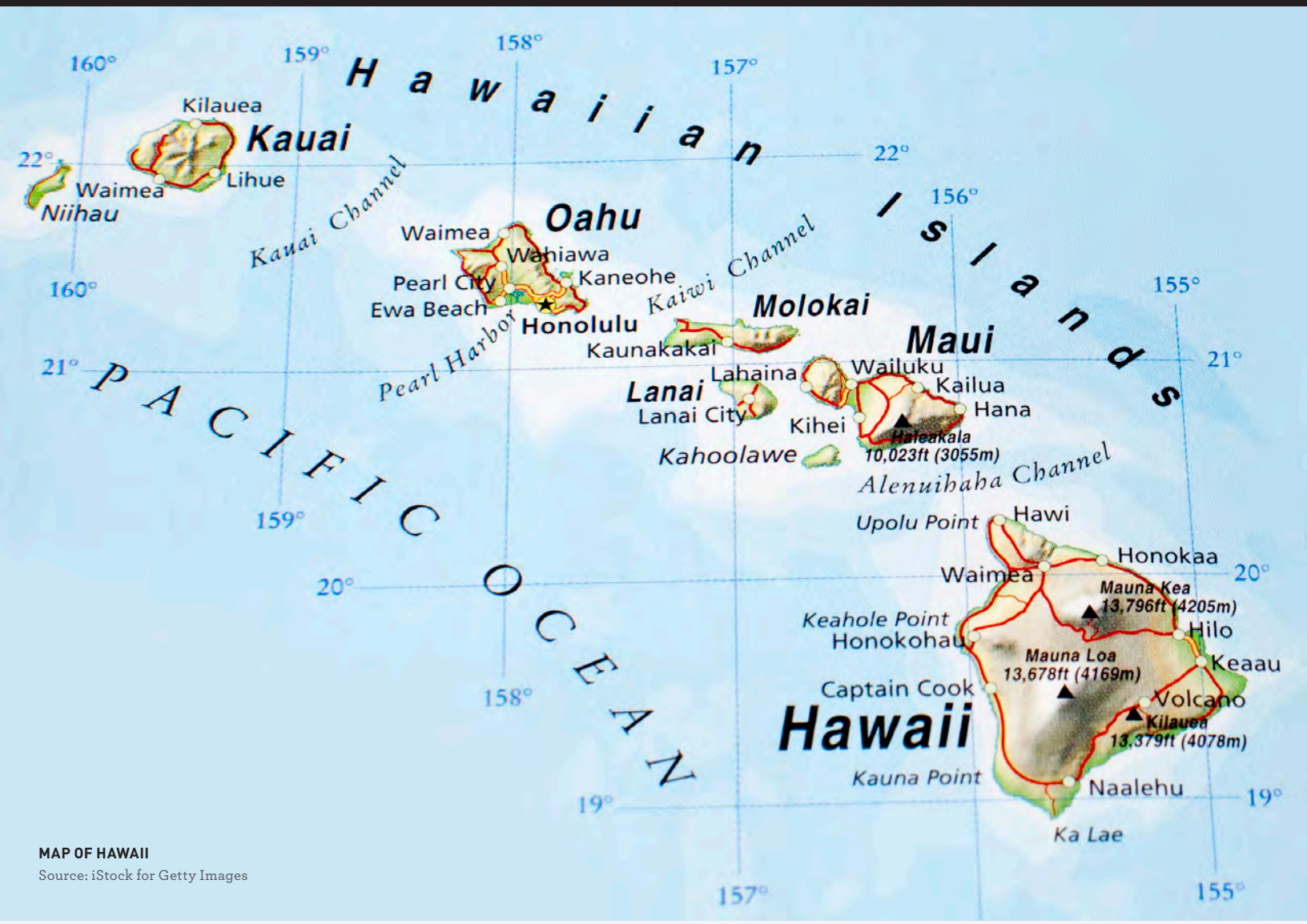
The fleet of vehicles operating at airports is an example of a custom mileage sweet spot. Research from the Delft University of Technology[1] shows that Schiphol Airport in Amsterdam has over 8,000 vehicles operating in its airside fleet, with a typical journey along a fixed route being under 4km. With this in mind, the airport has begun to electrify its fleet with the purchase in 2013 of 35 all-electric buses from Chinese Manufacturer BYD. According to Arno Veenema, Manager of Apron Planning and Control at Schiphol Airport: "We noticed that buses running on diesel aren't suitable for our process. This includes short rides and low speeds and diesel engines simply aren't designed for that." The consequence of this for the airport is that diesel buses mean high maintenance costs and poor emissions performance.

With the BYD buses capable of running 250km on a single charge, it would seem that they are more than capable of operating on such routes and that there is considerable opportunity to right size the battery and further reduce the total cost of ownership.

OUTLOOK

As the market for EVs matures, it can reasonably be expected that end-users will develop sophisticated understandings of the size of battery they require and manufacturers will seek to satisfy these needs with a range of vehicles and customisation options. However, right-sized battery thinking extends beyond new vehicles. For example, battery swapping models would allow customers to upsize their batteries for longer journeys. Similarly, as battery performance degrades over time, vehicles can be matched to lower mileage applications, extending the usable life of an EV in a fleet and supporting resale markets with educated consumers who better understand their requirements. These factors will also make leasing terms more favourable, with fleets and individuals prepared to take on extended contracts, and the residual values of vehicles enhanced by new opportunities for leasing of older EVs into lower mileage applications.

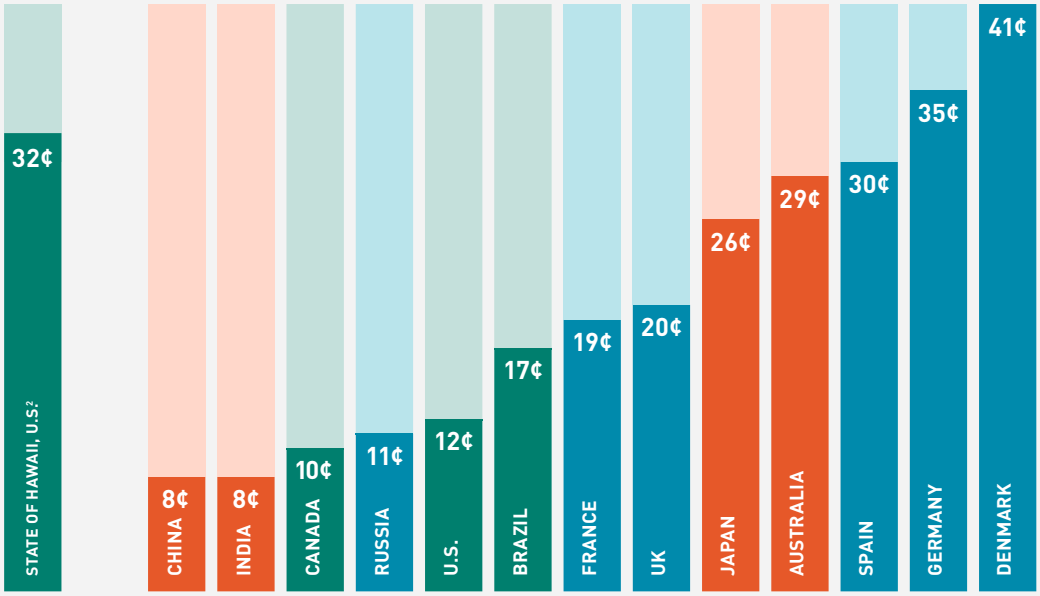
[1] repository.tudelft.nl/view/ir/uuid%3A11fb2a37-8c3f-446d-9c5a-0b2b7dbeab38



MAP OF HAWAII
Source: iStock for Getty Images

HOW MUCH DOES ELECTRICITY COST?[1]

Average national electricity prices in U.S. cents/kWh (2011)



[1] Average prices from 2011 converted at mean exchange rate for that year. IEA, EIA, National Electricity Board, OANDA.

06_ENERGY INDEPENDENCE

Hawaii, U.S. → Reducing Dependence on Fossil Fuels

Reducing road transport's dependence on finite fossil fuels is part of a global energy security movement which is focused on ensuring long-term access to an uninterrupted and affordable supply of energy. Many countries are promoting the electrification of transport to reduce expensive fossil fuel imports and to satisfy a greater share of their domestic energy needs by exploiting their own natural resources.

HAWAII: THE MOST PETROLEUM DEPENDENT STATE IN THE U.S.

The state of Hawaii is actively working to reduce its dependence on imported fossil fuels. Anne Ku from the University of Hawaii describes her state as "the most petroleum-dependent in the U.S." She explains that "Hawaii is the most isolated landmass on earth making the islands hostage to high shipping costs and volatile oil prices. As a result Hawaii's residents have to pay the highest energy prices in the U.S. and 10% of the state's gross domestic product is spent on energy."

To reduce Hawaii's dependence on imported oil, the state began a unique partnership with the U.S. Department of Energy to set up the Hawaii Clean Energy Initiative (HCEI) in 2008. The HCEI goal in transportation is to reduce petroleum consumption by 70% or displace 385 million gallons of petroleum by year 2030.

For Ku there is little doubt that Hawaii is the perfect location for EVs: "The islands' abundant renewable energy potential, high rooftop solar penetration, excess wind power at night, limited driving distances, and sustainability-minded residents all provide ideal conditions for electric vehicle adoption."

While Hawaii's rich renewable resources promise a viable alternative to fossil fuel-dependence, achieving this requires that these variable resources are properly harnessed. This is where Ku sees EVs as having a much bigger role in energy security than simply decarbonising road transport: "Through battery storage and controlled charging, plug-in electric vehicles will be essential in managing the variable loads from renewables and improving the management of distributed energy resources." This is being put into practice on the islands through over $60 million of investment in several smart grid projects,[2] which are preparing the islands electric system for increased renewables and widespread adoption of EVs.

OUTLOOK

Energy markets continue to be vulnerable to disruptions, ranging from geo-political strife to natural disasters, therefore it is understandable why there is a heightened focus on achieving greater control over domestic energy resources. Today, transport is the only end-use sector which is not diverse in terms of fuel choice, being overwhelmingly dependent on petroleum. The grid integration of electric vehicles also offers an important means to harness and control locally generated energy resources and further decrease dependence on finite fossil fuels.

EV TARGETS: STATE OF HAWAII[3]

To meet the HCEI goal in transportation, the State of Hawaii is committed to a comprehensive transportation strategy that includes the adoption and integration of EVs and charging networks.

Registered EVs as of 1 April 2014 = 2,375

Target by end of 2015 = 10,000

Target by end of 2020 = 40,000

[2] mauismartgrid.com; hnei.hawaii.edu/projects/smart-grid-inverters-high-penetration-photovoltaic-applications; jumpsmartmaui.com

[3] Leon Roose, University of Hawaii

07_LOCAL INCENTIVES

Oslo, Norway → Using Incentives to Encourage Widespread Adoption of EVs

Locally administered assets and powers can be leveraged to make EVs more cost effective, convenient and enjoyable to use. Exemptions from local taxes and charges can greatly enhance the cost advantages of EVs. Incentives can also offer non-financial benefits, such as the status or convenience offered by preferred parking, or reduced journey times through access to fast track lanes for buses or high occupancy vehicles. Local powers, can also incentivise investments in EVs and charging infrastructure, such as planning frameworks and building codes.

OSLO'S PACKAGE OF EV INCENTIVES

Local incentives have been a major factor in the growing popularity of EVs in Norway. Motorists in Oslo have reported saving an hour on their daily commute by driving in bus lanes and by gaining easy access to dedicated EV only parking lots across the city. A recent survey by the Norwegian EV Drivers Association[1] found that 64% of the 1,859 respondents felt that their electric car saved them time.

The same survey also showed that 94% of EV drivers agreed with the statement that their electric car was low cost to use. A big part of this cost equation is the difference in fuel costs between highly taxed gasoline and relatively inexpensive electricity from hydropower. However, a suite of incentives also means that Norwegian EV drivers enjoy additional daily cost savings. This includes exemptions from road charges, free travel on road ferries, free electricity and parking at over 5,000 chargepoints across the country, and free on- and off-street parking in all municipal spaces.

These local incentives are administered and funded by the municipalities themselves. A cross-party political agreement set the intention for incentives to remain until 2017 or when 50,000 EVs are registered in Norway. However, as the market grows the continuing viability of certain measures is to be kept under review. One such example is access to bus lanes, with cities such as Oslo monitoring local conditions to ensure any impact on public transport remains marginal.

Tom Nørbech, Senior Adviser at Transnova explains that, "these incentives have been in place for many years and have proven to be very popular, with few issues or concerns. Today we have almost 40,000 BEVs on the road in Norway and we are only just starting to see some localised issues in bus lanes in parts of Oslo. This will have to be phased out at some point, but on the basis of experience to date I'm sure that many other cities could enjoy benefits from implementing similar measures to support the early market for EVs."

OUTLOOK

While many national governments have supported electric mobility through fiscal incentives and coordinated research, development, and demonstration programmes, cities are able to employ a diverse range of incentives in unique and effective ways. Such specific incentives are not merely meant to support a specific technology, rather to advance the type of mobility that best fits into the fabric of the city.

[1] Haugneland, P. and Kvisle, H.H. (2013) Norwegian electric car user experiences, Proceedings of EVS27 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, 17-20 November 2013, Barcelona, Spain.

08_RAISING AWARENESS

Shanghai, China → Empowering Consumers with Knowledge

A low level of awareness, understanding, and confidence in EVs amongst the general public will undoubtedly temper demand. Addressing this requires active education and promotion efforts to create an informed public that is positively disposed to EVs.

The very first and most basic issue is that before an individual can consider investing in an EV, they first need to understand that this is an option. After this, the next challenge is to explain the relative benefits of EVs and how these vehicles could match different needs and lifestyles.

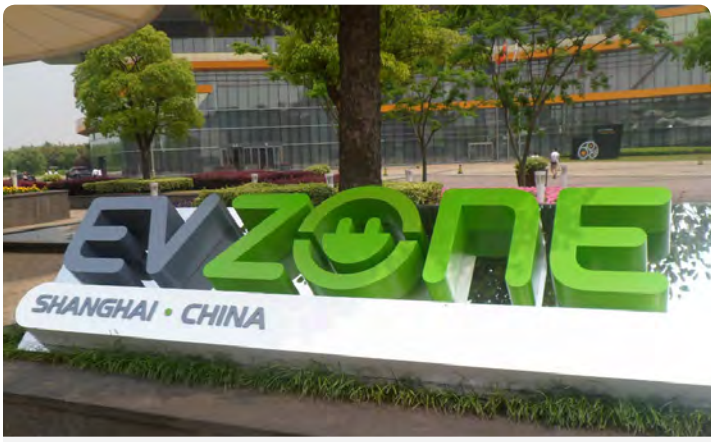
SHANGHAI'S EV DEMONSTRATION ZONE

In 2011, to spur the development of the burgeoning electric vehicle market, the Chinese government named Shanghai as an International Electric Vehicle Demonstration Zone.

Lucas Cao Yue, Project Manager at Shanghai International Auto City Group Co. explains that "the EV Zone offers the public free test drives in different EVs"—an opportunity which some 80,000 people have accepted to date. "We have many different electric vehicles in one place, so people can compare their options. We also have knowledgeable staff, an educational cinema, and lots of information that we can share with the public."

Cao explains that the EV Zone is not just about ride-and-drives: "We are finding that more people know about EVs today so our main focus is to find the best integration of new energy vehicles into the city and people's lives." This is done by surveying the test drivers to establish their likes, dislikes, and purchase intents. The EV Zone also has a fleet of 160 electric vehicles from which it collects usage data. This data and the information from the surveys are then shared with vehicle manufacturers to help establish a better understanding of the developing markets for EVs. For example, the 3,266 respondents to the survey in 2012 stated that their top concerns are short range, high price, and insufficient infrastructure. However, it was also discovered that 77% of respondents drive 30km or less per day, meaning that a number of EV models already on the market are suitable to a majority of drivers.[1]

Different business models for EVs are also studied, which Cao describes as "finding the best way to achieve a viable EV market." This, he elaborates includes "carsharing trials, rentals and purchasing at an EV-only dealership in the Zone."



EV ZONE – SHANGHAI AUTOMOBILE MUSEUM, ANTING, CHINA
Source: WikiCommons Author: Navigator84

OUTLOOK

Keeping pace with the different information requirements of the general public is one of the key challenges facing global efforts to promote EVs. Recognising that individuals have different attitudes, behaviours, and needs suggests that a variety of engagement initiatives are required across the public and private sectors. To progress from early adopters to the mass market requires that public engagement addresses different segments of the population and that targeted information is provided through a variety of different channels.

[1] Shanghai International Auto City Group, Co., EV International Demonstration Zone Annual Report for New Energy Vehicle Demonstrative Running, 2012.

09_WIRELESS CHARGING

Gumi, South Korea → Convenience Without the Cord

The wireless transfer of power to an electric vehicle when parked or in motion could extend driving range and enhance the convenience of recharging. This convenience could further differentiate EVs from internal combustion engine vehicles and other alternative propulsion fuels.

