# wattnow

THE SAIEE CHALLENGE: THE WORLD IS CHANGING

RSA | R30.00 incl. VAT

ENERGY

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | FEBRUARY 2019

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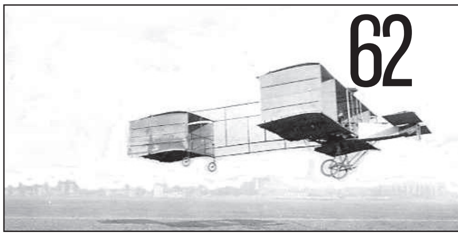


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**ISSN: 1991-0452**



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This issue features Energy – which is the buzz-word in our current South African climate.

Our first feature article, on page 18, "How will the energy landscape change in 2019?" makes for exciting reading. Concerns are growing on the target that the EU set on decarbonising for renewable energy and the efficiency thereof in 2007 as 2020 is indeed around the corner.

Then, on page 22 read more on the "Charting the global progress on clean energy" and we take a look at the progress so far in need to meet the global ambition to limit global warming.

Page 34 features an excerpt of a paper on opportunities for low-carbon electric cities in the global south. A transition to electric low-carbon towns is an essential strategy for reducing global greenhouse gas emissions and has the potential to provide many benefits to urban under-served.

Dr Brian Austin and Vincent Harrison wrote a beautiful historical article on the FELIX's transmitter which is set in the time when South Africa declared war on Germany in September 1939.
Read it on page 44.

As the Periodic Table celebrated its 150th anniversary on 17 February, Dudley Basson sketches a beautiful story on how the periodic table came to be.

Herewith the February issue, enjoy the read.

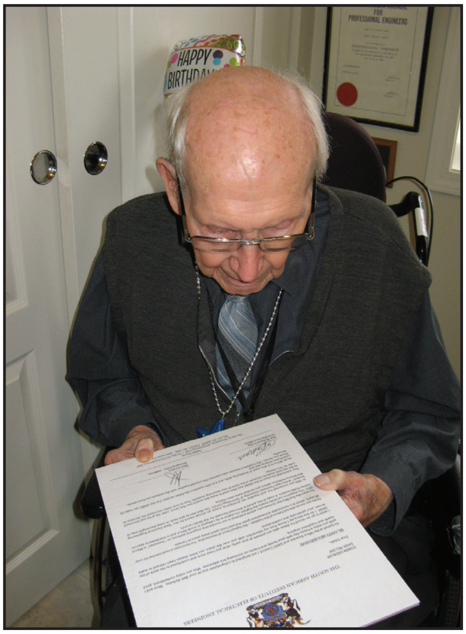
Minx

Earn CPD Credits

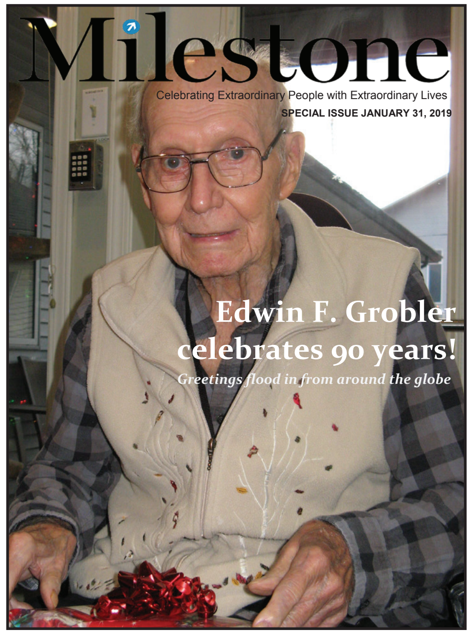
*Visit www.saiee.org.za to answer the questions related to these articles to earn your CPD points.*

# Watt A Milestone!

*Edwin Grobler turns 90*



*Edwin reads the letter sent from SAIEE Head Office wishing him happy birthday!*




*Edwin's birthday booklet compiled by his daughter.*

SAIEE Fellow, Edwin F. Grobler, celebrated his 90th birthday on January 31st in Vernon, British Columbia. On his special day, Edwin was delighted to receive a letter from the SAIEE congratulating him on his milestone birthday as well as acknowledging his contributions and achievements over the years.

His daughter, Wendy Bell, describes that after reading messages from overseas family and friends along with the SAIEE letter, Edwin began reminiscing about his early work in South Africa. He had many stories about the tasks he had as a young apprentice, his increasing responsibilities with various promotions, as well as recollections of the Baragwanath Training Centre, Potchefstroom, Beaufort-West and several other places.

One of the messages Edwin also received on his 90th was from his cousin, Albert Myburgh, of Cape Town. Albert thanked Edwin for *"showing me how to build a crystal set, and for teaching me about electrics – lessons which have proved invaluable in my life."*

Edwin immigrated to Canada in 1980 with his wife, Joanne, and their two children, Paul and Wendy. Since that time, he has remained a member of the SAIEE – a total of over 65 years! While in Canada, Edwin worked for General Data Communications. His biggest customer was B.C. Tel (now Telus). This was in the early days of modems, and he travelled extensively throughout Western Canada educating telephone company employees on the installation and operation of this new technology!

After retiring, Edwin and Joanne became involved with lawn bowling, volunteering and being on the Board of Directors for Bowls BC. Once again, Edwin's engineering mind entered the picture, and he was always full of ideas for improving the greens or bringing mathematics into the sport!

Edwin's 90th Birthday was a wonderful celebration of a kind, gentle and generous man who enjoys people, activities, intellectual pursuits and problem-solving. Edwin has always been concerned with accuracy and precision. When he won the Bingo game on his birthday, he insisted on all the numbers being verified. Edwin, F. Grobler, Fellow of the SAIEE, ever the engineer!

*The winning Bingo numbers had to be verified.*

# Rugged tools give reliable results on construction sites


Construction sites are harsh environments for instruments that need to give accurate results time after time, even if they have been dropped, kicked or stepped on. COMTEST has on offer Fluke construction instruments, including laser levels that are engineered to stay within specification, even after a one-meter drop. Whatever electricians, HVAC engineers, surveyors, inspectors, bricklayers, carpenters, roofers and plumbers need reliably measured, like distance, temperature, cable location, electrical values to indoor air quality across building sites, Fluke has a range of durable tools to meet the needs and deliver guaranteed results.

## BUILDING INSPECTORS NEED INTUITIVE TOOLS

The engineered but simple, intuitive operation of Fluke tools, means users don't need to be continuously referring to a manual. This translates to time saved – per measurement - which soon mounts up, meaning cumulative labour cost savings. Besides carrying out their primary job function, construction workers are increasingly having to inspect the work of the carpenters, tilers, brick-layers and plasterers working with them. If they can't, at best they risk significant waiting time and at worst, can jeopardize the quality of the whole job. Fluke's dedicated suite of products can save time and money on residential, commercial and industrial construction sites alike.

# Installation of 182kWp Grid-Tied Solar Plant Completed

Hanonox has recently completed a 182kWp grid-tied solar project for financial services provider, MHA Management Holdings in Johannesburg. Hanonox's technical and design teams undertook the entire project scope - from modifying the existing carport structure to allow for panel mounting, to installing and commissioning the system in January 2019.

Consisting of innovative 27.6kW SolarEdge inverters and Trina 270 solar panels, the system is connected to the main electric power feed for the building - generating approximately 874 800 kilowatt-hours of electricity annually and offsetting nearly two-thirds of the firm's electricity costs.

*"The MHA Management Holdings project has realized our mission of delivering true turnkey renewable energy solutions,"* said Nathan Bergemann, Director of Hanonox. *"Recognising the financial and environmental benefits, companies like MHA represent a compelling economic and sustainability case for solar and renewable energy deployment."*

## Schneider Electric named one of the Fortune's World's Most Admired Companies for 2019

Schneider Electric, the leader in digital transformation of energy management and automation, has been included in the World's Most Admired Companies, according to the 2019 list published by Fortune. This year, the company ranks fifth in the electronics industry, maintaining its strong position from 2018. The achievement reflects its growing reputation as an all-round achiever in its industry, pursuing innovation with a strong focus on sustainability and inclusion for all.

Fortune's annual ranking of the World's Most Admired Companies is based on a survey of U.S. and global Fortune 500 companies posting the highest revenues in their respective industries. To identify the top performers in 52 industries, 3,750 executives, directors and analysts in those industries were asked to rate companies on nine criteria: innovation, people management, use of corporate assets, social responsibility, quality of management, financial soundness, long-term investment value, quality of products and services, and global competitiveness. Schneider Electric was highly evaluated in the people management criteria, ranking no.3 in the electronics industry.

Olivier Blum, Global Chief Human Resources Officer, Schneider Electric, commented: *"We're delighted to be among this illustrious group of organizations. At Schneider Electric, our meaningful purpose is the common thread that motivates us - we want to bring energy and efficiency to enable life, progress and sustainability for all. As a global corporation, we believe in innovation that has a positive impact on our planet; equal opportunities for everyone, everywhere, and empowering our people to make the most their energy."*

For Schneider Electric, such recognitions reinforce the company's strong commitment to an inclusive, empowering culture, and its longstanding efforts to promote sustainability for all.

## CESA focuses on 'Reshaping our Future Together' – Doing what is Right!


*Mr Neresh Pather - CESA President*

Consulting Engineers South Africa's (CESA) President, Neresh Pather, presented his 2019 theme as 'Reshaping our Future Together' focusing on changing social norms by 'Doing what is Right!

Pather began his presentation by stating, *"All South Africans can be mobilised to participate and actively reshape our economy, our country, our projects, our government and ultimately our lives. It starts with us!"*

Pather in his opening remarks said, *"President Ramaphosa's renewed focus on the basic education sector specifically around maths and science and the development of skills will ready us for the 4th Industrial Revolution".* Over and above this the President's call for further investment into Africa and the latest statistics showing increased interest in South Africa as an investment destination are all positive indicators for the start of 2019.

# Ege Plug And Play Solution Makes Flow Monitoring Easy

Ease of flow monitoring with low maintenance benefits is a given with the compact plug and play EGE SNS 450 thermodynamic flow sensor from Countapulse Controls.

According to Gerry Bryant, managing director of Countapulse Controls, sole southern African agent for EGE's full range of flow sensors and controllers, the innovative screw-in adapter on the EGE thermodynamic flow sensor allows for universal use in a variety of applications.

The adapter is screwed into a T-piece or a welding sleeve and the probe is then secured in this adapter using a union nut. Users are reassured of the integrity of the connection, which is sealed up to 100 bar.

The EGE sensor, which includes an LED display for ease of use, can function in temperatures from between minus 20 to plus 80°C and is suitable for controlling the flow of fluids such as water, glycol mixtures and chemicals. Ingress protected to IP67 standards the design of the sensor, which features no moving parts, is focused on elimination of failure that would typically be caused by oxidised bearings, torn impellers or deflector deformation.

With a robust construction the EGE flow sensor is resistant to corrosion and is ideal for use in both liquids and air, as well as in hazardous environments. *"This is a welcome addition to the Countapulse Controls product line-up and complements the company's existing range of sensing solutions; all geared around reliability and longevity combined with uncompromising accuracy,"* says Bryant.


*The compact plug and play EGE SNS 450 thermodynamic flow sensor provides ease of flow monitoring.*

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There is a strong focus within CESA on working with and supporting Government, with increased collaboration with National Treasury on Procurement, the Auditor General's office on compliance support, together with partnering agreements with Client Bodies like SANRAL, Transnet and COGTA allowing CESA to contribute positively in terms of support that includes capacity building, skills development, compliance and good governance.

Value for Money, Resilience and Sustainability are three initiatives which aids CESA in working towards capacitating infrastructure teams appropriately, in all client organisations, ensuring that the appropriate technical skills are used in decision making related to infrastructure development. Pather states that there needs to be a strong focus on providing 'value for money' infrastructure.

*"We need to emphase on calculating the best possible infrastructure solution based on the total life cycle costing of the project and not on procuring the lowest cost design fees which make up only approximately 3% of the lifecycle cost of a project."* He added, *"Sound planning and good feasibility studies incorporating innovative technology for the development of infrastructure is needed to drive economic prosperity and growth".*

Pather believes that there is a strong need for cooperation of industry bodies and key stakeholders. *"We will all reap the benefits as opposed to weakening the effort. We need to engage with universities, academic institutions and research bodies to drive our education system but also training people sufficiently in both the private and public sectors to undertake the roles they are meant to play in delivering infrastructure"* he concluded.

## Technology could transform SA educational landscape

Educational technology will play a more significant influence in all South African schools – particularly in metro areas or regions that have increased access to an infrastructure that supports the blended learning model.

This is the belief of SPARK Schools' co-founder and CEO Stacey Brewer who recently attended BETT 2019, the world's leading global education technology show which took place in London and which was attended by educators from around the globe.

Blended learning is a style of education in which students learn online educational materials and technology as well as traditional face-to-face teaching.

Brewer shared some trends from the show: "It is apparent that everyone, no matter where they come from in the world, faces different educational challenges. However, one thing is clear: educational technology is progressing at a fast rate.

*"Strategy is key with a continued emphasis on integrating resources into the classroom. Data is being used for both informing choices and solutions as well as driving adaptive learning. Increasingly, scholars are engaging in their own learning and teachers are facilitating the opportunity for personalised learning,"* says Brewer.

She explains how technology has changed since SPARK opened its first school in 2012.

*"SPARK Schools started with basic consumer-grade network devices, laptops and internet connectivity, which was quickly exposed as being inadequate for the wear and tear experienced in a demanding use environment. After extensive research into best practices in ed-tech, we built relationships with vendors to open supply chains that allow us to quickly deploy enterprise-grade network equipment and built-for-purpose learner devices into our rapidly growing network of schools. We have also given all members of staff personal company email addresses for communication, productivity and identity and various other technologies that enable them to quickly and safely perform their instructional and business functions."*

Last year SPARK Schools announced that it would be using the Norwegian-based Learning Management System (LMS) in its 21 schools.

*Stacey Brewer*
*CEO | Sparks Schools*

Explains Bouwer: *"Google products underpin SPARK. They introduced us to learning who impressed us with what they have achieved in the educational technology space. We want the best for our learners so we are constantly on the lookout for the best tech solutions and we believe LMS is one of the finest."*

# Immersive on-site IT training to build SA's future workforce

HyperionDev, an IT training company founded by Riaz Moola in 2012 added two on-site IT training boot camps to its existing developer training offering.

The Web Developer and Software Engineering are structured to allow candidates to start coding as soon as possible with tasks designed to put acquired skills into practice, which aligns with industry's needs. Candidates learn from experts and will work in teams to develop essential skills like knowledge sharing, productivity, collaboration and complex problem-solving, among others.

Founder of HyperionDev, Riaz Moola referenced the SONA address as well as the budget speech, agreeing with the government's focus to boost technology skills and get the country's skills technology ready. According to Moola, there is a dire need for tech talent, not only to fill current demand but also to build a future-fit IT workforce that is globally competitive and locally relevant. *"The IT skills shortage is not going away, so we need to keep innovating IT education to strengthen and cultivate tech talent. Both the SONA address and Wednesday's budget speech reinforced our purpose. We agree that new training interventions are needed and we welcome the focus of budget allocated to getting the country technology ready,"* says Moola.

Moola adds that there is value in IT training that mimics an actual working environment. *"Traditional education routes are completely out of touch with the skills needs of the industry and the training needs of our people. The tech skills ecosystem is just not keeping up with the global shifts and pace of change. While we have seen a few welcoming interventions, more is needed to address the skills gaps,"* explains Moola.

Enrolment is open to working professionals and students or anyone interested in pursuing a career in IT. The boot camps will also focus on health and life balance and include meditation sessions.

*Riaz Moola | Founder*
*HyperionDev*

Candidates further benefit from post-graduation career services and will be connected to select hiring partners to increase their chances of employment. For full syllabi and breakdown of the training programme visit [www.hyperiondev.com/courses.](www.hyperiondev.com/courses)

The company released its annual graduate report, which highlights that 95% of its graduates reached their career outcomes, with 72% switching into a new career in tech within three months of graduating. The average salary increase of graduates was R144,000 per year, more than doubling their average salary. A copy of the report is available on request from Shimaylan Singh, at shimaylans@hyperiondev.com.

## Aluzinc Is A Game Changer For MCCs

The replacement of steel by aluzinc in the manufacture of Shaw Controls motor control centres (MCCs) is giving a range of benefits to the company's customers, according to the company's senior manager operations, Anderson Kohler.

*"Traditionally, we used only steel for our MCCs, which needs to be powder coated to protect it from corrosion,"* says Kohler. *"This made it necessary to follow quite a long process in completing our products – a process which aluzinc can now simplify and speed up."*

The usual process of preparing the MCC panels includes welding, grinding and prewashing before the powder coating painting process can take place. These phases can now be bypassed by using aluzinc which is a material that effectively resists corrosion without a protective coating being applied.

Kohler highlights the extended lifespan of aluzinc, which comprises 55% aluminium, 43,5% zinc and 1,5% silicon. Manufacturers of the product guarantee that it will last for about 35 years before any significant maintenance is required.

*"The powder coating of steel panels complicates the earthing requirement on an MCC, as the paint layer insulates the panel and prevents conductivity,"* he says. *"This means that technicians and installers must take special care to ensure that proper contact is made between the unit and the earth connection."*

For instance, the use of star washers must be strictly enforced among installation staff. Alternatively, certain areas of the MCCs are left unpainted to allow for earth connections. Kohler points out that this does raise the concern that it only takes a small oversight and the earthing will not be fully effective. The use of aluzinc eliminates this issue as there is no longer a paint layer between the earth connection and MCC panel.

There is also the possibility of painted parts being scratched or damaged during transport and installation. When this occurs, it leads to the time-consuming task of being returned to the factory for proper powder-coating, further delaying the installation and commissioning process. Indeed, if there is a need to weld again for any reason, then there is a repeat process of grinding and pre-washing before painting again.

*A semi-assembled motor control centre at Shaw Controls showing the aluzinc framework.*

Kohler highlights that the corrosion-resistant properties of aluzinc allow parts to be kept in stock, ready for quick assembly. He notes that this is not possible with mild steel due to corrosion.

*"By introducing the use of aluzinc in the manufacture of our MCCs, we can reduce the lead time on components by as much as two to three weeks, and this is a time-saving that we can pass on to our customers by delivering more quickly,"* he says.

## EM launches cost-effective smart-building retrofit system

Retrofitting older building stock with 'smart' automation solutions is now possible with the latest Hager system introduced locally by ElectroMechanica (EM).

Known as Coviva, the system does not require extensive construction work to be installed, or even additional cable routing, as it is an entirely retrofittable wireless solution, according to Ryan Whitelaw, EM Product Manager for Building Automation.

*"While this particular Hager product is not new internationally, we have just launched it in South Africa, which is slowly aligning itself with the trend towards increased building automation in advanced markets like Europe and the US,"* Whitelaw comments.

The coviva system is ideal for retrofitting, modernising, or upgrading, and also dovetails with the higher-end Hager domovea KNX system. *"The latest launch means EM can now comfortably supply either spectrum of the market demand, and can, therefore, cater for a broader range of clients, from homeowners to commercial, retail, hospitality, and industrial."*

The secret to the cost-effectiveness of the coviva system lies in its micromodules, which are easy to install, monitor, and control. Once installed behind existing switches or connection boxes, the

# Better Transformer Designs Improve Safety And Efficiency

As electricity utilities and users worldwide look to become more safety conscious and efficient in their use of electrical energy, it is essential to leverage the improvements that have been made in the design of transformers.

According to Trafo Power Solutions managing director David Claassen, there have been considerable strides in technology, surpassing both the efficiency and the reliability of the traditional oil-filled transformers that are predominantly used in power grid systems.

These high-efficiency solutions include open-wound transformers (OWTs), vacuum-pressured impregnated transformers (VPIs) and cast resin transformers (CRTs). Traditional oil-filled transformers use paper saturated in oil wrapped around the winding material as an insulation medium. If not maintained correctly, insulation degradation will occur, with the oil posing both a safety and environmental risk.

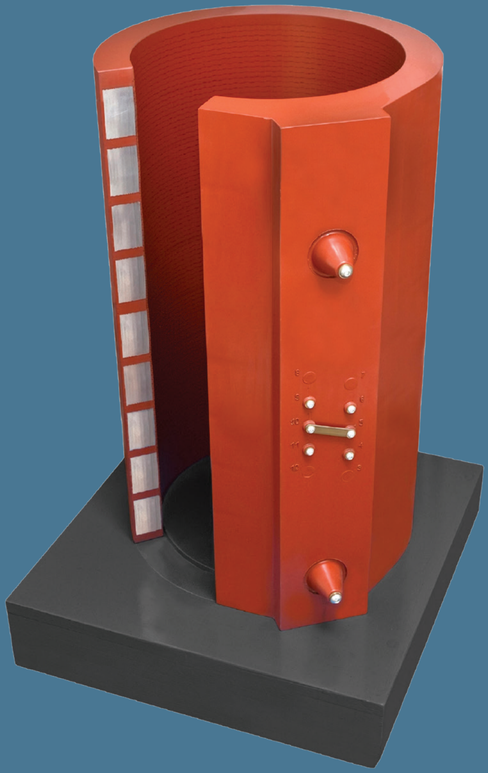
*"OWTs are constructed by dipping preheated windings into a high-temperature varnish bath and then baking the high-temperature varnish,"* says Claassen. *"This replaces the need for oil and paper, so only a small amount of material is flammable."*

In VPI construction, layers of polyester resin are applied to the windings, which are subjected to interchanging cycles of pressure and vacuum that ensures deeper penetration. This reduces the chances of air voids.

*"With CRTs, windings are placed in a mould which is filled under vacuum with resin epoxy,"* he says. *"Fibreglass reinforcing mesh is used to strengthen further the windings, which are cured in a heat-controlled oven. This process also prevents air voids, and the resin in CRTs is non-flammable."*

These designs have also made advances in reducing losses and thereby improving efficiencies. Some 84% of a transformer's losses at full load are copper losses – also known as load losses – and are due to current flowing through the winding conductor itself. The remainder is core losses, or 'no load' losses, pertaining to the core steel losses.

*"The use of OWTs, VPIs and CRTs offer considerable savings in energy costs of their life-spans – which for CRTs, for instance, averages about 20 years,"* he says. *"Despite the slightly higher capital cost of around 20%, these technologies can repay the price differential in just four years."*



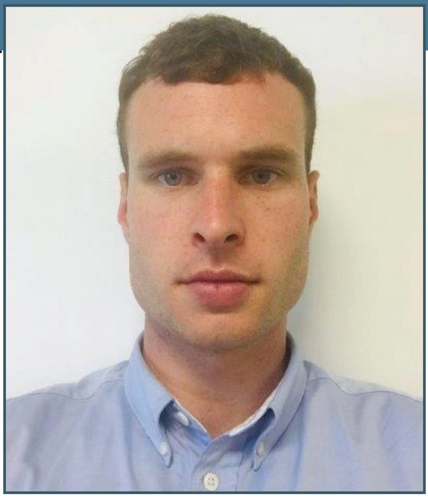
*Cross-section of a medium voltage winding.*

Claassen says that low loss cast resin transformers are being used exclusively in many parts of the world including Europe and North America, and this is because although there is a 12 to 15% premium on these the payback period is between two to four years. These are now available for the African market from Trafo Power Solutions.

micromodules communicate wirelessly to automate multiple functions.

Once connected, the micromodules can instantly control dimming systems, on/off switches, raising/lowering blinds and more. Each micromodule has a colour-coded function indicator for quick programming.
The micromodules have been explicitly designed to deliver exceptional wireless reach. This means they can penetrate two concrete slabs, and still transmit up to 30 m indoors, while outdoors their range can extend up to 100 meters in an open area.

The coviva system can be combined with additional Hager products such as the Domovea system, while the KNX wireless standard allows for built-in flexibility. By combining micromodules with the coviva smartbox and app, an ordinary building can be transformed effortlessly into an indeed 'smart' building.



*Ryan Whitelaw*

# Shedding light(ning) on the Gurus...

South Africa is a country with a generally high anual lightning ground flash density across vast areas, including many rural areas. According to the SA Weather Service, South Africa has one of the highest incidences of lightning related injuries and deaths in the world (more than 200 deaths on average each year), with only the USA and India experiencing more deaths per annum.

