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contents

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July is upon us, which means we've broken the back on 2015 - half of the year done and dusted!

We kick the month off with a Membership Drive, which means you can earn your 2016 Membership fees totally free of charge! This is how it works: for every member you recruit, who qualifies to become an SAIEE Member, and they submit the application form (which has been inserted into this issue of **watt**now), with all the relevant documentation, and they go through the processes, you will receive 20% discount PER MEMBER you recruit. So, if you recruit 5 new members, you receive 100% off your 2016 membership fees! Read more about this campaign on page 8.

The July issue features Transport Engineering, and our Feature section is jam-packed with lip-smacking content. "Green Growth" discusses the possibility of the 'death' of the Internal Combustion Engine, which is part of our everyday lives. Read more about this on page 28.

The London Crossrail Project (pg 38), aptly written by esteemed SAIEE Member, Ian Ross, explains how a wildlife sanctuary was created by the railway project in the UK.

Dudley Basson takes us down memory lane with this historical piece, "From Plateways to Maglev" (pg 42).

Herewith the July issue, enjoy the read!

Earn CPD Credits *Visit www.saiee.org.za to answer the questions related to these articles to earn your CPD points.*

SUB SAHARAN AFRICA

Power 2015

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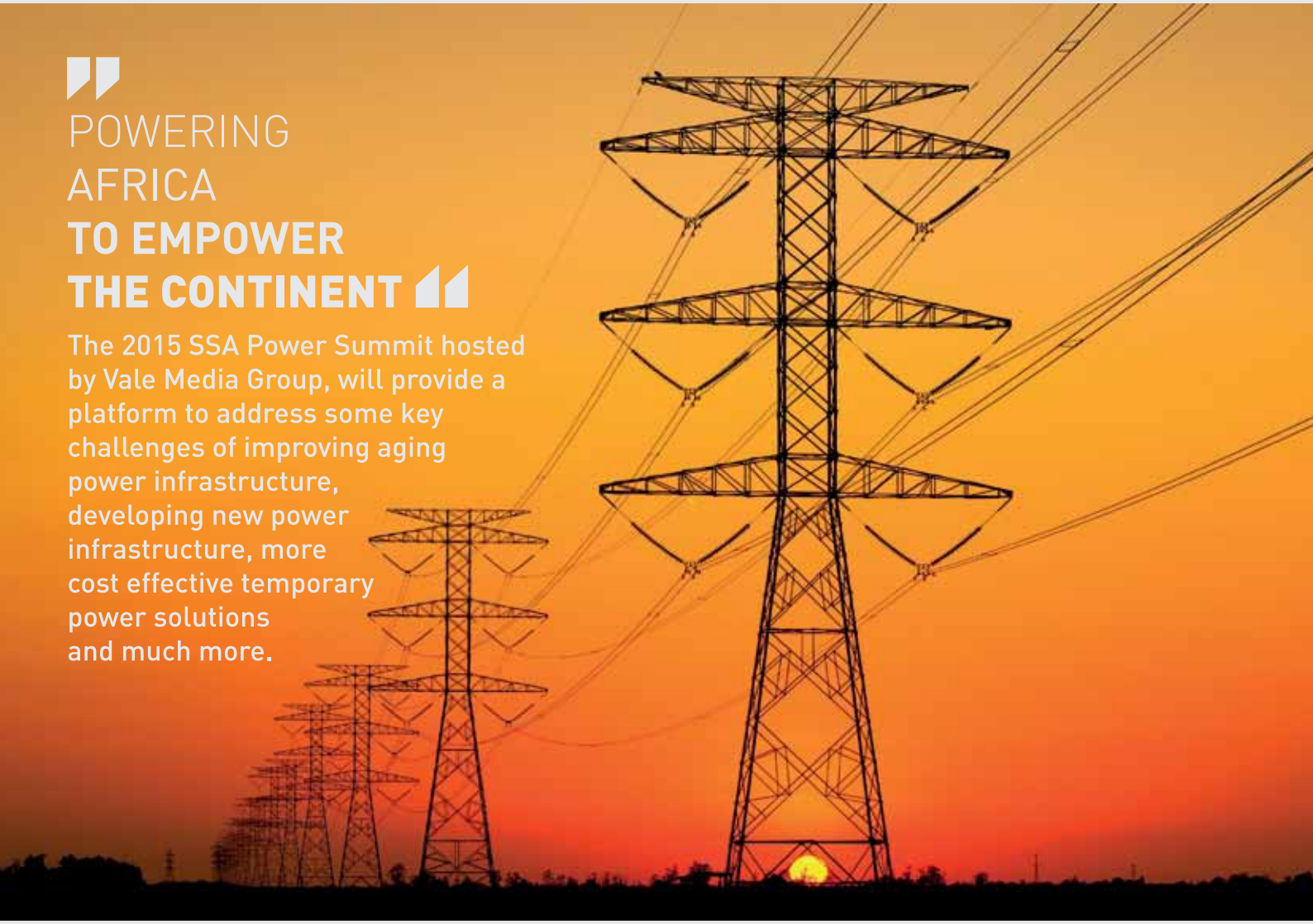

POWERING AFRICA **TO EMPOWER THE CONTINENT**

The 2015 SSA Power Summit hosted by Vale Media Group, will provide a platform to address some key challenges of improving aging power infrastructure, developing new power infrastructure, more cost effective temporary power solutions and much more.

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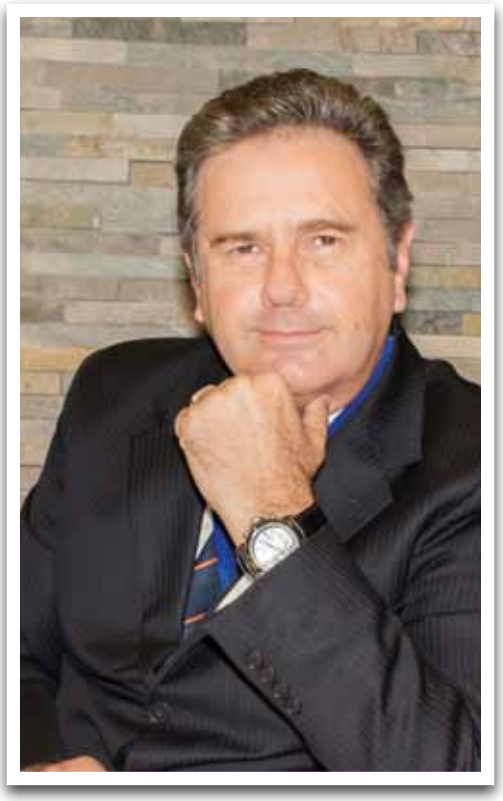


André Leo Hoffmann
2015 SAIEE President

Warm greetings from a chilly Johannesburg.

For us in the Southern Hemisphere, the Winter Solstice has just passed and we are on the return journey to summer. A journey is something we all like to take from time to time, which is where 'Transport Engineering' plays a key role.

My hobby is collecting antique maps. Some of the earliest maps of the sub-continent reflect the trade and shipping routes. After some time, one sees the road and rail infrastructure starting to appear on the maps. Transportation is fundamental to human existence, which is why most towns and cities are located on or near waterways and the sea. Except Johannesburg, whose existence is as a result of the discovery of gold in 1884. The city itself proclaimed in 1886.

It wasn't long before waggon trails gave way to the 'iron-horse', and before long motor vehicles arrived and required tarred roads. We now have this extensive network of rail and roads connecting cities to towns and to harbours and of course – don't forget the airport hubs!

I am encouraged to read that Transnet plans to establish a railway museum here in Johannesburg. Hopefully they will consider the old Park Station site; the grand old iron canopy framework, which stands proud and forlorn would be the obvious location for such a museum.

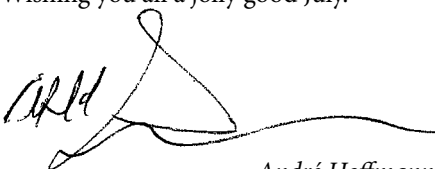
Movement of people and goods requires substantial amounts of energy. Electrical energy, being so convenient and relatively clean, forms a key contributor in supplying the transport industry with its 'potential energy', and its ability to function effectively.

Electrical engineers are pervasive contributors to the transportation industry, consider electric locomotives and rail systems, as well as electrical generation systems for aeroplanes and ships. The many complex control and traffic management systems that such networks demand, and not forgetting the extensive amount of electrical design that goes into the modern motor vehicle. Of course in Gauteng we fortunate to have the Gautrain, as a means of public transport, itself a fine example of electrical locomotion and design.

The electric car is an aspiration for many of us. Who remembers the 'Joule' electric car and South Africa's innovative 'car of tomorrow'? I was encouraged to see the project is not dead! It is being nurtured by the capable people at the Nelson Mandela Metropolitan University (NMMU) in Port Elizabeth. They have taken the project further, by accelerating the development of new technologies. These will be used to create a commercially viable infrastructure for the use of electric vehicles throughout South Africa. It remains to be seen whether the son of our soil, Elon Musk, will bring his Tesla electric vehicles to his home country. I think we will wait until they have worked out all the bugs and teething problems before we take it on a test drive across South Africa.

As engineers we are now challenged with making transportation more efficient. To use less fuel (energy) per unit of distance for the same payload. It goes without saying that we must make it cheaper to commute and transport our physical goods. Just as we have solved that challenge some clever politician will come up with a cunning plan to e-toll the not-so-freeways… Oh, they have already! Damn…. There are just some things we can't engineer our way out of. Death and Taxes.

Wishing you all a jolly good July.



André Hoffmann
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What do you expect from your SAIEE membership? .....

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The SAIEE is offering all current members the opportunity to qualify for free membership in 2016!

For every engineering colleague you recruit, who is NOT an SAIEE member, and they become a member, you will receive 20% off your membership fees. If you recruit 5 engineers, you will receive your 2016 membership fees totally free of charge!

To qualify for the discount, you need to:

- be in good standing with your current SAIEE membership;
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THE DEADLINE FOR NEW APPLICATION SUBMISSION IS 30 OCTOBER 2015.

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WATTSUP

Master Power Technologies supplies independent power to copper mines in the DRC

Master Power Technologies (MPT) have supplied two copper mines, in the Democratic Republic of the Congo (DRC), with stand-alone power generation capabilities totalling around 15 MVA. MPT's partner in the region, FG Wilson, installed the solutions and the company will continue to provide maintenance services to the mines.

The mines in question have rich copper veins which were to be mined, but there was no utility power in the area. The mines therefore had to ensure they were able to generate enough power independently to support the long-term mining of the area.

As a recognised power management solution provider in the area, MPT was awarded the tender with FG Wilson's P1250P3 diesel generators. MPT was able to deliver a high quality 15MVA to this remote area of the DRC.

The power solutions were built. The main portion was tested at Caterpillar's UK facility, and again at MPT's headquarters in Strijdom Park. The client then came from Australia to witness the testing prior to it being containerised and transported by road to the DRC. FG Wilson and MPT then reassembled the power solutions on site and ensured they were running optimally

before the new mining operation started. The process from design to delivery of the solution, took less than 5 months.

More than simply supplying the solution, FG Wilson provides the mines with local service and warranty support from local FG Wilson dealers. The system was commissioned on site in the DRC in December 2014 and the mine owners are satisfied with the reliable and stable power supplied by the solution.

Newsflash! Peak electricity use is about to pinch your wallet further

Do you know that electricity rates are about to change to a 'Time of Use (TOU)' system? This means that certain municipalities and electricity supply companies such as City Power will be able to charge you higher rates during peak periods, in the hope that the increased prices will encourage you to use power during off peak hours. Changes should come into effect shortly.

"The TOU tariff is designed to reduce the pressure on the electricity grid and City Power has said that they will charge less during off-peak periods. This means you will need to plan carefully and make changes to your current lifestyle, the easiest place to start is water heating" comments Roger Bulgin from Mr. Power.

If you haven't already assessed your power usage, don't delay as the new tariffs will increase your electricity bill significantly. Planning ahead is imperative for cooking, cleaning and bathing.

Start today. Reduce your electricity usage with your geyser: The pressure on the grid during the evening peak period is largely due to hot water consumption – tackle this first.

Have a Mr. Power Geyser Controller installed as this intelligent device is programmed to heat the geyser during off-peak periods only and will automatically switch off your geyser circuit once you have a full tank of hot water – eliminating the geyser's current function of continuously heating and re-heating the water throughout the day.

The Mr. Power Geyser Controller is priced at R1300 and your return on investment is normally a few months.

For more advice and information please visit www.mrpower.co.za.

The successful pressure testing of the Koeberg Nuclear Power Station Containment Building

Recognised as Eskom's most consistent and reliable power station, Koeberg is the only nuclear power station in Africa. Koeberg has a pressurised water reactor design. Featuring the largest turbine generators in the Southern Hemisphere, Koeberg is also the most southerly-situated nuclear power station in the world. International Law stipulates that all containment buildings of all nuclear plants have to be pressure tested every ten years, Eskom contracted their preferred supplier, well-established compressor and generator hire company, Rand-Air to facilitate the assignment.

Having previously supplied oil-free compressors for the containment integrated leak rate test in 2005, the decision to commission Rand-Air was as a result of previous successful project partnerships with Eskom. *"The purpose of the pressure testing of the containment building at Koeberg was to ensure that there was no leakage which could be harmful to the surrounding environment and public,"* says Andre Hopley, Projects Lead Technician at Rand-Air.

"Using ten PTS916 Rand-Air units running through desiccant dryers, dry oil-free air was pumped into the containment building. Both the inner and the outer sector of the building were surveyed before, during and after the test. Water particles have a big influence on pressure testing and the end result. We were required to match 18 degrees Celsius in temperature of the air going into containment.

We found that using heat exchangers and chillers reduced the pressure testing time by a few hours, allowing us to control the air pressure distribution. The requirement for the pressure testing was minus 20 degree dew point and we managed to achieve minus 40," Hopley explains.

Hopley adds *"The pressure test took between seven to eight hours. It took two and a half hours to reach a pressure of one bar. The procedure stops for eight hours when it reaches one bar, this is key in ensuring that everything is stable enough to continue to four bar. The process requires the go ahead from two parties namely (Électricité de France (EDF) and Eskom. It is critical to monitor the progression thoroughly, damage to the equipment inside the building could be detrimental."*

With an extensive fleet of over 700 Atlas Copco compressors and generators for hire in Southern Africa, Rand-Air is a market leader in the industry. *"We are proud to report that the Rand-Air contribution to the pressure test at Koeberg was a great success,"* concludes Hopley.

WATTSUP

BlackBerry Launches the BlackBerry Leap in South Africa

BlackBerry Limited, a global leader in mobile communications, announced the availability of BlackBerry® Leap in South Africa. Consumers who want to get things done and companies looking for enterprise fleet renewals can now purchase the modern and powerful BlackBerry Leap.

BlackBerry Leap features the latest BlackBerry® 10.3.1 operating system, a brilliant edge-to-edge five-inch HD display and more than a full day's battery power. Top features of the BlackBerry Leap include:

- Security to Maintain Privacy - You can feel safe in the knowledge that BlackBerry Leap was designed with the highest standards of security in mind to protect your privacy. It is equipped with support for encryption, plus built-in malware protection and back-up, wipe and restore. All to give you control and help secure your data against the next embarrassing and potentially costly cyberattack.
- Battery That Powers Through a Full Day - With up to 25 hours of heavy use,* the BlackBerry Leap will power through even your most demanding day. The impressive 2800 mAh battery and optimization of power consumption in BlackBerry 10 gives users more than a full day of productive usage.
- Best-in-Class BlackBerry Keyboard - Type faster and more accurately on a touchscreen keyboard that learns how you write. With superior error correction, multi-language support, customized adaption and flow, BlackBerry's touchscreen keyboard helps to reduce the mistakes and missteps that can hold you back.
- BlackBerry® 10 OS 10.3.1 - BlackBerry Leap comes preloaded with the new BlackBerry 10.3.1 operating system, offering a fresh look that incorporates updated icons. There is also an instant action bar so that users' most commonly accessed functions are in the center of their screen.

For more info please visit BlackBerry.com.

DEHN launches new version of its lightning protection book

For three decades, the lightning protection guide from DEHN has been the trademark for practice-oriented technical literature in the fields of lightning and surge protection for buildings, installations and systems.

Over time, the book has been revised and enlarged, due to changes in standardisation and technical advances. Now the third revised edition of the English language lightning protection guide is available.

The lightning protection guide provides expert knowledge for the practical understanding of lightning and surge protection, and spans almost 500 pages.

The topics covered by the book range from the characteristic lightning parameters up to the practical application of lightning protection components and surge protective devices. It documents the state-of-the art technology and recommendations based on the IEC and EN 62305 standards. Wherever no international or European standards exist, reference is made to pertinent German standards.

The LIGHTNING PROTECTION GUIDE can be directly obtained from DEHN and is also available as pdf document at www.dehn-international.com.

BIOMETRIC CONTROL SYSTEM ATTRACTS WIDESPREAD INTEREST

Booyco Electronics' biometric control system has attracted widespread interest in the local mining industry, after being introduced to market a little more than a year ago. The unique system was developed specifically for the local operating environment, and uses fingerprints to authenticate licensed machine operators.

Use is made of personalised smart cards on which an individual operator's fingerprints and other relevant data such as licensed capabilities and expiry dates are stored. This provides the ideal solution allowing controlled access to moveable items, such as earthmoving and mining equipment, blasting boxes and carts, as well as conveyor starter panels.

An operator gains access to and can operate a given machine or piece of equipment by validating his fingerprint on the scanning device on the machine.

This same level of control can be applied underground in other control environments, such as explosive magazines and facilitating access control to underground substations.

Communications to and from the biometric device takes places via an approved control module, and the system makes provision for an IS unit, powered by an IS power supply housed in a flameproof enclosure, to enable use in coal mines.

Booyco Electronics has an established reputation in the mining sector for engineering fit-for-purpose monitoring and controls systems that assist companies to maintain optimum safety under all operating conditions. The company is well known for its innovative Pedestrian Detection System which following its successes underground is being deployed to surface mining operations as well.

Booyco Electronics' pioneering biometric control system effectively addresses the challenge of maintaining proper control of underground machine operators.

A digital key to open your hotel door

South Africa's leading hotels are expected to digitally change the way in which guests can check in to hotels in the near future. New programmes and technologies will help speed up and may even do away with the check-in process, says PwC's Hospitality & Gaming Industry.

"Hotel business models are increasingly undergoing change in the advent of the digital era. Consumers are choosing when, where and how they want to interact with hotels, using an array of technological devices," says Nikki Forster, PwC Leader of Hospitality & Gaming Industry for Southern Africa.

Technology is making it easier and more efficient for guests to access hotels whenever and wherever they want. This is done by way of technological devices that usually involve strategically designed and free smartphone apps and Bluetooth technologies, says Veneta Eftychis, PwC Senior Manager, Hospitality & Gaming Industry.

On installation of an app, guests can do an array of things such as selecting their hotel rooms, as well as making reservations and payment. They can also check in online and have direct access to their rooms on arrival. Ultimately, with apps and Bluetooth technologies, guests' phones become their room keys for the duration of their stay – *"they need not stop at the reception,"* says Eftychis.

In addition, apps allow guests control in-room electronics, such as air conditioners, TV sets, curtains and blinds. They can even order room service and make reservations for restaurants and spa treatments.

Once guests have checked out of hotels, the apps delete the NFC (Near Field Communications) or Bluetooth code for the room.