There are a number of applications of wireless charging. The first is stationary, where wireless systems negate the need to plug in vehicles when they are parked. The next is semi-dynamic which allows vehicles to receive short top-ups when they temporarily stop as part of a journey, such as at a road junction or bus stop. The third is fully dynamic, where a vehicle charges in motion drawing current from technology embedded in the lanes of main roads and highways.

ONLINE ELECTRIC VEHICLE SYSTEM

In the city of Gumi in South Korea, a seven and a half mile stretch of inner-city road has been fitted with a wireless charging system to power an all-electric passenger bus. Developed by researchers at Korea's Advanced Institute of Science and Technology (KAIST), the Online Electric Vehicle system (OLEV) consists of electrical cables buried under the surface of the road that create magnetic fields which are picked up by a receiver on the underbody of the bus and converted into electricity. Dong-Ho Cho, Professor of Electrical Engineering at KAIST, explains, "The length of the power strips installed under the road is generally 5 to 15 percent of the entire road, requiring only a few sections of the road to be electrified. The bus receives 20 kHz and 100 kW electricity at an 85% maximum power transmission efficiency rate while maintaining a 17cm air gap between the underbody of the vehicle and the road surface. Safety to pedestrians is assured through compliance with international EMF (electromagnetic fields) standards. The road also has a smart switching function, with power only transmitted on the segments of roads on which the OLEV buses are travelling. This prevents EMF exposures and reduces standby power consumption."

A key advantage of the system is that the bus requires a smaller battery, which Professor Cho describes as being "About one-third of the size of the battery found in a regular electric car", making OLEV buses much less expensive. After the successful operation of the first two OLEV buses, Gumi City plans to provide ten more such buses by 2015.

OUTLOOK

Global interest in wireless charging is spurred by the advantages of eliminating the need to handle unwieldy cables, reduce the size of EV batteries, and avoiding infrastructure cluttering up streets and roads. However, the technology is not without challenges, especially in the areas of power loss, excess radiant heat, and the need for relatively precise alignment between the transmitting and receiving systems. Developers are therefore using in-vehicle guidance and automation to make it easier to align wireless charging systems, and public-private research is working to boost power transfer efficiencies. As a result, a number of major EV manufacturers and automotive suppliers have announced plans to introduce new wireless charging products to the market.

Another interesting area is the need for new business models for dynamic EV charging networks and services. Such developments could be a major factor in driving increased adoption of wireless technology and helping to extend the functionality and convenience of electric vehicles.

10_ALL-ELECTRIC BUS ROUTES

Rome, Italy → Greening Public Transport

Buses are an effective mass-transit solution for millions of urban dwellers each day, but also a major source of surface pollution in cities. Because buses operate almost 5-10 times more than the average passenger car, they are a key priority for emissions reductions. In IEA's Energy Technology Perspectives 2014 (ETP 2014), buses were singled out as the road transport mode with the most electrification options available, including battery swapping, overhead (catenary) lines, induction (static and dynamic), and stationary battery charging.

ROME'S ELECTRIC BUS FLEET

Italy's capital city Rome boasts one of Europe's largest fleets of electric buses. The city's entire bus system carries 945 million passengers per year[1] and has been running all-electric buses since 1989.[2] 60 all-electric minibuses operate on five routes, using battery swapping. The size of the minibuses reduces the amount of charging necessary, but it also means they can navigate the narrow alleyways of the city. This would simply not be possible with other buses which would be too large to fit into these historic streets and are also prohibited from doing so because of emissions and noise regulations. These "Limited Access Zones" form part of a wider municipality project, which is aiming to achieve a "Zero Emission Area" in the city centre.

Rome has also implemented trolley bus lines. This includes one hybrid line (Line 90) that uses overhead power until it reaches the centre and then uses battery power. Rome's electric buses are also greatly appreciated by users. A survey of passengers found that besides being zero emissions, the most appreciated qualities were comfort and silence.[3]

ELECTRIC BUS – DOWNTOWN ROME
Source: exclusiveelectriccars.blogspot.com

OUTLOOK

Electric buses, both minibuses and large-size buses, tend to have a higher upfront cost, but they are quickly nearing cost-effectiveness as more suppliers enter the market, battery costs keep declining, and electric bus operating costs (including maintenance) are lower than a fossil fuel equivalent bus. On average, energy consumption (kWh/km) of electric buses is 75% less than of diesel buses and 65% less than of hybrid electric buses (ETP 2014).

Rome is not alone in introducing all-electric buses, with cities around the world introducing systems based on battery swapping (China), overhead lines (Vienna), induction (Korea), and battery charging (Paris). Electrification of urban buses is expanding rapidly, as municipalities value the zero local emissions and low noise levels.[3]

[1] agenzia.roma.it/home.cfm?nomepagina=settore&id_settore=8
[2] eltis.org/index.php?id=13&study_id=800
[3] iea.org/etp/etp2014

FORMULA E – LONDON, ENGLAND, UK
Source: FIA Formula E

11_CHALLENGING MISCONCEPTIONS

Donington Park, England, UK → Demonstrating the Power and Performance of Electric Vehicles

There is broad agreement that public understanding of electric vehicles needs improving. However, in many developed markets, promoting greater understanding of the benefits and potential of EVs is not simply about giving people more information, but rather a need to challenge commonly-held misconceptions, scepticism, and bias.

Widely held misconceptions that EVs are slow, unreliable, and unsafe largely stem from traditional negative stereotypes and outdated associations with milk floats, golf carts, and older EV models. Another important influence is the media, who are expert in providing information that is easy to comprehend, but can introduce bias which is often motivated by a need to frame stories dramatically. This has seen polarised coverage of issues such as range anxiety, EV battery fires, and a stream of reports questioning whether electric cars charged with high-carbon electricity may pose an "environmental threat".

FIA FORMULA E

An initiative that has the potential to both challenge negative stereotypes and to also generate positive mainstream news headlines is Formula E, the world's first fully-electric racing series. Sponsored by the Fédération Internationale de l'Automobile (FIA), the series is intended to represent the highest class of competition for electrically powered single-seat racing cars.[1]

"We have an objective to make people believe in electric cars", explains Alejandro Agag, CEO of Formula E Holdings. "One of the biggest issues electric vehicles face is image. Many people think they won't work for them or they will be too slow but we want to show everyone what electric cars can really do, through motorsport, and to help shape perceptions of what is cool and exciting."

Formula E promises to introduce a sprinkling of glamour and excitement to the world of EV promotion. Races will take place in the heart of some of the world's leading cities—including London, Beijing, and Los Angeles—speeding past iconic landmarks at up to 225km/h and watched by major corporate sponsors and celebrity team owners such as Leonardo DiCaprio and Sir Richard Branson.

The series also offers the potential to support market uptake of new technological advances. As well as being a testing ground for breakthroughs in areas such as battery life and efficient drivetrains, it may also help build public confidence in new technologies. For example, according to the FIA Institute, part of the increased acceptance of diesel as a performance fuel came from its use in the famous Le Mans 24 hour race. Similarly, fuel-saving flywheels developed in Formula One are now used on buses in London.[2]

OUTLOOK

While motorsport alone will not challenge all public misconceptions about EVs, it is likely that this will be part of a wider change in the way that EV communications are delivered. Instead of simply focusing on basic awareness raising, which can often go little further than pointing out the existence of electric cars and charge points, the challenge will be to find innovative ways to persuade people that the EVs of today are desirable and a practical fit with their lifestyles.

[1] thecarsoftomorrow.com.au/wp-content/uploads/2012/02/Garry-Connelly-MAKING-CARS-GREEN-THE-CARS-OF-TOMORROW-FINAL.pdf
[2] theguardian.com/environment/2012/apr/18/f1-fuel-saving-flywheel-buses

12_REGIONAL PLANNING

Emilia-Romagna, Italy → An Integrative, Regional Approach

Initiatives to promote the electrification of transport are often focused on individual cities. However, municipal boundaries can create artificial limits that do not reflect the real-world movement of commuters, freight, public transport, and of course emissions. Successful integration of electric vehicles into regional transport and energy systems cannot be achieved by isolated municipal plans, but instead requires cooperation between all relevant stakeholders in the cities and communities within a region.

EMILIA-ROMAGNA'S REGIONAL APPROACH

In Italy's Emilia-Romagna Region, the "Mi Muovo Elettrico" project is working on education, outreach, interoperability, and integration of mobility services to benefit the citizens of the whole region, including 10 cities with a total population of 4.5 million people. The project aims to assist city and national level development of electric mobility; reduce regional air pollution and fuel consumption; and increase education and awareness of alternative fuel vehicles.

Users can gain access to a variety of mobility services across the region with the "Mi Muovo" mobility card. This provides a single integrated solution for buses, trains, bike sharing, carsharing, and EV charging points throughout Emilia-Romagna. The project also works with individual cities to ensure that any installed charging point are fully interoperable with the Mi Muovo card system.

Further coordination is achieved by sharing real-time information to users across the region on the availability of the almost 120 charging points installed to date; a network that was planned to take into account the movements of traffic between towns and cities. A region-wide approach has also been used to target the most effective distribution of funding to support the uptake of electric scooters and e-bikes in several different cities. Finally, non-financial incentives are coordinated on a regional basis, including free on-street parking and exemption from time restrictions for driving in historical zones. Having the same rules apply across the region avoids any confusion amongst the general public that could undermine the perceived benefits of these measures.

MI MUOVO MOBILITY CARD
Source: Simeoni Tammaso

OUTLOOK

Regional planning helps make both provincial and national borders more fluid, broadening the value proposition for electric mobility. This includes streamlining implementation programmes, sharing learning between peers, and creating electric mobility systems that better reflect the real-world movement of people and vehicles.

13_VEHICLE TO GRID

Delaware, U.S. → Energy Markets for Grid Connected Electric Vehicles

When connected to the grid, an electric vehicle can become a flexible and on-demand asset to enable more reliable and efficient running of electricity systems. This capability is giving vehicle owners access to business models and markets previously unavailable in transportation. One such opportunity is the frequency regulation market, in which generating assets provide balancing services to grid operators. By bidding into these markets, electric vehicle owners have access to a new revenue source and an opportunity to reduce the total cost of ownership of their investment.

UNIVERSITY OF DELAWARE'S V2G SCHOOL BUS

In the United States, the University of Delaware has established itself as an important centre for vehicle-to-grid (V2G) research and the economic opportunities offered by the technology. The university's Center for Carbon-Free Power Integration has partnered with a host of vehicle manufacturers, energy companies, and electricity system operators to quantify and showcase the economic opportunity available to grid connected electric vehicles. The team has published several reports demonstrating the potential for fleets of vehicles to bid into ancillary electricity markets, such as the frequency regulation market. But most recently, with its electric school bus initiative, the collaborative has produced a strong economic and environmental argument for commercialising V2G technology.

Many diesel school buses are highly inefficient and low mileage vehicles that produce considerable amounts of air pollutants in their day-to-day operation. They are also highly expensive to operate, when considering maintenance costs, fuel expenditures, and the health costs associated with the fumes, which studies have shown can collect within the cabins of the buses.[1] Comparing these costs to an electric bus, equipped with a 70-kilowatt on-board bidirectional charger, the Delaware team uncovered a substantial economic argument for switching to electric. Even though the up-front cost of a V2G-enabled bus is much higher than the traditional diesel vehicle—$260,000 compared to $110,000—the vehicle is able to save upwards of $6,070 per bus seat over its typical 14-year lifespan. After accounting for battery degradation and residual value, the team estimates a net present value of $190,000 in savings over the course of the bus's life—a significant reduction in the total cost of ownership and a strong economic argument for transitioning diesels to zero emission, V2G-enabled electric buses.

OUTLOOK

V2G developments come at a time when energy grids around the world are facing significant stresses. This includes increasing load-demand and the challenge of integrating a greater share of intermittent renewable generation. V2G technologies offer potential to increase the reliability of the entire electricity system and provide much needed decentralised storage.

The International Energy Agency estimates that on-board battery storage in EVs could halve the need for capital-intensive large-scale storage technologies that it calculates will be required as part of an electricity system that limits global temperature rises in 2050 to 2 degrees Celsius.[2] The U.S. Department of Defense has also recognised the potential of these technologies, announcing in 2013 that it plans to invest $20 million in fleet vehicles equipped to export energy. Such investments will continue to progress the technical capabilities of V2G technologies and provide greater insight on the potential environmental, economic, and energy system benefits. It will also help establish that EVs are not just cars, vans, trucks, and buses, but also batteries. New markets and business models will provide a means to harness this storage potential to generate revenues for individuals and fleets, while helping to address some of the biggest challenges facing energy systems today and into the future.

[1] Noel, L. & McCormack R. 2014. A cost benefit analysis of a V2G-capable electric school bus compared to a traditional diesel school bus. Applied Energy, 126: 246-265.
[2] IEA (2014), *Energy Technology Perspectives 2014*, IEA

14_SECOND LIFE FOR BATTERIES

Yume-shima Island, Osaka, Japan → Creating New Grid Energy Storage

Even after batteries have reached the end of their useful life in electric vehicles, there are still some valuable applications for which they can be used. Redeploying batteries has the benefit of enhancing the capital value and lifecycle performance of ageing EVs. It could also provide a valuable resource for managing energy grids.

NEW GRID ENERGY STORAGE ON YUME-SHIMA ISLAND

4R ENERGY BATTERY STORAGE SYSTEMS
Source: Sumitomo

On Yume-shima Island in Osaka, Japan, the Sumitomo Corporation is harnessing the potential of redeploying spent EV batteries by building the "world's first large-scale power storage system utilising used batteries collected from electric vehicles."[1] This prototype 600kW/400kWh system includes 16 used lithium-ion EV batteries. Over a period of three years, the system will measure the smoothing effect of energy output fluctuation from the nearby "Hikari-no-mori" solar farm.

The project has been developed under a joint venture between Sumitomo and the Nissan Motor Company known as "4R Energy Corporation" to create new business models for used lithium-ion EV batteries. Nissan expects that the "glide path" for a normal LEAF's battery degradation will be down to 70%-80% capacity after five years, with up to 70% of their capacity remaining after 10 years of service as a car battery. This would make these batteries ideally suited for grid energy storage.

OUTLOOK

While there are a slew of batteries expiring from useful applications in consumer electronics, what makes EV batteries an interesting value proposition is their large capacity and increasing availability, with EV sales continuing to grow year-on-year. The choice is either to recycle the battery (back into another EV, or broken down into its component materials), or to find another business opportunity, such as stationary energy storage. What companies will ultimately choose is still up in the air, but for now the technology is being tested to demonstrate its viability.

If standards for testing and reporting battery conditions are established, then broader issues related to energy storage need to be considered. According to Kristian Handberg, author of a white paper on EVs as Grid Support, "Electricity market rules must enable and incentivise the participation of energy storage. As these rules are complex and slow-to-change, it's likely that the early second-life battery applications will be for in homes or commercial buildings for interactions that take place completely behind the electricity meter."[2]

[1] ajw.asahi.com/article/economy/AJ201402080049
[2] percepscion.com/2014/02/13/opportunities-for-electric-vehicles-as-grid-support

15_FLEET OPTIMISATION

Livingston, Scotland, UK → Giving Fleet Managers Greater Control

Instead of just replacing fossil-fuelled engines on a like-for-like basis, fleet managers can increase the opportunities for electrification by optimising the operation of all of their vehicles. In other words, the best way to reduce costs and emissions is to place the right vehicles on the most efficient routes and this will often make a compelling case for EVs.

ROUTE MONKEY OPTIMISES FLEETS FOR EVs

From their head office just outside of Edinburgh in Scotland, software company Route Monkey has developed a tool to help fleet managers optimise their fleets for EVs. "Benchmarking EVs as like-for-like replacements for petrol or diesel vehicles is not the optimal away to think about this," explains Route Monkey's Chief Executive, Colin Ferguson. "We look at the total cost of ownership of the whole fleet—not just a single vehicle—and ask where would the vehicles ideally go if you planned it out again with a blank canvas. This often leads to a reduction in road miles across the whole fleet of 10%, which creates a budget to put new vehicles in place and achieve even greater efficiencies and savings."

Route Monkey's analysis uses telematics and GPS tracking to get real world driving data, because as Ferguson points out, "Fleet Managers often carefully plan what drivers will do, but the reality can be very different."

However, Route Monkey's unique selling point lies at the heart of their software, where their sophisticated algorithm calculates the optimum deployment of EVs. "Scheduling EVs is not just about benchmarking the total miles driven", explains Ferguson. "The same electric vehicle will have a totally different range if it is going up a hill with a heavy load compared to travelling on the flat. Our algorithm takes into account all of the factors that impact range—like weather, topography, payload, regenerative braking, and opportunities for charging—and calculates the optimal schedules, routes, and vehicles for a fleet."

With more than half of all new cars in the UK bought by fleets, both the Scottish and UK governments have recognised the potential of this approach and have funded programmes to help fleets access evidence-based analysis of their operations. This is providing fleet managers with data to define how EVs will best work for them and quantifying the cost and emissions savings that they can expect.