The Lightning Gurus launched a few weeks ago, and I wanted to find out more and took the time out to meet with some of them.

**BY |** MINX AVRABOS

**MINX AVRABOS (MA):** "Jurgen, please can you give me a bit of background on why you formed the Lightning Gurus?"
**JURGEN VOGT (JV):** "Minx, we've come to realise that the previously disadvantaged members of the South African population have found it difficult to gain entry into the earthing and lightning protection industry in South Africa. These start-up companies experience enormous barriers into our industry. They find it nearly impossible to obtain credit terms and reasonable pricing from manufacturers, and it is even more difficult for them to be specified on most tender lists. The Lightning Gurus has been set up to change this. We have compiled a network of ELPA-accredited installation companies who make up The Lightning Gurus. All of the Guru installers have more than 15 years' experience as lightning protection system installers, and they are also trained in compliance with the Lightning Gurus' extremely high quality and workmanship levels."

**MA:** "Please explain to me which sectors does the Lightning Gurus target?"
**JV:** "Industry demands that correctly designed earthing and lightning protection systems are installed for all industry sectors. We have the insight, skills and experience required to protect any structure."

**MA:** "So how many "Guru" companies do the Lightning Gurus support?"
**JV:** "We currently partner with four companies, and will have provision for more Gurus over time. Each installation Guru from the Lightning Gurus is the owner of his own business, and we all work together as a family. The Lightning Gurus have a combined experience of over 80 years in protecting all types of structures, which range from offices and shopping centres to explosive and classified zones. I have Israel Melody with me today, who is the MD of ELS Earthing and Lightning Solutions. He started his career as a general worker and rose through the ranks to become a contract manager, where he led six installation teams and was responsible for up to twenty different sites at any given time. He started his own business in 2017. All installation Gurus, including ELS Earthing and Lightning Solutions, are 100% black-owned companies."

**MA:** "Please explain to me the concept of the Lightning Gurus. What do they get out of joining you?"
**JV:** "We provide two main areas of support to each Lightning Guru. The first area is essentially a 'business in a box' solution whereby the accounting, financial, legal and marketing services are provided. We also offer all the support required for proper project execution, which includes project management, health and safety documentation, public liability insurance and component procurement for each project. In other words, we help each Guru installer to thrive in our industry, practically and sustainably."


## INTRODUCING A NEW CONCEPT IN LIGHTNING PROTECTION

The Lightning Gurus is a company dedicated to empowering B-BBEE companies in the earthing and lightning protection industry. Our calling is to turn this idealistic proposal into reality. With the right designs, products, installation expertise and management we enable these companies to offer turn-key protection solutions.

**The Lightning Gurus has various innovative and unique offerings that are designed to provide effective protection:**

- All the Gurus are 100% black-owned companies.
- All Gurus are highly trained Master Installers who are ELPA accredited.
- The Lightning Gurus have more than 80 years experience in all industry sectors.

**We are the only company to have independent testing, inspection & certification on all projects**

## OUR GURUS YOUR LEVEL 1 B-BBEE PARTNERS

B-BBEE LEVEL 1 CONTRIBUTOR

**GET PROTECTED NOW - CALL THE LIGHTNING GURUS**

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# Shedding light(ning) on the Gurus

continues from page 14

*Israel Melodi | Managing Director*
*ELS Earthing and Lightning Solutions*

*Jurgen Vogt | Director*
*The Lightning Gurus*

**MA:** "So how will the tendering process work that you've mentioned?"
**JV:** "The Lightning Gurus will essentially submit complete earthing and lightning protection proposals on behalf of our Guru installers. These proposals can be in the form of formal tender documents or negotiated to work with repeat clients. Once the order to proceed works has been received, then all Lightning Gurus tender on the lightning protection installation. It is the combination of the best Guru installer proposal and the best supplier proposal that makes our tenders and quotations highly competitive."

**MA:** "That's great, what happens next?"
**JV:** "During the internal tender process, the earthing and lightning protection designs are carried out by Lightning Protection Concepts (LPC, consultancy firm), and the winning Guru installer is awarded the project. This Guru installer then executes the installation and is consequently inspected by an independent lightning protection inspection company called The Testing Guys. On completion, The Testing Guys issue the required SANS certification of the lightning protection system."

**MA:** "So, what else makes The Lightning Gurus different?"
**JV:** "We are the only earthing and lightning protection company that provides third-party, independent certification of all of our earthing and lightning protection systems."

**MA:** "Israel, are you a professional engineer?"
**ISRAEL MELODI:** "No, I'm not. I had skills training throughout my career, which started in 1996. I have worked for many lightning protection companies over the past 22 years, and in 2017 I decided to start my own business. The first year was challenging, and we really battled to get the company off the ground. In 2018, I met the gentlemen from The Lightning Gurus who were testing their business concept. Since then, things have really gone well, and I am really proud to be a Lightning Guru."

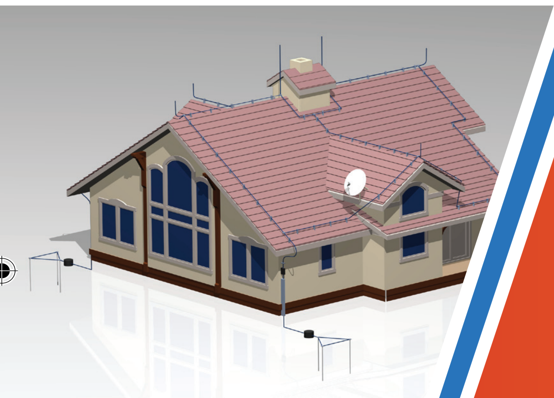
**MA:** "How many people do you employ?"
**IM:** "I employ six full-time LP installers, and then I can employ up to 20 contract workers at any one given time - this depends on the size of the job."

**MA:** "Israel, what is your aim with your business?"
**IM:** "My aim for ELS is to grow so that young people, especially young women, who are passionate about Lightning Protection, can get the same opportunities that I have been lucky enough to have. You have to be passionate about Lightning Protection – and committed. It can be a seven-day work-week to complete a job – but it will be for your gain."

**MA:** "Israel, in closing, what is your message to my readers?"
**IM:** "My message is to the young people - to join this type of business, in the lightning industry, you have to understand that you are saving lives, and if you become an installer, you must know that you have your clients' lives in your hands. You have to be committed and passionate and love lightning."

**MA:** "Jurgen, last thoughts?"
**JV:** "The compartmentalised approach to lighting protection system installations where the designer, installer and inspector are separate entities has been designed to provide the highest levels of competence and compliance. The system of delivering effective earthing and lightning protection solutions was tested throughout 2017, with the Lightning Gurus successfully completing more than 60 projects in the first year. One of our main goals is to create jobs, and as each Lightning Guru's company grows, the number of jobs being created will increase exponentially. We hope to create more than 250 jobs in the first three years. Our measure of success is to see how our installation gurus grow as people, as businesses and professionals. Seeing them grow and succeed is our measure of success." wn





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# How will the energy landscape change in 2019?

It's 2019 – that's nearly 2020! It doesn't seem long ago that the EU was setting what looked like reasonably radical targets for 2020; for decarbonization, for renewable energy use and energy efficiency.

BY | MATT BROWN & RAVI MAHENDRA, PÖYRY MANAGEMENT CONSULTING

However, time runs fast and looking back; it was 12 years ago in 2007. Despite the excellent work by EU member states, concerns over climate change are growing, and the expectation is that these concerns will grow faster in the coming year.

Now we often talk of the three Ds of energy; decarbonization, decentralisation and digitalisation (sometimes a couple more Ds are added for good measure; deregulation and democratisation). Do these three Ds have the same imperative?

Decarbonization of the power sector still seems fairly clear – the options haven't changed so much - energy efficiency, renewables, nuclear and CCS. Although, the costs and policies have changed enormously over time and renewables have made significant advances.

For 2019 we can expect to see further advances and more geographies around the world in which renewables can out-compete traditional forms of generation and face the market more and more. This means that renewables developers and investors are getting comfortable with more market and less regulatory risk.

## DECENTRALISATION AND DIGITALISATION

Decentralisation means different things to different people. For some its behind-the-meter investment, for others its generation and storage embedded in distribution networks. The drive for renewables produced much energy from the latter as onshore wind, and solar PV took off.

This decentralisation trend is set to continue next year with a return in some countries to onshore wind. More battery storage will be built, and it will be performing different roles. The first wave of batteries was fulfilling near immediate response requirements, but as that is

saturated, batteries will provide response more generally and play a role in alleviating grid constraints. However, real energy arbitrage opportunities are some way off requiring higher levels of renewables on the system. Behind-the-meter investment will continue into generation and storage but, as tariffs structures are reviewed and amended to be more cost-reflective, then care will be needed when making long-term investments. However, decentralisation is not an objective in itself; it is an outcome.

When thinking of the end user more corporate PPAs are expected, although solutions will need to be found to manage counterparty risks if these are going to form an enduring option for bankable renewable investments. Besides, some corporates need to understand better what they are signing up for. Ultimately it comes back to the market.

## MOREOVER, SO INEVITABLY TO DIGITALISATION

Over our working lives, change from digitalisation has always been there. With laptops, email, the internet, vast improvements in computing power, and an increasing reliance on algorithms and access, we now have more data than we can manage. Moreover, now the extremely high interest – and some would say hype – in digitalisation.

However, perhaps one's hope should be tempered by, for example, the utility failures in the past to combine and manage simple customer data and billing systems adequately. What will they make of big data? In last year's article looking to 2018, Steve Martin of GE quoted the IEAs Digitalization and Energy report as saying that digitalisation could save 5 per cent of annual power generation costs.

Given the fall in renewable and battery technology costs we've witnessed, this doesn't sound very exciting; nor in the light of increasing volatility of commodity prices. Perhaps those technology cost falls have themselves have resulted from greater

# Energy Landscape in 2019

continues from page 19

digitalisation, but does that make the energy sector mainly a recipient rather than a participant in the digitalisation journey?

## WHAT CAN WE EXPECT FROM DIGITALISATION IN 2019?

The step-change that we see is two-fold: on the one hand, computing power increases and enabling higher levels of AI and machine learning; and secondly, the amount of data available for those computers to analyse. These two combine to mean that better decisions are made and are also automated.

These are the key areas we expect to see further progress in 2019 in digitalisation in energy:

FAULT PREDICTION AND DYNAMIC MAINTENANCE: This is one of the most obvious uses of AI which enables operators to predict equipment failures by using sensor data from various units to reduce their costs of downtime and maintenance significantly. Pöyry has an offering for this called KRTI4.0. On the retail side, a startup Verv is offering a metering device which identifies individual home appliances and tries to predict faults or a device being accidentally left on by building up personal profiles from the meter data.

INVESTMENT OPTIMISATION: BP's venture arm invested in an AI startup called Beyond Limits to dig through seismic images and geological models to increase the chances of success when drilling wells. Another example of longer-term investment decisions is the US Department of Energy project where machine learning is being used on satellite imagery and operation data to prioritise reinforcement at vulnerable points of the grid to improve resiliency.

ENERGY EFFICIENCY: Deepmind, which is a part of Google, has championed the use of Reinforcement Learning to reduce energy use in its data centres by a claimed 15 per cent. The model learnt by looking at years of operational data and then issued changes to individual units within the operating constraints of the plant.

BETTER PREDICTION: Deepmind is also currently in talks with National Grid of the UK to better forecast demand of the system with the stated goal of reducing the entire country's energy usage by 10 per cent. Another example is improved prediction of wind power production to reduce imbalance costs by 50 per cent which was achieved by a company called Swhere.

TRADING: According to the FT, systematic and algorithmic trading now account for nearly 60 per cent of the traded volume on just the CME energy product group – the highest level of any commodity group. Anecdotal evidence from mid-2018 is that over 50 per cent of trades on the EPEX Spot intraday market are algo-trades (although the total volumes are still smaller than trades executed by human). Sophisticated machine learning models are also being deployed by speculators who are relying on massive streams of different data to respond to the market changes quickly.

A more commercial example is Origami Energy using machine learning to predict asset availability and balancing mechanism market prices in near real time to successfully bid into the Frequency Response markets. Pöyry is exploring a deep learning algorithm to support trading and dispatch decisions for generation assets in the prompt trading markets, focusing on the issue 'when should I commit a trade' (to maximise the option value of flexible capacity).

RETAIL: retailers are using machine learning to understand patterns of customer behaviour, to attract and retain customers and even to predict bill (non)-payment. Customer call centres are being fronted by algorithms which chat to customers (verbally or online) and deal with queries.

CUSTOMERS: For customers, AI solutions are also gaining traction, and many retailers are offering these systems as part of an integrated package. Devices such as Amazon's Alexa enable the customer to seamlessly interact with their thermostat (such as Centrica's Hive). This increasing customer interaction with the device leads to the development of a more personalised usage profile, which reduces bills for the consumer and also helps the energy provider to forecast demand accurately.

It would seem then that the digitalisation opportunities in energy are significant. It will be a vital enabler of decarbonization is some areas in the future such as flexible demand shifting to meet supply.

The opportunities available rely heavily though on sufficient volumes of good quality data being available. So, expect more sensors and more data acquisition throughout the energy sector in 2019- in time with growing autonomy expect the focus to switch to the appropriate monitoring, alerts and controls.

As succinctly put by computer scientist Andrew Ng: *"AI is the new electricity – enabling us to do more."* wn

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For more information contact
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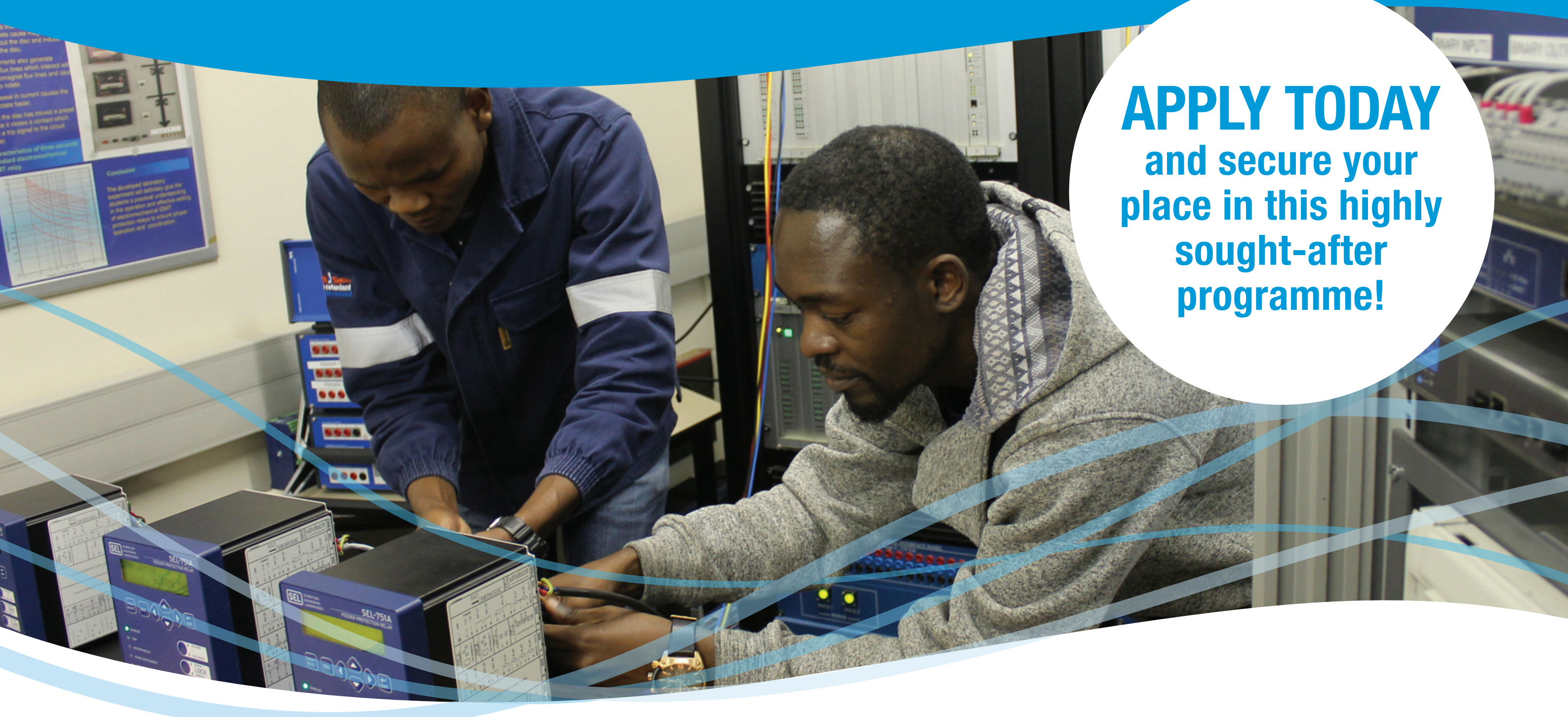

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# Charting the global progress on clean energy

Rapid progress towards clean energy is needed to meet the global ambition to limit warming to no more than 1.5 ˚C above pre-industrial temperatures. However, how are countries doing so far? In our Energy Revolution Global Outlook report, written with colleagues at Imperial College London and E4tech – and published by Drax– we rank progress in 25 major world economies.

**BY** I IAIN STAFFELL I SENIOR LECTURER I IMPERIAL COLLEGE LONDON

This report provides a league table of global efforts to clean up electricity generation, switch from oil to electric vehicles, deploy carbon capture and storage, eliminate fossil fuel subsidies and tackle energy efficiency.

The charts herewith compare these 25 countries today and their progress over the last decade.

## PROGRESS ON CLEAN ELECTRICITY

Electricity has been the fastest sector of the economy to decarbonise as countries move away from coal and embrace low-cost renewables.

The average carbon intensity of electricity worldwide has fallen only 7% in the last decade to 450 grams of $CO_2$ per kilowatt hour ($gCO_2$/kWh).

The chart (map 1) maps the carbon intensity of electricity generation around the world and ranks the 25 major economies covered by our report.

These countries include the G7 group of rich nations along with Brazil, Russia, India,

China and South Africa (the "BRICS") and others. These countries account for 80% of global population, 77% of global GDP and 73% of the world's $CO_2$ emissions.

Individual countries range from having virtually zero-carbon electricity (in the Nordics, France and New Zealand, left-hand columns in the lower chart) up to near-total reliance on coal (in South Africa and Poland, on the far right) (see Fig 1).

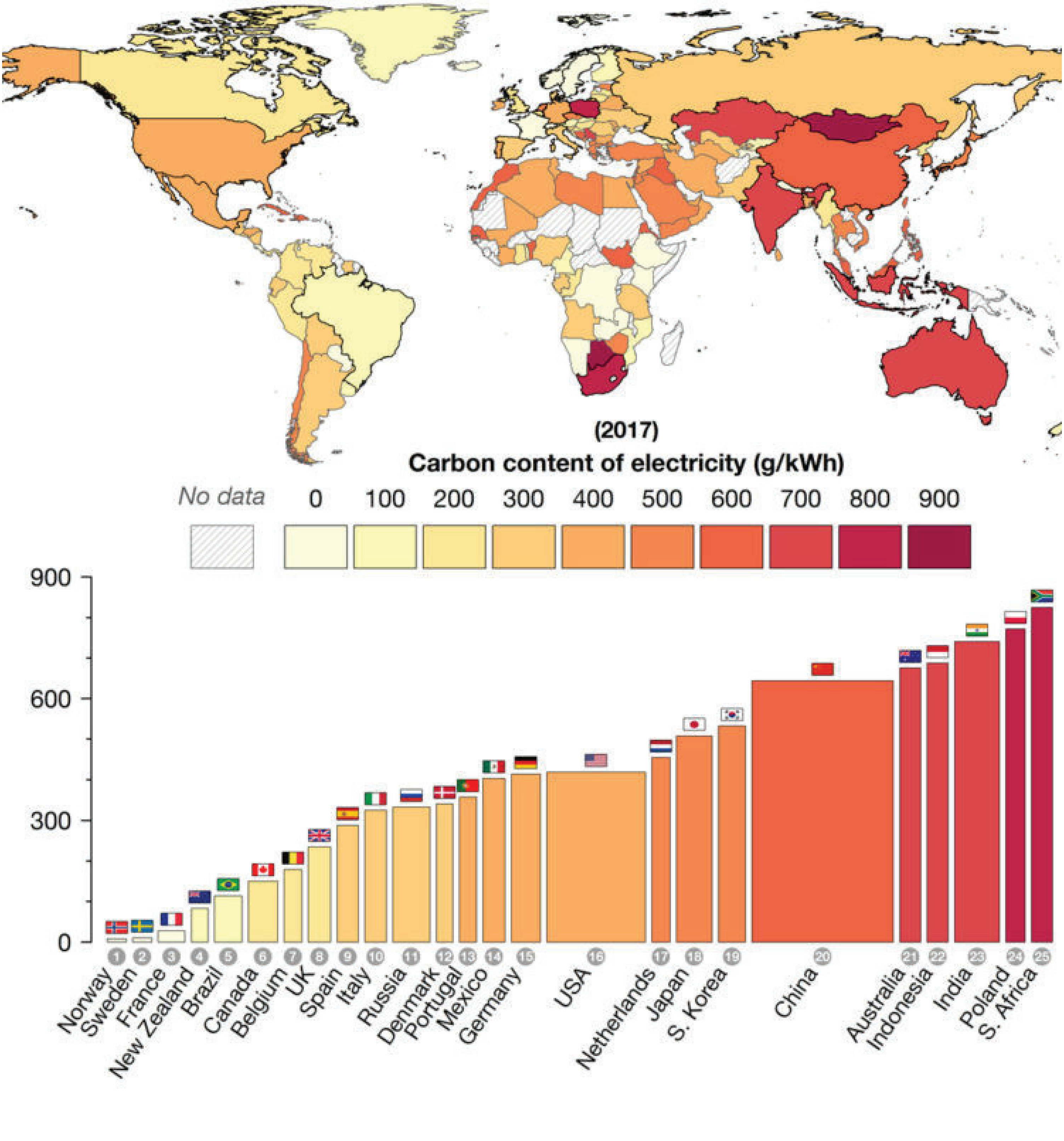


*Fig 1: The carbon intensity of electricity generation during 2017, in grams of $CO_2$ per kWh. The map includes all countries for which data is available. The bar chart ranks 25 major economies including all G7 and BRICS countries. Bar widths represent the amount of electricity consumed in each country, with a minimum width so that smaller countries are still visible.*

# Global Energy progress report

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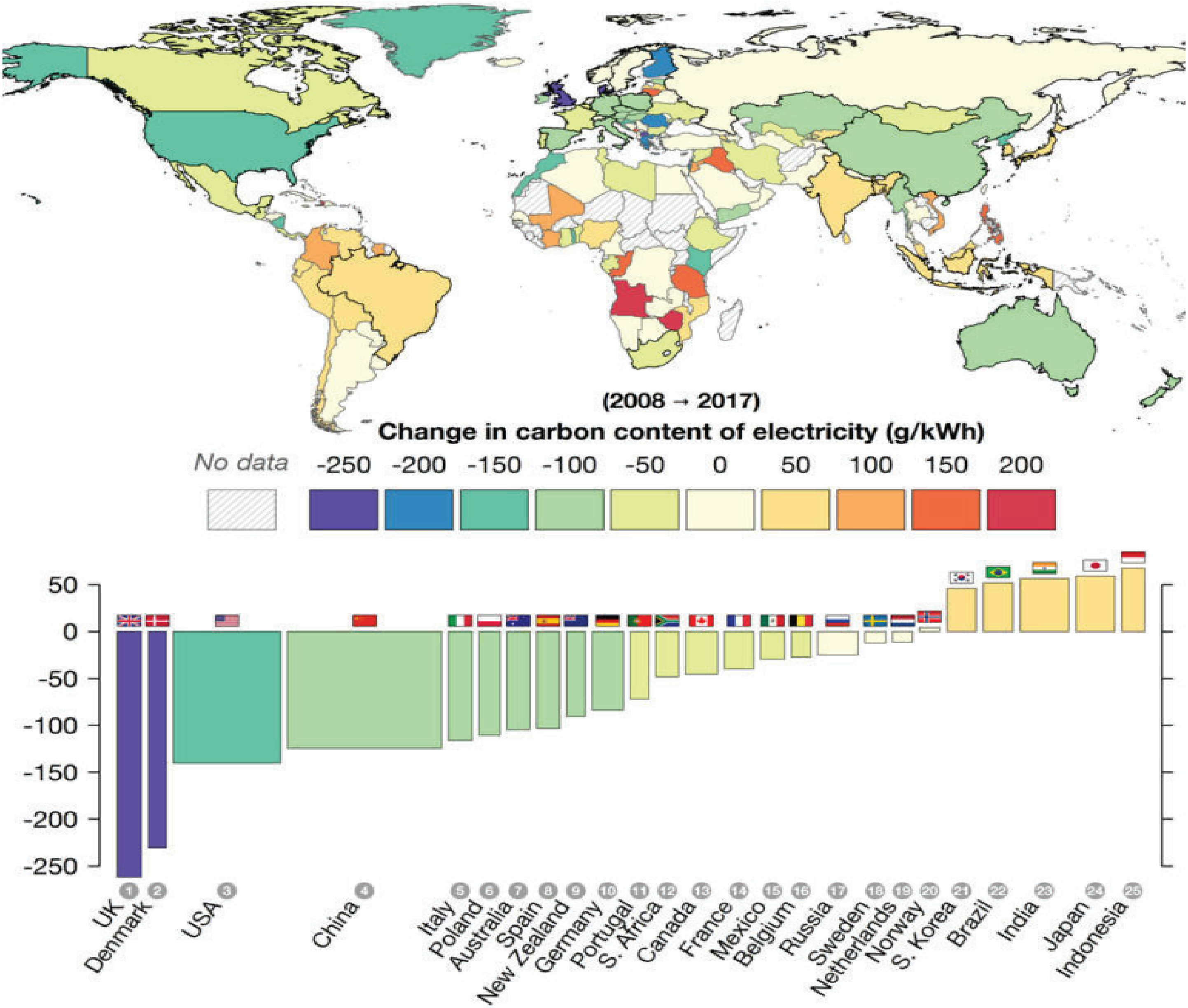


*Fig 2: The change in carbon intensity of electricity generation over the last decade, in grams of $CO_2$ per kWh. Shades of blue and green indicate reductions while yellows and reds are increases.*

Countries across Europe and North America have almost unanimously reduced the carbon intensity of their electricity over the last decade. They have done this by reducing their reliance on coal and increasing their share of renewables, as well as by reducing electricity demand in many cases.