Eftychis says according to research carried out in the hotel industry, hoteliers believe the technology will make their guests much happier. *"It also makes for more streamlined and efficient running operations,"* she adds. In addition, the technology will provide hoteliers with more marketing and branding opportunities.

"Hotel guests can expect their experiences to be very different in the near future from that of the traditional hotel. Truly innovative hotel brands will seek to exploit the digital wave to further grow increased loyalties and revenue," concludes Eftychis.

Tembisa school benefits from Aurecon's Carbon Neutral Board Meeting

Aurecon is a pioneer in the development of green building technology and the creation of sustainable environments. The board meeting of the South African company, held on 24 June 2015 at its Tshwane office, was rendered carbon neutral by the planting of 50 trees at the Inxiweni Primary School in Tembisa after the meeting. Aurecon works with a variety of schools in previously disadvantaged communities and identified this particular school as the ideal candidate for this tree planting opportunity.

"Aurecon is growing its business in sustainable development. Besides helping our clients achieve Green Star ratings, energy efficient developments and sustainable projects that will benefit future generations, we are also committed to positively contributing to the communities in which we operate.

It is for this reason that we chose the Inxiweni Primary School as the beneficiary of 50 trees to help us offset the environmental impact of today's board meeting," says Albert Geldenhuys, Managing Director of Aurecon South Africa.

Teachers and students from the school attended the tree planting ceremony, together with members of the Tembisa community and Aurecon South Africa's Board of Directors.

The event formed part of Aurecon's corporate social investment programme, Aurecon Cares, and demonstrates that the programme sees sustainable communities and environmental sustainability as intrinsically aligned.

Charlotte Mpenyana, Aurecon Quality, Environment & Sustainability Regional Manager Africa and Middle East, explains that a carbon neutral event is one in which the event's carbon footprint is measured and its impact neutralised through the purchase of carbon offsets or through activities that mitigate the negative impact of the event's equivalent carbon emissions.

From left: AB Geldenhuys, RM Khoza, ZB Ebrahim, NN Gwagwa, PC Lombard and SA le Roux

Planting trees is an effective way to draw excess carbon dioxide (CO_2) from the atmosphere through photosynthesis. The trees will also reduce air pollution and offer aesthetic benefits to the local community. Aurecon will be planting indigenous Combretum Erythrophyllum trees, which are resilient towards frost and draught.

"Aurecon used the DEFRA (Department for Environment Food & Rural Affairs) greenhouse gas conversion factors for Scope 3 emissions, which includes calculating the equivalent CO_2 transportation emissions of meeting attendees, to determine how many trees need to be planted in order to offset the carbon emissions produced by the meeting," says Mpenyana.

Thanking the Inxiweni Primary School for participating in the event, Geldenhuys said, *"By supporting this carbon emission offset project, the school is considered a champion of Aurecon's vision of being a Leading, Vibrant and Global Company. We commend you for your help to benefit the environment and reduce the threat of climate change."*

Why sponsor the SAIEE Annual Banquet?

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Grid management could mitigate SA power crisis

Better management of the power distribution network and harnessing of smart grid technology could deliver faster, more cost-effective solutions to the power crisis than building new power plants, say power sector experts.

Speaking ahead of the DistribuTECH Africa Power Distribution Conference, to be held in Cape Town in July this year, industry experts said focusing exclusively on generating more power is not enough to end South Africa's load shedding woes.

Dr. Willie de Beer, Chairman of the DistribuTECH Africa Advisory Board, says while adding generation capacity is necessary, the distribution network should not be overlooked. *"In the end, we still need to get that energy to the customer. This is where we could become unstuck in the next round. There is a massive shortfall on distribution maintenance and infrastructure, so even if we normalize generation capacity, there is pressure on the distribution network causing unplanned outages,"* he says.

De Beer notes that effective demand response is the key to minimising load shedding, and that the distribution network is where this demand response begins. He explains: *"Utilities in South Africa and the rest of Africa need to be more proactive in terms of managing the demand profile. If we can shift loads and better manage demand, we can reduce the pressure on the grid and limit outages. This implies using smart grid technology to implement measure such as increasing rates during peak times, communicating automatically with customers when demand is exceeding generation capacity, or automatically limiting each user's available capacity when the grid is under pressure. In this way, load shedding could be minimized at lower cost and within months."*

DistribuTECH Africa Advisory Board member and GM: Engineering Information System Sales at Powertech System Integrators, Lafras Moolman notes: *"Effective demand response is critical to hedge against load shedding. The challenge, however, is getting the right technology deep enough into the distribution network to enable finer grained control of what loads gets switched off when. The underlying technologies exist, but the question remains whether we can afford them, especially taking into account the maintenance and electrification backlogs we are currently facing."*

Scott Foster, CEO of Delta Energy & Communications and fellow DistribuTECH Africa advisory board member, says an investment in smart grid and associated technologies delivers significant returns: *"Throughout 2013, $1.6 trillion*

was invested in energy supply – nearly two-thirds of which was in emerging markets like those in Africa. And the region continues to demand more. In fact, according to a recent report by McKinsey & Company, Sub-Saharan Africa's electricity sector will need capital investment of about $835 billion by 2040 in order to meet the continent's increasing demand for electricity.

The South African Government – as well as any African nation anticipating this substantial investment – should be looking for a way to assure that it is well-spent. By leveraging big data, government and utilities can assure the optimization and impact of improved energy systems. For example, with data analytics, utilities can determine the most efficient operation of distribution equipment, which includes benefits like optimizing voltage settings to maintain specified voltages at customer meters while minimizing delivery system losses and power acquisition costs," says Foster.

"In the same vein, utilities could correlate blink counts at meters to identify fault locations or analyze outage reports to locate tripped circuits – again, resulting in lower costs and maximizing efficiency of any investments in the region. Further, analytics may be used to pre-emptively identify points of failure, messaging these events and identifying specific assets for preventative maintenance," he says.

"Although most utilities in South Africa are working with decades old infrastructure, leveraging the cloud provides easily configurable computing power so that data storage can be easily added, at almost any level, to store the data needed for the analytics. Utilities that are able to implement the cloud should look for solutions with a relatively low initial implementation cost and a fast return on investment."

How and why to harness smart grid solutions and better manage demand will come under discussion at DistribuTECH Africa, which will be staged alongside POWER-GEN Africa at the Cape Town International Conference Centre from 15 – 17 July 2015.

This co-located conference and exhibition will be presented by PennWell Corporation. The events bring together the world's leading power equipment suppliers along with companies developing power infrastructure in Africa.

For more information and to register, go to www.distributechafrica.com and www.powergenafrica.com wn

The Importance of Managing a Fleet

Effective fleet management is essential for companies that lease out machinery and equipment to the industrial, mining and construction sectors. Forming the heart of their business, the renting out of this equipment is important for business continuity and that is why it is so important that these valuable assets are adequately managed.

Managing a fleet of machinery across multiple locations is a complex procedure that requires the attention of a designated fleet manager who is responsible for the coordinating and facilitating of machinery for various related activities. The fleet manager is also in charge of selecting the fleet of machinery and is also accountable for the maintenance of the equipment.

"There is no specific way to successfully manage a fleet as this is dependent on the company's needs, budgets and experiences. What works for one company may not necessarily work for another but with this in mind, improvements can always be made. Standardising equipment and having maintenance schedules are aspects that can be modified to help managers boost efficiency" explains Craig Swart, Fleet Manager at Rand-Air, the largest fleet of generators and compressors for hire in Southern Africa.

With all the legalities involved, having a mutually beneficial contract agreement in place is important in maintaining the relationship with your customer. Swart advises *"a binding document that covers both parties is considered a major contributor of the success of the relationship."* The lease agreement includes the monthly cost of hiring the machinery, the obligations and responsibilities of the leasing agent and the customer. The contract agreement needs to be clearly outlined and understood by both parties.

Setting up scheduling programmes is a vital part of the fleet management process as this ensures that all the equipment is running in peak operating condition. *"Regular maintenance on and off site is imperative in minimising downtime. Another factor to better manage fleet is to ensure that you are familiar with your equipment at all times and that you are*

aware of any discrepancies," says Swart. An obvious risk in the management of a fleet of machinery is the wear and tear. Regular maintenance planning and executions will ensure that the fleet manager is well prepared for any repairs, costs and system downtime and enables alternative plans to be made if they are deemed necessary.

Swart adds *"regular scheduled inspections of equipment highlights early warning signs of any potential problems and diminishes the risk of major failure while optimising system efficiency."*

Further to this, training is key for a rental transaction of this nature and it is the duty of the fleet manager to provide extensive education on the product that they are renting out. *"Not only is this significant for your customer but it is important for you as this will reduce the risk of damage to the equipment. Health and safety training is also imperative as this will lessen the chances of injury when operating the equipment."*

It is also helpful to do regular customer surveys as this is a valuable way of obtaining feedback. *"This highlights the aspects of the rental transaction that were good and indicates the areas that require attention. Engaging with your customers on this level makes them feel that their comments are appreciated,"* states Swart.

"Having a fleet manager or a fleet management operation in your organisation allows companies that rely on the renting out their equipment to remove the risks associated with product investment, improving overall productivity on sites where their products are being utilised," concludes Swart.

Big player embarks on hydro-electric power project in Mali

Hydro-electric power is one renewable energy source that is in abundant supply in Africa

A major pan-African player in the electricity and water sectors, the Eranove Group, signed a 30-year concession agreement with the government of the Republic of Mali through its subsidiary Kenié Energie Renouvelable. Under the agreement, which is effective from the date of signing, the Group will finance, develop, build and operate the Kenié hydro-electric dam located in Baguinéda on the Niger River, 35 km east of Bamako. The signing ceremony took place in the presence of the Minister of Economy and Finance, Mamadou Diarra, the Minister of Energy and Water, Mamadou Frankaly Keïta, and the Minister of Investment Promotion and Private Sector, Mamadou Gaoussou Diarra.

This agreement represents an important step forward for the Eranove Group. The Group's managing duo of Vincent Le Guennou, Co-CEO of Emerging Capital Partners (ECP) and Chairman of the Board of Directors of the Eranove Group, and Marc Albérola, CEO of the Eranove Group, made the trip to Bamako in Mali, specifically to get the project up and running.

The signing of the concession agreement is likewise an important move for the Republic of Mali. According to World Bank estimates, the country's current installed power capacity of approximately 414 MW[1] covers only half of potential demand. The Kenié hydro-electric facility, with its installed capacity of 42 MW, will help Mali respond to this energy challenge. Initial simulations suggest that the Kenié dam could produce around 175 GWh, which is equivalent to the average annual consumption of 175,000 households[2]. What is more, the structure will enable Mali to make better use of its hydro-electric potential and thus reduce its dependence on imported hydrocarbons.

With an estimated potential of 400,000 MW[3], *"hydro-electric power is one renewable energy source that is in abundant supply in Africa. As part of the regional integration of power transmission networks, hydro-electricity can play a key role in increasing power generation capacity. And we mustn't forget micro and pico hydro-electricity either. These small hydro-electric facilities can supply power to villages or groups of villages in remote areas far away from interconnected transmission systems. Hydro-electricity is a renewable and competitive source of power in terms of production costs, and could even play a role in the financial balancing of power sectors and in meeting demand. This would prove hugely beneficial both for local populations and for regional industrial development,"* assesses Marc Albérola, CEO of the Eranove Group.

Marc Alberola, CEO, Eranove Group after the signing with Minister of Economy and Finance, Mamadou Diarra

The signing of the concession agreement comes after several years of cooperation between the Republic of Mali's Ministry of Energy and Water and IFC InfraVentures. IFC is a member of the World Bank Group and is the largest global development institution focused exclusively on the private sector in developing countries. Working together, these institutions conducted preliminary feasibility studies followed by an international call for tenders, which resulted in the selection of the Eranove Group as a strategic partner. The agreement of June 2015 is a significant milestone in the implementation of the project, as the financing of the project – estimated at EUR 110 million – can now get under way. According to the current project schedule, construction is due to begin in 2016 and the dam would be put into operation in 2020. The dam will then be operated under a concession agreement by Kenié Energie Renouvelable, a new subsidiary of the Eranove Group, whose shareholders will also include IFC InfraVentures.

Supported by Emerging Capital Partners (ECP), a pan-African leader in private equity investment that has raised over USD 2.5 billion in assets for the continent, the Eranove Group is embarking on a new stage in its pan-African development.

In addition to its operations in Mali, the Eranove Group already has a historic presence in Senegal, through water distribution company SDE, and in Côte d'Ivoire, via electricity companies CIE and CIPREL, water distribution company SODECI and AWALE.

Operating over 1,100 MW of power generation facilities in Côte d'Ivoire, the Eranove Group currently accounts for nearly 70% of the country's installed capacity and invests in a number of projects. CIE mainly operates six hydro-electric dams generating 604 MW of power with high availability rates.

The Eranove Group has fronted and coordinated one of the biggest infrastructure investments in Côte d'Ivoire in recent years, in the form of the CIPREL power plant (EUR 343 million). After an initial phase, which began in January 2014 (a 110 MW gas turbine), the second phase (a 110 MW steam turbine) will be completed in late 2015, creating a combined-cycle plant.

(1) Source: Energie du Mali
(2) Source: IEA, Africa Energy Outlook 2014 – demand per household with access to electricity in West Africa = 1,000 KWh
(3) Source: http://www.worldbank.org/en/topic/hydropower/overview

MUNICIPALITIES & ECSA

Collaboration necessary for the Benefit of the Public

The opportunity exists for closer collaboration between municipalities and the body regulating the engineering profession in order to ensure that the constitutional right to service delivery of every South African is met. This has stemmed from the challenges faced by municipalities in ensuring a seamless flow of service delivery and an ongoing focus on quality infrastructure development.

This was outlined during the panel discussion around municipal service delivery challenges, with the panel comprising Executive Mayor of Ekurhuleni, Cllr Mondli Gungubele; Executive Mayor of Midvaal, Cllr Bongani Baloyi in his capacity as SALGA's chairperson Municipal Trading Services; Deputy Public Protector, Advocate Kevin Malunga, and Engineering Council of South Africa (ECSA) Executive Education Standards and Policies, John Cato.

Speaking on behalf of the people, Advocate Malunga indicated that the bulk of queries coming to the office of the Public Protector in the last financial year have been targeted at municipalities. Out of the complainants received, the highest number was against municipalities, with the top five complaints being:

- Poor service delivery
- Land and housing
- Billings & service delivery
- Tender process irregularities
- Housing delivery gone wrong

"The number of requests we have received speaks to the public's frustration in the ability of the state to provide public services to its residents," said Advocate Malunga.

With a mandate which speaks to ensuring a democratic and accountable local government for communities, SALGA has a vital role to play in ensuring that the lost faith is restored. In outlining some of the challenges experienced by local government in its 15 year trajectory, Cllr Baloyi indicated that in some instances, unregistered engineers had delivered unacceptable work, resulting in a municipalities being unable to provide some critical services to its constituents. *"Our primary objective is to ensure the provision of services to communities in a sustainable manner, with our residents as the primary focus of our work,"* said Cllr Baloyi.

The first 15 years of local government's existence has seen some significant successes, although there is room for improvement. *"We have seen great achievements in the last 15 years, but we still need to do*

From right: Edgar Sabela, Executive Strategic Services ECSA, Advocate Kevin Malunga, Deputy Public Protector; Cllr Bongani Baloyi in his capacity as SALGA's chairperson, Executive Mayor of Midvaal; John Cato, Engineering Council of South Africa (ECSA) Executive Education Standards and Policies; Mr Lucky Leseane, Provincial Executive of SALGA GP, and Councillor Doctor Nxumalo, MMC Water and Energy Ekurhuleni Metro.

more work. It may appear as if we have not met all of our targets. However, as you can imagine, the population has grown, and this has meant that we need to keep improving our delivery to meet the growing demands of the communities we serve,' Baloyi added.

Speaking specifically about the Ekurhuleni Municipality, Cllr Gungubele said that their ability to provide quality service has been impaired by poor standards of work. *"It costs our municipality more to fix engineering work that has not been executed professionally in the first place. In Ekurhuleni, the focus is on how we can make the entire value chain of service delivery simpler, better and faster,"* he added. Ekurhuleni, through the construction of the O.R Tambo Cultural Precinct, has demonstrated that there is local engineering expertise that can offer specialised services to its community, such as a solar farm producing 200KW of energy; and efficient technologies such as rain water harvesting and waste water management. *"This facility generates its own resources and recycles the waste as well,"* added Gungubele.

In responding to the challenges outlined by the local government and municipal stakeholders, ECSA emphasized its role as the regulator of the profession, which includes setting standards; the registration of persons who meet educational requirements in candidate categories; and registration of persons in professional categories who demonstrate competency against the prescribed standards for the different categories.

In addition to this ECSA has a role to ensure that the code of conduct is adhered to by all registered engineering practitioners in their engineering activities. This was welcomed by the stakeholders, who indicated the need for closer collaboration in ensuring the standards set by ECSA are the same that are insisted on in service delivery roll-out, across all local government structures.

In outlining the solutions to some of these challenges, ECSA recommended the professionalization of systems at municipal level, which would ensure that professionals are empowered to do their jobs through an appreciation by administrators, of the nature and value of engineering. ECSA stressed the need for consideration to be given to creating a central tender awarding system at a national level which must then be supported by professional assessment and consultation.

There are also challenges at an operational level for engineers working within local government. We would recommend greater delegation of tasks, as technical staff are not given the authority to make importance decisions – with decision-making being an integral part of the engineering process. Engineers working in local government are often not in a position to sign off their projects and make decisions. *"The need to return authority to line management cannot be over-emphasized,'* said John Cato of ECSA.

The meeting adjourned with an agreement from all stakeholders that there is a need for a regular predicted interaction, working on specific milestones and deliverables per region. wn

Mechanical Engineering PhD Student Zahra Bagheri at the University of Adelaide in South Australia says that despite having low visual acuity and brains no bigger than a grain of rice, dragonflies are remarkably good at tracking prey.

"They're not like mammals which have developed very good brains, and they have very low resolution eyes compared to other animals, but they can catch their prey more than 97 per cent of the time while they're moving at very high speeds in very cluttered environments," Bagheri says.

"That means they have adopted very efficient methods for target tracking." Bagheri is part of a team of engineers and neuroscientists that have used those methods to develop a machine vision algorithm that can be applied in a virtual reality simulation, allowing an artificial intelligence system to 'pursue' an object.

Her project is a combination of neuroscience, mechanical engineering and computer science, building on years of research in to insect vision already undertaken at the University of Adelaide.

"Detecting and tracking small objects against complex backgrounds is a highly challenging task. Consider a cricket or baseball player trying to take a match-winning

Dragonfly eyes inspire machine vision

A dragonfly's eyes and brain are the inspiration for a new machine vision system that has applications for surveillance, wildlife monitoring or smart cars.

Zahra Bagheri and Benjamin Cazzolato with the robot that will use the newly developed machine vision algorithm.

catch in the outfield," Bagheri explains.

"They have seconds or less to spot the ball, track it and predict its path as it comes down against the brightly coloured backdrop of excited fans in the crowd - all while running or even diving towards the point where they predict it will fall!"

This is known as selective attention. Dr Steve Wiederman is leading the dragonfly project, and conducted the original research recording the responses of neurons in the dragonfly brain.

"Selective attention is fundamental to humans' ability to select and respond to one sensory stimulus in the presence of distractions," Dr Wiederman says.

"Precisely how this works in biological brains remains poorly understood, and this has been a hot topic in neuroscience in recent years," he says.