OUTLOOK

Fleet sales represent an important market for EVs around the world. Integrating EVs into fleets offers organisations an opportunity to achieve real financial, operational and reputational benefits. Positive experiences of driving EVs in the workplace will also help accelerate deployment amongst private consumers.

The ability to adopt EVs will largely depend on how vehicles are used by an organisation. The pressure to reduce costs and emissions provides fleet managers with an opportunity to change the way that their vehicles operate and create a broader base of applications for EVs and plug-in hybrids. Such decisions are often based on absolute calculations of costs and emissions savings. Accordingly, quantifying these savings and other organisational benefits will be central to building confidence and creating a clear business case for fleets to invest in electric vehicles.

[1] dtxtq4w60xqpw.cloudfront.net/sites/all/files/docpdf/climatechange.pdf

SCHOOL CHILDREN –VICTORIA, AUSTRALIA
Source: iStock by Getty Images (Editorial)

16_ENGAGING CHILDREN AND YOUNG PEOPLE

Victoria, Australia → Dedicated EV Resources for Teachers and Students

Many government targets and ambitions for increased EV adoption extend out to 2030 and 2050. Much of this progress will ultimately be driven by the present generation of children and young people. Accordingly cities, governments, and vehicle manufacturers are engaging with young people to raise awareness of EVs and to use the burgeoning interest in this exciting technology to promote careers in science, technology, engineering, and maths.

VICTORIA'S EV SCHOOLS PROJECT

The Australian State of Victoria has developed dedicated electric vehicle resources for teachers and students. "We saw this as a real opportunity to get people excited about EVs and increase the general level of knowledge amongst children, with the expectation that a lot of this would probably get passed onto their parents", explains Kristian Handberg, who initiated the EV School Project at the Victorian Department of Transport. "We developed web pages with dedicated resources for teachers and students with everything necessary to run a successful class on electric vehicle technology at both primary and secondary schools. We worked with experts to make sure that this met current curriculum standards and developed lesson plans for different subjects including science, humanities, civics, and design, creativity, and technology. There are also school project ideas, a glossary of electric vehicle technology terms, and classroom resources such as posters, fact sheets and diagrams to use during lessons."

Handberg points out that one of the real successes of this initiative was the ability to encourage discussions on wider issues related to climate change, energy efficiency, and sustainable transport. "For many kids, and indeed adults, EVs are cool, so it's a great way to start conversations about why they're important and the benefits they can bring. It also enabled us to address myths about EVs and to reinforce our wider messaging on the environment and sustainable transport."

OUTLOOK

If governments around the world achieve their future ambitions for adoption of EVs, many of the present generation of children and young people will be far less likely to drive a fossil-fuelled vehicle. Giving young people the opportunity and resources to engage with EVs can support wider education and help ensure that learners are equipped with the necessary skills in subject areas that are critical to many economies and to the future development of electric vehicle industry itself. Such engagement can also provide an opportunity for learners to think critically, tackle complex moral, ethical, and environmental issues, develop informed opinions, and help shape possible solutions.

17_SHARED MOBILITY

Paris, France → Accelerating Electrification through Carsharing

New shared mobility business models and services could provide a way to overcome a number of the early market barriers for electric vehicles. Shared mobility services offer a convenient and cost-effective alternative for urban residents facing increasing costs of car ownership and limited availability of dedicated parking spaces. Shared mobility models also mean that individuals are no longer faced with the high purchase price of EVs, or concerns related to battery degradation and resale values. Furthermore, carsharing can help to build confidence amongst a community of first time EV drivers, exposing the operational savings, benefits and performance provided by electric motoring.

2,500 SHARED EVs IN PARIS

In Paris, France the all-electric carsharing operation, Autolib', was first launched in December of 2011 as a public-private partnership between French holding company, Bolloré, the City of Paris, and surrounding cities. Autolib' consists of over 2,500 electric vehicles and 4,710 charging stations. Funded largely by Bolloré, the city also contributed over €35 million to the build out of charging stations and the allocation of parking spaces for the carsharing programme. The result is a widespread network of carsharing hubs that are never more than a quarter mile from a Parisian—providing easy access to zero emissions mobility.

The programme has attracted over 6.6 million trips and 178,000 individual subscribers, while logging over 60 million kilometres and saving 7,575 tonnes of CO_2. "We're very pleased," says Véronique Haché-Aguilar, managing director of Autolib' Métropole, which groups the 63 town councils in and around Paris that operate the scheme. "The main aim was to cut air pollution and reduce the load conventional cars place on the city, while giving people an easy option to use a car when they need one. I think we're making progress."

AUTOLIB' – PARIS, FRANCE
Source: Reuters/Gonzalo Fuentes

OUTLOOK

A study by Navigant Research found that the global carsharing industry grew dramatically from 2008 to 2013 and predicted that it would be worth $6.2 billion by 2020.[1] This includes the proliferation of various business models including university carsharing fleets, peer-to-peer carsharing, one-way carsharing, and services run by vehicle manufacturers. Such developments are transforming people's relationships with cars and could offer a pathway to decrease the economic and environmental burden of personal transport.

[1] navigantresearch.com/research/carsharing-programs

18_NEW MARKET ENTRANTS

Barcelona, Spain → Shaking up the Status Quo

The relative mechanical simplicity of electric vehicles creates opportunities for new market entrants to challenge the long-established dominance of incumbent automotive manufacturers. Few products are as complex to develop and manufacture as fossil-fuelled vehicles, which are assembled with thousands of precisely engineered components and demand extensive global logistics for sales and aftercare. This has given a dominant status to a few global manufacturers and created notoriously high barriers to entry to new market competitors. However, as electric vehicles only use basic motors and gearboxes, with relatively few parts, they are considerably easier and cheaper to both develop and assemble. Moreover, a case could be made that the new business models, products, and services accompanying the introduction of electric vehicles are more likely to come from outside the traditional automotive players that have deeply established procedures and operational norms.

BARCELONA'S EV STARTUPS

One of the world's most active electric vehicle start-up communities can be found in Barcelona, Spain. "The start-up and entrepreneur cultures are widespread amongst Barcelona citizens," explains Ramon Pruneda from the Department of Economic Promotion at Barcelona City Council. "For new start-ups offering EV products and services, we try to help them with different methods, such as the implementation of pilot projects, support to participate in international exhibitions and congresses, and investment forums where we present these companies to different investors and investment networks."

Pruneda explains that this is coordinated through a public-private platform known as LIVE (Logistics for the Implementation of Electric Vehicles) which has a key aim to incubate new start-ups in the city: "We have around 15 EV start-ups offering a range of products across the electric vehicle value chain." This includes: electric scooter manufacturer Motit; companies offering rental services for electric cars (ifRenting) and scooters (eCooltra); specialist EV consulting and engineering firms such as EVECTRA; and Mobecpoint, which manufactures charging stations for electric mopeds and motorbikes. "A key success has been to connect small start-ups like Mobecpoint with larger partners such as Schneider Electric and Iberdrola," explains Pruneda. "We hope that this is just the start and that many innovative businesses will come from Barcelona to capitalise on the new opportunities that electric mobility brings."

OUTLOOK

The shift to electric mobility undoubtedly represents a seismic transformation in the global automotive industry. Companies that have previously competed on their ability to engineer internal combustion engines now require new competences to perfect batteries and electric drivetrains. Further competitive challenges come from new patterns of mobility, changing models of car ownership, and the expected decline in aftersales revenues owing to the relative mechanical simplicity of electric vehicles.

New players offering niche products have already begun to make a mark in the burgeoning electric vehicle industry. Tesla Motors only began producing cars in 2008 and by 2013, its Model S was one of the best selling electric cars in the United States, with the company significantly outperforming established vehicle manufacturers in the stock market. Chinese automotive manufacturers such as BYD are also taking initial steps to expand outside of their home market. However, there have also been a number of notable EV start-up failures—such as Fisker, Think, CODA, and Modec—which demonstrate the difficulty of competing in the automotive sector. Nevertheless, the ability of new players to introduce innovative product and service offerings to reduce costs and increase acceptance of electric vehicles could prove an important element in the widespread adoption of this new technology.

19_LIGHTWEIGHTING

Munich, Germany → When Less is More

Weight is one of the most important factors in any vehicle's performance, range, and price. The heavier the vehicle, the less mileage it will get out of its powertrain. For electric vehicles, this is especially critical. Simply increasing the size of the battery may increase range, but each kilowatt-hour of additional battery capacity increases the weight and the total cost of ownership. To capture price sensitive buyers, the industry is implementing measures to cost effectively increase range while maintaining safety and performance. A particular area of focus is the potential offered by lightweight composites, metals, and plastics.

BMW'S LIGHTWEIGHT ELECTRIC VEHICLES

The 2014 international release of the BMW i3 signalled a new strategic priority for the Munich-based company's manufacturing of vehicles. Lightweight electric vehicles, according to BMW, will play a key role in its future design and production. The i-series, which also includes the higher end i8 model, uses carbon fibre and other lightweight materials to extend range and performance of its battery electric vehicles. This enabled BMW to design a car that is 20% lighter than the similarly sized Nissan LEAF. The i3 nearly matches the LEAF in range but utilises a battery that is significantly smaller. With an 18.8kWh battery pack, the i3 achieves an average range (130 km) that has required much larger batteries in comparable vehicles.

Just as innovative as the vehicle itself is BMW's production strategy for integrating new lightweight materials into the i3. The vehicle manufacturer built a carbon fibre production facility in Moses Lake, Washington, where they source 100% of their electricity from renewables. The carbon fibre is then shipped to Germany, where the vehicles are manufactured in the BMW plants. Furthermore, to reduce the costs of material sourcing, BMW formed a joint venture with SGL Group, a producer of carbon fibre. Through an advanced production process, BMW forms, bonds, and assembles the carbon fibre parts in half the time that it takes to produce a comparable fossil-fuelled vehicle. The result of BMW's ground-up design process is a vehicle with superior range that weighs over 454kg less than comparable electric vehicles built on a pre-existing frame.

BMW I3
Source: BMW Press Group

OUTLOOK

In response to vehicle mileage and emissions standards, and to secure a competitive advantage in the burgeoning electric vehicle market, vehicle manufacturers are beginning to embrace lightweight materials and design. As these practices become more commonplace, developments in manufacturing processes will enable an increasing number of vehicle manufacturers to take advantage of lightweight composites, metals, and plastics. These lightweight constructions will enable existing batteries to achieve greater distances, and for existing EV ranges to be achieved with smaller batteries. In doing so, this should reduce the cost of EVs and enhance performance, safety, and energy efficiency. This in turn will create new opportunities to achieve widespread adoption of battery powered electric vehicles.

20_RANGE EXTENDERS

Denmark → Pushing Boundaries

Auxiliary power units can be combined with EV battery packs to extend the driving range of an electric vehicle. The first generation of these range extenders are small fossil-fuelled internal combustion engines, found in vehicles such as the BMW i3 and the Audi A1 e-tron. However, in the longer-term, technologies such as fuel cells could offer lower emission solutions to enhance the range and performance of electric vehicles.

DANISH COMPANIES DEVELOP METHANOL FUEL CELL FOR EVs

A consortium of Danish companies are piloting the use of methanol fuel cells in electric vehicles. The project, known as "MECc" (Modular Energy Carrier concept), was launched in Autumn 2012 with funding from the Danish government. MECc aims to produce a prototype electric vehicle that integrates a liquid-cooled, high temperature polymer electrolyte membrane fuel cell module, with an integrated methanol reformer.

The project combines the know-how of three Danish companies: ECOmove, who develops engineering solutions for electric vehicles; Serenergy who design and manufacture fuel cell stacks; and Insero E-Mobility, a cluster organisation with specialist expertise in electric vehicles.

"When using liquid methanol to power the fuel cell, an electric car, in principle, can have a range of up to 800km," said Mads Friis Jensen, a commercial group manager at Serenergy. "This requires a tank size of 40-50 litres, which we now know from petrol and diesel cars." Jensen explains that the ambition is that a smaller battery pack and fuel cell will eventually be produced at the same price as an internal combustion engine.

In addition to optimising the fuel cell technology for automotive applications, the consortium is also working on full system integration including fuel, heat-utilisation and management, power management, and software. A further key consideration is the refuelling infrastructure. MECc uses an ethanol/water mix which eliminates many of the difficulties associated with the provision of compressed gases such as hydrogen: "Methanol can be transported in the same tank trucks and can also be refuelled in the same way as petrol and diesel. Thus, methanol is much easier to handle than, for example hydrogen, which must be kept under high pressure," says Jørgen Wisborg, CEO of the energy company OK, which recently launched a project with Serenegy and fellow Danish company Hamag A/S to test methanol infrastructure for EVs. "We see a wide energy market, because the future is likely to hold a palette of energy, and we see methanol as an option, because it is a liquid energy source that can be handled as we know it today," said Wisborg.

OUTLOOK

Globally, transport is the least diverse end-use sector in terms of fuel. Most future outlooks for transport recognise that a mix of fuel sources will contribute to the gradual phasing out of the dominance of petrol and diesel. However, there is a common misconception that this is a zero sum game, with different fuel types competing against each other for future market share. The basic architecture of a battery electric vehicle provides a platform to integrate a range of different fuel sources such as hydrogen, methanol, and natural gas. Hence advances in EVs and battery technologies will create new opportunities to further diversify transport fuels. Moreover, developments in range extender technologies offer potential to further enhance the range, performance, and cost of electric vehicles.

SIEMENS' eHIGHWAY TEST TRACK – GROSS DÖLLN, GERMANY
Source: Siemens

21_ELECTRIFYING HEAVY GOODS VEHICLES

Gross Dölln, Germany → Developing Electric Highways for Road Freight

In many countries, long-haul truck traffic is concentrated on distinct corridors, presenting opportunities for targeted deployment of solutions for electrification. For example, in France and the U.S., more than 50% of long-haul trucking activity takes place on just 2.5% and 17% of highway infrastructure, respectively.[1]

There are also compelling reasons to tackle emissions from these vehicles. While heavy duty trucks typically only represent a small percentage of a region's vehicle fleet, they emit a disproportionate share of certain pollutants such as particulate matter and nitrogen oxides. In addition, many trucks have lifespans of 20 years or longer, meaning that even when emission standards are implemented for new vehicles, it will be decades before the oldest and highest-emitting vehicles are retired from service.[2]

SIEMENS eHIGHWAY PROJECT

"Road freight has long been a blind spot in electric mobility," explains Patrik Akerman, Business Developer for Siemens' eHighway project. "The weight of these vehicles and the distance that they travel means that they present very different challenges when it comes to electrification. Our approach in eHighway is to use a catenary system (overhead wires) to dynamically deliver power to trucks while they are driving."

Catenary systems are widely used in a variety of heavy duty applications, including trains and buses, meaning that the technology and expertise already exists. However, according to Akerman, "it's only recently that hybrid electric drive technology has matured to provide a cost-effective truck that could operate on and off the catenary line. Our solution enables the trucks' pantograph to be retracted from the overhead wires when needed, giving full flexibility to truckers, without tying them to a single route."

Siemens has developed a two-kilometre test track in Gross Dölln outside Berlin. Three heavy goods vehicles (HGVs), including one developed with Swedish truck manufacturer Scania, have been tested under various driving and weather conditions. While the trucks would need to drive outside of the catenary using another fuel for the last-mile, Siemens estimates overall system efficiency to be twice as high as for conventional diesel trucks.

OUTLOOK

In addition to catenary lines, a variety of other solutions are being developed for delivering power to long haul trucks. For example: Volvo is trialling ground based contact wires, known as "slot roads", in Gothenburg, Sweden; a number of studies are evaluating the potential of contactless or inductive systems; furthermore advances in on-board storage through batteries, supercapacitors and fuel cells will also create new opportunities for the electrification of heavy duty road freight.

With industrialisation and globalisation stimulating freight transport, it is expected that use of heavy duty trucks will grow at an annual rate of 2.7% between 2000-2030.[3] Moreover, the promise of solutions that offer lower operational costs to freight operators—through reductions in fuel and maintenance expenditures, as well as longer vehicle lives—there is potential that these savings may offer a way to offset the necessary infrastructure investment as well providing a significant decrease in global road transport emissions.

[1] (IEA) ETP 2014
[2] theicct.org/sites/default/files/publications/ICCT_HDV_in-use_20130802.pdf
[3] World Business Council for Sustainable Development (2004) Mobility 2030: Meeting the Challenges to Sustainability

22_COLLABORATION AND PARTNERSHIPS

Global → Partnerships to Drive Innovation and Create Markets for EVs

Governments and vehicle manufacturers cannot independently do everything that is required to achieve widespread adoption of EVs. It demands a combination of diverse resources and expertise across far-reaching networks, which extend well beyond traditional industry boundaries and policy silos.

RENAULT-NISSAN'S GLOBAL PARTNERSHIPS

CARLOS GHOSN, CEO OF RENAULT NISSAN ALLIANCE
Source: Nissan News

Since 2008, the Renault-Nissan Alliance has established 100 zero emission cooperation agreements in 20 countries around the world. "From the very beginning we realised that we could not achieve our ambitions for zero emission mobility on our own," explains Olivier Paturet, Head of Nissan's Zero Emission Strategy in Europe. "We understood the need to work with partners to embrace and support EV deployment."