On the other hand, several large Asian countries – Japan, South Korea, India, Indonesia – increased their carbon intensity as they now rely more heavily on coal.

China is one of the only Asian countries to be cleaning up its power system, having reduced carbon intensity by one-sixth this decade. The US is also progressing faster than most, behind only the UK and Denmark as in the chart, see Fig 2.

One of the main drivers in cleaning up power systems worldwide is the rise of renewable energy. In absolute terms, China is the clear leader, having both one-third of

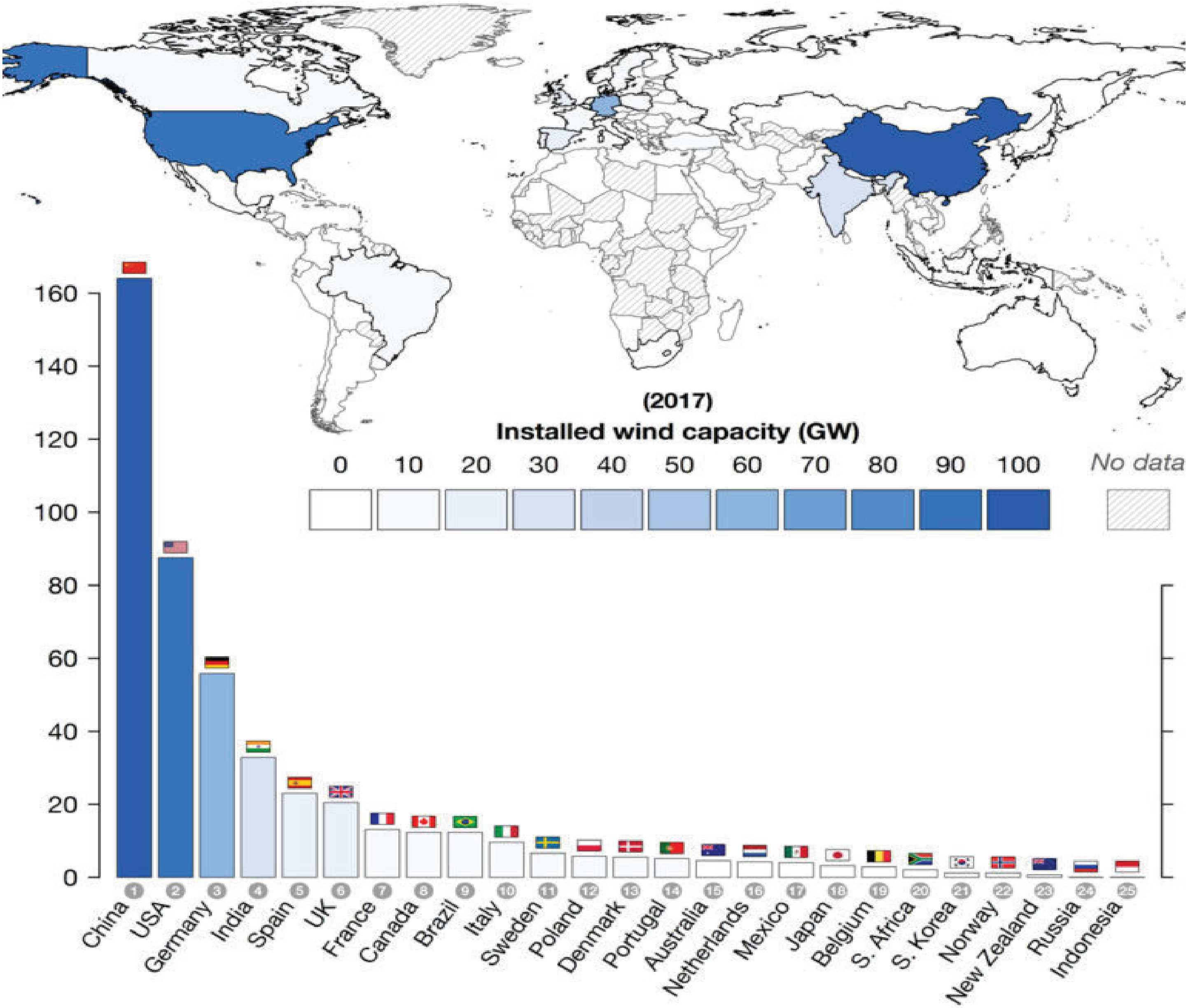


*Fig 3: The installed capacity of wind power at the end of 2017, in gigawatts (GW)*

the world's installed wind capacity and one-third of installed solar.

China's near-130 gigawatt (GW) solar capacity is roughly equal to the next three largest countries put together: Japan, Germany and the US. For wind capacity, other notable high-fliers include fourth-ranked India and Poland in twelfth, which has a larger wind capacity than Denmark, as shown in the chart, see Fig 3.

However, on a per-capita basis, Denmark has the most wind, with 1,000 watts of capacity per person, and Germany the most solar at 500 watts per person.

## PROGRESS ON CLEAN TRANSPORT

Clean electricity could move beyond homes and offices to power the way we drive. Electric vehicles are rapidly coming down at a price, and several countries are now legislating the demise of the internal combustion engine over the coming decades.

# Global Energy progress report

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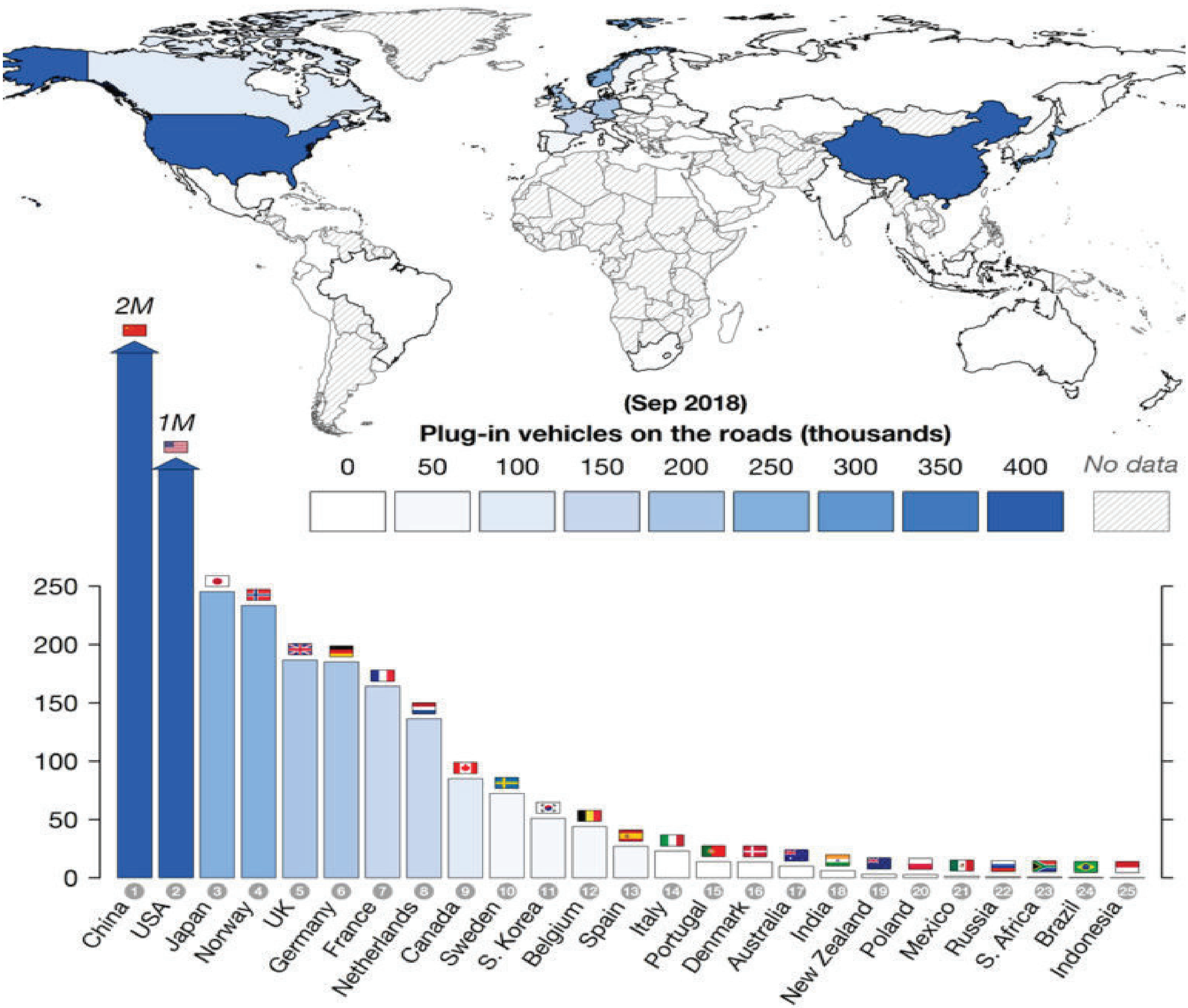


*Fig 4: The number of electric vehicles on the roads (both battery and plug-in hybrid) as of September 2018.*

So far, some 4.5 m electric vehicles have been sold worldwide, nearly half of which are in China, and a quarter in the US, as the chart in figure 4 shows.

Several countries have reached a 2% market share for electric vehicles, meaning they make up 1 in 50 new cars sold. The rate in China is around double this, while Norway is well ahead of the pack with almost 1 in 2 vehicles sold now electric.

Cleaning up the transport sector does not just rely on new technologies; however, as people could travel less or using more efficient forms such as public transport. The amount of energy consumed per person on transportation varies significantly across the world, with the average American consuming ten times more than the average Indian, as the charts in figure 5 show.

Large countries where people routinely fly between cities consume the most, but

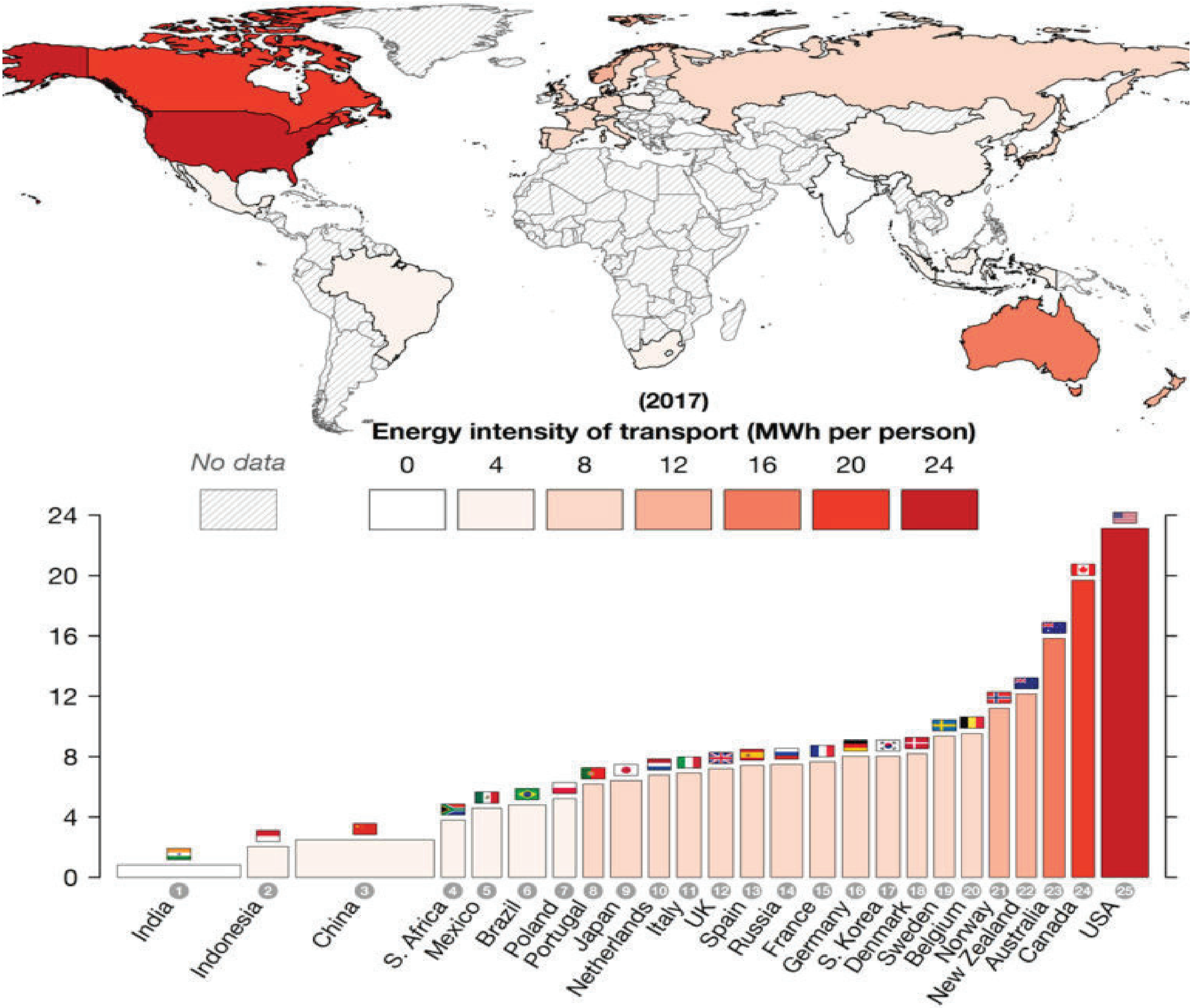


*Figure 5: The energy consumed per person for transportation of people and goods, in megawatt-hours (MWh) per person per year. Bar widths represent each country's population.*

China and India are rapidly catching up as incomes rise. Their transport energy consumption rose 80% and 60% per person over the last decade, respectively. This has dwarfed the modest increases in transport efficiency seen across Europe and North America, as in the chart in figure 6 shows.

# Global Energy progress report

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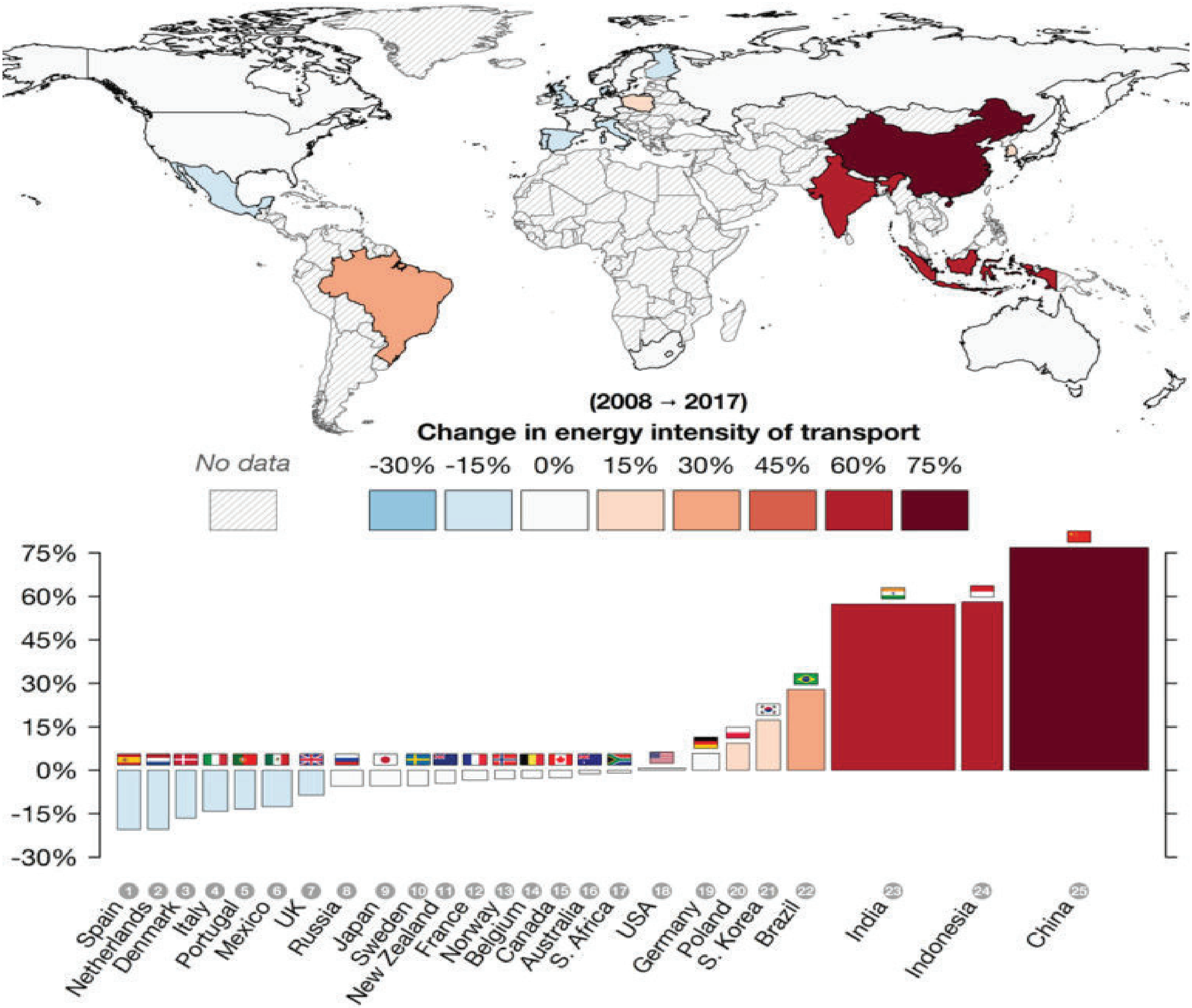


*Figure 6: The change in energy consumed per person for transportation of people and goods over the last decade, showing the percentage rise (reds) or fall (blues) in MWh per person per year consumed. Bar widths represent each country's population.*

## PROGRESS ON ENERGY EFFICIENCY

Efficiency is not only slow to improve in the transport sector. Improving the energy efficiency of buildings worldwide is urgently needed to reduce the demand for carbon-intensive heating.

Homes in most major countries are using less energy than they did a decade ago, per square metre of floor area.

While some of this can be credited to improving building standards and more energy-efficient appliances, the gains may also be due to the residual effects of the global recession and the run of mild winters caused by rising global temperatures.

In some parts of the world, notably China and South Africa, improved living standards have to lead to rapid growth in household energy consumption, as the chart in Figure 7 shows.

# Global Energy progress report

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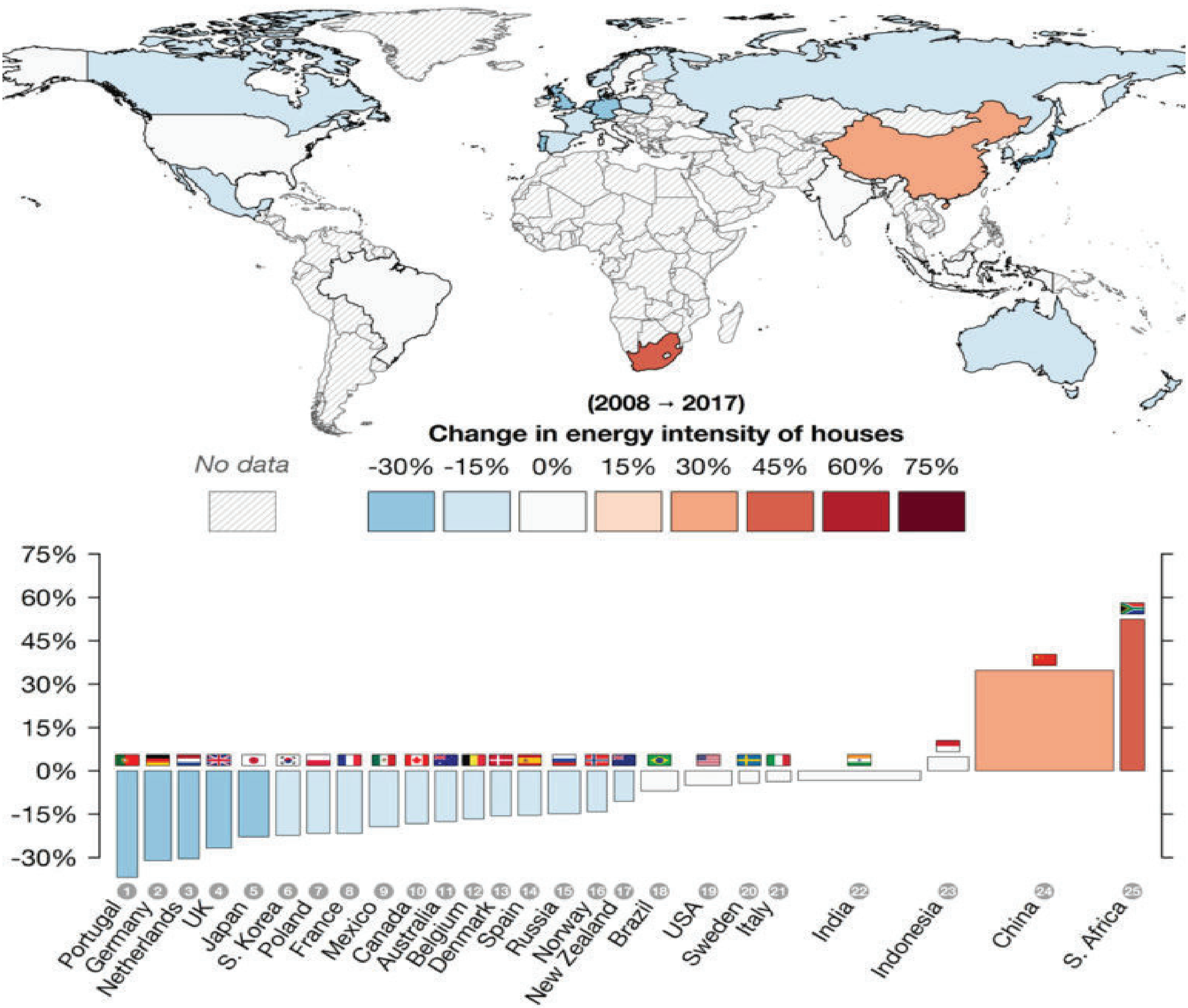


*Figure 7: The change in energy consumed for heating and powering households over the last decade, showing the percentage rise (reds) or fall (blues) in MWh per person per year consumed. Bar widths represent each country's population.*

## PROGRESS ON FOSSIL FUELS AND CARBON CAPTURE

Government support for fossil fuels is a perverse feature of many economies, holding back the transition away from coal, oil and gas.