"The dragonfly hunts for other insects, and these might be part of a swarm - they're all tiny moving objects. Once the dragonfly has selected a target, its neuron activity filters out all other potential prey."

The team has emulated that ability with their algorithm. Rather than trying to perfectly centre the target in its field of view, Bagheri says the system locks on to the background and lets the target move against it.

"This reduces distractions from the background and gives time for underlying brain-like motion processing to work. It then makes small movements of its gaze and rotates towards the target to keep the target roughly frontal," Bagheri says.

Because the algorithm is based on a dragonfly's small brain and limited vision, it can rival insects' abilities as well as those of more elaborate machine vision systems - all with relatively low complexity.

"It's shown that we can do it with very low resolution cameras and very limited computational resources. It doesn't need high-performance computers or anything like that."

This bio-inspired "active vision" system has been tested in virtual reality worlds composed of various natural scenes. The Adelaide team has found that it performs just as robustly as the state-of-the-art engineering target tracking algorithms, while running up to 20 times faster.

"We are hoping to test it on a robot - we're working on that right now. It has diverse applications. It can be used in surveillance, wildlife monitoring, smart cars and even bionic vision." wn

Apps driving 'democratisation' of the workplace

In the evolution of the digital world, apps have made just about anything possible by broadening the access that service providers have to customers.

Ultimately, it can be said that digital has democratised business by enabling anyone, even those operating on shoestring budgets, to start an enterprise of their own and exceed their wildest dreams. For consumers across the globe, this new world means more choice and better prices than ever before.

So says Ethel Nyembe, Head of Small Enterprise at Standard Bank, who points to the success of Uber, the innovative app that connects riders to drivers through smartphone technology. It has revolutionised the transportation industry around the world, and is presently making waves on South African shores.

The change Uber is bringing to the transportation industry, and the inspiration it provides to entrepreneurs looking for a new niche for their ideas, was illustrated in a recent episode of The Growth Engines, supported by Standard Bank and aired on Business Day TV. The series examines how innovative small and major businesses can collaborate to innovate in their markets.

"By using an app to create a connection point between transportation providers and passengers, Uber has changed the way that people move across 300 cities around the world. It has also boosted the earnings of taxi drivers who can use the technology to be connected to a new base of riders across their cities - thus reducing the 'dead return time' that normally occurs after a fare is dropped at a destination.

What is particularly interesting is that fitting the modern app-driven convenience of mobile technology into an established, traditional business like driving a taxi has involved some compromise on the part of Uber. Innovation has won the day, but collaboration between the old and the new is what is making the concept work," says Ms Nyembe.

"The app has become the middle-man, bringing the essentials of democratisation to the transportation business. By bringing efficiency and accessibility to the fore, it has simultaneously empowered drivers to transform the way they do business," says Alon Lits, General Manager: Uber (Gauteng and Durban).

In its six years of existence, Uber has transformed the way that people move around the world's major cities. Commuters use the app to request a driver close by, are collected by the vehicle, and are billed through Uber, making the service seamless and easy.

"The birth of the Uber service was spurred by the founders walking through the snow in Paris trying

to find a taxi. Both, already entrepreneurs in their own rights, returned to San Francisco and developed the app," says Mr Lits.

Uber does not employ drivers or own any cars, but partners with the drivers. The drivers, in return for being able to access customers through Uber, pay a fee for the lead generation software every time they pick up an Uber rider. Security, however, dictates that drivers must have the necessary public professional driving permit, commercial insurance, roadworthy certificate, and spotless character references before they can join Uber. It is at this point that the new way of doing business couldn't succeed without the traditional, concedes Mr Lits.

"We looked at the system in South Africa and saw drivers coming through who had criminal records. We instituted additional screening practices by partnering with EMPS (Employers' Mutual Protection Services) to clear prospective driver-partners."

Says Kirsten Halcrow, Managing Director: Employers' Mutual Protection Services, whose company uses the services of the South African Police Service (SAPS), Automated Fingerprint Identification System (AFIS), and other South African institutions to ensure that people who apply do not have criminal records and that they do in fact have the qualifications and experience they claim: *"We are constantly examining technology and what value we can add to our clients' recruitment processes. This is particularly important in the present socio-economic environment where it is tough to get jobs and individuals are looking for easy ways of getting employment – many will use fake qualifications to achieve their ambitions.*

Individuals who have criminal records do not admit this on application forms. For Uber specifically, we look for fake driver's licenses, permits and examine all partner-drivers' references. Unfortunately, to trust what is on a CV or driver application will not help anyone."

A more challenging problem for Uber has been the failure of regulations and legislation to keep pace with the changes that have taken place with the emergence of the app world. An alleged contravention of permit bylaws in Cape Town recently saw 60 Uber operators running foul of the law.
"We continue to engage with regulators at city, provincial and national levels to ensure that our partners have a clear route to licensing. At the end of the day, we are dealing with a case where regulation is lagging innovation. It doesn't make sense to step back and wait for regulation to catch up.

This is especially so in the context of South Africa. How can we sit back and let outdated regulations stand in the way of job creation, and safe and reliable rides that can transform the taxi industry?

We see Uber as not taking away business from traditional metered taxi drivers, but assisting them by taking away their down-time. It is not about them losing existing business, it is about adding to it. Even though Uber fares are lower, we are being told by drivers that they are making more money and also managing their time better," says Mr Lits.

"Inevitably, the needs of customers and the opportunities offered to people to find gainful employment by using apps and digital services will win out," says Ms Nyembe. wn

Earn CPD Credits

Green Growth

a game changer ushering in the death of the Internal Combustion Engine?

The global movement promoting green growth transition is growing into one huge multi-dimensional game changer and evidence pointing to the death of the Internal Combustion Engine (ICE) is growing.

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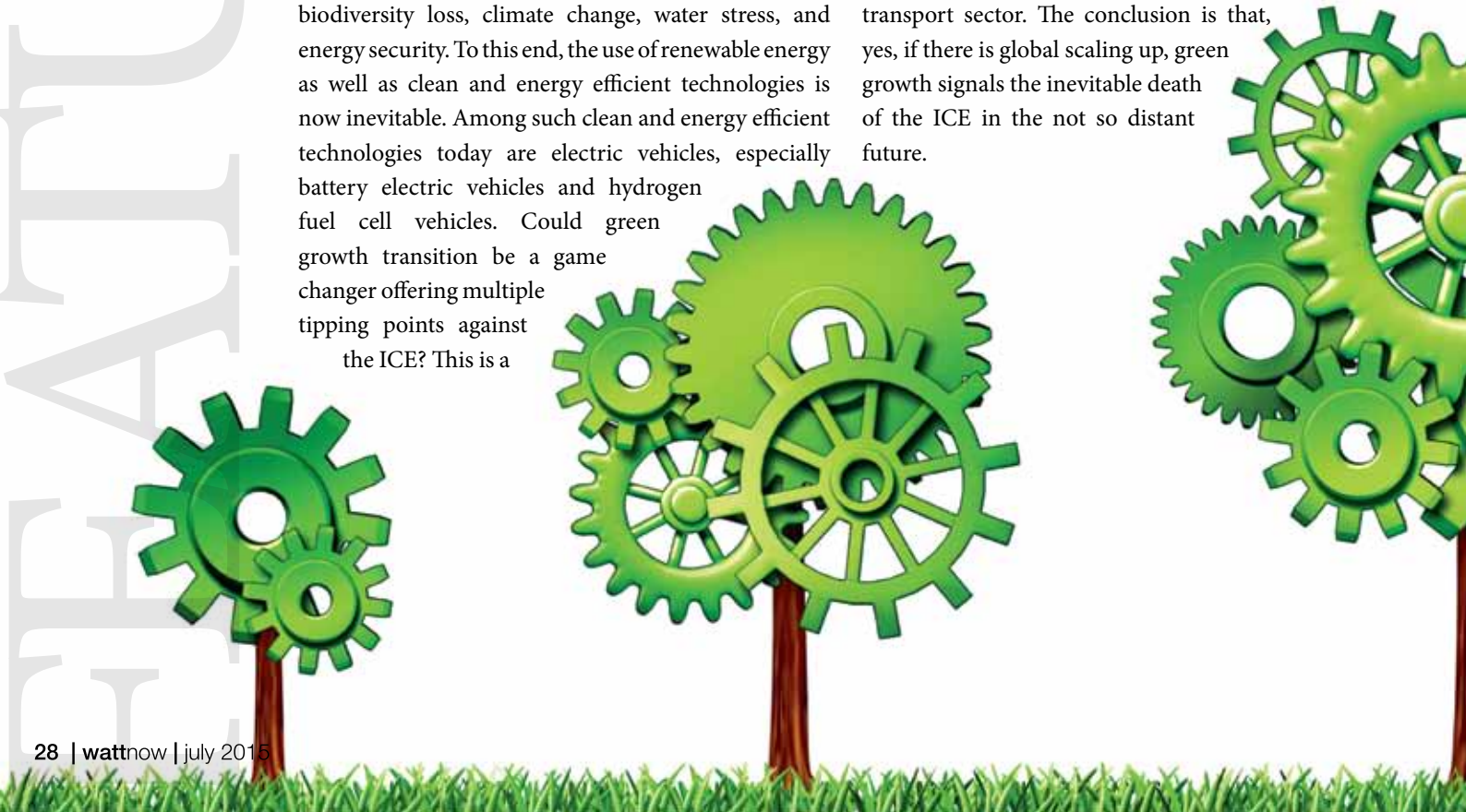
Green growth rests upon the need to convert economies from being resource-intensive to being low carbon and resource-efficient aimed at addressing, among key challenges, ecosystems decay, biodiversity loss, climate change, water stress, and energy security. To this end, the use of renewable energy as well as clean and energy efficient technologies is now inevitable. Among such clean and energy efficient technologies today are electric vehicles, especially battery electric vehicles and hydrogen fuel cell vehicles. Could green growth transition be a game changer offering multiple tipping points against the ICE? This is a question this article addresses. It presents arguments that contribute to current global debates regarding the role of renewable energy as well as clean and energy efficient technology in green growth, especially in the transport sector. The conclusion is that, yes, if there is global scaling up, green growth signals the inevitable death of the ICE in the not so distant future.

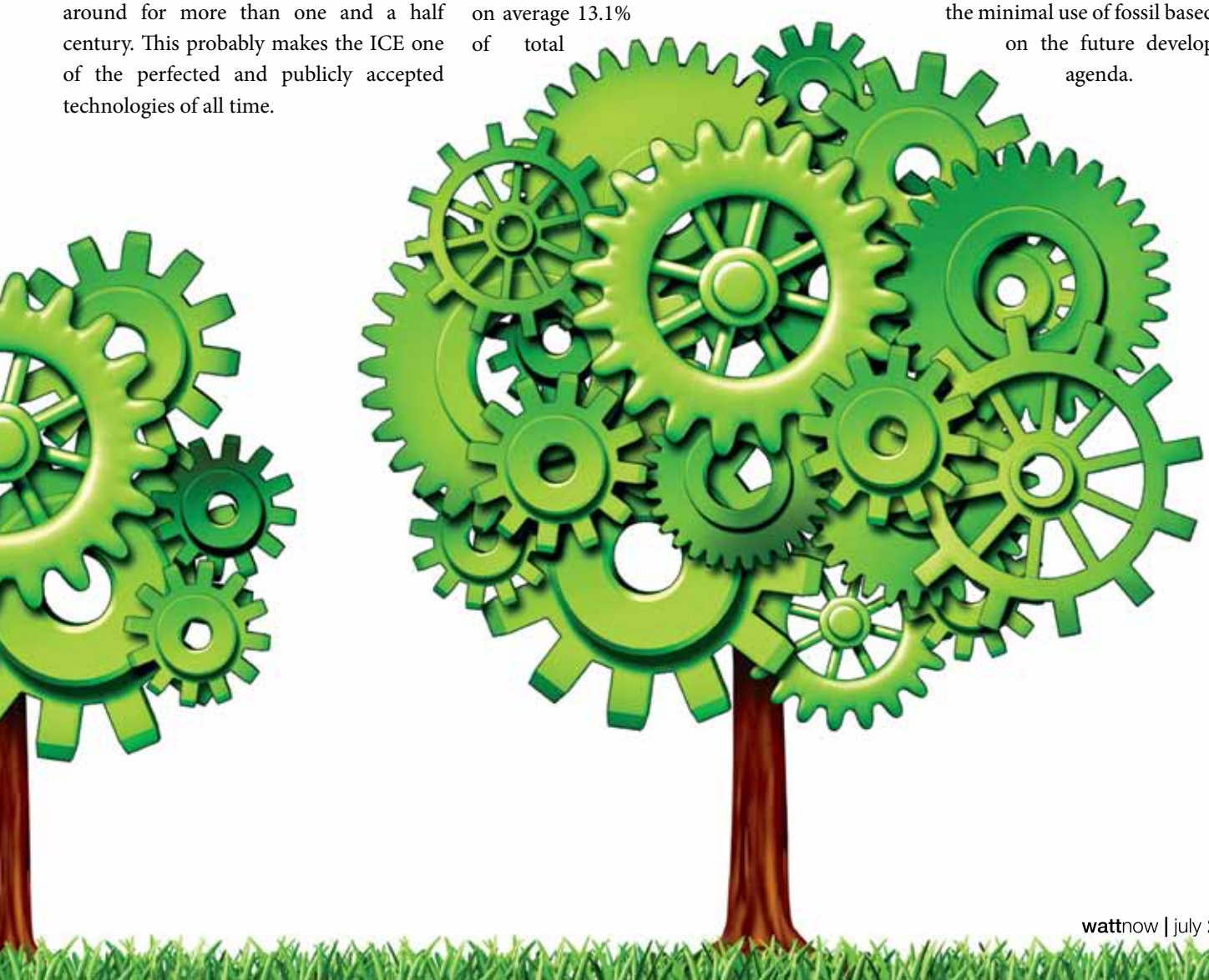


Game changers embedding multiple tipping points get professionals and non-professionals talking and worried. Such phenomena bring along risks and opportunities in the economic, social, environmental and governance spaces of engagement. Over the decades, the world has witnessed game changers in the vehicle manufacturing sector with the Internal Combustion Engine (ICE) having been one of the tipping points against steam engine and likewise, the lithium ion (Li-ion) battery is among multiple tipping points against the ICE. The ICE has been around for more than one and a half century. This probably makes the ICE one of the perfected and publicly accepted technologies of all time.

However, the ICE is now being threatened by green growth transition ushering in Battery Electric Vehicles (BEVs) and Hydrogen Fuel Cell Vehicles (HFCVs). The debate surrounding the promotion of electric vehicles, particularly those drawing from renewable energy sources emanates from the global challenge being experienced from Greenhouse Gas (GHG) emissions that cause climate change, of which the transport sector is a significant contributor.

Globally, the transport sector contributes on average 13.1% of total GHG emissions (Pollet et al. [1]). Other concerns from the transport sector include air pollution, oil depletion, energy security and population growth. With the global human population having reached seven billion people in 2011 and expected to reach nine billion by 2050, more challenges related to population growth and climate change will be witnessed (Pollet et al. [1]).

As a result, green growth that promotes migration from a development path littered with a resource intensive past to one that will be resource efficient, places the minimal use of fossil based fuels on the future development agenda.



Green Growth...

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This article draws data from authentic online sources such as the Electric Drive Transport Association (EDTA) (www.electricdrive.org), the United Nations Framework Convention on Climate Change (UNFCCC) (www.unfcc.int), Nissan South Africa (www.nissan.co.za) and other secondary sources to present a policy story that global leaders are witnessing as a potential substitute of the ICE in the form of electric and other non-fossil fuel based vehicles.

The intention is to challenge scholars from a multi, inter and trans-disciplinary perspective to generate more debate on the bold proposal that one day, in the near future the ICE will be an obsolete technology.

THE DIRTY INTERNAL COMBUSTION ENGINE (ICE)

Van Vliet et al. [2] reveal that more than 90% of the transport sector is powered by fossil fuels, mainly from the ICE. The ICE technology is not only confined to the transport sector but also extends to stationary ICE installations in mining, manufacturing and other sectors that use fossil fuel powered generators, mills and pumps. The energy flow of the combustion engine is presented in Figure 1.

Data retrieved from the UNFCCC website hosting National Communication reports indicate that transport contributes significant amounts of GHG emissions in many nations. For example, in India, 1994 figures reveal 11% of total GHG emissions was from the transport sector, 18% in Mexico (2002), 14% in Australia (2007), 27% in Canada (2007), 18.5% in Japan (2007), and 13% in South Africa (2000) UNFCCC [4].

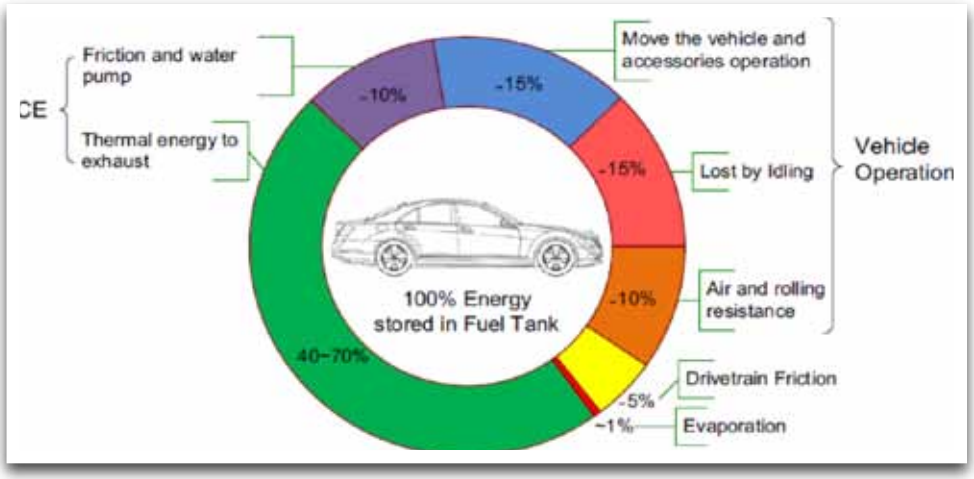

Figure 1: Typical energy flow of internal combustion engine vehicle. Source: Tie and Tan [3, p. 85].

EMERGING POLICY INCENTIVES

A range of policy incentives have surfaced globally. Due to space limitations, only two policy reform regimes for the United States of America (USA) and China are discussed here. The two economies are the largest in the world. Furthermore, China and the USA are the world's 1st and 2nd highest GHG emitters. In the USA, there has been significant policy reform to accommodate the sale of electric vehicles. The Recovery Act USA Department of Energy [5] witnessed the government commit to building local manufacturing capacity for advanced Li-ion batteries, a critical element in the industry. The investments to build this capacity amounted to US$2.4 billion in loans to Tennessee, Delaware and California factories. An additional US$2 billion in grants was budgeted for 30 factories to produce the Li-ion batteries, motors and other components for electric vehicles USA Department of Energy [5].

To this end, the companies have been matching the government financial support dollar for dollar with the aim to have 50,000 Li-ion batteries manufactured annually as of December 2011 and 500,000 Li-ion batteries by December 2014. The Recovery Act further supports demonstration projects of 13,000 electric vehicles and over 22,000 charging points in over 20 cities in the USA. This venture further witnessed companies matching the funding dollar for dollar to the tune of $400 million. Tax credits for buying electric vehicles were introduced ranging between $2,500 and $7,500 depending on the battery capacity.

Yang et al. [6] portray a late entry of China into the electric vehicle production platform with the country's designation of this technology as a key national programme in the 1990s.