These partnerships have developed at multiple levels. The first is that vehicle manufacturers have relied heavily on their supply chains for research and development, arguably more so than with internal combustion engine vehicles. For example, the lithium-ion battery technology used across Renault and Nissan's electric vehicles is the product of a joint venture with Japan's NEC Corporation. Paturet explains that this "combines NEC's expertise in cell-technology and electrode production with Renault-Nissan's long experience of real world vehicle applications."

Vehicle manufacturers have also formed alliances which have seen them simultaneously co-operating and competing with each other. Renault-Nissan, for example, has a joint venture with German manufacturer Daimler to share vehicle platforms, battery technologies, and production facilities.

In addition, EVs have given impetus for manufacturers to form partnerships with industrial players outside of the traditional automotive sector such as utilities, charge point manufacturers, and other specialist technology companies. One such joint venture is between Renault-Nissan and Japan's Sumitomo Corporation, which is developing second-life applications of EV batteries in Japan.

The final key area of Renault-Nissan's collaborative ventures has been public-private partnerships, many of which have focused on the build up of recharging infrastructure. "Deploying EV charging infrastructure ideally needs the joint engagement of local authorities and commercial partners to ensure that locations are visible. We have been promoting such schemes from the onset," explains Paturet. "Cities and regions are better placed to make this happen, but we see an opportunity to help them in the process."

OUTLOOK

Vehicle manufacturers have forged collaborations at various levels around the world. Cities, regions, and national governments have also initiated important partnerships to advance markets and technologies for EVs. The continued effectiveness of all these far reaching alliances is likely to be a key factor in firmly establishing the nascent market for EVs.

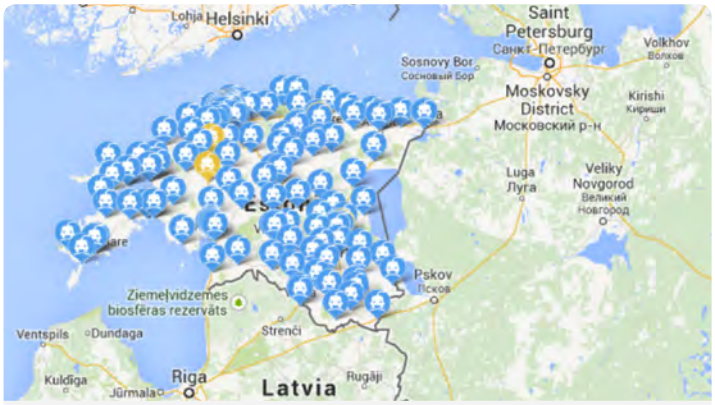
23_EXTENDING ALL-ELECTRIC JOURNEYS

Estonia → Strategically Located Fast Charging Enables Long Distance Travel

While today's electric vehicle batteries offer sufficient capacity for the majority of car journeys undertaken in the world, the ability to travel greater distances and between cities is highly valued by consumers. The provision of infrastructure to extend all-electric journeys has therefore emerged as a key priority for industry and policymakers around the world.

There are different ways to extend the journeys that are achievable in an EV. Battery swapping has the potential to allow vehicles to be recharged with comparable speed to refuelling an internal combustion engine vehicle. The long-term potential of dynamic charging on motorways is also being explored. However, the strategy favoured by most global vehicle manufacturers today is fast charging.

ESTONIAN ELECTROMOBILITY PROGRAMME



EV FAST-CHARGING NETWORK – ESTONIA
Source: ELMO, Electromobility in Estonia

The Baltic state of Estonia was one of the first countries to roll out a nationwide network of fast chargers, installing 165 fast chargers for a population of 1.3 million. This provided each town with a fast charger as well as charging stations every 40 to 60km. These stations can recharge an EV battery up to 80% in less than 30 minutes. Depending on the model of car, a driver could travel for over 100km in a battery electric vehicle.

A national foundation, KredEx, is responsible for the operation of all stations providing a uniform payment solution and technical support across the country. EV users have different service packages to choose from, with the pay-as-you-go cost to recharge of between €2.5 and €5; or a €30 fee for a monthly package for unlimited charging at no extra cost.

The construction of the network was financed by the Estonian government selling excess CO2 emission quota credits[1] to the Mitsubishi Corporation. This also funded a wider electric mobility programme which allowed the government to buy over 500 all-electric Mitsubishi iMiEVs for its own fleet, provide a €1,000 grant for installing charge points at home, and a consumer purchase incentive of up to €18,000 or 50 percent of the value of the car.

OUTLOOK

The global deployment of strategically located fast charging networks is picking up pace. Japan has over 2,000 fast chargers installed across the country today. Multi-standard fast charging corridors are being deployed to support the technologies developed by the main vehicle manufacturers, with notable examples including Norway, the Netherlands, and the UK. Tesla is rolling out its own supercharger networks and Chinese vehicle manufacturers are also exploring their own fast charging standard. These developments are allowing EVs to easily travel between cities and providing comfort to drivers on shorter journeys that they can quickly top-up their batteries should the need arise.

[1] Estonian Ministry of the Environment (2013) "Estonia's Sixth National Communication Under the United Nations Framework Convention on Climate Change" unfccc.int/files/national_reports/non-annex_i_natcom/application/pdf/est_nc6.pdf

24_CURTAILMENT

Orkney Isles, Scotland, UK → Making Full Use of Existing Renewable Capacity

Transitioning transport fuels from hydrocarbons to electrons can create a controllable and flexible demand for electricity that will play an important role in overcoming curtailment of renewable energy. This is where operational or grid constraints force generators to accept less renewable energy than is available.

In a world where energy efficiency is paramount, this creates the counterintuitive situation that in some cases increasing electricity consumption is actually good for the planet. This essentially comes down to how the electricity is generated, when it is used, and importantly what fuel source it is replacing. EVs offer a perfect example, with the potential to refuel with green electricity at times that match the intermittent supply from wind, solar or other renewable sources, and to displace highly polluting fossil fuels.

ORKNEY'S HIGH RENEWABLE GRID

BURGER HILL WIND FARM – ORKNEY ISLES
Source: K4 Graphics

Experience in the Orkney Isles, located off the north coast of Scotland, highlights that there is a sound economic argument for matching renewables and electric vehicles. In 2013, 103% of the local demand from the islands was generated from renewable sources, predominantly community owned on-shore wind turbines. Despite having the world's first active network management system, which controls the changing generation and demand loads to extend the amount of renewables that can be absorbed by the grid, Orkney's network is heavily constrained. "We have about 5MW of renewable energy that cannot be absorbed at peak times, so turbines have to be curtailed," explains Councillor James Stockan from Orkney Islands Council. "This means we're failing to make full use of our renewable assets and our small community of just 22,000 people is losing millions of pounds of revenue a year."

Councillor Stockan believes that one of the reasons that EVs are beginning to prove popular is that many islanders own wind turbines: "People in Orkney know exactly how much money they're making or losing every time a turbine blade turns. If they can charge their battery at a time when renewable electricity would otherwise be wasted, receive payment for that through feed-in tariffs and save on the price of a tank of petrol then the economics really do speak for themselves."

OUTLOOK

Curtailment is a growing concern in the wind and solar industry around the world. This especially applies in markets where there is limited opportunity to export this energy to where it is needed or where curtailment events are not compensated. Moreover, failures to maximise the available generation potential of existing wind and solar assets makes it more difficult to hit renewable energy generation targets and also often results in generators defaulting to more expensive resources.

Moving away from fossil fuels to increased electrification of transport offers an effective way to create a more flexible and controllable demand to absorb this additional renewable energy. It is also a decision over which individuals and communities have direct control.

25_BATTERY SWAPPING

Hangzhou, China → Extending Mileage and Duty Cycles of EVs

Battery swapping provides a means to quickly exchange a depleted EV battery for a fully-charged one, offering convenience to drivers, and extending EV range in ways similar to the refuelling process now used by fossil-fuelled vehicles. These advantages are seen to offer considerable benefits for high mileage applications where taking vehicles out of service to recharge for extended periods has a real economic cost or compromises service provision. This includes applications such as urban taxi fleets, buses, and delivery vehicles.

HANGZHOU'S ELECTRIC TAXIS

In the city of Hangzhou, China, there are currently about 500 electric taxis criss-crossing the streets, stopping only to pick up passengers and switch batteries. The taxi fleet, which started operation in 2009, has logged 34 million kilometres so far. The daily coverage of one electric taxi is about 230km. During normal operation, a taxi's battery will be swapped about 2-3 times per day at swapping depots located throughout the city, provided by State Grid Corporation of China, the nation's largest power provider.[1]

The switching process is semi-automatic, using two workers and one mechanical arm, and takes about five minutes to complete. When being recharged at the main switching hub, the batteries are also capable of storing power and balancing grid loads.

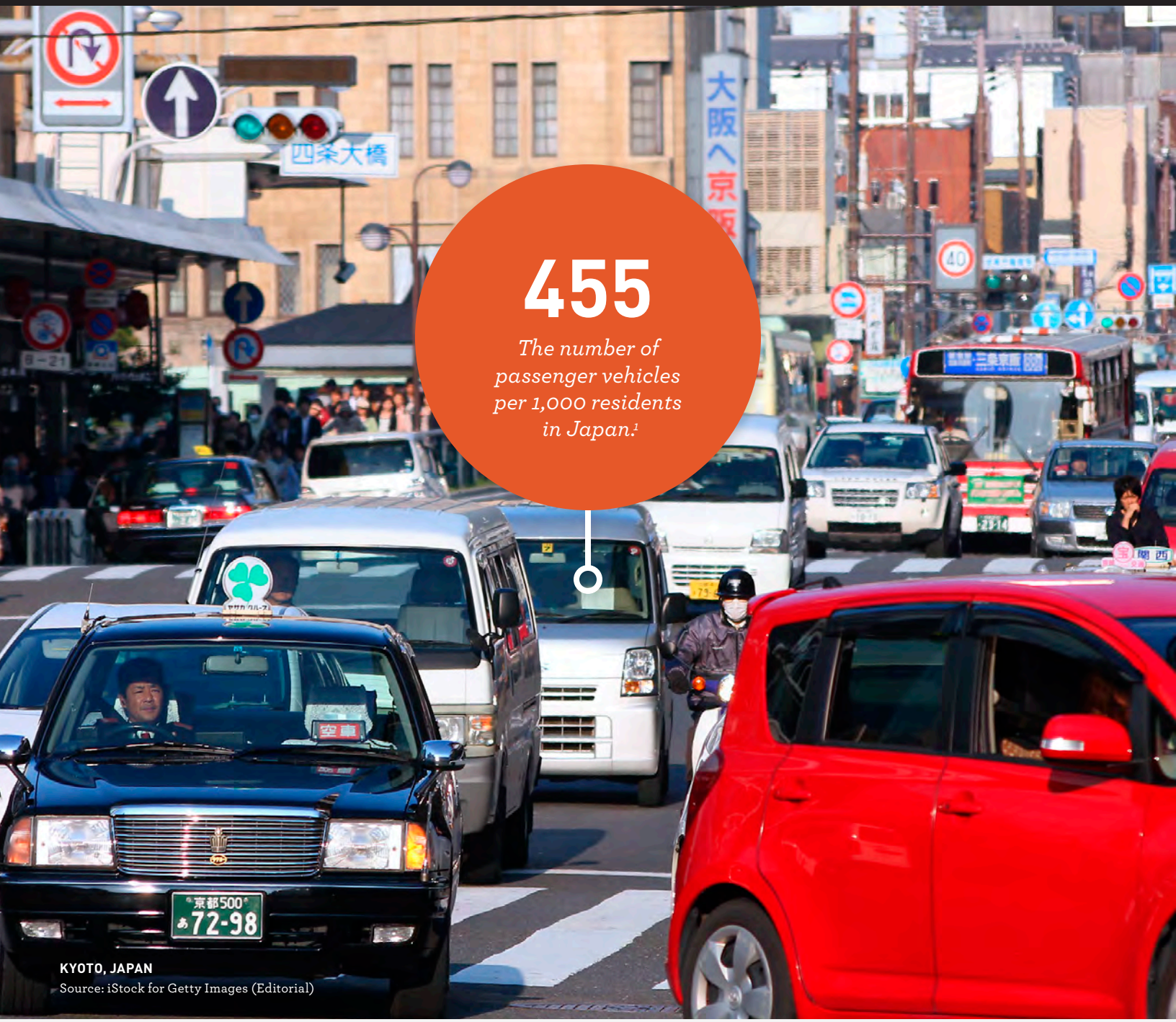
The electric taxis have proved to be popular with passengers owing to the quiet, smooth ride and wide carriage. The goal over the next year is to increase the city's fleet to 1,000 electric taxis.

OUTLOOK

Battery swapping is becoming more common in other Chinese cities as well, such as Shenzhen and Beijing. It is also finding a place in China's growing electric bus fleets. In Qingdao, for instance, a fully-automated process for swapping e-bus batteries takes only seven minutes.

Outside of China there are a number of other notable proponents of battery swapping. Tesla has announced plans to open swapping stations alongside its supercharger network in California; Slovakian company GreenWay has developed a network of swapping stations for its delivery vehicles; and a battery exchange system has been developed for an all-electric bus in Taiwan. However, the technology is not without its challenges. For example, concerns have been raised over the difficulty of standardising batteries across different manufacturers, the potential local grid impacts of swapping high volumes of fully charged batteries, and the compromises to the battery pack and other aspects of the vehicle needed to facilitate an easily exchangeable battery. Nevertheless, it appears that the promise of quick and convenient EV refuelling is starting to become a reality in a number of applications, particularly in China. Given the massive potential of China's EV market, this could bode well for the future of battery swapping generally.

[1] electronicsnews.com.au/features/battery-swapping-becoming-common-practice-for-comm

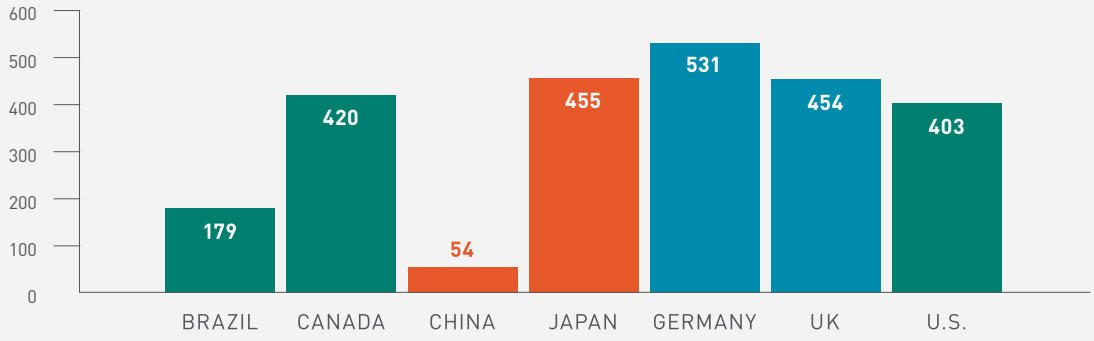


455

The number of passenger vehicles per 1,000 residents in Japan.[1]

KYOTO, JAPAN
Source: iStock for Getty Images (Editorial)

PASSENGER VEHICLES PER 1,000 PEOPLE[1]



[1] Source: data.worldbank.org/indicator/IS.VEH.PCAR.P3. Passenger cars (per 1,000 people). Passenger cars refer to road motor vehicles, other than two-wheelers, intended for the carriage of passengers and designed to seat no more than nine people (including the driver). Data for all countries from 2011, except Brazil and Canada (2009).

26_MANAGED CHARGING

Kyoto, Japan → Influencing Behaviours to Control Energy Demand and Avoid Cluster Charging

Centrally managed demand response strategies are being developed to address the cluster effect where multiple electric vehicles charging in a community can place a strain on local distribution grids. Managed charging discourages EVs from plugging-in at times of peak demand, avoiding local distribution problems such as power overloads and feeder congestions.

KYOTO: EV CHARGING MANAGEMENT CENTER

In Kyoto (Kansai Science City), Japan, an EV Charging Management Center (EVC) has been established to study ways to control the demand curves from electric vehicles in a defined community. The EVC collects data such as location and remaining battery level of 100 EVs connected to a 3G network, and forecasts power demand for battery charging. Next, the EVC sends out DR (demand response) requests to EV drivers via email and car navigation system displays, asking them to avoid charging their vehicles, or to charge their vehicles during specified time frames at a given location. If participants adhere to DR requests, they are provided with shopping points as an incentive.

The project is part of a wider $11.8 million initiative led by Mitsubishi Heavy Industries, with the EVC operating alongside home and building energy management systems to optimise energy supply and demand for the entire community. The attempt to distribute demand response requests was started in the winter of 2012 and showed high conformance rates amongst the trial participants. During a three-hour peak demand period, a recharging volume reduction of approximately 12% was achieved in the summer of 2013.