The definition of fossil fuel subsidies is widely disputed. According to the description used by the Organisation for Economic Cooperation and Development (OECD) several primary fossil fuel producing nations with relatively small populations, such as Norway and Australia, provide hundreds of dollars per capita per year, as the chart in figure 8 shows. On this measure, the UK also gives massive subsidies.

A critical feature of many pathways to 1.5 or 2 ˚C is to combine hard-to-avoid uses of fossil fuels, such as in steelmaking or cement, with carbon capture and storage. Today, however, there are just

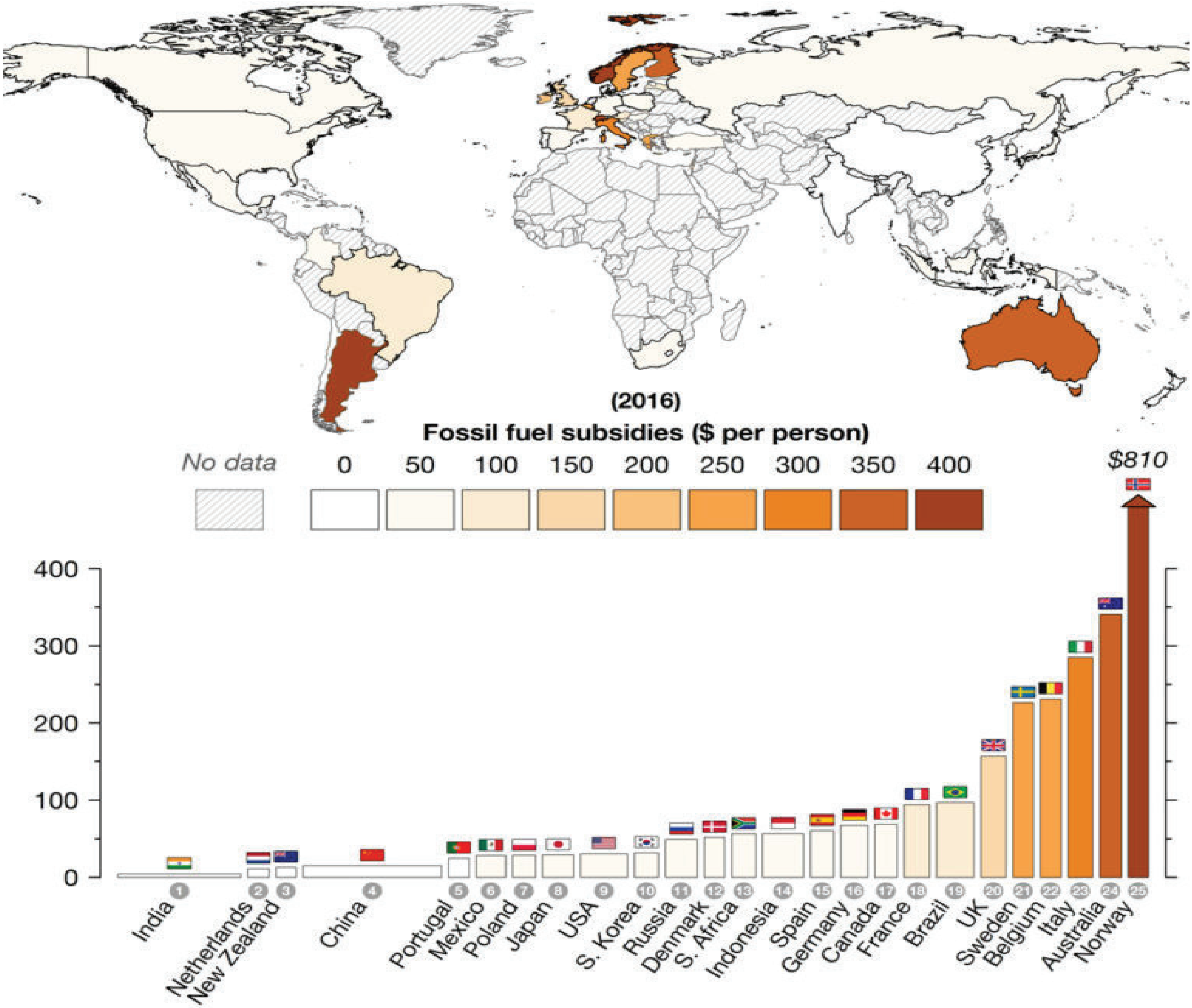


*Figure 8: The level of subsidies offered to fossil fuels per person in 2016, including direct expenditures by government, forgone tax revenues and other fiscal concessions. Bar widths represent each country's population.*

18 large-scale carbon capture and storage (CCS) facilities around the world, concentrated in six countries with significant oil and coal extraction industries, as the chart in Figure 9 shows.

Together, these CCS facilities are capable of capturing 32 million tonnes of $CO_2$ each year. This is less than one-tenth of one per cent of the roughly 37 billion tonnes of $CO_2$ produced each year by the world's energy sector.

If CCS does see widespread rollout over the coming decades, the potential for storing $CO_2$ underground will not pose a barrier. The US alone could save all of the $CO_2$ produced worldwide since the start of the industrial revolution.

# Global Energy progress report

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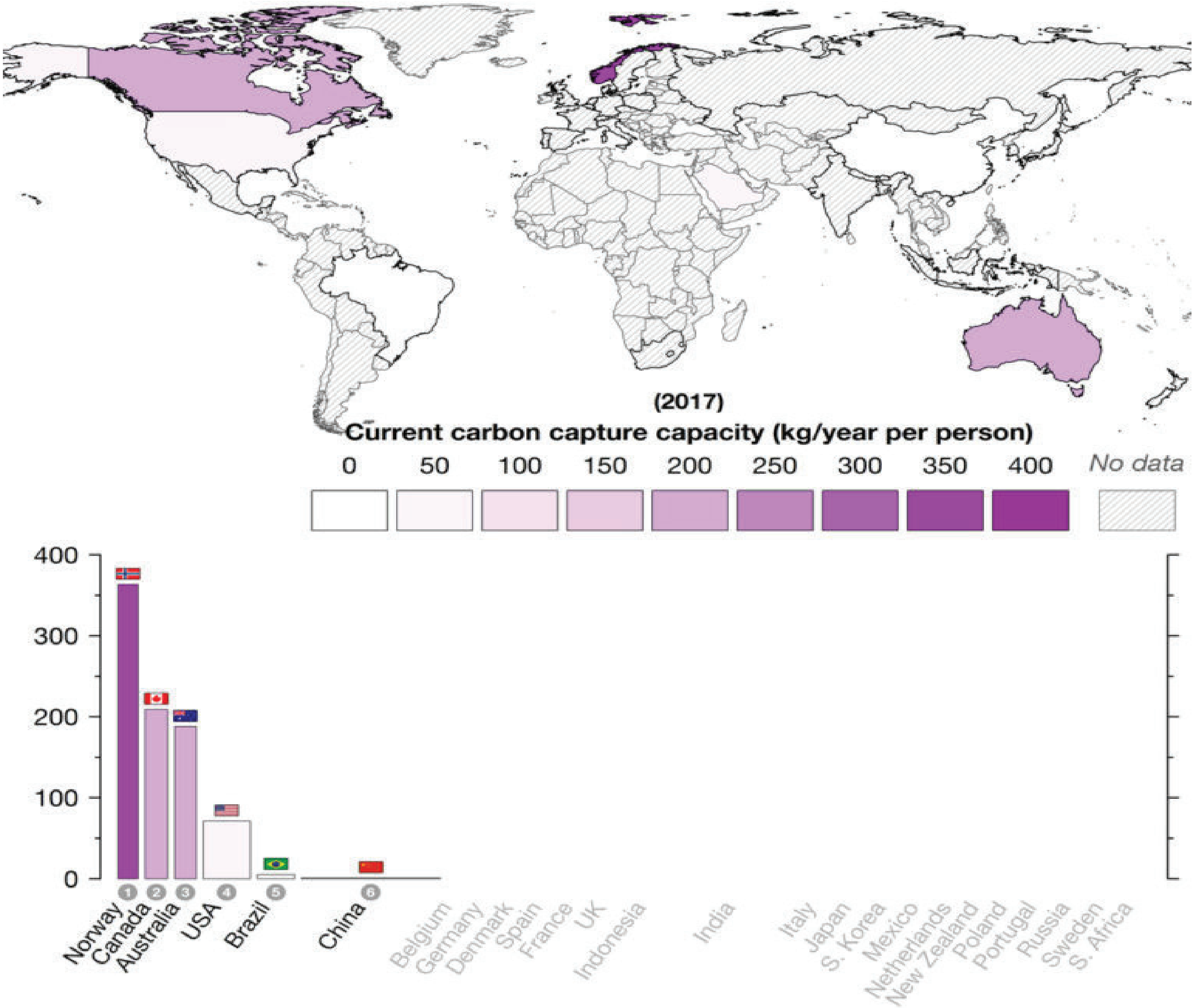


*Figure 9: The installed capacity for carbon capture at large-scale CCS facilities as of the end of 2017, measured as kg of $CO_2$ that can be captured per person per year. Actual level of capture may be lower, if facilities do not run at full availability. Bar widths represent each country's population.*

## CONCLUSION

All in all, progress towards clean energy around the world is mixed, with some countries pushing ahead on many fronts but others going backwards. Overall, our rankings show that the world's nations are falling far short of what is needed and that progress over the next decade must be far stronger to avoid the worst impacts of climate change. wn

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# SHIFTING CURRENTS

## OPPORTUNITIES FOR LOW- CARBON ELECTRIC CITIES IN THE GLOBAL SOUTH

A transition to low-carbon electric cities is an essential strategy for reducing global greenhouse gas emissions and has the potential to provide many benefits to the urban underserved.

The transition entails three elements: replacing fossil fuel-powered with electrically powered engines and devices (electrification), generating electricity from renewable or fossil fuel–free sources, and implementing energy efficiency measures.

**BY I** CHRISTOPHER KENNEDY
IAIN D. STEWART,
MICHAEL I. WESTPHAL

We identified 34 countries in the global South where electrification may already be a good strategy today, based on their level of urban access to electricity and the carbon intensity of their national power supplies. Electrification is an excellent strategy to pursue today in all South American cities, and many cities in the Middle East, North Africa, and Asia.

Not all cities are equally well-placed to begin the transition away from fossil fuel dependency toward clean, low-carbon electricity. We show which cities need to give urgent attention to electricity access—as well as those that have primarily tackled access but have unsustainable, high-carbon power systems that urgently need to be decreased in carbon intensity.

High upfront costs remain the most significant barrier to investing in low-carbon electricity generation and electric devices, but falling technology costs and momentum toward carbon pricing are encouraging.

### BACKGROUND

Cities will play a significant role in climate action and creating a decarbonised, sustainable future. Global electricity use will continue to rise as it is strongly linked to economic growth. In the global South, electricity consumption in cities is increasing much faster than population growth because of the relationship between consumption and economic growth. However, there is potential for this electricity demand to be met from carbon-free or low-carbon sources, and through efficiency measures.

Cities will need to make the transition from fossil fuel dependence to operating as

low-carbon "electric cities." This transition entails three types of technological development: shifting from fossil fuel-power to electrically powered engines and devices, which we term electrification, generating electricity from renewable or fossil fuel–free sources, and implementing energy efficiency measures. But not all cities are equally well-placed to begin the transition immediately.

## OUR APPROACH

This article addresses two questions:

- Which cities are currently in the best position to make the transition to electrification?
- What are the costs, barriers to, and enablers of low- carbon electric cities?

We explore the idea of electrification from the perspective of both people's access to electricity and greenhouse gas (GHG) reductions and to propose candidate cities by these considerations.

This article uses two criteria to identify cities in the global South that are candidates for electrification today. First, urban access to electricity (i.e., the percentage of people with a household electricity connection) must already be higher than 90 per cent. Below this threshold, electrification of fossil fuel–consuming devices may worsen inequities in access.

We use the 90 per cent threshold as an indication that a city has developed sufficient wealth and capability to provide electricity access to all citizens, and is well on its way to providing 100 per cent access. The 90 per cent threshold is, however, arbitrary, and city leaders are encouraged to debate the suitability of this threshold. Consideration should also be given to the quality of access, as reflected by frequency, reliability, safety, and cost.

Second, the carbon intensity of the electricity supply must be below a threshold of 600 metric tons of carbon dioxide equivalent per gigawatt hour ($tCO_2e/GWh$). Above this threshold, shifting to greater use of electricity would only increase emissions over the life cycle of the product or service.

While city-level data on electricity access and the carbon intensity of electricity would be ideal, they do not exist comprehensively. Therefore, although we highlight some city-level data, we use national-level data for both criteria to identify cities in the global South that are ideal for development as electric cities today.

# Shifting Currents

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## KEY FINDINGS

There are distinct regional variations in the carbon intensity of national electric grids. In Europe (with the notable exception of Poland), Latin America, much of sub-Saharan Africa, and North America, the national grids are fairly low carbon. In some countries in Asia, notably China, India, and Indonesia, as well as in South Africa and Australia, the electric grids are highly carbon intensive.

Access to electricity among urban populations in much of the global South is high, but access rates vary widely in sub-Saharan Africa. Urban access rates in South America, Central America, and the Caribbean exceed 90 per cent in all the countries we considered in these regions, except for Haiti (53 per cent). In the Middle East and North Africa (MENA) region, Djibouti stands out as the only country with low urban access to electricity, while in Asia, only Myanmar has urban populations with less than 90 per cent access to electricity.

Urban electricity access shows most significant variability in sub-Saharan Africa, where rates range from 20 per cent or less in Chad, Liberia, and South Sudan, to more than 90 per cent in Equatorial Guinea, Ethiopia, Ghana, Mauritius, and South Africa. Among all continental regions, sub-Saharan Africa has the lowest rates of urban electricity access.

Based on our analysis, we find that electrification is a good strategy to pursue today in many cities across the global South. We have identified 34 such countries in the global South from our two criteria of high electricity access and relatively low-carbon electricity supplies. In total, these countries contain 105 cities with populations higher than one million people. In broad terms, electrification is a good strategy to pursue in all South American cities, while many others can be found in the Middle East and North Africa region and Asia. Cities in Ethiopia, Gabon, and Ghana in sub-Saharan Africa also meet the criteria.

Cities in South Africa, Eritrea, Cuba, China, India, Indonesia, and other parts of Asia and the MENA region have carbon intensities above the 600 $tCO_2e/GWh$ threshold and need to prioritise developing lower-carbon electricity supplies while establishing enabling conditions for substantial electrification. A few major cities in the global South (e.g., Cotonou, Benin; Gaborone, Botswana; Port- au-Prince, Haiti; Niamey, Niger; Dakar, Senegal) have both low access to electricity and carbon-intensive electricity. Most cities in sub-Saharan Africa have sufficiently clean electricity supplies, but fewer than 90 per cent of urban residents currently have access to electricity. Of the countries we examined where data exist for both criteria, only 3 cities out of the 40 that have more than one million people in sub-Saharan Africa would be suitable for electrification (Accra, Addis Ababa, Kumasi) on the basis of our data; in South and East Asia, only 26 out of 202 cities with more than one million people are good candidates.

## MOVING FORWARD

The upfront investment cost of the infrastructure and technologies required to transition to low-carbon electric cities is perhaps the most significant barrier to progress. The infrastructure associated with upgrading existing electricity grids and new technologies to power electric vehicles and even simple devices can require significant investments. For example, the price of an electric cookstove (perhaps as much as $150 for an electric induction stove) remains a barrier for the urban poor, especially in sub-Saharan Africa. Electric vehicles remain expensive, although they have seen significant cost decreases in recent years, due in large part to steep reductions in the cost of batteries. Electric vehicles are projected to be cost competitive with internal combustion engines by 2022.

A range of economic policy initiatives will be needed to accelerate the transition to low-carbon electric cities. Broadly, the production and use of electric devices need to be incentivised, for example, through subsidies for electric rickshaws, buses, and cars or electric stoves, LED (light emitting diode) lighting, and solar lanterns, and through the provision of electric charging infrastructure for vehicles.

Legal and regulatory environments need to broadly support the electrification process by, for example, changing building codes and practices to foster the use of heat pumps in buildings. Other steps include updating procurement processes that mandate zero-emission vehicles in municipal fleets, blending public and private finance to address risk perceptions, and encouraging manufacturers to develop new models of engagement, such as battery leasing.

## THE URBAN ENERGY TRANSITION

If the United Nations Sustainable Development Goals and the objectives of the Paris Agreement on climate change are to be met, cities everywhere must transition away from a dependence on fossil fuels to reduce their emissions of carbon dioxide ($CO_2$) and air pollutants that undermine

| FOSSIL FUEL-BASED TECHNOLOGY | ELECTRIC EQUIVALENT |
|---|---|
| Automobiles with internal combustion engines | Electric vehicles |
| Diesel buses | Electric buses or streetcars |
| Liquefied-petroleum-gas (LPG)- or diesel-powered rickshaws | Electric rickshaws |
| Short-haul air flights | High-speed electric trains |
| Natural gas or oil furnaces | Ground or air source heat pumps |
| Charcoal, biomass, propane, LPG, natural gas, or other fossil fuel–powered stoves | Electric stoves |
| Kerosene, paraffin, or other fossil fuel–powered lanterns | Solar lanterns/LED (light emitting diode) lighting |

*Table 1 | Examples of Technologies and Products Suitable for Electrification*

human health. Both agreements recognise the vital role that cities play in the global effort to combat climate change and create a decarbonised, sustainable future.

The energy strategy with the most significant potential for achieving the urban energy transition involves the widespread use of electricity from low-carbon sources, which include renewable energy from solar and wind, geothermal and hydropower, sustainably harvested biomass, and ocean tides or waves. Low-carbon electricity may be generated either inside or outside city boundaries, with the specific technology dependent on local resource potential.

However, the transition involves more than just generating electricity from sustainable sources; it also involves substituting electricity in place of fossil fuels used for transportation, heating, and lighting.

When considering the transition to low-carbon electric cities in the global South, issues of social equity and quality of life are paramount. The energy priority of cities in the global South should be to address the lack of access to clean, reliable, and affordable energy that continues to afflict the urban underserved.

About 131 million people in urban areas lack access to electricity globally, 95 million in sub-Saharan Africa alone. Approximately 482 million people worldwide in urban centres use solid cooking fuels, including 213 million in sub-Saharan Africa, 146 million in East Asia and the Pacific, and 100 million in South Asia. Kerosene is one of the primary sources of light for unelectrified populations, but it has high associated fire risks and is a leading cause of child poisoning. Moreover, the use of solid fuels for cooking is a significant public health issue in the global South. Close to 550,000 premature deaths might have occurred in urban areas in 2010 due to their household use. So, the first consideration in assessing the potential for transitioning to low-carbon electric cities is the current level of access to electricity. Shifting to low-carbon electricity and adopting energy efficiency measures can bring benefits to the urban poor. Both approaches would improve air quality, mainly when existing fossil fuel-fired power generation is located close to cities—every kilowatt-hour (kWh) saved where cities depend on "dirty" electricity grids also means reduced air pollution. More energy-efficient structures and appliances will provide benefits in terms of reduced energy bills and improved economic productivity, comfort, health (reduced illnesses), and climate change resilience (e.g., to heat waves). However, the costs of transitioning to low-carbon electric cities, particularly upfront capital costs, need to be carefully evaluated for their impact. Other reasons for developing electric cities include a decreased reliance on diminishing fossil fuel reserves; reduced vulnerability to volatile fuel prices for poorer fuel- importing countries; and reduced expenditures on fossil fuel subsidies.

The Transition to Low-Carbon Electric Cities has three core elements:

- Replacing fossil fuel–powered engines, furnaces, and other equipment with electric devices. This shift from direct fossil fuel combustion to electric power is known as clean electrification.
- Generating electricity from renewable or fossil fuel–free sources, including distributed renewable energy systems, both outside and within the city boundaries.
- Implementing energy efficiency measures, especially building efficiency and more efficient electric appliances and devices that provide comparable or higher levels of service with lower energy input.

# Shifting Currents

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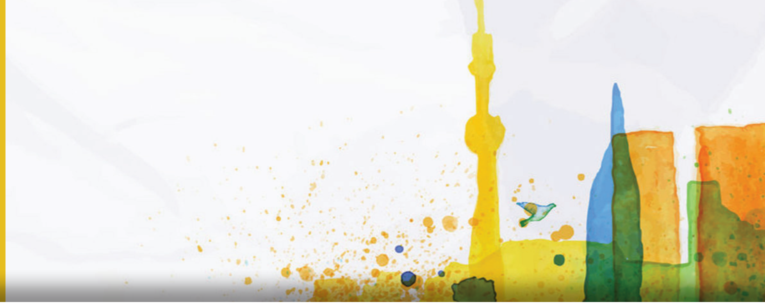

All three of these core elements are essential for the transformation to low-carbon electric cities and central to many national visions for deep decarbonization, where cities aspire to become low carbon, or even net-zero carbon or carbon neutral.

The importance of electrification (the shift from fossil fuel combustion to electric power) for reducing emissions is noted in the energy systems chapter of the Intergovernmental Panel on Climate Change's Fifth Assessment Report and further stressed by the International Energy Agency's (IEA's) Energy Technology Perspectives (2014). The Deep Decarbonization Pathways Project (2015) has developed pathways for 15 countries to transition to a low-carbon economy in line with keeping the increase in global warming to less than two degrees Celsius. In all the deep decarbonization pathways, electrification and the decarbonization of electricity play a central role. Across the 15 countries, the share of electricity in final energy consumption rises to 40 per cent, which represents a doubling between 2010 and 2050. Another recent study for the United States modelled pathways for achieving $CO_2$ reductions of 80 per cent below 1990 levels; by 2050, the main scenario results in electricity comprising more than 50 per cent of final energy use.

## THE CURRENT STATUS OF ELECTRICITY USE IN CITIES

The rate of increase in electricity consumption in many cities in the global South is already far exceeding the population growth rate. Because electricity use is strongly linked to economic growth, it will continue to rise. However, there is potential to meet this electricity demand from carbon-free or low-carbon sources and to curb demand growth through efficiency measures. The development of electric cities using low-carbon power supplies is thus a critical strategy for addressing the global climate change challenge. Electrification may also enhance the quality of life and the quality of energy services for the urban underserved in the global South.

Two metrics can be used to assess the degree to which a city can be described as a low-carbon electric city: the carbon intensity of its electricity supply, and the share of its electricity that is supplied by low-carbon or carbon-free sources.

It's determined by accounting for all the end uses of energy in a city—households, businesses, industry, transportation, and so on—then calculating the percentage of end uses that is served by electricity (as opposed to direct combustion of fuels).

To assess the share in the global South, we give special attention to megacities, most of which are located at low/ middle latitudes, because comprehensive energy data are available only for these cities. India's three megacities— Mumbai, Delhi, and Kolkata—have the highest share of electricity in the energy mix among all megacities considered here.

At the high end is Kolkata, with 65 per cent, while Dhaka, Tehran, and Lagos are at the low end, each with electricity accounting for less than 10 per cent of the energy mix. The Chinese megacities of Shanghai, Beijing, Tianjin, and Guangzhou sit between 20 and 30 per cent, while megacities of South America (Rio de Janeiro and São Paulo) and Southeast Asia (Manila and Jakarta) are slightly higher, at about 33 per cent.

A high share of electricity in the final mix does not, alone, indicate progress toward improved access to electricity, or reduced carbon content. For example, although Kolkata and Mumbai source more than 40 per cent of their energy from electricity, both are energy poor overall, with only 10 gigajoules (GJ) of energy use per capita per year (in 2011), although per capita energy use has been increasing. This compares with about 40 GJ per capita in the megacities of South America and Southeast Asia, and more than 70 GJ per capita in the megacities of China. In contrast, Tehran is energy-rich with 91 GJ of electricity consumed per capita per year, but less than 10 per cent of its energy is supplied from electricity.