The electric vehicle policy reform and regulatory environment came in five distinctive areas, namely: national strategies for new energy vehicles in 2009 and 2012; national research programmes in 2001, 2006 and 2011; national subsidies of 2009/10 (10 cities; 1,000 vehicles project), rules and regulations for manufacturing and products of 2009/10; and technology and emissions standards of 2007 and 2010.

ABOUT HYBRID ELECTRIC VEHICLES (HEVS), BEVS AND HFCVS

Chan [7] provides a good historical account on HEVs, BEVs and HFEVs. Of the three sets of vehicles discussed, the HEV is one propelled by both the motor and ICE. In terms of major issues, BEVs have challenges with the battery and battery management, charging facilities and cost. The historical landmarks in BEVs development are shown in Figure 2.

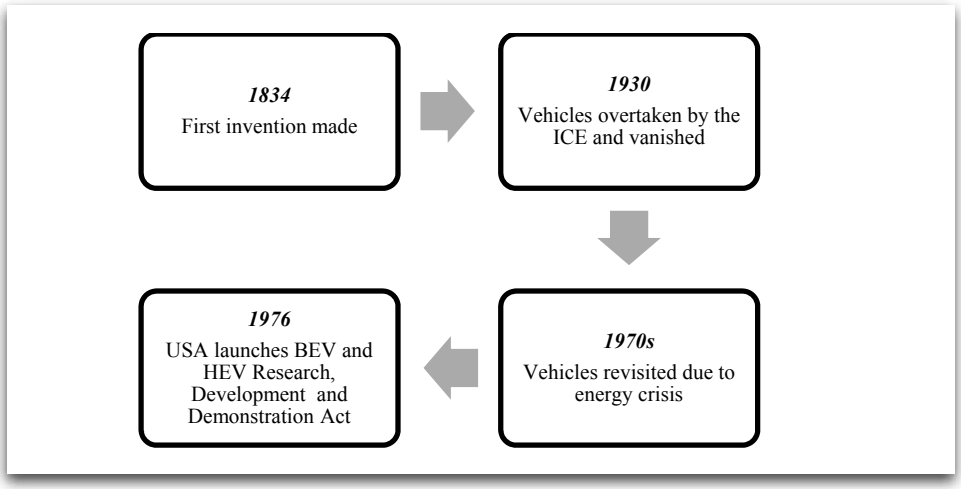

Figure 2: Historical landmarks in electric vehicles development. Source: author, based on Chan [7, p. 706–707].

The HEVs present difficulties in multiple energy sources control, optimisation and management. They also have challenges with battery sizing and management. Lastly, the HFEVs' major drawback is the fuel cell costs, life cycle and reliability Chan [7]. There are also further challenges with infrastructure such as the installation charging stations.

As early as 2002, Lave and MacLean [8] compared environmental impacts of HEV against the ICE. They used the second generation Toyota Prius and the ICE Corolla. In their conclusion, "the more complicated and expensive Prius has lower pollutant and carbon dioxide emissions and better fuel economy than the Corolla" (Lave and MacLean [8, p. 155]). A study comparing HEV, BEV and hydrogen fuel cell vehicles (HFCV) was conducted by Granovskii et al. [9]. It emerged that the BEV was more environmentally friendly if the electricity comes from renewable energy sources. Overall, BEVs and HFCVs are known to have 'zero emissions' (or ultra-low emissions) and for being high in energy efficiency. The common modes of electric vehicles are presented in Table 1. Although all the electric vehicles play out as tipping points for the combustion engine, it is the BEV type that will really substitute the combustion engine if up scaled (Egbue and Long [10]).

On 25 January 2011, in his state of the Union Address, President Barack Obama proclaimed that he wanted one million electric vehicles on American roads by 2015 to reduce dependence on oil and to

VEHICLE TYPE	DESCRIPTION	BENEFITS
Hybrid electric vehicles (HEV)	Electric vehicles that use an internal combustion engine in addition to an electric motor.	Better fuel economy, less expensive to run and lower emissions than similar conventional vehicles.
Plug-in hybrid electric vehicles (PHEV)	Electric vehicles with smaller internal combustion engine and more powerful electric batteries that can be recharged.	Better fuel economy, less expensive to run and lower emissions than similar HEVs and conventional vehicles. Offers flexibility of fuel source.
Battery electric vehicles (BEV)	Electric vehicles that derive motive power exclusively from on board electrical battery packs that can be charged with a plug through an electric outlet.	No liquid fuels and zero emissions at tailpipe. Less expensive to run than similar HEVs and conventional vehicles.

Table 1: Electric vehicles types. Source: Egbue and Long [10, p. 718].

Green Growth...

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take the lead in the growing electric vehicle manufacturing sector (Obama [11]). The proclamation was triggered by the fact that there were more plug-and-drive electric vehicles in China than the USA and anywhere in the world. Although not directly speaking about electric vehicles, in 2014, Obama followed up his 2011 address by announcing that he wanted fuel efficient trucks with 'tougher fuel efficiency standards for delivery vehicles' planned to be operational in March 2016 (Anderson [12]).

ELECTRIC VEHICLES UPTAKE

From its status quo report on the one million electric cars policy pronouncement by President Obama, the USA Department of Energy [5] revealed that although the policy statement goal was rather ambitious, the country's motor vehicle industry had the capacity to see 1.2 million electric cars on the roads by 2015. From the USA perspective, capacity remained a major threat to attaining that goal. As discussed earlier, to counter this threat, Obama initiated programmes that included improvements on consumer tax credit, preparing cities for the increasing demand for the cars and increased support on research, innovation and development. Among the early entries into the electric vehicle market was the Nissan Leaf and Chevrolet Volt. The USA consumers seem to have responded well to the President's goal and trends in the Nissan Leaf (BEV) sales reflect this clearly (Figure 3). The growth in sales has been phenomenal, increasing from 67 units sold in in February 2011 to 1425 units sold in February 2014.

As of April 2013, the Nissan Leaf had reached a landmark of 62,000 units sold globally since its launch in December 2010 [14]. This figure makes the Nissan

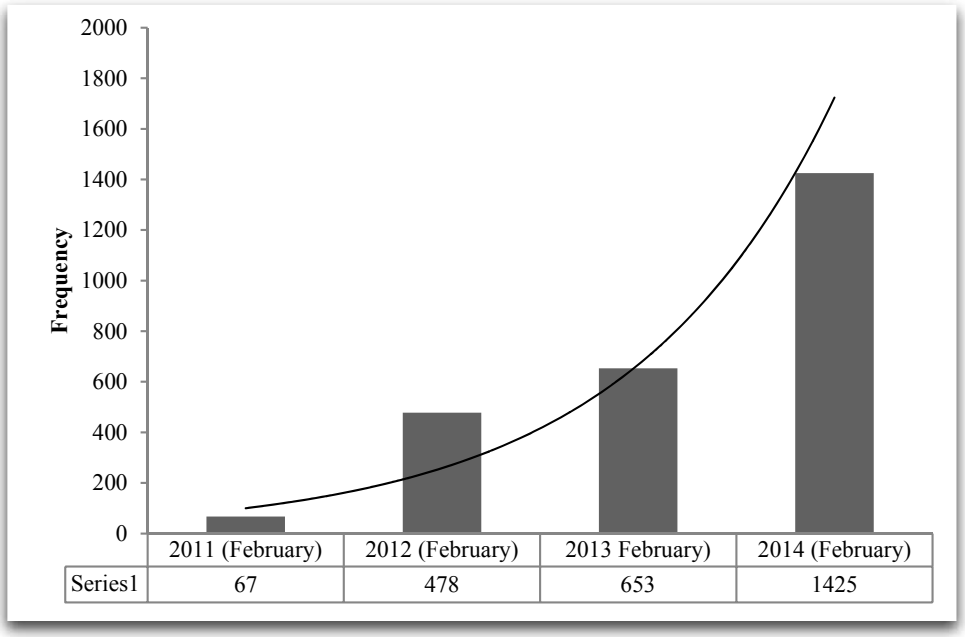

Figure 3: Nissan Leaf USA February month sales trends (2010–2014). Source: author, data from Voelcker [13].

Figure 4: A Nissan Leaf from South Africa's DEA. Source: author.

Leaf the most sought after 'zero emitting' electric car worldwide. The Nissan Leaf has also found its way into Africa with four such cars having been purchased by South Africa's Department of Environmental Affairs (DEA) making them the only 'zero carbon' emitting electric vehicle in Africa as of December 2013. Figure 4 shows one of the four Nissan Leafs owned by the DEA. The car can cover a distance of up to 200 km if fully charged Nissan Global [14] and a maximum speed of 150 km per hour.

The Nissan Leaf has been recognised globally for its 'greenness' winning a number of awards that include: being named 2011 World Car of the Year at the New York International Auto Show Nissan Global [14]; winner of the 2012 RJC Car of the Year award in Japan from the Automotive Researchers' and Journalists' Conference of Japan (RJC); winning the 2011–2012 Japan Automotive Hall of Fame (JAHFA) Car of the Year; and 2011–2012 JAHFA Car Design of the Year awards from the selection committee of JAHFA Nissan Global [14]. The January 2014 Nissan Leaf European sales compared to other electric vehicles (HEVs) is shown in Figure 5.

The Nissan Leaf outclasses all other electric vehicles even though it is a BEV rather than a HEV or HFCV. The Nissan Leaf's January 2014 sales figure for the USA, Japan and Europe stood at 3,736 units (Loveday [15]).

News 24 [16] reported the excitement of the Nissan-Renault CEO after concluding a national deal to supply ALL government departments with battery powered vehicles in the Himalayan kingdom of Bhutan. During the signing ceremony, the Nissan-Renault CEO announced the desire to have 1.5 million units sold globally by 2020. The

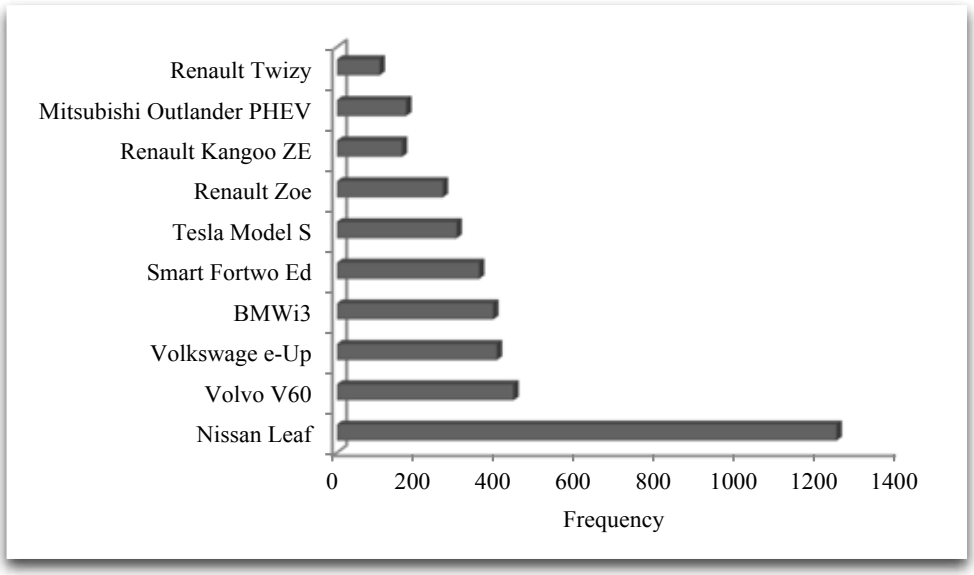

Figure 5: January electric vehicle sales in Europe. Source: author, data from Loveday [15].

CEO further indicated that the Nissan Leaf sales had gone past 100,000 units globally and the demand was pointing to over 60,000 units annually as from 2014.

The Renault Zoe (an HEV) was further highlighted as making good progress on the market, although the exact sales figures were not released.

BARRIERS TO ELECTRIC VEHICLES UPTAKE AND SCALING UP

Despite their 'greenness', electric vehicles' uptake face a number of barriers (Egbue and Long [10]). A key challenge is that consumers tend to be reluctant to take up technology that is novel and unproven. Among the highlighted concerns from consumers regarding electric vehicles are: battery range (distance travelled by the car before re-charging), battery size and weight, high purchase price (cost), charging infrastructure and duration, reliability and safety. I could add from my side, fear of accident damage and the local capability and to maintain such cars.

Other challenges may include financing and insurance as new technology presents risks. The USA data on electric and total vehicle sales reveal the challenge in scaling up sales in electric vehicles and the potential to close the gap (Figure 6).

Although there remains a huge gap in sales between electric and ICE vehicles, the general sales for electric vehicles reveal an upward trend (Figure 7). Another challenge relate to the cost of operating these vehicles. Lee and Lovellette [18] found out that as of 2010, the purchase and operation costs of a HEV and a BEV was $5,377 and $4,819 more expensive compared to the ICE respectively. However, modelling on pricing showed that between 2020 and 2030 BEVs could be cheaper by between $1,115 to $7,181 if battery costs decrease and petroleum prices increase. Pollet et al. [1] concur that cost is probably the key factor for public acceptance and uptake of the cars. The authors reveal that as of 2012, a Li-ion battery with 35 kWh storage capacity cost about $30,000 to produce.

Green Growth...

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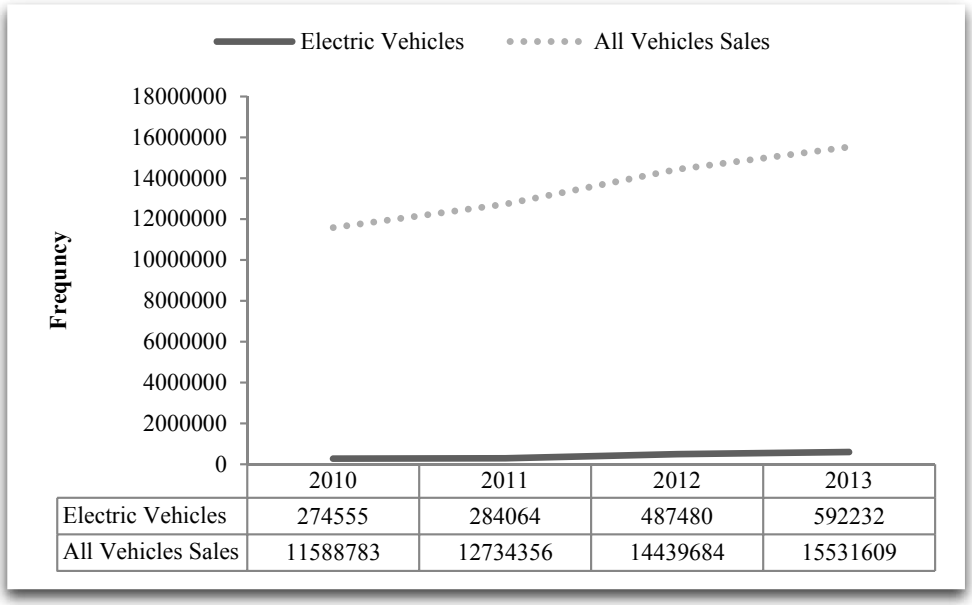

	2010	2011	2012	2013
Electric Vehicles	274555	284064	487480	592232
All Vehicles Sales	11588783	12734356	14439684	15531609

Figure 6: Vehicle sales in the USA (2010–2013).
Source: author, data from EDTA [17].

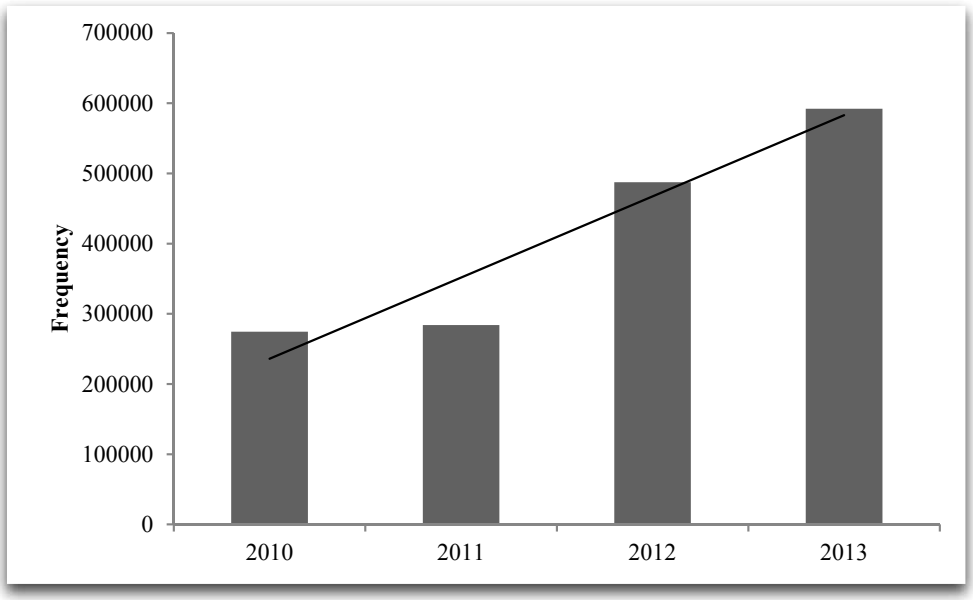

Figure 7: Electric vehicle sales in the USA (2010–2013).
Source: author, data from EDTA [17].

However, according to the authors, Toyota has been making advances in this space and has managed to cut the cost of producing its fuel cell vehicles by 90% since 2005 from about $1 million per unit to $100,000. Even then this cost is way too high compared to a mere $1,000 of producing the conventional ICE of similar functionality.

From Pollet et al. [1] work, the public acceptable price for a HFCV is about $50,000 for a luxury sedan and this is within reach. The price reach for the BEVs of about $40,000 has been attained and it is expected to go down to between $20,000 and $30,000 by 2020.

The cost issue is more pronounced in developing countries where citizens do not have the luxury of having savings. In South Africa (and many other African countries), what citizens require is to have at least a car. In this regard, the electric vehicles, particularly the popular brand Nissan Leaf may not be within many citizens' reach. The Leaf, for example (Nissan South Africa [19] was retailing about US$42,000 (Exchange rate of $1 = R10.7) in March 2014 compared to a higher range new Nissan Sentra at almost half the price (US$24,000).

Price comparison of the Leaf with selected ICE Nissan brands is shown in Figure 8. The Micra, which is very close to the Leaf in terms of shape and size is about a third in terms of pricing. Surprisingly, the Leaf price compares favourably with popular ICE Nissan SUVs like the X-Trail and Pathfinder. In Africa, many black citizens have two homes; one in town and the other in the rural areas where current small BEVs may not be able to manoeuvre. In addition, faced with a choice to buy a Nissan Leaf at equivalent price for a Pathfinder or X-train, African consumers may be biased towards a bigger car for reason mentioned here regarding the state of African and other developing countries roads.

After discussing the key message from this paper with my 11 year old son, Anesu Tadiwanashe Nhamo on picking him up from school in Pretoria, South Africa (7 March 2014), the boy was direct. "It will be difficult to abandon the combustion engine. What happens to Formula One as these electric cars do not have the necessary speed? Will the sport be abandoned?" This was a cool thinking for his age. This also sent me thinking. He further spoke about the battery capacity to store enough power to complete the race at such high speeds.

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Green Growth...