OUTLOOK

Many countries today have sufficient generation capacity to support large-scale adoption of electric and plug-in hybrid vehicles. For example, researchers at the U.S. Department of Energy's Pacific Northwest National Laboratory have calculated that the grid has enough excess capacity to support over 150 million battery-powered cars, or about 75% of the cars, pickups, and SUVs on the road in the United States.[2] However, as electric vehicle sales are not evenly distributed, cluster charging in neighbourhoods will become increasingly common. Moreover, vehicle manufacturers seeking to differentiate their vehicles by how fast they can charge could place an additional strain on the grid.

Data gathering and analytical intelligence to forecast and control any increased demand from EV charging will reduce the need for additional expansion and reinforcement of local distribution grids. Trials around the world are showing the potential to shift demands to times of day that are more favourable to energy systems. Influencing behaviours in this way requires innovative communication and reward strategies that motivate positive behaviours, as well as international demand response standards to guide such developments.

[2] technologyreview.com/news/518066/could-electric-cars-threaten-the-grid/

27_SELF-DRIVING VEHICLES

Mountain View, California, U.S. → EVs Provide Ideal Platform for Driverless Cars

The development of autonomous self-driving technologies could give EVs a further advantage over equivalent fossil-fuelled vehicles. This is the case because EVs provide an ideal platform for autonomous vehicles, with the mechanical nature of the electrical motor, drivetrain, and battery being far more responsive to signals and manipulation than internal combustion engine vehicles. This makes battery electric vehicles better equipped to operate in the conditions necessary for automated fuelling and speed variation. For example, as EVs do not coast in the way that petrol-powered vehicles do, they are better able to autonomously adjust their speed according to changing traffic dynamics. As Nissan spokesman Brian Brockman notes: "Electric cars are well suited to autonomous drive (AD) because all actuators are already electrified with precise controllability."[1]

GOOGLE'S AUTONOMOUS ELECTRIC VEHICLE

In Mountain View, California, search engine and technology giant Google launched its self-driving car project to tremendous fanfare. In 2012, the company released a now famous YouTube video of a blind man behind the wheel of a driverless car, navigating city streets and even ordering a meal from a fast food restaurant. Since then, the company has continued to grow its programme. Its original vehicles were adapted from existing models, such as the Toyota Prius, with bolt-on sensor technology. Recently, the company produced 100 electric, self-driving prototypes. The vehicles are powered by an electric motor, with a range of 160 kilometres, and can be called upon with a smartphone—arrive to their destination without a steering wheel, pedals, or manual controls. Built in sensors and global positioning system enable the vehicle to see up to 183 metres in every direction and to easily navigate urban streets.

GOOGLE'S SELF-DRIVING CAR PROTOTYPE
Source: Google

OUTLOOK

"The responsiveness and highly accurate controllability of the battery electric power train make the EV advantageous for autonomous vehicle operations, particularly at lower speeds—for example, self-parking in congested parking lots," says Gereon Meyer, Head of Strategic Projects for VDI/VDE Innovation + Technik GmbH. "An automated valet parking system in combination with inductive charging, where an EV is positioning itself on the primary coil, is an obvious example of a synergistic application of electrification and automation."

Advanced driver assistance features that can enable semi-autonomous driving are now being brought to market for the first time. Features such as self-parking, crash avoidance technology, lane keeping, and automated steering are being offered on increasing numbers of luxury and mid-range vehicles. This trend is expected to continue, with Navigant Research forecasting that 94.7 million autonomous-capable vehicles will be sold annually around the world by 2035.[2] With EVs providing the ideal platform for these technologies, this may encourage an increasing number of motorists to choose to drive electric.

[1] plugincars.com
[2] navigantresearch.com/research/autonomous-vehicles

28_EVs AND TOURISM

Zermatt, Switzerland → EV Only Tourist Destinations

Tourism is one of the most pollution-sensitive economic sectors. Failure to reduce noise and emissions from road transport could have profound consequences for tourism flows and the associated economic opportunities that this brings.

Many tourist destinations are dependent on climate as their principal attraction to visitors, or on environmental resources such as wildlife and biodiversity. At the same time, tourism also contributes to global warming, accounting for an estimated 5% of global carbon emissions.[1] Cars are responsible for around a third of these CO2 emissions and therefore present an important opportunity to combat a major threat to the industry, as well as preserving the natural environment and cultural heritage that is so important to this sector.

ZERMATT: AN EV ONLY RESORT

The world famous Swiss resort of Zermatt has restricted access to combustion engine vehicles to the town since 1966. With more than 500 electric vehicles as the main source of transportation, Zermatt offers long-established experience for other tourist destinations to follow.

"The town council issues special permits to residents wishing to own small electric vehicles," said Philipp Walser of the Swiss Association e'mobile. "Taxis and hotel owners are also eligible for EV permits but this depends on strict conditions such as the size of the hotel, number of guests, and the availability of parking."

Walser explains that any non-electric vehicles have to be parked on the northern outskirts of the town. Tourists arriving by public transport are either met by an electric taxi or one of eight electric buses that run on two circular lines.

Zermatt also uses electric vehicles for freight distribution: A depot on the outskirts receives freight from road vehicles and this is transferred to electric urban vehicles. Freight is then distributed around the town in a number of ways, including hand-towed electric carts and small electric lorries.

Zermatt is one of a number of Swiss resorts that are heavily marketed as a "no car" destination. Such measures are seen to be essential in preserving the relaxed holiday atmosphere and the romantic character of a quiet, stress-free, safe, and clean Alpine idyll.

ZERMATT, SWITZERLAND
Source: iStock by Getty Images

OUTLOOK

In a world where travellers are increasingly mobile, there is heightened global competition between tourist destinations, as well as a need to protect and develop this sector, which is a major contributor to many local and national economies. Governments, resorts, and destinations are realising the imperative to reduce the environmental footprint of tourism activities and to protect and enhance the assets on which the future of this industry depends.

[1] dtxtq4w60xqpw.cloudfront.net/sites/all/files/docpdf/climatechange.pdf

29_LEAPFROGGING FOSSIL FUELS

South Africa → First Time Car Buyers Go Straight to EVs

Developing cities and countries have to reconcile how to accommodate the intense desire for personal mobility while mitigating the heavy economic, environmental, and social costs this could bring. For UN Secretary-General Ban-Ki Moon the solution lies in bypassing fossil fuels and going straight to cleaner technologies such as electrification. "Developing countries can leapfrog conventional options in favour of cleaner energy solutions," wrote Moon in 2012,[1] "just as they leapfrogged land-line based phone technologies in favour of mobile networks."

As well as being an admirable aspiration, leapfrogging fossil-fuels could also bypass some of the perceived barriers to electrification. Negative stereotypes, range anxiety, and concerns over the availability of public infrastructure are to a large extent socially constructed barriers born in cultures that have been locked into fossil-fuelled motoring for generations. For citizens in developing countries making the leap from buses and bicycles to motorised personal travel, low cost electric mobility can offer a highly attractive solution.

SOUTH AFRICA'S ELECTRIFICATION ROADMAP

South Africa, a 2002 signatory to the United Nations Framework Convention (UNFCC) on Climate Change and the Kyoto Protocol, and the 2011 host of UNFCC's 17th Conference of Parties (COP17) often plays an influential role in international negotiations representing developing countries and Africa. However, South Africa also has the dubious status of being Africa's largest emitter of greenhouse gases, contributing 42% of total emissions on the continent.

In 2010, South Africa had an equivalent of one car for every six people in the country, while in the United States this stood at around 1.2 people per car[2]. "As development takes place so the demand for transportation will increase," said Dr. Rob Davies, South Africa's Trade and Industry Minister speaking in 2013 at the launch of South Africa's Electric Vehicle Roadmap[3].

The roadmap outlined measures to incentivise automotive manufacturers to produce EVs in the country, support R&D and pilot the deployment of EVs and charging infrastructure.

It may come as little surprise that the birth country of Tesla's chief Elon Musk has a long association with electric vehicles. "South Africa has been developing EV technologies since the 1970s," explains Carel Snyman from South African National Energy Development Institute. "The lithium-ion ZEBRA battery was developed in South Africa and is now used around the world." Snyman also cites a number of more recent developments including a 20-seater electric game viewing truck.

OUTLOOK

Many emerging economies are facing the pressures of rapid industrialisation, population growth, increased personal motorisation and large-groups of low-income travellers. This means that the timeline for transportation system development is compressed compared with more affluent cities and nations, providing an opportunity to leapfrog fossil fuel fuels in favour of electrification. This also has the parallel benefit of sharpening focus on the need for additional energy demand to be satisfied with clean energy, with EVs ultimately likely to prove a valuable asset in supporting increased grid penetration of renewables. In the words of Ban-Ki Moon, "Industrialised countries can and should support this transition to low-emission technologies, not least through their own example."

[1] nytimes.com/2012/01/12/opinion/powering-sustainable-energy-for-all.html?_r=0
[2] data.worldbank.org/indicator/IS.VEH.NVEH.P3
[3] youtube.com/watch?v=SjEdvZLJ9xI

30_THE CAR BUYING EXPERIENCE

Palo Alto, California, U.S. → Reinventing the Experience of Buying a Car

Direct-to-customer sales through online platforms and boutique stores has been a cornerstone of the highly succesful global strategy of technology giant, Apple. Emulating this approach in the automotive industry represents a radical departure from the tradition of selling through large showrooms owned by independent franchised dealerships on the outskirts of towns.

TESLA'S DIRECT TO CONSUMER STRATEGY

TESLA STORE – NEWPORT BEACH, CALIFORNIA, U.S.
Source: Tesla Motors

Tesla Motors has drawn direct inspiration from the success of its Palo Alto neighbour and appointed the architect of Apple's retail strategy, George Blankenship, to reinvent the car buying experience. Like Apple, Tesla's network of over 100 stores in 18 countries are stylish and inviting showrooms which adopt a soft-selling approach, with touchscreens and customer-focused specialists on-hand to answer questions rather than make a sale.

Tesla cites a number of advantages to this approach. Smaller stores in shopping malls enjoy greater foot traffic than the traditional out-of-town showrooms and also provide capital efficiencies through reduced inventory and floor space. Retaining ownership of retail channels also gives Tesla more control of its marketing expenses and brand image around the world.

The expectation that there will be less service-related income for EVs, due to their relative mechanical simplicity, also means that parts and maintenance services can be centralised. This provides further cost savings, but also exposes that traditional dealerships face a major disincentive when it comes to selling EVs, with Penske Automotive Group reporting that parts and maintenance represented 52% of an average U.S. car dealer's gross margin .[1]

OUTLOOK

Direct online sales and the boutique retailing experience have previously been unsuccessfully tried by automotive manufacturers, such as with Daimler's Smart cars. However, just as only a few companies in the consumer electronics sector have pursued comparable retail strategies to Apple, it is unlikely that in the short-term Tesla stores will spur an industry-wide change in the way cars are sold.

Rather, the significance of Tesla's retail strategy is twofold. Firstly, the need to establish a comprehensive network of dealerships and the associated global logistics for parts and maintenance has long been cited as a key barrier to new market entrants to the automotive industry—aside from current restrictions in a number of U.S. states,[2] it appears that for electric cars this is no longer the case.

Secondly, the real success of Apple stores has arguably not been in selling products but rather their contribution to shaping a brand that has helped to create global markets for new consumer technologies such as MP3 players, tablets, and smart phones. On this basis, should Tesla's marketing strategy achieve anything close to this success, then the latest aspirational lifestyle products to come out of Palo Alto are likely to offer similar industry-wide benefits.

[1] forbes.com/sites/jimhenry/2012/02/29/the-surprising-ways-car-dealers-make-the-most-money-off-of-you

[2] While automotive manufacturers owning retail outlets is a common and long-established practice in many places around the world, Tesla has encountered difficulties in rolling out this strategy in its native U.S., where a number of States prohibit manufacturer-owned 'factory stores'. This has resulted in legal challenges from dealership associations across the country.

KANDI PUBLIC EV CAR SHARE – HANGZHOU, CHINA
Source: Kandi Group

31_EV VENDING MACHINES

Hangzhou, China → EVs on Demand

Electrification of road transport on its own does not solve the increasing problems of congestion and limited parking in many cities around the world. However, new parking and carsharing models are being developed to help address these problems.

HANGZHOU'S KANDI MACHINES

Hangzhou, on the south eastern coast of China, is home to the world's first EV vending machines. These automated multi-storey vertical garages are part of a city-wide carsharing scheme that enables users to hire a fully charged electric vehicle at the push of a button. Launched by Kandi Technologies in 2013, users can hire an ultracompact EV with a range of 75 miles for around $3 per hour and drop it off at another Kandi station near their destination. The charging/parking towers are located at airports, train stations, hotels, business centres, selected residential areas, and other places that are typically congested.

"The Kandi public EV CarShare concept is based on Hangzhou's bikeshare, the largest bikeshare in the world and the first of its kind in China," explains documentary-maker Aaron Rockett who brought the EV vending machines to the attention of Western media in early 2014. It was reported in mid-2014 that there were around 50 of these garages in Hangzhou. "Kandi's plan is to build 750 of these garages in just the City of Hangzhou over the next four years through a 50-50 joint venture with Geely Automotive, China's largest passenger vehicle manufacturer. This would require some 100,000 electric vehicles to stock them,"[1] said Rockett.

With only 10 percent of the 1.35 billion people in China owning a car, and strict license plate controls designed to restrict purchases of new cars in Chinese cities, Kandi sees significant potential in this model. In August 2014, Kandi introduced over 200 EVs to a new car share scheme in Shanghai and has announced plans to expand the model to other cities and regions such as Shandong and Hainan.

OUTLOOK

China's rapid economic development has brought the issue of cars to the forefront of a number of policy discussions. However, many cities around the world face similar challenges. Rapidly growing urban populations, high density housing, limited parking opportunities, road congestion, and pollution are all forcing cities to develop new solutions to meet the needs for personal mobility without further adding to these problems. Parking lots full of EVs allows car share operators to provide convenient access to shared vehicles as well enabling cost effective servicing and maintenance of the fleet. Furthermore, locating the EV parking towers in densely populated areas offers interesting opportunities for smart charging strategies and management of often stressed local grids.

[1] aaronrockett.com/?p=447

32_EV READY BUILDINGS

Koto City, Japan → Installation of Charging Infrastructure in New Developments

The growth in markets for EVs will both demand and be supported by the provision of necessary wiring and electrical infrastructure for recharging in new residential and commercial developments. Making such provisions in new builds and major redevelopments can offer significant savings compared to retrofitting charge points. As a result many cities are implementing policies to encourage or mandate the installation of charging infrastructure in new developments.

ELECTRIFYING CONDOMINIUMS IN KOTO CITY

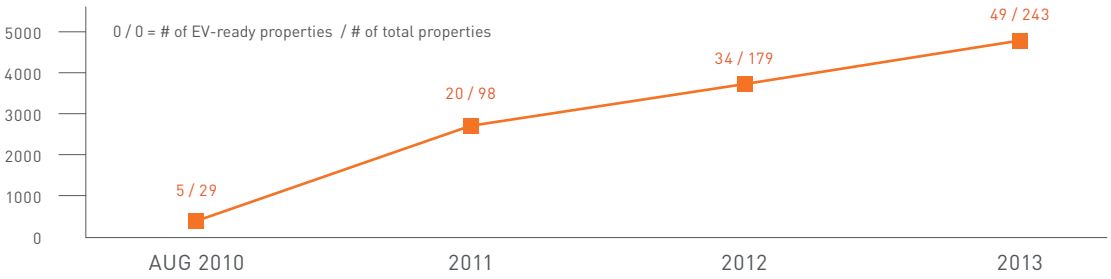
Japan's Koto City, located on the waterfront of Tokyo Bay, recently set a policy of installing charging stations at 10% or more of parking spaces in newly constructed condominiums. Koto has placed significant emphasis on multi-unit dwellings, in which 80% of its population currently resides. Every year, approximately 70 new apartment blocks are constructed in Koto, with even more construction on the way, especially as almost half of the venues for the 2020 Summer Olympics are located in Koto. It is expected that more than 100 apartment complexes will install charging stations in Koto over the next six years.

The last time Japan held the Games in 1964 coincided with a number of major infrastructure projects that transformed the face of Tokyo and the nation, such as the famous bullet train. This time around a key focus is on energy efficiency and new technologies to establish the Tokyo Metropolitan area as a Low Carbon City. This includes a fully integrated charging network that enables residents and visitors to easily drive an electric vehicle throughout the Tokyo area. By installing charging stations at the time of construction, the city is able to make better provision for the changing needs of its citizens, significantly reduce costs, simplify the installation process, and avoid any future disruption to residents. "It is very important that new apartments install charging stations at the time of construction, because it takes 40-50 years to apartments to carry out a repair work after construction," said Ayaka Oonishi from Koto City's Environmental Control Office.

OUTLOOK

Making such provisions requires supportive urban planning regimes and educated developers, building owners, and architects who understand the imperatives and opportunities of anticipating future needs for EV charging. In places like Koto this is seeing routine installation of dedicated circuits and charging units in new developments. However, as a minimum, increasing numbers of EVs will mean that all new buildings should be designed with appropriately sized service conduits to accommodate future necessary electrical infrastructure for recharging. Better understanding these needs may also encourage building designers to make allowances for on-site energy generation, storage, and management systems which reduce or eliminate the need for improvements to the local electricity grid resulting from increased adoption of plug-in vehicles.