## ELECTRIFICATION AND THE CARBON INTENSITY THRESHOLD

There are several approaches to electrification, including replacing internal combustion engines with electric vehicles (EVs), and natural gas furnaces with heat pumps. The success of these technologies and strategies in abating urban greenhouse gas (GHG) emissions depends on the local context: industry, technology, economy, climate, urban form, and changing consumption patterns.

Fundamentally, however, their climate mitigation benefit depends most upon the carbon intensity of local electricity supplies. In other words, the case for electrification of cities is compelling only insofar as clean energy sources are available and able to reduce traditional dependence on carbon-based fuels.

It was identified that an intensity of 600 metric tons of carbon dioxide equivalent per gigawatt hour ($tCO_2e/GWh$)

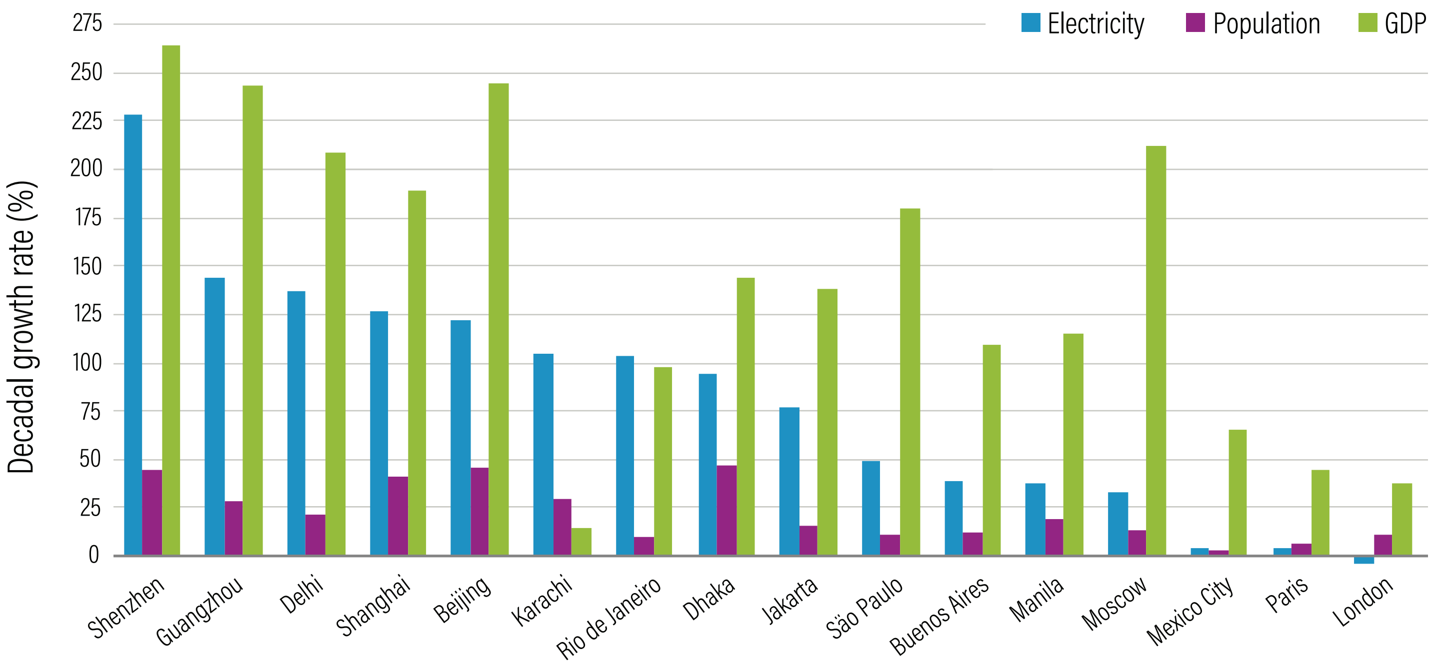


*Figure 1: Growth of Electricity Use, Population Size, and Gross Domestic Product in Select Megacities, 2001–2011.*

of electricity generated as the threshold for pursuing the transition to a low-carbon electric city. Below this threshold, the transition is expected to reduce urban GHG emissions.

The threshold is derived from life cycle emissions studies that estimated the impact of replacing fossil fuel devices with equivalent electric ones and has been verified by the IEA (2015). Above the threshold, reductions in furnace and tailpipe emissions due to electrification are more than offset by upstream emissions, such as those from smokestacks at power plants.

## URBAN ELECTRICITY ACCESS

The first significant factor in our analysis is the level of electricity access in cities, which we measure as the percentage of urban residents with a household electricity connection.

We recognise that the issue of access goes beyond the number of connections, and should include factors such as the reliability, cost, and safety of the electricity supply. For example, the World Bank's Sustainable Energy for All initiative has developed a framework that measures electricity access across five tiers using metrics of peak capacity, availability, reliability, quality, affordability, legality, and health and safety. However, in this paper, we have chosen to use a simple binary measure of access to make our analysis tractable.

Cities with low levels of access to electricity may prefer, for considerations of equity, to focus their limited resources on increasing access for the urban underserved rather than diverting funds to electrification. However, the two strategies are not mutually exclusive, and there can be complementarities between electrification and access. For example, distributed renewables, such as solar photovoltaics, can both provide electricity access and allow people to shift away from kerosene lighting.

## ACCESS TO ELECTRICITY AT THE NATIONAL SCALE

Access to electricity among the urban populations of South America, Central America, and the Caribbean is generally high, exceeding 90 per cent in all countries considered here, except Haiti (53 per cent). In the Middle East and North Africa, Djibouti stands out as the only country with low urban access to electricity, while in Asia, only Myanmar (86 per cent) has an urban population with less than 90 per cent access to electricity.

Urban electricity access shows the most significant variability in sub-Saharan Africa, where rates range from 20 per cent

# Shifting Currents

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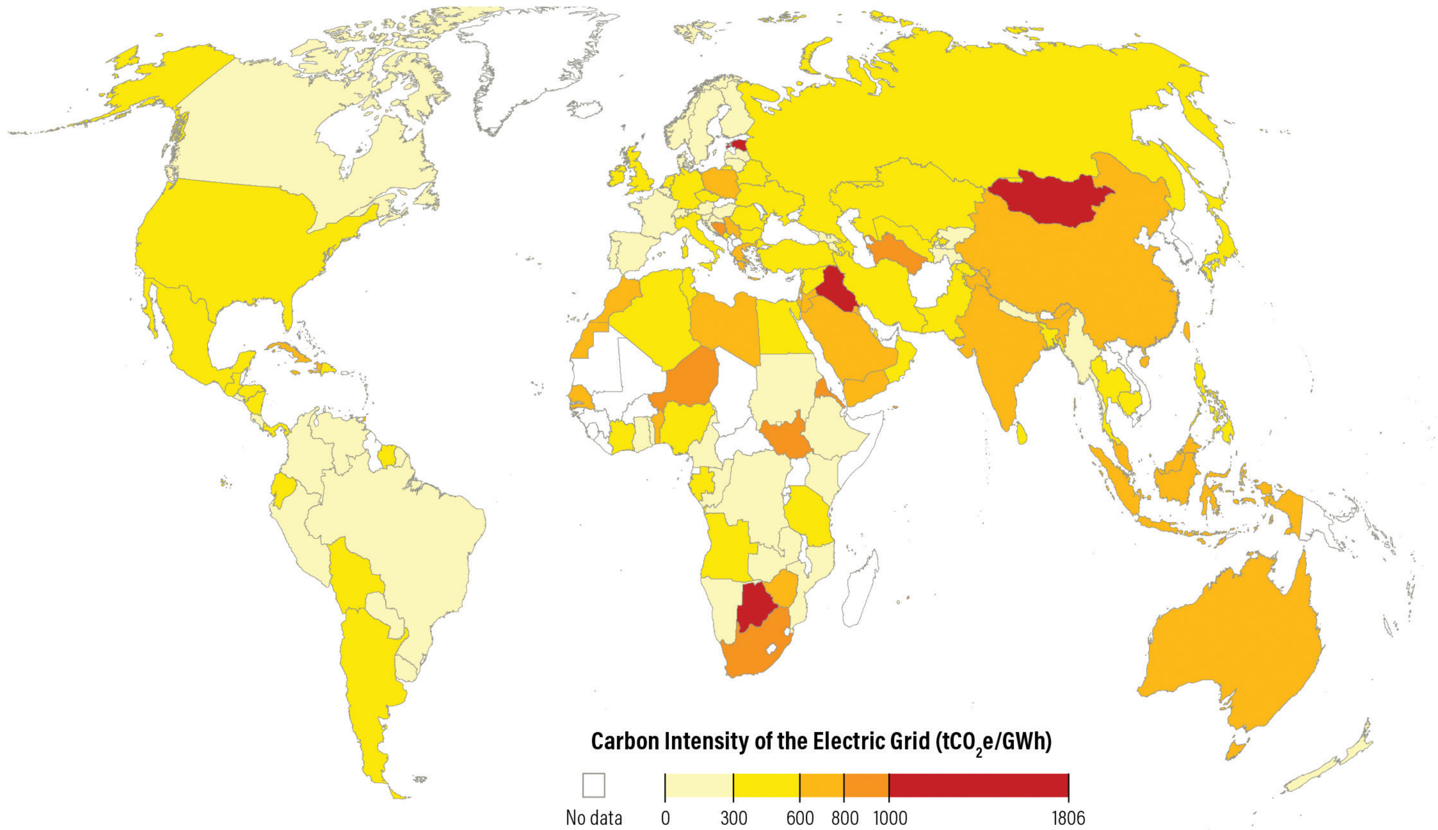


*The National Electric Grids in Europe, Latin America, North America, and Much of Sub-Saharan Africa Are Fairly Low Carbon.*

or less in Chad, Liberia, and South Sudan, to more than 90 per cent in Equatorial Guinea, Mauritius, South Africa, Ethiopia, and Ghana. Among all continental regions, sub-Saharan Africa has the lowest rates of urban electricity access.

## ACCESS TO ELECTRICITY AT THE LOCAL SCALE

Access rates at the national level do not necessarily reflect conditions at the local or municipal scale; that is, in cities and their neighbourhoods (especially informal settlements). Among Indian megacities, for example, access to grid electricity at the metropolitan scale was 82 per cent in Mumbai in 2011, compared with 93 per cent for the urban population of India as a whole in 2011. Moreover, power outages and voltage fluctuations can be frequent, further qualifying what "access" means. In Delhi's informal settlements—the majority of which are not officially electrified—one estimate was that only one-quarter of the population had legal access to electricity in 2007, with most residents gaining access through illegal "hooking". In one of Africa's largest informal settlements—Kibera, in the city of Nairobi—electricity reached only 42 per cent of residents and only 30 per cent of small-to-medium-sized enterprises in 2007. This compares with an access rate of 74 per cent for the urban population of Kenya at the national level during the same period. In contrast, Bangkok's informal settlements had nearly 100 per cent access to grid electricity in 2007, a rate equal to the national average for Thailand. However, 32 per cent of these connections were reported to be "unofficial".

While urban access data at the national level and for specific cities may be discordant in some cases, we do not know the extent of this issue. Extrapolating from known discrepancies would be inaccurate. Indeed, in some cases, the national urban numbers may be close to the level for a capital or most significant city. Because there is no universal dataset on electricity access at the city level, we merely use national-level figures for urban areas while acknowledging that this is an imperfect measure.

Looking only at megacities, empirical evidence suggests that grid electricity becomes universally accessible when annual electricity consumption exceeds two-megawatt hours (MWh) per capita. This threshold is not met in Mexico City, Karachi, Delhi, Mumbai, Cairo, Kolkata, and Dhaka, where the percentage of households without access to grid electricity reaches up to 67 per cent (Dhaka). All other megacities in low- and middle-income regions have universal access to electricity, coupled with annual per capita electricity use exceeding 2 MWh. Shenzhen, China, has the highest per capita electricity use of all megacities of these regions; the city's consumption level is comparable to those observed in the world's wealthiest cities, such as New York and Tokyo.

## WHICH CITIES ARE CANDIDATES FOR ELECTRIFICATION TODAY?

We suggest that cities are good candidates to make the transition to low-carbon electric cities when more than 90 per cent of their citizens have access to electricity, and their electricity supply has a carbon intensity of less than 600 t$CO_2$e/GWh.

The electricity access threshold of 90 per cent is somewhat arbitrary, but we have chosen it to represent the trade-offs that cities in the global South may face when choosing between allocating resources to increasing electricity access or investing in the shift to electric power. While these options are not mutually exclusive, policymakers must consider the opportunity costs of pursuing electrification, given other priorities in cities. Although many of the data reviewed in this section are from the national level, they can be used to identify cities in the global South that are currently best suited for electrification.

We examine 72 countries in the global South in Latin America, sub-Saharan Africa, the Middle East/ North Africa (MENA), and East, South, and Southeast Asia where data exist on urban electricity access and the carbon intensity of grid electricity.

# Shifting Currents

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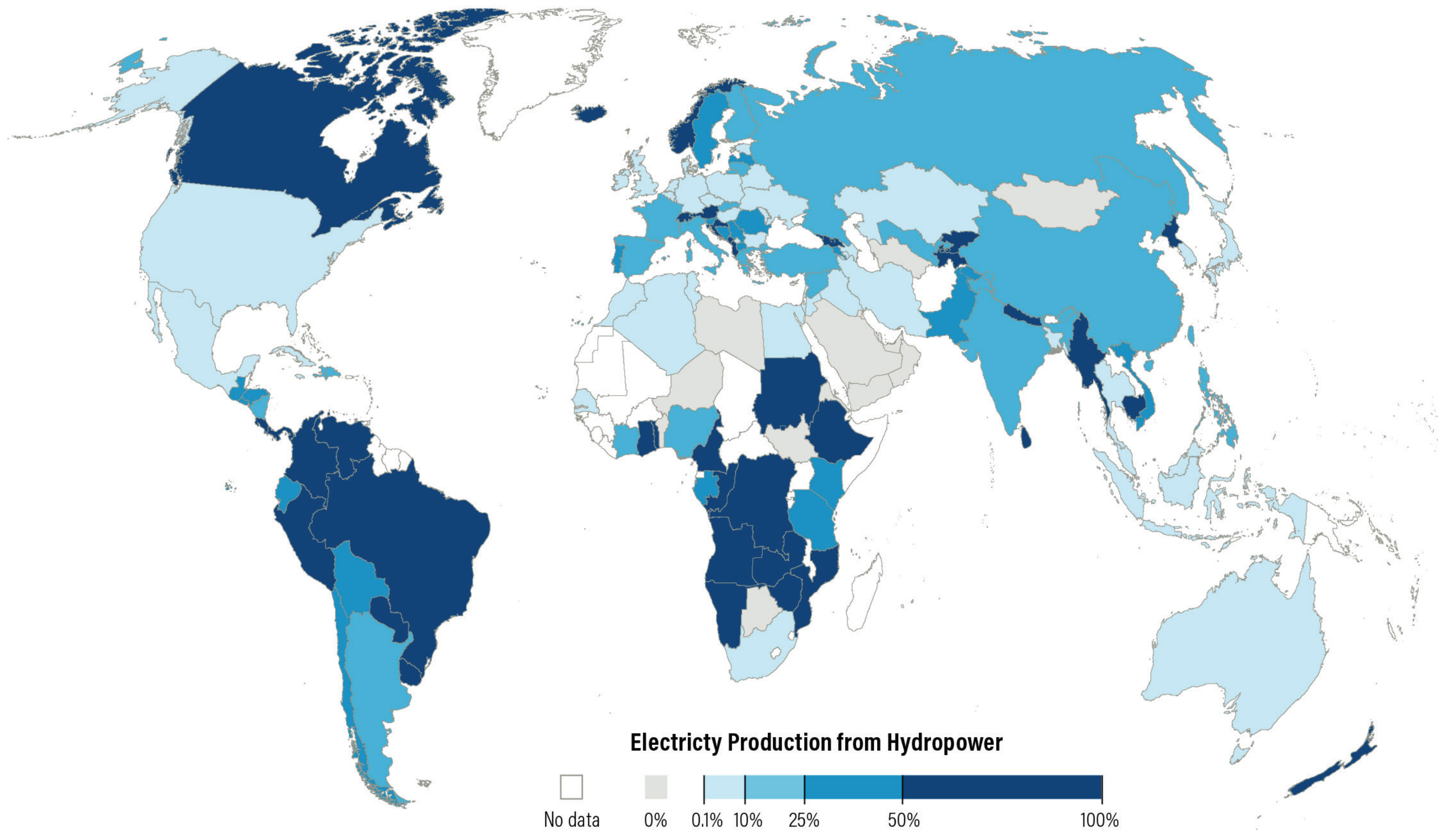


*Many Countries with Low-Carbon Electric Grids Generate Most of Their Electricity from Hydropower*

From our two criteria, we have identified 34 countries in the global South where electrification may be a good strategy.

In broad terms, electrification is a good strategy to pursue today in all South American cities and many cities in the Middle East and North Africa region.

In total, the 34 countries we've identified contain 105 cities with populations of over one million people. In sub-Saharan Africa, only 3 cities out of the 40 with more than one million people would be suitable for electrification according to our data; in the global South countries in South and East Asia, only 26 out of 202 cities with populations over one million people are good candidates.

Most cities in sub-Saharan African countries have a sufficiently low-carbon electricity supply, but many urban residents remain without access to electricity. On equity grounds, it may be argued that increasing electricity supply (including from renewable sources) and access rates are more pressing today than shifting to a more widespread use of electric engines and equipment.

This does not mean that electrification is not a good strategy for such cities, but it should be undertaken with greater attention to increasing access and the low-carbon electricity supply.

Substantial development of low-carbon electricity supplies with a grid connection available to more people is needed in these places before considering electrification.

## POLICY, INSTITUTIONAL, AND GOVERNANCE ENABLERS AND BARRIERS

The policy, institutional, and governance barriers and enablers for electric cities can be classified broadly as "economic" and "noneconomic." Chief among the economic barriers is the upfront investment cost of infrastructure and technology associated with low-carbon electricity generation and electric devices.

We examined the literature to assess the cost of measures that would likely be required as part of the transition to low-carbon electric cities. Specific technology choices

will be city-specific, based on the city's development and geographical context, current technology baseline and costs of energy-efficient or electric alternatives, the building stock, the electricity mix of the grid, and the current price of electricity and fossil fuels, among other factors.

## CONCLUSION

The development of low-carbon electric cities is an essential strategy for reducing global greenhouse gas emissions and has the potential to provide many benefits to the urban underserved, including increased access to energy; reduced energy bills; and improved economic productivity, comfort, health (reduced illnesses), and climate change resilience.

The transition to low-carbon electric cities has three core elements: replacing fossil fuel–powered engines, furnaces, and other equipment with electric devices (called electrification in this article); generating electricity from renewable or fossil fuel–free sources, including distributed renewable energy systems, both outside and within the city boundaries; and implementing energy efficiency measures, to provide comparable or higher levels of service with lower energy input.

All cities should seek to use electricity from fossil fuel–free sources, and always aim to improve energy efficiency. The first element of the strategy-electrification - however, should be a lower priority until cities have sufficiently high access to low-carbon-intensity electricity.

We identified cities that are suitable for electrification today by two thresholds: access to electricity use must be higher than 90 per cent, and the carbon intensity of electricity must be less than 600 $tCO_2e$/GWh.

By grouping cities by these thresholds, we not only identify suitable candidates for radical electrification today, we show which cities need urgent attention to electricity access—and those that have primarily tackled access but have unsustainable, high-carbon power systems that urgently need to be decreased in carbon intensity. Potential Electric-city leaders, which pass both thresholds, include all South American cities, many cities in the Middle East/North Africa region.

The second group of cities are the high-access polluters. This group includes many cities in China, India, and South Africa, for example, where greater attention should be given to reducing the carbon intensity of electricity grids while the enabling conditions for electrification are established.

The third category of cities are cleaner, but have limited access, with carbon intensities below 600 $tCO_2e$/GWh but access to electricity under 90 per cent. Such cities are particularly prevalent in sub-Saharan Africa. The highest priority for these cities is providing access to electricity. Cities that are high polluting with limited access are less common. Our study identified a few of these cities, which require significant investments in renewable power supply before pursuing electrification.

In some countries in which we argue that electrification makes sense, we see some promising signs of a transition. Most deployment of battery electric buses is in North America, Europe, and China, but six cities in Brazil either have battery electric buses in operation or have started pilot programs. While shifting from fossil fuel use to electric power can bring benefits to the underserved, there may be trade-offs, and the specific context matters.

The use of electric stoves may not be the best use of resources if the underserved population of a city lacks access to an affordable and reliable supply of electricity. Electrification of transport would also improve local air quality in the city, 10 but the electrification of a municipal bus fleet may not be a good mobility solution for the underserved if the bus lines do not serve their areas or are too expensive. However, some solutions, such as distributed renewables, could both provide access to clean, reliable, and affordable electricity and allow a shift from fossil fuel–burning devices, such as kerosene lighting.

Cities with highly carbon-intensive electricity supplies (> 600 $tCO_2e$/GWh) need to focus on transitioning to low-carbon electricity generation while establishing the enabling conditions for substantial electrification. Cities with low electricity access should first focus on ameliorating this situation through programs that specifically target the underserved and address the institutional, political, and cost barriers.

These include policy incoherence between state and federal governments, small utility and municipal service to informal settlements, and high costs of traditional grid connections. Possible solutions include, for example, electricity levies and financial models, such as pay-as-you-go schemes, that incentivise distributed renewable energy within the city. wn

*For the complete paper, please send an email to minx@saiee.org.za.*

# FELIX's Transmitter

## THE STORY OF THE NAZI SPY IN SOUTH AFRICA

Lothar Sittig (Fig.1) was trained as a diplomat, but he never served as one. Instead, in 1942, he became notorious as the Nazi spy, codenamed FELIX, in South Africa. Sittig left Germany in 1922, soon after he completed his academic studies intended to equip him for life in the world of international affairs but, as a result of the Treaty of Versailles in 1919, Germany had lost all her colonies, and so he turned to farming soon after arriving in Portuguese West Africa, the Angola of today. In 1925 he went to South Africa where he spent most of his time managing a farm near the Vaal River.

**BY |** DR BRIAN AUSTIN
**&** VINCENT HARRISON

Soon after South Africa declared war on Germany in September 1939 Sittig, who was still a German national, was interned along with many of his fellow countrymen. He was sent to the internment camp in Leeukop prison near Johannesburg. There he encountered the Ossewabrandwag (OB), the ultra-nationalist movement formed earlier that year, initially as a cultural organisation to represent those Afrikaners whose intentions were to sever all ties with Britain and turn South Africa into a republic. At that time South Africa was a self-governing British Dominion with a similar status to Australia, Canada and New Zealand. However, the OB rapidly evolved from a social body into a hard-line pro-German organisation intent on bringing about a change of government, even by force, if needs be. Their version of the SS, the 'Stormjaers' were itching for a fight.

The OB's new leader was the charismatic Dr Hans van Rensburg, (Fig 2) a former Secretary of Justice under Jan Smuts and the former Administrator of the Orange Free State. He had also been a senior officer in one of Pretoria's oldest regiments.

With the active connivance of some of the guards at Leeukop whose sympathies lay squarely with the OB, Sittig and a fellow German by the name of Nils Paasch managed to escape and, after some months being sheltered by various OB sympathisers around the country, they made their way to Lourenco Marques and specifically to the German consulate there. Portuguese East Africa was neutral territory but the German consul, Paul Trompke and particularly his vice-consul, Luitpold Werz, were actively supporting the Nazi cause by encouraging and assisting the flow of German agents across the border with South Africa. The intention was that they would make contact with the OB and so lend support to those Afrikaners who were seeking to overthrow the Smuts government and, ultimately, to remove South Africa from what they saw as the stranglehold of British domination in 'their' country.