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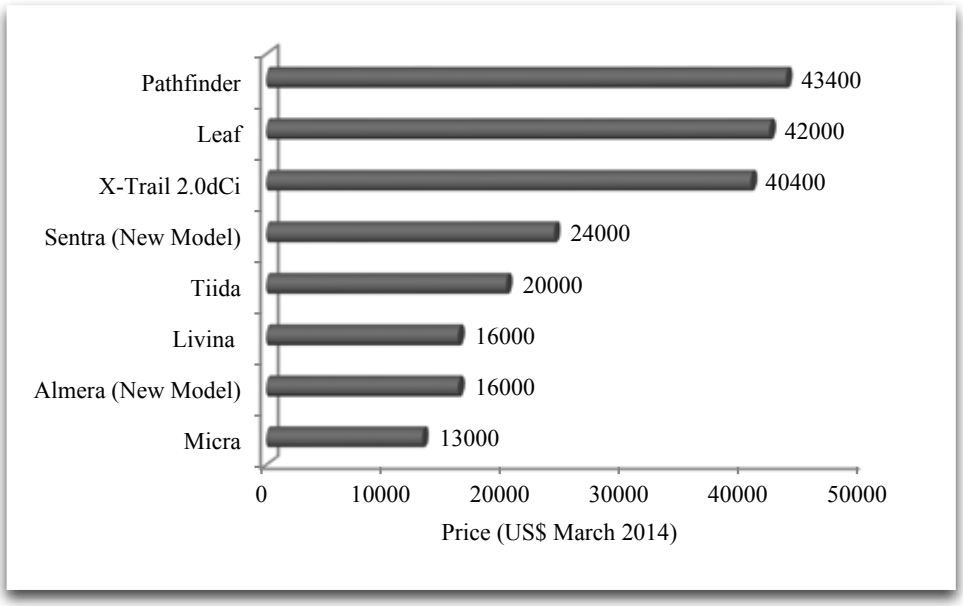

Figure 8: Leaf pricing versus selected Nissan brands in South Africa. Source: author, data from Nissan South Africa [19].

True, there are challenges for the battery technology here.

The issue of job losses may not be overemphasised. Ditching the ICE means the whole world must search alternative employment opportunities in the value chain. One only needs to think of those employed (to support their family and society's livelihoods) in the value chain covering radiator manufacturing, carburetors or direct injection systems, flywheel, crankshafts and casing, timing chains, oils, fuels (including Sasol's synthetic technology for coal), manifolds, fuel lines and tanks, gaskets, cylinders, pistons, engine blocks, injectors and oil rings, valves and valve seals, engine heads, springs, plugs, the value chain list goes on.

The bigger question comes: will the BEVs have the same functionality regarding jobs including repairs (mechanical, electrical and panel beating)? The same story is shared with other economic sectors with ICE based equipment like in agriculture, mining, tourism etc. Jobs are not only a social and economic issue, they are also politically charged.

KEY MESSAGES IN FAVOUR OF SCALING UP

In as much as the exact period of scaling up the uptake of, especially, BEVs, is not known, this paper wish to present some of the key tipping points against the ICE.

With regard to cost, there have been significant reductions already including those highlighted by Toyota. During the launch of the Nissan Leaf in South Africa in October 2013, Managing Director for Nissan South Africa, Mike Whitfield highlighted that *"the Leaf's sales price of R446,000 might seem costly. However, if one includes electricity costs of about R22,500 over a six-year period and maintenance costs of R1,500, the total cost of the car over the six-year period (R470,000) compares favourably to the total cost of ownership of equivalent petrol (R484,000) or hybrid (R505,000) models over the same period"* (Lamprecht [20]).

The political will to come up with new generation green procurement policies and regulations is picking momentum and this can fast tract the tipping points. In addition, (tax) incentives and disincentives will have a huge role to play, including subsidies for consumers who buy BEVs and exemptions, for example, from carbon taxes, fuel levies and e-Toll fees in countries that have such. Superpower political buy in will be fundamental.

For example, countries like the USA may be driving a BEV agenda to scale down their dependence on powerful oil rich trading blocks. Some of these oil rich countries are viewed as undemocratic. Furthermore, quick advancement in the BEV and similar breakthroughs will reconfirm the fading supremacy of countries like the USA.

Lastly, the ever rising oil prices are good enough an incentive for BEVs' continued research and development.

CONCLUSION

Given the forgone, it emerges that although there are challenges associated with scaling up the production and sale of low carbon emitting vehicles that include HEV, BEVs and HFCVs, there has been significant breakthroughs.

The Nissan Leaf (a BEV) has managed to sale over a 100,000 units since it broke to the market in 2010. Indications are that up to 50,000 units could be sold annually moving forward. Toyota on the other hand has been making significant progress with the HFCVs technology mainly aimed at

reducing the cost of these vehicles to the publicly acceptable price of $50,000. Given this trend the question remains: Is green growth transition a game changer leading to the death of the ICE?

The answer is: a qualified yes. There are indicators to this effect. What makes the BEVs a game changer is the fact that it is no longer Nissan (Leaf) alone on this front, but all major car manufacturers have joined in the green cars race. This is likely to have the cumulative impacts as each major car manufacturer's entry into the BEVs race is a mini-tipping point towards the death of the ICE. The role of green consumers (including the emerging green political parties) and environmentally conscious CEOs will further play a key role. Let us continue having this conversation! wn

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The London Crossrail Project

One may ask: what does a wildlife sanctuary have to do with a railway? The sanctuary is in the Thames River tidal estuary which, over the decades, has been slowly washing away. It was reaching a stage where there was the risk of losing the breeding habitat for birds and other creatures. So enter the much needed Crossrail Project.

IAN ROSS | PR ENG | MSAIEE

This is a major new £14.8 bn cross-London rail link project that has been developed to serve London, and the southeast of the UK. There was a challenge of what to do with 3 million tons of excavated soil from the underground stations and tunnels; hence the two problems were solved. The spoil was shipped to Wallasea Island in Essex, where Crossrail has created a new 1,500-acre RSPB nature reserve.

Crossrail will support and maintain the status of London as a World City by providing a world-class transport system. The project includes the construction of twin-bore tunnels on a west-east alignment under central London, and the upgrading of existing National Rail lines to the east and west of central London, a route exceeding 100 km. The project will enable the introduction of a range of new and improved rail journeys into and through London. It includes the construction of ten new stations, providing interchanges with existing London Underground Limited (LUL), UK National Rail and bus services, and the upgrading or renewal of existing stations outside of central London.

Crossrail will provide fast, efficient and convenient rail access to the West End and the City by linking existing routes from Shenfield and Abbey Wood in the east, with Reading and Heathrow airport in the west. Crossrail will be a significant addition to the transport infrastructure of London and the southeast of the UK. Crossrail will deliver improved services for rail users through the relief of crowding, faster journeys and the provision of a range of new direct journey opportunities. The project will also have wider social and economic benefits for London and the southeast of England.

The central section has seven new underground stations: Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel and Canary Wharf and the southeast branch has Woolwich underground station and new surface stations at Custom House and Abbey Wood. The stations all have passenger interchanges to the existing network via the London Underground Docklands Light Railway and National Rail transport systems. The central section underground stations will have extensive over-site development schemes incorporating a variety of apartments, shops and offices.

Designing the route under London was very challenging, with many obstructions such as the existing LUL railway network, sewers and other utility routes, deep piles of high-rise buildings and other such obstructions that the eight 1,000 tonne, 150 m long tunnel boring machines had to avoid.

The general power for lighting, ventilation, lifts, escalators, pumps and other equipment in the central section stations, shafts, portals and tunnels is obtained from 22 kV/400 V or 11 kV/400 V substations at these locations. The 3-phase 22 kV non-traction power network is dual redundant and consists of 400 mm^2 cables running through both tunnels that are fed at both ends from 132/22 kV BSP (bulk supply points). The 132/22 kV BSP at the western end, that feeds in at Royal Oak Portal, is being shared with London Underground Limited. The BSP at Limmo at the eastern end will be supplied from the UK Power Network's (UKPN) 132 kV network. UKPN will also be designing and building the BSP at Limmo. The Southeast branch non-traction power network is 11 kV because it is much less loaded, but is essentially

The London Crossrail Project

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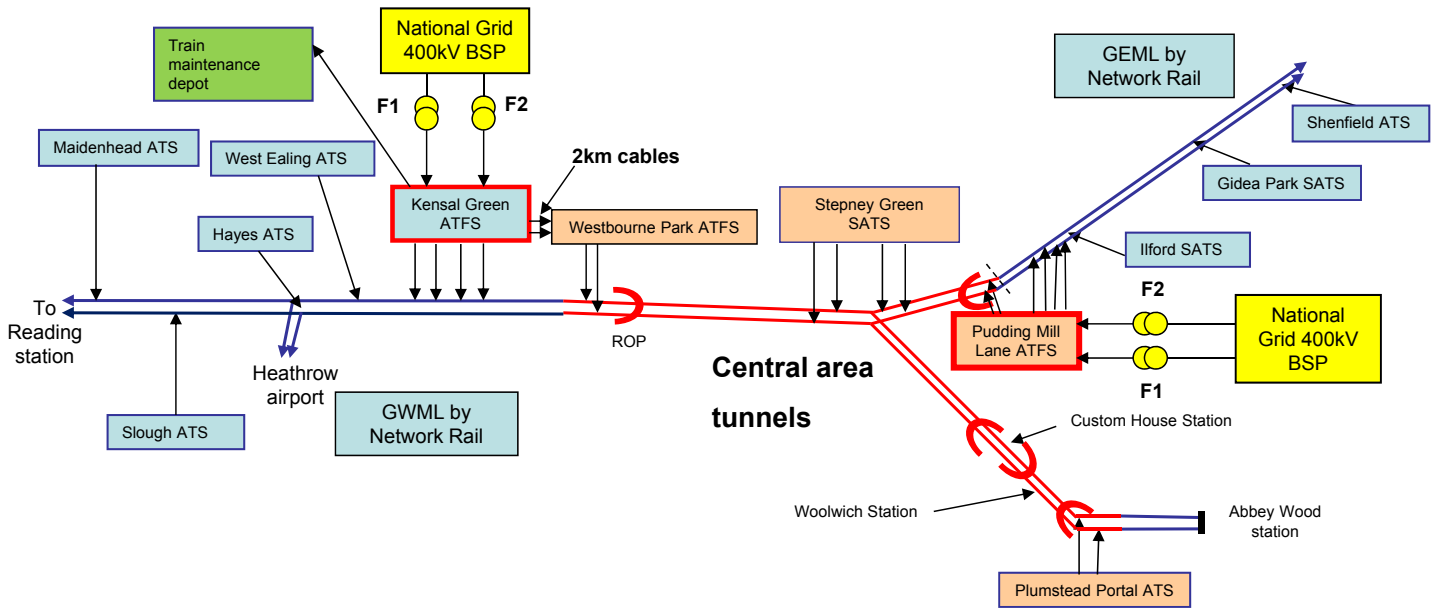
Traction Power System Overview



Outline of Autotransformer Type System to be used

Indicating Bulk Supply Points and Autotransformer Sites

IJ Ross

similar to the central section with a double 11 kV in-feed at Limmo, and another at Plumstead in the south east.

A new fleet of new Bombardier class 345 25 kV electric trains has been procured for the Crossrail service. The trains are 204 m long and rated at 5.5 MVA.

The intense metro type service of 24 trains per hour per direction through the central section was simulated to ascertain electrical traction loads, and the results showed that new power supplies in the London area were needed to supply the 25 kV Crossrail trains.

Two BSPs are being built, one at Kensal Green west of the central section, and the other at Pudding Mill Lane to the east. Each BSP consists of two 88 MVA (104 MVA ONAF) traction transformers fed from the 400 kV National Grid. An Autotransformer type traction power supply system will be used consisting of Autotransformer sites (ATS), Sectioning Autotransformer sites (SATS) and Autotransformer Feeder stations (ATFS). The autotransformer traction power supply system is used on most modern electrified railways and is used for the Gautrain in South Africa.

Pudding Mill Lane (PML) traction power bulk supply point transformers F1 will normally feed the whole of the Crossrail Central Area, and transformer F2 will feed the Great Eastern Mainline up to Shenfield. Kensal Green (KG) transformer F1 will feed the Great Western Mainline to Maidenhead and transformer F2 will remain on "Hot Standby" for central section. In first emergency, if F1 (or F2) at PML is out of service, PML F2 (or F1) will feed the Great Eastern Mainline, KG F1 will feed the Great Western Mainline and KG F2 will feed the Central Area. In second emergency, if F1 (or F2) at PML and F1 (or F2) at KG is out of service, PML F2 (or F1) feeds the Great Eastern Mainline, and also the Central Area. KG F2 or F1 will feed the Great Western Mainline to Maidenhead.

The BSPs feed Autotransformer Feeder stations that consist of outdoor switchgear, which is an arrangement of vacuum circuit breakers, busbars, voltage and current transformers, disconnectors and

earthing devices. The SCADA, electrical protection relays, batteries and chargers, and auxiliary equipment, is housed in a prefabricated building. The ATSs contain similar equipment but with the addition of 15 MVA autotransformers. The ATS at Stepney Green in the central area is located in the ventilation and escape shaft, so gas insulated switchgear will be used. The ATSs are spaced approximately 10 km apart along the route.

A team within Network Rail is delivering the part of the route that runs on the surface adjacent to existing Network Rail's infrastructure. This part of the new Crossrail infrastructure will be interconnected with existing infrastructure at many places along the existing routes, and hence will be owned and maintained by Network Rail. Crossrail is delivering the central section that consists mainly of 42 km of tunnels bored under London. Several dozen detail design and build contractors are employed by Crossrail to execute the project.

Rigid Overhead Conductor (ROC) system

In the tunnels and underground stations a Rigid Overhead Conductor (ROC) system is used, consisting of 150 mm^2 contact wire, fitted into extruded aluminium bar at a height of 4.25 m, and it is supported approximately every 9 m by insulated cantilevers fixed to the tunnel using drop tube supports. There are two 95 mm^2 Al aerial earth wires and one 95 mm^2 Cu traction earth wire per single-track tunnel.

The insulated negative phase feeder cable will be fixed along the tunnel wall. The ROC transitions at the portals to the usual catenary wiring for open routes. There are remote controlled 25 kV sectioning switches at stations, crossovers, and other strategic locations, to enable remote power system reconfiguration in the event of an incident.

Extensive computer simulations have been done to predict step and touch potentials under fault conditions along the route, and to confirm that they are within the standards and the earthing and bonding strategy. The simulations indicate that traction power short circuit currents (e.g. catenary to earth) will be less than the European Technical Specification for Interoperability level of 15 kA. As expected in a rail project of this size and complexity, careful electromagnetic compatibility (EMC) management is essential.

The highest number of passengers on the Crossrail trains will be travelling in the central underground section, so it is essential that the railway is safe and reliable. The power systems have been designed for high reliability and redundancy. All electrical equipment is fully controllable and monitored via the SCADA system from the Route Control Centre in Romford east of London, which is also shared with the control of signalling, customer information, building services and train operations.

Crossrail has been designed with sustainability in mind. All stations, tunnels and trains will make use of the latest energy saving technology such as LED lighting. The alignment in the underground part has gradients at the station approaches that assist braking and acceleration, and the trains will make full use of regenerative braking. All the Crossrail underground station platforms will have Platform Edge Doors (PED) for safety. Barges to the Thames River Estuary transported the excavated material from the bored tunnels and stations, in order to enlarge the Wallasea Island bird sanctuary.

The Crossrail sustainability strategy also includes skills training at the new purpose-built Tunnelling & Underground Construction Academy, Ilford, and an extensive apprenticeship programme. The Crossrail excavations have yielded thousands of archaeological artefacts dating back to the industrial revolution and to the Roman occupation and even earlier.

Testing the various systems will start in 2017 and the first Crossrail train services through central London will start in late 2018. An estimated 200 million annual passenger journeys will be made when the full service comes into operation. wn

Wallasea Island Bird Sanctuary

Earn CPD Credits

From Plateways to Maglev

Wheeled transport has been in use since ancient times. The invention of the wheel, and use of tree trunk rollers, goes back as far as 9500 BC. Wooden wheels with holes for an axle date from 6500-4500 BC. Potter's wheels also date from antiquity.

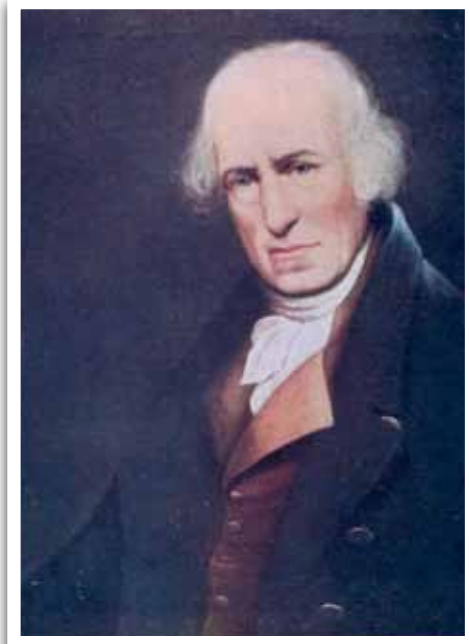
BY | DUDLEY BASSON

The earliest wheeled vehicles, which coincided with the domestication of the horse, date from 4500-3300 BC. The earliest depiction of a four wheeled vehicle was found on a clay pot, excavated in Poland, dating from 3500-3350 BC. By 2200-1550 BC the spoked wheel and chariot appeared. The ancient Chinese also developed wheeled vehicles. The manufacture of chariots developed to a fine art. Chariots were widely used by the Babylonian, Greek, Roman and Egyptian civilizations for warfare, hunting and sport. There is a splendid, if not horrific, display of Roman chariot racing in the movie 'Ben Hur.' In the 3rd century AD the Chinese developed a two wheeled vehicle with a differential gear. This had a pointer on top which pointed in the same direction regardless of how the vehicle was moved about. This vehicle performed the function of a compass.

Barges, ships and horse drawn carts, remained the primary mode of moving goods for centuries. Passenger carrying horse drawn carriages remained the fashionable mode of transport until the twentieth century and remain in occasional use for special occasions. There is a glittering assortment of horse drawn carriages in the Mews of Buckingham Palace.

The Industrial Revolution in Britain started in about 1760, which marked a major turning point in history. A major component of this development was the invention of steam power. The early steam engines worked at atmospheric pressure – the steam was used to fill a cylinder and then cold water was squirted in to produce a partial vacuum which drew in the piston to produce the power stroke. These early machines were mostly beam engines used for pumping water from the mines.

Scottish engineer James Watt (1736-1819) made radical improvements to the extremely inefficient Newcomen steam engine, introducing a separate condensing chamber so that the cylinder would not be heated and cooled with each cycle. In the early 19th century there was a need for more efficient high pressure steam engines, which could also be used for powering vehicles. This was strongly resisted by



James Watt (1736-1819)

Watt, who mistrusted the materials and boiler technology of the day, which could result in explosions.

Watt was delighted when a boring machine was developed which could machine the bore of the cylinders to an accuracy "within the thickness of a shilling." He introduced the power unit 'horsepower' (746 W).

Beam engines could also be fitted with a crankshaft and flywheel for providing rotary power. The piston rings of these machines was a length of tar soaked rope wound around the piston. The oldest surviving Boulton and Watt steam engine is 'Old Bess' constructed in 1777 and now housed in the Power Gallery of the Science Museum, London. This moderate steam pressure engine was the first with early valve cut-off allowing the steam to work expansively bringing a huge improvement to engine efficiency.