EV CHARGING IN KOTO CITY MULTI-UNIT RESIDENCES



If the current pace continues, 100 new multi-unit residential buildings are expected to install parking space charging stations over the next six years.

33_CITY LOGISTICS

Brussels, Belgium → Electrifying the First and Last Mile of Urban Freight

Logistics service providers are looking to clean and quiet EVs as a way to reduce the impacts of their operations on the cities they serve, as well as achieving significant operational cost savings. The characteristics of many city logistics operations are ideally suited for EVs, with a limited number of vehicle-kilometres per trip and multiple drops and collections.[1] Electric freight vehicles can also offer lower operating and maintenance costs which results in more productive hours, better service quality and lower total lifetime usage costs. Furthermore, the quiet running of electric vehicles means that they can benefit from extended operating windows in the many cities that have such time restrictions in place.

TNT MOBILE DEPOTS

In Brussels, TNT piloted a mobile depot in 2013 to increase the efficiency of its parcel delivery operations in Belgium's congested capital. The mobile depot is a custom designed trailer fitted with all depot facilities such as loading docks, labelling and data entry equipment. In the morning, the trailer is loaded with all deliveries for the day at a TNT depot outside Brussels, and then travels to a central location in the city. From this point 'last mile' deliveries and pick-ups are undertaken by electric tricycles, known as 'cyclocargos', with larger parcels transported by electric vans. This approach replaces the slow and environmentally unfriendly practice of multiple vans travelling into the city from external depots.

Tessa Koster, a Manager at TNT explains, "the real success of the pilot was that we managed to achieve significant emissions reductions. We were operating at around 110 drop-offs and pick-ups per day and showed a 57% reduction in diesel kilometres per stop." However, the operating cost per parcel was more expensive across the three month trial: "We're exploring how mobile depots could work in cities like Brussels and in combination with electric vans which have larger capacities than cyclocargos," explains Koster. "If we can increase the load rate of the mobile depot (which was only 40% during the trial) then we can expect a positive impact on operating costs as well as further reducing diesel kilometres and emissions."

TNT EXPRESS – BRUSSELS, BELGIUM
Source: TNT

OUTLOOK

Where the business case for logistic operators is uncertain, but the social and environmental benefits are evident, supportive public policy frameworks can play a major role in encouraging such developments. Congestion charge discounts, access to bus lanes or pedestrian areas, extended operating times, free parking, and priority access to public charging points can all help to build a compelling business case for low emission urban logistics.

Furthermore, the potential benefits to cities is evident when the scale of these operations is considered. For example there are over 280,000 daily freight trips in London, and in Amsterdam there are approximately 25,000 vans and 3,500 trucks driving into the city each day.[2]

[1] frevue.eu/wp-content/uploads/2014/05/FREVUE-D1-3-State-of-the-art-city-logistics-and-EV-final-.pdf
[2] ibid

34_CHARGING AT WORK

United States → Mobilising Employers to Take Action

Outside of the home, the next most common location for charging EVs will be at work. This means that employers around the world will need to provide their workforce with recharging opportunities.

The provision of workplace charging is especially important for EV drivers who commute long distances or have limited access to charging opportunities at home. Charging at work also maximises the economic and environmental benefits of plug-in hybrids, enabling drivers to complete a greater proportion of their commute in all-electric mode.

DOE'S WORKPLACE CHARGING CHALLENGE

The U.S. Department of Energy's (DOE) Workplace Charging Challenge is one of the first large scale programmes to mobilise employers to take concerted action. The DOE's manager for this initiative, Sarah Olexsak, explains that "U.S. commuters typically park their cars at the workplace for an average of eight or more hours a day, making the workplace the largest non-residential infrastructure opportunity."

Launched in January 2013, the Challenge is a partnership that gives employers technical assistance and recognition of success from the DOE, and offers access to a best-practice sharing network of organisations. Partners in the Challenge commit to assess employee demand for charging at the workplace, develop and implement a plan to satisfy these needs, and promote the benefits of plug-in EVs to their workforce.

WORKPLACE CHARGING CHALLENGE AT-A-GLANCE[1]		
125+ employer partners	200+/- worksites across U.S.	1.5+ million employees[2]

"Our goal is to achieve a tenfold increase in the number of employers offering workplace charging by 2018," explains Olexsak. As of September 2014, the programme is well on the way with over 125 participating employers, including large companies such as Google, Coca-Cola, and MetLife; small businesses, universities, hospitals, states, counties, and cities.

While awareness is improving, EVs and charging stations do not have the status that one might expect. Therefore, much of the work behind the Challenge has focused on educating sustainability managers on how workplace changing can fit into their programmes.

GOOGLE HEADQUARTERS – MOUNTAIN VIEW, CALIFORNIA, U.S.
Source: Rob Kalmbach

OUTLOOK

The ability to attract and retain top talent, the powerful demonstration of corporate leadership, and the sustainability benefits are three of the key motivations for employers providing workplace charging opportunities. Given the importance of workplace charging to EV drivers around the world, these initiatives will play a key role in achieving increased adoption of EVs.

[1] As of September 2014.
[2] Workplace Charging Challenge Partners employ more than 1.5 millions individuals across the United States.

35_PROCUREMENT CONSORTIA

Stockholm, Sweden → Cost-Cutting through Bulk Purchasing

Public and private procurement of vehicles allows the purchaser to negotiate favourable contracts, especially when the numbers are large. On a local and national level, governments can use the procurement process to achieve multiple policy objectives, including the reduction of emissions and fuel consumption. In the case of electric mobility, government agencies are looking to EV procurement as a pathway to support low emission transport.

JOINT PROCUREMENT IN STOCKHOLM

The City of Stockholm and Swedish utility Vattenfall together with procurement agency SKL Kommentus Inköpscental AB carried out a national procurement effort resulting in framework agreements for electric vehicles (battery electric vehicles and plug-in hybrids) from four different suppliers. Public bodies and private companies were invited to join the procurement consortium. This resulted in a total of 335 partners/buyers stating a requirement for an estimated purchase volume of 1,250 EVs per year. The contracts are for two years but may be prolonged for a total time of four years.

The Swedish Energy Agency is providing financial support by compensating for additional cost of the first 550 vehicles that are bought through the procurement framework contracts. This means that organisations will receive up to 50 percent funding of the additional cost to a maximum SEK 100,000 (approximately $14,000). The additional cost is the difference between the cost of an electric vehicle and its closest counterpart among combustion engine vehicles.

Already, 500 vehicles have been purchased, with another 300 being evaluated. The overall budget support is about SEK 248 million ($35 million). By using procurement contracts for larger amounts, Sweden was, according to Project Manager Eva Sunnerstedt, "able to get EVs to the country earlier than it would have otherwise, at a reduced price compared to individual purchases."

STOCKHOLM, SWEDEN
Source: iStock by Getty Images

OUTLOOK

EV procurement consortia have been developed in a number of countries, including France and the Netherlands. The achievable volumes are demonstrated in the U.S., where public procurement accounted for at least 200,000 in vehicle stock (not counting U.S. Postal Service).[1]

Through procurement, government agencies can implement wider policy objectives, give vehicle manufacturers confidence in long-term demand for low emission vehicles, and achieve economic and environmental improvements in their fleet operations. The private sector can also be brought into the process and given access to the volume discounts achievable through public procurement frameworks. Furthermore, pioneering private sector organisations can work with their supply chains to achieve industry-wide transformations.

With EVs offering increased value for money on a whole-life basis, and organisations placing a greater store on the environmental and social impacts of their transport operations, supportive procurement policies and initiatives will play a major role in developing markets for electric vehicles.

[1] gsa.gov/portal/content/104624?utm_source=FAS&utm_medium=print-radio&utm_term=gsafleet&utm_campaign=shortcuts

FINLAND
Source: iStock by Getty Images

36_EXTREME WEATHER

Lapland, Finland → Optimising EVs for Temperature Extremes

Electric vehicles need to be able to drive in both blisteringly hot temperatures and sub-zero winter conditions. This poses significant engineering challenges, especially in the performance and management of batteries. Automotive supply chains and researchers around the world are therefore optimising EV technologies to ensure that vehicles can cope with such extreme weather conditions.

WintEVE CONSORTIUM IN LAPLAND

In Lapland, in the far north of Finland, the WintEVE consortium is testing and developing electric vehicles and charging systems in demanding weather conditions. "In Northern Finland, the ground is covered with snow for six months a year and temperatures can drop to below -30°C (-22°F),"[1] said Sakari Nokela, Project Manager at Centria Research, the coordinator of WintEVE. "Every winter many car manufacturers choose to test their vehicles and vehicle components in Lapland. Businesses in the region have developed commercial methods to prepare for Arctic conditions and understand how these impact vehicles."

Nokela explains that the energy consumption of electric vehicles is impacted by a range of factors in these extreme conditions: "Changes in elevations, weather conditions along a chosen route, driving styles, driving habits, and driving speed all impact the energy consumption of an EV. By acknowledging these factors and using new network and mobile services to choose the correct route you can extend the range and improve the safety level for electric vehicles."

WintEVE has also investigated the performance of charging system components in the extreme cold and the specific end user services required in arctic conditions. "We are mapping the services needed by consumers, for example how to search for, reserve, and pay for charging stations," said Nokela. It also includes the ability to preheat vehicles, which Nokela explains is routinely done with fossil-fuelled engines today and as a result makes Finland particularly well set up to support widespread charging of EVs: "We already have over 1 million block heaters across the country which are currently used to warm engines, but can also be used for Level 2 charging at 240 volts."

OUTLOOK

While many countries do not suffer from such extreme weather, the influence of climate on EV performance remains a key consideration. A recent simulation of extreme temperatures in the United States found that electric vehicle driving range can be nearly 60% lower in extreme cold (-7°C/ 20°F) and 33% lower in extreme heat (35°C/ 95°F).[2] Manufacturers of EVs and charging technologies are therefore developing strategies to accommodate these temperature extremes. Optimising batteries and technologies for particular climates can give enhanced performance, but needs to be balanced against increased production costs and restrictions in the movement of products across regions. Another area, based on the experiences in Finland, is that new network and mobile services can play a role in extending the driving range of electric vehicles and help to safely navigate extreme weather conditions.

[1] evga.winteve.fi

[2] newsroom.aaa.com/2014/03/extreme-temperatures-affect-electric-vehicle-driving-range-aaa-says

37_RECOVERY OF BATTERY MATERIALS

Hoboken, Belgium → Reclaiming Valuable Raw Materials

Advances in battery design and treatment processes will enable EV batteries to be easily taken apart to reclaim valuable raw materials which can then be recycled back to battery-grade applications. As demand grows for electric vehicles, so too will demand for the materials that power their batteries. This, along with the expectation that governments and manufacturers will strive to further reduce the lifecycle emissions of EVs, mean that the recovery and recycling of battery materials will become increasingly important.

UMICORE BATTERY RECYCLING PROCESS

Belgian company Umicore has developed a unique recycling process at its plant in Hoboken which allows the treatment of complex materials found in lithium-ion and nickel metal hydride batteries used in hybrid and electric vehicles. Umicore's patented "Ultra High Temperature" smelting technology first converts the spent batteries into a metal alloy and uses a gas cleaning technology to remove organic compounds and to ensure that no harmful dioxins or volatile organic compounds are produced. Valuable elements such as cobalt, nickel, and copper are then separated and eventually converted into active cathode materials for the production of new rechargeable batteries.

Umicore claims that their process allows a higher rate of metal recovery compared to existing processes, minimises the consumption of energy, reduces CO2 emissions while maximising heat recovery to produce energy. To date, the company has signed collaborative agreements with Tesla and Toyota to recycle lithium-ion batteries from their all-electric and hybrid vehicles in Europe.

OUTLOOK

The legal frameworks to motivate EV battery recycling are already in place in many countries. For example, the European Commission's Battery Directive 2006/66/EC establishes requirements for the take-back and treatment of industrial batteries in Europe. Moreover, the benefits to both industry and the environment are clear. For example, Researchers at Argonne National Laboratory found that the amount of lithium needed for some types of lithium-ion batteries could be cut in half if those batteries were effectively recycled.[1] This could reduce material costs, provide additional security in supply, and decrease dependency on materials producing countries.

As well as developments in recycling technologies, the recovery of high-value materials will be supported by batteries being specifically designed for disassembly or recycling. Similarly, the standardisation of materials, cell design, and labelling could further support the development of automated recycling equipment. Research by Frost & Sullivan estimates that the EV lithium-ion battery recycling market is expected to be worth more than $2 billion by 2022, with more than half a million end-of-life EVs' battery packs becoming available for recycling through the waste stream.[2]

[1] transportation.anl.gov/pdfs/B/626.PDF
[2] frost.com/prod/servlet/report-brochure.pag?id=M5B6-01-00-00-00

38_MICROMOBILITY

Koshiki Island, Japan → Advancing Adoption of Ultracompact Vehicles

Ultracompact electric vehicles (or micro vehicles), which are big enough for only one or two people, are emerging as an affordable and energy efficient option to combat congestion, ease parking space identification and achieve greener short-distance journeys in increasingly crowded cities.

ULTRACOMPACT EVs ON KOSHIKI ISLAND

Support for micro vehicles in Japan is in part motivated by changing demographics. The country has the world's highest population of senior citizens, with almost a quarter aged over 65; a figure which is expected to reach 40% by 2050. Nobutoshi Horie from the Ministry of Land, Infrastructure, Transport and Tourism explains, "Micromobility vehicles are ideal for the many elderly citizens that live in areas without convenient access to public transport and who would not be comfortable riding scooters."

The government sees other sweet spots for micromobility as families with young children, small-scale goods distribution, and tourism promotion. The government is therefore actively working with developers, shopping districts, and transport planners to form visions of the potential to introduce these vehicles to regional transportation and public services. Horie clarifies that this includes, "support for the development of infrastructure and subsidies to manufacturers and local governments to encourage the use of micromobility and other low emission cars."

The Japanese government is working to create opportunities for people to see and drive the ultracompact vehicles. One example is Koshiki Island where 20 ultracompact EVs are being trialled with residents and tourists. "A big focus has been to allay people's fears and concerns about the safety and performance of these vehicles," explains Shinji Kubo, Section Chief of new energy provision department at Satsumasendai City. "We are collecting driving data and developing a better understanding of the needs for further infrastructure development."

A particularly successful initiative on the island was a "Marathon of EVs" where the drivers of the vehicles competed to see who could travel the furthest on a single charge. Kubo clarifies that the reason for this was that, "The vehicles greatly exceeded the 50km range that the manufacturers specify, with the longest recorded at 86km. The EV Marathon has shown that these vehicles pose no problems as a means for moving the around the island and provided a great way to address any anxieties that may have existed. In light of the efforts of Koshiki Island, we are aiming to expand the project further in Satsumasendai City."

TOYOTA AUTO BODY COMS – TOKYO, JAPAN
Source: Wikimedia Commons, Author: Momotarou2012

OUTLOOK

Ultracompact vehicles have been a feature in certain European cities for some time and are also attracting great interest in China and South East Asia, where narrow roads and limited parking are also a common feature. Renault has sold in excess of 3,000 all electric Twizys since its launch in 2012 and Frost & Sullivan estimates that more than 150 models will be launched by over 25 key global mainstream vehicle manufacturers in the global micromobility market by 2020.[1]

[1] frost.com/prod/servlet/press-release.pag?docid=263329770

39_BI-DIRECTIONAL CHARGING

Kitakyushu, Japan → EVs as a Power Supply

New developments in bi-directional charging mean that the battery of an EV can be used as a power supply. This has multiple applications including: emergency supply during power shortages or shutdowns; replacing diesel generators that power events, leisure activities or remote buildings where other forms of power are absent; helping grid operators to balance demand and supply fluctuations; and offsetting peak building loads to reduce the energy bills of households and business that are charged tariffs based on maximum usage.

VEHICLE TO HOME SYSTEMS IN KITAKYUSHU

In July of 2012, the city of Kitakyushu announced a partnership with Nissan Motor Company, of Japan, to develop and commercialise an EV power supply system called "LEAF to Home." The vehicle to home (V2H) system pulls electricity from the LEAF's rapid charging connector via a PCS (Power Control System) that is connected to the household's distribution board. The system has enough output to allow all household electronics to function at once and provides a stable supply of electricity at peak times of the day where household electricity usage is known to increase. The battery can be recharged at night, when electricity demand and pricing is much lower, or during the day, with linked rooftop solar panels. There are over 225 households and 50 workplaces involved in the Kitakyushu Smart Community Project to date. Together the partners and residents of the community are showcasing the potential for smart energy management and electric vehicle integration.