*Fig 1: Lothar Sittig as a much older man.*

The OB, using the services of well-placed individuals, would observe shipping moving in and out of South Africa's ports and then report these to the Kriegsmarine, Hitler's navy, so that the German submarines – the U-boats – could attack them. To do this, there had to be some effective means of communication between the OB and


SPECIAL EDITION
Sunday Times
A PAPER FOR THE PEOPLE
WAR DECLARE
A. DECLARES STATE OF WAR WITH REICH
GENERAL SMUTS SIGNS PROCLAMATION
German Planes Over
War came to South Africa on 4 September, 1939, when in the House of Assembly, beneath Table Mountain, General Smuts led the majority vote against General Hertzog's neutrality motion. It was not until 6 September, however, that the Union officially declared war against Nazi Germany. Throughout the country silent crowds awaited anxiously the fateful decision. Spontaneously the bulk of the people rallied to the support of General Smuts and his war government in the common struggle of free men against Nazi oppression.

# Felix's Transmitter

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*Fig 2: Dr Hans van Rensburg saluting his OB guard of honour.*

the German consulate in LM. That meant wireless, and Sittig soon became FELIX, his codename for the rest of the war.

The intention was that he would return to South Africa, obtain a radio transmitter and then communicate, initially, with Werz in Lourenco Marques but ultimately, so they hoped, directly with Berlin. The critical link in the OB – Nazi chain was another individual who had escaped from detention and had been smuggled across the border by willing members of the 'Stormjaers'. His name was Olaf Andresen, a musician and composer who would subsequently be remembered as the composer of Afrikaans 'liedjies', most notably *'My hart verlang na die Boland'* but he also wrote what would become the anthem of the Ossewabrandwag, called *'Opsaal Boere'*. It would subsequently play an essential part in the process of communicating with Berlin, as we will see.

Moreover, there were others too. The very first Nazi agent to become active in South Africa was Hans Rooseboom, an irascible character who soon fell out with everyone he was supposed to collaborate with. Eventually, van Rensburg cast him out, and it was even suggested that his name was placed on an OB assassination list. However, after lying low for some time, he reappeared and made contact with a German radio engineer named Herbert Wild, whose electronics business in Johannesburg still exists today. Wild had a transmitter which Rooseboom was to use to contact Berlin. There is no evidence he ever did.

Since all communications would be in code, Sittig received training in this black art, and though the Enigma machine had become the Nazi's tool of choice throughout the war, FELIX used a far simpler method based on a commercially available numerical code. He was to transmit using Morse code, another skill he did not yet possess. However, he was a resourceful man and, besides, he was driven by a great urge to serve the Fuhrer despite being a very long way from the war that was raging in Europe. Early in 1942, his attempt to re-enter South Africa was foiled, and he was arrested and interned once again. However, three months later he'd escaped again and headed for Pretoria


and the headquarters of the OB on van Rensburg's farm to the east of the city. There he came under the wing of van Rensburg's adjutant, a former officer in the Union Defence Force (UDF) by the name of Heimer Anderson. It was Anderson who had been instructed by van Rensburg to take charge of the OB's radio communications. His first task was to gather in the various transmitters that had been constructed in a veritable cottage industry around Pretoria and Johannesburg with the intention of providing wireless communications between the OB's many commandos wherever they happened to be.

All in all, Anderson accumulated between five and fifteen transmitters (depending on which source you believe), some built by radio amateurs and at least one by a senior engineer at the SABC by the name of CL Olën. The Johannesburg suburb of Sydenham housed one of these transmitter factories. It was owned by OB stalwart 'Kowie' Marais who, after the war, became a judge of the Supreme Court and then, in the 1970s, following a complete change of political direction, he joined the Progressive Federal Party and became an outspoken critic of apartheid.

None of those transmitters produced much output power, perhaps 10 to 20 W at most. The primary reason was the difficulty of obtaining suitable high-frequency thermionic valves. Any attempt to purchase such things (as well as the quartz crystals needed to determine the transmit frequency) from the various suppliers of amateur radio components was viewed with suspicion and would assuredly lead to a visit from the police because amateur radio had been closed down by government decree soon after the beginning of the war.

Sittig, now operating in the guise of FELIX, made his first radio transmission in May 1942 more in hope than expectation. Its purpose was to test the communication link between Pretoria and Lourenco Marques, but the optimists among them thought that Berlin might also receive his signal. No one did. The German consulate was ill-prepared in every way: they only had a domestic radio receiver and no skilled radio operators among their consular staff. It was the Italian consul, Umberto Campini, who stepped in to assist his Axis allies by ordering the radio operators aboard an Italian vessel stranded in the harbour to use their much more sophisticated receiver to listen out for FELIX's signals. The agreed schedule of transmissions was to be every Sunday, Tuesday and Thursday at 2315 SAST and on every occasion FELIX would

# Felix's Transmitter

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transmit 'blind', in other words, there would be no reply from LM because the Portuguese were monitoring the activities of the warring countries that they had the privilege of hosting on their neutral shores. Such transmissions would've violated international agreements, and the consulate concerned would've faced immediate closure. So this is where Olaf Andresen's music played a significant role. On receipt of a message from FELIX, Luitpold Werz would decipher it in LM and then re-encipher it in the diplomatic code used between his consulate and the German Foreign Office in Berlin. The message would then be sent to Germany via the regular landline diplomatic telegraphic service.

Along with all other landlines from the Portuguese territory that line went through Johannesburg before making its way to Cape Town and onward to Europe by undersea cable. The Germans would then acknowledge receipt of the message in Berlin by using the regular Afrikaans transmission from Radio Zeesen, the high-power shortwave transmitter near Berlin, to play 'Opsaal Boere'. So this is also where the British Intelligence agencies joined the fray.

All radio transmissions emanating from South Africa were being monitored by the Royal Navy's Wireless intercept stations, known as the 'Y Service', situated in all South Africa's major ports. Also, the two British security services, MI5 and MI6 (more accurately known as the SIS), which had direct responsibility for security within all the British Dominions, had 'tapped' the line from Lourenco Marques in Johannesburg's Central Telephone Exchange. Everything transmitted by FELIX ended up, ultimately, in Bletchley Park where the codebreakers there attended to it as a routine matter. The simple codes used presented a few problems, and so British Intelligence was able to follow FELIX's every move.

*Fig 3: The Groeneveld high-power transmitter used by FELIX.*

It would not be until May 1943 that FELIX's transmissions were received directly in Berlin without any intervention by Werz in LM. This only happened after FELIX began using a transmitter of considerably greater power (Fig 3). It was designed and built for him by another OB member, a Post Office technician by the name of Reijer Groeneveld, a Hollander who had expressed no desire to become a South African citizen as long as that required his allegiance to the King of England. Again, it was Heimer Anderson who was instrumental in setting Groeneveld up on the farm of a prominent OB supporter near Pretoria. There Groeneveld, assisted by his Post Office colleague Hans Thomas, built the transmitter. Its considerably increased output was made possible by the removal ('hy het voete gekry'), from the hospital in Bloemfontein, of a diathermy machine which Groeneveld himself had installed some while before for his previous employer, a supplier in Cape Town. The transmitter itself was housed in a steel box, and its power source was a 1 horsepower (746 W) petrol-driven alternator that produced 110V AC. Both the transmitter and its power supply were placed in a hole in the ground some 2,5 metres on a side. This was done to make them as inconspicuous as possible even though, by this time all FELIX's transmissions took place well away from any habitation on Hans van Rensburg's other farm near Vryburg in the western Transvaal. The two 60 foot antenna masts, assembled in three sections, came down during daylight hours and were covered by vegetation. Then, at around midnight on the scheduled days, they were re-erected, the antenna pulled up, and FELIX's transmissions commenced and continued until around 3 am.

Signalling direct to Berlin carried on, very sporadically, for about a year. The messages enciphered by Sittig and Paasche, who had now joined his colleague, were mostly transmitted by Hans Thomas, a trained telegraphist. Berlin had expressed, again via the consulate in LM, their unqualified congratulations to FELIX on his achievement and, presumably spurred on by this, they agreed to reply to his messages by direct transmissions themselves. Sittig was quick to ask that all those messages be sent slowly because of the limited Morse code skills of Paasche and himself when Thomas was not around. The content of FELIX's messages was, in the main, very

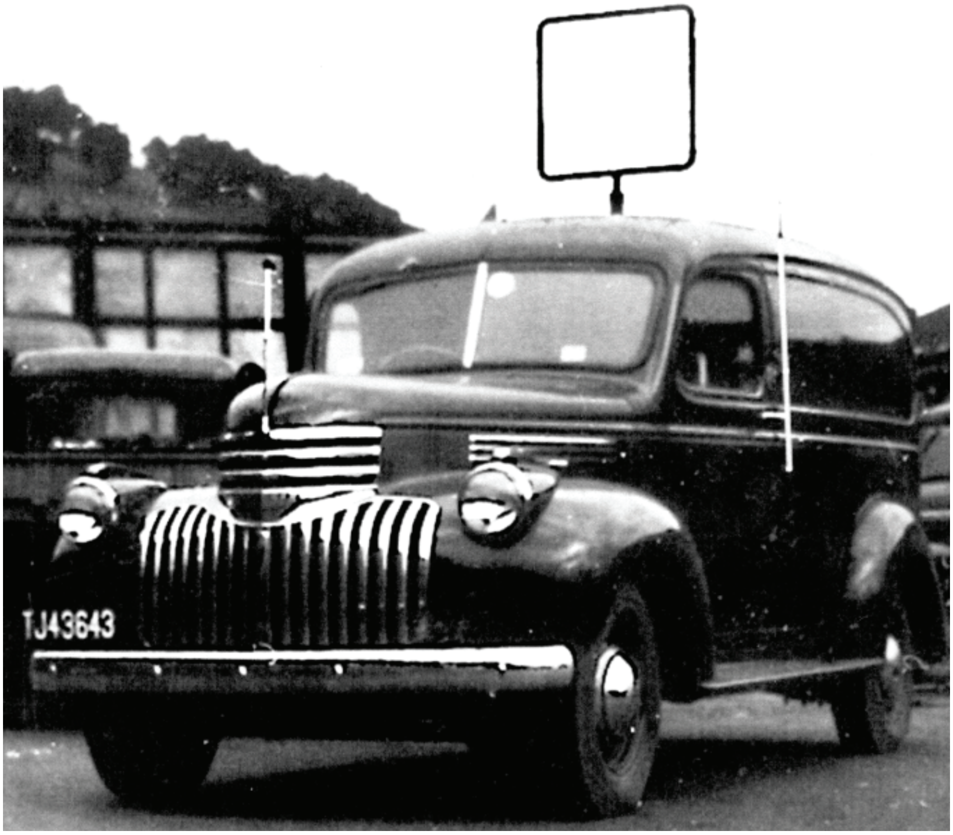


*Fig 4: A Price-Milne Organisation mobile direction-finding vehicle with its loop antenna.*

mundane. They consisted of extracts from fiery speeches by van Rensburg or shipping information, gleaned at the major ports, which was usually highly inaccurate and always out-of-date by the time it reached Vryburg, having been sent by post to van Rensburg in Pretoria for his approval before onward transmission to Berlin.

Once again the energy and initiative of Lothar Sittig came to the fore. Fully aware of the tardiness of the OB's Intelligence, he suggested to Berlin that he should be allowed to transmit directly to the U-boats when they surfaced at night to charge their batteries and communicate with their HQ. Unsurprisingly the Kriegsmarine gave this idea short shrift, but it was followed shortly after that by another one from Sittig. This time FELIX requested that a U-boat should enter St Francis Bay, near Port Elizabeth, where it would be met by an OB shore party who would take delivery of arms, ammunition as well as powerful radio transmitters. Moreover, then Sittig himself would return to Germany on the U-boat to brief the Abwehr on OB matters in South Africa. This suggestion caused the Germans to at least give it some serious consideration before deciding it was too risky. Of particular interest is that Sittig had warned Berlin that there existed around South Africa's coastline a means of detecting a surfaced submarine by its reflection of 'electric waves'. That, of course, was the network of radar stations operated by the Special Signals Service (SSS) of the army.

Unsurprisingly, the Royal Navy's Y Service had monitored all this radio traffic, and between them, the Navy, MI5 and SIS had been preparing, with the selective assistance of the UDF, a 'welcoming party' for the U-boat and its cargo had they ever arrived.

Remarkably, despite his numerous radio transmissions, FELIX was never apprehended even though the Royal Navy's radio direction finding (DF) stations had obtained many accurate bearings on his transmitter near Vryburg. The main reason for this was the South African Police, who would have been responsible for carrying out the raids to arrest Sittig and his co-conspirators, were severely compromised by the degree of infiltration of their ranks by the Ossewabrandwag. The second-in-command of the SAP, one Colonel 'Bill' Coetzee, was a known OB collaborator who harboured strongly-held anti-British views. Also, this degree of mistrust between the government of General Jan Smuts and his security forces even included sections of his military, the UDF.

This nest of vipers so close to the heart of government caused Smuts to request his scientific adviser, Dr H J van der Bijl, to commission the design of a radio direction-finding system that would remain completely independent of the SAP and UDF. The body that fulfilled this task became known as the Price-Milne Organisation after the two senior engineers from the Electricity Supply Commission and the Post Office who supervised their staff in the design and construction of highly secret fixed and mobile DF equipment for service across the country. (Fig 4) In 1943 the South African equipment came under the control of the Royal Navy in Simon's Town.

# Felix's Transmitter

continues from page 49


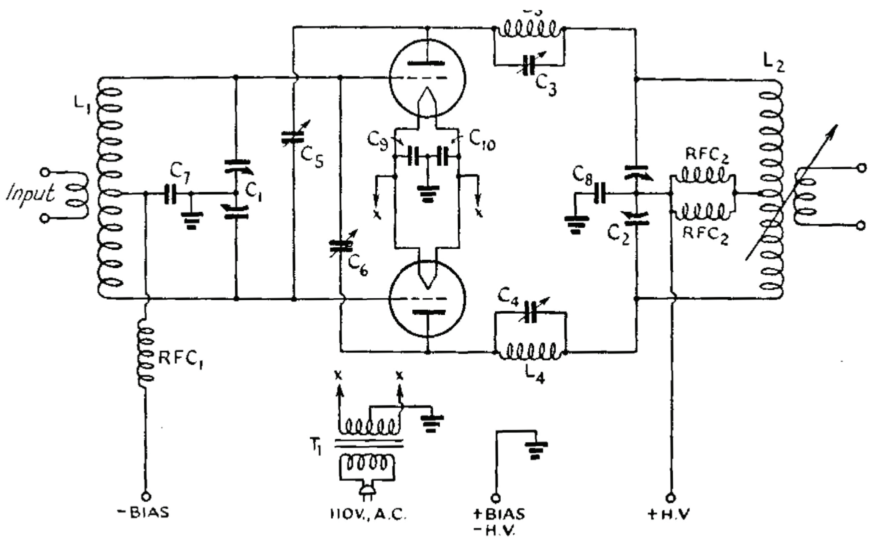


*Fig 5: A suggested circuit diagram of the power amplifier of FELIX's transmitter.*

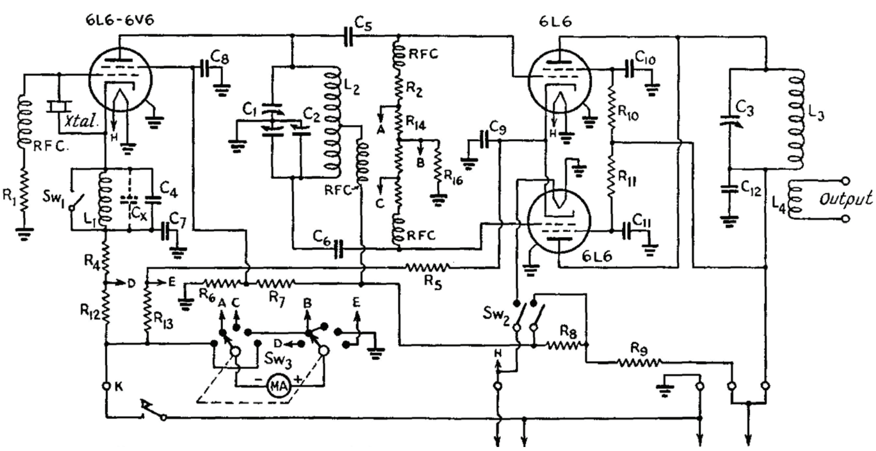


*Fig 6: A proposed circuit diagram of the CW exciter of the transmitter.*

There is no doubt that Reijer Groeneveld's transmitter which enabled FELIX to communicate directly with Berlin was a remarkable achievement. As such it deserves some special attention. The output power it produced can be estimated from the available power source: a 1HP petrol-fuelled motor and generator. After allowing for the primary power consumption of the five valves that made up the transmitter, and the efficiency of the Class C power amplifier stage, we estimate that the available output power was about 230 W (Fig 5). That final amplifier used the two Amperex P-150 triodes, obtained from the diathermy machine removed from the Bloemfontein hospital. From their specification, it is clear that the motor-generator set was the limiting factor and not the valves themselves: two HF-100s in push-pull were capable of 340W output from just 12 W of driving power from the CW exciter. The transmitter output is connected to the two insulated screw terminals visible on the left of the upper shelf. Two torch bulbs indicated the power output to the open-wire feedline to the dipole antenna.

The circuit diagram shows the link-coupled input-output configuration that Groeneveld used. It's of conventional design with cross-neutralisation to prevent the amplifier from going into self-oscillation. The two neutralising capacitors (C5 and C6), one immediately behind the other in the photograph, are worthy of attention because of the high voltage breakdown requirement they had to meet. Given the difficulty these OB renegades in South Africa would've had in obtaining components through the usual channels, Groeneveld resorted to an ingenious solution by constructing two capacitors from everyday items (see Fig 3).

He used the cylindrical metal containers intended for shaving soap (manufactured by Colgate) as the outer conductors of a pair of coaxial capacitors. The smaller, inner conductors were mounted on threaded shafts each of which screwed into a porcelain stand-off insulator. Removing the crocodile clip allowed the capacitance to be changed by merely screwing the inner cylinder in or out until neutralisation was obtained as indicated, in the usual way, by observing the meter monitoring the grids of the two valves. The small tuned circuit connected directly to the valve's anode terminal is one of two parasitic suppressors shown in the circuit diagram.

The CW exciter (Fig 6) was also conventional. It consisted of a crystal-controlled oscillator, using a 6L6 tetrode, driving a pair of 6L6s in push-pull. The output tuned-circuit is made up of the large inductor on the right of the PA valves with its associated variable capacitor (and calibrated scale) on the panel below. If needs be the oscillator and the two push-


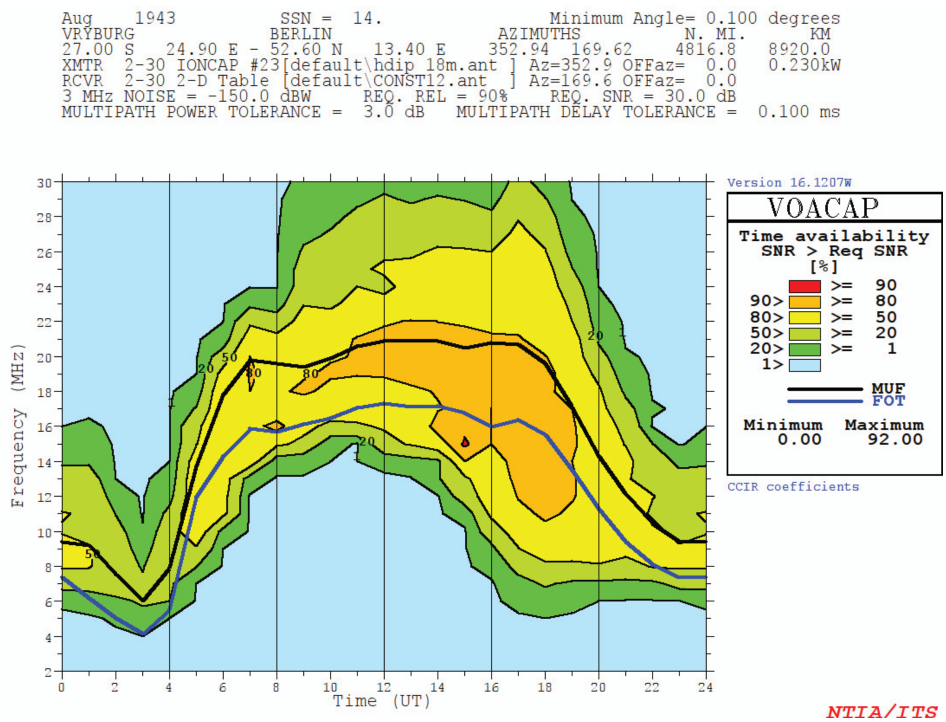


*Fig 7: The VOACAP prediction for August 1943 of the Vryburg – Berlin path.*

pull 6L6s could operate as frequency doublers thereby allowing a single third-overtone crystal to produce output on three different frequencies. Though FELIX only worked on one frequency (7.2 MHz), his transmitter allowed for some frequency agility if suitable crystals were to hand. From the available transcripts of the radio traffic between himself and Germany it is clear that he requested Berlin to use a U-Boat to smuggle suitable crystals to him but, as we have seen, none of those ventures ever took place. The success of his long-haul links between Vryburg and Berlin were always at the mercy of the ionosphere. During the period of two years, from mid-1942 when FELIX was active, the sunspot cycle was in decline, reaching its nadir around January 1944. As a result, the critical frequency of the F region – the most important one for long-haul circuits – was very low and this necessitated the careful selection of frequencies to establish and maintain contact over the nearly 9000 km path between Vryburg and Berlin. Given the need for absolute secrecy, FELIX never transmitted during daylight when his two 18m poles supporting the antenna would've been far too visible. As described above, those two poles, plus the centre-fed dipole between them, only went aloft after midnight on the three days of the week when he was at his transmitter, and they came down again before sunrise. His use of the 41.6m wavelength, a figure frequently mentioned in numerous FELIX-related files in the files at The National Archives in London, was reasonably close to the FOT (the optimum traffic frequency) for that path over some of that period. Analysis of the propagation using a sophisticated piece of software, known as VOACAP, (Fig 7) enabled us to assess the reliability of CW communication from Vryburg to Berlin. From the VOACAP predictions, it is clear that, for a limited signal-to-noise ratio of 30 dBHz for CW communications, the mean value of the reliability of the propagation path, expressed as time availability, was around 44%. In other words, if FELIX transmitted, typically, on twelve days per month, he was likely to have been received in Germany on around five of them. A similarly dedicated (though less numerically accurate) examination of the detailed MI5/MI6 records in the London archives suggests that this is probably not too wide of the mark. At best FELIX's success rate could be described as marginal; his radio communications were sporadic. However, none of that diminishes the achievement which was remarkable. wn

## ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance we received from Dr Evert Kleynhans, late of the OB archive at NWU in Potchefstroom; Mrs Riana Mulder, archivist at the Voortrekker Monument in Pretoria; the British National Archives at Kew, Mr Dirk Vermeulen and the SAIEE for permission to quote from relevant documents and to use photographs from their collections and publications.

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# Periodic Table – 150 Years

The familiar periodic table of chemical elements, which can be seen as a wall poster in every science classroom, celebrated its 150th anniversary on 17 February 2019.

The United Nations has declared 2019 the International Year of the Periodic Table.

The original idea that matter consists of elementary indivisible particles comes to us from pre-Socratic Greek philosopher Democritus (c460-370 BC). He named them a-tom meaning *'that which cannot be cut'.*

**BY** | DUDLEY BASSON

Many elements have been known since ancient times. However, there was no distinction made between elements and compounds.

Copper has been in use since 9000 BC. Originally obtained as a native metal but later obtained by smelting. Evidence of copper smelting has been found in the Rudnik mountains of Serbia dating from 5000 BC. Copper was an essential metal available at the time.

In the Roman era, copper was mined on Cyprus and named aes cyprium (metal of Cyprus). This became cuprum in Latin and later copper in English. Copper is one of the few metals that can be found naturally in metallic form.

Lead, obtained by smelting ore, has been in use since 7000 BC. An Egyptian lead artefact dating from 3800 BC has been found. Roman lead water pipes can still be seen in Pompeii.

Gold has been in use before 6000 BC. This was obtained from nuggets. A golden treasure was found dating from before 4200 BC at the Varna Necropolis in Bulgaria.

Silver and iron have been in use from before 5000 BC. Iron was initially obtained from meteorites. The smelting of iron was discovered at about 3000 BC which led to the start of the Iron Age in 1200 BC.