In 1801, Richard Trevithick (1771-1833) built the first high pressure double acting steam engine and constructed a steam powered road vehicle capable of 14,5 km/h. This vehicle carried six men, on Christmas Eve of 1801, up Fore Street of Cambourne hill. He built the first steam powered railway locomotive which hauled a train of 5 wagons carrying 10 tons of iron, and

Richard Trevithick (1771-1833)

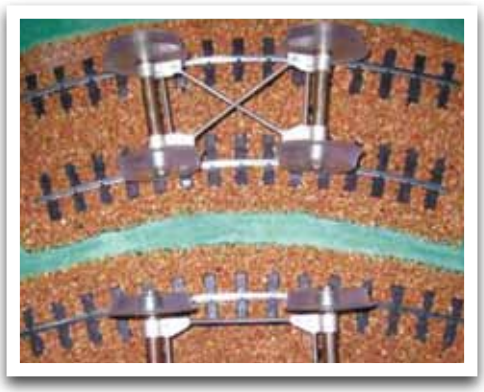
70 men on the tramway of the Penn-y-Darren Ironworks from Merthyr Tydfil, to Abercynon, Wales – a distance of 16 km. He worked as a mining consultant in Peru and later explored parts of Costa Rica. He was a well respected and known figure in mining and engineering.

From Plateways to Maglev

continues from page 43

Plateways were used in industrial situations for providing good tracks for horse or cable drawn carts. These were made of cast iron and later wrought iron, and remained in use for about 50 years up to 1830. The plateways were commonly used in South Wales. These plates were about 3 feet long and had a vertical flange to prevent the wheels from leaving the track. These were inadequate to carry the heavier loads of steam locomotives and rolling stock, which led to the introduction of raised steel rails (edgeways) attached to wooden sleepers, which accurately maintained the correct gauge (distance between rails) and kept the rails clear of stones and other debris. Flanges were added to the wheels and not to the rails. To this day, construction crews laying railway tracks are known as platelayers. The new tracks were first known as railroads and then later as railways. The term railroad took hold in the USA where it remains in use.

With horse drawn wagons having independently turning wheels and a swivelling front axle, rolling geometry was hardly worth a thought. With heavy rolling stock using wheelsets (two wheels solidly fixed to a common axle) correct rolling geometry was vitally important to avoid slipping, shuddering and excessive wear. A major improvement was the introduction of conical wheel treads tapering away from the tracks. On entering a curve the wheels would naturally roll slightly to the outside of the curve so that the outer wheel would roll on a slightly larger diameter than the inner. This would give perfect rolling geometry for a single wheelset rolling on a track, but for two wheelsets fixed at either end of a truck it would be impossible for both axles to point to the centre of the turning circle, causing slippage and the wheels to ride against the flanges. This problem could largely be dealt with by using swivelling bogies at either end of the truck, but the two axles of the bogies would still point to slightly different centres of turning circles resulting in some slippage and shuddering. This problem was dealt with by using bogies which allowed slight lateral movement of the axle bearings.



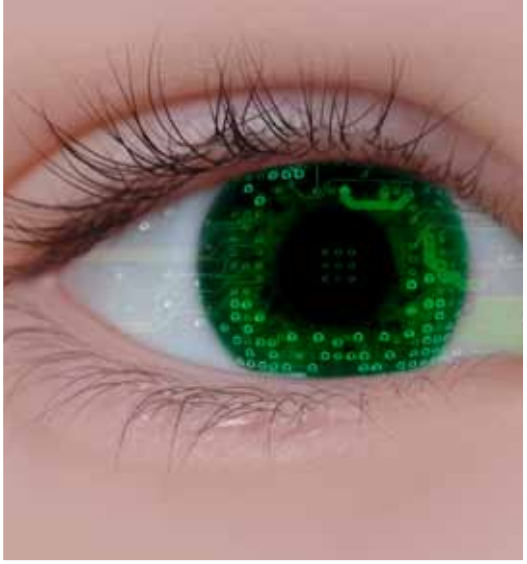
The Sheffel

The Sheffel (South African) design has diagonal bracing between the axle bearings allowing the outer wheels to spread slightly and the inner wheels to draw slightly closer together allowing both axles to point to the same centre of curvature. Another design allows the axles to turn slightly against springs.

With high speed trains the conical tapering of the wheels must be kept to a minimum, as the natural hunting movement can lead to excessive and dangerous oscillation at speed. Little conical tapering on the wheels however limits the allowable curvature of the track. Nearly all railways in South Africa have a narrow 'Cape gauge' of 1070 mm, which is more economical, and allows sharper curvature of tracks. Cecil Rhodes had a grandiose vision of a Cape to Cairo railway and telegraph, which never came to serious consideration. The broadest gauge ever envisaged, 2143 mm, was used by the famous engineer Isambard Kingdom Brunel from 1838 to 1892. Brunel was one of the truly great giants of engineering, building railways, bridges, tunnels, and the largest ships which had ever put to sea at that time. The UK, however, standardised on Stephenson's 1435 mm, which became known as standard gauge. This gauge was used for South Africa's Gautrain, which makes it incompatible with the rest of the network. A large number of different gauges are used by countries around the world.

With automotive road vehicles, the wheels are never fixed to common axles, so there is no problem with different speeds on the inside and outside of the turning circle. Using a swivelling axle for steering is hardly an option, so the inner and outer wheels must be steered to different angles to turn about a common centre of curvature. The usual mechanism used is the Ackerman linkage which has three positions for exact steering, straight ahead and one angle left and one right. At other positions the steering is so accurate that deviations are not noticed. Perfectly accurate steering can be achieved by the Davis mechanism but this requires sliding members ahead of the wheels and is seldom used. Large heavy haulage vehicles, with multiple steerable bogies, require computer controlled steering. Heavy trucks with multiple load bearing wheels or double wheels will experience scuffing on negotiating curves, but this is considered unavoidable.

George Stephenson (1781-1842) built the first inter-city railway using steam locomotives in 1839, which ran between Liverpool and Manchester. The opening was a glittering occasion with Prime Minister, the Duke of Wellington present.



BFA IS DEDICATED TO PROVIDING A CONSULTING SERVICE THAT WILL BENEFIT ITS CLIENTS BY MEANS OF APPLYING THE LATEST TECHNOLOGY PARTICULARLY WITH RESPECT TO ENERGY SAVING, WITHOUT COMPROMISING THE AESTHETIC AND CORPORATE IMAGE OF THE CLIENT AT THE MOST ECONOMICAL COST.

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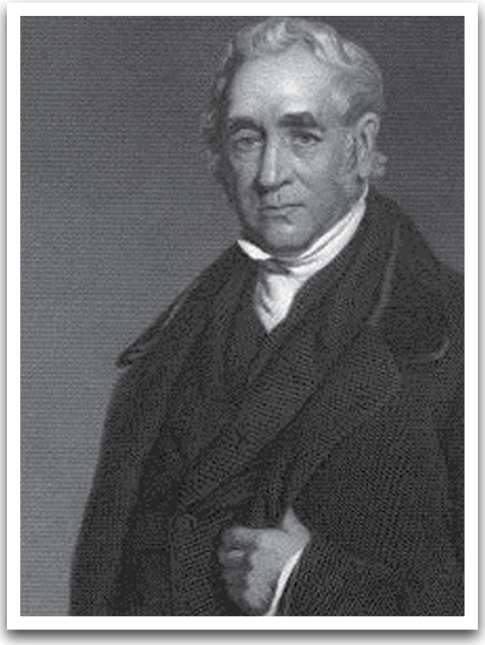
From Plateways to Maglev

continues from page 44



George Stephenson (1781-1842)

Stephenson built the Stockton and Darlington 40 km railway in 1821. His son Robert assisted with the surveying. Stephenson established a company to manufacture the locomotives. The first of the four locomotives, named 'Locomotion', was driven by Stephenson in September 1825 . It hauled an 80 ton load of coal and flour 15 km in two hours, at times reaching a speed of 39 km/h. A passenger car was attached which carried dignitaries for the opening journey. Stephenson became renowned for many other railway and civil engineering works.

Locomotive boilers at first had simple riveted longitudinal lap joints. These proved unsatisfactory as the joints were subjected to bending stress and the rivets were subjected to both shear and tensile stress. Using double strapped butt joints, which also facilitated effective steam proof caulking, solved this. Watt's concern about the safety of high-pressure boilers was justified. Several tons of water boiling under pressure can cause a catastrophic explosion. Boiler explosions peaked at about the beginning of the 20th century but steadily diminished due to stringent regulations for the manufacture, testing and inspection of pressure vessels.

In the first locomotive photo, the smokebox, with attached fire tubes, has been blasted away leaving the superheater tubes behind, partly withdrawn from the boiler.

The second photo shows a locomotive completely wrecked by the explosion. In steam locomotives it is vital that the fire tubes and firebox remain covered by water at all times. As a safety feature, fireboxes have a lead plug at the top which will melt if the water level drops dangerously. A melted plug will result in a powerful blast of steam into the firebox and out into the driver's cab.

Locomotives and rolling stock have fascinated hobbyists for nearly two centuries. A huge variety of model locomotives and rolling stock, as well as buildings for constructing villages and railway stations, are available at hobby outlets. The puffing chimney and simplicity of design seem to have a natural appeal. The piston to driving wheel linkage is as simple as a bicycle but the valve linkage is somewhat complex. This must provide for correct cutoff for steam economy or extra power, and also enable the engine to operate in reverse. Locomotives at first had mostly the Stephenson linkage but later the Walschaert linkage was adopted as this allowed a lower positioning of the boiler. Steam locomotives have a unique advantage in that they can provide maximum torque from standstill. Two double acting cylinders provide four power strokes per revolution of the driving wheels. Steam locomotives made no concession to electricity except

Smokebox Photo 1

Smokebox Photo 2

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The Annual SAIEE Banquet is an open event.
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Venue:	Birchwood Hotel & Conference Centre, Boksburg
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From Plateways to Maglev

continues from page 46

for a small turbo-alternator to power the lights. I can remember rewinding one of these, working as an apprentice in the Iscor electrical workshop.

Steam locomotives, even with the introduction of superheating tubes inside the firetubes, and using expansive steam in the cylinders, have an appallingly low thermal efficiency of about six percent. Feedwater from the tender is pumped into the boiler, and then passes to the cylinders as steam, after which it is blown through a venturi in the smokebox, drawing combustion gases through the fire tubes and out through the chimney. Most of the combustion energy from the coal is simply blown to waste. The wastage of feedwater can be a serious problem in arid regions. Steam driven power stations are able to operate much more efficiently by using multi stage turbines, recovering heat from the flue gases, and condensing the exhaust steam to water.

Electric locomotives are probably the most efficient form of railway propulsion, even when factoring in the power station efficiency and transmission line losses.

Diesel engine locomotives are advantageous where electrical power is not available, and are more economical than steam, despite the higher fuel cost. The giant diesel-electric locomotives are power stations on wheels. The engine is able to run at optimum speed driving the alternator, after which power electronics can provide superb control of the traction motors in the bogies.

The forms of transport can depend greatly on the topography of a region. In mountainous countries much use is made of rack and pinion driven trains. The track up Mount Pilatus, near Lucerne in Switzerland, has the steepest track gradient on Earth. Cableways are provided mostly for tourists and chair lifts for skiers.

Many major cities have large underground train networks. The London Underground started in 1863 and became the largest tube network on Earth. Much of the London network was too deep for cut and cover construction and had to be made by tunnelling. Tunnelling was greatly facilitated by the Greathead (South African) Tunnelling Shield. Brunel constructed one of the tunnels under the Thames River. The first trains were drawn by steam locomotives, but matters were greatly improved by the availability of electric power.

Huge advances have been made in high speed inter-city trains reaching speeds of over 300 km/h. The TGV (Train à Grande Vitesse) in France, the ICE (Inter City Express) in Germany and the Bullet Train in Japan are a few examples.

The new Maglev (Magnetic Levitation) trains are in an entirely different category. These trains use intense magnetic fields for levitation, guidance and propulsion. These trains have no driving wheels or motors – the guideway is a continuous linear induction motor. The trains do however need landing wheels for starting and stopping. The Shanghai Transrapid is the fastest commercial train in operation with a top speed of 430 km/h. It covers the 30,5 km from Pudong International Airport to central Shanghai in 8 minutes. It came into operation in April 2004.

At present only one other maglev train is in commercial operation. Japan began operation of its relatively low-speed Linimo line In March 2005, in time for the 2005 World Expo. In its first three months, the Linimo line carried over 10 million passengers.

Maglev trains use intense magnetic fields of between 5 and 10 tesla. This requires the use of superconducting super-cooled niobium-titanium alloy electromagnets making the guideways and trains horrifically expensive. Fully utilised Maglevs can compete with air travel on a cents per passenger kilometre basis, and by eliminating travel to and from out-of-town airports. The Maglev guideways do not need to be continuously energised – it is sufficient to energise only those parts of the guideways where trains are running.

A most bizarre train has been proposed for the future, which could out run a fighter jet at over 5000 km/h. This is the Vactrain (Vacuum tube train). This is similar to a system used in some department stores before the appearance of point of sale terminals. Clerks at pay points would place an invoice and cash into a small cylinder which would be placed into a vacuum pipe and sucked up to a central cashier. The receipt and change would then be sent back in another pipe to the customer. The proposal is that the tube size be kept small by providing reclining seats for the passengers. An interesting aspect of this idea is that much of the propulsion can be assisted by gravity. The train can rapidly descend to gain speed and at the other end rise up again to lose speed. This idea became the subject of a mathematical competition in June 1696. The major mathematical forces of the world were mobilised when Johann Bernoulli announced a competition for the solving of the brachistochrone problem.

The problem appears deceptively simple: determine the path that a particle, acted on only by gravity, which must slide down to move in the shortest time from point A to a lower point B, which is not directly below it. The problem was put to Newton, Jacob Bernoulli, Leibniz and de L'Hôpital. Johann Bernoulli had solved the problem before announcing the competition. Galileo had tackled the problem in 1638 and determined that the path was a circular arc, a near miss but not correct. All of the mathematicians were able to solve the problem but not by using the same methods. Johann Bernoulli and Leibniz deliberately tempted and goaded Newton in a carefully worded letter to attempt the problem.

Newton's biographer wrote:
"… in the midst of the hurry of the great recoinage, did not come home till four (in the afternoon) from the tower very much tired, but did not sleep till he had solved it, which was by four in the morning."

Newton was not pleased and said:
"I do not love to be dunned and teased by foreigners about mathematical things."

The correct solution is a cycloid. The simple cycloid is the path taken by a point on a circle when the circle is rolled along a straight line. For the present problem the circle must roll on the underside of the line. Euler found a solution to the problem with the particle moving through a resisting medium.

In the idealized case with no friction or air resistance the Vactrain could operate without using any power at all.

A similar gravity assisted rapid transport system was described in the early 20th century jungle stories of "Tarzan and the Apes". Tarzan would swing from tree to tree on hanging vines.

Swinging on a vine constituted a pendulum swing. Tarzan could either return right away or restrain the vine for later use. The only energy input needed was an initial thrust to compensate for air resistance.

On a lighter note – 'Vac-trains' can also be read as 'Cow-trains' (A cow in French is a "vache" which gives the word vaccine). wn

7 ways to lose your most valuable talent

Recruiting the right people is difficult in a market where many important commercial, technical and management skills are in short supply. Keeping employees once you've recruited them can be even harder.

BY | ANTON VAN HEERDEN | SAGE HR & PAYROLL

Every time you lose a good employee, it costs you money because you'll need to recruit and train someone to replace him or her. It disrupts continuity in your business, can hurt customer relationships, slows you down, and results in you losing a small piece of your corporate memory.

That's why organisations must create an employee engagement and retention strategy to ensure that they remain competitive and productive. Here are some common mistakes that can result in your business losing good employees.

NOT LISTENING TO EMPLOYEES

It's important to gather employee feedback through formal and informal channels alike. Conduct regular surveys to assess workplace happiness and find out what you can realistically do to improve employee satisfaction. Also, make some time to listen to employees' suggestions in more informal settings.

Even though not every suggestion will be viable to implement and some complaints might not be valid, people like to feel that their opinions are heard and their issues are understood. Employees might have great suggestions that can help you improve your business – their perspectives can be invaluable.

NOT COMMUNICATING WITH EMPLOYEES

It's important to keep employees as well informed about activities within the business as you can. Too much secrecy can eat away at employees' happiness, trust, and confidence, leading to staff turnover. Rather be as transparent about the business's plans, opportunities, and challenges as you may within the constraints of JSE regulations, customer confidentiality agreements, and so forth. Even when there's bad news, it's better to tell employees than to allow office rumours to shape people's ideas about what is happening behind closed boardroom doors.

INFLEXIBLE WORKING PRACTICES

The world has changed thanks to technologies that allow people to be productive wherever they are. However, working practices at many organisations have yet to catch up. These days, the best people gravitate towards organisations that offer them the work-life balance they desire. Rather than enforcing rigid office hours, why not allow knowledge workers who can do their jobs anywhere to work remotely or keep more flexible hours?

Long commutes in traffic are the source of much misery for the workforce, so it seems sensible to adopt working practices that help people spend their time as productively as possible.

SLASHING TRAINING AND DEVELOPMENT BUDGETS TO REDUCE COSTS

Most employees place a high value on opportunities to develop their skills and learn new things, and that's doubly true of the most ambitious, high-performers that could become your business's future leaders.

For that reason, it's important to have a formal learning and training strategy, and to keep budget available for training and development. Even when times are tough, training should be one of the last places you look when you're trying to reduce costs. Losing good people or having an unskilled workforce will cost your business more money in the longer term.

MAKING POOR HIRING CHOICES

One of the biggest reasons people don't last in a job is that they weren't a right fit for the role or the company in the first place. Evaluate every candidate for his or her cultural fit with your organisation – don't just look at the skills, qualifications and experience, but also assess his or her attitude, values and outlook.

A person might be a great hire for another business, but not for yours, simply because of cultural fit. Also, be sure to check that you're hiring (or promoting) the person for the right job. A candidate could be a spectacular salesperson and a terrible manager.

NOT HAVING TRANSPARENT PERFORMANCE MANAGEMENT

A formal performance management process brings fairness and transparency into your relationship with employees.

It helps them understand what is expected of them and helps you to understand what their goals are.

Employees who know what they are working towards will be happier and less likely to leave than those who feel uncertain about what their goals and those of the company are.

FAILING TO INVEST IN EMPLOYEE ENGAGEMENT

Employee engagement can be defined as the techniques, tools and strategies you can use to get employees motivated about their work and engaged in the business's strategy, values and culture.

Some examples of these include employee satisfaction surveys, employee self-service tools, team-building exercises, and mentoring processes. Without this investment, the business and its employees will be in poor alignment. The result will be poor staff retention. wn

Earn CPD Credits

SAVING POWER QUALITY RANDS

Defining the Power Quality "Blue Print"

The Effects of Poor Power Quality for any business are established by critically examining two core areas:

- Operational losses such as downtime, equipment failures, scrap, rework etc.
- Power Bill Demand (kVA) related costs/ penalties as a result of poor power factor

Impact Energy represent the unique, leading edge and patent pending Elspec PQ Energy Saving Concept to add a third dimension to defining and quantifying the PQ Blue Print. The Energy Saving Concept quantifies Technical Energy (kWH) loss and savings potential across key components in the network i.e. Transformers, cables and loads.

- Power Bill Energy (kWH) related costs due to technical network losses

Establishing a Power Quality consequence and cost fingerprint for any site is the key step in driving reliability and engineering value back into power networks. Impact Energy provide the transition from establishing Power Quality consequence and cost baselines into real financial value through leading edge Elspec Power Quality Measurement and Solutions Technologies.