The "LEAF to Home" programme is part of a larger initiative called the Smart Community Project, in which Kitakyushu is developing an energy management system that can adjust electricity demand and supply according to real-time signals from grid operators. It is within this framework that V2H technology can play an even larger role in balancing fluctuations on the grid, filling in gaps in renewable energy variability, and providing an overall resiliency benefit to the electricity system. The Smart Community Project marries electric vehicle battery storage with energy efficiency measures such as demand response and smart grid technologies that communicate with utility signals in real-time. Going forward, vehicle electrification will play a key role in the city's efforts to prepare for climate uncertainty and to function as a smarter, cleaner, and more secure place to live.

OUTLOOK

Recent extreme weather events have increased global awareness and concern over the vulnerability of homes and businesses to fragile electricity systems. In many parts of the world, power outages are an infrequent nuisance; but in others, they can have significant negative social and economic consequences. New developments in bi-directional charging can enable electric vehicles to serve as emergency backup generators and much more.

BI-DIRECTIONAL CHARGING

2,800

BI-DIRECTIONAL CHARGERS DISTRIBUTED IN JAPAN BY NISSAN.[1]

// Average daily electricity use of a Japanese household is approximately 10~12kW.

// The capacity of the Nissan LEAF's lithium-ion battery is 24kW, and thus is able to provide two days worth of electricity to a household unit when the battery is fully charged.

// By 2020, Navigant Research predicts that nearly 200,000 electric vehicles will be equipped with bi-directional charging capabilities.

[1] Approximate quantity at time of publication.

40_BALANCING THE TAXATION EQUATION

France → A Level Playing Field for the Electric Vehicle

In addition to providing incentives to support the early market for EVs, taxation systems can also establish longer-term frameworks which discourage people from buying the most polluting vehicles. This represents a radical shift from the status quo as markets currently favour internal combustion engine vehicles through differential taxation for petrol and especially diesel vehicles, not to mention fossil fuel subsidies, which the IEA says amounted to half a trillion U.S. dollars in 2013. Meanwhile, the health and environmental impacts of fossil fuel vehicles lead to quantifiable costs to governments and individuals, which ultimately need to be funded from elsewhere.

FRANCE'S BONUS/MALUS PROGRAMME

To address this situation, France introduced the "bonus/malus" programme in 2008 to level the playing field for EVs, and to ensure vehicle owners understand the full societal cost of different types of vehicles. This programme is not simply of benefit to early adopters, but also gives consumers and vehicle manufacturers confidence in market development.

Bonus/malus works in such a way that the buyers of high-CO2-emitting cars pay a penalty and the buyers of low-emitters reap a bonus. The structure has been designed to be revenue neutral for the government, with the malus penalty payers financing the bonus receivers. Vehicles with CO2 emissions of 131-160 grammes per kilometre are between bonus/malus; a moving scale that France aims to push downwards in the future. At the upper end, vehicles that emit more than 250g/km are penalised with a €2,600 penalty and those with less than 60g/km, collect a €5,000 bonus payment.

The effect of this policy has been immediate: between January 2008 and November 2009, the sales of vehicles with CO2 emissions in the 101-120g/km range increased from 20% of new sales to more than half. These consumers were rewarded with a €700 bonus payment.

OUTLOOK

In the OECD[1] alone, the financial cost of road transport air pollution in 2010 was approximately $850 billion[2]. Governments around the world are evaluating how to use taxation to cover the long-term health and environmental costs by having vehicles compete on a broader basis. The experience from countries such as France, Norway, Denmark, Austria, Chile, and Belgium suggests that an effective way to make low emission vehicles cost competitive is not merely to offer short-term tax breaks, but to also phase out continued subsidies for fossil fuels.

THE COST OF AIR POLLUTION

// The cost of the health impact of air pollution in OECD countries (including deaths and illness) was about $1.7 trillion in 2010.

// Available evidence suggests that road transport accounts for about 50% of this cost in the OECD, or close to $1 trillion.

// In China, the cost of the health impact of air pollution was about $1.4 trillion in 2010, and about $0.5 trillion in India. There is insufficient evidence to estimate the share of road transport but it nonetheless represents a large burden.

[1] The Organisation for Economic Co-operation and Development (OECD) is an international economic organisation of 34 countries founded in 1961 to stimulate economic progress and world trade.

[1] oecd.org/environment/cost-of-air-pollution.htm

UBITRICITY SOCKET-SYSTEM
Source: Ubitricity, Robert Lehmann

41_PLUG SHARING

Berlin, Germany → Opening Up Access to Existing Electrical Outlets

Technologies and business models that open up access to existing electrical outlets for commercial charging could instantly create high-density public charging networks to support widespread operation of EVs.

A major advantage of EVs compared to other alternatively fuelled transport is that the majority of infrastructure is already in place in the form of nationwide electricity grids. However, standard electrical outlets cannot separately meter energy drawn by EVs or properly monetise individual charge events. There are various requirements to have such administrative and monitoring systems in place. For example, individuals and businesses could charge a fee for providing access to electrical outlets; expenses could be reimbursed for the many fleet vehicles that will be recharged overnight at the employee's home; and costs can be apportioned for using shared outlets at condominiums and workplaces.

UBITRICITY'S MOBILE METERING

Berlin-based start-up Ubitricity has developed a solution that builds the intelligence of revenue-grade metering into the standard charging cable that comes with every electric vehicle. This provides access to Ubitricity "socket-systems," which are bolted onto the existing electrical outlets that are abundant throughout cities. The mobile meter attached to the charging cable tells the outlet to accept the charge and keeps track of how much electricity is used. This information is then sent back to Ubitricity via a cellular connection and passed on to the relevant utility.

Ubitricity has launched a number of pilot projects throughout Germany. In Berlin, the company is working with the Verband der Automobilindustrie (VDA) to install socket-systems in street lights throughout the city. In Frankfurt, Ubitricity has formed a partnership with Welcome Hotels, which will begin to offer the technology at all of their locations. Going forward, Ubitricity sees great potential in workplace charging.

According to Ubitricity, some 1 to 2% of the approximately 10 million street lights throughout Germany could immediately be refitted with charging spots (single phase AC), as their grid connection and position allow for charging day or night. The approximately 300,000 street lights that are exchanged or renewed per year present the next opportunity for cost-effective roll-out of charging infrastructure.[1]

OUTLOOK

From a municipality's standpoint opening up access to existing charging outlets could reduce the costs of building out expensive public infrastructure networks. However, as such outlets will likely be limited to low-voltage charging this will not replace all public charging needs. Nevertheless, mobile metering technologies built into vehicles or charging cables—with the supporting communications infrastructure, business models, and legal frameworks—could provide an effective means to increase the charging opportunities for EVs around the world.

[1] ubitricity.com

42_INNOVATIVE FINANCING

Indianapolis, Indiana, U.S. → Public-Private Partnerships to Promote EV Investments

The potential to reap cost savings through electrification has been well documented and realised in real world applications across the globe. However, given the upfront capital needed, the newness of technology, and the perception of risk, individuals and fleet managers remain apprehensive about investing in EVs. In response to this, public-private financing mechanisms are being developed to remove the risk and capital expenditure by providing electric vehicles as an operational service.

INDIANAPOLIS' ESCO MODEL FOR FLEETS

In the City of Indianapolis, Indiana, Mayor Greg Ballard has instituted an ambitious mandate to move the entire municipal fleet off oil by 2020. In the period 2014-16, the city will deploy over 425 EVs in its fleet, making it the largest U.S. fleet electrification effort to date. Leading this initiative is a startup called Vision Fleet Capital, which both optimises fleets for electrification and provides vehicles through innovative financing structures.

Vision Fleet's model borrows from the structure of energy performance contracts (EPC), power purchase agreements (PPAs), and other similar models. This contracting approach is supporting the deployment of EVs across six city departments: Department of Water and Power, Code Enforcement, Police, Fire, Probation, and the Coroner's office. Through a low-risk, total-cost-of-ownership model, the company guarantees savings to the city and captures additional shared savings when operational performance measures are exceeded.

"We're applying the financing and contracting innovations that transformed the solar and energy efficiency industries to the market for clean mobility for fleets," says Vision Fleet CEO, Michael Brylawski. "When combined with advanced telematics technology and hands-on support, this approach eliminates obstacles that once stood in the way of large-scale adoption of alternatively fuelled vehicles."

INDIANAPOLIS, INDIANA, U.S.
Source: iStock by Getty Images

OUTLOOK

In both developed and developing economies, financial innovations provide a means to promote low carbon growth and highly resilient communities. Cities such as Indianapolis are showing that innovative public-private partnerships can develop to achieve savings, enhance revenues, and reduce emissions. Importantly, such approaches also provide a mechanism to unlock private finance and develop supportive policy frameworks to promote further investments in electric vehicles.

43_BASELINE DEMAND FOR PUBLIC CHARGING

London, England, UK → Guaranteeing Utilisation from Large Urban Fleets

The case for developing city-wide charging infrastructure ahead of demand from EV drivers could lie in guaranteeing a baseline of utilisation from one or more large fleets.

Many governments, cities, vehicle manufacturers, and consumers see public infrastructure as critical to the adoption of EVs, but business models for private sector investment are problematic. While governments can make investments ahead of demand as part of a wider policy programme or a more general public benefit, private companies are understandably more hesitant—especially when there is also broad consensus that the majority of urban EV drivers will have little need to charge away from their home or workplace. However, if this infrastructure is developed to support the operation of a large electric fleet then the business model is no longer solely dependent on revenues from individual transactions.

SOURCE LONDON

In late 2013, French company IER, the operator of Paris' all-electric carsharing scheme Autolib', won the contract to run London's network of 1,400 charge points across 700 sites in the city. London's transport authority were not only paid a substantial fee by IER for the rights to operate this network, known as "Source London," but the French company also committed to cover the costs of maintenance and operation, as well as providing London's local boroughs with ongoing income for the provision of dedicated on-street EV parking spaces.

At the time of the announcement, the Source London network had 1,000 subscribers paying an annual fee of £10 (approximately $16) to charge for free at any of the charge points in the city. However, for IER, increasing revenues from public charging was secondary to the opportunity to access the real estate necessary to recreate the large-scale point-to-point electric carsharing scheme that they had developed in Paris.

IER plans to introduce 100 all-electric Bluecars, built by its parent company Bolloré. If the public take-up is strong, and the London boroughs agree to provide the necessary permits and parking spaces for introducing the EV carsharing service, IER hopes to ultimately deploy 3,000 vehicles.

The anticipated success of the electric carsharing scheme will optimise the currently underutilised network of charge points, while also creating more opportunities for private users to charge across the city. IER has committed to improve the service and expand the Source London network to a planned 6,000 publicly accessible charge points by 2018.

OUTLOOK

For many cities, the provision of charging infrastructure is expected to require public subsidy until there is a critical mass of EV drivers. However, in parallel to this, cities have freight, taxi, and carsharing operators who require infrastructure to support increased electrification of their fleets. If infrastructure is developed to meet the needs of these fleets, then it not only provides a means to guarantee a baseline revenue into the future, but the costs to connect additional charge points to satisfy the needs of individual users is marginal once the grid connections and operational systems are in place. This requires that the design and development of public infrastructure is not solely geared to individual users, but gives due consideration to the needs of fleets, such as the importance of faster charging, real-time information and the ability to make reservations.

44_INTELLIGENT TRANSPORT SYSTEMS

Nagasaki, Japan → Information and Communications Technology to Enhance Mobility

Intelligent transport systems (ITS) are providing EV drivers with real-time information that can help extend driving distances, enable easy access to charge points, enhance the driving experience, and optimise vehicle performance. A key application is the use of ITS to extend an EV's range. This includes extending the 'technical range', whereby real-time monitoring of factors such as driving style, traffic, regeneration systems, and weather can optimise the routes that people take and how they drive. It also recognises that accurate and trusted information can extend 'range comfort' which is the distance that a person will feel confident driving in an electric car.

GOTO ISLAND, NAGASAKI PREFECTURE, JAPAN
Source: METI (Ministry of Economy, Trade and Industry)

NAGASAKI EV & ITS PROJECT

The Nagasaki EV & ITS project in the archipelago of the Goto Islands of Nagasaki Prefecture has been developing such systems since 2009. Over 100 EVs, with accompanying energy micro-grids, charging spots, and critically, an ITS network have been deployed across the islands to integrate the components into a more efficient and intelligent driving experience. "An in-vehicle system customised especially for EVs provides the driver with information to navigate to charge points, forecast battery levels along the route, and give warnings on low battery levels," explains Takahiro Suzuki of Tohoku University. "ITS spots connect the vehicles to a cloud-based service which provides real-time information on charge point status and helps drivers to smoothly navigate to an available charger or other point of interest."

According to Suzuki, an important output of the project has been to develop standardised specifications for the ITS spots and for communications with both vehicles and charge points. As Goto is a tourist destination, another area of focus has been on ITS enabled sightseeing tours in rented electric vehicles. "We use the ITS network to provide location-based information, navigation, push notifications, and promotions from local businesses," said Suzuki. "In the longer-term we plan to integrate weather information and disaster notifications."

OUTLOOK

ITS infrastructure is being deployed in cities around the world to help address challenges from increasing congestion and pollution to reducing the number of accidents in metropolitan areas. These systems can also enhance the performance and driving experience of electric vehicles. This includes providing drivers with trusted and reliable information on achievable distances and the real-time availability of charging infrastructure. This recognises that range anxiety is a very human concern that engineering solutions, such as bigger batteries and more charge points, will not independently address. Such driver information and assistance systems will therefore play a crucial role in changing the narrative on EVs from addressing range anxiety to providing range comfort.

45_INTEROPERABILITY

Belgium → EVs Without Borders

Commercial and technical solutions are being developed to enable electric vehicles to recharge across national borders and between infrastructure networks. Such initiatives recognise that to accelerate the use of electric vehicles, it is crucial that the end user has easy access to the available charging infrastructure, even if charging services are provided by different market players. Providers of both public and semi-public infrastructure are therefore working to make charging stations ready for customers and enable interoperability between service providers. The ultimate aim is to make driving a borderless experience, regardless of fuel choice.

"OLYMPUS" OPEN SERVICE PLATFORM

Flemish Living Labs in Belgium is working to create an open platform for mobility services to enable charging for different vehicles, different fuels (including electricity), across seven different brands of charge points, different charge point operators and mobility providers.[1]

According to project manager Carlo Mol, "Interoperability is not only important for the end users comfort, but also allows the mobility service providers and infrastructure operators to optimise their investment costs and offer more valuable and integrated mobility services to their customers. This requires some commercial and technical agreements, but progress is being made and we see some very promising developments in Europe." The Olympus Open Service Platform in Belgium focuses on networked mobility solutions and a seamless connection of private transport, public transport, and shared vehicles. As a platform for multi-modal mobility, Olympus helps all players in the mobility sector to develop new markets and services.

The Olympus Open Service Platform has created a common usage and payment platform for drivers and service providers, underpinned by a substantial and reliable back office support. Currently, charging is free in many different networks and countries, but once "e-roaming" becomes possible, a large and varied amount of data will be exchanged, much like international calls and roaming charges and payment systems. This data will optimally be exchanged with ease and automation for the consumer, so that all the consumer needs to do is to bring one card, which allows the charging providers to charge the right company, who in turn charges the consumer.

OUTLOOK

The interoperability of charging infrastructure has been identified as a key enabler of the future growth in markets for electric vehicles. IT architecture and commercial marketplaces are essential to facilitating convenient consumer experiences and healthy competition amongst service providers. Connecting different regional and national networks enables consumers to access a greater range of services and increases the potential customer base of all charge point providers. It enables EV drivers to travel further and across borders, making electric motoring more appealing thanks to the now internationally available network of charging stations. It is just one small step in the right direction, but it is an important step in giving drivers greater autonomy and convenience where and when they need to recharge.

[1] ebcd.org/pdf/presentation/470-Carlo_Mol.pdf

VANCOUVER, CANADA
Source: iStock by Getty Images (Editorial)

46_INTEGRATED INFRASTRUCTURE

Vancouver, Canada → Coordinating the Development and Operation of Infrastructure Networks

Independent infrastructure networks are woven across cities, providing a range of services such as broadband, telecommunications, street lighting, monitoring systems, and traffic management. Instead of electric vehicle charging developing as another siloed system of infrastructure, the installation and maintenance of charging points can be made more cost effective and less disruptive through coordination with the developers and providers of these other urban infrastructure networks.

VANCOUVER COMBINES EV CHARGING WITH TELECOMS ANTENNAE

In Vancouver, Canada, the City's Board of Parks and Recreation approved the installation of integrated electric vehicle charging stations and cellular telecommunications units in parking lots at three locations. There are two components to the design: a nine metre high monopole housing wireless antennae at the top; and a shelter housing electronic equipment and outlets for the EV charging station.

The project, launched in 2013, is a partnership between the City of Vancouver and TELUS, a Canadian telecommunications company. TELUS is fully funding the one million Canadian dollar construction and operation of this new infrastructure at no cost to the taxpayer, which frees up funds for the Park Board to help support the betterment of parks and recreation throughout the city. "This partnership with TELUS demonstrates a creative and fiscally responsible way to provide infrastructure that supports both our economic and greenest city goals, while providing better service for taxpayers,"[1] said Vancouver Mayor Gregor Robertson.