Carbon has been in use since 3750 BC and


used as charcoal in the smelting of copper, tin and zinc ores in the manufacture of bronze by the Egyptians and Sumerians.

Sulphur has been in use from before 200 BC. This abundant element was readily obtainable in volcanic areas. Mercury was known from before 2000 BC by the Chinese, Indians and Egyptians. Antimony and Arsenic have been known from before 200 BC.

The recorded discovery of elements started in 1669 with phosphorus by H Brand, and Cobalt in 1735 by G Brandt. Phosphorus was initially obtained from urine.

Platinum was found in South American gold in 1557 but was only first referred to as a new metal in 1750 by William Brownrigg. Nickel and Bismuth followed.

Henry Cavendish FRS (1731-1810) was the first scientist to distinguish hydrogen from other gases and named it "inflammable air". He demonstrated the production of water by burning inflammable air (hydrogen) in dephlogisticated air (oxygen). He concluded that dephlogisticated air was dephlogisticated water and that hydrogen was either pure phlogiston or phlogisticated water, but it was Lavoisier who named hydrogen and oxygen in 1783. Cavendish found that there was a minimal unaccounted component of air – this was later found to be argon. Scottish inventor James Watt published a paper on the composition of Water in 1783.

Daniel Rutherford FRS (1749-1819), discovered Nitrogen in 1772 while studying at the University of Edinburgh. Lavoisier named it in 1775.

These discoveries were followed by Barium 1772, Chlorine 1774, Manganese 1774, Molybdenum 1778, Tungsten 1781 and Tellurium 1787.

Thorium was discovered in 1829 by Norwegian amateur mineralogist Morten Thrane Esmark and identified by Swedish chemist Jöns Jacob Berzelius.

It is about three times as abundant as uranium, is weakly radioactive, and like uranium has a half-life of about the age of the universe.

# Periodic Table - 150 years

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Sir Humphrey Davy (1778-1829), who employed the young Michael Faraday, made huge advances, using electrochemical methods in the identification of elements. He discovered potassium, sodium, calcium, strontium, barium, magnesium and boron. He also identified chlorine and iodine as elements. He joked that his most significant discovery was Michael Faraday.

Antoine-Laurent Lavoisier (1743-1794), a French nobleman and chemist had a significant influence on both the history of chemistry and the history of biology.

He is widely considered as the father of modern chemistry. Lavoisier is noted for his discovery of the role oxygen plays in combustion. He recognised and named oxygen (acid maker) and hydrogen (water maker). Oxygen is poorly described as the acid maker but to rename this gas would now be unthinkable.

Lavoisier helped construct the metric system and wrote the first extensive list of elements and helped to reform chemical nomenclature. He predicted the existence of silicon and was the first to determine that sulphur was an element. He discovered, using precise quantitative methods, that matter retained its mass despite changes in its form or shape.

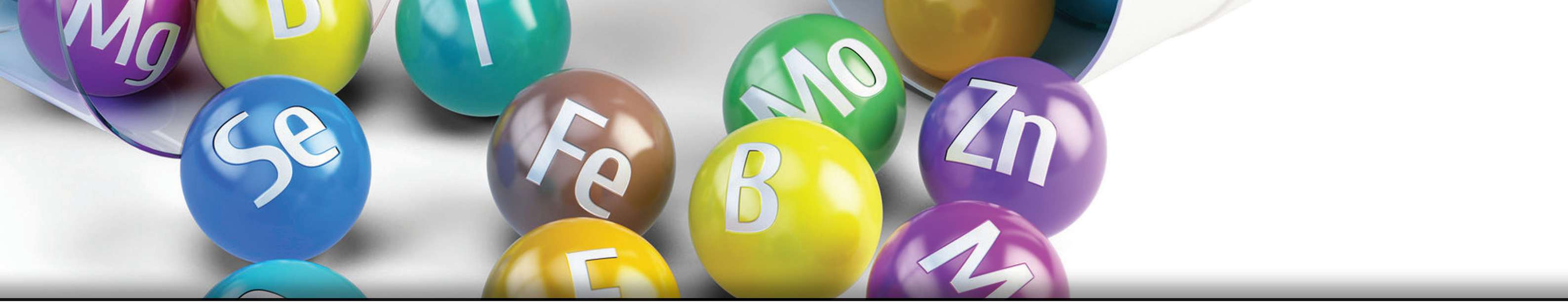
Lavoisier was an influential member of many aristocratic councils and an administrator of the Ferme Générale, a tax farming financial company which advanced the estimated tax revenue to the government in return for the right to collect taxes.

Lavoisier dedicated a significant portion of his private fortune and worked toward benefitting the public, concerning himself with improving the livelihood of the population by agriculture, industry and the sciences. In 1765 he submitted an essay on improving urban street lighting to the French Academy of Sciences for which the King awarded him a gold medal.

*Double portrait of Lavoisier and his wife Marie-Anne Pierrette Paulze by Jacques-Louis David.*

In 1771, aged 28, Lavoisier married Marie-Anne Pierrette Paulze who was able to assist him in his work by translating the work of the English scientists, notably Joseph Priestley and also helping in the laboratory.

In 1788 the famous artist Jacques-Louis



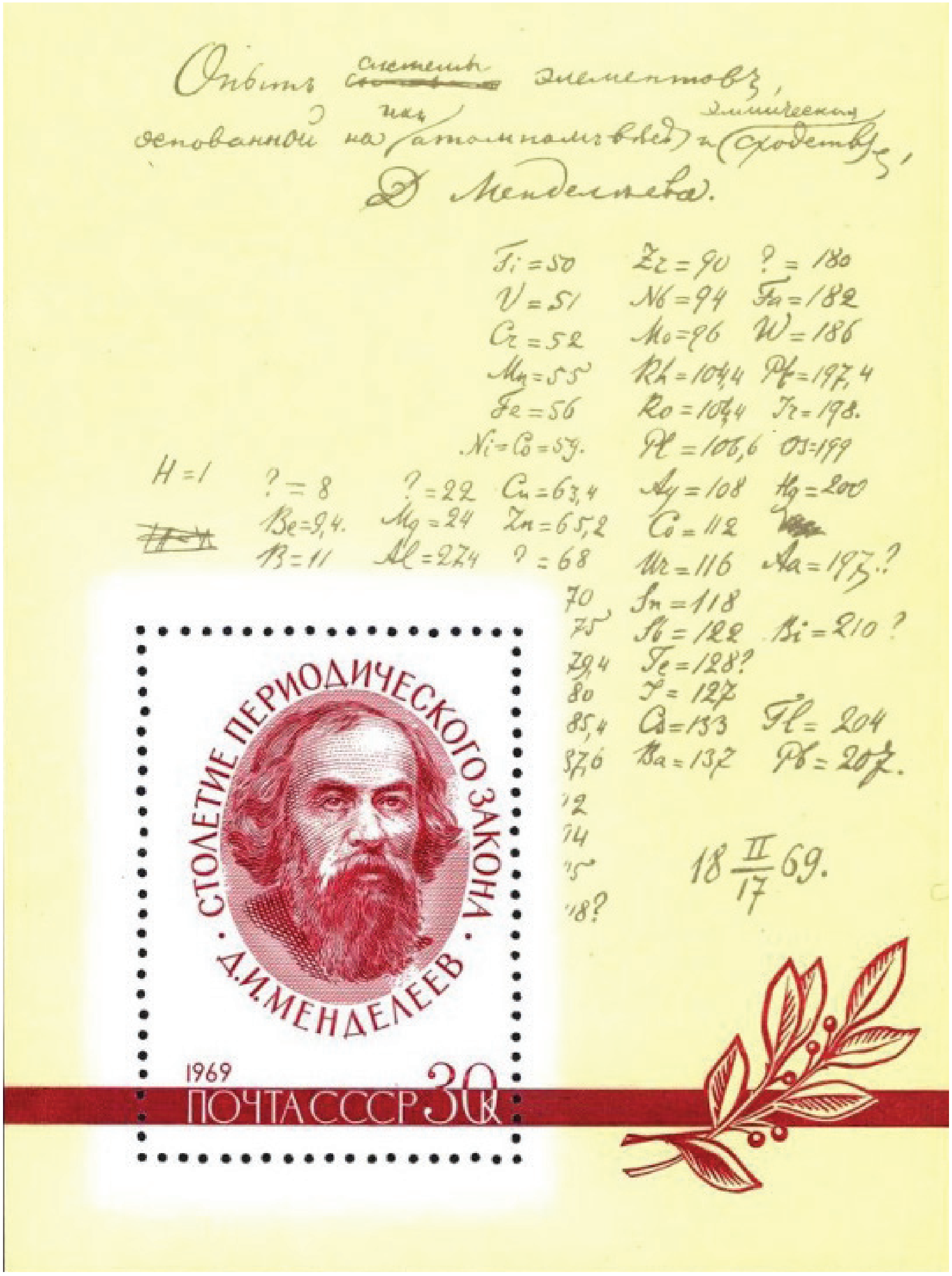

David painted a double portrait of Lavoisier and his wife. David produced a vast output of magnificent work, before the revolution, during the revolution and then during the Napoleonic period. Much of his work was of historical subjects.

Europe had come through the Age of Reason, and the Age of Enlightenment and civilisation seemed at its brilliant best. Lagrange (1736-1813) had made distinguished contributions to mathematics. Fourier (1768-1830) was about to give the world his Fourier series and would also make an ink impression of the Rosetta Stone to assist Champollion in deciphering the Egyptian hieroglyphics. Pierre-Simon Marquis de Laplace (1749-1827) had developed the differential equation Laplace Transform and Gauss (1777-1855), known as 'The prince of mathematicians', had made his huge contributions to mathematics and science.

Carnot (1796-1831) was about to make a huge contribution to thermodynamics and Beethoven (1770-1827) was a young man of towering musical genius. Bach (1685-1750) had left the world a huge timeless treasure of music and The Bernoullis and Euler (1707-1783) had left the world a huge mathematical legacy and also the exquisite beauty of complex number algebra.

Rembrandt (1606-1669) had painted his 'Night Watch' more than a century before in 1640 where Newton (1643-1727) and Leibniz (1646-1716) gave the world calculus, which would become of inestimable value to modern science and engineering.

With the start of the French Revolution in 1789, civilisation in France seemed




*A commemorative stamp collector's miniature sheet showing some of Mendeleev's original notes. Horizontal lines like Cr, Mo and W (in the third tow down) correspond to today's groups. Note the date, 17 February 1869.*

to gradually collapse until it all but disappeared in the Reign of Terror. The revolutionaries were determined to make a complete break with the *Ancien Régime*. The Monarchy was violently overthrown and the French aristocracy targeted. The revolutionaries even tried to introduce a new calendar and time system and the public was told to address one another as 'citizen' instead of Monsieur or Madame. Place and street names were changed which added to the confusion. There was

# Periodic Table - 150 years

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even talk of demolishing the cathedrals but fortunately, sanity prevailed.

On 24 November 1793 Lavoisier and 27 tax farmers were arrested. Lavoisier was falsely charged with using government money for his scientific work and adulterating the supply of tobacco. On 8 May 1794, Lavoisier and his 27 co-defendants were given a short trial and guillotined on the same day. The 'judge' remarked that the course of justice must not be slowed and that the Republic had no need of scientists.

Dmitri Ivanovich Mendeleev (1834-1907) was a Russian chemist and inventor. He formulated the Periodic Law which states that if the chemical elements are listed in order of increasing atomic number, many of their properties go through cyclical changes, with elements of similar properties recurring at intervals, as can be seen with lithium, sodium, potassium and caesium. He created a farsighted version of the periodic table of elements and used it to correct the properties of some already discovered elements and also to predict the properties of eight elements yet to be discovered.

No theoretical explanation for the Periodic Law was available, and it was used only as an empirical principle, but, with the development of quantum mechanics, it became possible to understand the theoretical basis for the Periodic Law.

The periodic recurrence of elements with similar physical and chemical properties, when the elements are listed in order of increasing atomic number, results directly from the periodic recurrence of similar electronic configurations in the outer shells of respective atoms.

In 1863 there were 56 known elements with a new element being discovered at a rate of approximately one per year.

Mendeleev developed his extended version of the periodic table on 6 March 1869 and made a formal presentation to the Russian Chemical Society, titled *The Dependence between the Properties of the Atomic Weights of the Elements.*

For his predicted eight new elements, he used the prefixes eka, dvi and tri – the Sanskrit words for one, two and three. Adding the eka prefix to an element would place it one period position lower in the table so that the name eka-aluminium would denote gallium and eka-silicon would denote germanium.

The discovery of the Periodic Law constitutes one of the most critical events in the history of chemical science.

Scientific organisations all over Europe widely honoured Mendeleev, and in 1882, he was awarded the Davy Medal by the Royal Society of London.

Mendeleev investigated the composition of petroleum and helped found the first oil refinery in Russia. He recognised the importance of petroleum as a feedstock for petrochemicals. He is credited with a remark that burning petroleum as a fuel *"would be akin to firing up a kitchen stove with banknotes".*

In 1905, Mendeleev was elected as a member of the Royal Swedish Academy of Sciences. The following year the Nobel Committee for Chemistry recommended to the Academy to award the Nobel Prize in Chemistry for 1906 to Mendeleev for his discovery of the periodic system. Dissenting members, unfortunately, thwarted this.

The Periodic Table is now complete showing all elements from 1 to 118. Elements from 109 to 118 cannot occur in nature as these are incredibly radioactive and have very short half-lives. These are produced in tiny quantities by bombarding various atoms with other atoms.

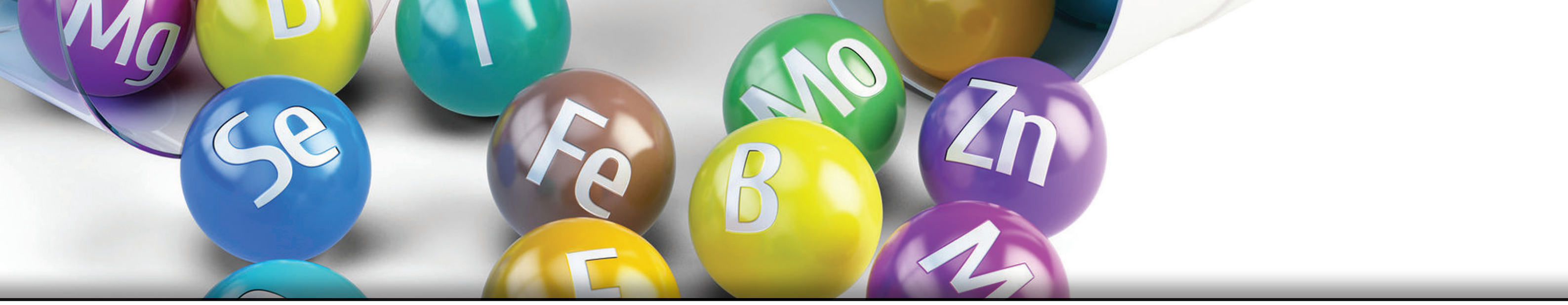
The existence of isotopes was first suggested by radiochemist Frederick Soddy in 1913 studying decay chains. He found about 40 species of radioelements between uranium and lead although the periodic table allowed for only 11 elements in this range. Isotopes are elements which differ in the number of neutrons in an atom. The term isotope is formed from the Greek 'isos' and 'topos' meaning 'same place' indicating that they occupy the same place in the periodic table.

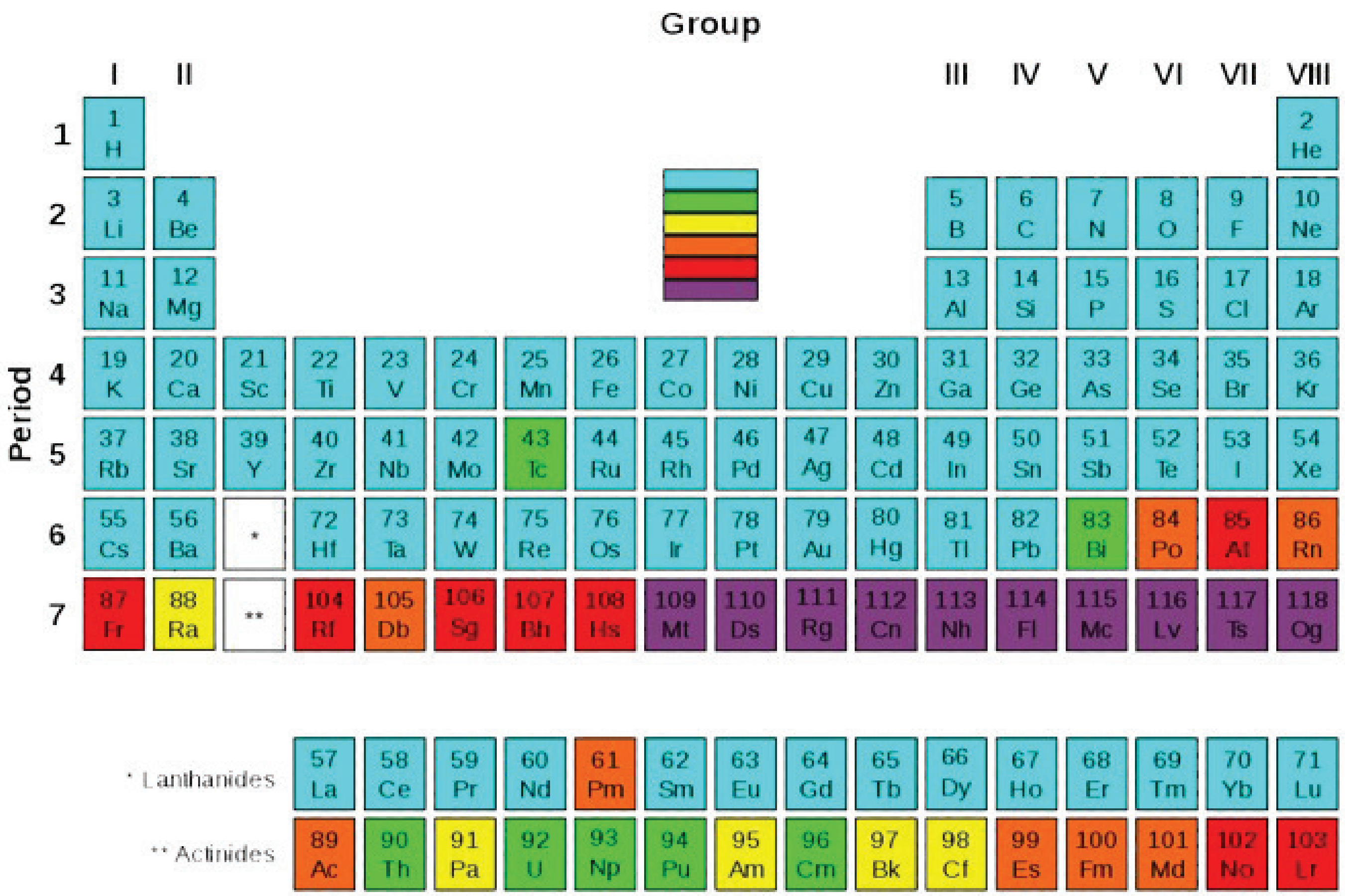
This is how the Periodic Table would appear with the lanthanides and actinides included - see table 1.

The study of the electron orbitals and chemical valences is a complicated matter. Cells of the table usually contain an atomic number, chemical symbol and atomic weight.

Other designs have also been devised which include a circular pattern, another with a spiral design and one with squishy cells denoting the relative abundance of the elements. One design looks like a map of the London underground.

Most of the recent work on the periodic table has been on period 7 where all of the missing elements have been added and






*Periodic table with elements colour coded according to the half-life of their most stable isotope*

| | |
|---|---|
| | Elements that contain at least one stable isotope |
| | Radioactive elements with most stable isotope with a half-life of over 4 million years |
| | Radioactive elements with most stable isotope with a half-life from 800 to 34 000 years |
| | Radioactive elements with most stable isotope with a half-life from 1 day to 800 years |
| | Highly radioactive elements with a half-life from several minutes to one day |
| | Extremely radioactive elements with most stable isotopes with half-lives of less than several minutes |

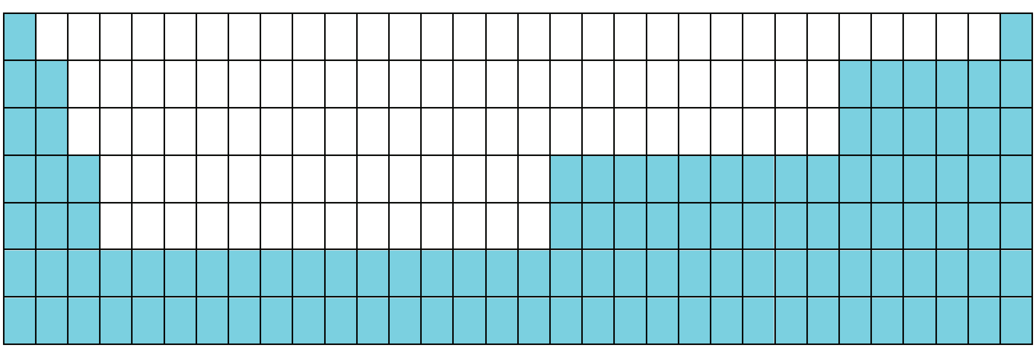


*Table 1*

# Periodic Table - 150 years

continues from page 57

some renamed. Some of the undiscovered elements had been given temporary numerically derived names: element 115 was named ununpentium (one one five) and 118 was named ununoctium (one one eight). There is no definite reason to stop the table at 118, but it seems likely that further elements would be too unstable to bother with.

Period 7 is given here with the discovery dates and the actinide series included as seen in Table 2.

Click the arrowhead to get it going.

The elements have been set to the famous can-can tune from Offenbach's "Orpheus in the Underworld".

Singer-songwriter, satirist, pianist and mathematician Tom Lehrer set the elements to the tune of the Major-General's song from the Gilbert and Sullivan comic opera "The Pirates of Penzance".

Tom Lehrer can be seen singing this himself while vamping at the piano at: [https://www.youtube.com/watch?v=AcS3NOQnsQM](https://www.youtube.com/watch?v=AcS3NOQnsQM)

An original performance of the Major-General's song can be seen at [https://www.youtube.com/watch?v=Rs3dPaz9nAo](https://www.youtube.com/watch?v=Rs3dPaz9nAo)

This is frivolous entertainment from a bygone age.

| | | |
|---|---|---|
| 87 Fr Francium 1939 | 98 Cf Californium 1950 | 109 Mt Meitnerium 1982 |
| 88 Ra Radium 1898 | 99 Es Einsteinium 1952 | 110 Ds Darmstadtium 1994 |
| 89 Ac Actinium1902 | 100 Fm Fermium 1952 | 111 Rg Roentgenium 1994 |
| 90 Th Thorium 1828 | 101 Md Mendelevium 1955 | 112 Cn Copernicium 1996 |
| 91 Pa Protactinium 1913 | 102 No Nobelium 1966 | 113 Nh Nihonium 2003-2004 |
| 92 U Uranium 1789 | 103 Lr Lawrencium 1961 | 114 Fl Flerovium 1999 |
| 93 Np Neptunium 1940 | 104 Rf Rutherfordium 1969 | 115 Mc Moscovium 200 |
| 94 Pu Plutonium 1941 | 105 Db Dubnium 1970 | 116 Lv Livermorium 2000 |
| 95 Am Americium 1944 | 106 Sg Seaborgium 1974 | 117 Ts Tennessine 2009 |
| 96 Cm Curium 194 | 107 Bh Bohrium 1981 | 118 Og Organesson 2002 |
| 97 Bk Berkelium 1949 | 108 Hs Hassium 1984 | |

*Table 2*

The naming of the elements seems to have happened haphazardly. Many are named after places, others after planets and mythical deities, fifteen are named after scientists of whom only two were women - Marie Curie and Lise Meitner.

The chemical symbols of the elements are abbreviations of the element names, with some of these are abbreviations of the Latin names. Wolfram is not a Latin name but has been included - see table 3.