THE INNOVATIVE AND SYSTEMATIC POWER QUALITY APPROACH

Energy is supplied on a continuous cycle by cycle basis, naturally PQ (power quality) analysis and loss analysis should be done on a cycle by cycle basis for an accurate representation of the performance of a power network. This is the principle distinctive offering by Impact Energy, brand ambassadors and exclusive agents for the Elspec product and service portfolio. A formal engagement with Impact Energy on an innovative systematic PQ approach ensures the following key deliverables:

- Comprehensive Power Quality Study (using Elspec's G4K cycle-by-cycle continuous measurement devices and patented PQZIP compression technology, permanent fixed or temporary rental meters)
- PQ Modelling and Loss Analysis (through a combination of network parameter modelling and cycle by cycle measurements, Elspec is able to produce highly accurate simulations of system technical losses)
- PQ Solution Conceptual Offering (The model and measurements would be used to determine the primary PQ issues for the site. This in turn would inform various solutions from Reactive Energy Compensation, Voltage Support, Motor Start, Dip Ride Through and Harmonic Filtering.
- Present a loss analysis and business case evaluation (Emphasis will be placed on 3 key aspects of losses i.e. Technical System Losses, Non-Technical Production related losses and possible demand (kVA) related savings on the power bill)
- Obtain approval on designs and prepare for procurement and execution phase
- Official report for Energy Saving (after solution implementation)
- Power Quality Metering and Solution Routine Reporting and Maintenance (this is supplementary/optional to support key personnel in ensuring that benefits and value realised are sustainable).

TECHNICAL LOSSES (KWH)

Technical Losses are an inherent facet of any Power Network resulting in losses and inefficiencies across key components on the network. These losses have historically been an acceptable and ignored cost implication for all business types. In the current and future context of Power constraints and business profitability impact, ignoring any opportunity in optimising efficiency, is unacceptable.

Reactive Energy increases the RMS current through components such as transformers and cables, resulting in progressive and more often than not premature ageing.

If we add the long term effects of I^2R heating with anomalies such as switching transients, lightning surges, hot connections, sub-standard equipment, poor maintenance practise etc., this simply compounds the degradation process of critical assets.

This has a direct impact on the capital planning process and impacting the sustainability of any business.

TRANSFORMER LOSSES (KWH)

Transformer losses occur due to a few factors seen in the formula, here we focus on harmonic currents, eddy currents, hysteresis and resistive losses common to transformers.

The presence of Harmonic Currents increases the transformer core losses, copper losses and stray flux losses.

The NO LOAD losses, which are predominately affected by Voltage Harmonics, consist of Hysteresis and Eddy Current losses. Hysteresis Loss is due to non-linearity of the transformer and Eddy Currents Loss varies in proportion to the square of the frequency.

The LOAD LOSSES on the other hand consist of Resistive losses found in the windings, conductors and leads, Eddy current losses from the windings and conductors and thirdly, Eddy current losses

$$P_T = P_{CU} \times \left(\frac{I_L}{I_1}\right)^2 + P_{WE1} \times \left(\sum_1^n \left(\frac{I_n}{I_1}\right)^2 \cdot n^2\right) + (P_{CE1} + P_{SE1}) \times \left(\sum_1^n \left(\frac{I_n}{I_1}\right)^2 \cdot n^{0.8}\right)$$

Total Load Losses PT of a Transformer where Harmonics are present on a network

from the tanks and structural steel work of the transformer.

Another common occurrence caused by harmonics is from the Triple N harmonics, which do not pass upstream, is then forced to circulate within the closed delta winding of the transformer, thus leaving the transformer vulnerable to overheating.

CABLE LOSSES (KWH)

The presence of harmonics, in cables influences conductor resistance, and further increases operating temperature. This can eventually cause early ageing of the cables.

Harmonic currents have 2 main effects on cables:

- "Ohmic Losses" (I^2R Losses) in the line and neutral conductors as a result of increased RMS values of current, results in increased temperatures
- Harmonic Voltages across various parts of the network. This increases the dielectric stresses on cables and thus shorten lifespan

Eddy Current, which is generated due to relative motion of the Electromagnetic Field and circulating current in a conductor, is the root cause of the Skin Effect. This current tends to flow on the outer surface of the conductor.

$$Q(m) = \sum m \cdot I_n^{\,2} \cdot r_{ac}(n)$$

Heat Generated in a cable

$$\rho = \rho_{rat} \cdot e^{-\left(\frac{E}{K}\right) \cdot \frac{\Delta\theta}{\theta_{rat}(\theta_{rat}+\Delta\theta)}}$$

Life Expectancy of a Cable

LOAD LOSSES (KWH)

Increased motor currents in individual phases result in heating and copper losses. Other mechanical/electrical issues also occur: e.g. torque reductions, cooling fan problems, insulation degradation.

Tripping of VSD's during unbalance, under -voltage and overcurrent conditions are additional concern factors associated with loads.

Negative sequence – the effect of the negative sequence field on asynchronous motors, which are direct connected to the mains (not controlled, such as in variable speed), can be estimated using the current harmonics components.

DYNAMIC REAL-TIME VOLTAGE STABILIZATION

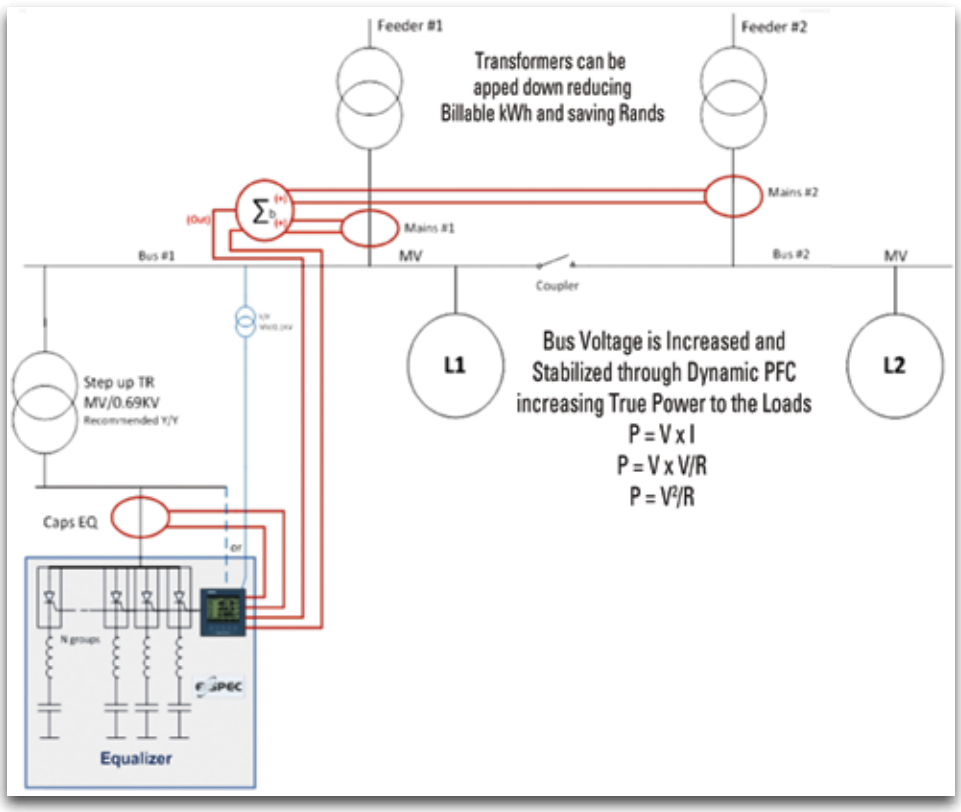
For non-linear loads, voltage variation due to load variations affect power consumption patterns. Through cycle by cycle reactive energy compensation, voltage is increased and more stable. It is possible to tap down transformers and this has potential energy saving benefit.

The Equalizer offers transient-free, electronically switched Power Factor Correction, with acquisition of targeting Power Factor (full compensation) within one network cycle (typically 5 to 20 milliseconds at 50Hz).

The Technical Loss considerations and associated implications are tabled and hold true for almost all types of industry regardless of customer perceptions. Energy (kWH) savings potential of up to 13% can be estimated with a confidence level of 80% or greater. This, together with any form of quantified operational loss analysis serve as a sound basis for investment into Power Quality Solutions.

SIMULATIONS AND MODELING

Once the Comprehensive Power Quality Study has been completed using Elspec G4K metering devices, site network data is captured, which feed into the formulation of site electrical models. The data includes



Saving Power Quality Rands

continues from page 53

Transformer short circuit impedances; tap positioning, cable impedances; type and lengths, and other relevant data. The models are then used for simulations of various PQ scenarios to determine network losses, potential solutions, savings, and the formulation of an official Energy Saving Report.

- Simulation
  In this step the plant is represented by a one line diagram for simulation purpose, where static load is replaced by dynamic (cycle by cycle).

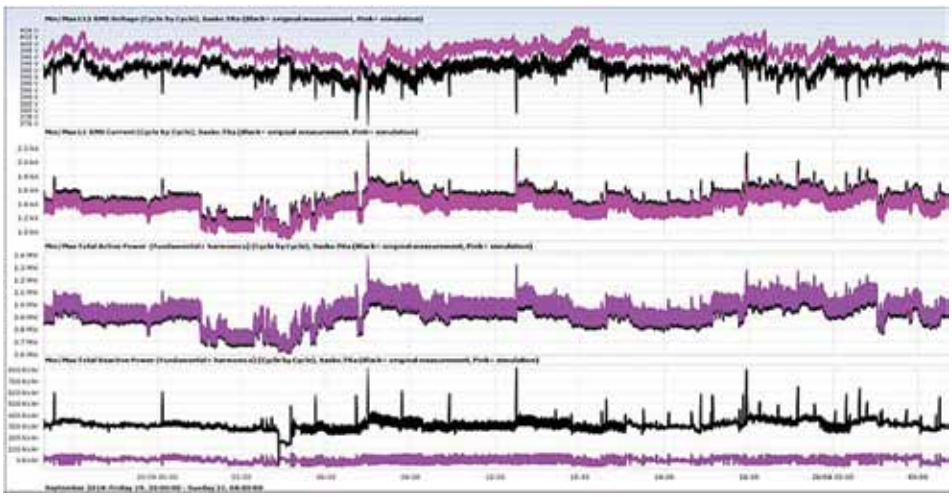
- Saving due to Current reduction
  In this step, loss saving due to current reduction as a result of reactive power compensation are calculated by simulation.

- Saving due to Harmonic losses
  The harmonic losses, including skin effect, hysteresis & negative sequence are calculated and estimated in two modes of operation:
  - Without compensation and filtration
  - With compensation and filtration
  - The saving is the difference between the 2 modes.

- Saving due to voltage control
  The minimum voltage level is determined based on long period of measurement. The consumption before and after voltage tap down is calculated by simulation and the saving is the difference.

- Total saving is the sum of the losses reduction due to current and harmonic reduction and the saving which is created due to voltage tap down.

	TRANSFORMER A	TRANSFORMER B
Savings due to Current Reduction	0.07%	0.09%
Savings due to Harmonic Reduction	0.5%	0.5%
Savings due to Voltage Control	2.37%	2.52%
Total Energy Savings Potential for the Site	6.05% (kWH)	
Total Demand Savings Potential	300 kVA	



Measurement without compensation (Black) and simulation with Equalizer (Pink)

THE ENERGY EFFICIENCY CONCEPT IN ACTION

Two cases are presented where clients have engaged Impact Energy on their PQ and Network Optimization Studies. The progress to date on both these projects is advanced, based on the Systematic Approach described earlier, with clients being presented Savings and Business Case Models to assist in their investment decision.

The identity of clients cannot be revealed at this stage of the project in the interest of Impact Energy, Elspec's and the client.

During post-implementation of the projects, with Verification of PQ enhancements and Energy Savings realized, further project information will be made public. The primary intent of this article is to create awareness around the potential for PQ network optimization and the engagement required to quantify the size of the prize.

CASE STUDY 1: FMCG INDUSTRY IN SA

The client in the FMCG (Fast Moving Consumer Goods) industry has branches located across the country and is using the Business Case Models for one site to inform a group wide rollout of the project.

In this Case the site has 2 X 11 kV Municipal Feeders stepped down through 2 X 11/0.4 kV Transformers into a 400V

distribution and load network. The site has poor power factor of 0.8 and instances where power factors drop significantly to levels of 0.4 during large reactive load start-up and demands. The site also has a high 5th harmonic component due to inherent loads connected.

Through the introduction of distributed 400 V Elspec Equalizer 1220 kVAR real-time PFC tuned to filter the 5th harmonic the site has the following savings potential as quantified through the Elspec Energy Saving Concept.

The Simulations demonstrate the Increased and Stabilized voltage levels (V) for Transformer A, the reductions in RMS current (A), the increase in True Power (P) and the reductions in Reactive Energy (kVAR).

CASE STUDY 2: COMMERCIAL BUILDING IN GAUTENG PROVINCE

The client manages a large commercial building in the Gauteng area, and has an installed base of approximately 17 MVA transformers. The site has distributed traditional contactor based PFC that has been switched out of service for an extended period over the years due to technical failures. The Munic supplies the site at 11 kV through multiple feeds onto bus and cable distribution networks.

Poor power factors as low as 0.4 during peak reactive loading start-ups and 0.8 during steady state nominal loading are seen consistently across the majority of the load centers. The site does not have high loss incurring individual harmonics. Some transformers are significantly under-loaded and present an additional opportunity to optimize networks and reduce losses.

	TRANSFORMER A	TRANSFORMER B
Savings due to Current Reduction	0.04%	0.06%
Savings due to Harmonic Reduction	0%	0.5%
Savings due to Voltage Control	3.75%	3.26%
Total Energy Savings Potential for the Site	4.0% (kWH)	
Total Demand Savings Potential	1200 kVA	
Total Energy and Demand Cost Savings Potential over 6 year period 2016-2021	R29.3 mil (based on 12 months latest historical billing and annual tariff escalations of 8%)	

Through the introduction of distributed 400 V, Elspec Equalizer 4 MVAR real-time PFC detuned 7%, the site has the following savings potential as quantified through the Elspec Energy Saving Concept. The data below represents the simulations of 2 transformers that are representative of the other transformers that run similar loads and hence representative of the site as a whole.

SAVING PQ RANDS

The Energy constraints and rising costs facing South African power users imposes a critical examination of all inefficiencies within the operation and specifically within Power networks in order to drive profitability and ensure sustainability.

The leading edge Elspec Energy Saving Concept, backed by proven PQ measurement and solution products, takes the guesswork out of quantifying the PQ Energy Cost Blueprint.

Several other Elspec Energy Optimization Projects are in process around the country with energy users embracing the concept of turning PQ Technical Losses into Saving PQ Rands. wn

Article courtesy of Impact Energy
For more information. on the Elspec Equalizer range, contact 0861 357732

WATT?

EXPERT INDUSTRY ADVICE

WATT? is a newly established forum related specifically to the industrial and commercial electrical sector.

Do you have any burning questions, topical issues or points of interest about the electrical industry, from the perspective of a contractor, supplier or professional service provider? Submit your comments, thoughts, ideas, suggestions or questions for the attention of our industry experts, and these will be addressed in a future issue of the magazine. This is your forum, and we would like to hear from you!

The rapid pace of technological change and product development is a global trend that affects entire economies. We may have access to more information than ever before, but is this information readily understandable? Does it give us insight into the fundamental issues? Is it precise and based on technical clarity?

WATT? is an opportunity for people on the ground to engage with each other and related professionals in an informative and friendly manner. This is a platform for you to discuss anything related to your particular sector, to highlight anything new, or to ask a specific question related to a technical topic or to engage in general industry issues. . Please note that we will not be considering anything related to the domestic sector, such as residential wiring.

We hope that this section of the magazine not only becomes a regular feature, but that it is widely read and distributed among your peers. Remember, it can only become a success with the full participation of our readers! Send your burning questions to minx@saiee.org.za - subject 'WATT?'.

We look forward to hearing from you.
- Ed

QUESTION ONE

What are the required test standards for low voltage circuit breakers in South Africa?

ANSWER ONE

All low voltage switchgear and controlgear supplied in South Africa must be tested to the International Standard IEC 60947-2, SANS 60947-S or approved by the South African National Standards Commission (SABS). The Standard applies to circuit breakers, the main contacts of which are intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c. Or 1 500 V d.c.

QUESTION TWO

Can miniature circuit breakers switch 525 volt?

ANSWER TWO

When selecting miniature circuit breakers for 525 volt applications you must ensure the following:

a. That the circuit breakers rated operational Voltage (Ue) are suitable for 525 volt applications. For single pole equipment the rated operational voltage is generally stated as the voltage across the pole. For multipole equipment it is generally stated as the voltage between phases.
b. That the circuit breakers rated insulation voltage (UI) are suitable for 525 volt applications.

The rated insulation voltage of equipment is the value of voltage to which dielectric tests and creepage distances are referred.

QUESTION THREE

What is kA rating?

ANSWER THREE

The value of the kA rating determines how much current the circuit breaker can withstand under fault conditions. The circuit breaker only has to withstand this for a brief period of time, usually the time it takes for the circuit breaker to trip. For example, a value of 25 kA means that the circuit breaker can withstand 25 000 amps of current during the time it takes to trip.

QUESTION FOUR

What is the rated ultimate short circuit breaking capacity (Icu)?

ANSWER FOUR

The maximum symmetrical short circuit current the circuit breaker can interrupt. The test sequence for "Icu" is O-t-CO.

This means that upon occurrence of a full short circuit fault with short circuit current being equal to the rated ultimate short circuit breaking current of the circuit breaker, the protective release would sense this fault and trip the circuit breaker .The circuit breaker would then break its full rated breaking current. This is the first 'O' in the test sequence. The circuit breaker is reset this is the 't' (time interval) and is usually 3 minutes. The circuit breaker is closed 'C' (closed operation), if the fault is

still present the circuit breakers protective release will sense the fault and trip the circuit breaker, the breaker would then break its full rated breaking current for the second time. This is the second 'O' and occurs immediately after the 'C'. The circuit breaker breaks its full rated ultimate short circuit current "Icu" twice within a time period of 3 minutes.

QUESTION FIVE

What is the rated service short circuit breaking capacity (Ics)?

ANSWER FIVE

The maximum current that the breaker can interrupt multiple times and be returned to service without being damaged and is expressed as a % "Icu". The test sequence for "Ics" verifies that the circuit breaker can be returned to service O-t-CO-t-CO.

This means that upon occurrence of a full short circuit fault with short circuit current being equal to the rated ultimate short circuit breaking current of the circuit breaker, the protective release would sense this fault and trip the circuit breaker. The circuit breaker would then break its full rated breaking current. This is the first 'O' in the test sequence.

The circuit breaker is reset this is the 't' (time interval) and is usually 3 minutes. The circuit breaker is closed 'C' (closed operation), if the fault is still present the circuit breakers protective release will sense the fault and trip the circuit breaker ,the breaker would then break its full rated breaking current for the second time. This is the second 'O' and occurs immediately after the 'C'. The circuit breaker is reset this is the 't' (time interval) and is usually 3 minutes. The circuit breaker is closed 'C' (closed operation), if the fault is still present the circuit breakers protective release will sense the fault and trip the circuit breaker, the breaker would then break its full rated breaking current for the third time. This is the third 'O' and occurs immediately after the 'C'. The circuit breaker breaks its full rated ultimate short circuit current "Icu" three times within a time period of 6 minutes.