"For TELUS, these sites will allow us to keep up with the rapidly growing demand for wireless services in the area," said Eros Spadotto, TELUS executive vice-president of technology strategy and operations. "Because Vancouver's West End is such a densely populated neighbourhood, it is also exactly where you want an electric vehicle charging station, making this a great combination."[2]

OUTLOOK

It is a common frustration in many cities that the same stretch of road or pavement can be dug up multiple times to install different infrastructure. As separately regulated industries driven by individual costs, there is often little coordination in the installation, upgrade, and maintenance of infrastructure. Yet such coordination could doubtless minimise costs, carbon, and disruption, as well as incentivising efficient completion of works. The importance of achieving such savings is arguably even greater for public EV charging infrastructure, with high installation costs and low expected revenues in the early market.

Integrating EV charging with different infrastructure networks in cities also provides a model that reduces the need for government investment in public charging stations and one that is conducive to the continued growth of networks. Combining infrastructure in this way requires industry and government to work closely and offers a means to provide increased access to EV charging at a lower overall cost.

[1] about.telus.com/community/english/news_centre/news_releases/blog/2012/06/12/vancouver-park-board-approves-unique-stations-for-charging-electric-cars-and-enhancing-wireless-coverage-in-busy-west-end

[1] ibid

47_BUNDLED SERVICES

Boulder, Colorado, U.S. → Packaging EVs with Other Products

Bundled service offerings provide a way to make EVs more cost competitive, an appealing lifestyle choice, and part of a personal energy or mobility management programme. Packaging multiple products and services into a single offering can provide scale efficiencies that allow suppliers to deliver them at lower cost than they would be on their own. This approach provides a way to better serve and expand existing customer bases, while offering enhanced or differentiated products at a lower cost.

BOULDER, COLORADO, U.S.
Source: iStock by Getty Images

INTEGRATING EVs WITH ENERGY EFFICIENCY MEASURES IN COLORADO

In Boulder, Colorado, U.S., SnuggHome, a residential energy efficiency company, is working with banks to develop a product that combines the financial advantages of an electric vehicle with cost savings that can be achieved with home energy services. According to the company, a typical Boulder household will spend, on average, a total of $800 per month for home electricity, natural gas, as well as vehicle fuel costs and loan payments. SnuggHome found that a bank could match or undercut those costs with a combination of an electric vehicle, a home energy efficiency retrofit, and a rooftop solar system. SnuggHome's model provides a means to combine the financial benefits of these technologies and services, creating a financial package that rolls all technologies and services into one loan. "The loan is paid off in less than five years. And after those five years, customers never have to pay for petrol for their car or electricity for their house, as long as they live there," says SnuggHome CEO, Adam Stenftenagel. "And over the next five years, they'll save over $16,000 on energy costs. This is a real business model with a real value proposition to drivers and homeowners."

OUTLOOK

A number of vehicle manufacturers and energy companies around the world have formed alliances to capitalise on the potential of combined products related to electric vehicles. Outside of the energy sector, other innovative business models are also being developed to enhance the EV driving experience. This includes wider personal mobility packages that give EV drivers access to the most appropriate vehicles for different trips, such as vans, bicycles, and petrol vehicles for longer journeys. Electric vehicles and EV charging also offer considerable potential to be bundled with other transport oriented services such as parking, valet, repair, maintenance, navigation, car-sharing, and public transport. Such convenient and cost effective packaging of multiple products could introduce the electric vehicle to new customer segments in both the private and commercial fleet markets, enhancing the benefits and ease of switching to EVs.

48_PRICING SIGNALS

Munich, Germany → Influencing Behaviour with Real-Time Information

Developing ways to connect real-time, dynamic data to the driver is a key challenge in enabling cost-effective and low-emission transport. Sending price signals for recharging an EV enables the consumer to use low-cost electricity, and the energy provider to smooth demand peaks and avoid expensive and often highly polluting marginal power supplies.

BMW'S SMART CHARGING APP

For BMW's electric i3 and i8 models, the company launched the accompanying 'Smart Charging App,' which gives consumers a real-time understanding of not just where to charge their car, but also, when and how much it will cost.[1] The data provided gives both an indication of when to charge so as to get the lowest rates, but also includes how the rates are developing.

Through a direct connection to the U.S. national energy rate database hosted by software company Genability, drivers are able to automate their charging strategy in advance for daily and weekly use. They can also check their energy rates, determine the optimal times to charge their vehicles and track their charging costs. According to BMW, this real-time information is enabling consumers to save up to $400 a year.

Besides saving money for consumers downstream, this type of app functionality with real-time information can also work to reduce upstream emissions. Since electricity is often cheapest at night, if consumers get the signal to charge when demand is low, this shaves peaks, reduces over-capacity for utilities, and leads to overall cost and emission savings for both utilities and consumers.

By unleashing the potential for this saving, BMW has added to the overall value proposition of EVs. The app is currently only available to participants in its early adopted "Electronauts" programme, but will be available to the public in 2015.

While all transport modes and vehicles need data, EVs are well-poised to benefit. "By automating the at-home charging planning process with the BMW Smart Charging App, we are offering BMW i customers greater convenience and helping them conserve energy while maximising their cost savings," said Jose Guerrero, Product Manager and U.S. Product Planning and Strategy for BMWi, BMW of North America.[2]

BMW i REMOTE APP
Source: BMW of North America

OUTLOOK

Advances in vehicle intelligence and software applications will dramatically increase connectivity between EV owners and electric utilities. These developments pose exciting opportunities for increasing energy efficiency across the electricity system. However, greater automation of the delivery and response to these signals is critical to ensure convenience and increase consumer participation. Vehicle manufacturers, utilities, and software developers therefore have a compelling need, and also a business opportunity, to develop advanced and intelligent pricing signal applications.

[1] evobsession.com/bmw-charging-app-automates-best-time-lowest-cost

[2] press.bmwgroup.com/usa/pressDetail.html?title=bmw-launches-first-app-to-automate-the-home-charging-process-for-bmw-i-electric-vehicles&outputChannelId=9&id=T0183262EN_US&left_menu_item=node__6728

MILLENNIALS
Source: iStock by Getty Images

49_CHANGING TRAVEL BEHAVIOURS

Ann Arbor, Michigan, U.S. → Millennials are Less Likely to Learn to Drive or Own a Car

Business and cities are taking advantage of changing behavioural patterns in transport to better match mobility services with demand, which is especially imperative in an increasingly urbanising world with limited space. To optimise the efficiency of our transport system to suit the needs of young people, options include new mobility services and business models, such as carsharing, or alternative fuelled vehicles adapted to changing needs.

LESS DRIVING, MORE EVs

Economic recession is not the only cause for a slow-down in the transport activity, "There's something more fundamental going on," says Michael Sivak of the University of Michigan noting that the slowdown preceded the economic recession by four years. The major contributing factors identified by Sivak were increased telecommuting, increased use of public transportation, increased urbanization of the population, and changes in the age composition of drivers.[1]

Sivak and Brandon Schoettle's research finds that the share of Millenials with driver's licenses is decreasing, partly due to the ubiquity of smartphones and apps that allow you to connect with others and complete errands without leaving your home.[2] Sivak and Schoettle found that 32% of young Americans who do not have a driver's license find owning and maintaining a vehicle too expensive; 31% were able to get transportation from others; 9% were concerned about how driving impacts the environment; and 8% were able to communicate and/or conduct their business online instead. These changing priorities open up space for new mobility models, make alternative fuel vehicles more attractive, and necessitate a greater interconnection between vehicles and ICT.

Similar to University of Michigan's research, Zipcar's fourth annual "Millenial Survey" found that 53% of Millenials find high costs of maintenance, parking, and petrol make car ownership less attractive, compared to 35% of older generations feeling the same. "From driving less, to preferring mp3 over mpg, to valuing experiences over possessions, this generation has a fundamentally different approach to living than their elders," said Zipcar President Mark Norman.[3]

OUTLOOK

A change in the behaviour of a generation will have a big impact on transportation. As Millennials are more prone to take alternative transportation, and place a larger value on services over products themselves, the transportation system will change as interest in driving plateaus in a number of key automotive markets around the world.[3] Even before the economic recession, Japan and the U.S., to mention two countries, were seeing declining car travel, ownership, and interest. In Japan in the 1990s, the term "Kuruma Banare" appeared, which roughly translates to "moving away from cars."

For young people assessing their mobility options today, they will be more focused on getting from Point A to Point B, rather than assessing a purchase. Furthermore driving can be a rather miserable experience given increasing population densities. In Tokyo for example, you need to prove that you have an available parking space before you can buy a car. At the same time, mass transit is abundant and highly efficient. Given this context, it may not be surprising that younger people, usually with less income, find public transport or bike-sharing better overall choices.

Exactly what this means for electrification is yet to be defined. However, given the significance of the changes taking place around the world, it is likely that future electric transportation will not just be a cleaner version of what we know today. Rather, EVs are likely to become part of a fundamentally different way in which future generations move around cities.

[1] deepblue.lib.umich.edu/bitstream/handle/2027.42/106404/102994.pdf
[2] deepblue.lib.umich.edu/bitstream/handle/2027.42/99124/102951.pdf
[3] zipcar.com/press/releases/fourth-annual-millennial-survey

50_THE AIR WE BREATHE

Global → Air Quality is the World's Single Largest Environmental Health Risk

Increased understanding of the risks, consequences, and healthcare costs of poor air quality could be the single most important issue in realising a significant change in policies and attitudes around electric vehicles.

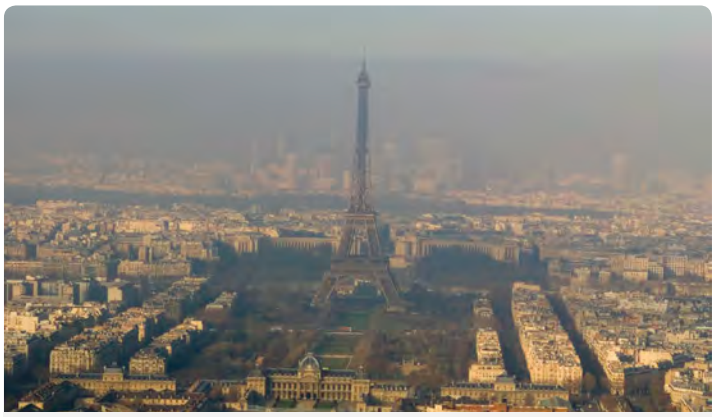
For policymakers, increased focus on air quality represents a shift in emphasis for low emission vehicle programmes, which have traditionally been motivated by carbon reduction, energy security or economic development. These will remain highly important in a national and global context. However, to an individual motorist there is a certain psychological distance that limits the perceived significance of these issues in their own life, or indeed their ability to have any positive influence on such massive global challenges. Breathing polluted air into our lungs is an altogether more local and tangible issue.

Recent years have led us to understand that the risks from road transport emissions are now far greater than previously thought or understood. This stems from a greater knowledge of the diseases caused by air pollution, and improved measurements and technology providing a better assessment of the levels of human exposure around the world.

WHO'S URBAN AIR QUALITY DATABASE

"Air pollution doesn't just cause respiratory problems in children and adults," explains Christian Schweizer, a Technical Officer in World Health Organisation's (WHO) European Office in Copenhagen, "It also causes heart attacks, strokes, messes with your metabolic system, has links to diabetes and can even have impacts on a child's health before it's born."

WHO's urban air quality database proves that these risks are not just limited to a few highly polluted cities. The database covers 1,600 cities across 91 countries and shows that a mere 12% of this population live in places that comply with safe guideline levels, with over half exposed to pollution at least 2.5 times higher than WHO recommends.[1] For example, Schweizer points out that "almost 90% of Europe's urban population is exposed to air quality which puts them at risk of serious long-term health effects."



AIR POLLUTION – PARIS, FRANCE
Source: iStock by Getty Images

One of the most significant landmarks in our developing understanding of the health impacts of air quality was the 2012 communication by WHO's International Agency for Research on Cancer.[2] This classified diesel exhaust emissions as a definite cause of cancer, placing it in the highest category hazard alongside smoking and asbestos. Schweizer explains, "When something is classified as carcinogenic (causing cancer) it means that there is no safe exposure threshold below which no adverse health effects will occur." In other words, incremental efficiency improvements to internal combustion engines do not solve this problem.

[1] who.int/mediacentre/news/releases/2014/air-quality/en
[2] iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

OUTLOOK

Today, people around the world have the visceral experience of seeing, tasting, and feeling the negative effects of road transport pollution. This makes it far easier to convey the levels of exposure and risk that they face. However, the challenge for policymakers is not simply to raise concern but to help people make responsible transport choices that reduce their long-term health risks and those of their family and neighbours.

Increased understanding of the risks and costs of urban pollution have strong parallels to the factors that led to indoor air quality controls being implemented around the world. Research from Staffordshire University identifies that three key milestones led to a major change in public attitudes.[3] The first was "demarketing" campaigns aimed at decreasing smoking, which resulted in smoking being regarded as a socially and culturally unacceptable behaviour. The second was a landmark announcement by the U.S. Surgeon General that no amount of second hand smoke was risk free—while this was not the first such report, it received a considerable amount of media attention. The third development was the growing number of communities worldwide that adopted public smoking bans. The bans were widely accepted by citizens, with little disruption and remarkably high compliance rates.

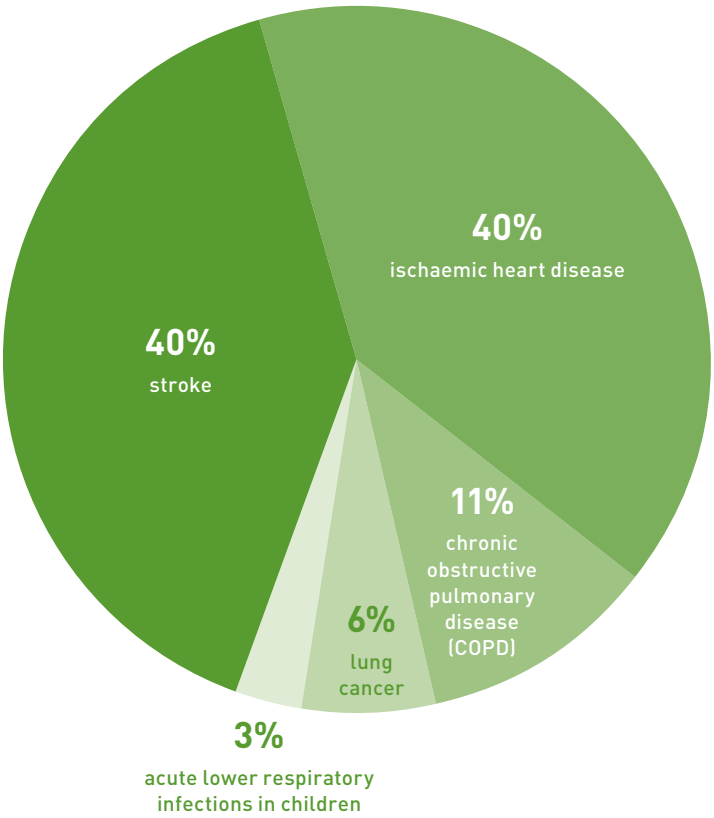
Indoor and outdoor air pollution exposure is responsible for one in eight of all global deaths, making it the world's largest single environmental health risk.[4] WHO's Dr Carlos Dora identifies that "Excessive air pollution is often a by-product of unsustainable policies in sectors such as transport and energy. We cannot buy clean air in a bottle, but cities can adopt measures that will clean the air and save the lives of their people."

GLOBAL AIR POLLUTION

3.7 million

deaths caused by outdoor air pollution in 2012

WHO reported that globally, outdoor air pollution was responsible for the deaths of some 3.7 million people under the age of 60 in 2012.



[3] Bickerstaff, K., & Walker, G. (2001). Public understandings of air pollution: the 'localisation'of environmental risk. Global Environmental Change, 11(2), 133-145.

[4] who.int/mediacentre/news/releases/2014/air-pollution/en/

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The Electric Vehicles Initiative (EVI) is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide. EVI is one of several initiatives launched in 2010 under the Clean Energy Ministerial, a high-level dialogue among energy ministers from the world's major economies. EVI currently includes 16 member governments from Africa, Asia, Europe, and North America, as well as participation from the International Energy Agency (IEA). EVI seeks to facilitate the global deployment of 20 million electric vehicles, including plug-in hybrid electric vehicles and fuel cell vehicles, by 2020.

cleanenergyministerial.org/evi

The 17 Contracting Parties to the International Energy Agency's Implementing Agreement for Cooperation on Hybrid and Electric Vehicle Technologies and Programmes share the following objectives: 1) Provide governments, local authorities, large users and industries with objective information on electric and hybrid vehicles, and their effects on energy efficiency and the environment; 2) Collaborate on pre-competitive research projects and investigate the need for further research in promising areas; 3) Collaborate with other transport-related Implementing Agreements and other organizations with an interest in energy for transportation and vehicles; and 4) Serve as a platform for reliable information on hybrid and electric vehicles.

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