A musical setting of the periodic table can be seen at: [https://thekidshouldseethis.com/post/50916289643](https://thekidshouldseethis.com/post/50916289643)

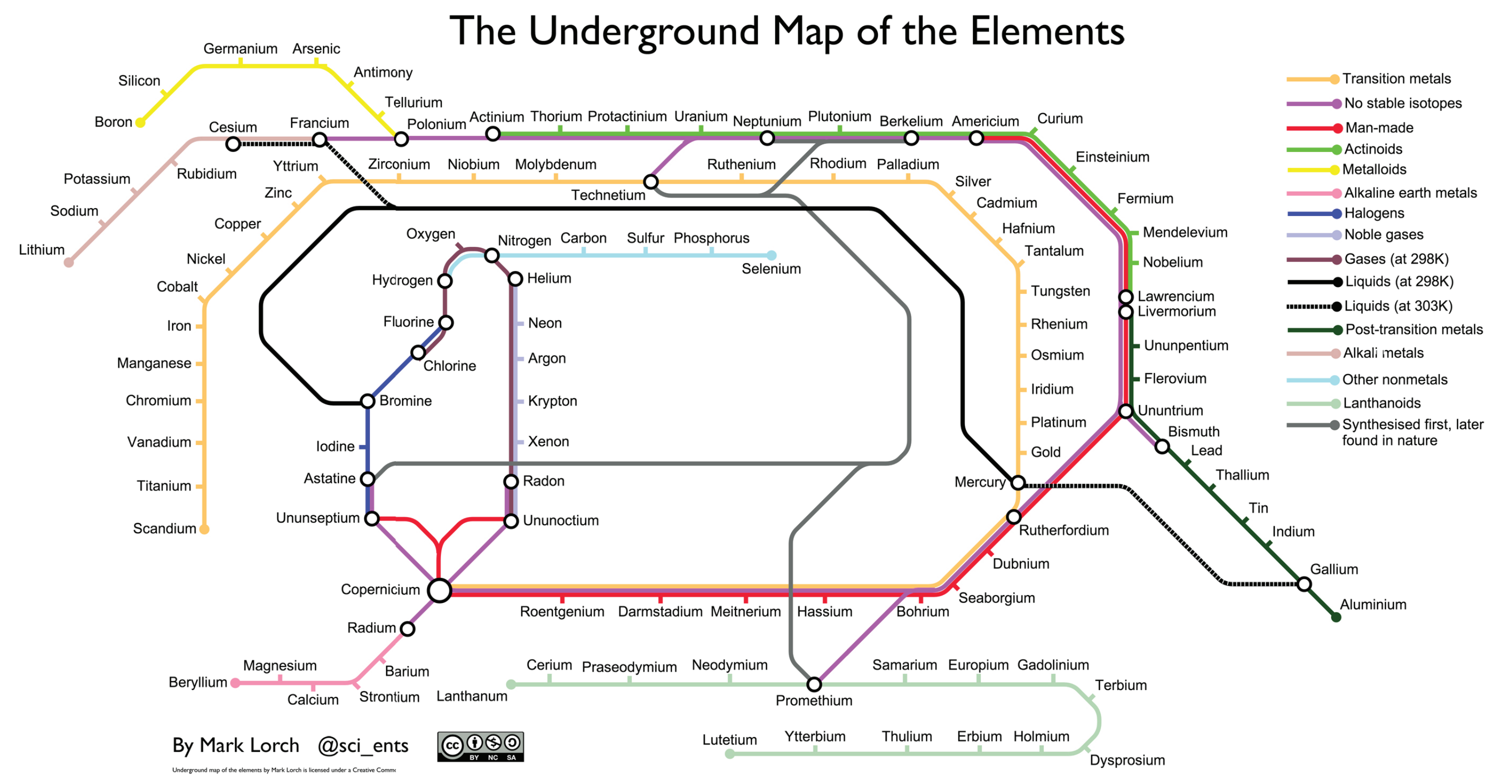
| ELEMENT | LATIN NAME | SYMBOL |
|---|---|---|
| Antimony | Stibium | Sb |
| Copper | Cuprum | Cu |
| Gold | Aurum | Au |
| Iron | Ferrum | Fe |
| Lead | Plumbum | Pb |
| Mercury | Hydragyrum | Hg |
| Potassium | Kalium | K |
| Silver | Argentum | Ag |
| Sodium | Natrium | Na |
| Tin | Stannum | Sn |
| Tungsten | Wolfram | W |

*Table 3*

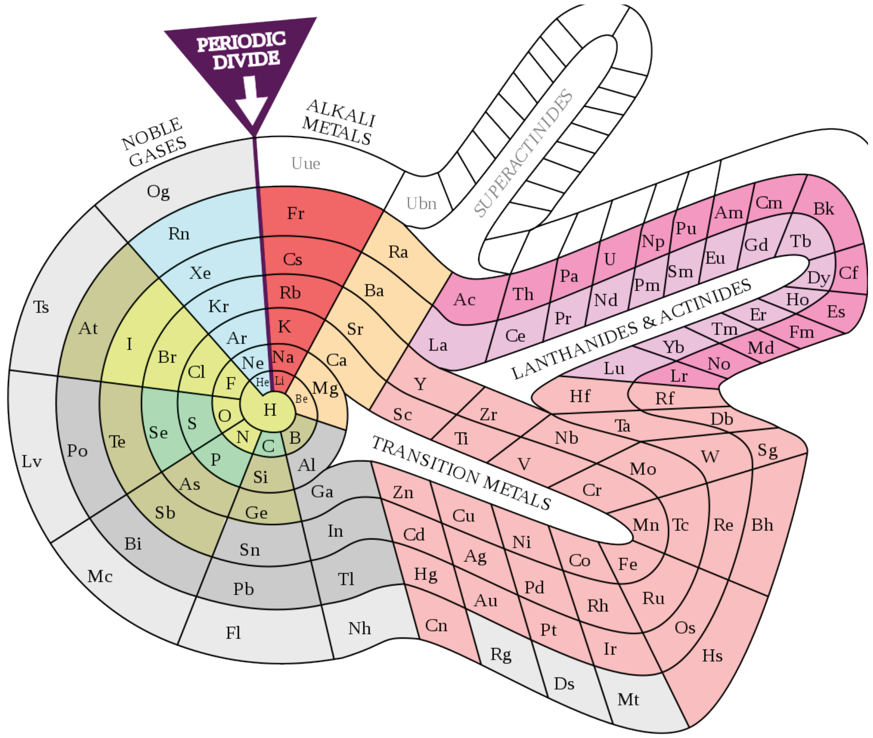
Tom Lehrer must not be confused with Alan Jay Lerner who, with Frederick Loewe, wrote the libretto for Shaw's famous play 'Pygmalion' as the musical stage performance and movie *"My Fair Lady"*.

The chemical periodic table is now complete, but this is by no means the end of the atomic structure. The chemical atoms are not the ultimate particles, and neither are protons and neutrons.

The discovery of radioactivity by Antoine Henri Becquerel (1852-1908) in 1896, and elaborated on by Marie and Pierre Curie, indicated that atoms had internal structure.


*Underground version of the Periodic Table, but where are the Piccadilly and Bakerloo lines?*




*Spiral version of the Periodic Table with an extension into period 8*

Becquerel and the Curies were awarded the 1903 Nobel Prize in physics for this work. The 1897 work on cathode rays by Sir Joseph John Thomson, identified electrons, charged particles much smaller than the hydrogen atom.

This opened up the vast world of subatomic physics. wn

# Our Expert Answers

*Information provided by Zest WEG Group*

In most mining and industrial construction projects, the Electrical, Instrumentation & Control contractor(E&IC) is always last on the project site. Ideally, the E&IC work should commence only once the bulk earthworks, civil construction and mechanical and piping erection have been completed. In practice, due to delays in all the other disciplines, all project float would have been consumed, and the majority of the E&IC scope would, therefore, be on the critical path.

This situation is very often aggravated by the preceding contractors still being on site, completing tasks upon which the E&IC contractor relies to commence their work. The E&IC contractor is therefore under considerable pressure to meet tight deadlines right from the start. This makes the overriding question how do you get the most from your E&IC contractor.

## QUESTION ONE:

What sort of contract should be used?

## ANSWER ONE :

A standard NEC or FIDIC contract is preferable. The only fundamental change which may be necessary is to reduce the notification turnaround requirements. Legal teams will spend a great deal of time modifying standard contracts trying to ensure their clients' interests are protected, but invariably disputes arise around two issues – either the E&IC contractor falls behind due to factors both in and out of their control, and/or the client does not honour the payment obligations. These issues of principle are very seldom affected by complicated amendments to standard contract wordings. Standard contracts are internationally understood, and impartial third party mediators/arbitrators are readily available. It is also less costly for both parties to have their project governed by standard wording.

## QUESTION TWO :

How do I ensure a harmonious multi-disciplinary workforce?

## ANSWER TWO :

Different disciplines belong to different bargaining councils. The most important consequence of this is the different rates paid to the general worker. The skilled workers will have different job descriptions, and are generally not a problem.

A Project Labour Agreement (PLA) should be in place at the start of the project to ensure that basic labour rates are set. To avoid labour pay difficulties on site towards the end of the project, codes of conduct defined and pay weekends agreed. In general, bargaining council agreements will recognise the significant provisions of properly constituted PLA's.

## QUESTION THREE :

What is the essential information required by the E&IC contractor before site establishment?

## ANSWER THREE :

At this stage of the project, all E&IC design work should be complete to allow the E&IC contractor to perform material take-offs to be able to procure materials and plan site deliveries. A full set of Approved For Construction (AFC) drawings should be issued well in advance of planned site establishment. This will allow for sufficient time to resolve ambiguities and technical queries. The design pack will also let the contractor to timeously compile and test their quality assurance plan and check sheets.

Where procurement is done in piecemeal fashion, late design information will delay this process, which can result in additional supply and transport costs. End user site requirements for training, induction and medical assessments are also crucial to allow the E&IC to implement the personnel plan.

## QUESTION FOUR :

When should the E&IC contractor access site?

## ANSWER FOUR :

The client should endeavour only to bring the E&IC contractor to the site when there are sufficient work fronts available with full safe access to justify the E&IC mobilising. The contractor would have priced the work assuming full secure access unless partial access was specified at the tender stage.

When multiple contractors are expected to share access to work fronts, the project loses efficiency in various disciplines. It is therefore in the best interests of the overall project progress to allow preceding contractors to complete work fronts before the next contractor is given access. It is quicker to catch up lost time when a contractor has unrestricted access to a working front and can deploy a full team.

## QUESTION FIVE:

How should ad-hoc tasks be delegated?

## ANSWER FIVE:

Additional tasks inevitably arise, which fall outside the defined contractor scope. These are best handled by a dedicated ad-hoc works team, so as not to disrupt the main workforce which will be working to meet the deadlines in the agreed schedule. Clients are often guilty of issuing instructions directly to the contractor's employees, mainly when there is a perceived urgency. This, however, effectively compromises the control of the contractor's supervisory staff, and is often a cause of programme slippage. It is difficult to hold a contractor accountable for delays if the client interferes with the contractor's chain of command.

## QUESTION SIX :

How should free issue equipment be managed?

## ANSWER SIX:

Where the contractor is engaged to provide installation only, the client must give suitable stores from which the E&IC contractor draws daily requirements. The E&IC contractor cannot be expected to maintain a store if they do not get the benefit of supplying materials.

# February in History

The Roman month Februarius was named after the Latin term februum, which means purification, via the purification ritual Februa held on February 15 (full moon) in the old lunar Roman calendar. ... These days do not correspond to the modern Gregorian calendar.

**COMPILED BY I**
JANE BUISSON-STREET
FSAIEE I PMIITPSA I FMIITSPA

## 1 FEBRUARY

1957 Felix Wankel's first working prototype DKM 54 of the Wankel engine started up in Germany. The Wankel engine is more commonly referred to as the "rotary engine", because it is the most successful design of such an engine, although other engines are also considered rotary. The most common use of the Wankel engine was by Mazda in their RX series of cars.

## 2 FEBRUARY

1536 Pedro de Mendoza founded the Argentine city of Buenos Aires.

## 3 FEBRUARY

1947 As Snag, Yukon, locals stepped outside on that day, their breath hissed as it froze mid-air before falling to the ground as white dust. It was -62.8 C in the tiny village — the coldest day in Canadian history.

## 4 FEBRUARY

1922 The Ford Motor Company acquired the failing luxury automaker Lincoln Motor Company for $8 million. The acquisition came at a time when Ford, founded in 1903, was losing market share to its competitor General Motors, which offered a range of automobiles while Ford continued to focus on its practical Model T.

## 5 FEBRUARY

1996 British supermarket chains started stocking genetically modified tomato puree - the first GM food to be sold in the United Kingdom.

## 6 FEBRUARY

1935 The Parker Brothers began selling the game, "Monopoly," which is now a global pastime.


## 7 FEBRUARY

1956 Doug Ross presented a paper on gestalt programming at the Western Joint Computer Conference in Los Angeles. Ross had experimented with the programming while working for the Air Force and Emerson Electric Co. The purpose of a Gestalt system is to facilitate the transmission of general ideas as in a conversation, between a human and a computer, so that the maximum use of their respective capabilities can be made.

## 8 FEBRUARY

1945 C.D Lake, H.H. Aiken, F.E. Hamilton, and B.M. Durfee file a calculator patent for the Automatic Sequence Control Calculator, commonly known as the Harvard Mark I. The Mark I was a large automatic digital computer that could perform the four essential arithmetic functions and handle 23 decimal places. A multiplication took about five seconds.

## 9 FEBRUARY

1969 The Boeing 747-100 jumbo jet took to the sky for the very first time. Currently the 747s, after 50 years in the air, is being taken off commercial passenger routes and being repurposed as cargo planes.

## 10 FEBRUARY

1942 The Glenn Miller Orchestra was awarded the 1st ever gold record for selling 1 million copies of "Chattanooga Choo Choo."

## 11 FEBRUARY

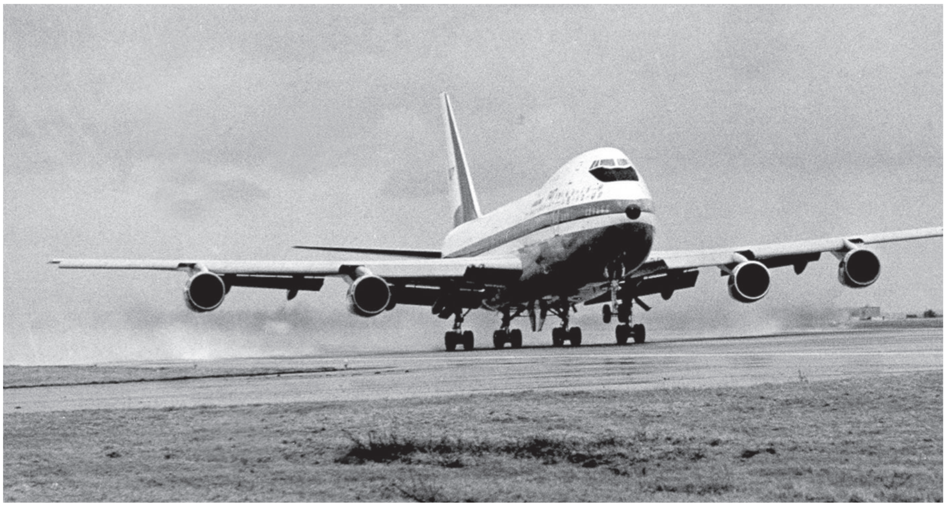
1826 University College London (UCL) was founded, under the name London University, as a secular alternative to the strictly religious universities of Oxford and Cambridge. It was established with the intention from the beginning of it being a university, not a college or institute. However, its founders encountered strong opposition from the Church of England, the existing universities and the medical schools which prevented them from securing the Royal Charter under the title of "university" that would grant "London University" official recognition and allow it to award degrees. It was not until 1836 when the latter-day University of London was established that it was legally recognised (as a college, under the name of University College, London) and granted the authority to submit students for the degree examinations of the University of London.

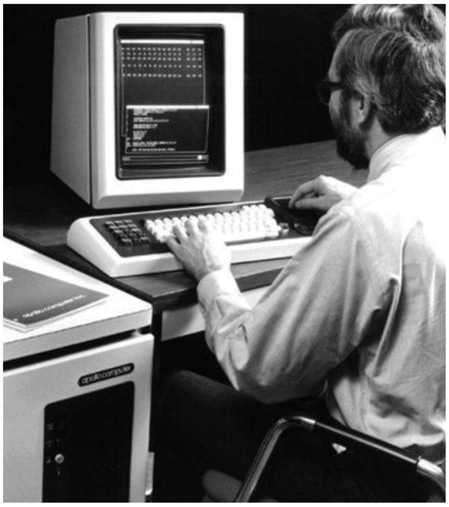
## 12 FEBRUARY

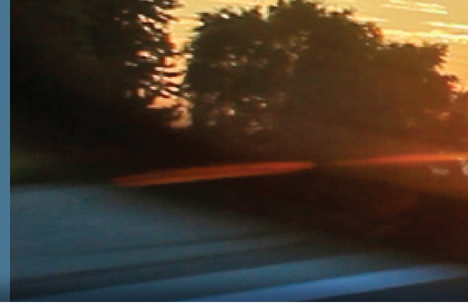
1965 The Gateway Arch, a 192 m monument in St. Louis, Missouri, United States. Clad in stainless steel and built in the form of a weighted catenary arch, it is the world's tallest arch, the tallest man-made monument in the Western Hemisphere, and Missouri's tallest accessible building. Built as a monument to the 'westward expansion of the United States,' and officially dedicated to "the American people," the Arch, commonly referred to as "The Gateway to the West" is the centrepiece of the Gateway Arch National Park and has become an internationally recognized symbol of St. Louis, as well as a popular tourist destination.

## 13 FEBRUARY

1980 Apollo Computer was incorporated in Chelmsford, Massachusetts, UDA. Apollo was used to create the original workstations: small but powerful computers mostly used for engineering. In 1989, Hewlett-Packard Company acquired Apollo in a $476 million deal.







# February in History

continues from page 63

## 14 FEBRUARY

1929 The first report on penicillin's medicinal properties were published. Sir Alexander Fleming's famously accidentally discovered penicillin after leaving a Petri dish out for too long. On this date, he released his report about his findings regarding the mould and its potential medical use.

## 15 FEBRUARY

1971 This became known as the "Decimal Day" in the United Kingdom, the British currency was brought onto the base 10 system. Before this date, one British pound was made up of 240 pence (20 shillings) which made it difficult for those who didn't grow up in the system to calculate exact change.

## 16 FEBRUARY

1937 Dupont patented a new thread, nylon, which replaced silk in many products and thereby reduced costs.

## 17 FEBRUARY

1869 Dmitri Mendeleev (Russia) cancelled a planned visit to a factory and stayed at home to work on the problem of how to arrange the chemical elements in a systematic way. To start, he wrote each element and its main properties on a separate card and arranged these in various patterns. Eventually, he achieved a layout that suited him and copied it down on paper. Later that same day he decided a better arrangement by properties was possible and made a copy of that, which had similar elements grouped in vertical columns, unlike his first table, which bundled them horizontally. These historical documents still exist and mark the beginning of the form of the Periodic Table as commonly used today.

## 18 FEBRUARY

1911 Frenchman Henri Pequet made the first official airmail delivery from Allahabad, British India.

## 19 FEBRUARY

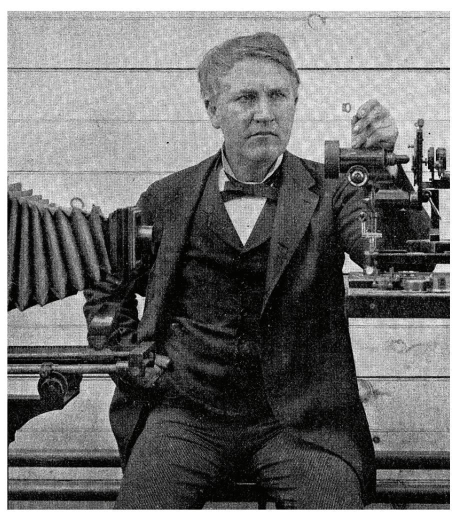
2019 2019's largest supermoon will be visible; a supermoon is a new or full moon closely coinciding with perigee, the moon's closest point to Earth in its monthly orbit.

## 20 FEBRUARY

1835 Charles Darwin, on the H.M.S. Beagle voyage reached Chile, and experienced a powerful earthquake and shortly afterwards saw evidence of several feet of uplift in the region. He repeatedly measured over the next few days and found the land had risen several feet. He had proved that geological changes occur even in our own time.

## 21 FEBRUARY

1893 Thomas Edison receives three US patents on this day, two of which are in essence the first light switches: "Cut Out for Incandescent Electric Lamps" (US Patent 491,992) and "Stop Device." (US Patent 491,993).

## 22 FEBRUARY

1630 Popcorn was introduced to English colonists by an Indian named Quadequina who brought it in deerskin bags as his contribution at their first Thanksgiving dinner. Popcorn is a type of corn with smaller kernels than regular corn, and when heated over a flame, it "pops" into the snack that we know it as today. Native Americans were growing it for more than a thousand years before the arrival of European explorers. In 1964, scientists digging in southern Mexico found a small cob of popcorn discovered to be 7,000 years old. Today, the United States grows nearly all of the world's popcorn.

## 23 FEBRUARY

1854 Under the Bloemfontein Convention, the British relinquished their sovereignty, and the local Boer settlers formed the independent Orange Free State.

## 24 FEBRUARY

1938 DuPont began commercial production of nylon toothbrush bristles for the so-called "Miracle Tuft Toothbrush." Before 1938, the world relied on toothbrush bristles of neck hairs from wild swine from Siberia, Poland and China. When DuPont created nylon, it was the toothbrush which was the first item to benefit. There were many advantages in this new brush including a dramatic reduction in production costs and the ability to control bristle texture. At first, the consumers were not entirely satisfied because the early nylon bristles were very stiff and hurt the gums. By 1950, Du Pont produced softer nylon bristles.

## 25 FEBRUARY

1925 The first bank cheque photographing device patent was issued in the US to its inventor, George McCarthy, who called it the Checkograph.

## 26 FEBRUARY

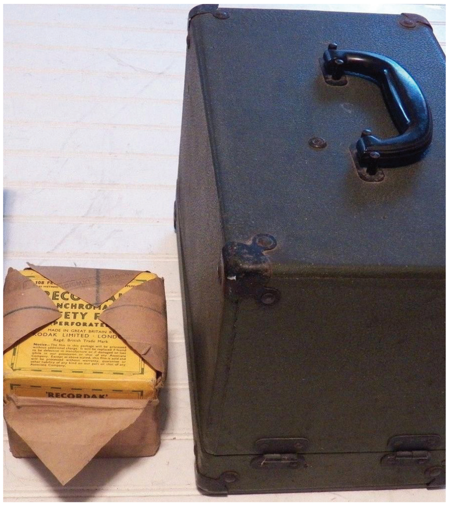
1995 Barings Banks, founded in 1762 and was among the largest and most stable banks in the world, was a British merchant bank that collapsed in 1995 after one of its traders, 28-year-old Nick Leeson operating in its Singapore office, lost $1.3 billion in unauthorised trades.

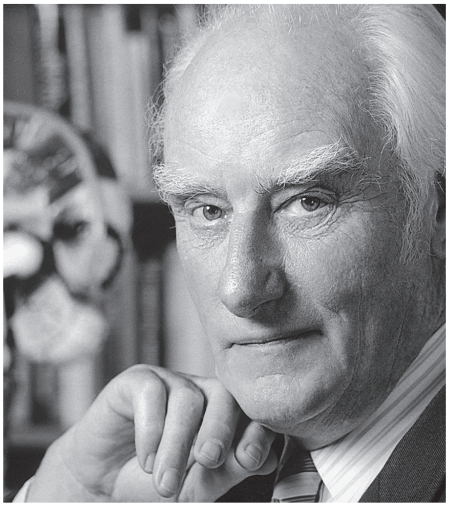
## 27 FEBRUARY

1867 Dr William G. Bonwill of Pennsylvania, USA, invented the dental mallet after having watched a telegraph key sounder operate in a Philadelphia hotel.

## 28 FEBRUARY

1953 Staff of Corpus Christi College, Cambridge, England, were having their lunch in the famous 'Eagle' pub when Francis Crick declared: "We have found the secret of life." The "we" in this declaration was his collaborator and later fellow Nobel prize winner, James Watson, and the "secret" was the double helix structure of DNA.





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