The circuit breaker should be able to function with reduced service until it is replaced or maintained. The test equates in real life to an operator accidentally closing the circuit breaker after it has opened on a fault.

These test tests are undertaken to prove the safety in the device in these circumstances. wn

Answers provided by Zest WEG Group

IN MY OPINION : ANDRIES TSHABALALA AND FRANS WEYGERTZE

Revitalisation of the Rail Transport Sector – Local Impact?

Every day we hear about poverty, inequality and unemployment. These are some of the biggest challenges South Africa has faced for decades, where unemployment is the major contributor to crime and instability within the youth and poor communities, whihc is the root cause of poverty and inequality".

BY I ANDRIES TSABALALA I PR ENG I FSAIEE
AND FRANS WEYGERTZE

The Government adopted a strategy to address these challenges with the roll-out of the National Development Plan (NDP) based on some fundamental commitments. Government will be funding viable projects with private sector participation, and of course BBBEE and community buy-in and acceptance.

Government also implemented a "New Growth Path" strategy through investments in power generation, rail and public transport in order to rejuvenate the economy, build local capabilities and revitalise the rail engineering sector.

In the Transport Engineering Sector, two major investment programmes are being rolled out:

- PRASA's recapitalisation programme includes a 10 year, R51bn Rolling Stock Fleet Renewal Programme, various signalling and infrastructure upgrade projects including new Locomotives for the long distance passenger Services.
- Transnet investment programme introduced the 7 year Market Demand Strategy plan (MDS) investing R300bn to expand and modernise the rolling stock, rail, pipeline and port infrastructure.

At the end April 2014 PRASA finalised the contract for 600 new trains (3600 coaches) with Gibela Rail Consortium at R51bn, which included a 10-year manufacturing undertaking and 19 year

service agreement. The contract made provision for various economic and social development targets, including a 69% local content commitment.

The first 20 train sets will be imported from Brazil with the first train expected to arrive in South Africa at the end of 2015. The project's localisation, social and economic development programme is still in its early stages. The delays to the construction of the new custom built state of the art "Rolling Stock Factory" will impact on the roll out of the localisation programme.

Broad Based Black Economic Empowerment and Black Industrialists will play a major role in the estimated R30bn local spend. Agreements with the IDC will provide designated financial assistance to local suppliers in order to assist with the local manufacture of components and transfer of technology for 580 train sets to be assembled locally.

Although a lot of work has been done over the last 2 years to meet the stringent localisation requirements, to date very little has materialised. We expect activities for local manufacture to increase next year once the new factory becomes active. Therefore, the current impact in terms of sustainable job creation will be minute in terms of the over-all project commitments.

Transnet's MDS is now in full swing and contracts worth R50bn have been awarded to 4 Major Original Equipment Manufacturers (OEM) for the manufacture and supply of new locomotives. This all since the implementation of the MDS investment programme in 2012.

China's state owned Rail Equipment Manufacturers CSR and CNR Corporations, (which have since merged and now called CRRC), have received the bulk of the orders for the 786 locomotives. CSR's allocation totalled 554 dual voltage electric and CNR's 232 diesel locomotives.

General Electric (GE) has received a contract for 293 diesel locomotives and Bombardier 240 electric dual voltage locomotives. These projects will add more than 1300 new locomotives to the fleet and drastically reduce the average age of the fleet which should improve the reliability and availability to meet the forecast tonnage requirements, including the general freight "road to rail" efforts.

As for the PRASA project, the Transnet projects also make provision for various economic and social development targets including a minimum 60% and 55% localisation for Electric and Diesel Locomotives respectively.

CSR and GE have the bulk of the orders and their partnerships with Transnet Engineering already established to meet the requirement in terms of the tender qualification processes. To date, both the OEM's and Transnet Engineering have made available limited scope to the private sector. This adds to the local industry frustrations in the absence of long term supply agreements in order to create sustainable jobs within companies who have existing capacity and capabilities.

Both Bombardier, as well as the CNR projects, are still very much in their early stages of development and will take some time to establish possible partnerships with the private sector or local suppliers.

The impact of these massive projects on job creation and localisation should become evident as time goes by. However, the question remains, are the figures transparent? Yes, we read about it in the media where black-owned companies are supplying engineering services and/or equipment for the new build programme, which is commendable.

Transnet has signed agreements and memorandums of understanding with CSR for research and development, build locomotive production and maintenance facilities and rail components.

What about making use of local companies which have been in the sector for many years with the available capacity and expertise, waiting to be utilised and contribute to localisation and job security?

The questions remain:

- Will these infrastructure projects achieve the localisation and job creation targets for new-build and the aftermarket?
- What will the impact be on the existing local companies in the manufacture, repair and maintenance sector? wn

July

COMPILED BY JANE BUISSON-STREET
FSAIEE | PMIITPSA | FMIITSPA

You're generally sensitive, emotional, selfless, caring and loving, and like to demonstrate your feelings for others. You often exhibit an uncanny ability to get right to the heart of things without any intellectual sidetracking.

1 JULY

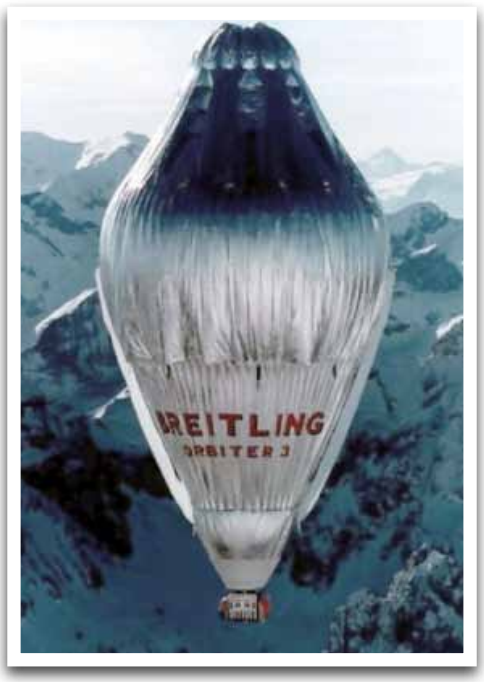
1997 American Airlines became the first United States air carrier to place defibrillators in each of its fleet of 700 aircraft.

2 JULY

1937 Amelia Earhart and her navigator Fred Noonan disappeared over the Pacific Ocean during an attempt to make the first equatorial round-the-world flight.

3 JULY

1987 British millionaire Richard Branson and Per Lindstrand became the first people to cross the Atlantic by hot-air balloon, named Virgin Atlantic Flyer. They travelled a distance of 2,900 miles in 33 hours to set a new record for hot air ballooning.



4 JULY

1883 The first three-wire central-station incandescent-lighting plant in the U.S. started operations in Sunbury, Pennsylvania and was built by the Edison Electric Illuminating Co.

5 JULY

1952 Thousands of spectators watched the run of London's last tram, which ran from Woolwich to New Cross.

6 JULY

1905 John Walker's (Cattle Rustler) fingerprints were the first ones to be exchanged by police officials in Europe and America.

7 JULY

1936 Several U.S. patents were issued for the Phillips-head screw and screwdriver to their inventor, Henry F. Phillips.

8 JULY

1881 Legend has it that Edward Berner, a druggist in Two Rivers, Wisconsin poured chocolate syrup on ice cream in a dish. Up until then chocolate syrup had only been used for making ice-cream sodas. Theory had it that the human taste buds wouldn't be able to handle the intense flavour and that he might cause the first case of extreme flavour induced sensory brain shutdown; Berner disregarded this and young Billy Hamilton ate and enjoyed the first vanilla ice cream with chocolate syrup drizzled over its top. Young Mr Hamilton survived and the rest was ice cream history.

9 JULY

1993 British and Russian scientists used DNA genetic fingerprinting tests to identified the bone fragments discovered in Yekaterinburg in 1979 to be those of the Russian Tsar Nicholas II and members of his family executed on 17 July 1918.

10 JULY

1962 A U.S. patent was issued to Swedish engineer, Nils Bohlen, for the three-point seat-belt. His lap and shoulder design are now familiar as the passenger-restraint safety device in cars that has saved countless lives.

11 JULY

1975 Chinese archaeologists announced the uncovering of a 3-acre burial mound concealing 6000 clay statues of warriors and their regalia dating from 221 to 206 BC. The "Terracotta Army" was uncovered near the ancient capital of Xian.

12 JULY

1844 The first "telephone" was demonstrated by Captain J.N. Taylor of the British Royal Navy. The device was not, however, the same technology that would later be known as a telephone. Rather, it is the original name for a foghorn.

13 JULY

1992 U.S. hardware manufacturer International Business Machines (IBM) announced that it had entered into an alliance with former competitors Siemens of Germany and Toshiba of Japan in order to develop memory chips.

14 JULY

1850 James Harrison of Australia publicly demonstrated the process of making ice by refrigeration for the first time in history.

15 JULY

2007 Fabiano Caruana became the youngest Chess Grandmaster in history at the age of 14 years, 11 months, 20 days.

16 JULY

1926 National Geographic magazine published the first natural-colour underwater photographs in history. The photos were taken off the Florida Keys.

17 JULY

2005 Apple iTunes Music Store sold its 500-millionth song to Amy Greer of Lafayette, Indiana. The song is "Mississippi Girl" by Faith Hill.

18 JULY

2008 Warner Bros released the superhero film 'The Dark Knight' to 4,366 US theatres, to set a new record for the widest opening in history.

19 JULY

1843 The SS Great Britain, the first iron hulled, propeller driven steamship, the SS Great Britain, was launched.

20 JULY

2001 Reuters News Service reported that personal computer sales have fallen throughout the world for the first time in fifteen years.

21 JULY

1955 Ian Donald used an industrial ultrasonic metal flaw detector to image tumours on human organs.

22 JULY

1983 Dick Smith completed the first solo helicopter flight around the world, over the course of eleven months.

23 JULY

1904 According to some sources, the first ice cream cones were sold at the Louisiana Purchase Exposition in St. Louis, Missouri by Charles E. Menches.

24 JULY

1911 American Hiram Bingham III 're-discovered' the Lost City of the Incas, Vilcapampa, where the last Incan Emperors once found refuge from the conquistadors.

25 JULY

2008 Google announced that its search engine has processed its one trillionth unique URL, a milestone Google engineers had never expected to reach when the company launched its first index of twenty-six million in 1998.

26 JULY

2002 Sony announced that it had shipped ten million PlayStation 2 systems to date in Japan alone.

27 JULY

1866 After three failures, Cyrus West Field finally succeeded in laying the first underwater transatlantic telegraph cable. The Atlantic Cable spanned the 1,686 miles across the Atlantic Ocean between Valentia, Ireland and Heart's Content, Newfoundland, USA.

28 JULY

1962 A bug in the flight software of the Mariner I space probe caused the rocket to divert from its intended path on launch. Mission control was forced to destroy the rocket over the Atlantic Ocean. A later investigation into the accident reveals that a formula written on paper in pencil was improperly transcribed into computer code, causing the computer to miscalculate the rocket's trajectory.

29 JULY

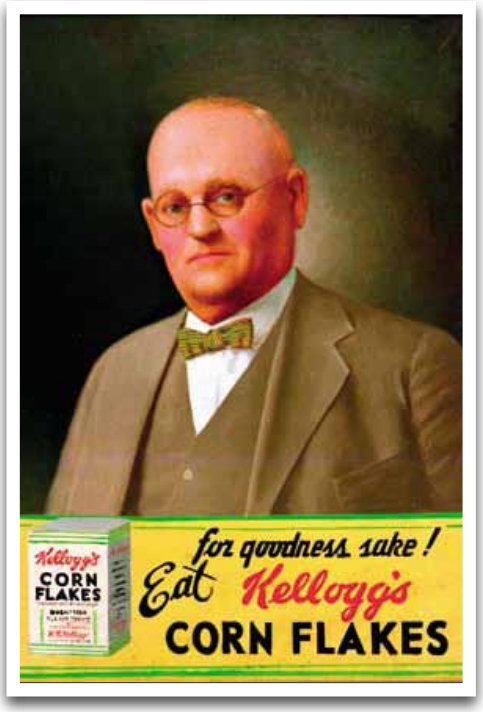
1957 The International Atomic Energy Agency was established to promote peaceful uses for nuclear energy.

30 JULY

1898 Scientific American ran the first magazine advertisement for an automobile, placed by the world's largest automobile factor The Winton Motor Car Company of Cleveland, Ohio. The ad invites readers to "dispense with a horse."

31 JULY

1898 William Kellogg unintentionally invented Corn Flakes. WN



Going round in circles....

I am starting to think my kids may be safer off living in another country. Not for the reasons you may imagine, but rather because I think they would be safer travelling on public transport (which we have so little of) than in this mom's taxi.

BY I ANGELA PRICE

Our morning trips in the car can be hair raising, I just can't work out if it's because everyone else is a bad driver, or if it is just me.

Before I throw myself under the bus (can't find any!) I should point out the following in my own defence:

- I travel at the worse possible times (morning rush hour for school runs) and seemingly encounter the worst possibly people on the roads;
- there are usually two hell raisers in the back seat - hell bent on raising hell (and my blood pressure);
- despite my best attempts to discipline the kids and keep the car tidy, I have often had foreign objects beneath my feet or flying past my face;
- most days we are running late and trying to 'warp/hyper drive' just to beat the school bell;
- during the trip I have likely passed five newspaper headlines rendering me depressed ; and
- all this before I have even begun playing dodgem cars with taxis on Jan Smuts Avenue!

So, by the time I approach the run of traffic circles just before the school, my brain is pretty much fried and a simple traffic circle can be my undoing.

Some days I have no recollection of how I even got there, much less who entered the circle first, yielded to the right and so on. Add a bunch of other equally distracted, disgruntled drivers to the mix, maybe even a 'Larner' driver or two (yup, I recently got stuck behind a driving school truck at an intersection for what seemed like an age and found myself staring at the large red word LARNER!) - and you have an accident waiting to happen.

I therefore made a mental note to brush up on traffic circle etiquette or rules, and recalled seeing a good diagrammatic representation on Facebook (likely posted by some poor sod who had encountered someone like me at a circle early one morning).

I began my internet search, only to stumble upon the most horrifying image (below).

Is it Native American art, is it a maze, is it a crop circle? No, it is a roundabout - the kind you have nightmares about.

The Magic Roundabout in Swindon was voted as one of the "10 Scariest Junctions in the United Kingdom" (there are scarier ones?!) Conversely however, the roundabout has an excellent safety record. This is likely due to the fact that everyone is equally confused or terrified and as a result the traffic barely moves fast enough to cause any serious harm, should there be a collision.

I confess that if I came across the Magic Roundabout whilst driving, I would feign a break-down, abandon my car and walk. The sight of such a complex traffic circle makes my head spin - I would literally be going in circles.

I'm glad to report that I successfully refreshed my traffic circle knowledge (having first managed to scare myself witless). Now, I think I may need to go and have a drink to calm the nerves, and prevent the kids from driving me round the bend. wn

calendar

JULY | AUGUST | SEPTEMBER | OCTOBER

JULY 2015

1-2	SABC Education African EduWeek 2015	Johannesburg	www.educationweek.co.za
6-7	Photovoltaic Solar Systems	Johannesburg	www.saiee.org.za
15-16	Understanding Transact Sql, Db Optimisation & Database Design	Johannesburg	www.saiee.org.za
15-16	Core Financial Management Skills For Engineers	Johannesburg	www.saiee.org.za
15-17	PowerGen Africa & Distributech Conference	Cape Town	www.powergenafrica.com
15-17	MediaTech Conference & Exhibition	Johannesburg	www.mediatech.com
22-23	Design Of Economical Earthing Systems For Utility Electrical Installations	Johannesburg	www.saiee.org.za
22-23	Leadership & Management Principles & Practice In Engineering	Johannesburg	www.saiee.org.za
24	MTN Telecommunications Breakfast	MTN Head Office, Johannesburg	www.saiee.org.za
29	Electric Arc Flash Safety	Johannesburg	www.saiee.org.za
29	Electrical Engineering Explained To Non-Electrical Engineers	Johannesburg	www.saiee.org.za

AUGUST 2015

12-13	Microsoft Project Professional 2013	Johannesburg	www.saiee.org.za

SEPTEMBER 2015

9-10	Environmental Crimes Conference	Johannesburg	www.intelligenvetransferc.co.za
15-18	Bauma ConExpo Africa 2015	Nasrec, JHB	www.bcafrica.com
21	64th Bernard Price Memorial Lecture - Sustainable Engineering	Central Centre, Freestate	www.saiee.org.za
22	64th Bernard Price Memorial Lecture - Sustainable Engineering	Southern Cape Centre, George	www.saiee.org.za
23	64th Bernard Price Memorial Lecture - Sustainable Engineering	Western Cape Centre	www.saiee.org.za
28	64th Bernard Price Memorial Lecture - Sustainable Engineering	Eastern Cape Centre	www.saiee.org.za
29	64th Bernard Price Memorial Lecture - Sustainable Engineering	KZN Centre	www.saiee.org.za
30	64th Bernard Price Memorial Lecture - Sustainable Engineering	Gauteng	www.saiee.org.za

OCTOBER 2015

3	SHELL ECO Marathon - Registrations are open!!	Johannesburg	esther@uj.ac.za
11-13	FILTECH 2015	Cologne, Germany	www.filtech/de

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4TH ANNUAL

ENVIRONMENTAL CRIMES CONFERENCE

-COMPLIANCE, ENFORCEMENT & PROSECUTION

Date: 9 & 10 September 2015 **Venue: Indaba Hotel, Fourways, Johannesburg**

REGULATORY UPDATE - DAY 1

Dr. Thuli Mdluli
Chief Director: Air Quality Management
DEPARTMENT OF ENVIRONMENTAL AFFAIRS

Nigel Adams
Acting Chief Director: Enforcement
DEPARTMENT OF WATER AND SANITATION

Rainy Disebo Mashitisho
Chief Director: Compliance & Enforcement
GAUTENG DEPARTMENT OF AGRICULTURE & RURAL DEVELOPMENT

EXPERT ADVICE - DAY 2

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Regional Specialised Officer
INTERPOL REGIONAL BUREAU HARARE

Robert Wabunoha
Legal Officer & Africa Regional Coordinator Environmental Governance
UNITED NATIONS ENVIRONMENT PROGRAMME

Advocate Connie Erasmus
Senior Deputy Director of Public Prosecutions
NATIONAL PROSECUTING AUTHORITY

Douw Steyn
Director: Sustainability
PLASTICS SOUTH AFRICA

Dr Isaac Rampedi
Senior Lecturer & HOD: Dept of Geography, Environmental Management & Energy Studies
UNIVERSITY OF JOHANNESBURG

DUAL PRESENTATION:

PRO-ACTIVE ENVIRONMENTAL COMPLIANCE – A PETROCHEMICAL CASE STUDY

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KEY STRATEGIES TO BE DISCUSSED:

- Reporting requirements in terms of the National Environmental Management: Air Quality Act 39 of 2004
- Enforcement within the Regulatory Framework – through change management
- Escalating environmental enforcement through strengthening collaboration between key government departments
- Evaluating the quality of selected Environmental Impact Assessments for effective decision-making processes
- Emerging legal trends in inclusive green economy
- Discussing INTERPOL's tools and services manifested both regionally and globally
- Zero plastics to landfill 2030
- Safeguarding the environment through strong monitoring and prosecution

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